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HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 1.

JULY, 1888.

AMHERST, MASS.
J. E. WILLIAMS, BOOK AND JOB PRINTER.
1888.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds but having no connection with it.

Its officers are :—

HENRY H. GOODELL, . . .	*Director.*
WILLIAM P. BROOKS, . . .	*Agriculturist.*
SAMUEL T. MAYNARD, . . .	*Horticulturist.*
CHARLES H. FERNALD, . . .	*Entomologist.*
CLARENCE D. WARNER, . . .	*Meteorologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be sent to the Director or to any of the officers in charge.

Division of Entomology.

CHARLES H. FERNALD.

The work in this division was commenced in April and a series of experiments and investigations has been undertaken, many of which can not be completed before the end of the season, but reports will be made of them in this Bulletin whenever results are obtained.

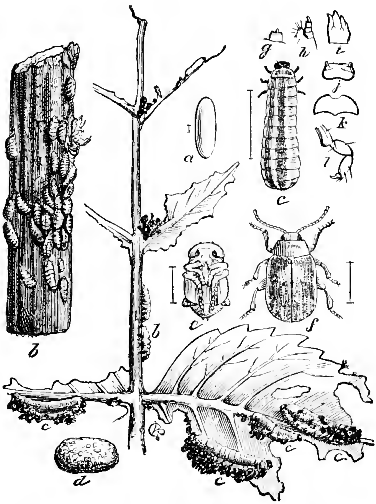
Many inquiries have been made by farmers in different parts of the Commonwealth, concerning insects which have been injuring their crops, and a large amount of time has been consumed in giving answers. The following is published here because of its general interest.

Mr. C. Wasgatt of Lancaster reported that his seed corn was destroyed in the ground before it sprouted, and specimens were sent to me with an insect which he found eating the kernels to such an extent as to prevent their growth. The insect was a small, shining, black beetle, about one-eighth of an inch long, and proved to be the grain Aphodius (*Aphodius granarius*, Linn.)

This insect has long been known in America, having found its way here many years ago from Europe its native country. The different species of *Aphodius*, while in the larva state, feed in stable manure, and if this be used as a fertilizer in the hills these insects will emerge at the very place where they can do great damage. They are also liable to attack the various kinds of seed grain which have been sown on lands where stable manure is used. In this case, however, the loss is not so noticeable, since the destruction of a few kernels of wheat usually provokes only the remark that "it did not come up." But when the manure infested with these beetles is put into hills, and a few kernels of seed only, put into each, they may be able to destroy the whole crop.

REMEDIES.

It is recommended, when these beetles are troublesome, to soak the seed in water for a short time, and then after pouring off the water to stir in with it a mixture composed of one part of Paris Green to twenty parts of flour. The reason why we recommend flour instead of plaster or other substances as a diluent, is that flour is attractive as food for the beetles and they will eat the poisonous mixture more readily. This mixture over the surface of the seed corn will also prove destructive to wire worms and other insects which might attack it. It is said that crows will not disturb corn which has been treated with Paris Green. We would very much like to have farmers who are troubled by crows, try this remedy and report the results to this station.



BLEPHARIDA RHOIS:—*a*, egg; *b*, *b*, egg masses; *c*, *c*, *c*, *c*, *c*, larvæ; *d*, cocoon; *e*, pupa; *f*, beetle; *g*, *h*, *i*, *j*, *k*, mouth parts of larvae; *l*, leg. (After Riley).

THE JUMPING SUMACH BEETLE.

This insect (*Blepharida rhois*, Forst.) has not been reported from New England before, so far as I can learn, but is common in the southern and western states where it is said to do very great injury to the different species of sumach.

In this State they are very destructive to the Smoke-tree or Purple-fringe (*Rhus cotinus*), in fact they completely destroyed one of these shrubs on my grounds, giving me every opportunity to study their habits and experiment on them with insecticides.

The natural history of this species has been admirably presented by Prof. Riley in his Sixth Entomological Report of Missouri, but as that paper is not generally accessible, I give here my own observations, making use, however, of Prof. Riley's admirable illustration.

The perfect beetles appeared on the wing early in May (from the 10th to the 15th of this year), having come out from their places of hibernation. They immediately began to pair on the branches of the Smoke-tree, and soon after each female laid about forty eggs in masses on the sides of twigs, covering them with a dark smoky brown substance which quite concealed them from view, fig. 1, b. The eggs, fig. 1, a, are ellipsoidal in form, about one twenty-fifth of an inch in length and vary in color from white to orange. Some are of a deep orange color over the entire surface, others are white at one end shading into orange at the other; others are pink and still others are cream colored at one end and shading into salmon color at the other.

The eggs hatched in fifteen days, giving rise to larvae of the form shown at c, in fig. 1. These larvae were dull greenish yellow, with jet black heads and legs and the top of the segment following the head, black in the young. There were three longitudinal, broken whitish lines on each side of the body, and the anal proleg was of the general color of the body. The anus is situated on the top of the last segment and the excrements are retained upon the back as shown at c, on the lower leaves in the illustration.

The mature larva is about half an inch long, of a dull greenish yellow color, with jet black head and legs. The anal proleg is of the same color as the body and divided in eight or ten lobes. The stripes are of the same color and in the same position as in the young larva. When done feeding they descend into the ground where they make a cocoon of the form shown in fig. 1, d, in which they transform to pupae, fig. 1, e, and the perfect insects emerge in about two weeks. A second brood occurs later in the season and the beetles hibernate during the winter.

The beetles, fig. 1, f, are about one-fourth of an inch long, oval in outline and convex. The hind thighs are thickened, thus giving the insect the ability to leap when disturbed, though not to so great a distance as the small flea-beetles. The head and thorax are dull yellow, sometimes reddish yellow. The under side of the abdomen and the legs are mahogany red and the wing-covers are variously striped or mottled with mahogany red and yellow. The antennae are black, except at the base where they are pitchy.

REMEDIES.

At first I tried hand-picking but soon found that this would cost more than the shrubs were worth. I then showered them with Paris Green in water in the proportion of half a pound to fifty gallons of water which quickly destroyed all the larvae then on the shrubs. This remedy should be applied when the eggs first hatch, and again when the second brood appears. If rains occur it should be repeated.

THE BUD MOTH.

The Bud Moth (*Tmetocera ocellana*, Fab.) has been very abundant this year, and has done a greater amount of injury than I had formerly supposed it capable of doing. A careful estimate was made with several trees and, as nearly as I could judge, more than half of the flower buds were destroyed by this minute insect; a very undesirable condition of things in the "off year" for apples. The food plants of these insects are apple, pear, plum, and laurel oak.

If the trees had been showered with Paris Green in water at the time the buds began to swell in the spring, and again about ten days later, these bud-moths would undoubtedly have been destroyed, and the apple crop nearly doubled on the trees mentioned above. The same spraying would also have killed the tent caterpillars, canker-worms and any other leaf-eating insects that might have been feeding on them at that time.

Severe criticisms have appeared in the Entomological journals on the kind of work which has been published in some of the Experiment Station bulletins by the entomologists. These criticisms whether just or not, lead us to consider what is the proper work of the entomologist, and how he can make his division most useful to the farmers in his particular state.

Entomologists have already accumulated a vast store of useful knowledge which is now scattered through the publications of various scientific societies and not generally accessible. In many cases these papers are too technical to be of interest except to specialists, but the facts of general interest to farmers and fruit growers can be selected and given in a popular way so as to be easily understood. It seems to me that this is perfectly in accord with the language of the first section of the act establishing these stations,—"to aid in acquiring and diffusing useful and practical information."

The second section of the act makes it clear that original investigations are to be carried on, but in my opinion they should be of such a character that they can be finally reported to the farmers in a tangible and useful form, and all descriptions of species should appear first in some scientific journal if they are to be recognized and take priority.

As a matter of interest to the officers of the stations it may be well to mention the fact that the leading authorities on the different groups of insects have decided to charge for their services when called upon to name insects. It seems only fair that these gentlemen should be paid for such expert services, especially when the value of the bulletins will be in this way so greatly enhanced.

Horticultural Department.

S. T. MAYNARD, B. Sc.

In presenting the first report of experiments made in this department, I wish to call attention to the fact that, owing to the limited time we have been at work, most of our experiments require further time and repetition, under the same and varied conditions, in order to come to positive conclusions. Further reports will be made in future bulletins, and it is hoped that interested fruit-growers, market gardeners, etc. will repeat the experiments as fully as possible that their value may be tested under as many conditions and in as many localities as possible. We would especially invite information from all who have well substantiated facts upon any horticultural subject and also suggestions as to experiments which should be made in the interest of the Horticulture of Massachusetts.

In most of the experiments made in this department the work is largely done by students of the College, thus giving them the habit of close, careful observation and a knowledge of the subjects involved which they could obtain in no other way, and at the same time encouraging and training their powers of observation and investigation which are so much needed in studying the great subjects of plant growth, the diseases and insect foes we have to contend with in all agricultural operations.

PLANT BED CLOTH AS A SUBSTITUTE FOR GLASS.

The growing interest in the use of a cheap substitute for hot-bed glass, has led to the recommendation and introduction of patent waterproof cloth for this purpose.

To determine its value, tests were made upon frames as nearly as possible of the same construction and exposure. The temperature was registered by government standard soil thermometers placed within each bed.

The period of experiment covered quite a range of temperature, although at no time did it go below the freezing point. Careful observations, made later, when the temperature ran lower show the general results to be the same.

The following tables explain themselves.

TABLE NO. 1.

Date.	Weather.	Temperature of Air.				*Bed No. 1.* Thick Cloth Covers.				*Bed No. 2.* Glass.			
		6 A M	10 A M	2 P M	9 P M	6 A M	10 A M	2 P M	9 P M	6 A M	10 A M	2 P M	9 P M
May 4.	Cloudy.	41°	54°	58°	48°	49°	57°	61°	52°	52°	64°	71°	56½°
" 5.	Cloudy, Some rain.	46°	58°	60°	50°	49½°	56½°	66½°	54°	52°	62°	76°	58°
" 6.	Foggy A. M. Clear P. M.	40°	60°	72°	56°	46°	68½°	82°	58°	51°	80½°	87°	64°
" 7.	Pleasant.	46°	58°	63°	46°	47½°	63°	72½	51°	52½°	75°	88½°	56°

TABLE NO. 2.

Date.	Weather.	*Bed No. 4.* Thin Cloth Covers.				*Bed No. 5.* Glass.				*Bed No. 6.* Thick Cloth Cover.			
		6 A M	10 A M	2 P M	9 P M	6 A M	10 A M	2 P M	9 P M	6 A M	10 A M	2 P M	9 P M
May 4.	Cloudy.	47°	57°	59°	49°	48°	64°	71°	56½°	49°	57°	60°	57°
" 5.	Cloudy, Some rain.	48°	59°	65½°	53°	50½°	62½°	77°	57⅓°	50°	57°	65°	54°
" 6.	Foggy A. M. Clear P. M.	46°	75½	86°	56°	50½°	85½°	110°	73°	47½°	72½°	86°	61°
" 7.	Pleasant.	46°	68°	79°	48°	56°	103°	127°	66°	49½°	71°	89°	56°

The temperature is registered by Farenheit thermometer.

TABLE NO. 3.

Date.	Weather.	Temp. of Air.		Temp. of Bed No. 1. *Glass.*		Temp. of Bed No. 2. *Thick Cloth.*	
		6 A.M.	9 P.M.	6 A.M.	9 P.M.	6 A.M.	9 P.M.
May 8.	Pleasant.	38°	48°	60½°	68°	53°	59½°
" 9.	Rainy A. M. Pleasant P.M.	46°	61°	63°	78°	56°	66°
" 10.	Rainy A. M. Cloudy P. M.	56°	60°	69°	75°	62½°	67°
" 11.	Cloudy A. M.	58°		68½°		63°	

The sashes remained on during the day, and were equally covered at night with mats and shutters.

CONCLUSION.

The conclusions reached in the above experiments are :—

1st. That the glass gives the greatest amount of protection from cold.

2d. That the heat accumulates most rapidly under glass when the sun shines, and is best prevented from escaping from the heating material in the bed at night.

3d. That there is less danger of injury from sun-burning, and of a too great accumulation of heat with the cloth than with glass, and consequently less care is needed in using beds covered with this material during the day. At night, however, more protection is needed to keep out the cold.

In our experience the cloth sash is especially valuable for beds of recently transplanted plants, as the light is less intense and the evaporation less than with glass.

The cloth frame may be made at a cost of about one-sixth that of glass.

The details of this experiment were carried out by Mr. W. M. Shepardson, '88.

PROTECTION OF PEACH BUDS FROM INJURY BY COLD.

For the past five years no peach crop has been grown upon the College farm. Last year a few buds survived the winter, and gave us a few specimens of fruit. This spring a few buds only opened, but perhaps rather more than last season.

During the winter of 1887 the temperature reached 16 below 0° once or twice, Last winter (1888) it ranged from 28° below 0° on the low lands to 16° below 0° on higher lands at three separate times.

With this failure of the crop for so many successive seasons, peach growing has been a very discouraging business and some sure, cheap, and easily applied protection for the fruit buds has become a positive necessity if peach growing is to be a successful industry in New England.

To overcome this difficulty the following experiments have been made during the past few years.

EXPERIMENT NO. 1.

1st. In the fall of 1886 trees were laid down upon the ground and covered with soil,* by first loosening the roots on one side and carefully bending those on the other.

2d. The branches were drawn together and tied, 1st without covering, 2d with a covering of pine boughs, 3d with a covering of strong matting. The drawing of the branches together on young trees is easily accomplished by two men standing close to the trees on opposite sides and clasping hands around them and drawing them in with a strong steady pressure. Very large trees could not be very easily drawn close enough to cover except at a great expense.

Result.

No satisfactory results were obtained from Experiment No. 1, a few scattering buds only being found on those unprotected as well as those covered.

Covering trees bent over on the ground except with soil was not tried on account of the danger of injury from mice, although in one or two experiments made several years ago favorable results were obtained by covering with cornstalks.

A covering of pine boughs is suggested as the least liable to attract mice.

EXPERIMENT NO. 2.

Following the suggestion that the peach buds might be injured by the drying out of the moisture during the fall and winter, the following materials were applied to the branches early in December of 1887. Two trees were syringed with

1st. A thin solution of glue.
2d. Turpentine.
3d. Turpentine and benzine.
4th. Benzine and rosen.
4th. 1 " and hard oil finish.
5th. Linseed oil and turpentine.

*The wood was not well matured and many of the branches heated. The branches not thus injured showed more uninjured buds than those protected in any other way.

Result.

All the trees except those treated with glue, linseed oil and turpentine were killed. The trees treated with linseed oil and turpentine were badly injured, but are now making a good growth. The tree treated with glue was wholly uninjured, but showed no more fruit buds than those unprotected.

EXPERIMENT NO. 3.

To still further extend the last experiment, a single tree which had a large number of fruit buds upon it was selected. Three branches of as nearly the same condition as possible were selected, and treated with each of the following materials applied with a brush.

1st. Linseed oil.
2d. Linseed oil and turpentine.
3d. Linseed oil and benzine.
4th. Benzine and rosin.
5th. Shellac.
6th. Glue.

Result.

Upon examination in March it was found that the buds covered with linseed oil, shellac and glue were apparently uninjured, but as the season advanced it was found that the turpentine and benzine had been applied to branches near the trunk and had spread over it so much as to kill it, consequently those buds which seemed uninjured failed to start.

EXPERIMENT NO. 4.

Four trees of the same kind were selected and covered with straw matting. After the mat was bound about the tree, dry sawdust was poured in at the top of one, moist sawdust into another, and coal ashes into another, and the fourth contained nothing. After tying up the ends of the mats, the whole was supported by two strong stakes.

Result.

The trees covered and protected with dry sawdust show more uninjured fruit buds than those covered in other ways or unprotected.

The trees protected with wet sawdust and ashes showed no more uninjured fruit buds than the same kinds unprotected.

This experiment was carried out in detail by Mr. L. F. Kinney of the Class of '88.

Conclusion.

Very little satisfactory information has been obtained by the above experiments, but the following facts are as fully demonstrated as is possible by one series of experiments.

1st. That turpentine and benzine will destroy peach trees when applied to branches or trunk.

2d. That the fruit buds are not protected by the ordinary light covering of mats, pine boughs, etc.

3d. That the glue solution as applied is of no value in protecting the buds.

The system of covering trees by binding over must be more fully worked out as to detail, to demonstrate its practicability and economy.

Further experiments are required to demonstrate the value of linseed oil and shellac.

GIRDLING APPLE TREES TO PRODUCE FRUITFULNESS.

In many sections where the soil is moist and rich, fruit trees grow largely to wood and foliage, and fail to produce fruit until they reach considerable age and size.

To discover some means of hastening the fruiting of such trees the following experiments have been made.

A row of crab apple trees of about the same size and condition of growth were selected and treated as follows.

EXPERIMENT NO 1.

1st. Three trees were girdled by cutting out a ring of bark 1-8, 1-4 and 1-2 inch wide *at the ground*, July 12th, 21st and 29th.

2d. Three trees were girdled just below the main branches with the three widths of girdle as in 1st, July 12th, 21st and 29th.

3d. The same as above was made on one or more main branches with the three widths of girdle, July 12th, 21st and29th.

Result.

1st. All the girdles made near the ground healed over readily and completely.

2d. Those on the main trunk healed less completely, but sufficiently to ensure a good growth of tree and the covering of the injured part in another year.

3d. The girdles made in the branches healed less completely than the last, and in two instances the new growth failed to meet and consequently the branch died soon after starting growth in the spring.

4th. All showed a marked increase in fruitfulness over those not girdled.

5th. Little difference was observed in the effect of the girdling made at different times or in the various widths of the ring of bark taken out.

Conclusion.

No definite conclusion can be made at this time as to the effect of this treatment upon the permanent health of the tree. Observations for many years alone can determine the point.

Reasoning from analogy and from the known laws of plant growth we can only advise this treatment upon trees that are planted too closely and a part of which must be removed after a time to allow the full development of others, or those in very rich moist soil which are long coming into bearing.

GIRDLING THE GRAPE VINE TO HASTEN RIPENING OF THE FRUIT.

Cutting rings of bark from the canes of the grape vine to hasten the time of ripening has been practiced more or less for many years to prepare large specimens for exhibition, but only for the few years past has it been practiced to hasten the crop for market.

In a series of experiments made in the college vineyard in 1877 and 1878, and recorded in the Report of the Board of Agriculture of Mass. for 1878 and 1879, it was found that removing a ring of bark early in July, 1-4 of an inch wide, resulted in hastening the time of ripening from one to two weeks.

It was also concluded from very careful tests made at the time that the increased size and early maturity *was not at the expense of the quality*, and that as far as could be determined at that time, and which further observations have confirmed, that the vines are not materially injured by the girdling.

Girdling has been practised in the college vineyard more or less every year since with favorable results; the canes that are to be cut away at the fall pruning only have been girdled, to avoid any possibility of injury to vine or root from stopping the downward flow of sap by the girdle.

Some seasons the results of this practice have been more marked than in others, but generally the increased price obtained for the early fruit has much more than paid expenses of the work, and in seasons of early frost, to which many sections of New England are liable, it has made the difference between total failure and fair profit.

To save expense in the work, for the past two years the girdling has been done by twisting a wire very firmly about the canes the last of June above the point where the cane is to be cut away at the fall pruning.

About No. 20 wire has been found best, and results obtained have been more satisfactory when the wires were put on the last of June or early in July and twisted very firmly about the cane.

Conclusion.

While we have no proof that the vines are in any way injured (notwithstanding that we have made very careful observations for many years), we would not advise girdling the entire vine, but would treat only those canes to be cut away at the fall pruning, and would leave about one-half of the vine to grow to a natural condition.

PROTECTING TREES FROM MICE.

During the winter of 1886 and 1887 thousands of fruit and ornamental trees were destroyed by mice in Massachusetts; all of the ordinary precautions taken to prevent this injury having failed.

To discover some sure and cheap remedy for this condition of things, the following experiments have been made during the past two years.

EXPERIMENT NO. 1.

In March, 1887 a row of Transcendent crab apple trees were painted with linseed oil and Paris green and a mixture of linseed oil, turpentine and Paris Green as follows.

1st. The trunk was painted 15 inches from the ground.

2d. Trunk painted to main branches.

3d. Trunk and main branches painted.

4th. Trunk, main branches and some of the lateral branches were painted.

Result.

Trees have shown no signs of injury from the paint which still adheres to the bark.

EXPERIMENT NO. 2.

Having fears of the danger of using Paris green and oil upon young trees, in November of 1887 trees of all kinds were painted with lime wash, glue and Paris green (1-2 lb. glue dissolved in hot water and mixed with 10 qts. of lime wash and 1 table-spoonful of Paris green). This was applied to many hundred trees.

Result.

This mixture adhered well to the trees until after several rain storms and some frost, when it scaled off rapidly so that before winter was over it was entirely washed off. Upon trees so treated very few were girdled although the deep snow has been favorable for the working of mice.

EXPERIMENT NO. 3.

To secure some paint that will not injure delicate trees, the following mixtures were applied in April, 1888.

Series No. 1.

Lime wash of the consistency of common paint.
" " 10 parts and gas tar 1 part.
" " 10 parts and asphaltum 1 part.
" " 10 parts and Morrill's tree ink 1 part.
" " and skimmed milk equal parts.
" " skimmed milk (equal parts) and gas tar.
" " " " (" ") and asphaltum.
" " " " (" ") and Morrill's tree ink.

Series No. 2.

Portland cement, of the consistency of common paint.
" " 10 parts, gas tar 1 part
" " 10 parts, asphaltum 1 part.
" " 10 parts, Morrill's tree ink 1 part.
" " and skimmed milk equal parts.
" " " " " " " and gas tar 1 part.
" " " " " " " and asphaltum 1 part.
" " " " " " " and Morrill's tree ink 1 part.

The above was applied with a common paint brush.

Results.

Although these have been upon the trees over two months, most of them still adhere well. The skimmed milk was found to add but little to their adhesiveness.

None of trees treated show any indications of injury from the

The details of this experiment were carried out by Mr. E. P. Felt of the Freshman class.

paint; in fact, from the simple nature of the materials we do not believe it possible that any injury can result.

Conclusion.

By the addition of Paris green to such compositions as the above, provided they prove upon further trial to be harmless to the trees, we feel certain some of them will prove an effectual preventive against depredations by mice, and will be free from danger except when poultry or small animals may be allowed to remain in the orchard.

Further reports will be made upon this subject before the close of the season, so that anything discovered in this line may be made use of or thoroughly tested the coming winter.

Department of Meteorology.

C. D. WARNER.

It seems necessary to give only a brief outline of the work to be done in this department.

We shall so far as possible keep a complete record of all meteorological phenomena. For agricultural, legal and other purposes, such a record is of vital importance.

It is intended to note very carefully the direction, velocity and force of the wind; the quantity of rain-fall and depth of snow; the pressure, temperature, the amount of moisture, and quantity of ozone in the atmosphere; to ascertain the quantity of sunlight and amount of solar radiation.

There will be a record of all electrical phenomena; the quantity of electricity in the atmosphere; magnetic disturbances and the general appearance of the heavens.

Daily, weekly and monthly records will be kept, and these records will be bound and placed among the archives of the Station for future reference.

So far as possible, self-registering instruments will be employed in making observations.

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BULLETIN NO. 2.

OCTOBER, 1888.

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The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be sent to the Director or to any of the officers in charge.

Division of Entomology.

C. H. FERNALD.

THE GRAPE-VINE LEAF-HOPPERS.

These insects belong to the order Hemiptera or true bugs, and to the suborder Homoptera. They are of small size, averaging only about one-tenth of an inch in length, and are exceedingly variable. They were first mentioned by Harris in his article "Locust" in the Encyclopædia Americana, published in 1831, where he gave the name of *Tettigonia vitis* to one of the species. He also refers to it in his "Insects Injurious to Vegetation," and states that it does much damage to the grape leaves in this country.

In 1856 Dr. Fitch, in his "Third Report on the Noxious Insects" in New York, described three species and established for them the genus *Erythroneura*. His species are *vulnerata*, *tricincta* and *vitifex*. Say had previously described a species under the name *Tettigonia basilaris* which has been found on the leaves of the grape at this place. All these species have been referred to the genus *Erythroneura* by Prof. Uhler, our highest authority on the Hemiptera, but it is more than probable that some of them are only varieties of others. Vine growers generally call them thrips, vine-hoppers, leaf-hoppers, etc. They all have similar habits, and the same remedies may be used for each.

These insects are believed to pass the winter in the perfect or adult stage, under bark or leaves, and in the spring deposit their eggs on the under surface of the tender leaves. These eggs hatch in June, and the young larvæ, which resemble the adult except in size and in having no wings, suck the juices from the leaves, generally remaining on the underside. During their growth they molt their skins several times, and these may often be seen on the leaves. After a time the larvæ transform to pupæ with the rudiments of wings, and finally when they reach maturity the wings appear fully developed.

They are now able to fly from vine to vine or even from one vineyard to another. Late in October they seek a shelter for the winter, where they hibernate till the following spring. Leaf-hoppers are very active in their movements, and hop from one leaf to another or run sideways, often passing quickly from one side of a leaf to the other for protection when disturbed.

NATURE OF THEIR ATTACKS.

Leaf-hoppers do not consume the substance of the leaves, but, forcing their tube-like mouth-parts through the epidermis or skin, suck the sap from the interior. The leaves first indicate the presence of these insects by becoming yellowish or brownish in small spots where the sap has been exhausted. As the insects increase in size and take more sap, these spots grow larger and the whole leaf appears as though scorched, turning brown and even falling off in cases where the hoppers are very abundant. The result is that as the leaves are injured, the growth of the stems is checked, the fruit is stunted or fails to ripen, and if the ravages of these insects are not prevented, the vines become entirely ruined in a few years.

Some varieties of grapes are especially liable to suffer from the leaf-hoppers, as the Delaware, Clinton, and in general all varieties having thin leaves. The abundance of these insects from year to year seems to depend in a large degree upon the severity of the winter and their ability to obtain protected places for shelter.

REMEDIES.

The remedies should vary according to the location of the vines. If they are in graperies, smoking them with tobacco, taking care to prevent the escape of the smoke, has been tried with good results. Similar treatment with Persian Insect Powder poured upon burning coals carried under the vines is also successful. Syringing with strong tobacco-water or soapsuds, dusting with lime, sulphur and lime, hellebore and cayenne pepper have all been recommended but have not yet been tested at this station.

In vineyards, the treatment is more dificult as the adult insects can fly away, and thus avoid the fumes of tobacco or insect powder. If fumigating be attempted in the field, it should be done several times at intervals of a day or two, and before the hoppers develop their wings, that is, in this state the last of July or the first of August. It is always desirable to destroy these insects early, before they are large enough to greatly affect the vines, and before the energy of the plant that should be devoted to ripening its fruit, is required to repair the damages inflicted on its leaves.

If fumigation in the field be tried, its success will be much increased by using a small canvas tent which can be let down over the vines and kept there for a litttle time to retain the smoke, though entirely satisfactory results will hardly be obtained in this way. Another method of some value is to carry lighted torches through the vineyard at night, beating the vines lightly at the same time. The insects will be attracted to the light as they fly from the disturbed vines and perish in the flames. It is well, also, to remove all rubbish from near the vines, and frequently rake the ground late in the fall and early in the spring, to expose the hibernating insects to the frosts.

About the middle of August the attention of this Division was called by Hon. J. H. Demond, of Northampton, to the condition of the grape vines in his grapery. A special agent, sent to examine them, reported that the leaves were badly discolored, and that leaf-hoppers were present in large numbers. The remedy used in this case was that of fumigating with pyrethrum. The grapery was tightly closed and the powder scattered on burning coals carried under the vines. The treatment was entirely successful, all the insects being destroyed. A similar experiment tried on a vine in the open air in Amherst gave much less satisfactory results.

The Glassy-winged Soldier-bug (*Hyaliodes vitripennis* Say) devours many of these pests, and is their only insect enemy so far as known. It belongs to the Heteroptera, the other group of the true bugs, and is rather larger than the leaf-hopper, and when mature is pale green with a pinkish head and thorax, and the wings are transparent with a pink cross band. This insect should not be destroyed.

ANTS.

Small ant hills in smooth lawns, and in the cracks or along the edges of walks, much injure the otherwise neat appearance of the grounds about our houses. During the past year many inquiries how to drive away the industrious nuisances have been made, and a number of experiments have been conducted, to discover a remedy.

In Bulletin No. 11, of the Division of Entomology of the Department of Agriculture is a report of experiments made in Indiana for the same purpose. These experiments were: 1. Carbolic Acid and Water; 2. Copperas Water; 3. Ammonia Water; 4. Tar Water. The last three proving ineffectual were not tried here, but the Carbolic Acid was reported as being quite successful and so was repeated at this Station this summer.

EXPERIMENT I. CARBOLIC ACID.

One part of Carbolic Acid to sixty-four parts of water. About three table-spoonfuls were applied to each hole.

Result.—One day later no ants could be found and the hills showed no signs of fresh work. The following day, however, fresh dirt was present around the holes, and ants were seen at work.

The grass near was killed by the solution.

EXPERIMENT II. CARBOLIC ACID.

One part of Carbolic Acid to thirty-nine parts of water. About three table-spoonfuls were applied to each hole.

Result.—This stronger solution seemed to have even less effect than the solution tried in Experiment I. The grass was killed as in the other case.

Why these experiments, which were a success in Indiana, should fail here I cannot say. The injury done the grass, however, would render this an undesirable remedy even if successful so far as removing the ants is concerned.

EXPERIMENT III. KEROSENE.

The kerosene was poured on in sufficient quantity to moisten the entire hill.

Result.—The nests were deserted and the ants either destroyed or driven away.

The grass around was killed, however, which makes this an undesirable remedy also.

BISULPHIDE OF CARBON.

This disagreeably smelling chemical may be obtained of any druggist at about fifty cents a pound. The bottle in which it is contained should be kept tightly stoppered, as it loses its strength if exposed long to the air. When used, care should be taken to avoid breathing the fumes, not only because these are disagreeable but also because when breathed for some time the health is affected. It should also be kept away from fire as it burns at 107° Far.

EXPERIMENT IV. BISULPHIDE OF CARBON.

Eight or ten drops poured on the top of the hill.

Result.—The ants seemed greatly disturbed, but after a time returned to their work and were apparently unaffected.

The grass around was not killed.

EXPERIMENT V. BISULPHIDE OF CARBON.

About twenty-five drops poured on top of the hill.

Result.—Same as in experiment IV.

EXPERIMENT VI. BISULPHIDE OF CARBON.

An ant hill nearly six feet square, next to the underpinning of a house, was doing much damage. The ground was so thoroughly mined that a person walking over it would sink in quite deeply, the grass on the hill was nearly dead. With a small stick, holes about six inches deep, were made about fifteen inches apart, over the hill, and two or three teaspoonfuls of the Bisulphide poured into each hole, after which all the holes were closed up and the earth pressed down by stepping on them.

Result.—No ants have since appeared there, no fresh earth has been brought to the surface, and the whole place has formed a good turf.

It is probable that the method of treatment in this case is the explanation of its success and of the non-success of experiments IV. and V. Further trials are needed, however, to obtain any final results, and for that reason this should be considered as a partial report, only.

ALUM NOT DESTRUCTIVE TO CURRANT WORMS.

The statement was quite widely circulated in the agricultural papers during the early part of the summer, that alum in solution in water would destroy the currant worm (*Nematus ribesii* Scop.)

To settle the question beyond the shadow of a doubt, a plant with currant worms upon it was placed in a breeding cage and showered with a weak solution of alum from an atomizer such as is used by physicians. The worms showed a little disquiet when the spray was falling on them, and threw the posterior end of their bodies back and forth a few times, and then went on feeding as though nothing had happened. In a few days they were treated again with a stronger solution but with like results. Finally a saturated solution of alum was made and showered over them and the leaves of the currant, but they in no case fell from the leaves, and appeared no more disturbed than when clear water was thrown upon them from the atomizer.

After this the worms under observation were not disturbed, but continued feeding quite as if nothing had happened, and passed their transformations in quite as healthy a condition as those which were not treated.

From these experiments we must conclude that alum as an insecticide for the currant worm is a perfect failure. It is possible that some one who tried showering currant worms with alum water, did it just before they were done feeding, and when they went down into the ground, he supposed his application had destroyed them, and at once reported his supposed success in the papers.

POISONOUS DOSES OF INSECTICIDES.

We have frequently been requested to give information as to the quantities of poisonous insecticides in general use, that would prove fatal or dangerous to man and our domestic animals. It is impossible to be very exact in this matter as Toxicologists differ in their opinions as to the quantities required to prove fatal. This is undoubtedly due to the fact that some persons are not as susceptible to the action of certain poisons as others, and amounts that would prove fatal in some cases might not prove seriously injurious in others.

ARSENIC.

Arsenious acid or white oxide of arsenic, known in common language as arsenic, is not very much used as an insecticide, but some of its compounds are the most useful insecticides now known. The following table of approximately fatal doses may prove useful, and serve as a basis for calculations on its compounds.

From one to two grains will probably prove fatal to an adult person.

About one-half as much will probably prove fatal to a person fourteen years old.

About one-third as much will probably prove fatal to a person seven years old.

About one-fifth as much will probably prove fatal to a person four years old.

About one-sixth as much will probably prove fatal to a person three years old.

About one-eighth as much will probably prove fatal to a person two years old.

About one-tenth as much will probably prove fatal to a person one year old or under.

Blyth in his "Poisons, their Effects and Detection" states that the following doses of arsenic may be considered as dangerous: two grains for an adult, thirty grains for a horse, ten grains for a cow, one-half of a grain to one grain for a dog.

There are numerous cases on record of recovery after enormous doses. In nearly all these cases, however, two conditions are recorded: first, that the poison was taken after a full meal, and secondly, that very early and free vomiting occurred. This, indeed, is doubtless the explanation of many cases which otherwise appear inexplicable.

TREATMENT FOR ARSENICAL POISONING.

Never neglect treatment because the case seems hopeless. As a rule vomiting sets in spontaneously, and, if the poison has been taken on a full stomach, the whole of it may be gotten rid of. If, however, the poison be taken on an empty stomach, it sticks to the walls and sets up an intense inflamation.

It should be the endeavor first to get rid of the poison, and to this end, Woodman and Tidy, in their work on Forensic Medicine and Toxicology, advise the administering of hot milk and water, and "emetics of sulphate of zinc or mustard; at the same time the throat should be tickled with a feather, but in no case should antimony be given. After free vomiting, give milk and eggs. Sugar and magnesia in milk is a good mixture, an insoluble compound with arsenious acid being in this way formed." Whatever active measures are taken in case of poisoning, one should not neglect to call a physician as early as possible.

PARIS GREEN.

Arsenite of Copper, generally containing an excess of arsenic. It varies somewhat in composition, hence, no absolute percentage table can be given, but there is generally over 50 per cent. of arsenic in that which has not been adulterated. The commercial Paris Green is undoubtedly more or less adulterated, and that sold in the market for the destruction of insects probably never contains more than 50 per cent. of arsenic, and may contain no more than 30 per cent. If the average is between these percentages, a fatal dose would be from two to three times as much as of arsenic, and the table given under that poison can be changed so that it will apply to Paris Green.

The antidotes for Paris Green are given on the packages sold in this state, or that given for arsenic may be used.

LONDON PURPLE.

This substance is one of the waste products obtained in the manufacture of aniline dyes, and, according to an analysis made by Prof. Collier, contains about 43 per cent. of arsenic. If unadulterated, a fatal dose would be about the same as that of the commercial Paris Green. It does not appear to be so generally used as an insecticide in Massachusetts as Paris Green, for which I cannot find any good reason, unless the farmers first got accustomed to the use of Paris Green and are slow to change; or else because London Purple is sold in bulk, while Paris Green is put up in more convenient packages.

HELLEBORE.

White Hellebore (*Veratrum album*) is in general use for the destruction of the currant worm (*Nematus Ribesii*), and is the most poisonous of all the species of Hellebore. Blyth, in his work previously referred to, states that a dose of "20 grains of powdered root has caused death, and, on the other hand, ten times that quantity has been taken with impunity, so that at present, it is quite an open question just how much may prove fatal." It is probable that the powdered root loses its active principle with age, and becomes not only less poisonous, but also less valuable as an insecticide.

Division of Horticulture.

S. T. MAYNARD.

Report on new and standard varieties of fruit.

As each season passes, more positive knowledge as to the value of the old and new varieties is brought out. Old varieties often develope some quality either good or bad, not before known, which affect their value for market or other purposes: diseases or weaknesses become more marked, or valuable qualities become more noticeable, or the consumer learns more of those qualities and greater demand is created.

For these reasons, in making this report of the past season's experience in the college orchards and fruit plantations, we shall not only sum up the merits of new varieties, but also note any change in the standing of the older varieties.

This summary will be based principally upon observations taken on our own grounds, but we may also note the standing of varieties in other sections of the state.

THE APPLE.

The crop in this state will probably prove one of the largest recorded. The fruit is large and fair generally, but less free from codling moths than for several years. Should the crop in other sections prove as small as reported, good prices will prevail, if the growers will not allow themselves to be frightened into putting their fruit upon the market too rapidly. To obtain the best prices more care must be given to sorting and packing of the fruit than is usually given.

VARIETIES.

Yellow Transparent. This is one of the best Russian varieties yet introduced. In time of ripening it is in advance of the Early Harvest or Red Astrachan. Its color is against it as a profitable market apple, even should it prove as vigorous and productive as the latter varieties. Tree only moderately vigorous. It is a very promising variety, but further trial must be made to establish its value.

Early Harvest. The fault of this variety of producing few perfect specimens in many localities, especially under the "no care" system by which a great many of our orchards are managed, has increased so largely in this state as to seriously injure its value. Its color and tender flesh are so objectionable that it can no longer be recommended as a market fruit except in favored localities. The only way any profit can be expected from it is to pick it several weeks before the larger and better varieties like the Astrachan are colored enough to market.

Red Astrachan. This variety, which has always been profitable, is growing in favor as a cooking apple. It reaches large size early in the season, and by picking the largest and most colored specimens very early good prices may be obtained.

Oldenburg. This variety on account of its vigor of growth, productiveness and good qualities for both cooking and the table is gaining in favor with both grower and consumer.

Early Williams. For table use this is by far the best and most profitable variety grown in Massachusetts. The best results can only be obtained from trees in vigorous condition, in full exposure to sun and wind to cause early coloring of the fruit.

Porter. This once popular and profitable apple seems to be losing much of its vigor of growth, and many trees are dying, Unless grown on vigorous trees, the fruit is so small as to be almost unsalable in many markets.

Gravenstein. Notwithstanding the many new varieties introduced and the numerous valuable older varieties so abundant, this still holds its own, and even is gaining in popularity in almost every market. It has scarcely a fault, and is perhaps the most profitable variety to grow.

Fall Pippin. The vigor and hardiness of the tree, together with the large size and good quality of the fruit, make it an apple that should be more generally grown.

Haas. This has fruited heavily and regularly for several years, and although it ripens at the same time as many very valuable varieties, its handsome color, good quality, and great productiveness will probably make it a profitable variety.

Red Bertigheimer. The largest and most showy apple of its season. It is of a good quality, tree vigorous and said to be productive, although, on the college grounds, the young trees have borne only a few specimens. It is so large and heavy that, if planted on high and exposed land, much loss often occurs from heavy winds. It is colored early and, although not mature, may be put upon the market between the first and middle of August. Unless it developes some failing not at present known, it will prove a valuable market apple.

WINTER.

Baldwin, R. I. Greening and Hubbardston retain their place of supremacy as the best varieties well known in the market for both home use and shipping. It was generally reported during the past winter that, for some unknown cause, the second variety kept better than the Baldwin.

King. In sections where the soil is heavy and rich, this apple proves valuable, but does not generally yield the quantity obtained from the above mentioned three varieties.

Fameuse. This beautiful apple has failed in many localities to fulfill the expectations of its growers. Unless the soil and location are very favorable, it is very irregular and imperfect. It also has the fault of being attacked by the apple maggot which renders the fruit useless.

Roxbury Russett. On heavy, rich soil it has done admirably for the past few years, but shows the effect of neglect more than many other varieties.

N. Spy. Generally not profitable in New England.

Red Russett. This variety is gaining favor where known on account of its vigor, productiveness, beauty and long keeping qualities. The tree is as vigorous as the Baldwin, the fruit nearly as large and keeps about as long as the Roxbury Russett.

Fallawater. Large, showy, of good keeping qualities, mild subacid flavor and very productive. The skin is tough and less injured in shipping than almost any green or yellow apple. For table use it will be valuable, but is not quite acid enough for cooking.

Sutton Beauty. This valuable apple has been a long time in making its good qualities known. Its principal fault is its medium size, but its many good qualities of flavor, beauty and productiveness are being recognized. With so popular a variety as the Baldwin occupying the field, it will be only by persistent effort on the part of those who appreciate its merits that it will be largely planted.

Pewaukee. A seedling of Oldenburg which possesses the great vigor and productiveness of that variety. The fruit is of good size, striped and splashed with red and covered with a deep bloom. It is a late keeper, of fair quality and may prove valuable as a market fruit. It has borne heavily annually on young trees in the college orchard.

PEARS.

The pear crop in the experiment orchard has been so light, and so few varieties have fruited, that little extended observation could be made. The varieties bearing the most fruit are the Bartlett, Anjou, Lawrence, Belle Lucrative and Louise Bon; although none of these have produced a full crop, the Anjou and Bartlett throughout the country are producing more fruit than any other varieties.

Kieffer. This has failed to make the rapid growth credited to it in more southern localities, in the orchard, but in the nursery the growth has been very good.

Le Conte. Notwithstanding the claim that the Le Conte and other Japanese pears are not subject to the attack of the blight, this and a seedling Sand pear were destroyed by blight the past season.

Lawson. A tree of this variety having been planted beside a variety from Kentucky known as the Early Harvest, it is shown that the two are very much alike in foliage. The Early Harvest has fruited with us and answers the description of that of the Lawson, but it is worthless for any purpose. The table on page 17 shows the condition of the atmosphere and amount of leaf blight noticed during the months of July and August.

PEACHES.

Owing to the destruction of the fruit buds by the cold during the winter of '87 and '88, little or no fruit has been produced this season. The trees are making a fine growth and are generally free from disease. A few trees standing partly in turf with strips of cultivated land between the rows, however, have died, while those where all the land has been cultivated, and where they stand wholly in turf have escaped.

The early varieties like Amsden, Alexander, Waterloo and Schumaker have rotted so badly, except in warm, airy places, as to be almost worthless. While these and other *very early* white fleshed varieties are more hardy than those of the Crawford and Old Mixon type, this defect of rotting is so serious that, unless some remedy is found, it will not be profitable to plant such early varieties. It is hoped that another season experiments may be made to test some of the well known agents destructive to such fungus growth as cause this rotting.

The following varieties are growing upon the grounds, but few of them have fruited this year. Our data is therefore so small, owing to the limited fruiting, that we simply give a list of varieties growing in the orchard without attempting to decide upon their comparative value for this locality.

Amsden, Alexander, Waterloo, Schumaker, Mt. Rose, Old Mixon, Stump, Mrs. Brett, Sally Worrel, Arkansas Traveler, Conklin, Red Cheek, Coolidge Favorite, Morris White, Holland (local seedling), Wager, Wheatland, Reeves Favorite, Smock, E. Crawford, L. Crawford, Foster.

PLUMS.

The plum crop has been small in the college orchard and many varieties have rotted badly on the tree before fully ripe. Owing to the cool weather, the quality has not been up to the average of former years.

The curculio has been more than usually abundant, but notwithstanding that nothing has been done to destroy it, those trees that blossomed and set fruit produced a moderate crop. The black wart upon the branches seems the most serious obstacle to the growth of the plum. We are making experiments with suggested remedies for this disease and hope, another season, to report something of value in this line. In the mean time, every grower should cut away all warts as soon as they break through the bark and burn them, for, with every wart destroyed early in the season, millions of spores may be prevented which, under favorable conditions, would produce warts upon other branches. Vigorous growth obtained by good cultivation will, in a measure, prevent the attack of this disease. The following is a list of varieties growing upon our grounds. The old varieties are growing in the college orchard and the newer kinds in the Experiment plot.

Lombard, Washington, Wild Goose, Yellow Egg, Imperial Gage, Green Gage, Coe's Golden, Smith Orleans, Bradshaw, McLaughlen, Jefferson, Gen. Hand, Reine Claude de Bary, Prince Englebert, Pond's Seedling, Victoria, Grand Duke, Niagara, Peach, Ogden or Ogan, Kelsey, Mariana, Quackenbos, Duanes, Lawrence, Simooni.

CHERRIES.

Owing to the increase of insect enemies and the ravages of birds but little success has attended the cultivation of this fruit in New England. Unless a large number of trees are grown, the birds get all of the fruit, and should any escape, the larvae of the plum curculio is so abundant as to render them almost worthless. The question, how to prevent the ravages of birds is a serious one, yet, considering the great benefit such birds as the robin, catbird, etc., render in destroying noxious insects, we shall take the ground that they do more good than harm and urge the planting of more trees that they may have a due share of the fruit and leave some for the grower.

The prevention of insect injuries is a more serious problem. The remedies, applied for the destruction of the curculio on the plum, of jarring of the trees or of planting in poultry yards, cannot be depended upon. It is possible, however, that the use of Paris green or London purple while the fruit is still quite small may be effectual, although from the nature of the condition we are unable to see how. Experiments made at the Ohio Experiment Station seem to indicate favorable results, and it is to be hoped that so simple and cheap a remedy may be found successful. Another season this matter will be fully tested on our grounds. The varieties growing in our orchard are: Yellow Spanish, Gov. Wood, Black Tartarian, Early Purple, Royal Duke, May Duke, Early Richmond, Belle Magnifique, Downer's Cleveland, Tradescants, Black Heart, Downer, Reine Hortense, Napoleon, Rockland, Bigarreau, Montmorency Ordinaire.

GRAPES.

Owing to the unusually cool summer the grape crop has been very backward in ripening, and in many localities was cut off entirely by the early frosts. Where it has escaped however the warm, moist weather following the frost has caused the crop to mature in a fairly good condition.

Very little mildew has appeared, and only a few cases of serious rotting of the fruit have been reported.

In order to make a careful study of these two diseases a series of weather observations have been made, taken in the centre of the vineyard. By this means we hope to become thoroughly familiar with all the conditions under which they become destructive. It is proposed the next season to make a thorough test of the numerous remedies recommended in this country and Europe for the destruction of these most serious obstacles to grape growing in America.

The following table shows the condition of the atmosphere during the two most critical months, together with the amount of mildew noticed upon the foliage or fruit.

July.	9 A.M. Dry Bulb.	9 A.M. Wet Bulb.	9 A.M. Dew Point.	9 A.M. Relative Humidity.	9 A.M. Barometer.	9 A.M. Weather.	3 P.M. Dry Bulb.	3 P.M. Wet Bulb.	3 P.M. Dew Point.	3 P.M. Relative Humidity.	3 P.M. Barometer.	3 P.M. Weather.	9 P.M. Dry Bulb.	9 P.M. Wet Bulb.	9 P.M. Dew Point.	9 P.M. Relative Humidity.	9 P.M. Barometer.	9 P.M. Weather.	Maximum Temperature	Minimum Temperature	Per Cent. Grape leaves mildewed.	Per Cent. Pear leaves blighted.
7	78	76	75	.90	29.5	Fair.	85	82	81	.88	29.35	Fair.	68.5	66.5	65.5	.90	29.35	Fair.	97	62	0	0
8	70	66.5	65.5	.87	29.45	Clear.	76	72	70	.82	29.5	Fair.	63	62	61	.93	29.5	Cloudy.	82	55	0	0
9	61.5	60.5	59	.93	29.5	Cloudy.	73	69.5	78	.84	29.5	Fair.	62.5	62	61.5	.96	29.5	Cloudy.	82.5	59	0	1
10	73	69	68	.84	29.5	Clear.	84.5	77.5	74	72	29.5	Fair.	66.5	65	64.5	97	29.5	Cloudy.	88	56	0	1
11	74	70	69	.85	29.4	Clear.	87	82	80	.80	29.25	Clear.	79.5	74	71	.755	29.	Clear.	88	56	0	1
12	63	61.5	60.5	.90	28.95	Fair.	75	71	69	.82	29.	Cloudy.	58	56.5	55.5	.915	29.1	Cloudy.	79	49	0	1
13	61.5	60	58.5	.96	29.15	Cloudy.	73.5	70	68	.84	29.3	Clear.	61	60	59	.93	29.4	Clear.	76.5	56.5	0	4
14	71.5	69	67.5	.87	29.5	Clear.	83.5	78	75.5	.77	29.5	Clear	61.5	63	62	.915	29.5	Clear.	82	50	0	10
15	72.5	70	68.5	.87	29.6	Clear.	82.5	78	76	.815	29.6	Clear.	68	66.5	66	93	29.6	Clear	86	50	0	12
16	72	70	69	.90	29.7	Fair.	75.5	74	73.5	.94	29.7	Fair.	63.5	62.5	61	.915	29.7	Clear.	85	56	0	13
17	72	70	69	.90	29.8	Clear.	77.5	74	72	.83	29.8	Clear	64	62	61	.90	29.8	Fair.	87.5	52	0	13
18	70.5	68	66.5	.87	29.8	Clear.	78	75	74	.94	29.8	Fair.	65	64	63	.92	29.7	Cloudy.	84	49	0	13
19	62	62	62	1.00	29.7	Rainy.	70	69	68	.94	29.6	Rainy.	69.5	68	67.5	.93	29.6	Rainy.	72.5	59	0	15
20	72	70	69	.90	29.6	Cloudy.	77.5	73	74	.89	29.6	Cloudy.	67.5	66	65	.915	29.6	Rainy.	83	64	0	20
21	72	68	66	.82	29.7	Fair.	84	79	77	.80	29.7	Fair.	70	66	63	.785	29.7	Fair.	86.5	57	0	20
22	70	68	67	.90	29.7	Cloudy.	75	72.5	71.5	.89	29.55	Clear.	66.5	66	65.5	.97	29.55	Clear.	77	63	0	20
23	71	69	68	.90	29.55	Clear.	84	79.5	78	.82	29.55	Fair.	70	69	68	.97	29.5	Clear.	88.5	59	0	20
24	72	70	69	.90	29.5	Fair.	86	81	79	.82	29.5	Clear.	69	66	64	.84	29.5	Clear.	87	59	0	20
25	72	68.5	66	.82	29.7	Clear.	84	79.5	78	.82	29.7	Clear.	66	64	63	.90	29.7	Clear.	87	54	0	20
26	70	67.5	66.5	.87	29.6	Clear.	81	77	75	.82	29.6	Fair.	71	69	68	.90	29.6	Fair.	87	52.5	0	20
27	63	62.5	62	.98	29.6	Cloudy.	67	66	65	.92	29.6	Cloudy.	60	60	60	1.00	29.6	Clear.	74	59	0	20
28	60	58	56	.87	29.7	Fair.	76	73	71	.85	29.75	Clear.	61.5	60	59.5	.93	29.75	Clear.	82	53	0	20
29	68	67	66	.93	29.75	Fair.	81	78	76	.88	29.7	Clear.	65	64	63	.93	29.7	Clear.	84	54	1	20
30	69	68	67	.93	29.7	Clear.	85	82	81	.88	29.6	Clear.	67.5	67	66.5	97	29.6	Clear.	89	56	1	18
31	74	70	68	.82	29.6	Cloudy.	84	82	81	.91	29.5	Fair.	72	71.5	72	.98	29.4	Cloudy.	88	61	2	18

August.	9 A. M. Dry bulb.	Wet bulb.	Dew point.	Relative humidity.	Barometer.	Weather.	3 P. M. Dry bulb.	Wet bulb.	Dew point.	Relative humidity.	Barometer.	Weather.	9 P. M. Dry bulb.	Wet bulb.	Dew point.	Relative humidity.	Barometer.	Weather.	Maximum temperature.	Minimum temperature.	Per Cent. Grape leaves mildewed.	Per Cent. Pear leaves blighted.
1	69	67	66	.90	29.5	Clear.	80.5	77	76	.89	29.5	Clear.	64.5	63	62	.91	29.5	Clear.	85	62	2	18
2	68	65	63	.84	29.6	"	87	83	79	.77	29.6	"	68	66	65	.90	29.6	"	89	59	3	18
3	70	69	68	.93	29.6	Smoky.	84 5	81	79.5	.85	29.6	"	71	69	68	.90	29.6	"	88	55.5	4	17
4	73	72	72	.97	29.5	Cloudy.	82	79	78	.88	29.4	Shower	70	69	68	.94	29.4	Fair.	90	64	4	17
5	77	75	74	.90	29.45	Fair.	86	85	85	.97	29.45	Clear	77	77	77	1.00	29.5	Rainy.	90	67	6	17
6	69	68	67	.93	29.5	Cloudy.	69	69	69	1.00	29.5	Rainy.	66.5	66	65.5	.97	29.5	Cloudy.	79	65	8	17
7	68	67	66	.93	29.5	"	74	73	73	.97	29.5	Cloudy.	72	71	71	.97	29.5	"	86	62	11	16
8	69	68	67	.93	29.6	"	73	72	72	.97	29.6	"	69	68	67	.93	29.55	Rainy.	78	67	13	16
9	78	75	74	.88	29.6	Fair.	88	84	78	.72	29.6	Clear.	66	65	64	.93	29.6	Clear.	91	66	13	16
10	70	67	65	.84	29.75	Clear.	80	77	76	.88	27.6	"	61	59	57	.87	29.8	"	83	53	13	16
11	66.5	64	62.5	.87	29.9	Fair.	68	66	65	.90	29.85	Rainy.	63	62	61	.93	29.9	Cloudy,	76.5	50	13	20
12	61	61	61	1.00	29.8	Rainy.	63	63	63	1.00	29.8	"	61	60	59	.93	29.7	"	65	60	14	20
13	63	63	63	1.00	29.45	"	68	65	62	.81	29.35	Fair.	69	67	66	.90	29.35	Fair.	72	56	14	20
14	66	63.5	60	.81	29.65	Clear	76	72	70	.82	29.6	Clear.	60	59	58	.93	29.6	Clear.	79	54	14	20
15	66	64	63	.90	29.6	Cloudy.	80	77	76	.88	29.75	"	71	70	69	.94	29.7	"	89	55	15	20
16	76	75	75	.97	29.6	Fair	89	85	84	.85	29.6	Fair.	80	79	79	.97	29.6	Fair.	92	66	15	20
17	78	77	77	.97	29.5	Cloudy.	73	71.5	71	.94	29.4	Cloudy.	72.5	72.5	72	.98	29.45	"	82	70	15	18
18	75	72	70	.85	29.6	Fair	79	76	75	.85	29.6	"	68	67	66	.93	29.55	"	83	63	15	18
19	70	67.5	66	.87	29.6	"	80	77	76	.88	29.5	Clear.	66	64	63	.90	29.5	Clear	79	58	15	18
20	72	69	67	.84	29.55	"	89	86	85	.88	29.55	Fair.	63	62	61	.93	29.55	Fair.	84	59	15	16
21	66	65	64	.93	29.55	Cloudy.	68	67	66	.93	29.4	Cloudy.	61	61	61	1.00	29.2	Rainy.	72	56	16	16
22	71	69.5	68.5	.92	29.2	Fair.	72	70	69	.90	29.35	Fair.	58	57	56	.93	29.5	Fair.	76	56	16	16
23	61	59	57	.87	29.55	Clear.	69	66.5	65.5	.89	29.5	Clear.	58	56	54	.85	29.5	Clear.	71.5	45	17	16
24	74	71	69	.85	29.5	"	82	78	76	.82	29.5	Fair.	69	68	67	.93	29.5	Fair.	89	54	20	15
25	78	75	74	.88	29.5	Fair.	90	88	88	.94	29.5	Clear.	72	70	69	.90	29.6	Clear.	91	64	20	15
26	75	73	72	.90	29.5	Clear.	89	84	77	.68	29.5	"	71	69	68	.90	29.5	"	91.5	60	20	15
27	80	79	79	.97	29.4	Fair.	79	75	73	.82	29.4	"	56	54	52	.86	29.5	"	82	54	20	15
28	61.5	59	58.5	.91	29.5	"	66	64	63	.90	29.5	Fair.	56	55	54	.93	29.5	"	72	47.5	20	15
29	67	65	64	.90	29.5	"	77	75	94	.90	29.5	"	61	59	57	.87	29.5	"	82	49	20	15
30	73	70	68	.84	29.5	"	85	81	79	.82	29.5	Clear.	73	72	72	.97	29.5	"	89	55	20	15
31	72	71	71	.97	29.5	"	78	76	75	.91	29.5	Fair.	69	68.5	66.5	.92	29.5	"	86	63	20	15

We give a brief account below of the behavior of the varieties growing on our grounds.

Agawam. Mildewed and rotted to some extent; many vines were injured last winter by the cold weather. It is too unreliable for this section.

Amber Queen. This variety shows but little fruit this season. The foliage is good, but will not withstand the attacks of mildew when the season is more favorable for its development, than this has been.

Ann Harbor. Slow in growth, but foliage good. Lacking in vigor and productiveness.

August Giant. Foliage mildewed badly; has not fruited enough to enable us to give a fair judgment of its merits.

Bacchus. Foliage like the Clinton and entirely free from mildew. Fruit not much better than that variety, but a little larger.

Beauty. Good foliage and no mildew on the leaves, but the fruit has been attacked by a dry rot that has destroyed it.

Brackman. The foliage very much like the Clinton and entirely free from mildew. The grapes resemble the Iona in size, color and quality. It is early and from the two seasons' trial we are led to believe that it will be one of the best grapes for New England. It ripens with the Delaware and although not of as sugary quality, is more vinous and nearer the perfect grape than any variety, except the Iona.

Brighton. An early red grape of some value, but often gives straggling bunches that are not attractive.

Concord. This grape still takes the lead as the "grape for the millions." Probably more vines of this variety are planted in the county than all others together. It is, however, too late for New England, to ensure its ripening every year, and while we have in the Wordens, a grape in all its important qualities like it, and one that ripens more than a week earlier, the Concord should not be planted.

Cottage. Foliage good, ripens early and is of fair quality, but lacks vigor.

Champion. Very early, but too poor to be recommended for cultivation.

Delaware. One of the most delicate varieties in quality of fruit and foliage. In warm, sheltered and airy locations with a good soil it reaches great perfection. It mildews badly in moist, warm weather, which often destroys all the foliage. If the remedies recommended by the Department of Agriculture for the destruction of mildew and rot shall be proved successful we may hope to see the Delaware among the most satisfactory varieties in New England.

Duchess. Foliage poor, and as far as fruited with us, not promising.

Early Victor. Ripens very early, but the fruit is of the same character as the Telegraph and Champion and of little value.

Eldorado. Vine immensely vigorous and foliage good, but too late in ripening its fruit for this section.

Empire State. The vine is moderately vigorous and a little inclined to mildew. In quality the fruit is good and a late keeper, but it has not shown the vigor and productiveness claimed for it when first introduced.

Hayes. Vine perfectly hardy and with good foliage, but of slow growth. The fruit is rather medium in size of bunch, but ripens early and is of good quality.

Highland. Vigorous and hardy, but the fruit is too late for any but warm localities.

Hartford. This old grape is seldom planted on account of the fault of the fruit in dropping from the bunch, but from its hardiness and perfect foliage it should be used as a parent for the production of hardy and early new varieties.

Iona. Vine tender, foliage liable to mildew and the fruit to rot, yet the fruit is so fine that in favored localities it should be planted, unless the Brackman, which so closely resembles it in fruit, shall prove to be a success in New England.

Janesville. Another grape with the Clinton foliage and with a fruit that is much better than its parent, but which has the very serious fault of dropping from the bunch when ripe. As a parent of new varieties it may be of value.

Jefferson. Too late to be of any value in this section.

Jessica. Vine of moderate growth and a foliage that has mildewed badly this season. Fruit of good quality.

Lady. One of the most satisfactory early white grapes, although moderate in growth and not very productive.

Lady Washington. A magnificent growing vine, but too late for this section.

Martha. An old variety scarcely equaled by any new variety ripening at the time unless by the Lady; foliage good, but of very moderate growth.

Moore's Early. The one really good grape that is sure to ripen in Massachusetts when any variety does. The vine is not quite as vigorous as the Concord, but it is as hardy and the fruit of nearly as good quality.

Niagara. The most vigorous and productive white grape in cultivation. It is late in ripening and in unfavorable seasons has rotted badly, but the foliage has not been injured by mildew.

Onieda. A red grape of some promise which has thus far failed to produce a sufficient crop to be profitable.

Pearl. Vine vigorous, but fruit does not ripen here.

Pocklington. Foliage good, vine vigorous and the fruit large, fine and of good quality, but it is unfortunately late in ripening.

Poughkeepsie Red. A promising variety, but has failed to fruit as abundantly as in other sections.

Prentis. Vine slow in growth, fruit of medium size and good quality, late.

Rochester. Foliage good, vine vigorous; has fruited but little with us.

Telegraph. Early, perfectly hardy, but of poor quality.

Ulsters Prolific. Small red grape of good quality; we have not fruited it long enough to test its value.

Vergennes. Hardy, vigorous and moderately productive; a very promising variety.

Wyoming Red. Good foliage, moderately vigorous and early. Promising.

Wilder. Rogers' No. 4. One of the best of Rogers' hybrids and under favorable conditions succeeds well.

Worden. By far the best grape to plant for profit in New England. It is equally hardy, productive and of as good quality as the Concord and more than a week earlier. In vine and foliage almost identical.

RED RASPBERRIES.

Hansel. Hardy, rather weak in growth, foliage good, fruit early, ripening with the Marlboro and before the Turner. The fruit is of fine color and good quality, moderately firm and productive. In some localities the foliage has mildewed badly; on the college grounds it has been injured in this way, but one season since its introduction four years ago.

Rancocas. This variety as we have it is in every way identical with the Hansel, although it never has been injured by mildew. It is possible that we may not have the true variety.

Marlboro. For the past three seasons this variety has fruited with us and we consider it the most promising variety for profit. The fruit is large, of light color, firm and of fair quality. It has proved entirely hardy and moderately vigorous. In some sections the foliage is reported to burn badly in dry weather; but with good cultivation and liberal manuring in the fall, it has proved by far the most profitable raspberry.

Cuthbert. This superb variety still heads the list for hardiness, reliability under all conditions, and the quality of fruit produced. With an abundant supply of the earlier varieties in the market it may not be quite as profitable in the future as in the past, but can be recommended everywhere for home use.

Turner. Under the ordinary methods of cultivation this variety is too small to be profitable, especially if such varieties as the Marlboro, Hansel and Rancocas are grown extensively.

Superb. Truly superb in form and size, but of so poor a quality and breaks up or crumbles so in picking as to be valueless for market. The plants are rather weak in growth.

Shaffer's. A hybrid between the Blackcap and red raspberry. In vigor it exceeds all of the former, and in size of fruit all of the latter. Its color is very objectionable as a market berry, being like that of the old Philadelphia, a reddish purple. In quality not quite equal to the best red raspberries; especially valuable for canning. The canes have not proved quite hardy, but it has produced a fair crop of fruit for the three years past.

YELLOW RASPBERRIES.

Caroline. A comparatively old variety that is perfectly hardy and immensely productive, but the fruit is very soft and of only medium quality. It can only be recommended for home use, where other varieties fail.

Golden Queen. A seedling of the Cuthbert which it resembles in habit of growth and form of fruit, but the latter is nearly golden yellow. It has proved hardy for the two winters we have tested it and very productive. In quality, to the taste of many it is very inferior to most of the red varieties. Its value as a market fruit is very uncertain, for it has not as yet been grown in sufficient quantities to know how such a color will "take;" we think, however, that it will not sell as readily and at so good prices as the bright red varieties.

Several new varieties were planted last spring, but they have not made growth enough to give any comparative test. They are Excelsior, Thompson's Early Prolific, Thompson's Pride, Crystal White.

BLACK CAP RASPBERRIES.

Carman. This is of the Doolittle and Souhegan type and has failed to show the vigor and hardiness of those varieties.

Centennial. A vigorous, rapid growing variety producing large, shining, black, fine flavored berries in great abundance. It ripens a little later than the earliest, but much before the Gregg. The one serious fault noticed is its tenderness, having been injured last winter and during the winter of '86.

Hopkins, Doolittle, Souhegan and Tyler. These are four varieties that are so nearly identical that we see no reason for giving them separate names. If there is any difference it may be shown a little in the Tyler, which may be a little larger and more productive.

Gregg. In growth, foliage, and color of cane this resembles the Centennial, but the fruit is thickly covered with bloom. Sometimes a little tender, but is generally considered one of the most profitable.

Ohio. This variety has not fruited with us, but it proves a good grower and is highly recommended and largely planted in some sections of the country.

Of the *new varieties* planted, but not fruited are—

Butler's Seedling. Of the Doolittle type, but very vigorous in growth with thick, hard foliage.

Crawford. Canes and habit of growth like the Gregg.

Nemeha. Canes and habit of growth like the Gregg.

Hillborn. Foliage and habit of growth like the Doolittle, vigorous.

Thompson's Sweet. Not making very vigorous growth.

Other varieties have been received, but owing to the condition of the plants failed to grow.

BLACKBERRIES.

Agawam. After another season's trial we can report that it is perfectly hardy, very vigorous in growth, productive, and of the best quality. It is not quite large enough, however, to compete with such varieties as the Wilson, but for New England no other variety possesses so many good qualities. It ripens before the Snyder.

Snyder. Perfectly hardy, vigorous, productive and of good quality. The fruit is firm but often changes to a reddish color after being kept a short time.

Taylor's Prolific. The most productive blackberry on our grounds, but the fruit ripens late and is not of as good quality as the two previously mentioned.

Wachusett. Hardy, vigorous, moderately productive and of good quality, but small size. The canes are less thorny than other varieties, whence the name Wachusett Thornless, often given. Except on a rich soil the berries are too small to sell readily in market.

Early Harvest, *Early Cluster*, *Wilson* and *Wilson, Jr.*, are all too tender to grow successfully in Massachusetts, except by covering. From the large size of the berry, the Wilson and Wilson Jr. may be found profitable by covering the canes to protect them.

Lucretia. The fruit upon this running blackberry was very fine and of good quality. It ripens its fruit so early that it may become profitable if covered in winter and if the ground can be mulched to protect the fruit from coming in contact with the soil.

The new varieties which will fruit next year are Erie, Fred, Minnewaski, Western Triumph, Thompson's Mammoth.

STRAWBERRIES.

The strawberry crop began ripening about one week later than the average season. In most sections of the State the crop was reported good, and of large size, but the yield very much below the average. The price realized for the fruit on account of its improved size and scarcity was much above the average, and we hope growers generally, will take the lesson of the season and improve their methods of cultivation and shipping, as an improved condition of the fruit will certainly increase the consumption and enhance the price.

We must also give more attention to quality, for people are learning, though slowly, that there is a great difference in the varieties, and are still more positive in their demands for size and appearanee.

The following tables give a summary of the characteristics and qualities of the varieties grown upon the College grounds.

STRAWBERRY PLOT. VARIETIES PLANTED IN 1886 AND 1887.

VARIETY.	Time of Ripening.	Foliage.	Quality.	Product-iveness.	Vigor.	Size.	Beauty.	VARIETY.	Time of Ripening.	Foliage.	Quality,	Product-iveness.	Vigor.	Size.	Beauty.
Ada,	7	8	2	3	3	2	1	Kentucky,	8	6	4	8	5	5	5
Atlantic,	8	5	5	5	3	5	4	Lida,	5	8	5	1	4	2	2
Belmont,	5	5	2	3	4	3	2	Mammoth,	7	7	2	6	6	1	1
Bidwell,	3	5	3	2	4	4	5	May King,	2	2	6	5	10	10	9
Buback,	2	9	3	7	1	2	2	Miner's Prolific,	3	7	3	8	5	8	7
Chas. Downing,	5	5	3	7	5	5	5	Monmouth,	1	5	4	4	7	5	3
Cohanzie,	9	1	8	9	9	9	8	No. 23,	1	5	2	4	4	8	2
Cornelia,	10	7	5	6	5	6	7	" 24,	8	6	3	4	3	1	1
Covill's Early,	4	7	1	8	7	8	7	" 26,	7	8	3	4	3	3	2
Crescent,	2	3	8	5	9	7	9	" 29,	1	6	5	4	4	6	5
Crimson Cluster,	4	6	8	5	5	5	4	Ohio,	8	4	8	9	5	8	4
Crystal City,	1	5	6	2	9	2	3	Old Iron Clad,	2	5	4	5	6	5	6
Daisy,	5	9	6	9	8	7	6	Ontario,	7	9	3	8	4	3	3
Daniel Boone;	2	5	2	8	3	3	1	Parry,	6	8	3	3	3	6	8
Emerald,	5	8	7	8	7	7	5	Piper's Seedling,	4	5	7	5	6	9	5
Garibaldi,		8			8			Prince of Berries,	5	8	4	2	3	5	8
Garrek Seedling,	8	4	7	8	7	8	7	Pioneer,	2	5	2	8	3	3	1
Golden Defiance,	9	6	6	5	8	8	9	Seth Boyden,	4	6	3	7	7	5	5
Grandy's Prize,	7	9	5	4	4	2	3	Sharpless,	4	2	5	3	4	2	3
Hampden,	8	8	5	7	8	6	6	Sucker State,	5	8	7	8	7	7	5
Henderson,	5	9	3	9	8	5	5	Summit,	8	8	2	6	4	2	2
Hervey Davis,	6	7	1	8	8	4	2	Sunapee,	6	6	2	8	5	8	5
Jersey Queen,	5	4	4	5	5	7	9	Triumph de Gand,	6	5	2	6	5	5	3
Jessie,	3	9	2	4	5	5	2	Wilson,	2	5	7	5	6	6	6
Jewell,	3	3	3	4	8	5	3	Woodhouse,	8	8	9	7	7	6	8
Jumbo,	4	5	5	7	6	4	3								

The new varieties planted last spring gave no fruit, consequently we report only upon the vigor and character of foliage and growth. In this table 1 means perfect as to qualities under each heading, while 10 stands for the lowest condition of same.

VARIETIES PLANTED IN SPRING OF 1888.

VARIETY.	Vigor.	Foliage.
Beseck,	8	8
Cardinal,	3	4
Carmichael,	8	8
Eva,	9	8
Excelsior,	6	6
Fansworth,	5	5
Gold,	9	8
Haverland,	4	4
Itaska,	6	5
Katie,	4	4
Leroy,	5	6
Logan,	6	4
Norman,	6	7
Auger's No. 70,	3	3
Photo,	2	3
Warfield,	3	6

It may be said in connection with the test of the new varieties planted this spring that the soil has not received quite as much manure as 1886 and 1887.

THE EFFECT OF THE DIFFERENT FERTILIZING ELEMENTS UPON THE TIME OF MATURING OF CROPS.

The time of ripening of most of our farm and garden crops often makes all the difference between profit or loss on them; and it is very important that we know what agencies we may employ to hasten ripening.

In order to test the effect of the various essential elements of plant food, we have conducted a series of experiments with several kinds of crops.

The elements employed are as follows:

Nitrogenous. Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda and Dried Blood.

Potash. Sulphate Potash, Nitrate of Potash and Muriate of Potash.

Phosphoric Acid. Dissolved Bone Black.

In order to make the test a fair one the plots were arranged with the nitrogenous alternating with the mineral elements and with sufficient space between each.

To prevent any uncertainty as to the varying nature of the soil, the plots were duplicated three times in different parts of the field.

The first experiment extended across a field in which there were planted cabbages, peas and potatoes for annual crops, and three varieties of red raspberries and three of blackberries for perennial crops. The application of fertilizer was made early enough to influence the annual crops, but not so materially that of the perennials, yet, as some results are shown, we give in the following tables, the crops resulting in the order of maturing,

PEA PLOT.

Planted April 17th. Harvested June 29th.

	M. Potash,	Sul. Ammonia.	Sul. Potash.	Nitrate Soda.	Bone Black.	Nitrate Potash.	Dried blood.
Condition of Maturity at Harvesting.	1*	5	3	4	2	4	5
Quantity.	3 lbs. 7 oz.	4 lbs.	4 lbs. 12 oz.	4 lbs. 3 oz.	5 lbs. 1-2 oz.	3 lbs. 14 oz.	4 lbs. 8 oz.

The time was so short between that of planting and harvesting that we do not feel we that have results that might not have come from natural causes. In fact we do not hope to establish any facts until the experiments have been repeated several years and under many varying conditions.

*Marked on scale of 1 to 10; 1 equaling perfect maturity, 10 nothing mature.

CABBAGE PLOT.

NUMBER OF HEADS MATURING.

July	M. Potash	S. Am.	Sul. Potash	N. Soda	B. Black	N. Potash	D. Blood
9	0	3	0	2	0	2	7
14	5	9	7	4	7	7	6
18	5	3	1	2	2	0	0
27	11	7	7	12	13	9	8
Aug. 10	3	2	9	4	2	6	3
Total,	24	24	24	24	24	24	24

WEIGHT OF HEADS.

July.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
9	0	12 6	0	10 7	0	11 7	18
14	25 2	23 8	16	20 8	16 8	19 6	8 8
18	18 8	12	3 8	12 8	8 8	0	0
27	41 8	51 8	32	74	62 8	57 8	57 8
Aug. 10	16	12	62	31	10	18	22
Total,	101 2	111	113 8	148 7	97 8	106 4	106

AVERAGE WEIGHT PER HEAD.

lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
4 3	4 10	4 11	6 2	4 1	4 7	4 7

Total average per head, 4 lbs. 9 oz.

RASPBERRY PLOT.

July	Muriate Potash oz.	S. Am. oz.	S. Potash oz.	N. Soda oz.	B. Black oz.	N. Potash oz.	D. Blood oz.
10	3	6	4	4	4	4	3
12	3	14	6	6	9	7	4
14	12	17	15	18	13	13	12
16	12	16	15	20	16	17	14
18	10	11	17	16	13	13	12
21	36	38	48	48	56	36	62
24	76	72	62	76	62	64	30
26	50	48	48	38	31	30	39
28	36	44	30	32	34	34	33
31	48	42	46	40	40	32	36
Aug. 2	28	24	29	28	15	20	25
4	22	20	15	16	12	14	10
7	19	22	16	16	26	8	20
10	10	10	22	13	9	4	14
Total	365	384	373	381	340	296	314
	lbs. oz.	lbs.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
	22 13	24	23 5	23 13	21 4	18 8	19 10

POTATO PLOT.

	Wt. of 24 hills. lbs. oz.	Wt. of Large. lbs. oz.	Wt. of Small. lbs. oz.	Wt. per hill. oz.	Per cent. of Large.
Muriate Potash,	19 8	11	8 8	13	56
Sulphate Ammonia,	28	20	8	27	71
Sulphate Potash,	23 8	14 8	9	15	65
Nitrate Soda,	29	17 8	11 8	19	60
Bone Black,	26 8	19 8	7	17	74
Nitrate Potash,	31 8	24	7 8	21	77
Dried Blood,	31 8	23 8	8	21	75
Unfertilized (Ave.)	21	14	7	14	65

BLACKBERRY PLOT.

Aug.	M. Potash oz.	Sul. Am. oz.	Sul. Potash oz.	N. Soda oz.	B. Black oz.	N. Potash oz.	D. Blood oz.
2	2	4	6	9	3	5	2
4	2	1	1	2	6	1	1
7	1	1	1	2	4	3	2
10	2	3	2	3	2	1	2
Total,	7	9	10	16	15	10	7

The blackberry crop was very small, but enough fruit was given to make a fairly accurate test.

In the following two plots, wood ashes and four grades of bone were added:

BEAN PLOT.*

	Sulphate Ammonia.	Sulphate Potash.	Nitrate potash.	Muriate Potash.	Nitrate Soda.	Bone Black.	Dried Blood.	Wood Ashes.	Hargraves' Bone.	Bowker's Special Bone.	Acidulated Bone.	Fine Ground Bone.
	Horticul'l											
Aug. 4.	24 oz.	18 oz.	18 oz.	8 oz.	8 oz.	16 oz.	24 oz.	24 oz.	20 oz.	18 oz.	16 oz.	16 oz.
" 31.	96 "	40 "	64 "	64 "	44 "	44 "	80 "	64 "	32 "	42 "	40 "	36 "
	War.											
Aug. 20.	40 oz.	40 oz.	44 oz.	32 oz	36 oz.	32 oz.	28 oz	28 oz.	48 oz.	16 oz.	24 oz.	36 oz.

CORN PLOT.* No. of Ears.

Aug. 9.	14	2	3	2	5	12	24	17	21	21	11	11
" 17.	54	16	36	22	55	30	62	54	73	67	65	58
Sept. 10.†	445	395	495	430	451	305	480	405	430	415	415	450
Total.	513	413	534	454	511	347	566	476	524	503	491	519
Amt. Ears. Sept. 10.	162 lbs.	117 lbs.	165 lbs.	132 lbs.	166 lbs.	145 lbs.	140 lbs.	130 lbs.	134 lbs.	129 lbs.	130 lbs.	140 lbs.
Amt Stover. Sept. 10.	160 lbs.	106 lbs.	145 lbs.	137 lbs.	157 lbs.	140 lbs.	145 lbs.	143 lbs.	175 lbs.	185 lbs.	170 lbs.	170 lbs.

*These crops were planted on a separate plot from the preceding where the soil was not quite so uniform, but there were four duplicate plots, so that the average should show uniform results.

† All harvested.

LIQUID MANURE FOR PLANTS UNDER GLASS.

In the growth of plants in green houses and in the sitting-room, the plant food in the limited amount of soils that can be used, often becomes exhausted or rendered unavailable to the plant, and to overcome the difficulty the application of liquid manures is resorted to as the best means of giving the plants a rapid and vigorous growth.

The use of some liquid food is also necessitated by the small pots that must be used to insure an abundance of bloom.

To test a liquid plant food under the name of "Flora Vita" sent for comparison with other liquids, twenty-eight Bon Silene rose bushes were selected. Fourteen of these were potted in soil made very light with sand, and the remainder were put in a good rose soil, made of rotted turf and manure.

These plants were divided into four lots of seven each. Two of these lots, seven in sandy soil and seven in good soil, were watered with a liquid manure made by placing stable manure in a tub and filling up with water, and the other two lots were watered with "Flora Vita." The first liquid was diluted to the color of weak tea.

RESULTS.

The results of this experiment show :—

First. That the liquid called "Flora Vita" gave as good growth as the ordinary liquid manure.

Second. That the roses potted in a soil composed largely of sand made as good growth and gave more buds than those in soil with little or no sand in it.

In regard to the above liquid sent for trial we know nothing of its composition ; but its liquid form and perfect solubility make it especially easy of application and free from the objections to other plant foods for the sitting-room, since it is odorless and free from dust.

We hope to give an analysis of "Flora Vita" in our next Bullitin.

PROTECTING YOUNG TREES FROM MICE.

In our last Bulletin we reported experiments made for the purpose of finding some simple and harmless mixture which could be used to hold Paris Green to the bark of young trees during the winter. It will be seen by referring to this report that the simple mixture of lime, and lime and glue were very soon washed off.

The condition of the various mixtures applied in April, 1888, the results of which were also reported in this same BULETIN have been carefully observed during the summer, the result of which we give below.

For the benefit of those who may not have the last BULLETIN at hand we repeat the series:

Series No. 1.

1. Lime wash of the consistency of common paint.
2. " " 10 parts, 1 part gas tar.
3. " " " " " " asphaltum.
4. " " " " " " Morrill's tree Ink.
5. " " and equal parts skimmed milk.
6. " " " " " " " , gas tar 1 part.
7. " " " " " " " , asphaltum 1 part.
8. " " " " " " " Morrill's Tree Ink 1 part.

Series No. 2.

1. Portland Cement wash of the consistency of common paint.
2. " " 10 parts, gas tar 1 part.
3. " " " " asphaltum 1 part.
4. " " " " Morrill's Tree Ink 1 part.
5. " " and skimmed milk, equal parts.
6. " " " " " " " gas tar 1 part.
7. " " " " " " " asphaltum 1 part.
8. " " " " " " " Morrill's Tree Ink

RESULTS.

Series No. 1.

1. Nearly all washed off. Sept, 22d.
2. " " " "
3. " " " "
4. Washed off but little.
5. " " " "
6. " " " "
7. " " " "
8. " " " "

Series No. 2. Sept. 22d.

1. Nearly perfect.
2. " "
3. " "
4. " "
5. Nearly all washed off.
6. " " " "
7. " " " "
8. " " " "

CONCLUSION.

It will be seen by the above that in the first series the addition of the skimmed milk rendered the paint more permanent while in series No. 2 it had the opposite effect. From the present appearance of the trees painted we feel confident that No's 1, 2, 3, and 4 of the 2d series will adhere sufficiently long to hold the Paris green during the winter and that there can be but little, if any, danger from their use.

NEW VARIETIES OF APPLES AND OTHER FRUITS.

In every locality there are found growing local varieties of fruits of more or less merit, which are known only to those sections, and as most of our best varieties in cultivation are chance seedlings we feel hopeful that among the great number there may be many of value.

For this reason we would urge every one who may have such varieties of promise, to make careful observations as to their qualities. One of the great advantages of such varieties is that they are mature trees or plants and their merits are more or less known. There is need of improved varieties of all of our fruits, yet no variety should be introduced unless it has decidedly superior qualities to those already in cultivation.

In order to aid in this matter, we would ask all growers who have any varieties of fruit of merit to send a sample to the Horticultural Department of the College Experiment Station for comparison and test. Named varieties of which the owner may have lost the name will be received and named if possible.

SULPHUR AS AN INSECTICIDE AND FUNGICIDE.

The fumes of sulphur are well known to be destructive to both plant and animal life, but in its crystalline or "brimstone" form it is wholly insoluble and therefore inactive as an agent of destruction to either plants or animals.

Almost every season the report comes to us through the agricultural journals or from other sources, of experiments made with the insoluble form of sulphur for the prevention of insect injuries to the foliage of fruit or other trees.

The most common method of application is to insert the sulphur in holes bored in the trunks of the trees, with the idea that it will be dissolved by the sap of the tree and carried to the foliage or fruit in such quantities as to render it offensive to insects. No longer ago than the past spring it was reported that the Forester of the city of Boston had bored large holes in many of the large elms within the city limits, and had inserted sulphur to prevent the elm beetle from injuring the foliage.

Now, it has been found upon cutting down trees that have been plugged with sulphur that the material remains unchanged for many years, and from the very nature of these conditions it is absurd to suppose any good result can come from this practice. We have in the Botanic Museum a specimen of a tree cut down and split open, in which is found a mass of sulphur wholly unchanged. It had been inserted in an inch augur hole twenty-five years before the tree was cut down. See Hovey's Magazine of Hort. No. CCLXXX, P. 182.

It is hoped that at the close of the coming season some of the trees thus treated by the city of Boston may be cut down and examined, and the results made public, for, while we spend so much time in trying to prevent injury to our trees from borers, we certainly ought not to make holes in them many times larger than those of any known species of insect borers.

While we would discourage anything that may be of such serious injury to the tree as the above, the suggestion comes to us that sulphur in a soluble form may be introduced into a tree in sufficient quantity to affect fungus growths which cause the rusts, blights, mildews, etc.

In order to test this matter, a lot of rose bushes of large size, which were badly mildewed, were selected and the following solutions inserted by boring a hole with a small gimlet and forcing the liquid into the opening with a medicine dropping tube.

1. Potassium Sulphide, saturated solution.
2. Hydrogen " " "
3. Ammonium " " "

After forcing in all the liquid the plant would take (about a tubeful) the holes were plugged with hard grafting wax.

Observations were made from time to time with the following results: At first a slight improvement was noticed in the amount of mildew upon the foliage, but as the season advanced, the effect of the holes made in the trunk became more apparent, so that Sept. 22d, all the bushes were dead except one of those treated with ammonium sulphide.

This experiment was made in part to demonstrate the great injury that must result in making large incisions in the trunks of trees or shrubs, and that while there is some promise that the introduction of antiseptics into the circulation of the sap may prevent the growth of injurious fungi like the blights, mildews, etc., we must find other means of introducing the solutions.

From the very nature of the case presented, it seems hardly possible to introduce any substance into the circulation of a plant in sufficient quantities to affect insect life, and no experiments were undertaken in this line.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 3.

JANUARY, 1889.

The Bulletins of this Station will be sent free to all newspapers in the State and "to such individuals actually engaged in farming as may request the same."

AMHERST, MASS.:
J. E. WILLIAMS, BOOK AND JOB PRINTER.
1889.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Tuberculosis.*

This disease has been known by various names, as consumption, pulmonary consumption, tuberculous consumption, consumption of the bowels, phthisis, pulmonary phthisis, tuberculous phthisis, pulmonary ulceration, pining, wasting of the lungs, pearl disease, perlsucht, nymphomania, satyriasis, knots, kernels, grapes, angleberries, human tuberculosis, bovine tuberculosis, tubercle, miliary tubercle, tubercular disease and tuberculosis.

The last name is more widely used at the present time than any of the others, and it is adopted in this paper for a general term; but I make use of the name human tuberculosis for the disease in man, and bovine tuberculosis for the disease in other animals.

Tuberculosis has been observed to attack nearly every organ in the body, but the lungs and lymphatic glands appear to be particularly subject to it.

The tubercles in the lungs at first are small, semi-transparent, grayish, or colorless grains, varying from one-sixteenth to one-half an inch in diameter. These gradually increase in size and become yellowish or opaque. Several unite and form larger masses of a pale yellow color, and of a cheesy consistency, which finally soften and liquefy. These masses, often as large as a grape and sometimes even much larger, are more or less globular, and may fill the entire diseased portion of the lung, and exhibit a series of hemispherical elevations over the surface.

The lining membranes of the thorax and abdomen, and also the membranes covering the brain and spinal cord, are subject to tubercular growths which appear like the pile on velvet, or wart-like growths over the surface.

Not unfrequently joints become diseased, and, when opened, discharge a pale yellow granular matter. I recently examined a cow that had died with tuberculosis, and besides the characteristic tubercles in the lungs, the caul was so thoroughly affected as to be one mass of putrefaction. This same animal had the fetlock joint on one hind leg badly affected with tuberculous matter, and there were also a few tubercles in the liver.

*Prepared by Charles H. Fernald, at the request of the Director, in response to the many demands from all over the state for information on the subject.

ANIMALS ATTACKED BY TUBERCULOSIS.

Man.—Tuberculosis is very prevalent in the human family, and was estimated by Dr. Robert Koch of Berlin to be the cause of one-seventh of all the deaths of the human race, while fully one-third of those who die in middle age are carried off by the same disease.

Dr. Edward Hitchcock of Amherst College informs me that there were 38,049 deaths reported in the State of Massachusetts for the year 1885, and 5,955 of these were reported as caused by consumption. This is a larger proportion than that given by Dr. Koch, but it is probably only an average percentage for people living under the weakening influences of our modern civilization.

Travelers tell us that consumption is entirely unknown among many of the savage tribes. This may be due to their life in the open air, and freedom from the conventionalities of dress, or to the fact that the disease has never been carried to them so as to gain a foot-hold.

Ox.—The bovine race shows a strong tendency to tuberculosis, especially in confinement, but far less when at large.

Swine.—These animals are without doubt very susceptible to the disease, notwithstanding the opinion so frequently expressed to the contrary. The number of cases on record and the circumstances surrounding them, place the matter beyond all doubt.

Horse.—This animal appears to possess an almost absolute immunity from tuberculosis, and many believe that it never has the disease, but there are several cases on record. Gerlach states that he had known of four cases. Tuberculosis in the horse was reported by Gotti in the Journal of Anatomy of Pisa for 1872, and also by Bruckmuller and others. Some doubt, however, has been expressed about these cases, and many think they were only cases of chronic glanders.

Dr. J. Mc Fadyean reported two cases in the Journal of Comparative Pathology and Therapeutics for March, 1888, in which the lungs, spleen and other organs contained a large number of tubercles characteristic of this disease, and stained sections of the diseased organs revealed enormous numbers of the bacilli of tuberculosis. This, of course, settles the question, and we can no longer doubt that the horse may have this disease.

Sheep.—The existence of tuberculosis in sheep is not yet well established. The descriptions thus far published by observers are of such a nature as to leave doubt whether they really had cases of tuberculosis or some other disease. Villemin, Röll and others did not succeed in producing the disease in sheep, by inoculation, while Colin and Zürn state that the majority of their experiments in this direction failed, though they succeeded in a very few cases.

GOAT.—Tuberculosis has been found in this animal in a few instances.

HENS.—Dr. Ribbert of Bonn states that tuberculosis sometimes attacks hens, and may even become epidemic in a flock. He found the bacilli of tuberculosis in abundance in the walls of the intestine, and also in the spleen and liver.

Mr. Sutton of the London Zoological Garden, who made an examination of more than a thousand birds of various species, informs us that those most commonly affected by this disease are the granivorous birds, and those which feed on fruit. Those most liable to the disease are the hen, peacock, grouse, guinea-fowl, pigeon and partridge.

Rabbits and guinea-pigs are very susceptible to the disease, probably nearly as much so as the bovine race. Other animals in which tuberculosis has been found are cats, dogs, mice, rats, also caged lions, monkeys, kangaroos, deer and gazelles in a zoological garden, and a rhinoceros in Barnum's Museum. According to Satterthwaite, frogs are subject to miliary tuberculosis, but this seems almost incredible.

HISTORY OF TUBERCULOSIS.

This disease under one name or another has been known from the earliest times. According to ancient authors on medicine as Hippocrates, 400 B. C., Aristotle, 330 B. C., Galen, 180 A. D., and others, it consisted of abscesses or ulcers in the lungs. The term "tubercle," as meaning a solid node, is first met with in the works of those who paid especial attention to the anatomy of the human body. Silvius, in 1695, first advanced the idea that phthisis sometimes resulted from larger or smaller nodes which finally led to abscesses and the formation of cavities in the lungs. Manget, in 1700, stated that in the dissection of a person who had died of phthisis, he discovered small nodes of the size of a millet seed in the lungs, liver, spleen and kidneys. These small bodies are now called miliary tubercles, wherever found. He also described the cheesy structure of these nodes, but supposed them to be minute lymph glands. Other writers of that date held similar views.

Stark, in 1785, gave a very complete description of the miliary tubercles, and Reid, in the same year, advanced the idea that they were not enlarged lymphatic glands, but independent formations in the substance of the lungs. He denied that there were any lymphatic glands in the substance (parenchyma) of the lungs; but his contemporaries did not agree with him, but held to the opinion that the tubercles in the lungs were glands, viz.: scrofulæ, that owed their existence to the influence of a so-called scrofulous acid that had been secreted by pre-existing lymphatic glands in the lungs. Baillie, in 1794, opposed the idea that scrofulous nodes were of the same character as tuberculosis, and claimed that the large nodes in the lungs were caused by the union of two or more of the smaller ones (miliary tubercles).

At the beginning of the present century, Bayle gave an exact description of the miliary tubercles and all the phases of their development, as well as the part they play in forming larger tubercles. He also recognized the relation existing between the tubercles in the different organs of the body, and considered tuberculosis to be a general disease whose origin was a tuberculous tendency. Laënnec adopted the same view in his work on the diseases of the heart and lungs, published in 1818. He described the development of tuberculosis very clearly and accurately, but classed every cheesy deposit, wherever found, as tuberculous, making cheesy degeneration the principal characteristic of tuberculosis, a theory which was accepted by many of his contemporaries.

Virchow has done much towards bringing order out of this chaos of ideas. He proved that cheesy deposits were not characteristic of tuberculosis alone, but that they might occur in all possible formations of an inflammatory nature under certain conditions of nutrition. He thus separated from the genuine tuberculous formations, all those cheesy deposits that appear under certain inflammatory conditions, as the scrofulous tumors of the lymph glands, in caseous pneumonia or even in tumors of different kinds.

Virchow believed in the infectious property of tuberculosis. He claimed that the infectious element was dispersed over the organism either by means of the blood-vessels, or by the extension of the disease by the development of new tubercles in the immediate vicinity of older ones, the latter infecting the tissues in their immediate vicinity.

In 1857, Buhl advanced a new theory of tuberculosis, which had many of the most competent observers among its advocates. According to this theory, tuberculosis is a specific infectious disease, caused by a particular poison called "tubercular virus," which is formed in cheesy matter of every description. If this virus be absorbed into the blood, it can generate miliary tubercles in all predisposed organs.

Previous to this time, various experiments had been made by introducing tuberculous matter into the lower animals for the purpose of determining whether they could be infected with the disease; and these experiments proved so successful that, in 1864, Villemin expressed the belief that tuberculosis is a specific infectious disease, independent of other internal and external circumstances, and can only be caused by the introduction of tuberculous matter into the body, and that it can be transferred from animal to animal, or from man to animal by vaccination. It is seldom that so startling an assertion has given greater impulse to scientific labors in the field of experimental pathology than this doctrine of Villemin. The most prominent men of science exerted their utmost powers to prove or disprove the new doctrine. The experiments made with tuberculous matter for the purpose of infecting other animals were by inoculation, inhalation or by feeding.

Innumerable experiments of almost every form and variety were made by inoculation. Tuberculous material from men and the lower animals was introduced under the skin, into the abdominal cavity, the larger blood-vessels, the anterior chamber of the eye, and even into the lungs themselves.

Toussaint concluded from the experiments which he made that no disease is more infectious than tuberculosis, and that all the fluids of the body, the blood, nasal secretion, saliva, the juices of the tissues, the urine, and even the lymph from the vesicles of the inoculated variola (vaccine matter) are all able to convey the infectious material of tuberculosis. These experiments were made upon cows, calves, goats, swine, rabbits and dogs, and almost invariably led to the development of miliary tuberculosis.

Zürn, in 1871, observed micrococci in the blood of a cow that had died of tuberculosis, and Chauveau made similar observations in the following year, and the opinion prevailed to some extent that the micrococcus was the real cause of this disease.

On the 24th of March, 1882, Dr. Koch read a paper before the Physiological Society of Berlin, which was as remarkable as it was unexpected. It was his aim to determine the precise character of the contagious matter which previous experiments had proved to be capable of indefinite transfer and reproduction. He examined the diseased organs of man and the lower animals microscopically, and found the tubercles infested with a minute rod-like parasite which he called *Bacillus tuberculosis.* These rods vary from one seven-thousandth to one ten-thousandth of an inch in length, and their diameter is about one-tenth as much. Within these rod-like plants more or less globular spores are formed, which, under favorable circumstances, after the disintegration of the parent plant, will develop into new plants.

Koch first discovered this parasite by staining the thinnest possible slices of the diseased tissues with methylene blue in alcohol, followed by a solution of vesuvin. By this method the tissues are slightly colored with brown, while the Bacillus stands out clearly of a bright blue color. This method of staining has been improved upon by Ehrlich, Baumgarten and others. These bacilli were separated and cultivated on specially prepared blood-serum for more than six months in some cases, and then these purified bacilli were inoculated into healthy animals of various species, and in every case there was a multiplication of the parasite and a reproduction of the original disease. Since that time the greatest activity has prevailed in experimentation; and with new and improved methods, the conclusions of Koch have been tested and verified again and again, till the facts are now placed beyond all doubt.

DISTRIBUTION OF TUBERCULOSIS.

Tuberculosis occurs in cattle wherever they are kept in domestication, but seems to be most prevalent where consumption is most common in the human family. It is almost unknown in Iceland, and is very rare in Polar countries generally, but increases as we approach warm climates. It appears to be very common in Italy and Algeria; and, according to Fleming, it is becoming more common in England. I am not able to give any estimate of the prevalence of this disease among the herds of Massachusetts, but my attention has been called to it so frequently during the past two years, that I am inclined to believe that the disease is more common than is generally supposed. On two occasions I visited one of our large city meat markets, and examined the lungs still attached to the livers offered for sale, and the superficial examination which I was able to make led me to conclude that nearly half of them showed traces of the disease.

It seems from all we can learn that a cold climate is less favorable to the development and propagation of tuberculosis than a warm or tropical one. Veith states that the disease does not occur in animals living in a wild condition, nor even in those which are in a semi-savage state. Spinola confirms this statement, and adds that the affection is unknown in the Russian steppes, and is rare in elevated regions. According to Zippelius, tuberculosis is most frequently developed in deep and narrow valleys, or in densely populated localities. The disease causes the greatest ravages in damp and dark dwellings with imperfect ventilation and drainage.

IS HUMAN TUBERCULOSIS CONTAGIOUS?

A careful research into the literature of the subject shows that nearly all the celebrated medical writers from the earliest times believed in the contagiousness of human tuberculosis, among whom may be named Aristotle, Hippocrates, Galen, Morton, Valsalva, Morgagni, Riverius and many others equally noted in the annals of medicine.

About a hundred years ago, however, a reaction set in against this almost universal belief, in central and northern Europe, and also in America, while the old opinion still prevailed in Italy and other parts of Southern Europe. Within a comparatively short time, however, the leading physicians of Europe and America have been changing back to the old opinion, and so many observations on this point have been published in the medical journals during the last few years, that we are forced to accept the view that the disease is really contagious. The word contagious is used in this paper in its widest sense, as synonymous with communicable, transmissible or "catching." I must leave further discussion of this question, and also whether the disease is hereditary, to the medical profession; but the following cases are of so great interest in this connection that I venture to give them. Eisenberg of Warsaw reports a case where tuberculous infections followed the Jewish custom of circumcision, and the application of the lips to the wound to stop the bleeding. In this case the contagious matter was transferred from the lips of the operator to the wound. Several other similar cases are on record.

Tascherning reports in the Progress of Medicine for 1885, the case of a young woman who wounded her finger with the broken edge of a vessel containing sputa (the substance raised from the lungs in coughing) rich in bacilli from a consumptive patient. In a short time there was a swelling as large as a pea beneath the skin. Several months later the trouble had increased to such an extent that the finger was useless, and at the same time the lymphatic glands were more or less swollen. The finger was amputated, and in various places within the tissues were found numerous miliary tubercles which contained the characteristic *Bacillus tuberculosis*.

Demet, Paraskeva and Zallonis, in Syra, Greece, had succeeded to their satisfaction in producing tuberculosis in rabbits by inoculating them with sputa and blood from a man sick with consumption, but they felt that the demonstration would be more complete and convincing, if they could operate on man himself. They therefore selected a patient who was suffering from gangrene in a toe, and whose death was inevitable because of his persistent refusal to allow the diseased member to be amputated. An examination showed that the lungs of the man were perfectly sound and healthy, and that he had not the least tendency to tuberculosis. A quantity of sputa from a consumptive patient was injected into the upper part of the left thigh. In three weeks an examination of his lungs gave evidence that they were becoming diseased, and at the death of the man, in thirty-eight days, seventeen tubercles were found in the upper lobe of the right lung, and two in the left lung.

Dr. E. J. Kempf gives an account, in the London Medical Record, July 15, 1884, of an outbreak of consumption in a Convent in the village of Ferdinand. The inmates had been entirely free from consumption up to 1880, but lived a very secluded life, taking very little exercise. The Convent was situated on high, dry ground and was well drained and ventilated. In fact, the hygienic conditions were all that could be desired. In the autumn of 1880, Dr. Kempf was called to attend one of the inmates, a girl eighteen years of age on account of a cough, pain in the chest, and a feeling of general indisposition. The girl came from a family which could not be called healthy, and from which a brother of the patient had previously died with consumption. An examination of the girl showed difficult breathing, hacking cough, loss of appetite, sleepless nights, weary limbs, a daily fever and difficulty in the apices of both lungs as if from tubercular deposits. The patient was not isolated, but slept in the general dormitory with the other inmates. In a short time one after another began to show similar symptoms, and in four months after the first one was seized by the disease. there were nine cases of consumption in the Convent, some of them among those who were formerly thought to be exceptionally healthy. Four of the inmates died of the disease, and the others were lingering along with the chronic form. The director of the Convent then took energetic measures to isolate the sick and send away the ailing and the epidemic was stopped.

IS BOVINE TUBERCULOSIS CONTAGIOUS?

Veterinary surgeons have for a long time insisted that bovine tuberculosis is contagious, and the veterinary journals are teeming with cases pointing unmistakably to its contagious character.

The experiments of Villemin, Cohnheim, Toussaint, Koch and others leave no possible doubt of the contagiousness of the disease. Dr. Koch inoculated the tuberculous matter from diseased animals into healthy ones, and reproduced the disease in every case.

To prove that it was the parasite itself that caused the disease and not some virus in which it was imbedded in the diseased tissue, Koch cultivated his bacilli artificially for a long time, and through many successive generations, by a very ingenious and novel method. Before this time, bacteria had been cultivated on slices of potato. beet, etc., or in liquid substances, as beef tea. It is a well known fact as stated by Tyndall, that there are many species of bacteria differing from one another in the effects which they produce in the medium in which they are cultivated. Like other plants, they "exhaust the soil" as it were. It is also known that bacteria are so universally distributed that the examination of any natural medium attacked by them is almost sure to yield evidence of the presence of more than one species, the various species being grouped together in inextricable confusion. On this account it has been extremely difficult to determine what effects are due to one species of bacterium and what to another. It has often been impossible to determine in such a mixture of forms, one species from another.

Dr. Koch cultivated the Bacillus of tuberculosis on a thin layer of blood-serum spread on a glass microscope slide. This blood-serum was prepared by allowing fresh blood to remain in a vessel until it had clotted, and the clot had separated from the serum. This serum was then put into test-tubes and closed with a plug of cotton to exclude all germs floating in the air. It was then exposed to a temperature of 136.4° F. one hour daily, for a period of six days. This method insured the destruction of all living germs in the serum, without coagulating the albumen. Finally the blood-serum was subjected to a temperature of 149° F. for several hours which gave a solid, transparent jelly upon which Koch made his cultures. This was protected from every possible source of contamination, and kept at the proper degree of temperature and moisture. It was then inoculated by dipping the point of a needle into the diseased tissue of the lung and drawing it across the surface of the blood-serum, making a long shallow streak. The bacilli which adhered to the point of the needle were in this way dropped at intervals along the streak, but in such a way that the subsequent growth of each one could be seen under the microscope.

When these grew and multiplied, the point of the needle was touched to them, and the adhering bacilli were transferred to another layer of blood-serum for a new generation. Each bacillus grew and multiplied at the point where it left the needle, producing around it a little spherical nest of its own kind.

By this method, Koch and his assistants were able to obtain generation after generation without the intervention of disease. At the end of the process, which sometimes embraced successive cultivations continued for six months or more, the purified bacilli were introduced into the circulation of healthy animals of different species, and in every instance was followed by the reproduction of the disease, while other animals kept under precisely the same conditions except that they did not receive the tubercle bacilli, remained perfectly healthy.

Koch has shown, in his experiments, that this parasite requires for its development a temperature between 86° and 104° F., and a period of two weeks, so that it is only within the animal organism that suitable conditions occur; yet, as has been shown by numerous observers, these plants or their spores retain their vitality outside of a body, for a long time.

Galtier made a series of experiments on the resisting power of this parasite, and demonstrated that it retained its activity after being subjected to temperatures ranging from 18° below freezing up to 108° F.; that it also resisted the action of water, and the dessicating process, as well as strong pickle, so that the use of corned or salted beef from animals affected by tuberculosis is dangerous.

Lydtin states very positively that the virus may be taken into the lungs through the inspired air, or into the digestive system with the food or water, or in copulation. If this statement be true, and there appears to be abundant proof of it, a single infected animal brought into a herd of cattle may communicate the disease to every animal in the herd. Infection by the generative organs has been doubted, but Zippelins and others state, however, that they have observed instances in which the infection could not have occurred by any other means. Bollinger produced tuberculosis in pigs, by feeding them for a long time on milk from tuberculous cows.

A large percentage of the animals suffering with tuberculosis are most seriously affected in the lungs, and it seems probable that these were infected by the bacilli which gained access with the inspired air.

In the winter of 1885-6, an outbreak of tuberculosis occurred in the herd of fifty-one animals on the State College farm at Orono, Maine. There had been an occasional case in the herd for eight or ten years previous to that time, but it was not then known to be tuberculosis. Late in the autumn of 1885, a cow was attacked with a husky cough which increased in severity, and becoming much emaciated she was killed about the last of January, when her lungs were found to be badly diseased. About the same time three others were "affected with slight husky cough, and, by the end of February, most of the animals in the herd commenced coughing almost simultaneously." In fact the disease had become epidemic in the herd, and an examination made by Drs. Michener and Bailey revealed the fact that nearly all the animals in the herd were more or less affected with tuberculosis. By order of the Cattle Commissioners the entire herd was then slaughtered and buried.

Such epidemics are apparently uncommon, and it is impossible to say what caused the sudden and general outbreak at that time. The feeding, as reported by Dr. Michener, was judicious in every sense, and the hay and grain of the best quality. The history of this outbreak, from the time when the disease first appeared until the animals were slaughtered, proves conclusively that tuberculosis is both contagious and hereditary. The animals were watered from a tub into which the water was pumped from a cistern in the cellar of the barn, and any discharges from the lungs of an infected animal could very easily have fallen into the water, and been taken up by the others drinking from the tub. It is quite certain, however, that many of these animals received the disease by inheritance, while others probably inhaled it. It is a noteworthy fact that four horses were kept in the barn with some of the worst cases, and did not take the disease, which simply indicates that the horse is much less susceptible to it than the bovine race.

IS HUMAN TUBERCULOSIS COMMUNICABLE TO LOWER ANIMALS?

The experiments of Villemin. Chauveau, Klebs, Orth, Koch and others prove beyond all doubt that if the sputa of consumptive persons be injected into the tissues of our domestic animals, it is sure to induce tuberculosis in them; and if they be confined in an atmosphere more or less saturated with such sputa in water, they may also take the disease; or if fed on the diseased tissues of the lungs, the same result follows.

Dr. E. G. Janeway reports a case in the Archives ot Medicine, of a consumptive young man who allowed his pet dog to sleep with him nights, nestling in his arms. The dog became affected with a cough and died. Another dog shared the same fate, and a third began to cough, when its owner died, and the dog subsequently recovered.

Several cases are on record of cats and hens eating the sputa of consumptive patients, and thus taking the disease.

Dr. E. De Renzi found that the blood of tuberculous patients injected into the tissues of rabbits would produce the disease, though not as certainly as the sputa. This seems to indicate that the bacilli are in the blood, but not so numerous as in the sputa.

Koch made experiments on guinea-pigs with tuberculous sputa which had been kept dry for two weeks. for four weeks, and for eight weeks, and in each case it was found to have retained its full virulence, and induced the disease as certainly as fresh sputa. It is therefore safe to assume that the sputa of consumptive persons, even when dried on linen, or distributed in the dust of a room, or in a barn, may prove a source of infection to both man and beast.

IS BOVINE TUBERCULOSIS COMMUNICABLE TO MAN?

From the nature of the case, we cannot expect direct experiments to be made on man with tuberculous matter from other animals, but so many cases are on record which seem to prove that human beings are frequently infected with tuberculosis, through the milk or flesh of cows, that it seems like madness to disregard them. It is more than probable, that when children are fed with milk from tuberculous cows, serious intestinal disturbances or even tubercular meningitis may occur.

Dr. Anderson of Seeland reported a case of a calf which received tuberculosis from the milk of a cow with the disease in the udder. The wife of the owner, who had previously been considered healthy, soon developed a cough, with the other symptoms of the disease. Her child, born before the appearance of the disease, was fed with milk from a tuberculous cow, and died with the disease within six months. Dr. Anderson believed that both the mother and child contracted the disease from the cow's milk.

Dr. Bang, in a paper before the Medical Congress at Copenhagen, in 1884, said that the danger of transmission of tuberculosis from the lower animals to man lies chiefly in the use of milk from diseased cows, because it is largely used in an uncooked condition. In one case which he examined, he estimated that the bacilli of tuberculosis were so abundant, that in drinking a glass of such milk, a person would introduce into his system millions of these disease-producing germs.

Dr. Nocard read a paper on the "Danger of Tuberculous Meat and Milk" before the Medical Congress held in Paris in July, 1888, in which he said that "so far as milk is concerned, everybody agrees. The milk is not virulent except when the mammary gland is tuberculous, but the diagnosis of this localization is difficult, and often impossible, and one must treat all tuberculous cows as if the gland was always invaded."

Prof. Walley stated, at a recent meeting of the British Medical Association, that if there was no direct evidence of the transmission of tuberculosis from animals to man, there was a vast amount of indirect evidence. He said he had not the slightest hesitation in saying that it was communicable from animals to man, and back again from man to animals, in every possible shape and form. He also expressed the opinion that it might be transmitted from tuberculous hens through their eggs.

ARE HUMAN AND BOVINE TUBERCULOSIS IDENTICAL?

The numerous experiments which have been performed thus far prove that when lower animals are inoculated with the tuberculous products of man, the results are precisely the same as when the products of other animals are used, and stained sections of the diseased parts exhibit the same bacilli in each case.

Dr. Bizzozzera read a paper before the International Congress held in Turin, in which he gave it as his opinion that human and bovine tuberculosis are identical, because they have the closest anatomical affinity; and Dr. Johne states that nearly all the authorities admit the identity in construction of the tubercles in man and the lower animals.

IS BOVINE TUBERCULOSIS HEREDITARY?

From the earliest times many have believed that bovine tuberculosis is hereditary, while others have strongly doubted it. It has been repeatedly observed that calves and pigs born of tuberculous parents became affected sooner or later with the disease, and many cases have been reported of persons suffering heavy losses because of employing tuberculous animals for breeding purposes, and finally getting rid of the scourge, by disposing of all their infected animals, and obtaining others which were free from all suspicion of taint.

In the outbreak of tuberculosis in the herd on the State College farm in Maine, already referred to, there were calves slaughtered, which were scarcely a month old, but which were plainly affected with the disease.

Zippelius, in 1876, published a remarkable case proving the transmission of the disease by the male. He states that a stock-breeder whose herd had shown no signs of tuberculosis for more than twelve years, purchased a bull that proved to be affected with this disease, and was therefore killed, and all the animals sired by this bull had to be slaughtered when they reached adult age, because of tuberculosis which developed in them at that period.

The writings of Chanveau, Esser, Semmer and many others give numerous cases illustrating the heredity of this disease.

Dr. Johne, of the Dresden Veterinary School, found an eight months foetus taken from a tuberculous cow, to be affected with the disease. The placenta and uterus showed no visible signs of the disease, but in the lower lobe of the right lung a tubercle as large as a pea was detected containing the characteristics of the disease. The bronchial glands and also the liver were affected, and microscopical examinations revealed the tuberculous bacilli. This case puts the question of inheritance beyond all doubt.

It is a notable fact that tuberculous cows are very liable to abortion, and it is quite probable that, in such cases, the foetus is attacked and killed by the disease, and the abortion is the consequence.

An opinion prevails very generally that animals descended from tuberculous parents inherit a special predisposition to the disease. A similar opinion is entertained by many of the medical profession, but the celebrated Prof. Cohnheim, in his work on tuberculosis, published in Berlin in 1880, denies that man is ever born with a predisposition to tuberculosis any more than to other contagious diseases, as syphilis, small-pox, or yellow fever. He claims that the "hectic state" is one of the symptoms of the individual already diseased, and not that of one who "may be." The hereditary transmission of tuberculosis is nothing more than the infection of the ovum or foetus through the medium of one or both of the parents. The germs of the disease (spores of *Bacillus tuberculosis*) may be received into the ovum from the mother, or through the spermatozoids from the father, and these germs may cause the disease in the young, or it may fail to appear till the second generation. It seems to require some peculiar physical condition, not well understood, to cause these germs, which may have lain dormant through an entire generation, to germinate finally and produce the disease.

WHAT ARE THE SYMPTOMS OF BOVINE TUBERCULOSIS?

It is exceedingly difficult, if not impossible, in many instances, to recognize bovine tuberculosis in its earliest stages, especially when the disease is located in other organs than the lungs. When, however, the lungs are diseased, or the malady is somewhat advanced, it is not so difficult a matter. The safest way for our farmers is to accept the contagious and hereditary character of the disease, and weed out from a herd every suspected animal, bearing in mind that the owner himself and his family are in the greatest danger of becoming contaminated with this terrible disease.

The best series of symptoms that I have anywhere seen, are given in the Swiss Archives of Veterinary Medicine, published in Zurich, which, translated into as simple language as is consistent with accuracy, are as follows:

Tuberculous animals very often have a short, interrupted and dry cough which is most apparent in the morning, at the time of feeding, and sometimes after active exertion. At the commencement of the disease, the animals are often in good condition, and, with good care and feeding, they may even gain during the earlier stages of the disease. As it progresses, however, the animals grow poor, the hair becomes dull, erect and matted, losing its healthy appearance; the skin becomes tender and appears very pale over the udder and other parts not covered with hair. The eyes are dull and sunken in their orbits because of the wasting away of the fatty cushions upon which they rest. The cough grows more frequent, but it is seldom accompanied by any nasal discharge. The animal becomes more and more emaciated, notwithstanding the fact that the appetite may be good and the food of the best quality, and supplied in abundance. As these changes go on, the quantity of milk diminishes in milch cows, and the animal has a general unhealthy appearance.

There is sometimes an unusual sensitiveness and flinching exhibited when the sides of the chest or the breast are pressed, and this sensitiveness is sometimes present from the very commencement of the disease: and in the more advanced stages, the animal tries to avoid the pressure, or indicates the suffering it causes by groans. The disease may nevertheless be present without these symptoms.

Nymphomania is also occasionally observed in tuberculous cows. In this case they exhibit all the symptoms of being in heat, as inquietude, indocility, etc., but as nymphomania sometimes occurs in other diseases, it cannot be regarded as positive evidence of the presence of tuberculosis.

When the lungs are diseased with tuberculosis, the movements of the ribs and wings of the nostrils are normal, unless the disease is in a very advanced stage; but if the animal is forced to move quickly, the breathing becomes laborious or disturbed. In cases where the disease is not so advanced, the difficult breathing is scarcely noticed during repose; but if the lining of the thorax (pleura) is affected, it is more apparent and may be so pronounced as to assume the abdominal character. When this occurs there is more than ordinary sensitiveness exhibited on pressure, especially above and behind the shoulders, along the back and in the costal region.

I would add that when the tubercles are on the membranes of the brain, the animal is liable to have a stiff neck or carry its head to one side. When the disease is located in the liver, spleen, mesenteries or other organs, the animal will give more or less evidence of suffering in these organs, or may flinch and give other evidences of pain when the parts over the affected organ are pressed. The presence of nymphomania undoubtedly indicates a diseased condition of one or both of the ovaries, and this might be sufficient to destroy the ova and cause sterility. When the disease attacks the udder it frequently causes a very diffuse painless swelling of a portion of the organ, most frequently one of the posterior quarters, and a considerable swelling may occur in a few days. It is a remarkable fact that the udder swollen with this disease may yield the usual quantity of apparently healthy milk, which is not the case when the swelling has a different origin.

IS BOVINE TUBERCULOSIS CURABLE?

From the nature of the disease it does not seem possible to destroy the bacilli in the body, so that the malady may not make its appearance again under favoring conditions; and when we recall the extreme danger there is to the whole herd, and to man also, from a single infected animal, it seems neither wise nor prudent to retain an animal which is suspected of being contaminated in any way with this disease. This same idea is expressed by Dr. Law in his most excellent "Farmer's Veterinary Adviser."

WHAT MEASURES SHOULD BE TAKEN TO AVOID THE CONTAGION?

It is believed that if living bacilli of tuberculosis be received into the body, by whatever means, or from whatever source, they will be liable to cause the disease, especially in those organs which contain stagnant or nearly stagnant fluids, such as mucus, lymph, etc. The bacillus which causes tuberculosis is a plant, and within it are developed seeds (spores), and any consideration of it must recognize this fact. These spores require suitable conditions for germination and growth, such as a suitable "soil," moisture, and temperature, as surely as corn or the seeds of other plants. Koch found in his experiments that these spores would develop in a temperature ranging between 86° and 104° F., and this condition is furnished within the bodies of warm-blooded animals. The time required for these plants to germinate—the period of incubation as it is called—is not very accurately established, but according to the experiments of Koch, it is probably about two weeks. It is therefore necessary for the germs to remain fixed in the nutritive material for a protracted period ni order to germinate and produce the well-known results.

The bacilli, as has already been stated, may gain entrance into the body through the inhaled air, with the food and drink, or with the genital organs, and in the case of man, it may be inoculated into the body with vaccine matter, if this, by any chance, be taken from an infected animal. This fact suggests that the utmost care should be used in selecting vaccine matter.

Tuberculosis can be successfully combated only by destroying the means of infection, and, as Dr. Johne says, we must look upon the sputa of consumptive persons, as well as substances polluted by the same, and animals having the disease, as the centers of infection.

The Council of Hygiene of the Department of the Seine published the following rules for preventing the propagation of Tuberculosis, in the *Medical Gazette* of Paris, Feb. 27, 1886.

"The most active agent in the transmission of tuberculosis is the sputum which should therefore never be deposited on the floor or on the linen where it may be converted into a dangerous element.

"The patients in question must be instructed to expectorate into vessels containing sawdust, the contents of which must be daily thrown into the fire, and the vessels themselves washed in boiling water at least once a day.

"The furnished apartment of a consumptive patient, especially in case of death, must be thoroughly disinfected, together with all bedding, and the clothing of such a patient must not be used until it has been subjected to the action of steam.

"Since sheep are far less susceptible to tuberculosis than cattle, it would be far safer to recommend the rare flesh of that animal for sickly children and adult invalids, than rare beef."

Dr. Johne give the following very sensible recommendations which may prove useful to farmers and stock-breeders, in stamping out this disease in their herds.

"All tuberculous animals or those with tuberculous tendencies must be unconditionally excluded from breeding.

"All animals diseased with tuberculosis must be separated from healthy ones, and immediately slaughtered. Suspected ones should be treated in the same manner.

"Stables in which such animals have been kept must be thoroughly cleansed and disinfected.

"Everything tending to cause a predisposition to disease must be carefully avoided, and great care given to ventilation, diet, exercise and exposure."

There ought to be a careful and critical supervision, at the public expense, of all slaughter houses and of the meat offered for sale in our markets, and also frequent examinations of the herds kept for supplying the public with milk, butter and cheese; but as this will not probably be secured immediately, it is a wise precaution adopted in many families to boil all the milk and to cook thoroughly all the meat used. Even then we shall have to take our chances on the butter and cheese used, since it is impracticable to boil the milk before the manufacture of these products.

It has been shown that boiling or roasting in the ordinary way is not sufficient to destroy the germs in the center of large pieces of meat, and that the bacilli will not be destroyed unless the heat is sufficient to change the color of the animal juices. It has also been shown that a temperature of 185° F. is sufficient to destroy the virulence of tuberculous milk, and that this temperature will not change its taste.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 4.

APRIL, 1889.

The Bulletins of this Station will be sent free to all newspapers in the State and "to such individuals actually engaged in farming as may request the same."

AMHERST, MASS.:
J. E. WILLIAMS, BOOK AND JOB PRINTER.
1889.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL,	*Director.*
WILLIAM P. BROOKS,	*Agriculturist.*
SAMUEL T. MAYNARD,	*Horticulturist.*
CHARLES H. FERNALD,	*Entomologist.*
CLARENCE D. WARNER,	*Meteorologist.*
WILLIAM M. SHEPARDSON,	*Assistant Horticulturist.*
H. E. WOODBURY,	" "

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

HATCH EXPERIMENT STATION,
AMHERST, MASS.

Division of Horticulture.

S. T. MAYNARD.

EXPERIMENTS IN HEATING GREENHOUSES.

STEAM HEAT versus HOT WATER.

During the past few years much attention has been given to the subject of economy in heating greenhouses, and the manufacturers of steam heating apparatus have made great efforts to supplant the long established system of hot water heating.

In order to get at some facts in regard to this subject, so important to the grower of plants under glass, and gain some positive knowledge as to the relative value of the two systems, two houses were constructed during the summer of 1888, 75x18 feet, as nearly alike as possible in every particular. Two boilers of the same pattern and make* were put in, one fitted for steam and one for hot water; the steam for heating the east house, and hot water for the west and most exposed one. The boilers were completed and ready for work in November and were tested until January 9th, 1889, when these experiments began.

Records of temperature of each house were made at 7-30 and 9 A. M., and 3, 6 and 9 P. M. Sufficient coal was weighed out each morning for the day's consumption and the balance not consumed deducted the next morning. The two boilers and fittings were put in so as to cost the same sum and were warranted to heat the rooms satisfactorily in the coldest weather.

The following tables give the maximum, minimum and average daily temperatures for the months of January and February, with the amount of coal consumed. The average daily outdoor temperature is given in the second column for comparison.

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*F. W. Foster, Manufacturer, 51 Charlestown St., Boston, Mass.

January, 1889.

January	Outdoor average daily temperature.	HOT WATER. Lettuce and Carnation Room. Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.	STEAM. Lettuce and Carnation Room. Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.
1	33.7°	41. °	53. °	45.8°	*	38. °	51. °	43.8°	*
2	35.2	43.	49.	45.2		41.	49.	44.6	
3	38.	42.	52.	44.8		41.	53.	44.	
4	39.	40.	54.	46.		39.	53.	44.4	
5	37.	41.	47.	43.4		39.	46.	42.6	
6	36.	42.	43.	42.4		40.	42.	41.	
7	37.2	43.	48.	45.4		42.	45.	43.6	
8	39.	43.	53.	47.6		41.	52.	45.4	
9	41.8	46.	58.	49 4		45.	58.	49.2	
10	38.	42.	51.	44.6		42.	53.	44.6	
11	34.3	40.	54.	45.		39.	48.	42.6	
12	31.	40.	53.	44.8		36.	53.	42.8	
13	33.	38.	56.	46.8		36.	56.	44.8	
14	30.3	42.	55.	48.		41.	52.	46.6	
15	25.7	45.	55.	48.6		45.	53.	49.	
16	36.3	44.	56.	48.8		44.	47.	45.4	
17	50.	50.	55.	51.8		48.	55.	51.2	
18	37.3	46.	59.	49.8		41.	51.	47.4	
19	18.6	42.	52.	46.6		45.	55.	48.4	
20	17.3	45.	58.	50.4		42.	58.	49.2	
21	27.	39.	48.	44.2		37.	45.	42.6	
22	22.	41.	54.	45.8		41.	56.	44.6	
23	23.	42.	58.	49.2		40.	60.	48.4	
24	39.	47.	58.	50.8		42.	48.	45.	
25	34.3	42.	68.	54.		38.	69.	48.4	
26	29.3	44.	66.	52.6		42.	64.	50.4	
27	32.6	45.	49.	47.2		40.	44.	42.8	
28	33.6	45.	62.	49.8		42.	55.	45.8	
29	17.3	39.	54.	43.6		40.	59.	45.6	
30	21.3	42.	67.	51.6		42.	67.	51.6	
31	33.3	43.	65.	51.		43.	64.	49.6	
Av'ges	29.1	42.7	55.1	47.5	Total 2532 lbs.	41.0	55.1	45.9	Total 3220 lbs.

*The daily consumption of coal was not taken until Feb. 1st.

February.

February.	Outdoor average daily temperature.	HOT WATER. Lettuce and Carnation Room. Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.	STEAM. Lettuce and Carnation Room. Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.
1	22.3°	44. °	66. °	50.4°	250 lbs.	41. °	64. °	47. °	245 lbs.
2	28.	40.	67.	48.6	50	42.	67.	48.8	70
3	25.3	41.	59.	47.2	140	39.	58.	45.4	150
4	12.3	39.	66.	49.8	104	37.	69.	48.2	111
5	29.7	49.	61.	52.	109	46.	61.	50.4	90
6	16.3	42.	59.	48.4	200	41.	55.	44.6	290
7	14.7	47.	63.	52.8	158	47.	61.	52.2	202
8	23.7	43.	59.	51.	47	46.	58.	51.6	66
9	27.	35.	65.	47.	31	41.	62.	48.4	49
10	25.	40.	61.	49.6	102	38.	66.	47.	150
11	21.	41.	60.	50.2	70	39.	57.	46.	104
12	20.	45.	68.	52.	80	42.	69.	49.	154
13	11.3	40.	60.	46.8	140	10.	55.	44.8	194
14	21.	46.	70.	53.	72	43.	73.	53.8	103
15	25.	44.	65.	55.6	78	42.	68.	52.4	118
16	30.	48.	64.	53.8	32	44.	53.	50.4	60
17	39.3	46.	60.	52.2	24	44.	57.	49.	55
18	34.	45.	52.	47.4	36	42.	54.	47.4	81
19	25.7	40.	68.	50.8	56	38.	71.	51.	130
20	32.	40.	68.	48.2	94	40.	67.	47.	121
21	25.7	40.	70.	51.4	35	38.	72.	49.6	63
22	34.	41.	52.	45.4	117	41.	56.	45.2	67
23	2.	38.	50.	42.8	117	39.	46.	42.	183
24	8.7	37.	56.	46.2	139	37.	55.	47.4	167
25	15.7	41.	65.	49.0	192	42.	55.	47.	127
26	17.3	41.	62.	49.4	150	38.	53.	46.2	61
27	29.7	42.	58.	47.4	61	40.	48.	43.8	29
28	30.7	40.	60.	50.8	43	39.	56.	45.6	110
Av'ges	23.1	41.9	58.4	49.6	2642 total	40.9	60.2	47.9	3362 total

UNCONSUMED COAL IN ASHES.

As far as we could determine by close examination and weighing, there was about the same proportion of unconsumed coal as of that consumed in the ashes from each boiler.

The following table shows the record of the week ending Feb. 26.

February, 1889.	Average daily outdoor temp'ture.	Average daily indoor temperature.		Fuel consumed.		Ash.	
		Hot water.	Steam.	Hot water.	Steam.	Hot water.	Steam.
20th	32.°	48.2°	47.°	94 lbs.	121 lbs.	20 lbs.	33 lbs.
21st	25 7°	51.4°	49 6°	35	63	17	21
22d	34.°	45.4°	45.2°	117	67*	6.5	11
23d	2.°	42.8°	42.°	117	183	16	26
24th	8 7°	46.2°	47.4°	139	167	26	45
25th	15.7°	49.6°	47.°	92	127	17	25
26th	17.3°	49.4°	46.2°	150	61*	25	16
Average.	17.9°	47.6°	46.3°	T'l744	789	127.5	177

*These two are the only days of the whole month in which the amount of coal consumed in the steam boiler was materially less than that consumed in the hot water boiler, and any other week would show much more marked difference in favor of the latter.

RESULTS.

It will be seen by the foregoing tables that the hot water boiler consumed 720 lbs. less coal than the steam boiler in February, and 688 lbs. less in January, a saving of nearly 20 per cent.

At the same time the temperature of the room heated by hot water averaged 1.7° higher than that heated by steam.

The temperature was more even where heated by hot water, and consequently there was less danger from sudden cold weather. This was strikingly shown on the night of February 22d.

The average outside temperature for the day was 34°.

At 9 P. M. it was above 32° and proper precautions not having been taken for so sudden a change as followed, at 6 o'clock on the morning of the 23d, the temperature of the room heated by steam was 29°, while in that heated by hot water it was 35°.

CONCLUSION.

While this test is conclusive for the two boilers employed in these two houses as constructed and for this unusual winter, in a larger house and in a winter where the temperature runs lower and with greater extremes, different results might possibly be obtained, but this can only be settled by carefully made and accurately recorded tests which we hope another year to make.

We would suggest that if those who have kept accurate records of the temperature of their greenhouses, together with the amount of coal consumed, will send us the figures, giving size of house and kind of heating apparatus, we shall be glad to put them on record in our bulletins for the benefit of those who are thinking of building new houses or refitting old ones.

GREENHOUSE WALLS.

The comparative protective value of different materials for construction.

To determine the value of greenhouse walls constructed of different materials as a protection against the weather, four sections, six feet long by four high were constructed in the new greenhouse recently erected.

Section 1. Concrete, (Roslindale cement, one part to three parts of sand).

Section 2. Hollow brick, nine inches thick.

Section 3. Framed hollow wall covered with lining boards, building paper and sheathing on the outside, and the same without the paper on the inside.

Section 4. Same as section 3, but the space was filled with dry pine shavings.

In each of these walls was made a space five inches wide and one foot long running to the center, in which were placed thermometers so protected as not to be affected by the inside temperature of the house. Other thermometers were placed on the inside surface of the walls similarly protected from inside temperature.

The temperature of each kind of wall, both inside and surface, was recorded at 7-30 A. M., 3 P. M. and 9 P. M.

The results are stated in the following tables, in which will be found the daily average temperature of both the interior and inner face of the walls from Jan. 9 to March 1st.

The outdoor temperature for the same time, is given in the central column, for comparison.

Average Daily Temperatures.

JANUARY, 1889.

Date.	Inner Surface. Cement.	Inner Surface. Brick.	Inner Surface. Boards and Air Space.	Inner Surface. Boards and Shavings.	OUT-DOOR.	Interior. Cement.	Interior. Brick.	Interior. Boards and Air Space.	Interior. Boards and Shavings.
9	42.°	43.6°	45°	48°	41.8°	41.8°	41.3°	42.3°	42.3°
10	41.	41.6	43.6	44.3	38.	38.6	37.3	41.	41.3
11	38.	39.3	41.6	43.3	37.3	37.	35.3	42.	42.3
12	37.	39.3	38.6	39.3	31.	35.3	37.6	36.	36.
13	38.3	39.3	42.3	43.3	33.	38.6	37.3	38.6	37.
14	41.6	43.6	46.3	47.6	30.3	41.	39.3	42.3	40.6
15	40.	42.3	45.6	47.3	25.7	39.	36.3	40.	42.3
16	39.6	41.6	45.3	47.	36.3	39.6	38.3	42.3	41.3
17	48.3	49.6	51.3	52.	50.	49.6	46.6	47.	49.3
18	43.6	45.	46.6	48.6	37.3	42.	40.6	43.7	43.
19	39.3	41.3	44.	47.3	18.6	34.3	34.	36.6	36.3
20	39.	41.	46.	48.6	17.3	31.6	30.6	38.6	37.3
21	36.	39.3	43.	45.3	27.	32.6	32.	37.	44.3
22	36.3	39.	42.	44.	22.	33.3	32.6	39.	36.
23	37.	39.3	44.	45.6	23.	38.	32.3	39.	37.3
24	38.3	41.6	45.3	48.	39.	38.6	38.3	42.3	42.6
25	41.3	44.6	47.	49.3	34.3	43.	42.	44.3	42.3
26	42.3	45.	49.	51.	29.3	40.6	40.3	43.	42.3
27	40.3	42.6	49.	46.6	32.6	38.6	38.3	41.3	41.
28	41.6	43.3	46.	47.3	33.6	40.	39.	42.	41.3
29	38.3	39.	42.	44.	17.3	34.6	34.6	36.3	35.3
30	38.	39.3	42.6	45.	21.3	32.6	31.3	36.6	36.3
31	38.3	40.	44.3	46.6	33.3	37.3	35.6	40.6	41.6
AVERAGE MONTHLY TEMPERATURE.	39.8°	40.9°	44.3°	46.5°	30.9°	38.3°	37.2°	40.2°	40.4°

FEBRUARY, 1889.

Date.	Inner Surface. Cement.	Inner Surface. Hollow Brick.	Inner Surface. Boards and Air Space.	Inner Surface. Boards and Shavings.	OUT-DOOR.	Interior. Cement.	Interior. Hollow Brick.	Interior. Boards and Air Space.	Interior. Boards and Shavings.
1	42.3°	43.3°	46.3°	46°	22.3°	40.3°	38°	42°	41°
2	38.7	40.	43.3	45.3	28.	38.	37.3	37.	36.
3	39.	40.3	44.	46.7	25.3	37.3	39.3	47.	39.3
4	38.7	39.	45.	47.3	12.3	32.3	30.7	35.7	37.
5	39.	40.7	46.7	48.7	29.7	34.7	34.3	41.	40.
6	40.	41.	46.7	49.3	16.3	34.3	28.	37.7	36.3
7	39.	39.	44.3	49.	14.7	27.7	24.7	30.3	33.
8	40.	40.	46.	47.7	23.7	32.3	32.	37.3	37.3
9	38.3	40.3	46.7	46.7	27.	33.7	34.	41.7	40.3
10	42.	40.3	49.	48.7	25.	35.	35.7	41.7	42.7
11	40.	40.7	45.3	45.	21.	34.	34.7	37.	37.
12	43.	43.	46.7	49.3	20.	39.7	36.	43.7	41.7
13	39.	38.	42.7	43.	11.3	31.7	26.3	31.3	31.7
14	41.3	41.	48.3	49.7	21.	31.7	30.	39.7	37.3
15	42.	42.3	48.	49.7	25.	38.3	34.7	43.3	40.3
16	42.	43.3	48.7	49.3	30.	37.3	37.3	41.	41.3
17	45.3	46.7	49.3	49.	39.3	46.	45.7	48.7	46.3
18	44.7	44.7	46.3	46.7	34.	41.7	41.	43.	43.
19	43.3	42.7	46.3	46.7	25.7	38.3	36.3	40.7	40.3
20	42.	41.	44.3	46.	32.	36.	32.7	38.7	38.3
21	40.3	39.7	42.7	43.	25.7	35.7	30.7	35.	37.
22	41.3	41.	45.3	44.7	34.	41.3	39.7	41.	40.
23	38.7	37.	39.3	39.	2.	33.7	27.7	30.7	30.
24	40.	37.	41.3	42.	8.7	27.7	26.7	30.3	32.3
25	36.7	37.7	42.3	43.7	15.7	32.7	30.7	37.	35.
26	37.3	37.7	43.7	43.	17.3	32.	30.	37.3	35.
27	38.	39.	44.7	44.3	29.7	35.7	35.	41.	39.
28	40.3	43.	46.	47.	30.7	44.7	43.7	47.3	44.
AVERAGE MONTHLY TEMPERATURE.	40.4°	40.6°	45.3°	46 3°	23.1°	35.8°	33°	38.9°	36.3°

Much has been said and written as to the protective value of the building materials commonly used in the construction of greenhouse walls, but generally without facts or figures to substantiate the statements.

After the extended observations recorded above, we feel that we have facts and figures which lead to the following

CONCLUSIONS.

1st. That on the inside of the wall, the lined board walls, filled with shavings, give the best results, that with the hollow space being but little less valuable.

2d. That hollow brick and concrete walls are about equally valuable in protecting from cold, but not equal to the framed and board walls.

REMARKS.

As to the cost of construction there can be but little difference, and the important question of durability can only be determined after ten or fifteen years' service.

GLAZING EXPERIMENT.

Zinc Strips between the joints in glazing Greenhouses.

In the construction of a new greenhouse for experimental purposes, a portion of the house was glazed with Gasser's Patent Zinc Joints. These joints consist of zinc strips about one-half inch wide, bent in form of the letter a···Z···b, the ends of the lights of glass coming together on the opposite side of the vertical part of the letter, as at a and b. This allows the glass to be laid flat on the sash bars, with little or no chance for the frost to act upon the putty as in lapped glass. No water can enter between the laps of the glass to start it from place when frozen, and no air can possibly enter no matter how strong the wind may blow.

In glazing, the strips were simply dipped in linseed oil, and the glass tacked in place with ordinary zinc points; large points not being needed as with lapped glass. As no laps were made there is a saving of from 1-8 to 1-4 inch with each light of glass used. The drip of water that runs down the glass inside was found to be no more than with lapped glass.

CONCLUSIONS.

1. By the use of these strips there is a saving in glass.
2. The glass is more easily laid.

3. Less putty is needed.
4. The frost cannot get under the glass as readily as when lapped.
5. The glass does not slip down if the lower light is well fixed in place.
6. No air can penetrate between the joints.
7. No more drip was observed than with the lapped glass.

EVAPORATED SULPHUR,

For the destruction of Mildews and Insects in Greenhouses.

In the growth of plants under glass we meet with many parasitic fungous growths and minute insects that are very destructive. Having made some extended experiments with *Evaporated Sulphur* for the destruction of mildews and leaf blights on the rose, lettuce, and violets. and the minute insect known as the red spider, so injurious to the leaves of roses and other plants, we give the following results.

ROSE LEAF-BLIGHT.

(*Actinonema rosea*).

During the fall, the roses in the Durfee Plant-House were seriously injured by large, dark brown or nearly black spots on the leaves, covering in many cases the entire leaf, and soon causing it to wither and fall. Upon investigation and inquiry it was found to be the rose leaf-blight, *Actinonema rosea*, which was described and illustrated in the report of the Section of Vegetable Pathology of the Agricultural Department for 1887.

To overcome the injury we began the use of evaporated sulphur, which we had previously used for the destruction of the common rose mildew and red spider.

RESULTS.

After a few weeks' use, no new spots developed on the leaves and none have since appeared.

THE REMEDY.

This remedy consists in keeping a kettle or basin of sulphur (brimstone) heated to nearly the boiling point, in the room for three or four hours twice or three times a week. The apparatus used was a Florence or Monarch hand-stove with the sulphur in a thin iron kettle. Enough sulphur must be evaporated to fill the room with the vapor, so that it will be visible and give something of the odor of sulphur.

Caution. It is well known that *burning sulphur* is quickly destructive to all plant growth, and every precaution should be taken that it is not heated so hot as to take fire, or that the kettle does not get upset. The lamp or stove should have a broad base or the kettle be placed on a tripod with feet well spread. It should be placed under the bench where it can be readily seen, but where the clothes of a person passing by may not catch upon it and upset it.

ROSE MILDEW.

Erysiphe (Sphaerotheca) pannosa.

Another very common difficulty we have had to contend with in our greenhouses, which are not properly constructed for successful rose culture, is the rose mildew.

Careful observations lead us to the conclusions: (1) That this disease may be brought on by the exposure of the plants to draughts of extremely cold air when they are growing rapidly, (2) by high temperature running the same both night and day, (3) by watering or syringing just before night, (4) by too little water, (5) by extreme dryness, (6) by poor drainage, and (7) by a deficiency in plant food. In fact anything that may in any way weaken the plant.

REMEDIES.

Since the use of evaporated sulphur was begun in the house it has been almost impossible to find enough mildew on the plants to afford specimens for examination in the laboratory.

LETTUCE MILDEW.

(*Peronospora gangliformis.*)

Perhaps the greatest obstacle to the growth of good lettuce under glass, and which causes the greatest loss to our market gardeners, is that of the lettuce mildew.

By observations made in the growth of lettuce in our greenhouses for the past ten years, we conclude that this disease may be brought on by the following conditions:

1. A temperature ranging from 45° to 50° at night, especially if following a cloudy day, when it has not been above 55°. In sunny days, if the temperature runs up to 65° or 70°, the night temperature may run up to 45°, and perhaps higher, without injury, if the house and beds are not very moist.
2. Want of proper plant food in the soil.
3. Too much moisture in the soil.

4. Sudden and extreme changes in the temperature when the plants have been growing rapidly and are soft and tender.

5. The same temperature both day and night.

1. In our experience the best results have been obtained where the temperature runs as low as 35° and 40° at night, and not higher than 65° to 70° during the day, and where but little outside air is admitted to the house, *unless the out-door temperature is as high as 40°.*

On the nights of Feb. 4th, 5th and 7th, the temperature ranged from 48° to 52°, and our records show that the mildew developed rapidly during that time, while on the nights of Feb. 19th, 20th and 21st the temperature stood below 40°, and during this time there was no perceptible increase.

2. All the elements of plant food must be supplied in abundance and especially, in a quickly soluble form. In an experiment made with Sulphate of Potash, Muriate of Potash, Nitrate of Soda, Nitrate of Potash, Sulphate of Ammonia, Bone Black, Dried Blood, and seven other mixed fertilizers, it was found that the Nitrates of Soda and Potash, applied to a soil liberally supplied with stable manure, produced a vigor of leaf that was much less injured than where the other elements were used.

Of two soils, one made of rotted sods and old compost taken from a hot bed, and the other of the sods and freshly-composted stable manure, it was found that the first gave by far the best results. Equal quantities of each material were used as nearly as could be determined in both cases.

3. While lettuce cannot be grown under glass without an abundance of water, it has been found best to apply it only in the morning. It is a settled fact that the lettuce mildew, like most plants of its kind, can only grow under conditions of a close moist atmosphere and a high temperature, and if the watering is done in the morning, and especially on sunny days, the moisture gets dried from the leaves before night and the mildew is less liable to grow.

4. As with the rose mildew, a sudden chill, when the lettuce plants are growing rapidly, will check their growth and so weaken them that the cells develope food in the proper condition for the rapid growth of such parasitic plants. That a plant in a vigorous, healthy condition will resist the attack of the mildew longer than a sickly one, is shown by the fact that the weakest plants are always first injured by it.

Under proper conditions of soil, temperature and moisture, the lettuce crop can be successfully grown, but if the plants become weakened from any cause, they are likely to be attacked when the temperature is allowed to go above 40° at night.

5. In order to have perfect assimilation and growth in plants under glass, that temperature must be provided under which they grow most vigorously out of doors. In the garden we find the night temperature averaging from 15° to 25° lower than that of the day. In the summer when the temperature is high and ranges about the same, night and day, mildew, blight, rust, smuts, and all manner of parasitic plants grow rapidly. Now, if in our greenhouses we ventilate during the daytime, and at night start up the fires so that the temperature is as high at night as during the day, we have just the conditions under which mildews develope outside, and if a record of the temperature were kept I am confident that in those houses most afflicted with mildew this condition of things would be found.

PREVENTIVES.

Before looking for remedies we should take advantage first of such preventive measures as are effective, and experience has shown that:

1. Lettuce must be grown at a low temperature, ranging from 35° to 40° at night to 50° to 70° during the day to escape the mildew.
2. An abundance of plant food must be supplied at all times.
3. Nitrate of Soda and Potash are valuable in developing a vigor of leaf that will tend to resist the attack of the mildew.
4. An abundance of water must be used, but the drainage should be good and the watering done in the morning and on bright days only.
5. Sudden extreme changes of temperature must be avoided.

REMEDIES.

Evaporated Sulphur. To test the value of this remedy for lettuce mildew, the temperature of the house on the nights of March 12th, 13th, 14th, and 15th was allowed to run up to 50°, 56°, 47°, and 51° respectively. Most of the crop had been cut for market, but what remained was badly mildewed. Two kettles of sulphur were kept running from 6 to 9 o'clock in each evening, the vapor being very abundant. Except where the vapor could not penetrate among the leaves the mildew was certainly very much checked and no new growth appeared on the exposed surface of the leaves.

From this trial and the continued use of it for several weeks previous, although not as thoroughly made, we feel convinced that evaporated sulphur will largely prevent the development of mildew, but when it has once become established it will not entirely destroy it.

Sunlight. This is one of nature's greatest antiseptics and in the construction of houses for the growing of lettuce, as much sunlight must be admitted as possible.

RED SPIDER.

(*Tetranychus telarius.*)

This minute insect is often very destructive in greenhouses, especially where the air is kept dry and at a high temperature. It is so small, and under favorable conditions it increases so rapidly, that serious harm is often done before it is discovered. In our rose room and other rooms where the sulphur has been evaporated regularly, scarcely a specimen can be found, and if at any time we find them upon plants, an exposure of a few hours in the room where the sulphur is used will exterminate them.

Experiments of Hon. E. W. Wood, West Newton, Mass.

In connection with our report of the use of evaporated sulphur as a fungicide and insecticide, we are pleased to report the results of experiments made by Mr. Wood, who, with the late John B. Moore of Concord, Mass., first suggested its use to us. He writes as follows:

"In answer to your inquiry as to my experience with evaporated sulphur as a fungicide and insecticide in the cold grapery, I would say that in 1884 the red spider appeared on two of my eighteen vines, the first week in August, and so injured the foliage that the fruit ripened but imperfectly. The following year the spiders appeared on all the vines the last of July, the foliage commenced turning brown and their webs covered the under side of the leaves. I procured some flowers of sulphur, and using an ordinary sauce dish of glazed granite ware, put in the sulphur to the depth of one and one-half to two inches and placed it over the blaze of the second size Summer Queen Oil Stove and boiled the sulphur three and one-half hours, filling the room with the vapor. The next morning by the most careful examination with a microscope I could not find a live spider in the house. From that time on the new foliage was as clean and bright as in the early part of the season and the fruit ripened perfectly. I have found the evaporated sulphur equally effectual in destroying mildew which occasionally appears in most cold graperies."

Mr. Wood also finds this remedy effectual in preventing the fungous growth that causes the dropping of the leaves of the chrysanthemums after they have been taken from the ground in the fall.

CONCLUSIONS.

From our own experiments and the reports of those who have used the evaporated sulphur we can recommend its use for the destruction of rose leaf blight, rose mildew, grape mildew, chrysanthemum leaf blight and the red spider. It is certainly an aid also in preventing mildew on the lettuce. Further experiments however begun earlier in the season may give more positive results, but our main dependence in the growth of lettuce under glass must be the proper conditions of temperature, moisture and plant food.

I would again advise *caution* in the use of sulphur, and that every precaution be taken to avoid its taking fire, for the fumes of burning sulphur will quickly destroy all plant life, and even five minutes of burning might destroy hundreds and perhaps thousands of dollars worth of plants.

THE PLUM WART.

(*Sphoeria morbosa.*)

The plum is easily grown and would be a profitable crop in Massachusetts were it not for the black wart so common on the branches of the old trees, and the plum curculio (*Conotrachelus nenuphar.*) A means of overcoming the latter has been found by planting the trees in poultry yards, and by recent experiments it is believed that syringing the trees with paris green at the time when the curculios are working will prove effectual. The black wart however has not been so successfully controlled. The wart, which every plum grower is familiar with, and which is also found on the old sour garden cherry and the wild choke cherry, often more abundantly even than upon the plum, is due to a parasitic fungous growth, the spores of which germinate in moist weather on the bark, and penetrating it, feed upon the soft inner tissues of the branch. The growth of the fungus and that of the tree in its effort to overcome the injury, causes this enlargement which is known as the black wart or the black knot of the plum.

To determine if there is not a more effectual and satisfactory remedy than that of cutting off and burning the warts (which is in part effectual) the following liquids were applied.

1. Linseed Oil.
2. Turpentine.
3. Kerosene.

These remedies were applied with a small brush as soon as the warts began to appear. As they do not all come out at once, examination and application of the remedies were made three times during the summer, all warts being painted over each time.

RESULTS.

In three examinations made with the microscope during the fall and winter, no spores, (ascospores) were found in the warts. In fact none of the sacks (perithecia) were developed enough to produce them before the warts were destroyed by the remedies. In some cases where the kerosene and turpentine were applied in so large quantity as to spread around the branch or to run down it, the branches were killed. No such injury occurred where the linseed oil was used.

CONCLUSIONS.

1. Linseed oil, turpentine and kerosene all effectually destroyed the plum wart.

2 Turpentine and kerosene must be used with great care.

3. Examinations should be made at least three times during the summer, from June 1st to August 30th.

4. Enough of the liquids must be applied to saturate the wart.

5. As the plum wart is readily propagated on the wild choke cherry all such trees should be destroyed, and all of the warts upon the trees of the garden (morello) cherry should receive the same treatment as those on the plum trees.

SUGGESTION.

While the above remedies have proved effectual it is suggested that possibly a more harmless remedy may be found in the use of sulphate of copper, although no experiments have been made with it to our knowledge. Applied with the hand pump in the spring, before the leaves have unfolded, it would probably destroy all spores lodged in the crevices of the bark; and used in concentrated solutions with the brush it would probably destroy all warts that might start later in the season from the mycelium or spores remaining in the tissues during the winter.

TESTING NEW VARIETIES.

Owing to the lateness of the season when the Hatch Appropriation was available, our plans for experimentation with varieties of fruits, vegetables, flowers, etc., were not matured in time to do much satisfactory work.

A few especially promising varieties were purchased and others were sent in by the originators or introducers. The latter were given as careful treatment as our circumstances would allow and the results are given as follows.

POTATOES.

The varieties sent in for testing, one of each kind, were cut into pieces of single eyes, one piece being planted in each hill, fifteen inches apart. The land on which they were planted was naturally rather heavy and wet and the abundance of rain made it almost impossible to properly cultivate them. A mixed fertilizer was applied containing an abundance of plant food. Although the crop was almost a failure, the conditions being the same for all varieties, we give the record of the yield of each in the following table, to show their comparative behavior under equally unfavorable conditions.

NAME.	SENT BY	No. of Hills.	Weight of Yield. lb.	oz.	REMARKS.
Seedling,	E. A. Everett, Indianapolis, Ind.	10	3	4	Small, decayed.
Rural New Yorker,	J. M. Thornburn, New York City,	12	10	4	Good.
Chas. Downing,	J. J. H. Gregory, Marblehead, Ms.	4	7	0	Very good.
Early Oxford,	" "	6	9	12	Good.
Delaware,	" "	11	18	8	Good.
Seedling,	" "	8	21	4	Very good.
Scotch Magnum,	Imported,	10	7	10	Small, poor.
Beauty of Hebron.	Northern New York,	8	11	0	Medium.
" "	Amherst,	7	12	0	Good.

BEANS.

The varieties of beans in the following table were sent in for trial and all received the same treatment, as to soil, time of planting, fertilization, and cultivation.

NAME.	SENT BY	No. of Hills.	Weight of Product. lb.	oz.	REMARKS.
Boston Favorite,	J. J. H. Gregory, Marblehead,	19	3	4	Good, late.
Early Carmine, Podded Horticul'l,	" "	16	1	6	Showy, extra early.
New Prolific Black Wax,	" "	24	2	0	Good.
Snow Flake,	" "	58	5	12	Fair.
Champion,	" "	20	2	13	Fair.

LIST OF FRUITS.

The following varieties of fruits are now growing for experimental purposes in the grounds of the Horticultural Department.

APPLES.

Alexander,
American Beauty,
Baldwin,
Ben Davis,
Benoni,
Brilliant,
Carolina Red June,
Chenango Strawberry,
Congress,
Delaware Winter,
Early Harvest,
Early Strawberry,
Fallawater,
Fall Pippin,
Fameuse,
Garden Royal,
Gilliflower,
Gravenstein,
Grimes Golden,
Greening R. I.,
Haas,
Hubbardston,
Hurlbert,
King of T. Co.,
Lady Apple,
Ladies' Sweet,
Leicester Sweet,
Mann,
Minister,
Mother,
Northern Spy,
Oldenburg,
Pewaukee,
Porter,
Pound Sweet,
Primate,
Red Astrachan,
Red Bietigheimer,
Red Russett,
Roxbury Russett,
Stump,
Summer Extra,
Summer Rose,
Tetofski,
Wealthy,
Williams,
Willow Twig,
Westfield Seek-no-further.

RUSSIAN APPLES.

Blue Anis,
Enormous,
Hibernal,
Lord's Apples,
Red Anis,
Repka Malenka
Switzer,
White Russet,
Yellow Transparent.

CRAB APPLES.

Hyslop,
Lady Elgin,
Transcendent,
Yellow Siberian.

PEARS.

Andre Desportes,
Anjou,
Ansault,
Bartlett,
Belle Lucrative,
Beurre Gris d' Hiver,
Bosc,
Buffum,
Boussock,
Easter Beurre,
Early Harvest,
Edmonds,
d' Eté,
Flemish Beauty,
Frances Dana,
Frederic Clapp,
Golden Beurre,
Giffard,
Mt. Vernon,
Nouveau Poitean,
Onondaga,
Osbands,
Pratt,
Pres. Clark,
Rostizer,
Seckel,
Sheldon,

Clapps,
Clairgeau,
Columbia,
Congress,
Crumbs,
Dana's Hovey,
Dearborn,
Duchess,
Howell,
Japanese Sand Pear,
Keiffer,
Lawrence,
Lawson,
Louise Bonne,
Le Conte,
Merriam,
Student,
Superfine,
Tyson,
Urbaniste,
Volga,
Vicar,
White Doyenne,
Winter Nelis.

PLUMS.

Botang,
Bradshaw,
Coe's Golden,
Damson,
Duane's Purple,
Grand Duke,
German Prune,
Gen. Hand,
Green Gage,
Gueii,
Imperial Gage,
Italian Prune,
Jefferson,
Kelsey,
Lawrence,
Lombard.
Mariana,
Manitoba,
McLaughlin,
Niagara,
Ogon,
Peach Plum,
Prince Englebert,
Pond's Seedling,
Quackenbos,
Shipper's Pride,
Simonii,
Smith's Orleans,
Victoria,
Washington,
Wild Goose,
Wild American,
Yellow Egg.

CHERRIES.

Black Tartarian,
Belle Magnifique,
Cleveland's Bigarreau,
Downer's Late,
Early Richmond,
Elton,
Gov. Wood,
May Duke.
Rockport Bigarreau,
Royal Duke,
Transcendent,

PEACHES.

Arkansas Traveler,
Alexander,
Amsden,
Chair's Choice,
Conklin,
Coolidge,
Early Crawford,
Foster,
Globe,
Hale's Early.
Honest John,
Holland,
Jennie Worthen.
Late Crawford,
Morris White,
Mrs. Brett,
Mountain Rose,
North Russian.
Old Mixon,
Red Cheek,
Reeve's Favorite,
Schumaker,
Sally Worrell,
Smock,
Stump,
Waterloo,
Wager,
Wheatland,

APRICOTS.

Albert du Montagnet,	Catherine,	Improved Russian,
Alexander,	Eureka,	Common Russian,
Alexis,	Gibbs.	

GRAPES.

Agawam,	Dutchess,	Martha,
Ann Arbor,	Early Victor,	Massasoit,
Amber Queen,	Eaton,	Mills,
Arnold's No. 1,	Eldorado,	Moore's Diamond,
Arnold's No. 2,	Empire State,	Moore's Early,
August Giant,	Eumelan,	Naomi,
Bacchus,	Ester,	Nectar,
Barry,	Excelsior,	Niagara,
Beauty,	Goethe,	Norwood,
Berckman,	Golden Drop,	Oneida,
Brighton,	Hartford,	Oriental,
Black Delaware,	Hayes,	Pearl,
Catawba,	Highland,	Pocklington,
Caywood's No. 50,	Iona,	Poughkeepsie Red,
Centennial,	Isabelle,	Prentis,
Champion,	Isarella,	Rochester,
Clinton,	Ives,	Salem,
Concord,	Janesville,	Secretary,
Concord Chasselas,	Jefferson,	Telegraph,
Cottage,	Jessica,	Ulster Prolific,
Creveling,	Jewell,	Victoria,
Croton,	Lady,	Vergennes,
Delaware,	Lady Washington,	Wilder,
Diana,	Lindley,	Worden,
	Wyoming Red.	

SPECIES.

Vites labrusca,	Vites cardifolia,	Vites riparia,
Vites Mexicana,	Vites Arizoniea,	Vites Californica.

RASPBERRIES—RED.

Belle Fontainè,	Excelsior,	Marlboro,
Brandywine,	Hale's Early,	Raneocas,
Cuthbert,	Highland Hardy,	Superb,
Crimson Beauty,	Hansel,	Thompson's Pride,
	Thompson's Early Prolific,	Turner.

YELLOW VARIETIES.

Caroline,	Golden Queen,	Crystal White.

BLACK CAPS.

Butler's Seedling,	Gregg,	Ohio,
Carman,	Hopkins,	Schaffer's,
Centennial,	Hilborn,	Souhegan,
Crawford,	Mammoth Cluster,	Springfield,
Doolittle,	Nemeha,	Thompson's Sweet.

BLACKBERRIES.

Agawam,	Lucretia,	Western Triumph,
Erie,	Minniwaski,	Wachusetts,
Early Harvest,	Snyder,	Wilson,
Early Cluster,	Taylor's,	Wilson Jr.,
Fred,	Thompson.	

GOOSEBERRIES.

Ashton,	Downing,	Ironmonger,
Champion,	Houghton's Seedling,	Mountain Seedling,
Crown Bob,	Industry,	Smith's Improved,
	Whitesmith.	

CURRANTS.

Black Naples,	Fay's Prolific,	White Seedling (Caywood's),
Cherry,	La Versaillaise,	White Grape,
Crandall's,	Ruby Castle,	Victoria.

STRAWBERRIES.

Ada,	Garreck's Seedling,	No. 29, (M. A. C.),
Atlantic,	Gold,	No. 12, (M. A. C.),
Belmont,	Golden Defiance,	Leroy,
Beseck,	Gandy's Prize,	Logan,
Bidwell,	Hampden,	Norman,
Buback,	Haverland,	Ohio,
Cardinal,	Henderson,	Old Iron Clad,
Carmichael,	Hervey Davis,	No. 70, (Augers),
Chas. Downing,	Itaska,	Ontario,
Cohanzic,	Jersey Queen,	Pansy,
Cornelia,	Jessie,	Photo,
Covill's Early,	Jewell,	Piper's Seedling.

Crescent,	Jumbo,	Prince of Berries,
Crimson Cluster,	Katie,	Pioneer,
Crystal City,	Kentucky,	Seth Boyden,
Daisy,	Lida,	Sharpless,
Daniel Boone,	Mammoth,	Sucker State,
Eva,	May King,	Summit,
Excelsior,	Miner's Prolific,	Sunapee,
Emerald,	No. 23 (M. A. C.),	Triomphe de Gand,
Farnsworth,	No. 24 (M. A. C.),	Wilson,
Garibaldi,	No. 26 (M. A. C.),	Warfield,
	Woodhouse.	

NEW VARIETIES OF FRUITS AND VEGETABLES.

We would again invite all who may have valuable or especially interesting new varieties of fruits, vegetables, trees, shrubs or flowers, to send them to us that they may be tested side by side and under the same conditions, with other new and the standard older varieties. We are now situated so that we can give all such the best of attention, and shall make very careful observation and give unprejudiced reports of their behavior and merits.

We would urge that especial attention be given to promising local seedling apples that have not been propagated and disseminated. On almost every farm may be found numerous chance seedlings, and as most of the standard varieties now in cultivation have originated in this way, all seedlings that have the valuable qualities of size, beauty, flavor, vigor and freedom from disease should be further tested.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 5.

JULY, 1889.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
J. E. WILLIAMS, BOOK AND JOB PRINTER.
1889.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, . .	*Assistant Horticulturist.*
HERBERT E. WOODBURY, . .	" "

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

HATCH EXPERIMENT STATION,

AMHERST, MASS.

Division of Entomology.

C. H. FERNALD.

HOUSEHOLD PESTS.

During the past year many demands have been made on this Division for information concerning insects which are troublesome to housekeepers. As similar inquiries are being made almost daily, as to the habits and the best methods of destroying these pests, it seems to be an economy of time to publish an account of them in the BULLETIN.

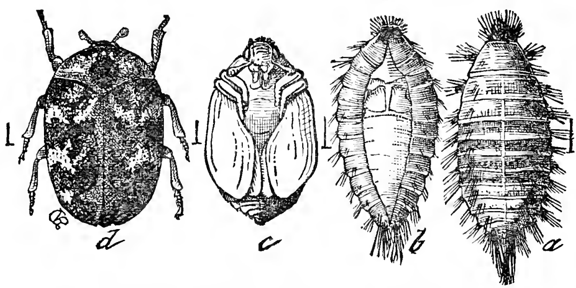

FIG. 1. Anthrenus scrophulariæ Linn. *a*, larva; *b*, skin of a larva; *c*, pupa; *d*, beetle. All much enlarged. (After Riley.)

THE BUFFALO CARPET BEETLE.

Anthrenus scrophulariæ Linn.

This insect is exceedingly destructive to all kinds of woolen materials and also to collections of insects and plants. The opinion that it injures cotton or silk goods, lace curtains, etc., must be erroneous, for I have repeatedly put the larvæ or young of this beetle into bottles with various substances for them to feed upon, and when furnished with cotton and wool mixed goods, they invariably ate the woolen fibres, leaving the cotton intact; but when I gave them only cotton, silk, or pieces of newspaper, they as invariably died without eating any of these substances. The injuries reported to have been done to silk, lace curtains, etc., must have been done by some other insect.

So far as my observations extend, the Buffalo beetles and their larvæ are much more abundant in rooms on the second and third floors than below, and during the month of March, in rooms that have been kept warm, the beetles emerge and fly to the windows where they may be taken and destroyed. It is probable that these early beetles pair and lay eggs, which produce the first generation of larvæ, for early in April very small larvæ are found, while later in the month larger ones, and early in May, full grown larvæ occur. About the middle of May, or about two months later than their first appearance, the beetles appear on the windows a second time. This leads me to believe that there is more than one generation in a year, and perhaps a succession of them during the summer. It is certain, however, that they pass the winter in the pupa stage, and that the beetles emerge in March as already stated.

The larvæ are very often found feeding upon the woolen lint that has accumulated in the cracks of the floor, and unless this is carefully cleaned out or covered with paper under the carpet, they may come up and eat the carpet along the line of the crack, cutting it as completely as could have been done with scissors. It is desirable, therefore, before putting down a carpet in a badly infested room, to saturate the lint in the cracks of the floor with benzine or kerosene, and cover the floor very carefully and fully with carpet paper, or even with newspapers, in such a way that the larvæ cannot find access to the carpet from beneath.

The beetles usually lay their eggs, and the larvæ attack the carpets under their exposed edges, and these parts may be protected by washing over the edges and a few inches of the underside with a solution of corrosive sublimate in alcohol, in the proportion of sixty grains to one pint. The alcohol quickly evaporates, leaving the corrosive sublimate over all the fibres of the carpet where the application has been made, and when the larvæ eat it they are quickly destroyed.

It must be remembered that corrosive sublimate is a rank poison, and cannot be safely used where children play upon the carpet, lest they might get some of the poisoned portions in their mouths and thus be poisoned.

The larvæ of the Buffalo beetles appear to be attracted to the bright red figures of a carpet more than to any other color, and some people have found it very useful to spread pieces of carpeting in which red was the prevailing color, on the bare floors of the closets, and then take up and shake these pieces every few days, and kill the larvæ found under them. It might be well to wet these pieces of carpet with the solution of corrosive sublimate in alcohol, to poison the larvæ as soon as they attack it.

It has been recommended to spread wet cloths along the edge of an infested carpet, and to pass a hot flatiron over them. If this be properly and frequently done, the steam will be forced down through the carpet and will kill the larvæ. Naphthaline and gasoline have been recommended for the destruction of the carpet beetles, but they are so volatile, and the danger of explosion which might cause fire, so great that insurance companies will not give permission to use them.

This insect was named by Linneus more than one hundred and thirty years ago, and he stated that the adult insect was found feeding upon *Scrophularia*, probably in the flowers, for they are known to feed on many different kinds of flowers, and are frequently brought into houses in them.

The insect destroys woolen fabrics only while in the larva stage, and when it is ready to transform into the pupa stage, it is nearly a quarter of an inch in length, and covered with coarse brown hairs which are arranged somewhat in tufts on the head and along the sides, while at the posterior ends, they are extended into a tail-like appendage. (Fig. 1, a.)

Late in the autumn the larva transforms to a pupa, *c*, which, however, is retained within the skin of the larva until its transformations are completed. and the perfect beetle emerges through a rent along the middle of the back as shown in Fig. *b*.

The perfect beetle, *d*, is ovate and moderately convex. The head is black with a few orange red scales around the eyes and above the mouth. The antennæ are black, eleven-jointed, terminated by a broadly oval three-jointed club, which is as long as all the preceding joints united. The thorax is black, with the sides and base more or less covered with white and orange scales. The wing-covers are black, but the suture along the back is broadly red, with three equidistant, lateral projections of the same color, the first two of which join sinuous, white, imperfectly defined bands. The posterior is obscurely connected with a red spot at the end of the wing-covers, and there is usually a small white spot at the base. The under side of the body is black, more or less covered with red and white scales. Length, from one-seventh to one-eleventh of an inch. The colors are subject to considerable variation. The red band along the middle of the back is sometimes replaced by white, and the first two bands of white on the wing-covers run together, forming one broad, white band.

THE PITCHY CARPET BEETLE.

Attagenus piceus Oliv.

The larva of this beetle is often found feeding on carpets in the same manner as the Buffalo carpet beetle, and sometimes associated with it. The full-grown larva is about one-third of an inch in length; of a brownish color, ringed with whitish between the segments, largest near the head, and tapering towards the posterior extremity, which is provided with a long pencil of diverging hairs. The whole surface of the body is covered with short, coarse, brown hairs, which are so arranged as to give a smooth and somewhat glossy appearance to the larva, which is quite hard and wiry. It crawls quite rapidly, with a peculiar gliding movement.

The perfect beetle is from one-fifth to one-seventh of an inch in length, more elongated than the Buffalo carpet beetle, black, and clothed with minute yellowish or brownish hairs, giving the beetle a general brownish color, varying from light brown to dark pitchy brown. There is but one generation in a year, as indicated by those which I have bred, for larvæ found in June did not transform to the perfect beetle until the following May.

The remedies for this pest are the same as for the Buffalo beetle.

THE LARDER OR BACON BEETLE.

Dermestes lardarius Linn.

This beetle belongs to the same family as the two carpet beetles already described, and often proves a great pest in our houses. The larvæ attack all kinds of food that contain fat, as roast-beef, hams, bacon, old cheese, etc., also feathers, skins, hair, bees-wax, and often prove a great annoyance to the entomologist, since they are as fond of the bodies of dried insects as of any of the above named substances.

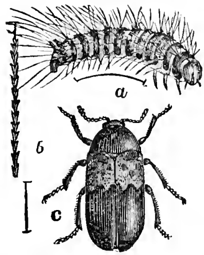

FIG. 2. Dermestes lardarius Linn. *a*, larva; *b*, one of its barbed hairs; *c*, beetle. (After Riley).

These pernicious little beetles make their way into our houses in May or June, and at once deposit their eggs on their favorite food if they can obtain access to it, or, if they find this impossible, they frequently lay their eggs near small openings or crevices so that the young when hatched may make their way in to the coveted articles of food.

The full-grown larva (Fig. 2, *a*) is about one-third of an inch in length, of a brownish color, tapering somewhat from the anterior to the posterior extremity. It is clothed with long rough hairs (Fig, 2, *b*), and has a pair of short curved spines on the top of the last segment.

The perfect beetle (Fig. 2, *c*), is from one-third to one-fourth of an inch in length, black, with a broad gray band across the base of the wing-covers, upon each side of which are three small black spots. The under side is black with a yellowish tinge.

Dr. Hagen states that if pieces of old cheese be placed in favorable situations, the beetles will be attracted to them, and may then be very easily destroyed.

CLOTHES MOTHS.

There are three different species of clothes moths in this country, all of which were undoubtedly imported from Europe, where they have been known from the earliest times.

The first of these moths (*Tinea tapetzella* Linn.) is quite rare in this country. I have seen but two or three specimens in our collections, and have never seen the larva. The moth is about three-fourths of an inch between the tips of its expanded wings. The head is white; the forewings are black on the basal half and white on the outer portion, but more or less clouded with dark gray, with a small black spot on the anal angle, and two or three similar spots on the apex of the wing. The hind wings are pale gray. The larva in Europe feeds upon animal matters, pelts, felts, carpets and also on dried plants. It makes a gallery on the substance on which it feeds but forms no case.

The second moth (*Tinea pellionella* Linn.) expands about one-half of an inch. The head is of a dull ochre-yellow color, and the forewings are dark gray with three dark brown spots, one on the end of the cell, one near the middle of the cell, and the third below it. The hind wings are silky gray, and lighter than the forewings.

The larva of this species constructs a cylindrical case of the materials on which it feeds, binding it together and lining it with silk. This case is enlarged as the insect grows, by splitting it on one side from the middle to one end, and filling in a new piece of the material, then it splits the opposite side and puts in a piece in a similar manner, after which the other end of the case is enlarged in the same way. I took a pair of moths of this species, male and female, and put them into a glass jar with a piece of blue flannel. The female laid her eggs which were so small that they were overlooked, but in a short time there were about sixty minute larvæ, each with its tiny case, crawling about and feeding upon the flannel. When these larvæ were about three-fourths grown, I removed the blue flannel and put in a piece of a scarlet color; and when they enlarged their cases the scarlet stripes which they had pieced in were plainly visible.

These moths may be seen from the last of May until August flitting about in our houses in the evening, avoiding the light, but seeking the darker portions of the rooms. Those small moths that are attracted to the light are not clothes moths, but some species which live upon plants out of doors. The clothes moths pair and lay their eggs in the night, but rest quietly on the walls of the rooms, or in some concealed place during the day.

This species feeds upon all kinds of woolen clothing, carpets, furs, feathers, etc. The larva is dull whitish with the head and upper part of the next segment of a reddish brown color, but it never leaves its case unless forced to do so.

The third species of clothes moth (*Tineola biselliella* Linn.) expands about half an inch. The head is of a dull ochre-yellow color, and the forewings are pale ochre-yellow without any spots. The hind wings are a shade lighter than the fore wings.

The larva is white with a light-brown head. It does not construct a case, but before transforming into a pupa, it forms a kind of loose cocoon from portions of the substance upon which it feeds:—woolen stuffs, furs, feathers, horse-hair, linings of furniture, dried animals and plants.

REMEDIES.

Reaumur, more than one hundred and fifty years ago, made quite extensive researches on clothes moths; and, observing that they never attacked the wool and hair on living animals, he inferred that the natural odor of the wool or of the oily matter in it was distasteful to them. He, therefore, rubbed various garments with the wool of fresh pelts, and also wet other garments with the water in which wool had been washed, and found that they were never attacked by moths.

He also experimented with tobacco smoke and the odors of spirits of turpentine, and found that both of these were destructive to the moths, but it was necessary to close the rooms very tightly and keep the fumes very dense in them for twenty-four hours, to obtain satisfactory results.

I have always found that any material subject to the attacks of moths may be preserved from them if packed away with sprigs of cedar between the folds. The odor of cedar is so disagreeable to them that they will not deposit their eggs where this odor is at all strong. Chests of cedar or closets finished in the same wood will protect clothing from moths as long as the odor is strong, but this is lost with age, and then they are no protection. It must be remembered that the odor of cedar, camphor, etc., only prevents the moth from laying her eggs on the fabrics, but if the eggs are laid before the garments are packed away with cedar, etc., the odor will not prevent the hatching of the eggs nor the destructive work of the larvæ afterwards.

Clothing may also be protected from moths by packing it in bags made of either stout paper or cotton cloth, if made perfectly tight, but this must be done before the moths appear on the wing in the spring.

ANTS.

In the second Bulletin issued by this Station, an account was given of experiments made for the destruction of ants in lawns and walks, but no methods were given for those that find their way into houses and become an intolerable nuisance because of their desire for sugar and other sweets. These are more frequently the small species, but what they lack in size they usually make up for in numbers. I am inclined to the opinion that they enter the houses and discover the coveted articles by chance; that their scouts, in exploring, find these articles, not by keen sight or smell, but by mere accident. When one has found some choice dainty, she—these wingless workers are undeveloped females, not neuters as some have supposed—sips her fill and at once starts for home, where, by some means, she communicates the information of the locality of untold treasures to others, which return with her, and they in turn appear to spread the information on their return home, and soon the throngs that come and go are sufficient to disturb the most amiable of housekeepers. Various remedies have been suggested, one of which is to draw a chalk mark on the floor around the sugar barrels or other articles to be protected from them. It is undoubtedly true that ants travel in a regular beaten track, as it were, by the sense of smell, and if this be removed from the ground over which they travel, they are at a loss, and often wander around for some time before they find the trail again. They may be thrown off the trail by drawing a chalk mark or even the finger across it. This is only a temporary protection, however, for sooner or later they will find their way across and then travel goes on as uninterruptedly as before.

It has been recommended to sprinkle sugar into a sponge and place it in their path, and as it fills up with ants several times a day, immerse it in hot water to kill those adhering to it. This will undoubtedly prove successful if carefully followed up for some time; but when we remember that the females are constantly laying eggs to produce workers which will take the places of those already destroyed, the task seems almost hopeless.

There can be no doubt that a better method would be to follow the ants carefully, and discover, if possible where their nest is, and then destroy the entire community by making one or more holes down through the nest, and then pouring in a teaspoonful of bisulphide of carbon, carefully stamping down the ground afterwards to close the holes. The fumes of this substance will penetrate the nest in all directions, and destroy the entire community.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 6.

OCTOBER, 1889.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
J. E. WILLIAMS, BOOK AND JOB PRINTER.
1889.

While we do not wish to enter into any controversy as to the merits of the different kinds of steam or hot water boilers, so many of which possess such valuable qualities, we hope to further experiment on this question by replacing the boilers in use last winter with others, and make most careful records of the results.

		HOT WATER. Lettuce and Carnation Room.				STEAM. Lettuce and Carnation Room.			
March.	Outdoor Average Daily Temperature.	Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.	Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.
1	32.6	43	67	53.	99 lbs.	44	55	49.	72 lbs.
2	34.	46	71	56.3	8 "	41	55	47.3	9 "
3	40.	47	55	50.	37 "	45	55	48.6	56 "
4	39.6	49	56	51.6	37 "	45	57	50.	84 "
5	38.6	47	58	51.6	50 "	45	57	50.3	78 "
6	39.3	48	58	51.3	57 "	46	61	52.3	74 "
7	35.	42	59	49.2	40 "	41	54	46.7	50 "
8	28.6	41	61	48.5	74 "	38	57	44.5	125 "
9	29.3	43	54	47.7	74 "	40	55	46.	107 "
10	30.	42	59	48.5	72 "	41	64	49.	125 "
11	31.3	45	56	48.5	63 "	40	57	47.5	95 "
12	38.	45	75	55.2	37 "	42	67	51.	91 "
13	44.3	50	59	55.2	31 "	49	61	54.	88 "
14	35.6	45	65	52.	44 "	47	60	52.2	94 "
15	37.	51	76	59.	42 "	46	77	56.2	80 "
16	43.3	47	58	52.2	49 "	44	58	49.2	63 "
17	37.3	48	59	51.7	25 "	45	55	48.5	76 "
18	42.3	51	69	57.	69 "	45	59	51.5	65 "
19	42.3	50	67	57.2	32 "	46	67	53.7	60 "
20	37.3	47	63	53.2	49 "	44	59	49.	72 "
21	40.	47	56	51.	31 "	42	51	46.5	46 "
22	46.3	45	67	54.7	61 "	41	65	53.	94 "
23	48.6	47	65	55.2	33 "	45	68	54.7	60 "
24	53.3	53	67	57.5	19 "	51	70	60.7	66 "
25	42.	46	57	49.5	79 "	45	56	49.7	113 "
26	36.	43	59	49.7	26 "	46	56	51.5	128 "
27	43.	50	55	51.7	41 "	49	54	52.	64 "
28	39.	45	53	49.5	66 "	44	49	47.5	100 "
29	43.3	47	58	52.2	81 "	47	60	54.	117 "
30	31.3	44	60	52.	121 "	48	62	52.2	147 "
31	29.3	49	59	53.5	69 "	47	65	55.2	149 "
Ave.	38.3	46.5	61.3	52.4	51.5 "	44.4	59.5	50.7	85.4 "
					Total 1598lbs.			Total	2643 lbs.

HOT WATER. STEAM.

APRIL.	Outdoor Average Daily Temperature.	HOT WATER. LETTUCE AND CARNATION ROOM. Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.	STEAM. LETTUCE AND CARNATION ROOM. Indoor Minimum Temperature.	Indoor Maximum Temperature.	Indoor Average Temperature.	Coal Consumed.
1	34.	47	60	52.5	64 lbs.	46	59	52.2	100 lbs.
2	38.3	46	77	56.2	54 "	45	76	56.	80 "
3	36.6	47	55	50.7	65 "	45	51	47.7	87 "
4	44.	47	65	53.5	39 "	45	64	52.	60 "
5	41.	51	66	56.5	21 "	44	59	50.	63 "
6	43.	49	60	53.7	50 "	42	61	51.	61 "
7	42.6	50	58	53.5	63 "	46	57	51.2	73 "
8	48.6	52	67	61.5	27 "	44	66	57.2	27 "
9	50.	58	82	68.	40 "	52	76	62.	15 "
10	48.3	56	75	64.5	50 "	48	71	59.2	68 "
11	54.3	59	77	67.	57 "	54	76	64.2	22 "
12	56.	60	67	63.5	28 "	56	64	59.2	48 "
13	45.3	54	65	61.2	56 "	45	64	56.	38 "
14	45.6	56	77	66.2	81 "	44	69	59.2	82 "
15	50.	58	76	68.7	45 "	47	72	61.7	14 "
16	50.3	56	73	64.5	10 "	48	71	58.2	31 "
17	49.6	56	70	61.	23 "	51	72	59.	33 "
18	57.6	64	71	67.	17 "	57	71	63.	4 "
19	68.	64	85	72.2	24 "	59	88	70.5	0 "
20	64.3	68	76	72.5	2 "	65	78	71.2	2 "
21	63.6	62	84	74.	90 "	60	83	73.5	84 "
22	44.3	56	75	64.7	90 "	50	70	60.5	69 "
23	47.3	58	71	65.	68 "	50	67	60.7	51 "
Ave.	48.8	55.3	70.9	62.5	46.2 "	49.8	68.9	58.7	48.3 "
				Total	1064 lbs.			Total	1112 lbs.

Summary for Hot Water Boiler.

Total coal consumed by Hot Water boiler from Dec. 23, 1888, to April 24, 1889, 4 tons, 1155 lbs. Average daily temperature for the four months, 53.5°.

Summary for Steam Boiler.

Total coal consumed by Steam boiler from Dec. 23, 1888, to April 24, 1889, 5 tons, 1261 lbs. Average daily temperature for the four months, 51.2°.

STRAWBERRIES.

The strawberry crop in Massachusetts, this season, has been much smaller than for the past ten years. The causes that have contributed to this failure are in part the cold, wet summer of 1888, which promoted a late growth in which the fruit buds were not matured sufficiently to withstand the winter,—the long, open winter in which the plants were not well protected, and the continued wet weather of the past spring preventing perfect fertilization.

NEW VARIETIES.

Many of the new varieties not previously fruited, produced some fruit this season, and not having been as much injured in the plots as in the field, we give the results in the following tables.

For economy of space we have recorded the various qualities on the scale of one to ten. One indicating the earliest blossoming and ripening and the greatest perfection in quality, size and yield.

	Number of Years tested.	Order of Blossoming.	Order of Turning Red.	Size.	Yield.	Quality.
Ada.	2	9	3	3	6	4
Atlantic.	3	10	7	5	9	9
Auger.	1	7	4	3	3	5
Belmont.	2	9	5	1	2	2
Beseck.	1	10	8	3	3	2
Bidwell.	5	8	3	4	4	4
Buback.	2	9	2	3	2	2
Cardinal.	1	8	4	4	5	3
Carmichael.	1	10	7	4	6	7
Chas. Downing.	10	5	3	3	6	5
Cohanzie.	2	9	8	5	8	6
Cornelia.	4	10	10	7	8	3
Corville's Early.	3	2	2	5	6	8
Crescent.	8	2	2	5	2	9
Crimson Cluster.	2	9	5	8	5	7
Crystal City.	5	2	2	7	9	2
Daisy.	3	4	4	8	9	3
Daniel Boone.	4	7	3	5	7	6
Emerald.	3	4	5	7	8	4
Eva.	1	8	5	5	8	5
Excelsior.	2	7	3	4	3	8
Farnsworth.	1	4	2	6	6	2
Gandy's Prize.	2	10	10	1	6	2
Garrick's Seedling.	2	10	4	7	6	8
Gold.	2	9	7	4	9	4
Golden Defiance.	8	10	6	5	4	5
Hampden.	2	6	5	9	9	4

Haverland,	1	6	2	3	4	4
Henderson,	3	10	8	6	10	1
Hervey Davis,	8	10	6	8	9	1
Howard's No. 5,	1	4	7	5	5	5
Howard's No. 6,	1	3	7	5	7	8
Itaska,	1	9	4	5	6	4
Jersey Queen,	4	5	3	6	6	4
Jessie,	2	3	2	2	2	3
Jewell,	3	9	4	1	2	2
Jumbo,	4	7	3	6	5	6
Katie,	1	8	5	6	5	2
Kentucky,	8	4	6	3	8	3
Leroy,	1	8	6	5	5	4
Lida,	2	8	5	5	3	4
Logan,	1	8	2	2	2	5
Mammoth,	2	9	2	4	5	3
Manchester,	3	7	6	5	8	8
May King,	4	3	3	5	4	2
Miner's Prolific,	8	2	2	5	4	4
Monmouth,	3	8	2	4	4	6
Mrs. Garfield,	3	8	6	6	7	4
Norman,	1	9	5	8	9	4
Ohio,	2	9	6	8	5	7
Old Iron Clad,	4	7	3	5	5	5
Ontario,	2	9	9	8	5	7
Parry,	3	8	3	6	6	4
Photo,	1	7	4	2	2	4
Pioneer,	5	4	2	6	8	2
Piper's Seedling,	4	2	2	5	5	8
Prince of Berries,	3	8	4	3	9	1
Seedling,	4	1	5	3	3	4
Seth Boyden,	5	2	4	7	9	4
Sharpless,	8	8	6	1	6	3
Sucker State,	4	10	6	7	4	7
Summit,	2	10	10	7	7	6
Sunapee,	2	5	2	6	7	6
Triumph,	10	9	4	5	8	5
Warfield,	1	8	3	5	3	7
Wilson,	15	2	2	6	4	8
Wood House,	2	2	3	5	3	9
No. 1 Seedling	5	4	3	6	2	5
No. 6 "	5	3	5	5	4	5
No. 11 "	5	2	2	5	1	5
No. 12 "	5	3	2	6	4	2
No. 21 "	5	5	2	5	1	9
No. 23 "	5	1	1	4	5	1
No. 24 "	5	8	9	1	2	9
No. 28 "	5	5	2	5	5	1
No. 29 "	5	5	2	7	5	5
No. 31 "	4	7	5	8	7	5

REMARKS.

The position of many of the old varieties remains unchanged, and few, if any, of the new varieties have shown qualities which make them superior to those already in general cultivation. The tendency of the market has been to demand large berries at the expense of quality. Such berries can only be grown under the highest state of cultivation, which many of our growers have not yet learned is a necessity to the profitable growth of the strawberry. We mention a few varieties which have done the best with us the past season.

OLD VARIETIES.

The position of the old standard kinds, which are still cultivated, may be summed up in a few words, and I will take them in their order of ripening.

Crescent.—This variety is still largely grown and proves profitable although the quality is such, that, as people become familiar with the better and larger varieties, it cannot long be grown profitably.

May King.—Although not quite as early or as productive as the Crescent, its good size, beauty, and good quality have proved it a profitable variety.

Sharpless.—The large size of this berry and its vigor of growth still keep it as one of the leading varieties. Grown on a medium, light soil, with an abundance of plant food, and with the plants not too thickly set, it produces a good crop of fine, well-colored fruit, but in a heavy soil, less fruit is produced, and it is of poor shape and quality.

Belmont.—Almost as large as the Sharpless, of more perfect form and better quality, this variety gives more satisfactory results than the latter and is more profitable when well grown.

Miner's Prolific.—This variety, although rather soft and of dark color, on account of its hardiness and productiveness, is still a profitable variety to grow, when given good cultivation.

VARIETIES TESTED TWO OR THREE YEARS.

Jessie.—This variety, on our grounds, has given good promise. It is vigorous, productive, of good size, form, color, and good quality.

Bubach.—A pistillate variety of great vigor and productiveness. Berries of large size, good form and color, but not of the best quality. Certainly promising.

Gandy's Prize.—A very late variety of the largest size, vigorous, moderately productive and of fair quality. The most promising late variety.

VARIETIES TESTED ONLY ONE SEASON.

Of the new varieties that were especially promising are the Logan, Photo, Haverland, Warfield, Howard's No. 6, and Cardinal. Many other varieties have developed remarkable qualities, and another season may develop others that would render them worthy of a higher place in the list than is at present indicated.

Division of Vegetable Pathology.

JAMES ELLIS HUMPHREY.

Prof. of Vegetable Physiology, State Agricultural Experiment Station.

FUNGOUS DISEASES OF PLANTS.

Various *rusts*, *smuts*. *mildews*, *blights*, and similar diseases of cultivated plants have been generally known and dreaded since plants began to be cultivated. Any understanding of the cause of these troubles, of the conditions of their occurrence, and of their relations to each other and to the plants they infest is a matter of comparatively recent acquisition even among botanists. Among American farmers and gardeners. it is only recently that intelligent inquiry and thought regarding these important sources of loss has been awakened, and they are but just beginning to be popularly spoken of as *fungous* diseases. With this increased popular interest has naturally arisen an increased interest in their scientific investigation. which is as yet but fairly begun, and in the practical application of our technical knowledge in devising ways and means for checking the spread and preventing the ravages of the pests. It is, doubtless, true that to the average reader the term *fungus* carries with it no definite idea. This is due partly to the newness of the popular use of the term and the meagreness of generally accessible sources of information concerning the *fungi*, and partly to the inherent difficulty and technicality of the subject. To obtain a clear notion of organisms so small as to be barely recognizable by the naked eye and requiring high powers of the microscope for their study, yet with such apparently disproportionate capacities for mischief, is not easy. It is, for this very reason, all the more important that, in a discussion of fungous diseases intended for popular information, an attempt should be made at the outset to remove, so far as may be, this fundamental difficulty.

In the first place, then, a fungus is a *plant*, as truly and essentially a plant as the corn-stalk or rose-bush on which it grows. Yet it is not only much smaller, but also much simpler than these. While the plant-body of the corn or rose shows much specialization of structure, having the various vegetative functions of the plant performed by distinct organs, the root, stem, and leaves, very many plants show no such specialization, but have all their vegetative functions performed by the whole plant-body, which then needs no variety of organs. Of the latter class of plants are the *rockweeds* and *sea-mosses*, the fresh-water *pond-scums* and the *fungi*, which are obviously much simpler and more primitive plants than those with roots, stems, and leaves. In all true fungi the plant-body consists of numerous simple or branching white threads which spread over the surface or through the substance of the object on which the fungus grows. These threads constitute the so-called *mycelium* of the fungus, and are comparable with the more elaborate plant-body of other plants, since they perform all its vegetative functions.

Equally important with its own healthy growth is the provision by any plant or animal for the perpetuation of its kind, and to this end it develops organs of reproduction. In many of those plants provided with root, stem, and leaf, these reproductive organs are grouped into a structure called a flower, and such plants are known as *Flowering Plants.* They all produce, by the further development of certain parts of their flowers, structures known as *seeds*, which can, under favorable conditions, develop into new plants similar to that which produced them.

Fungi do not produce flowers, and they vary greatly in their reproduction, but they all agree in producing bodies called *spores*, much simpler than seeds, as would be expected, but analogous to seeds in their ability to develop, under favorable conditions, into plants similar to those which produced them. These spores are usually produced on special fruiting or *reproductive* threads which grow from the vegetative threads of the mycelium of the fungus. The reproductive threads may remain separate, thus producing their spores free in the air; or they may become interlaced or consolidated into a complicated fruiting structure, on which the spores are produced either superficially or in cavities from which they finally escape into the air. The spores of fungi, being so small and light, are readily taken up and widely spread by currents of air, and are easily carried by insects from plant to plant. In such ways a fungous disease may spread from a single insignificant case until it becomes epidemic over a large area.

In the course of its life-cycle the ordinary *flowering plant* passes from the seed, through the seedling, to the adult plant bearing flowers and then seeds like that from which it grew. Many of the *fungi*, however, pass through a much more complex life-cycle, during which a given fungus may produce several kinds of spores and assume several forms so unlike each other that they can be recognized as different stages of the same plant only by careful, patient cultivation and study. It is convenient to select some one stage of such a variable fungus as its perfect or adult form, and it is natural and logical to regard as such that stage in which the fungus shows the greatest elaboration of structure, while the simpler stages through which it passes are commonly called *imperfect forms*. This tendency of fungi to variety in form, or *pleomorphism*, as it is called, greatly increases the difficulty of their study and complicates those problems which concern the successful combating of fungous diseases.

A question which very naturally suggests itself is: Why do fungi attack and cause diseases of other plants, instead of living independly? This question involves matters of the greatest interest and of fundamental importance and significance. It is well known that all *green* plants owe their characteristic color to the presence of a definite pigment known as leaf-green or *chlorophyll*, which is so generally present among the higher plants, that to most minds the very word plant carries with it the idea of greenness. Now the possession of chlorophyll is the preeminent feature which gives to plants their all-important place in the economy of nature. No living thing can continue to live on inorganic substances, but all require as food some of those materials of comparatively complex chemical composition, known as organic substances. The materials furnished by the earth, the air and water are all of simple composition and unorganized, but in leaf-green we have the connecting link, the means of bridging the interval between the inorganic and the organic. We need not here discuss the process in detail. It is sufficient for our present purpose to say that in Nature's laboratory of the leaf, some of the simple constituents of air and water are combined, by the action of leaf-green in the sunlight, into the complex organic compounds which serve the plant as food. The chemistry of this remarkable process is not well understood, but the commonest permanent form in which these food materials appear is that of starch.

Now, as was noticed above, the threads of the fungi are white, uncolored; that is, they contain no leaf-green. Consequently, the fungi cannot elaborate their own food material, but must obtain it ready elaborated, from some other source. Evidently the available sources of organic food-supply fall under two heads, *living organisms*, and *dead organic matter*, commonly decaying. And, on this basis, we may divide the fungi into two classes, those which derive their nourishment from other *living* things, and those which live on the remains of *dead* organisms. The latter, known as corpse-plants or *saprophytes*, include the moulds, toad-stools and many other fungi. But the first named group is that which at present interests us, since it contains the various groups mentioned at the beginning of this sketch, which live on or in the bodies of other living plants at their expense, and cause extreme weakening or even the death of the affected plants. Such fungi are known as *parasites*, and the plants they attack are called their *hosts*. This distinction between saprophytic and parasitic fungi is a very useful one, but no sharp line can be drawn between the two groups, since some fungi seem to be able to live either as parasites or as saprophytes, while it is probable that very many *pleomorphic* fungi are parasites in some of their forms, and saprophytes in other stages of their life-cycle.

Finally, we may notice the interesting fact that any given parasitic fungus is usually restricted in its capacity for harm to a single host-plant or to a few closely related ones; though, on the other hand, closely related fungi may attack plants of widely different relationships. Thus, the mildew of the lettuce and that of the onion are very closely related fungi, yet neither mildew can attack the host-plant of the other, since the structural resemblances are few and the relationship remote between the lettuce and the onion.

From the above facts we may derive a few important principles for our guidance in attempts to avoid or check the ravages of fungi among plants cultivated for use or beauty. Since the mycelium of a parasitic fungus grows usually within the tissues of its host-plant, it is too late to try remedies after a plant is once infected. It is true that a few fungi are superficial in growth, and a treatment may perhaps be found which shall destroy such parasites without harm to the host. But in most cases our aim must be to fortify exposed plants against infection by the timely application of protective solutions or mixtures, which shall prevent the germination of the spores which fall upon the plant so treated. Some progress has been made in this direction and some results have been reached which justify hopes of ultimate general success in largely avoiding the present enormous annual losses resulting from fungous diseases.

The treatment which now gives promise of most general applicability and efficiency is the spraying of the plants with a solution of sulphate of copper (blue stone) or with one of the preparations in which it is the important ingredient, known as Eau celeste, Bordeaux mixture, etc. It seems very possible, too, that plants may be fortified against the attacks of parasitic fungi, or their susceptibility to such attacks be largely diminished, by special fertilization, for the purpose of introducing into the plant substances which, while not interfering with its growth, shall make it a less congenial soil for the growth of fungi. The line of investigation here suggested, has not yet been followed out, although it offers an opportunity for chemico-physiological work which may yield important results. It is obvious, also, that a vigorously healthy plant will resist the fatal influence of parasites far better than a poorly nourished one.

Much may be done, after a plant is too far gone to be saved, to prevent further spread of the disease, by removing and destroying the diseased parts. It is not sufficient, however, to throw the portions removed into the rubbish heap; the spores must be actually destroyed and this can be effectually done only by burning. A considerable number of fungi produce, in the plants on which they live, *resting-spores* which ordinarily remain on or near the ground in dead leaves or stubble, survive the winter, and, germinating in the spring, infect the new growth. In these cases the danger of a severe attack in the following year can be greatly lessened by clearing up and burning all such sources of infection.

Numerous instances can be cited of more or less common weeds or wild plants so closely related to certain cultivated plants that they are liable to the attacks of the same fungi, and so serve to perpetuate those fungi and to infect the related cultivated plants when growing near. Evidently, then, such plants should be carefully and thoroughly exterminated wherever they may prove a source of danger.

We may pass, now, to the application of the foregoing facts and principles in the consideration of a few particular fungous diseases.

THE BLACK-SPOT OF ROSE LEAVES.

Actinonema rosae Fr.

In December, 1887, my attention was called by Prof. S. T. Maynard to a disease which considerably affected the leaves of roses cultivated in the Durfee Plant House, and which he desired me to investigate. The leaves presented all the external characters usual to the disease which examination showed to exist, namely, the so-called *Black-Spot*, caused by a parasitic fungus known as *Actinonema rosae.*

This is probably the commonest and most troublesome disease of cultivated roses, whether of out-door or greenhouse cultivation, in both Europe and America. It first appears in the form of dark discolorations of the upper surfaces of the leaves, which spread outward and often show a yellow band surrounding the dark spot. Often the discoloration begins at the tip of the leaf and spreads downward. The centres of the spot frequently become dry and brown, indicating the complete death of the tissue. In consequence of the attack of the fungus, the leaves fall from the stem and may be replaced by a new crop if the weather be favorable. The loss of the functional activity of the leaves at a time when their work is most needed, not to mention the waste involved in producing an extra investment of foliage, must greatly weaken the plant and lessen the amount and vigor of its bloom, as well as seriously impair the ability of out-door roses to resist the following winter.

The mycelium of the fungus develops in the leaf, chiefly just below its surface layer or *cuticle*. From this principal mass threads penetrate deeper into the interior of the leaf and absorb its fluids for the nourishment of the fungus. Other threads grow upwards and produce the spores, which, as they grow, make room for themselves by forcing up the cuticle, which finally bursts open, allowing the ripe spores to escape through ragged openings. The spores germinate promptly on a moist surface, and readily infect fresh leaves. It is probable that this parasite of the rose is merely an imperfect stage in the life-history of a fungus, whose perfect stage is very probably, or at least possibly, saprophytic and serves an important purpose in carrying it through the winter. In the lack of definite knowledge on this subject, however, we can deal only with the parasitic or *Actinonema* form.

In combatting the disease it is essential to begin early, for leaves once penetrated by the mycelium of the fungus are irretrievably lost. All efforts must be directed toward preventing infection, by the application of some protective compound. For this purpose it is recommended that the bushes be sprayed shortly *before* the unfolding of the leaves, again as soon as they are fairly opened, and at intervals of three or four weeks until the flowers begin to open, especially after heavy rains which may wash off the protecting substance from the leaves, with blue-water or *Eau celeste*, prepared as follows:

Dissolve 1 pound sulphate copper
in 4 gallons warm water;
when cool, add 1 pint commercial ammonia,
and 18 gallons water.

Any leaves on which the spots may appear should be promptly cut off and burned.

When the autumn is long and mild, plants which have lost their leaves from *Black-Spot* during the summer often put out fresh shoots from the terminal buds of their branches. This process exhausts the plant and lessens its ability to withstand the winter, and should be prevented by clipping off the terminal buds, leaving those lower down to make the next season's growth. There is no advantage in spraying the already affected plants in summer and fall, but the "spotted" leaves should be collected and burned, as they drop, to prevent further mischief as far as possible.

THE BLACK-KNOT OF THE PLUM.

Plowrightia morbosa Sacc.

This wide-spread and fatal disease, so common on cultivated plums and cherries and on some species of wild cherries, is peculiar to America, being, as yet, unknown in Europe. Its characteristic elongated, black, knot-like excrèscences are too well known in Massachusetts to require detailed description, since its attacks have practically put an end to the culture of plums in many parts of the state.

The disease is caused by a fungus, *Sphaeria* or *Plowrightia morbosa*, which attacks the branches of the trees and whose mycelium lives in the swollen tissues of the knots. One of these may often extend nearly or quite around the branch, girdling it and causing the death of all above the knot. When this is not the case, the tree is greatly weakened and soon ceases to produce fruit, while the knots increase rapidly and finally kill it.

Besides reproducing itself by spores, the fungus spreads within the branch by the growth of its mycelium and the consequent gradual extension of the knot. Thus it is common to find, in the spring, a new knot immediately adjoining the remains of that of the preceding year.

The fungus produces two chief forms of spores. In spring and early summer the surface of the young knot becomes covered by a "bloom," composed of short threads which bear what we may call the *summer spores*. These germinate promptly and can probably produce fresh infections at once, though our suppositions on this point are based rather on analogy than on direct evidence. Later in the season the black surface of the knot shows to the naked eye, on close examination, a division into many minute facets or regions, separated by slight furrows. Microscopic study shows that each of these facets corresponds to a cavity which finally communicates with the exterior by a pore at the middle of its facet. In these cavities are developed the *winter spores*, which become ripe and are set free in late winter and early spring, and, presumably, produce the beginnings of new knots at that time.

Nearly all our knowledge of this fungus is due to the admirable account of it in Part V. of the Bulletin of the Bussey Institution, by Prof. W. G. Farlow, of Harvard University; but further study is needed of the manner in which the infection of the branches of the host by the spores of the fungus is accomplished, and of the early history of the development of the knots. When a tree has become badly infested with the knots not much can be done except to prevent its continuance as a spreader of contagion, by cutting it down and *burning* it. Simple cutting down is not sufficient, for Dr. Farlow has shown that knots on a tree, cut down in summer and allowed to lie through the winter, developed their winter spores as if the tree had been standing.

The treatment which has been recommended is that the knots be cut off and burned, as fast as they appear. This often leads, however, to very serious disfigurement of the tree, and a less heroic remedy is much to be desired. A treatment similar to that recommended in Bulletin No. 4, of this Station, namely, the painting of the knots with a mixture of red oxide of iron in linseed oil, has given very good results in case of young trees on the private grounds of Dr. C. A. Goessmann, Director of the State Experiment Station. This preparation seems to stop the development of the fungus so that the knots crumble and fall away, with the least possible injury to the branch. Even were its effects not so complete, such an application would be useful in preventing the dissemination of the spores of the knot-fungus. In connection with this painting of the knots, special fertilizers have been applied to the soil about the trees, with the object of lessening their susceptibility to the attacks of the fungus.

A very serious difficulty in dealing with a disease of this sort is presented by the fact that one man who is intelligently and persistently fighting it by destroying all his old trees and carefully treating the young ones, may be surrounded by and constantly exposed to old trees belonging to neighbors, who have too little energy or public spirit, or too little faith in "new-fangled notions" to coöperate in any systematic attempt to conquer the trouble. General coöperation over a considerable area is an important prerequisite to success, especially in dealing with diseases of long-lived plants, like trees. But unfortunately, there is found in almost every community, the slip-shod man who reasons that, because his trees have suffered so long from black-knot, they always must, and whose simple laziness and conservatism lessen the results of the intelligent efforts of his progressive neighbors.

But attention must be paid, in fighting the black-knot, to other than cultivated trees, merely. Since, as stated above, the disease attacks some of our common species of wild cherry, care should be taken to destroy all such trees within a considerable distance of the cultivated trees, for they may serve, as well as any others, to spread the infection. Since one species of wild cherry, the black rum-cherry, is said not to be attacked by the black-knot, it would be safe to destroy those wild trees seen to be affected and keep all others in the neighborhood under careful observation.

THE POTATO BLIGHT AND ROT.

Phytophthora infestans deBy.

The combined warmth and moisture of the season just closing have been very favorable to the development of fungi, whose attacks have consequently been, in many instances, unusually severe. Probably no one disease has been more generally prevalent or more disastrous in its effects throughout the state than the *blight* or *rot* of potatoes. It may be worth while, though it may seem like guarding the barn door after the horse is stolen, to discuss briefly our knowledge of its cause and to give some hints as to treatment which gives promise of usefulness in aiding to ward off threatened attacks in future years.

The potato rot is caused by the development within the potato plant of a fungus closely related to these which cause the mildewing of grape leaves, of lettuce, etc. The threads of the fungus grow in the tissues of the stems and leaves of the host and send out fruiting threads, through tiny openings or pores which exist in the surface, into the outer air, where they produce the spores. These spores germinate readily in a warm, moist place, and give rise to new threads which, when produced on the surface of a fresh potato leaf, make their way into its interior and quickly spread throughout the plant.

A striking feature of this fungus is that it causes the complete breaking down of the infested tissues of the host-plant into a slimy, putrescent, ill-smelling mass. Most fungi weaken or kill by gradually sapping the vitality of their hosts, but here is no half-way work, no uncertainty as to whether fungus or host will win in the struggle. The development of the fungus and accompanying death of the tissues of the host is usually quite rapid, and in very violent cases most astonishingly so, forty-eight, or even possibly twenty-four, hours being sufficient to convert an apparently flourishing field into a putrid mass. This destruction of the "tops" is commonly known as the *blight*. Extreme cases like this can only occur, however, when atmospheric conditions are very favorable, in wet, sultry weather, with a wind which serves to carry the spores freely and in the right direction. At best, however, the rapidity of its development is the one element which makes this fungus very difficult to deal with.

But while the killing of the potato tops while in vigorous growth, and the securing of a much reduced crop would be a sufficiently serious matter, the trouble does not stop there. After killing the tops the fungus penetrates through the stems to the tubers and causes a similar rapid decay in them also. It is to this destruction of the tubers that the name *rot* is commonly applied, and the belief is quite general that the *blight* and the *rot* are due to different causes. This, however, is not the case, and it is as well to designate both by the name ROT. The only hope of saving the tubers when the tops begin to show the disease, is to dig them at once, which can often be done before the fungus reaches them, when the progress of the disease is not extremely rapid. It should be said, however, that many writers believe that the parasite can reach the tubers through the medium of the soil, as well as through the stems.

In mild forms of the disease, the tubers often become infected by the threads of the fungus without suffering much decay. If such tubers are stored in a comparatively warm place for the winter, the fungus may continue its destructive development within them and even infect neighboring tubers. Frequent picking-over and a cold place for storage are the chief preventives of loss from this source. Infected tubers, planted in the spring, are very likely to produce diseased plants, from which a whole field may become diseased. Care should, therefore, be exercised in selecting "seed" potatoes, that none of them bear the brown decayed spots which indicate the presence of the *rot* fungus, though it is true that sound crops have been raised from infected "seed".

This brings us to the least definite feature in our knowledge of this parasite. Since its summer spores cannot live long or endure cold, how does it survive the winter? Doubtless, by the hibernation of its threads in potato-tubers, as just described; but this method alone seems hardly certain enough to constitute the sole reliance of the plant, or sufficient to account for the phenomena of its sudden and abundant appearance. Most of the mildews, the nearest relatives of our plant, produce, in the stems and leaves of their host plants, peculiar *resting spores* which can live and resist cold or dryness for a long time and finally germinate and reproduce their respective fungi when warmth and moisture return. But, although certain botanists have stoutly claimed that the potato fungus produces such spores, their existence has never been satisfactorily proved.

A preparation which has given remarkable results in the prevention of grape-vine mildew, when sprayed upon the vines, would probably prove equally efficacious in protecting potato plants against the *rot*, if it can be applied in time. This is the so-called *Bordeaux mixture*, prepared as follows:

A. Dissolve 6 lbs. sulphate of copper in 16 gals. water.

B. Slake 4 lbs. lime with 6 gals. water.

C. When cool, mix A and B, stirring thoroughly.

As the preparation is a mixture and not a solution, some form of spraying apparatus with an attachment for keeping it thoroughly stirred is required for its application. But few attempts at fighting the potato-rot have been made, and it is impossible to say how effectual the above treatment will be; but, as it has proved so valuable in other related diseases, a thorough trial of it is earnestly recommended. The chief difficulty will be in making the application promptly enough. To ensure this, the materials should be kept on hand, and the mixture applied on the first signs of the trouble in any part of the field, or in any field in the neighborhood. To determine the utility of the application, a part of the field should be left untreated as a "control-experiment." A comparison of results on the treated and untreated plants will show the efficacy of the treatment.

The writer wishes to render all possible service to the farmers, horticulturists, and florists of Massachusetts, in dealing with fungus diseases of plants, and will be glad to answer all requests for information and advice as promptly and as fully as possible.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

W. W.

BULLETIN No. 7.

JANUARY, 1890.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
J. E. WILLIAMS, BOOK AND JOB PRINTER.
1890.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell,	*Director.*
William P. Brooks,	*Agriculturist.*
Samuel T. Maynard,	*Horticulturist.*
Charles H. Fernald,	*Entomologist.*
Clarence D. Warner,	*Meteorologist.*
William M. Shepardson,	*Assistant Horticulturist.*
Herbert E. Woodbury,	" "

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Horticulture.

SAMUEL T. MAYNARD.

SMALL FRUITS.

RASPBERRIES AND BLACKBERRIES.

The crop on the College grounds the past season was unusually good, but reports come to us of a light and poor crop in many sections.

Under good cultivation both the raspberry and blackberry are profitable and the demand for choice fruit is increasing.

We give in the following tables a summary of the qualities of those varieties, both old and new, which have been tested here two or more years.

The tables are arranged on a scale of 1 to 10; 1 indicating the greatest perfection.

RED RASPBERRIES.

	Productiveness.	Quality.	Earliness.	Size.	Order of Blooming.	Per cent. of Canes, winter killed.	REMARKS.
Rancocas	6	1	1	4	1	40	Very good.
Herstine	10	1	7	4	4	80	Not profitable.
Brandywine	5	3	3	5	6	23.3	Good.
Belle de Fontaine	7	6	7	2	8	13.2	
Highland Hardy	8	1	2	6	2	15.5	
Crimson Beauty	5	4	2	5	1	28.2	
Cuthbert	1	5	9	2	9	9	Standard market berry.
Superb	4	5	7	1	9	58.9	Crumbles.
Hansel	1	2	2	5	1	35.5	Soft, but profitable.
Marlboro	2	5	2	2	2	52.1	Firm, profitable, requires high culture.
Golden Queen	5	7	9	2	9	27.7	Soft.
Caroline	4	3	3	6	4	12	Too soft for market.
Turner	5	6	2	7	2	13	Small and crumbles.
Thompson's E. Prolific	3	3	2	4	2	41.6	Not fully tested.
Thompson's Pride	5	7	2	5	1	62.5	" " "

	Productiveness.	Quality.	Earliness.	Size.	Order of Blooming.	Per cent. of Canes winter killed.	REMARKS.
BLACK-CAP RASPBERRIES.							
Carman	8	5	2	5	3	0	Weak in growth.
Butler's Seedling. (Cromwell)	1	7	1	2	1	0	Strong and vigorous.
Nemeha..........	4	7	9	5	8	78.5	Vigorous.
Crawford.........	2	3	3	4	2	0	Promising, vigorous.
Hilborn	1	2	8	3	2	0	Not sufficiently tested.
Thompson's Sweet	6	7	4	5	6	0	" " "
Ohio	3	7	3	2	7	16.6	Vigorous.
Springfield.	5	7	3	5	2	54.0	Weak in growth.
Gregg...... ...	1	3	10	1	10	39.3	Tender.
BLACKBERRIES.							
Erie............	5	6	5	2	8	16.5	Continued fruiting till Aug. 28.
Fred	2	7	4	3	4	0	Continued fruiting till Sept. 5.
No. 1...........	7	8	3	4	7	21	Continued fruiting till Sept 20.
Early King.......	6	3	4	1	4	0	
Thompson's Mammoth..........	2	3	3	2	6	42.8	
Wilson, Jr.......	2	8	3	2	2	25.8	
Wilson's Early...	3	7	2	2	2	48	
Early Harvest....	1	5	1	5	3	62.3	
" Cluster.....	5	6	1	4	1	21.8	
Agawam....	1	1	2	3	2	5	Sweet and moderately firm.
Taylor's Prolific..	1	3	9	3	10	10	
Wachusett	4	4	5	5	5	8	
Snyder..........	3	3	5	1	6	9	
Minniwaski	5	7	4	5	3	20	
Excelsior	8	6	5	8	6	50	
Lucretia.........	3	8	2	2	2	14.5	Productive, good.

GIRDLING THE GRAPE VINE.

The practice of girdling the grape vine to hasten the time of ripening of late varieties, has attracted much attention during the past year or two, and has led to the statement by some prominent grape growers, that the increased size of the fruit was *at the expense of quality*.

To settle this matter beyond dispute, in 1888 we suggested to Dr. Jabez Fisher, of Fitchburg, the father of grape growing in northern Massachusetts, that he make careful experiments in girdling, noting accurately the results, and that the Hatch Station would make chemical analyses of such girdled specimens as he should provide.

Vines were carefully treated in his vineyard in 1888, but the frost of Sept. 6th destroyed the crop. Again, the past season vines were girdled and samples sent to the station for analysis, the results of which are shown in the following report in Dr. Fisher's own words and in the table of analysis furnished by Dr. Goessmann.

DR. FISHER'S REPORT.

At the suggestion of Prof. Maynard, I give you the details of an experiment that I made during the past season, to determine the influence exerted by girdling the grape vine.

July 5, I girdled one of the two bearing arms on each of sixty Concord grape vines by taking out a ring of bark half an inch long near the trunk of the vine. As a result these grapes showed color August 12th, six days before those on the opposite half of the same vines. They were fit for market September 20th, the berries being then from 30 per cent. to 40 per cent. larger and much sweeter than the others. October 1st they still were sweeter than those not treated, which latter were then ripe, but the first had a somewhat insipid taste without the refreshing sparkle of the others.

An analysis was made by Dr. C. A. Goessmann, chemist of the station, which is here given:

September 20th.	**Girdled.**	**Not Girdled.**
Moisture at 100°C	83.00 per cent.	84.69 per cent.
Ash	.42 "	——
Sugar	8.13 "	6.24 "
Soda Sol. required to neutralize acid	84.4 C.C.	75 C.C.
October 1st.		
Moisture at 100°C	82.69 "	85.51 "
Ash	.37 "	.53 "
Sugar	8.50 "	6.09 "
Soda Sol. required to neutralize acid	50 C.C.	48 C.C.

The loss of acid at the second period, is the only explanation of the increased sweetness evident to the palate, particularly in those not girdled and unpleasantly in those girdled.

The results, so far as they are apparent from this trial, show a gain of ten days in fitness for market, with largely increased size of berries. The drawbacks are, in a season as wet as the past, a loss of from 20 per cent. to 40 per cent. of the berries by cracking open, and the production of berries too soft to bear carriage. Both of these drawbacks would be lessened in a drier season, though not overcome in my experience, and there would be a decided diminution in quality for connoisseurs. Add to this, the harm which may come to the vine from the operation repeated year after year, but which is not yet settled.

I propose to repeat the experiment upon the same vines another season. Yours truly,

JABEZ FISHER.

CONCLUSION.

It will be seen by this report, as in our previous reports, that there is a decided gain in the time of ripening of the fruit which will enable us to grow many late varieties not possible without it; that a gain of ten days would make a great difference in the price of the fruit; that there is no loss of sugar, and the increased size of the fruit would make it very attractive and more than make up for the softness of the berry. This latter condition can be of little objection, as most of the grapes grown in New England are sold in local markets.

REPORT UPON VEGETABLES.

TOMATOES.

In preparing for this experiment, no special effort was made to obtain every variety in the trade catalogues, but more especially, those of some value to the grower.

They were planted on soil in every way as nearly alike as possible, four perfect plants being set in each plot and with several varieties duplicate plots were set out.

The fruit was gathered each week as soon as fully ripe, and a careful examination made of the various qualities, a summary of which is given in the columns of the following table :

VARIETIES.	Color.	Number of Double Blossoms Observed.	Number Picked Ripe up to October 2nd.	Number Picked Green on October 2nd.	Size.	Form.	Beauty.	Solidity.	Quality.	Order of Ripening.
Alpha,	R	14	200	68	7	7	8	8	8	10
Arlington,	R	93	125	120	9	6	7	10	9	5
Atlantic Prize,	R	5	105	18	6	7	6	8	8	10
Bay State,	R	0	95	92	8	9	9	8	9	8
Boston Market,	R	8	133	74	8	9	8	9	9	9
Canada Victor,	R	10	145	42	6	6	7	7	7	10
Cardinal,	R	0	77	86	8	8	8	8	8	1
Cheswick Red,	R	17	93	39	8	9	9	8	8	5
Conqueror,	R	4	176	38	7	6	6	5	7	9
Dwarf Champion,	P	1	39	96	7	9	9	9	9	9
Early King Humbert,	R	0	232	200	5	7	7	6	7	5
Essex Hybrid,	P	1	157	40	6	9	9	9	8	9
Essex Round Red Smooth,	R	1	214	112	7	8	8	8	9	8
Extra Large,	R	15	45	34	9	7	7	9	8	3
Faultless,	R	9	162	31	6	7	7	7	6	10
Fulton Market,	R	20	173	7	6	7	7	8	8	10
General Grant,	R	2	130	82	6	7	8	7	7	10
Golden Rod,	Y	13	125	100	8	8	8	9	9	5
Green Gage,	Y	0	322	200	4	9	8	7	9	10
Haines No. 64,	P	0	202	107	7	9	9	9	10	9
Hathaway's Excelsior,	R	0	196	75	6	9	8	8	9	9
Hubbard's Curled,	R	50	232	20	5	5	5	6	6	9
Ignotum,	R	0	87	43	9	8	9	8	9	5
Large Round Red Smooth,	R	4	145	90	7	9	9	9	8	5
Little Gem,	R	7	466	0	4	9	8	8	7	10
Livingston's Acme,	P	4	102	36	6	9	9	7	8	9
Livingston's Beauty,	P	1	134	60	8	9	9	9	9	9
Livingston's Favorite,	R	0	111	44	8	8	8	9	9	9
Livingston's Perfecton,	R	2	95	40	8	8	8	9	9	9
Lorillard,	R	1	139	100	7	9	9	8	10	10
Mayflower,	R	3	136	116	7	8	8	8	9	9
McCullum's Hybrid,	R	0	100	110	8	8	8	8	9	5
New Bronzed Leaf,	R	137	118	22	8	7	8	9	9	8
New Jersey,	R	1	121	126	9	9	9	10	10	6
New Queen,	R	1	185	132	7	9	9	9	8	8
New White Apple,	Y	0	265	357	4	9	9	7	7	5
Optimus,	R	0	149	61	6	9	9	8	8	9
Paragon,	R	0	63	104	8	9	9	10	10	1
Red Pear Shaped,	R	0	380	0	3	5	7	2	6	9
Shah,	Y	29	104	30	9	7	7	9	8	9
The Mikado,	P	31	128	27	9	8	8	10	9	10
Tilden's New,	R	0	194	44	6	8	8	8	8	3
Trophy Selected.	R	18	109	68	9	8	8	10	8	9
Volunteer,	R	2	196	77	8	9	9	8	9	9
Yellow Fig,	Y	0	280	0	4	4	6	4	6	5
Yellow Victor,	Y	15	156	86	6	7	7	7	7	8

Column No. 1 refers to color; all of a distinctly red or scarlet hue are designated by the letter R; those of the Acme color by P, and those yellow or greenish white by Y.

**Column No.* 2 refers to the Double Blossoms found on the four plants in each plot.

Column No. 3 gives the number of tomatoes which ripened up to the time of the last picking October 2nd.

Column No. 4 gives the number of green tomatoes at the last picking on October 2nd.

Column No. 5 gives the size; 1 indicating the smallest and 10 the largest.

Column No. 6 gives the form marked on the same scale; perfect form being round, smooth and without ridges or deep grooves.

Column No 7 gives the beauty according to color, smoothness of skin, and the amount of cracks, or green centres.

Column No. 8 refers to solidity, or the per cent. of the fleshy portion; 1 indicating a very large per cent. of seeds and pulp, while 10 is almost solid.

Column No. 9 gives quality. This most difficult test was made by several persons carefully testing specimens picked each week.

Not less than five tests were made of each variety.

Column No. 10 gives the order of ripening; 1 indicating lateness, while 10 is the earliest.

EASTERN VS. WESTERN SEED SWEET CORN.

At the suggestion of some of the seed growers and dealers of Massachusetts, the following experiments were made to test the comparative value of seed sweet corn grown in New England and that grown in the Western States.

All varieties were planted May 11th, 1889. The ears for analysis were taken when the kernels were just passing from the milk, or in the best condition for the table, and specimens were taken from duplicate plots for each test.

Columns No. 1 and 2 give size of ear and kernel on the scale of 1 to 10, 1 indicating smallest, 10 the largest. The other headings are sufficiently explanatory.

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*We wish growers of fruit and seeds to note the fact that the varieties producing the most double flowers, were the most irregular in form. In every case they produced very irregular fruit, and the more double the flower, the more imperfect the fruit. This fact was suggested to us by Mr. A. B. Howard, of Belchertown, Mass., the originator of the Bay State Tomato, and will be of vast importance to the grower of choice fruit; for by discarding those plants having double blossoms—and very few plants are set out in the field until some blossoms open—much of the irregular fruit will be avoided. This fact should also be borne in mind by seed growers, for by the careful selection of plants, much waste may be saved, and a more perfect strain of seed obtained, than by the usual method of setting out any and all plants, and then selecting the specimens of fruit. In the latter case the seeds having been fertilized by the pollen of the double flowers, would be more likely to produce plants with double flowers, than if they were fertilized by pollen from single blossoms.

VARIETIES.	Size of Ears.	Size Kernels.	Number of Ears.	Weight of Ears.		Weight of 3 Ears Tested for Sugar.		Weight of Stalks.		Average Height of Stalks.		Time of Ripening.
Corey, Eastern. ....7....	6	10	11	3lbs.	7½oz.	1lb.	5½oz.	3lbs.	10oz	3 ft.	10 in.	July 24
Crosby, Eastern.........	6	7	25	7	4	1	7	8	3	5		Aug. 6
Crosby, Minnesota..	7	8	29	9	1½	1	9½	8	4	3	8	July 31
Stowell's Evergreen, No. 1. Eastern.	7	7	29	23	9	3	3	23		5		Sept. 2
Stowell's Evergreen, No. 2, Eastern.	10	9	26	24	6	4	9	26	8	5	8	Aug. 28
Corey, Western.	6	10	13	3	½	1	5	3		3	9	July 23
Crosby, Nebraska	7	7	29	9	14	1	12	5	10	4	10	Aug. 6
Crosby, Ohio	7	7	24	10	14½	1	11½	17	10	5		Aug. 6
Stowell's Evergreen, Michigan......	9	10	29	28	10	3	1	25	8	7	4	Aug. 17
Stowell's Evergreen, Minnesota ..	10	8	36	31	10	3	5	55	12	7	1	Aug. 31
Stowell's Evergreen, Nebraska.....	8	9	32	29	13	4	1½	50	4	7		Sept. 2
Stowell's Evergreen, Nebraska. ...	9	9	28	26	14	3	12	33	8	5	7	Aug. 29
Stowell's Evergreen, Ohio	8	10	30	25	15	2	2	27		5	3	Aug. 15
Stowell's Evergreen. Western......	10	8	27	21	5½	3	6½	29	12	5	6	Aug. 28
Alexander's Pride of America.....	7	10	9	3	3	1	9	1	11	3	1	July 24
Burlington Hybrid	6	7	13	6	9	1	10¼	8		5	5	Aug. 6
Cleveland's Colossal	7	7	21	12	11¼	1	11½	15		5		Aug. 20
Extra Early Dwarf, Crosby........	6	7	11	3	13½	1	8½	2	12	3	6	July 30
Marblehead, No. 1.............. ...	7	10	23	6	11½	1	12½	4	3	3	2	July 25
Marblehead, No. 2	6	10	24	7	10½	1	10½	6	3	3	4	July 25
Ne Plus Ultra	5	6	31	9	15½	1	1½	19		7	3	Aug. 24
Northern Pedigree	7	9	11	2	1½		14		11	2	10	July 23
Potter's Excelsior Sweet.....	6	7	13	7	14½	1	12½	15	20	6	9	Aug. 13
Roslyn's Hybrid Sugar Corn........	7	6	8	3	11½	2	1½	6	10	5	9	July 30
Stabler's Early Sugar Corn. ..	7	6	12	6	9	1	15	13	12	5	3	Aug. 15
Underbluff Sweet Corn.......	8	10	21	4	14	1	10½	4	1	4	11	July 30
Golden Sweet	5	6	19	6	14	1	12	8		5	1	Aug. 6

ANALYSIS.

VARIETIES.	Total Moisture.	Dry Matter.	IN AIR-DRY KERNELS.			
			Moisture.	Glucose.	Cane Sugar.	Total Sugar.
Corey, Eastern	82.40	17.60	10.60	1.22	3.84	5.06
Crosby, Eastern.	77.67	22.33	8.31	1.92	2.14	4.06
Crosby, Minnesota.......	82.18	17.82	7.15	1.45	3.39	4.85
Stowell's Evergreen, No. 1, Eastern..... ...	72 07	27.93	8.66	2.18	4.76	6.94
Stowell's Evergreen, No. 2, Eastern...... ...	76.47	23.53	9.28	1.83	3.96	5.79
Corey, Western...........	81.32	18.68	11.15	.82	3 20	4.02
Crosby, Nebraska.......	—	—	8.44	1 73	3.13	4.86
Crosby, Ohio	77.68	22.32	8.30	1.64	2.17	3.81
Stowell's Evergreen, Michigan	79.04	20.96	9.40	2.59	4.51	7.10
Stowell's Evergreen, Minnesota	76 67	23.33	9.44	2.40	4.63	7.03
Stowell's Evergreen, Nebraska	78.00	22.00	8.82	2.93	5.60	8.53
Stowell's Evergreen, Nebraska	79.07	20.93	9.34	2.18	4.22	6 40
Stowell's Evergreen, Ohio	82 24	17.76	9.22	1.48	3.71	5.19
Stowell's Evergreen, Western	75.96	24.04	9.49	2.57	4.68	7.25
Alexander's Pride of America	79.48	20.52	11.19	.97	3.08	4.05
Burlington Hybrid	73.05	26.95	9.11	1.32	2.27	3.59
Cleveland's Colossal	81.96	18.04	9.55	1.57	3.18	4.75
Extra Early Dwarf, Crosby......	81.94	18.06	7.79	.76	2.31	3.07
Marblehead, No. 1, Eastern	84 96	15.04	10.51	1.71	2 48	4 19
Marblehead, No. 2, Eastern	83.10	16.90	10.79	1.39	3.17	4 56
Ne Plus Ultra	73.11	26 89	9.80	2.26	3 73	5.99
Northern Pedigree.......	78.25	21.75	10 21	1.40	2.76	4.16
Potter's Excelsior Sweet	84.83	15.17	9.20	1.87	4.64	6.51
Roslyn's Hybrid Sugar Corn.	87.54	12.46	9.02	2.09	.78	2.87
Stabler's Early Sugar Corn	80.92	19.08	9.10	1.69	4.82	6.51
Underbluff Sweet Corn	81.82	18.18	8.59	.69	3.81	4.50
Golden Sweet	77.72	22.28	9.00	2.78	3.87	6.60

To give each variety a fair test they were planted in soil of as nearly the same character as possible and duplicates made in different parts of the plot.

Seed of the three varieties, Corey, Crosby and Stowell's Evergreen, was obtained from various sources, both east and west; the other varieties reported were sent in for testing, but no attempt at a comparative test was made, except that the soil was of as nearly the same character as could possibly be provided.

CONCLUSION.

The results of this test lead us to no very definite conclusion.

In the corn varieties there is a decided increase of sugar in the Eastern grown over that in the Western, but in the other varieties the results seem to be in favor of the Western grown seed. Such a test, however, as the above requires several years repetition before we can feel that we have reached conclusive results.

One element in this experiment which perhaps makes the results uncertain, and yet which we know little about, is the influence the pollen of one variety may have upon the variety fertilized by it, yet as all were equally exposed, we feel that the results are more conclusive than if each variety was isolated and planted in widely different soils.

LETTUCE.

The varieties tested were largely obtained from seed dealers of Massachusetts, but some were sent us for testing.

In the following table 1 indicates the least and 10 the greatest perfection. In column 4 H stands for head, C for curled and F for fringed lettuce.

VARIETIES.	Earliness.	Lasting Qualities.	Size.	Form.
All-the-year-round	2	9	8	H
Bath Co.'s White Seeded	3	7	9	H
Black Seeded Simpson	4	10	10	C
Black Seeded Tennis Ball	4	8	3	H
Brown Genoa	3	9	8	H
Buttercup	4	7	4	H
California All Heart	3	8	7	H
Deacon	3	7	4	H
Defiance	4	9	5	H
Drumhead	5	9	9	H
Dwarf Green Early Black Seeded	8	8	8	H
Early Butterhead	4	7	6	H
Early Curled Silesia	5	8	8	C & H
Early Curled Simpson	8	8	7	H
Early Prize Head	4	8	9	C
Golden Ball	5	5	4	H
Green Fringed	4	9	7	F
Hanson	5	3	6	C & H
Henderson's Lettuce	6	6	9	C
Henderson's New York	4	8	8	H
Improved Spotted	3	9	7	H
Lacineated Beauregard	4	9	8	F
Large Princess Head	5	7	7	H
Marblehead Mammoth	4	8	8	C & H
Market Gardener's Private Selected	3	3	5	H
Neapolitan Cabbage	4	9	6	C & H
New White Russian	1	6	1	H
Oak Leaved	2	10	9	F
Perpignan	6	9	4	H
Red Besson	5	5	9	H
Satisfaction	5	2	5	H
Sugar Loaf	6	10	10	C
Sure Head Golden Yellow	6	1	4	H
True Boston Curled	8	2	6	F
Versailles Cabbage	2	10	6	C & H
Ward's Improved White Tennis Ball	9	1	2	H
White Paris Co.'s	4	6	8	H
White Tennis Ball	10	1	4	H

POTATOES.

Twenty-four varieties of potatoes were sent to the station the past season for testing.

They were planted in plots of four rows, each row containing five hills.

The soil was of the same character throughout, and fertilized and prepared in the same way. The potatoes were cut to single eyes and planted May 16th, one piece in each hill.

Where the seed did not produce enough eyes for four rows, only one or two were planted.

The following table gives the results:

VARIETIES.	Weight of Seed.	Number of Hills.	Weight of Dried Tops.	Weight of Crop.
Boley's Spy,	12 oz.	20	3lbs 7.5oz.	25lbs. 11oz.
Crown Jewel,	10	19	1 10.5	25 4
Early Maine,	13	20	1 13.5	36 10
Early Market,	9	16	12	11 1
Early No 1,	12	20	1 9	29 5
Early Puritan,	1lb. 2.5	19	1 9.5	30 3
Fearnaught,	8	20	1 2.5	16 9
Hampshire County,	13	20	9.5	30 15
New Queen,	12	20	1 12.5	33 9
Ohio Junior,	10	20	1 1	20 7
Pearl of Savoy,	13	19	1 14	45 4
Pootatuck,	9	19	1 1.5	18 15
Summit,	7.5	18	2 5.5	23 2
Thorburn,	11	17	1 5.5	19 11
Toole's Seedling No. 1,	11	20	1 5.5	24 12
" " No. 2,	12	19	14.5	19 3
" " No. 3,	9	20	1 2.5	25 11
Ben Harrison,	7.5	7	5.5	4 5
Mrs. Foraker,	3.5	9	7	6 7
O. H. Alexander's No. 1,*	7	5	6	5 8
" " No. 2,*	7.5	5	7	8 12
" " No. 3,*	5.5	2	6	1
" " No. 4,*	5.5	5	4	2 11
" " No 5,*	6	5	8.5	3 13

*Seriously injured by drying before planting.

COMBINED FUNGICIDES AND INSECTICIDES IN POTATO GROWING.

For the past two years the potato crop in Massachusetts has been seriously injured by blight and rot caused by the minute parasitic plant (*Phytophthora infestans*) the history of the development of which was given by Prof. J. E. Humphrey in Bulletin No. 6. To overcome this injury and to make a success of the crop in our experiment plot, the following experiments were made:

The land containing the twenty-four varieties reported above was divided into two plots—No. 1 including the first three hills of each row, and No. 2 the fourth and fifth hills.

To plot No. 1 was applied Paris green and plaster, one part of the former to five hundred of the latter by weight.

To plot No. 2 was applied Paris green in water, one teaspoonful to two gallons, and one-fourth ounce of sulphate of copper.

In both plots the potato beetle larvæ were effectually destroyed.

In plot No. 2 the growth of foliage was slightly checked, but the blight did not strike it quite as soon as that in plot No. 1.

The injury to the foliage may have been due in part to the Paris green as in other tests made with the water solution, similar results were noticed.

Beneficial results were found upon digging the tubers. In plot No. 1 where no sulphate of copper was used, we found 74 rotten tubers, while in plot No. 2 only 16 rotten ones were found. This result may be accounted for perhaps on the theory that the spores or germs of the disease were destroyed when they reached the ground where the copper solution had been retained by the soil, for with tubers near the surface of the soil it is probable that the spores would reach them before the threadlike growths of the blight could pass through the stem and roots.

While this experiment gives no very conclusive results, it outlines a method, which we shall develop further, by which we may hope to overcome many insect and parasitic enemies to both our farm and fruit crops at a minimum cost.

We cannot grow potatoes without the use of Paris green, and if at the time of its application we can combine an effectual fungicide, our crop may be made certain with little or no increased cost.

PROTECTION OF FRUIT TREES FROM MICE, RABBITS AND WOODCHUCKS.

Another season's test has confirmed the results of our experiments of previous years in protecting trees from injury by girdling, and as numerous letters of inquiry for means of protection from girdling by mice, rabbits and woodchucks have been received, we give the results of our experiments up to date.

In addition to the simple mixture of lime, cement and Paris green wash, we have found if the above be mixed with skim milk it adheres better than if mixed with water; in some cases adhering firmly for six months or more.

Portland cement adheres more firmly than the Roslyndale and is more satisfactory when not mixed with milk than the latter.

Several reports have come to us of young trees having been injured by woodchucks during the Summer, and in one case we can report that out of more than 1,000 trees treated with cement, milk and Paris green, not one was injured during the past Summer, while many not painted were seriously injured.

The amount of Paris green used was one tablespoonful to each two gallon pail full of paint, mixed so as to easily apply with a paint brush.

Division of Agriculture.

William P. Brooks.

GENERAL RESULTS OF A TRIAL OF A FEW JAPANESE CROPS.

At the time of leaving Japan in October of last year I was unaware that I should be placed in charge of a department of the Hatch Experiment Station, and did not, therefore, make arrangements for the forwarding of any considerable amount of seed of any kind. I had been located in a section of that country, however, with a climate having essentially the same range of temperature as that of Massachusetts; and had become convinced by observation that some of the crops there cultivated were of peculiar value. I, therefore, on my own account had the seeds of a few varieties collected, and left them to be forwarded with shrubs and trees which were to be taken up after the fall of their leaves.

I have thought it best to make these statements in explanation of the fact that the quantities of some of the seeds were so small, and I must add further that, since the living plants could not safely be sent across our continent in winter, an arrangement was made to have them started so that they would reach San Francisco in early Spring. It was not anticipated that the package would be so long on the road between that city and here as proved to be the case. By "fast freight" it required thirty days! This explains the lateness of planting which was about two weeks after the proper season. Our results were possibly unfavorably influenced by this; but since frosts held off late, the effect was probably not great.

All these crops were planted June 3d on a light loam which had been some years in grass, the soil before planting receiving a light dressing of a complete fertilizer partly broadcast and partly in the furrow.

I. MILLET—*Panicum crus-corvi.* JAP. *Hiye.* This was sown in drills two and a half feet apart and rather thickly, as it was supposed the seed might be injured. It however, apparently all came, and we thinned it so that about four plants only remained to the linear inch of a rather broad row. It was kept free from weeds by the use of a hand cultivator, but grew so rapidly that not much labor was required. It was in blossom Aug. 23d. and was cut with seed "in the dough" on Sept. 21st. When in blossom it stood six and a half feet high; later, as the heads fill they droop. The plants had an abundance of large leaves which remained green up to the time of harvest.

The promise of seed was enormous: but the sparrows found it, and we saved very little. Nothing that we were able to devise served to keep them off; which fact, considering that there were several other varieties of millet in the same field, sufficiently indicates the quality of this. This species furnishes an unusually large and beautiful seed, which must prove excellent either for poultry or cage-birds.

As a fodder crop the species may prove of value, though the stems are harsh and coarse. For ensilage it will probably prove better suited than for feeding either green or dry. Our yield was large. On 616 sq. ft. of land we had 98 lbs. of dry straw, which is at the rate of rather more than three and one-half tons per acre.

II. MILLET—*Setaria Italica or Panicum Italicum*, RED HEADED VARIETY. JAP. *Mochi Awa.* The Japanese name means Glutinous Millet, this variety being much used by them for making a kind of a tough dough-cake which is allowed to dry, and then often toasted in small bits over the fire, when it swells up and tastes not unlike pop-corn. The seed was planted in the same manner as the preceding. It appeared above ground on June 12th, and was in flower Aug. 6th. The heads were very long and full and as they filled drooped heavily, but there was no lodging. Many heads, by actual measurement, were found to be a foot long. When straightened up the plants were from five to six feet high. The birds showed their appreciation of this variety also, and, it is judged, took fully half the seed. We got 23 lbs. seed and 64 lbs. dry straw. The area was 616 sq. ft., so that these yields are at the rate of 1,702 lbs. (about 28 bush.) of seed and 4,736 lbs. (a little more than 2 1-4 tons) per acre. This variety gave every indication of proving a valuable one; it is earlier than the preceding, but later than the next described. The seed was fully ripe about the middle of September.

III. MILLET—*Setaria Italica, or Panicum Italicum*, JAP. *Awa.* This variety in appearance resembles our ordinary millet, but seems much more vigorous and productive. It was planted in the same manner as the others and was similarly treated. It was in blossom July 27th, and the seed in the large drooping heads was perfectly ripe Sept. 7th, when it was cut. The height is not quite equal to that of the preceding variety, neither are the heads as large. The area was 616 sq. ft., the yield of seed 45 lbs. and of dry straw 50 lbs., being at the rate of about fifty-five bushels of seed and nearly two tons of straw to the acre. Both this and the preceding variety give promise of proving very valuable either for seed production or for fodder.

IV. VARIETIES OF BEANS—All of these were planted thinly in rows two feet and a half apart. In the furrow before planting a small quantity of a fertilizer containing available nitrogen, potash and phosphoric acid, was scattered. All varieties came up quickly and grew rapidly, presenting a remarkably healthy appearance throughout the season.

SOJA BEAN, MEDIUM EARLY—*Glycine hispida*, JAP. *Daidzu.*

This variety showed its first flowers July 28th, and the crop was fully mature Sept. 25th, when it was pulled. The area was 880 sq. ft. and the yield 30 lbs. of cleaned beans, which is at the rate of 25 bu. per acre. Should this class of beans prove desirable here this variety will be superior to most of the kinds offered under the same name because so much earlier. It is well known that the beans of this class are of remarkable richness, containing a very unusual proportion of nitrogen, and it certainly seems desirable to give them a fair trial.

SOJA BEAN NO. 2, VERY EARLY VARIETY.—*Glycine hispida.* JAP. *Kurakake Mame.*

The Japanese name means "*Saddled* Bean," and is given because of the peculiar disposition of black around the eye and on the sides of the bean, for all the world to their fancy like a saddle on the back of a horse. The first blossoms were noticed July 10th and the crop was pulled fully ripe on Aug. 31st. The weather was thereafter for some weeks so bad that a large share of this seed was damaged. The yield was good, but not as heavy as was that of the preceding variety. In Japan I have cultivated this variety side by side with some of our earliest sorts and found it to excel them in earliness, but no comparative test was made here this year.

Red Beans.—*Phaseolus radiatus.*

A peculiarity both of this and the following variety in germination may be of interest. They "come up" like peas, the bean remaining wholly underground. The pods of both are unusually long, containing eight to ten small beans, which are characterized by a very thin and tender skin. This variety blossomed about the end of July, and was well ripened Sept. 25th, when it was pulled. The area was 440 sq. ft., and the yield was 23 lbs. of dry beans, or at the rate of about 38 bu. per acre. These beans present an unusually handsome appearance and bid fair to prove an acquisition.

White Beans.—*Phaseolus radiatus.*

This variety was in full blossom July 27th, and was ripe Sept. 25th, when it was pulled. The area under cultivation, 440 sq. ft., gave 21 lbs. dry beans (weight taken, as in case of all crops spoken of, Dec 21st) which is at the rate of about 35 bu. per acre. This variety except in color closely resembles the preceding; but is not as handsome. The amount of seed now on hand is insufficient for a trial of their food qualities, but another season, if successful in securing crops, we shall make such a trial.

Division of Entomology.

C. H. Fernald.

A DANGEROUS INSECT PEST IN MEDFORD.

The Gipsy Moth. (*Ocneria dispar L.*)

On the 27th of last June, during my absence in Europe, several caterpillars were received at the Station, from Hon. William R. Sessions, Secretary of the Board of Agriculture, with the request for information as to what they were, and the best methods of destroying them. These caterpillars were brought into the Secretary's office by Mr. John Stetson of Medford, Mass., who stated that they were very destructive in that town, eating the leaves of fruit and shade trees. Mrs. Fernald, who had charge of the Entomological work during my absence, determined the insect to be the Gipsy-moth (*Ocneria dispar* Linn.) of Europe, but as the moths were emerging and laying their eggs for next year's brood, there was nothing to recommend at that time except to destroy the moths and their eggs as far as possible, and prepare for the destruction of the caterpillars when they first appear next spring.

FIRST IMPORTATION INTO AMERICA.

There is a statement in the 2d volume of the American Entomologist, page 111, published in 1870, and also in Riley's 2d Missouri Report on Insects, page 10, that "only a year ago, the larva of a certain Owlet moth (*Hypogymna dispar*), which is a great pest in Europe both to fruit trees and forest trees, was accidentally introduced by a Massachusetts entomologist into New England."

These are the only notices I have thus far been able to find of the introduction of this insect into America. Mr. Samuel Henshaw and Dr. Hagen of Cambridge have both informed me that the entomologist who introduced this insect was Mr. L. Trouvelot, now living in Paris, but at that time living near Glenwood, Medford, where he attempted some experiments in raising silk from our native silk worms, and also introduced European species for the same purpose. Dr. Hagen told me that he distinctly remembered hearing Mr. Trouvelot tell how they escaped from him after he had imported them.

It seems, then, that this was an accidental introduction, but that they have now become acclimated, and are spreading and doing so much damage as to cause very great alarm.

DISTRIBUTION.

The Gipsy-moth is abundant in nearly all parts of Europe, Northern and Western Asia, and it even extends as far as Japan.

In this country it occurs only in Medford, Mass., and so far as I could learn at the time of my first visit to that place, it occupied an area in the form of an ellipse abont a mile and a half long by half a mile wide.

This represents the territory where the outbreak occurred and where the insects were very abundant; but, without doubt, they are distributed in smaller quantities outside of this ellipse, but how far it is now impossible to tell.

FOOD PLANTS.

This insect was reported as feeding upon the leaves of apple, cherry, quince, elm, linden, maple, balm of Gilead, birch, oak, willow, wisteria, Norway spruce and corn.

The food plants given in Europe are apple, pear, plum, cherry, quince, apricot, lime, pomegranate, linden, elm, birch, beech, oak, poplar, willow, hornbeam, ash, hazel-nut, larch, fir, azalea, myrtle, rose, cabbage and many others. Curtis, in his British Entomology, states that they are sometimes very destructive in gardens. Prof. W. P. Brooks reported this insect as very abundant in Sapporo, Japan, in 1883, and gave strawberry as a food plant in addition to those mentioned above.

DANGER OF SPREADING.

The fact that this insect has now been in this country for the last twenty years, and has not only held its own, but has multiplied to such an extent as to cause the entire destruction of the fruit crop and also to defoliate the shade trees in the infested region, is sufficient cause for alarm. The citizens of Medford are immediately interested, but the entire Commonwealth and country are threatened with one of the worst insect pests of all Europe. In 1817, the cork-oaks of Southern France suffered severely from the attacks of this insect. One of the papers of that time stated that the beautiful cork-oaks which extended from Barbaste to the city of Podenas were nearly destroyed by the caterpillars of the Gipsy-moth. After having devoured the leaves and young acorns, they attacked the fields of corn and millet, and also the grasslands and fruit trees.

In 1878, the plane trees of the public promenades of Lyons were nearly ruined by this same insect. Only last summer I saw the moths in immense numbers on the trees in the Zoölogical gardens of Berlin, where the caterpillars had done great injury; and the European works on Entomology abound with instances of the destructiveness of this insect. When we consider its long list of food plants, we can see how injurious this insect may become if allowed to spread over the country, and become established.

The opinion was expressed to me by prominent Entomologists in Europe, that if the Gipsy-moth should get a foothold in this country, it would become a far greater pest than the Colorado potato beetle, because it is so prolific, and feeds on so many different plants, while the potato beetle confines itself to a small number.

ENEMIES OF THE GIPSY MOTH.

In Europe eleven species of the *Ichneumonidæ* and seven species of flies (*Tachina*) have been known to attack the eggs and caterpillars of this moth, but it is not known that there are any parasitic insects in this country that destroy it. Undoubtedly our predaceous beetles and bugs destroy more or less of them, and mud-wasps and spiders are also to be counted among their enemies.

HOW TO DESTROY THEM.

All the masses of eggs should be scraped from the trees and other places where the females have deposited them, and *burned*. Crushing is not sufficient, as possibly some might escape uninjured. This should be done in the fall, winter or early spring before the eggs hatch. It is not at all probable that one will find all the egg-masses even with the most careful searching on the trees in a small orchard; but when one remembers that this insect deposits its eggs on all kinds of shade and forest trees also, it appears a hopeless task to exterminate this pest by an attempt to destroy the eggs. It is a habit of these caterpillars, after they have emerged, to cluster together on the trunks or branches of the trees between the times of feeding, and this affords an opportunity of destroying vast numbers by crushing them; and after they have changed to pupæ they may be destroyed wherever they can be found. The female moths are so sluggish in their flight, and so conspicuous, that they may be easily captured and destroyed as soon as they emerge; yet any one or all of these methods which have been employed in Europe are not sufficient for their extermination. At best they will only reduce the numbers more or less according to the thoroughness with which the work has been done. I could not learn that any attempts have ever been made in Europe to destroy this insect by means of poisonous insecticides, and it is to this method that we may look for positive results in this country.

If all the trees in the infested region in Medford be thoroughly showered with Paris Green in water (1 lb. to 150 gallons), soon after the hatching of the eggs in the spring, the young caterpillars will surely be destroyed, and if any escape, it will be because of some neglect or ignorance in the use of the insecticide. It will be absolutely necessary to shower every tree and shrub in that region, for, if a single tree be neglected, it may yield a crop sufficiently large to eventually restock the region.

I can hardly feel confident that all these insects can be exterminated in one year, but if this work of showering the trees be continued during the months of April and May for two or three years under competent direction, I have no doubt but that they may be entirely destroyed.

This is, in my opinion, the cheapest and surest method of exterminating this pest, but its effectiveness depends entirely upon the thoroughness and carefulness with which it is done, and those who do the work must have authority to shower the trees not only on public but on private grounds.

As this insect was introduced into this country by an entomologist who carelessly allowed it to escape, the same thing may occur elsewhere, if the people of Medford allow the eggs or caterpillars to be sent out of the town. The only proper thing to do with such a dangerous and destructive enemy is to burn it.

Already applications have been made to me for specimens of this insect in its different stages, but I have declined to furnish them because of the great danger of their escaping into other parts of the country.

NAMES.

This insect was first described by Linneus in 1758, in the tenth edition of his Systema Naturæ, Vol. 1, page 501, under the name of *Bombyx dispar*, and, while it has retained the specific name of *dispar*, the European entomologists, since the time of Linneus, have given several different generic names, as *Liparis*, *Hypogymna*, *Porthetria*, *Ocneria* and *Psilura*, but I have adopted that given by Standinger in his Catalogue of the Lepidoptera of Europe :—*Ocneria dispar*.

Several different common names have also been given to it in Europe, as the sponge-moth, the Gipsy-moth, the great-headed-moth, the fungus-moth and others, but I have adopted the one used by the English entomologists :—the Gipsy-moth.

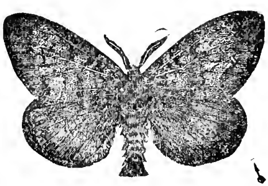


Fig. 1.

DESCRIPTION OF THE INSECT.

The males, fig. 1, are of a yellowish brown color, with two dark brown lines crossing the forewings, one at the basal third, the other on the outer third, somewhat curved, and with teeth pointing outwards on the veins. The outer end of all the wings is dark brown. A curved dark brown spot (*reniform*) rests a little above the middle of the wing, and a small round spot of the same color (*orbicular*) is situated between this and the base of the wing, just outside of the inner cross-line. A similar spot rests near the middle of the base of the wing. The fringes on the forewings are dull yellowish, and broken by eight brown spots. The antennæ are strongly bipectinated, or feather-like. The fore wings expand about an inch and a half.

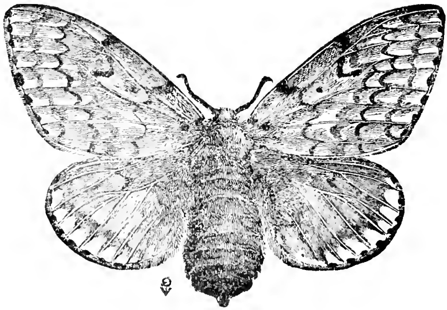


Fig. 2.

The females, fig. 2, are pale yellowish white, with dark brown cross-lines and spots similar to those of the males. The cross-lines in both sexes are much darker and more prominent on the forward edge of the wings (*costa*) than elsewhere. In some specimens there is a faint stripe of brown across the middle of the wing (*median shade*), and a toothed line across the wing near the outer edge (*subterminal line*). The fringes of the forewings have eight dark spots between the ends of the veins, as in the males, and similar but fainter spots often occur in the fringes of the hind wings. The body is much stouter than in the males, and the antennæ are not so heavily feathered. The expanse of wings is from one and three-fourths to two and three-fourths inches.

The eggs are globular, about one-eighteenth of an inch in diameter, nearly salmon colored and with a smooth surface. They are laid on the under side of the branches, on the trunks of the trees, often below the surface of the ground where the latter has shrunk away from the tree, and not unfrequently on the fences or on the sides of buildings. They are laid in oval or rounded masses, often to the number of 400 or 500, and covered with ocher yellow hairs from the abdomen of the female. The eggs are laid in the early part of July, but do not hatch till the following spring. The caterpillars remain together, feeding upon the leaves, and when not feeding they habitually rest side by side on the branches and trunks of the trees.

The full grown caterpillar, fig. 3, is about an inch and three-fourths in length, very dark brown or black, finely reticulated with pale yellow. There is a pale yellow line along the middle of the back and

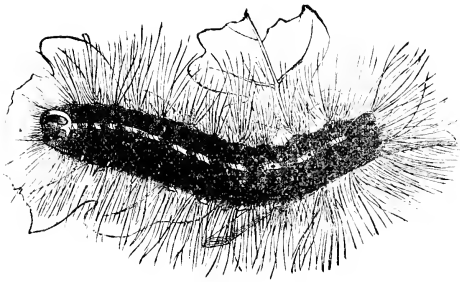


Fig. 3.

a similar one along each side. On the first six segments following the head there is a bluish tubercle armed with several black spines on each side of the dorsal line, and on the remaining segments, these tubercles are dark crimson red. On the middle of the 10th and 11th segments there is a smaller red tubercle notched at the top. The whole surface of the body is somewhat hairy, but along each side the hairs are long and form quite dense clusters.

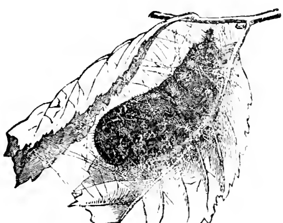


Fig. 4.

The pupa, fig. 4, is from three-fourths of an inch to an inch in length, and varies in color from chocolate to reddish brown. On each side, at the base of the wing-covers is a dark reddish brown, oval, velvety spot. The wing-cases are quite broad and reach to the posterior third of the fifth segment. The antennæ cases are strongly curved, and are quite wide in the middle. There are a few yellowish brown hairs on the face and head, also on the first five segments, arranged in broken circles or clusters, which are in longitudinal and transverse rows. The *cremaster* or spine at the posterior end is flattened, rounded at the outer end, grooved longitudinally, and has twelve or more minute hooks at the end.

The moths emerge from the pupæ from the first to the middle of July.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 8.

APRIL, 1890.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF THE AMHERST RECORD.
1890.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
HERBERT E. WOODBURY, .	" "

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Horticulture.

S. T. MAYNARD.

EXPERIMENTS IN GREENHOUSE HEATING.

STEAM VS. HOT WATER.

Much discussion having been provoked relative to the results of our experiments with steam and hot water for heating greenhouses, reported in Bulletins No. 4 and 6, especially as to the accuracy of the results, we have the past winter made a careful repetition of the experiments to correct any errors that might be found and to verify previous results.

The boilers having been run with the greatest care possible from Dec. 1st, 1889, to the present date, March 18th, and every precaution having been taken that no error should occur, we give the results in the following table:

MONTH.	HOT WATER. Lettuce and Carnation Room.					STEAM. Lettuce and Carnation Room.			
	Outdoor average daily temperature.	Indoor minimum temperature.	Indoor maximum temperature.	Indoor average daily temperature.	Coal consumed.	Indoor minimum temperature.	Indoor maximum temperature.	Indoor average daily temperature.	Coal consumed.
December.	34.99°	41.52°	57.°	47.59°	1505	40.21°	51.69°	46.39°	2350
January.	33.27	44.35	62.48	51.41	2304	42.72	61.	49.45	3202
February.	32.04	43.67	65.96	52.54	1704	42.42	66.32	51.01	2540
March, 17 days.	29.75	39.94	58.83	47.44	1085	39.16	58.11	46.73	1692
Averages.	32.51°	42.37°	61.06°	49.74°	Tot. 6598	41.12°	59.28°	48.39°	Tot. 9784

SUMMARY FOR HOT WATER BOILER.

Total coal consumed from Dec. 1st, 1889, to March 18, 1890, 6598 lbs. Average daily temperature for the time, 49.74°.

SUMMARY FOR STEAM BOILER.

Total coal consumed from Dec. 1st, 1889, to March 18, 1890, 9784 lbs. Average daily temperature for the time, 48.39°.

REMARKS.

The following criticisms have been made by parties not conversant with the facts of the case:

1st. That the piping and check valve were not arranged so as to get the most perfect circulation of steam without a great loss of fuel.

2d. That the flues from the two boilers entered the chimney in such a way as to give a better draft to the hot water boiler.

3d. That the exposure of the two houses was such that the house heated by hot water received more sun-heat than the one heated by steam.

These criticisms we think we can answer to the entire satisfaction of all fair-minded readers.

PIPING AND CHECK VALVE.

By numerous test examinations we have found that the circulation of steam through all the pipes, above the water line of the boiler, is perfect whenever there is fire enough to create steam in the boiler,—that the check valve must consequently work easily and that there is never any standing water in the return pipes above the water line of the boiler.

FLUES.

The flues are arranged so as to give as nearly equal draft to the boilers as is possible and have them enter the same chimney and enter at the same point, and if there is any difference in the draft of the two it is in favor of the steam boiler.

EXPOSURE TO SUN–HEAT.

It was suggested by the late Mr. Geo. Hills of Arlington, that, perhaps, from their location, the steam-heated house received less sun-heat than that heated by hot water.

To test this matter two standard thermometers were placed in each house so that the sun's rays should fall upon them equally in both houses at the same time, one on the eastern and one on the western exposure.

Records were made three times each day for twenty days, ending March 18th, the results of which are shown in the following table.

SUN TEMPERATURES.

DATE.		10 A. M. Sky: No. of 10ths cloudy.	10 A. M. Hot Water. Eastern Exposure.	10 A. M. Hot Water. Western Exposure.	10 A. M. Steam. Eastern Exposure.	10 A. M. Steam. Western Exposure.	1-15 P. M. Sky: No. of 10ths cloudy.	1-15 P. M. Hot Water. Eastern Exposure.	1-15 P. M. Hot Water. Western Exposure.	1-15 P. M. Steam. Eastern Exposure.	1-15 P. M. Steam. Western Exposure.	Outdoor Temperature at 1-15 P. M.	3-30 P. M. Sky: No. of 10ths cloudy.	3-30 P. M. Hot Water. Eastern Exposure.	3-30 P. M. Hot Water. Western Exposure.	3-30 P. M. Steam. Eastern Exposure.	3-30 P. M. Steam. Western Exposure.
Feb.	27	9	63	62	63	63	10	63	62	60	58	43	10	63	64	64	64
"	28	10	53	53	56	57	10	61	61	60	60	39	10	60	60	55	55
March	1	10	60	60	60	60	10	61	60	60	59	35	10	59	57	55	54
"	2	10	47	47	54	54	9	59	58	59	59	22	10	55	55	54	54
"	3	0	67	57	71	81	0	76	100	80	106	26	0	57	68	56	60
"	4	0	73	63	67	57	0	63	68	58	77	36	0	61	83	61	86
"	5	0	62	65	60	63	8	66	67	62	62	33	0	68	94	66	93
"	6	10	46	45	51	51	10	52	52	56	56	18	10	53	53	58	57
"	7	0	69	53	70	60	0	66	75	70	88	20	0	59	85	66	92
"	8	0	89	73	91	73	0	65	73	57	75	29	0	56	79	56	77
"	9	0	91	75	93	74	0	59	79	58	76	33	0	62	88	64	86
"	10	0	83	64	76	57	2	57	75	61	75	44	8	51	53	51	53
"	11	10	54	53	55	55	10	61	60	65	64	37	10	63	62	63	61
"	12	10	53	53	57	56	8	71	78	72	78	56	5	67	75	66	75
"	13	10	57	56	54	53	10	64	64	63	61	53	10	60	59	57	56
"	14	10	51	51	50	48	10	53	53	51	50	34	10	51	51	47	46
"	15	10	48	47	45	44	10	52	52	49	48	34	10	54	53	57	56
"	16	0	82	66	76	58	6	65	76	63	70	32	9	52	51	54	53
"	17	0	95	74	85	62	9	67	64	61	58	35	8	65	72	63	76
"	18	10	64	59	64	58	5	72	86	80	91	42	0	59	67	56	69
Average.		5.45	65.35	58.80	64.90	59.20	6.35	62.65	63.15	62.25	63.55	35.05	6.00	58.75	66.45	58.45	66.15

REMARKS.

Of these twenty days about eleven days were cloudy and nine clear and probably the period of time under observation was long enough to show that the amount of sun-heat received by each house is so nearly equal as to, *in no way*, change the results given in the temperatures of each house.

SOME OBSERVATIONS ON PEACH-YELLOWS.

That healthy and vigorous peach trees can be grown to the age of six to ten years in New England needs no demonstration, but we seldom find healthy trees of a greater age on account of the destruction resulting from the cold and by the disease called the "yellows."

In this bulletin we shall discuss the causes of this short life and the "yellows," that disease which has been so destructive to the peach tree in all sections of the country.

THE "YELLOWS."

The symptoms of this disease are as follows :—

1. A sickly yellowish green color of the foliage.
2. Small leaves, often clustered and tinged with red, with a small amount of chlorophyll in the cells.
3. The new shoots are small and wiry and grow in clusters or tufts, especially if they come out on the trunks or main branches.
4. The fruit ripens prematurely, is small and of a high color and insipid or bitter to the taste.

Trees may present the yellow sickly appearance from want of food or from injury, but if the fine wiry shoots, the prematurely ripened, high colored and bitter fruit are present, the trees have the "yellows."

It is still an open question whether there is a specific germ or microbe which develops at the expense of the tissues of the tree under favorable conditions, as in the diseases of a similar nature attacking other plants and animals but, from the development of the disease, it is reasonable to suggest that it may be of a similar nature to the pear blight, and other kindred diseases.

The same disease, apparently, although we have made no careful study of the tissues, often destroys the wild cherry, the wild plum, the sweet birch, (Betula lenta) and other trees.

In 1869 a small orchard of 100 peach trees was planted on a light gravelly piece of land on the College grounds. These, after some years of indifferent culture, reached the bearing stage. In 1873 many of them showed signs of the disease, but after a severe heading back and special manuring they were brought into a healthful condition and bore fruit. These were the trees which Professor Goessmann, a few years later, treated with special manures and upon which Professor Penhallow made at the same time extensive microscopic examinations, publishing the results.

The writer having the above trees under his care then and up to the present time, and having made a careful study of the peach for nearly twenty years, can say positively that many of the trees were badly diseased with the "yellows," notwithstanding the statement by parties not conversant with the facts, "that it was doubtful if the true 'yellows' had made its appearance in this section at that time." Many visitors familiar with the disease also pronounced it the typical "yellows."

The results of Professor Goessmann's experiments made in 1875 as well as those of the writer, who carried out most of the details of the field work of the above experiments, proved conclusively to us that the disease is curable, many of the diseased trees having been restored to health and borne several crops of perfect fruit.

The causes which are productive of this disease we believe to be as follows:—

FOOD SUPPLY.

1. In almost every case investigated, where the trees are neglected and the food supply is small, the trees soon die: many of them showing unmistakable signs of the yellows, while where the food supply is abundant and of a kind suited to perfect development, the growth is vigorous and healthy, and the trees live often from fifteen to twenty years.

Too large an amount of nitrogenous manure, especially if applied so that the trees do not get the benefit of it early in the season, results in a late, immature growth of wood that is often seriously injured by cold during the winters, and this is followed the next season by signs of the yellows.

The fertilizers that will be found to produce a very vigorous yet healthy growth are, equal quantities of muriate of potash and nitrate of soda with about four times the weight of fine ground bone, applied in March or April, from 5 to 10 lbs. to the tree, according to size. Wood ashes, 5 pounds, ground bone, 2 pounds, with from $\frac{1}{2}$ to 1 lb. of nitrate of soda to each medium sized tree will also prove very satisfactory. If the land is poor, containing little organic matter, a liberal dressing of stable manure may be applied in the fall, but if the land is not *very poor*, chemical manures will give better results. All manures or chemical fertilizers should be applied so that the trees may get the benefit of them early in the season. If very soluble they should be put on in March or April, but stable manure or ground bone should be put on in the fall.

INJURY BY COLD.

2. When a late growth of the trees occurs from any cause, as from

too much nitrogenous manure applied late in the season, or from a warm late fall, the action of frost during the winter often breaks the tissues in such a manner that they cannot be repaired during the next season's growth and dead places are found, often on the trunk and main branches.

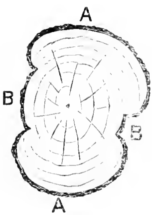


FIG. 1.

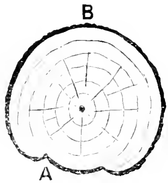


FIG. 2.

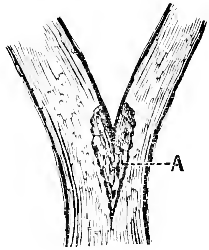


FIG. 3.

This is shown in Figs. 1 and 2, which represent cross sections of the trunks with the injured parts at A, in Fig. 1, and B. in Fig. 2, with two annual layers of wood over the injured part, and Fig. 3, an injured place in the fork of the tree.

These conditions are very common to trees from eight to ten years old in most orchards of New England.

INJURY BY BORERS.

Injuries as great and often presenting a very similar appearance more frequently occur than that caused by cold, and are the results of a decay of the tissues about the holes made by the peach borer, (*Ægeria exitiosa*). This insect generally works near the ground, but may be sometimes found in the forks of the main branches.

INJURIES BY ACCIDENT.

If an injury to the peach tree by cold or by a borer will bring on a condition rendering it liable to the yellows, the question is suggested will not other injuries result in a like condition.

An illustration of this was presented in some experiments made to test the value of adhesive mixtures to cover the buds to protect them from injury by cold, during the winter of 1887 and 1888.

Among other solutions used was that of linseed oil and turpentine in varying proportions. This was applied to six trees in the same row and in as nearly the same condition as possible, and resulted in killing five out of the six trees. The sixth tree upon which a thin solution was used, was seriously injured, many of the branches being killed, but the remainder started into growth, with that sickly yellow appearance of foliage and the tufty, wiry shoots indicative of the "yellows," and was pronounced by many experts as a case of the typical "yellows."

In the same row and with the same exposure, soil, etc., were twenty or more other trees of the same variety (Coolidge's Favorite) not treated with the oil and turpentine, all of which have remained in perfect health up to the present time.

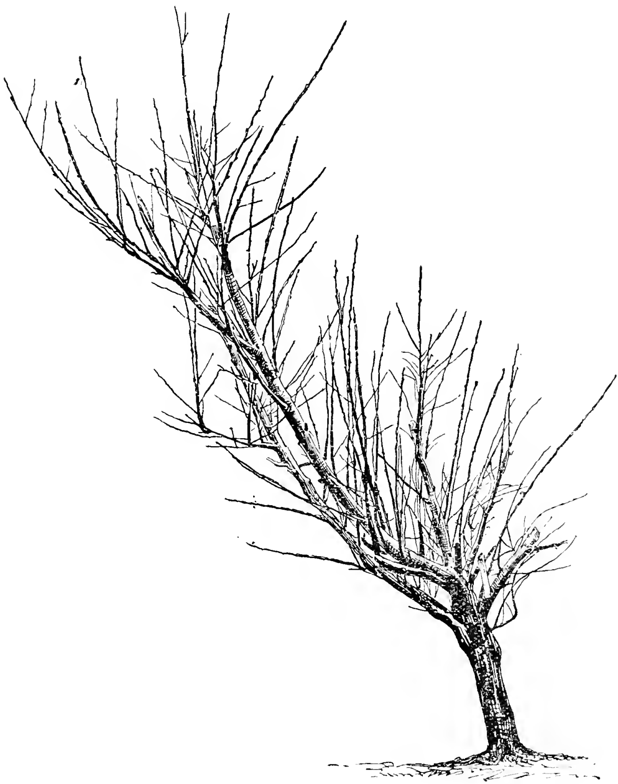


FIG. 4.

Fig. 4 is engraved from a photograph of the tree and is correct in most particulars, but the engraver has not brought out the fine tufted wiry shoots as distinctly as is shown in the photograph.

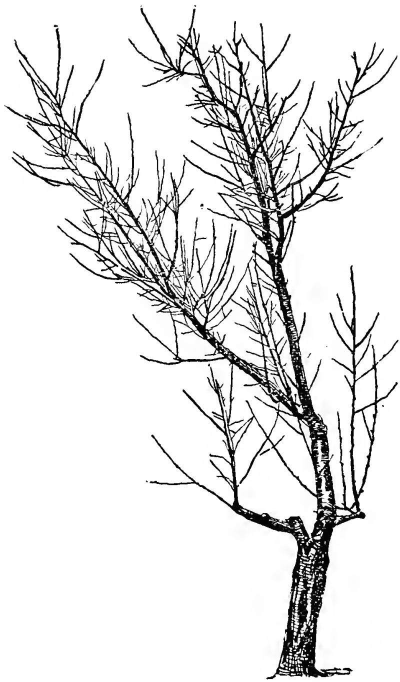


FIG. 5.

Fig. 5 is an illustration from a photograph of a tree near the original orchard of 100 trees.

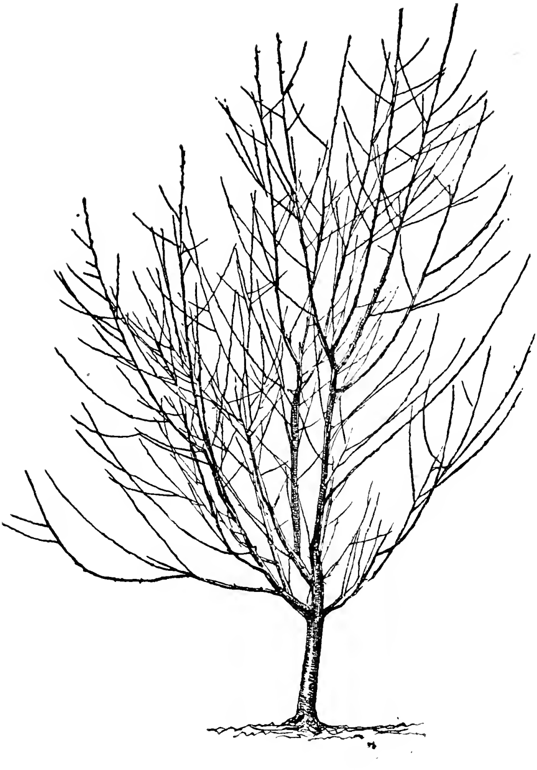


FIG. 6.

Fig. 6 shows a perfectly healthy tree.

PER CENT. OF INJURY TO TRUNKS AND BRANCHES OF DISEASED TREES.

In the college orchard of some nine hundred trees careful examination of all the trees was made during the past season. Of these, about fifty in different parts of the orchard gave unmistakable evidence of the "yellows," and in *every case* the trunks or main branches were found to be injured from 10 to 60 per cent.

In *no case* could we find any indications of the disease where the branches or trunk were not injured in some way. Figs. 1, 2 and 3 illustrate some of the injuries.

CONCLUSION.

While we do not know the exact nature of the disease called the "yellows" and cannot wholly control the atmospheric causes, the other causes we can largely control and by careful cultivation in the spring and early summer only, by the use of complete fertilizers in the fall or early in the spring we can largely prevent this destructive disease. It may not be profitable to try to save diseased trees, and it would be *advisable* to destroy them as a matter of safety, although we have no evidence that the disease is contagious; for upon the college grounds more or less diseased trees may be found at all times and young trees are planted where old trees have died and with an abundance of plant food have grown in perfect health for six years.

HOW FAR MAY A COW BE TUBERCULOUS BEFORE HER MILK BECOMES DANGEROUS AS AN ARTICLE OF FOOD?*

By Harold C. Ernst, A.M., M.D., of Boston.

The change of opinion in regard to the infectious nature of tuberculosis has been very marked in the last few years, not among the scientists, but among the people at large. Of course the medical world has, as a rule, accepted the conclusions to be drawn from Villemin's work of twenty-five years ago, and the discovery of the specific cause of the disease by Koch has only added strength to the theories advanced in certain quarters before that time.

The change of opinion spoken of is, after all, hardly a change, but, more properly, an acceptance of the knowledge gained in regard to the disease by the more recent and exact methods of research, and a much wider diffusion of that knowledge. More and more is it the rule that the knowledge of the transmissibility of tuberculosis by means of infected material is recognized among those whom it concerns the most, and nothing but good can come from the diffusion of that knowledge.

It is hardly too much to say that proper methods of management of tuberculosis, both in human beings and in animals, involve more important interests—pecuniary as well as vital—than any other subject that engages the attention of medical men. It is well known that one-seventh of the human race, approximately, perish from this disease, and when we acknowledge to ourselves, as a fair review of the evidence at hand must force us to do, that most, if not all, of this loss is preventable our duty is plain before us. That is, never to cease speaking of it, never to give up trying to reconcile the money interests of man with his own welfare, and to do all in our power, by the collection of clinical and experimental evidence, to make the case complete.

The work showing the etiological relationship of the bacillus of tuberculosis to the disease was, to all intents and purposes, complete upon the publication of Koch's monograph upon the subject. Nothing more in the way of proof was actually needed, and, indeed, very

*Preliminary results of experiments undertaken under the auspices of the Massachusetts Society for Promoting Agriculture.

little has been furnished. At the same time, confirmatory evidence was demanded by some who had, and many, who had not access to the original details, and this confirmatory evidence has been furnished in such overwhelming amount that it is to-day but a waste of time to repeat, what is accepted the scientific world over, that in the organism described by Koch we have the specific cause of this pathological change, and that without its activity we do not have tuberculosis in any form or under any conditions.

An imperfect understanding of the nature of bacteria in general, and of this organism in particular, has led to many attempts to arrest the pulmonary form of the disease it produces, by therapeutic measures, most of which would have been seen to be useless at the outset, if a knowledge of the problem had been complete. It is not upon drugs or mechanical means that our reliance should be placed in attempting to stamp out this scourge of civilized man. Our attention must be turned in the direction of proper preventive measures and until the necessity for this is impressed upon physicians in general, and by them upon the people at large, so that the preventive measures suggested after mature deliberation will be complied with, but little can be effected, and the knowledge gathered after so much hard labor must be considered as wasted, for the time being.

In order to the suggestions upon which the stamping out of tuberculosis must depend, there is necessary a large amount of investigation into the methods by which it spreads and by which the virus is carried from person to person. Among these methods are undoubtedly the excreta—more especially the sputum—from persons affected with the disease; the excreta are carelessly treated and scattered broadcast to the injury of persons susceptible but not previously affected. The methods of distribution in this way, and the behaviour of the bacillus of tuberculosis outside of the body, have been well and recently treated by Cornet (*Zeit. f. Hyg.*, Bd. v. S. 191, 1888).

Other methods of distribution are of importance, however, and until within a few years have not received attention from the medical profession at all commensurate with their value. These methods of infection are those arising from the ingestion of food materials coming from the domestic animals, especially the flesh and milk of cattle.

In Koch's *Etiology of Tuberculosis* he uses the following expressions:

"Since by far the greatest number of cases of tuberculosis begin in the lungs, it is to be supposed that the infection in all these cases has taken place in the manner just suggested—by the inhalation of phthisic sputum dried and made into dust. The second principal source for the tubercle-bacilli, viz., tuberculosis of the domestic animals appears not to have anything like the importance of the phthisic sputum. The animals, as is well known, produce no sputum, so that during their life no tubercle-bacilli get from them into the outer world by means of the respiratory passages. Also in the excrement of tuberculous animals the bacilli appear to be only exceptionally present. On the contrary, it is a fact that the milk of tuberculous animals can cause infection.

"With the exception of this one way, therefore (*i. e.*, through milk), the tuberculous virus can only have effect after the death of the animal, and can only cause infection by the eating of the meat. The same conditions hold for the milk of cows suffering from 'perlsucht.' Before all things, if infection is to take place, it is necessary that the milk contain tubercle-bacilli; but this appears to be the case only when the milk-glands themselves are affected with the disease. This explains at once the contradictions in the statements of various authors, who have made feeding experiments with the milk from cows suffering from 'perlsucht.' If infection from tuberculous animals does not appear to be frequent, it must by no means be underrated."

This caution is one which was necessary at the time it was written, and its repetition is as necessary now as ever. What conclusions may be reached in regard to its *extreme* importance, are well shown by the statistics collected and presented by Dr. Brush before the New York Academy of Medicine, on April 29, 1889 (*Boston Med. and Surg. Journal*, cxx. p. 467 *et seq.*). In this paper the author states that after several years of close study of the affection, including a consideration of all accessible statistics, and the habits of the people among whom it prevails, he has arrived at the conclusion that the only constantly associated factor is found in the in-bred bovine species. If a community was closely connected with in-bred dairy cattle, tuberculosis prevailed, and, *vice versâ*, if there were no in-bred dairy cattle there was no tuberculosis. In the discussion following this paper many objections were raised. Dr. Brush went on to say that he believed that the disease was originally derived from the bovine species. He did not believe that less than fifty per cent. of all dairy cattle were affected by it, while the statistics he had quoted showed that wherever there was a race of people without cattle phthisis was unknown. He believed, furthermore, that if all the cattle in this country were to be killed, the disease would finally die out entirely here.

Such statements as these are a revelation to the generality of practitioners, and may seem to be somewhat forced, but they certainly indicate, together with the statistics upon which they are based, the existence of a greater danger than has been fairly realized. That the danger from the consumption of milk coming from cows affected with tuberculosis has been understood by individuals at least, and that, too, before the announcement of Koch's discovery, is very well shown by extracts from a letter which I take the liberty of quoting here. The gentleman writing it is a veterinarian in practice in Providence, R. I., and the observations were made and the advice given more than ten years ago. That portion of his letter bearing upon the subject in hand is as follows:

"Mr. W., June 15, 1878, called me to see a white and red cow. Coughs and is short of breath and wheezes. Pulse 60; respiration 14, and heavy at the flanks; temperature 104°. Diminished resonance of right lung, but increased in part of the same. Emphysematous crackling over left lung and dulness on percussion. Diagnosed a case of tuberculosis and advised the destruction of the animal.

"*Dec.* 12. Cow in a cold rain a few days ago for about two hours Milk still more diminished than at a visit made on September 25th. Again advised the destruction of the cow. Family still using the milk. Respiration 20; pulse 85; temperature 104.6°.

"*Feb.* 22, 1879. Temperature 104.8°; respiration 26; pulse 68. Losing flesh fast. Milk still in small quantities. Advised, as before to destroy the animal and *not to use milk.*

"*May* 30. Called in a hurry to see cow. Is now as poor as could be. No milk for a week. Pulse 80; respiration 40; temperature 106°. The cow died in about three hours. Autopsy made fourteen hours after death: Lungs infiltrated with tuberculosis deposit. Weight of thoracic viscera 43.5 pounds. Tuberculous deposits found in the mediastinum, in the muscular tissues, and in the mesentery, spleen, kidneys, udder, intestines, pleura, and one deposit on the tongue. The inside of the trachea was covered with small tubercles.

"In August, 1879, the baby was taken sick, and died in about seven weeks. On post-mortem of the child there was found meningeal tuberculosis—deposits all over the coverings of the brain and some in the lung.

"In 1881 a child, about three years old, died with, as it was called, tuberculous bronchitis. And in 1886, a boy, nine years old, who for three or four years had been delicate, died with consumption—'quick,' as it was called.

"So far as known, the family on both sides have never before had any trouble of the kind, and the parents were both rugged and healthy people, and so were the grandparents—one now being alive and sixty-eight years old, and the other dead at seventy-eight."

Of course there is much room for criticism, if these cases be quoted as carrying out an exact clinical experiment, and no one can say that the occurrence of the three deaths in the same family was anything more than a coincidence. At the same time it must be acknowledged that they offer very solid suggestions for consideration, and that the light thrown upon the disease by the investigations of recent years makes the advice of the veterinarian to "kill the cow and stop using the milk" much more sound than it appeared to the minds of the medical gentlemen who "laughed" at him at the time it was given.

It is my hope within the coming year to collect a series of clinical observations which will be of interest and some service in elucidating the question of how many cases of tuberculosis occur which produce suspicion in the minds of medical or veterinary attendants of having an origin in the milk from infectious cows.

It is upon this question of possible danger from the domestic animals—especially cattle—that much recent work has been done, but the subject has been by no means exhausted.

If there is danger to human beings from the wide spread existence of tuberculosis among cattle, some sort of restrictive measures must be taken, by means of which this danger can be lessened. At the same time legislation calling for so much pecuniary loss as would be the case if the present supply of tuberculous cattle were to be destroyed, can only be asked for with a backing of as much carefully gathered scientific evidence as can be obtained, and it is the part of preventive medicine and the experimental method to furnish some of this evidence.

Through the liberality and broad-mindedness of an association of gentlemen in Boston, it is possible to present the results of certain experiments undertaken to determine the question which is expressed in the title of this paper. "How far may a cow be tuberculous before her milk becomes dangerous as an article of food?" is an extremely important point to decide. If it be considered already settled and Koch's dictum be accepted, that there is no danger in the milk, if the mammary glands be not affected, then there remains only for the veterinary surgeon to determine the existence of such lesions, and restrictive measures can go no further. If, however, the milk from cows with no visible lesion of the lacteal tract be shown to contain the specific virus of the disease in a not inconsiderable number of cases, and if this milk be shown to possess the power of producing the tuberculous process upon inoculation in small quantities and in feeding experiments carried out with every possible precaution, then restrictive measures must have a far wider scope, and be carried on from an entirely different standpoint than has heretofore been considered necessary.

It is familiar to most of us that little importance has been attached to this question—the danger of milk from tuberculous cows with no lesions of the udder—for the reason that many experiments have been made with negative results, and because *à priori* reasoning would seem to indicate the absence of such danger; because tuberculosis is not a disease like anthrax, in which the specific poison is to be found in all parts of the system and is carried from one place to another by the blood-stream. Koch's assertion that the milk from cows affected with tuberculosis is dangerous only when the udder is involved, appears to be based upon theoretical considerations rather than practical work in this especial direction. It has been widely accepted, however, and the weight of his name has caused the assertion to be repeated many times with but few attempts to verify its correctness.

The increased attention that has been paid to the disease among cattle, and the suspicions that have been aroused that tuberculosis among the domestic animals is a more frequent cause of its appearance among men than has been supposed, have made a careful investigation of this point imperatively necessary. With the exception of a few successful experiments by Bollinger (*Deutsch. Zeit. f. Thiermed.*, Bd. xiv. S. 264) and Bang (*Ibid.*, Bd. 11, S. 15, 1885), no evidence of great value is to be adduced. These authors, as well as Tschokke (quoted by Bollinger), bring out isolated cases showing successful inoculation experiments with the milk from tuberculous cows with no disease of the udders, but the experiments are so few in number that they cannot be accepted as furnishing more than a probability, and extremely critical persons might be justified in ascribing the results to contamination.

Bang (*Congrès pour l'étude de la Tuberculose*. 1, p. 70, 1888) gives new results. Examining twenty-one cases of cows affected with general tuberculosis but with no signs of disease in the udder, he found but two whose milk showed virulent qualities upon inoculation in rabbits. He concludes that since the cows experimented with were in advanced stages of the disease and yet showed such slight virulent properties in their milk, the danger from cows in less advanced stages is much less. And this conclusion he thinks is borne out by experiments with milk drawn from eight women affected with tuberculosis; specimens were used from all for inoculation and none were found to be virulent. He draws the conclusion, therefore, that it is not necessary to consider all milk dangerous coming from tuberculous cows, but that it should always be *suspected*, because no one can say when the udder will be diseased, and because, without this, the milk from tuberculous cows contains the virus in rare cases.

I shall endeavor to show that it is not at all rare for such milk to contain the virus.

Galtier also (*loc. cit.*, p. 81) has given the result of certain experiments with milk coming from tuberculous cows, but he says that

"certain experimenters claim to have established the virulence of milk coming from animals whose udders appeared to be normal and free from any lesions; the greater number, and I am one of them, have merely encountered a virulence in milk after the udder had become tuberculous. However, as a beginning tuberculosis of the udder is an extremely difficult thing to recognize, especially during the life of the animal, the milk should be considered dangerous which comes from any animal affected, or suspected of being affected, with tuberculosis."

I shall endeavor to show that this view of the case is justified by something more than probabilities.

In the *Deutsch. Arch. fur klin. Med.*, Bd. xliv. S. 500, Hirschberger reports the results of an experimental research upon the infectiousness of the milk of tuberculous cows, in which—following out Bollinger's work—he attempts to settle, 1st, whether the cases are rare in which tuberculous cows give an infectious milk; and 2d, whether the milk is infectious only in cows with general tuberculosis, or whether it is also infectious when the disease is localized. He made the trials of the infected milk by injection into the abdominal cavity of guinea-pigs with the usual precautions. His results were as follows:

1. Milk was used five times from cows affected with a high degree of general tuberculosis in all the organs.

2. Milk was used six times from cows with only a moderate degree of disease.

3. Milk was used nine times from cows in which the disease was localized in the lung.

From these twenty cases the milk was proven to be infectious in eleven. The percentage of positive results in the animals when arranged in accordance with the three groups above given was 80 per cent. in the first group (milk from cows in a very advanced stage of the disease), 66 per cent. in the second group, and 33 per cent. in the third. He found the bacilli in only one of the specimens of the milk, and considers that this, therefore, shows that the inoculation experiments are the more certain guide as to whether the milk is infectious or not.

These results are extremely interesting, although they do not lay as much stress as do mine upon the presence or absence of lesions of the lacteal tract.

The experiments which I am able to report* have been made possible by the liberality of the Massachusetts Society for Promoting Agriculture, which became interested in the question some time ago, and has put it in my power to carry them on. They have given everything in the way of pecuniary and moral support that the work has required; my own part has been that of general director, and I have had associated with me during the whole time the Society's veterinarian, Austin Peters, D. V. S. For the last year I have also had the very valuable aid of Dr. Henry Jackson and Langdon Frothingham, M. D. V.

All of the inoculation experiments and most of the microscopic work have been done in the bacteriological laboratory of the Harvard Medical School, some of the microscopic work at the Society's laboratory in Boston, whilst the feeding experiments have been done and the experimental animals have been kept at a farm in the country devoted to this especial purpose, and situated among the healthiest possible surroundings. Nothing has been set down as the result of microscopic observation that I have not myself verified, and every portion of the work has been carried out under the most

* The full notes of these experiments will be found in the Transactions of the Association of American Physicians, vol. iv., 1889.

exacting conditions and with every possible precaution against contamination.

Before the farm buildings were used at all they were thoroughly cleaned from top to bottom. Every portion of old manure was carted away, as well as all the old earth. The whole of the woodwork was scrubbed and then washed with corrosive sublimate solution (1:1000) and finally whitewashed, and every care was taken to secure good drainage and free ventilation. The result and effectiveness of all this have been best demonstrated by the fact that every animal brought to the place made a most marked improvement in its general condition, while some of them even went so far as to appear to get well.

In deciding whether the milk from any cow affected with tuberculosis is dangerous, when the udder shows no lesion, the first point is to see whether the milk contains the infectious principle or not. In this case, of course, that infectious principle is the bacillus of tuberculosis, and attention was turned to that for some time. The observations have been carried on over a long space of time, and were made as follows: The milk was taken from the cow in the morning—or evening, as the case might be—the udders and teats having just been thoroughly cleaned. The receptacle was an Erlenmeyer flask, stoppered with cotton-wool and thoroughly sterilized by heat. The specimen was taken at once to the laboratory, there placed in conical glasses, with ground-glass covers—the whole of these having been carefully cleansed beforehand—and then allowed to stand in a clean refrigerator for twenty-four to forty-eight hours, and sometimes for seventy-two hours.

At the end of that time from ten to twenty cover-glass preparations were made from various parts of the milk or cream. These were stained after Ehrlich's twenty-four hour method, with fuchsin and methylene blue as a contrast color, and then searched with an immersion lens.

We prepared for examination in the way spoken of above, one hundred and seventeen sets of cover glasses from as many different samples of milk. Of these specimens three spoiled, *i. e.*, turned sour or acid before the examination was completed, and must be rejected, leaving, therefore, one hundred and fourteen samples of milk of which the examination was completed. These samples were obtained from thirty-six different cows, all of them presenting more or less distinct signs of tuberculosis of the lungs or elsewhere, but none of them having marked signs of disease of the udder of any kind.

Of these samples of milk there were found *seventeen* in which the bacilli of tuberculosis were distinctly present; that is to say, the *actual virus was seen in* 10+ per cent. of the samples examined (17:114=10+). These seventeen samples of infectious milk came from ten different cows, showing a percentage of *detected* infectiousness of 27.7 per cent. (10:36=27.7). These results are exceedingly interesting, it seems to me, and I confess I am surprised at the size of the percentage named. Not because I had not expected to find the bacilli—I have been convinced for several years that persistent search would show their presence in such cases as those that are here recorded—but because the amount of dilution to which the organisms must be subjected diminished immensely the chance of their being found at all. In no case have they been seen in large numbers, but equally in no case has a diagnosis been made where there was the slightest doubt of the appearance under the microscope.

The large number of cases in which these organisms have been found seem to me to indicate their presence in a still greater proportion of cases, if only a sufficiently thorough examination of all the milk could be made. This of course is out of the question, but the results here given seem to establish, beyond a doubt, the fact that milk coming from cows with no definite lesion of the udder may contain the infectious principle of tuberculosis, if the disease be present in other portions of the body of the animal. Also, that this presence of the infectious principle is not merely a scientific *possibility* but an actual *probability*, which we should be thoroughly aware of and alive to.

Other interesting facts shown are these: that the cream after rising is quite as likely to be infectious as the milk, because the bacilli were found in the milk nine times after the cream had risen, and in the cream eight times after it had separated from the milk.

In regard to the constancy of the occurrence of the bacilli in the milk, in two of the ten cows in whose milk the bacilli were found, but one sample of the milk was examined; and the bacilli were found in one sample out of several examined at different times, in two cases In the remaining six cows, bacilli were found two or more times in different samples of milk. So that, as far as they go, these results seem to indicate that the bacilli are present with a fair degree of constancy. At the same time it should not be surprising if one examination was successful and others failed, because of the chances against success, owing to dilution, which were spoken of above.

In nine of the seventeen cases the time of the milking and the portion of the milk used were noted; that is to say, a sample was taken from the first of the milking, or the last of the milking, and then cover-glasses made from the milk or cream. In these cases bacilli were found in the cream three times, and in the milk four times, from the first of the milking; in samples from the last of the milking, in the cream no times, and in the milk four times; and this too seems to show an interesting point, viz., that the bacilli, if present at all in the udder, are not washed out entirely by the first manipulations of the teats, but may be supposedly present in any portion of the milk. The converse is also indicated, that the manipulation of the udder in the process of milking does not express the bacilli from the tissue into the latter portion of the milk, but that, as before, they may be supposed to be pretty evenly distributed in all parts of the udder if they be present at all.

Before going on to consider the results of the inoculation experiments made with various specimens of milk, it may be well to glance at the condition of the cows that have been under our control from the time of the beginning of the experiments until they were killed, or until the date of preparing this paper.

The history of each cow, as far as we have been able to secure it, bears out our assertion—as far as the examinations have gone, that none of the udders were affected with tuberculosis—certainly so far as gross appearances were concerned. This was true, also, in the microscopic appearance of every case but one (No. 6, cow F). In this case the gross appearances in the udder were healthy, except that one quarter seemed to be slightly fibrous, and there were one or two yellow spots which were seen to be made up of fat under the microscope. With a low power lens only a slight increase of fibrous tissue was observable, and the oil-immersion was put on merely as a matter of routine. One giant cell was discovered, containing a number of bacilli, but a careful search failed to show any others, or any signs of change, except the increase of fibrous tissue noted above. So that the assertion is still true, that we have failed to discover any signs of tuberculosis that were easily recognizable in any of the cows here recorded, and these include all we have had under close observation.

Those from which milk was used for inoculations that are not here given had no signs that permitted of even a probable diagnosis by skilled veterinarians.

We also made an interesting series of experimental inoculations in rabbits and guinea pigs with milk or cream from various cows, in varying quantities and at different times. Of rabbits there were used fifty-seven animals. Of these, five were inoculated with milk which had turned sour, two died of intercurrent diseases in a few days (coccidium oviforme), and of one the material was lost before the microscopic examination was completed—so that eight animals are to be rejected, leaving forty-nine upon which the results can be based. Out of these, five were made more or less tuberculous, as proven by microscopic examination, and in forty-four the results were negative —that is to say, we obtained 5 : 49, or 10.2 per cent. of successes out of all inoculations in rabbits.

There were used thirty-three different specimens from thirteen different cows—that is, there were 23 per cent. (3 : 13) successful results from the cows used, and 15.15 per cent. (5 : 33) successful results from the specimens used.

Positive results were obtained from

Cow P twice (at different times).

Cow L once.

Saunders cow twice (at different times).

The results of the inoculations of guinea-pigs are more striking. There were sixty-five animals used in all. Of these, nine were inoculated with sour milk or cream, and two died in a day or two of other diseases (peritonitis and pleurisy). There are, therefore, but fifty-four that should be counted. In them, there were twelve positive results, or 28.57 per cent. (12 : 42) successes out of all the inoculations. There were used thirty-two specimens from fourteen different cows, and the successful results came from six different cows—that is, 42.8 per cent. (6 : 14) of the cows were shown in this way to have infectious milk, and 37.5 per cent. (12 : 32) of the specimens used were shown to have active infectious properties.

Positive results were obtained from

Cow P (three times in two different inoculations).
Cow D (three times in three different inoculations).
Cow F (once).
Slocum cow (once).
Saunders cow (once).
Mayhew cow (three times in two different inoculations).

The combining of the results obtained from both rabbits and guinea-pigs shows the following: Successful results were obtained in milk from cow P three times (two different specimens) in guinea-pigs, and twice in rabbits (two different specimens); from cow L once in rabbits; from cow O three times (three different specimens) in guinea-pigs; from cow F once in guinea-pigs; from the Slocum cow once in guinea-pigs; from the Saunders cow once in guinea-pigs, and twice in rabbits (two different specimens); and from the Mayhew cow three times in guinea-pigs (two different specimens)—that is to say, out of fourteen cows used the milk was shown to be infectious in seven, or 50 per cent. by inoculation experiments.

An interesting fact is also shown, and that is, that bacilli were found in the milk or cream, and successful inoculation experiments made in animals with the same specimen in five different cases (including eight of the successful ones) as follows:

Comparison of the dates when Bacilli were found in the Milk and the same Milk was used for successful inoculation experiments.

Cow.	*Positive.* Cover-glass.	*Positive.* Guinea pig.	*Positive.* Rabbit.
P.	Cream, A. M.	Cream, A. M., March 9, 1889	Cream, A. M., March 9, 1889
	Cream, P. M.	Cream, P. M., March 9, 1889 Cream, P. M., March 9, 1889	Cream, P. M., March 9, 1889
O.	1st of milking, cream, March 9, 1889.	First of milking, cream, March 9, 1889.	
Slocum.	Last of milking.	Last of milking. June 10, 1889	
Mayhew.	Last of milking, milk.	Last of milking, milk. June 21, 1889	

The inoculation experiments, above detailed, seem to me to be deserving of consideration because they were done under the most careful precautions that could be devised. In all cases the experiment animals were kept under observation long enough to determine, so far as could be seen, that they were in good health, and after the inoculations they were separated and kept under close watch, but in healthy surroundings. Some of those that were used were inoculated immediately after purchase, because of a scarcity of the supply at the farm, and were not in good condition. But as no sign of tuberculosis appeared in any of these, their ill health cannot come in as a disturbing factor in the results.

The results obtained from certain feeding experiments with calves show that there were thirteen calves used, and fed for varying lengths of time with milk from cows affected with tuberculosis, but not of the udder. Of these, the material was thrown away from one before the microscopic examination, and this should be rejected in the final results. Of the remainder, there were five positive results obtained and one suspicious. The latter is counted as negative, for the reason that, although giant cells and granulation tissue were seen, no bacilli were found. There were, therefore, five out of twelve positive results, or 41.66 per cent. It should also be said that of those counted as negative three sets of specimens were suspicious, but were hastily examined for the purpose of this paper, so that a more careful search may very probably increase the percentage of successes.

In the series of feeding experiments on one set of pigs, the milk being given to them from the same cows as before, there were seven pigs used in all, from one litter and healthy parents. Of these, examination showed negative results in two, positive results in two, one was subjected to a very hasty microscopic examination, and the material from two was thrown away—a mistake, as was shown by the results of the microscopic examination of the material from No. 3. There are to be counted, therefore, only five, giving as successful results 40 per cent.

By the cover-glass examinations we have shown that the milk contains infectious material in ten cows out of thirty-five from which the milk was examined for bacilli—that is, in 28.57 per cent. We have also shown that the milk was infectious, by inoculaton experiments, in seven out of fourteen of the cows from which the milk came—that is, 50 per cent. And we have shown the infectious nature of the milk by ocular demonstration and successful inoculation from the same specimens in five cows out of fourteen used—or, 35.7 per cent.

These results are, to a certain extent, preliminary—that is to say, they are but part of the work upon this subject which is being done under the auspices of the Massachusetts Society for the Promotion of Agriculture. The work will not be completed, at any rate, until next year.

They show, however:

1st, and emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.

2d. That the virus is present whether there is disease of the udder or not.

3d. That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.

4th. That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk of cows affected with tuberculosis but with no discoverable lesion of the udder.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 9.

MAY, 1890.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1890.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
HERBERT E. WOODBURY, .	" "

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Agriculture.

Wm. P. Brooks.

SOIL TESTS WITH FERTILIZERS.

In February of last year Prof. W. O. Atwater, Director of the office of Experiment Stations of the United States Department of Agriculture, issued a call for a conference of Directors of Experiment Stations and others interested in field and plot experimentation, to be held in the library of the Department of Agriculture on Tuesday and Wednesday, March 5 and 6, 1889, for the purpose of adopting, if practicable, a uniform method of conducting such experiments. It was decided by Director Goodell that I should attend this conference, as it was supposed that such experiments, if decided upon, would be carried on under my immediate supervision.

This conference in which twelve stations were represented, decided upon recommending a plan of experiments of which the following are the chief features:

1. That in each state, soil-tests with fertilizers, with a view to finding out the requirements of soils in different parts of the state for the most economical production of different crops be made a leading feature of the work.

2. That uniform kinds and quantities of fertilizing materials be used.

3. That the experiments be continued throughout a series of years, when practicable, and that the fertilizers be repeated on the same plots year after year; but that the particular crops used be left to the discretion of the stations.

4. That both manured and unmanured plots be duplicated to as great an extent as may be found practicable.

5. That in the distribution of such experiments regard be paid to the surface geology of the state.

6. That reports upon such experiments should contain as full information as can be furnished respecting the geological origin and history of the soil on which they may be made, its physical and chemical condition, and its fauna and flora, and also as full meteorological data as can be obtained.

Some of the more important details settled upon by the conference will be of interest.

1. Shape and Size of Plots. It was the sense of the conference that plots should be long and narrow in order to avoid as far as possible, the disturbing influence of the inequalities in the natural fertility of the soil in different parts of the field. Evidently a long and narrow plot, extending wholly across a field, is less likely to lie wholly within an area naturally either richer or poorer than the average soil of the field than is a square plot which might, for example, chance to fall where sometime in the past a pile of manure had stood. In width these plots should be adapted to accommodate an even number of rows of the crop to be cultivated. Thus for corn or potatoes, (the distance between the rows being quite commonly $3\frac{1}{2}$ feet) some multiple of this number such as 10 feet 6 inches would be suitable. To prevent the roots of one plot feeding upon materials in an adjoining one, it was decided to recommend that the plots be separated by alley-ways not less than three feet wide; and the majority were in favor of planting a row in the middle of this strip which should be cultivated precisely like the plots but should not be included in the harvest. This row should be harvested and carried off before the harvest of the plots proper be commenced. The size of plot recommended was one-twentieth of an acre.

2. Methods of Applying Fertilizers. It was the general sense of the conference that the larger portion, at least, of the fertilizers used should be applied broadcast and that the nitrate of soda be used in the spring rather than in the fall. It was thought best not to make specific recommendations as to the time and manner of applying fertilizers; that these points had better be left to the judgment and discretion of the officers of the several stations.

3. Kinds and Quantities of Fertilizers. The following quantities of fertilizers were recommended for general adoption:

As a source of nitrogen, nitrate of soda, 160 pounds per acre, containing 16 per cent. nitrogen.

As a source of phosphoric acid, dissolved bone-black, 320 pounds per acre, containing 16 per cent. soluble phosphoric acid.

As a source of potash, muriate of potash, 160 pounds per acre, containing 50 per cent. potash.

As a source of sulphate of lime, 160 pounds of high grade gypsum per acre.

As a source of lime, 160 pounds quick lime per acre. In all cases multiples of 16 were recommended on account of the manifest convenience of being able to apply a whole number of pounds for each square rod. The use of gypsum was recommended in order that the sulphate of lime in it might offset that in the superphosphate, and also because of the general fertilizing action of gypsum.

3. It was recommended that the outside corners of sections or series of plots be marked with sections of gas pipe driven to or below the surface and that at least one stake be driven along each side of the section.

4. It was voted to recommend that when practicable missing hills be replanted (in order to equalize conditions of light, soil, space, etc.) but that in computing results re-plants be rejected from the computation.

5. The importance of duplication of both fertilized and unfertilized plots to as great an extent as feasible was unanimously agreed upon; and it was the general opinion that in computing results fertilized plots should be compared with contiguous or nearest unfertilized plots rather than with the average of all the unfertilized plots.

6. The plots should extend north and south whenever the contour of the land will permit. They should extend up and down rather than across the line of greatest slope of the field.

7. The importance of analyses of the produce and of care in sampling for such work was discussed at length; and it was decided to be desirable that the amount of nitrogen, at least, in the soil be determined.

The convention voted to ask Prof. Atwater to prepare explanations of the experiments and directions for carrying them out, and in accordance with this decision he prepared such explanations and directions, which were published by the Department of Agriculture and furnished in such numbers as the several stations required.

Being deeply impressed with the general excellence and many advantages of the proposed plan of experiments, and fully convinced of its importance as a step towards the more rational and economical use of fertilizers by the farmers of the state, I decided with the approval of our Director upon adopting it on such a scale as our finances would permit. I accordingly sent a copy of the following letter to the President of each of the following County Agricultural Societies: Barnstable, Berkshire, Bristol, Essex, Franklin, Hampshire, Hampden, Middlesex, Plymouth and Worcester:

"I am desirous of inaugurating this year a system of local soil tests with fertilizers, to be carried out under my supervision by selected farmers in the different counties. Similar tests have been carried out in several states, and a conference of experiment station workers in Washington in March of this year, which was called to consider the subject, unanimously decided in favor of inaugurating such soil tests upon one uniform plan in as many states as possible.

Without at this time entering into details, I may say that the object especially aimed at in these tests is to find out the particular fertilizer requirements of the soils of different localities. It is recognized that, however valuable the results obtained in experiments of this particular kind at this station may be for this locality, such results may be inapplicable to other localities.

It is proposed for this year at least that this station shall pay all expenses of such tests, furnishing fertilizers, seeds and whatever else may be necessary, and paying a fair price for the work of carrying them out. The station, through myself or my assistant, will supervise the experiments and we reserve control of the results; all rights of publication and discussion shall be ours.

The area required for each test is one acre; the crop proposed for this year is corn. The harvest with the exception of such small samples as we may take is to belong to the farmer.

The best soil for the purpose is one which represents best the average conditions in your county, which is level or of uniform moderate slope, of uniform and low fertility and now in grass. Upon the proper selection of the locality and the soil and still more upon the selection of the man to carry out the work our success depends; and believing that your society will be willing to co-operate in this work I have addressed you this note which I send also to the presidents of the other county societies.

The funds available will allow me to undertake but one experiment in each county and I shall be pleased to hear what you think of the plan. In the event of your favorable consideration, my assistant will soon visit you to co-operate in the selection of the place and the man and to arrange the necessary details."

This letter elicited a favorable response from every man addressed;

and the men and localities for experiments were selected by my assistant, Mr. F. S. Cooley, acting in co-operation with the presidents of societies addressed. In a number of cases these gentlemen expressed a willingness to undertake the experiment upon their own farms and whenever these were found to contain suitable soil selection was made accordingly. In every case except two, Mr. Cooley had the opportunity to make a personal inspection of the land before selection was made, and the further very important advantage of personal explanation of the objects and methods of the experiment to the party selected to carry it out. The following is a complete list of the localities and owners of farms on which an experiment was undertaken: Yarmouth, John Simpkins; Pittsfield, O. T. Benedict; Lexington. A. G. Douglas; Marblehead, Wm. S. Phillips, Jr.; Shelburne, Dole Bros.; Westfield, C. F. Fowler; Hadley, L. W. West; Freetown, S. P. Richmond; West Bridgewater, J. C. Swan; and Worcester, Pliny Moore. Besides these a similar experiment was carried out upon the station grounds in Amherst.

In accordance with the conclusions of the conference already briefly stated, the plan of experiment was as follows:

1. Area occupied by each 1 acre; if circumstances permitted of the following dimensions: length 213 feet 4 inches, width 204 feet.

2. Plots—fifteen in number, each 204 feet long and 10 feet and 8 inches wide, containing one-twentieth of an acre. In each plot three rows.

3. Strips between and also outside experimental plots—length, 204 feet; width 3 feet 4 inches. In the middle of each strip one row.

These fifteen plots and the strips make within 10 square feet of an exact acre. As a matter of fact few of the experiments were laid out exactly upon these dimensions; but the principle of arrangement was the same in all and most approached these proportions quite closely.

4. The treatment of the several plots was as follows:

No. 1. Nothing.
" 2. Nitrate of soda.
" 3. Dissolved bone-black.
" 4. Nothing.
" 5. Muriate of potash.
" 6. Nitrate of soda and bone-black.
" 7. Nitrate of soda and muriate of potash.
" 8. Nothing.

No. 9. Bone-black and muriate of potash.
" 10. Nitrate of soda, bone-black and muriate of potash.
" 11. Land plaster.
" 12. Nothing.
" 13. Barnyard manure.
" 14. Lime.
" 15. Nothing.

To each plot where used the following quantities were supplied: nitrate of soda, 8 pounds; dissolved bone-black, 16 pounds; muriate of potash, 8 pounds; land plaster, 8 pounds; lime, 8 pounds; barnyard manure, 32 cubic feet.

The composition of the barnyard manure used was of necessity unknown at the time of use. It was, however, carefully sampled by throwing one side every tenth fork-full in loading, thoroughly mixing what was thus thrown out, and taking in each case about a solid cubic foot for analysis. The results of each analysis so far as samples have been secured will be found under the appropriate experiment. The weights used were not determined as facilities for weighing were not available in most cases. The manure was used at the rate of five untrodden cords per acre.

The fertilizers used were carefully sampled and analyzed with results shown in the tables below:

NITRATE OF SODA.

Moisture at 100° C.,	3.22	per cent.
Nitrogen,	15.03	"
Sodium oxide,	53.44	"
Insoluble matter,	.19	"

DISSOLVED BONE-BLACK.

Moisture at 100° C.,	17.41	"
Organic and volatile matter,	43.81	"
Total phosphoric acid,	21.70	"
Soluble, " "	15.60	"
Reverted " "	6.02	"
Insoluble " "	0.08	"
Insoluble matter,	3.99	"

MURIATE OF POTASH.

Moisture at 100° C.,	4.01	"
Potassium oxide,	45.16	"
Sodium oxide,	2.88	"
Chlorine,	45.87	"
Insoluble matter,	1.01	"

GYPSUM.

Moisture at 100° C.,	14.05 per cent.
Calcium oxide,	41.90 "
Sulphuric acid,	32.65 "
Insoluble matter,	2.22 "

LIME.

Calcium oxide,	74.79 per cent.
Insoluble matter,	0.77 "

It will be seen that the ascertained composition was found to be so near the proposed that the amounts of nitrogen, phosphoric acid and potash supplied per acre were not essentially different from the amounts fixed upon in the convention as appropriate. The exact figures per acre are as follows: Nitrogen, 24 pounds; available phosphoric acid, 69.2 pounds; and potash, 72.3 pounds.

In all cases fertilizers and manures were evenly spread broadcast upon the ploughed land and harrowed in just previous to planting the seed.

5. The selection of seed was left to the individual experimenters, as it was felt that success would be more certain with varieties suited to the several localities and familiar to the cultivators. In every case a variety of yellow flint corn was selected. The rows were in all cases three and a half feet apart and hill planting was generally adopted.

6. Each experimenter was furnished with a standard maximum and minimum thermometer and a rain gauge; and, although accidental breakages of instruments caused some irregularities, observations were generally kept up from about the middle of June to the time of harvest. A summary of the record of each observer will be found under the account of his experiment.

7. Each experiment was visited once by myself during July and once by Mr. Cooley during August, and the latter gentleman assisted in the harvest, weighed the crops on the several plots and took a sample from each in every experiment.

These samples will be analyzed as rapidly as our resources permit and the results, if deemed of sufficient importance, will be hereafter published.

8. A large number of systematic measurements were taken by several of the experimenters. These were advised with a view to a study of the effects of the several fertilizers during different stages of the growth of the crop. The general method of measurement was

to take every sixth to tenth hill (varying according to length of row) in the middle row of each plot. The leaves were straightened to the highest possible point, and from the highest tip to the ground was the height recorded. The records will be found under the appropriate experiments.

Before giving a detailed account of these experiments a few general explanations are necessary. In each experiment the weight of the entire product of each plot was taken, hard corn, soft corn, and stover separately*. In converting hard corn into bushels 75 pounds of ears are considered equal to one bushel of shelled corn; and in the case of soft corn, 90 pounds. In obtaining the value of the crop, hard corn is estimated at forty cents and soft corn at twenty cents per bushel, and stover at $4 per ton. The bare cost only of fertilizers is taken into consideration in calculating profit or loss. No account is made of the labor of applying. Nitrate of soda is estimated at $50 per ton; Dissolved bone-black, at $30; Muriate of potash, at $40; Plaster, at $9; Lime, at $12; and barn-yard manure at $5 per cord.

In determining gain or loss for any plot it is compared with the average of the two nearest nothings, with one or two exceptions which will be especially pointed out and the reasons for the exception given. Each of the nothings in these calculations has been given equal weight; no allowance for varying distance from the plot under comparison being made.

In the determination of the effect of each of the ingredients of plant-food—nitrogen, phosphoric acid and potash—four comparisons are made. For example in the case of nitrogen:

1. The crop where nitrogen alone is applied is compared with the average of the two nearest nothings.

2. The increase (*or decrease*) where nitrogen and phosphoric acid are used is compared with the increase (*or decrease*) where phosphoric acid only is used.

3. The increase (*or decrease*) where nitrogen and potash are used is compared with the increase (*or decrease*) where potash only is used.

4. The increase (*or decrease*) where nitrogen, phosphoric acid and potash are used is compared with the increase (*or decrease*) where the two latter only are used.

5. The results of these four comparisons are added, the sum divided by four; and the result is considered the average increase (*or decrease*) due to nitrogen.

*To this statement there are two exceptions which will be explained later.

Upon this average the profit or loss from the use of nitrogen is calculated, no allowance being made for unexhausted residue.

Similar comparisons and calculations are made for phosphoric acid and potash. The results for all three ingredients are shown in tabular form under each experiment.

For convenience of comparison with each other and with the results just mentioned the net results of the use of "complete fertilizer", barnyard manure, plaster and lime are shown in another table, although this plan involves the repetition of some of the figures given in the general tabular view of the entire experiment. Below this table will be found a calculation as to financial result of the use of each. In this calculation no allowance is made for unexhausted residue of either manure or fertilizer. This omission undoubtedly makes the showing for manure more unfavorable than it should be. If we make the usual allowance of one-half, the manure will come much nearer to paying for itself and for the labor of application which, it should be remembered, has not been charged. The expression "complete fertilizer" is used in the ordinary sense, to designate a mixture which supplies nitrogen, phosphoric acid and potash.

The Pittsfield experiment was ruined by crows which pulled the young plants, and the results in West Bridgewater and Lexington were affected by so many accidental conditions that it is not deemed best to publish them. An account of each of the others follows :

YARMOUTH.

SOIL TEST WITH FERTILIZERS ON CORN.

By J. Bryden.

No. of Plot.	FERTILIZERS. KIND.	Lbs. per Acre.	Yield per Plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per Acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft	Stover, lbs.
1	Nothing,		167	23	*	44.5	5.1	*			*
2	Nitrate of Soda,	160	168	18		44.8	4.		4.3	—1 2	
3	Dissolved Bone-black,	320	127	16		33.9	3.6		—6.7	—1.6	
4	Nothing,		137	24		36.5	5.3		—5.3		
5	Muriate of Potash,	160	129	19		34.4	4.2		—5.3	—1.6	
6	Nitrate of Soda, / Dissolved Bone-black	160 / 320	160	18		42.6	4		2.9	—1.8	
7	Nitrate of Soda, / Muriate of Potash,	160 / 160	158	25		42.1	5.6		2.4	—2	
8	Nothing,		161	28		42.9	6.2				
9	Dissolved Bone-black / Muriate of Potash,	320 / 160	170	21		45.3	4.7		12.5	— .9	
10	Nitrate of Soda, / Dissolved Bone-black / Muriate of Potash,	160 / 320 / 160	182	13		48.5	2.9		15.7	—2.7	
11	Land Plaster,	160	95	23		25.3	5.1		—7.5	— .4	
12	Nothing,		85	22		22.7	4.9				
13	Barnyard Manure,	†5	246	19		65.6	4.2		40.1	—1.2	
14	Lime,	160	106	21		28.3	4.7		4.	— 8	
15	Nothing,		98	27		26.1	6.				

The field selected for this experiment, on the farm of John Simpkins, President of the Barnstable Agricultural Society, is a part of a nearly level tract quite near the sea. The soil is composed of very fine sand and proved to vary considerably in fertility in different parts. It had never received much manure, was cultivated last, seven years ago, and subsequently had been used as a pasture. The seed came up nicely, and the stand was good, scarcely a plant missing.

The field was visited in July and the following notes were made:

Plot 13. Much better than any other.

Plot 10. Ranks next to 13 but considerably inferior.

Plots 2, 6 and 7. Rank next in the order named.

Plot 11. Slightly better than nothing plots near it.

Plot 8. Includes the back furrow and is better than neighboring nothings.

In August no striking differences were noted except in the case of Plot 13, which showed a marked superiority to all others.

*All weights of stover are omitted on account of accidental mixture in part of the plots. Average of all the nothings, hard corn, 34.7 bu.; soft corn 5.6 bu.

†Cords.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements.			
		July 19.	July 30.	Aug. 10.	Aug. 21.
		Inches.	Inches.	Inches.	Inches.
1	Nothing...	44.6	62.3	75.2	78.2
2	Nitrate of Soda,......	43.8	60.3	75.8	77.2
3	Dissolved Bone-black, ...	41.2	57.8	73.9	75.3
4	Nothing,........	37.2	53.5	70.3	76.1
5	Muriate of Potash.	41.9	57.8	73.4	76.4
6	Nitrate and Bone-black,..	43.7	57.3	73.8	76.3
7	Nitrate and Potash, ...	40.2	55.0	68.8	74.6
8	Nothing,.....................	42.3	56.8	73.7	80.8
9	Bone-black and Potash, ...	36.9	51.4	69.3	75.1
10	Nitrate, Bone-black and Potash,	38.5	52.1	70.2	75.1
11	Land Plaster,................	32.9	44.3	59.7	66.6
12	Nothing,......	29.3	38.3	52.7	61.0
13	Barnyard Manure, ...	48.6	64.8	79.5	81.3
14	Lime, ...	31.3	42.5	58.1	65.3
15	Nothing,.....................	26.1	36.6	50.9	62.6

These measurements indicate that the superiority early shown by the plots which received nitrate of soda was not maintained throughout the season. Thus on July 19, No. 2 is considerably better than No. 5, but by Aug. 21, this difference has nearly disappeared; and again on the earlier date No. 7 is better than No. 9, but on the latter date No. 9 is the better.

COMPOSITION OF MANURE.

Moisture at 100° C.,	70.160 per cent.
Organic and volatile matter,	86.553 "
Ash,	13.447 "
Phosphoric acid.	0.553 "
Calcium oxide,	0.323 "
Magnesium oxide,	0.271 "
Potassium oxide,	0.614 "
Nitrogen,	0.486 "
Insoluble matter,	11.991 "

This manure is in composition considerably superior to most of the others used in our experiments which undoubtedly accounts for its relatively better effect on the crop.

SUMMARY OF WEATHER OBSERVATIONS.

June 12—Nov. 1, 1889.

Month.	Temperature in open air in degrees Fahrenheit.									Monthly range.	Rain fall inch's
	Means of Daily.			Highest.		Lowest.		Greatest daily range.			
	Min.	Max.	Rnge.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June.	59.7	76.1	16.4	84.	21st.	50.	19th.	26.	23d.	34.	.64
July.	62.	76.1	14.1	84.	1st.	56.	16th.	23.	18th.	28.	4.12
August.	67.4	77.1	9.7	84.	23d.	55	27th.	19.	23d.	29.	6.04
September	57.3	69.7	12.4	77.	7th 16th	41.	23d.	20.	4, 22.	36.	3.14
October.	45.6	58.	12.4	70.	5th.	37.	11, 24.	24.	11th.	33.	5.71
Season 142 days.	57.6	71.	13.4	84.		37		26.		36.	19.65

The comparative equability of temperature at this station is particularly noticeable. Both the average and absolute range are much less than at other stations. The thermometer registered 84 degrees only three times during the season, and the first frost was recorded Nov. 6.

RESULTS OF THE ADDITION OF NITROGEN.

	To nothing.	To phosphoric acid.	To muriate of potash.	To phosphoric acid and potash.	Average result.
Hard corn, bush. per acre,	4.3	9.6	7.7	3.2	6.2
Soft corn, " " "	—1.2	— .1	1.3	—1.8	—.4

Value of the net average increment,	$2.40
Result,	$1.60 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID.

	To nothing.	To nitrate of soda.	To muriate of potash.	To nitrate and potash.	Average result.
Hard corn, bush. per acre,	—6.7	—1.3	17.9	13.3	5.8
Soft corn, " " "	—1.6	— .6	.7	—2.4	—1.

Value of the net average increment,	$2.12
Result,	1.68 loss.

RESULTS OF THE ADDITION OF POTASH.

	To nothing.	To nitrate of soda.	To phosphoric acid.	To nitrate and phosphoric acid.	Average result.
Hard corn, bush. per acre,	—5.3	—1.9	19.2	12.8	6.2
Soft corn, " " "	—1.6	1	.8	— .9	— .2

Value of the net average increment, $2.44
Result, .76 loss.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barnyard manure.	Plaster.	Lime.	
Hard corn, bush. per acre,	15.7	40.1	—7.5	4.	
Soft corn, " " "	—2.7	—1.2	— .4	— .8	

Value of net increment due to fertilizer,	$5.74
Financial result,	6.26 loss.
Value of net increment due to manure,	$15.80
Financial result,	9.20 loss.
Value of net decrease due to plaster,	$2.92
Financial result,	3.64 loss.
Value of net increment due to lime,	$1.44
Financial result,	.48 gain.

The results of this experiment are, on the whole, not very conclusive as to the requirements of the soil. The evident difference in natural fertility complicates matters. The fertilizers used on the poorer side of the field evidently stood a better chance to make their influence felt than those used on the other side. The average net increase caused by each of the ingredients, nitrogen, phosphoric acid and potash is about equal; but it is noticeable that nitrogen causes a smaller increase over nothing, than either of the others. It is important to bear in mind, however, in this connection that the element nitrogen was furnished by the amount of fertilizer used in a much smaller proportion of the total taken by the crop than were the phosphoric acid and the potash. Thus Prof. Levi Stockbridge, in the

Report of the Massachusetts State Board of Agriculture for 1875–6, states (by inference) that fifty bushels of shelled corn and the natural proportion of roots, stalks, leaves and cobs contain: nitrogen, 64 pounds; phosphoric acid, 31 pounds, and potash 77 pounds. These figures were the result of actual determination of the proportion existing between grain and all other parts of the plant and calculations based on average statements of composition. Figures obtained by myself by calculations based upon more recent American analyses applied to the proportion existing in most of our experiments between grain and stover show the amounts of these ingredients in fifty bushels of grain and the usual amount of stover to be about as follows: nitrogen 91 pounds, phosphoric acid 29 pounds, and potash 63 pounds.

Though these two sets of figures are not alike there is a general agreement in the relative proportions of the three ingredients. The differences are in part due to the fact that I allowed a smaller proportion of stover to grain; in part to the fact that different analytical results were used.

Now as has been stated the fertilizers used in these experiments supplied per acre: nitrogen, about 24 pounds; phosphoric acid, 69 pounds and potash, 72 pounds. Here then is nitrogen enough according to Prof. Stockbridge for only about 19 bushels of corn, phosphoric acid enough for about 110 bushels, and potash enough for about 47 bushels; or according to my figures respectively, for about 13, 119 and 57 bushels. It would evidently, then, be unreasonable to expect as large an increase from the relatively small application of nitrogen as from the larger applications of phosphoric acid and potash. It is significant, however, that in no case in this experiment was the increase in crop large enough to account for all of either of the ingredients under consideration. The largest increase seemingly due to nitrogen, 9.6 bushels, is considerably under the lowest estimate of quantity of crop for which the supply of this element is adequate, viz.: 13 bushels.

It is evident that we recovered in the increase of the crop only a comparatively small proportion of the nitrogen applied and the same is true of phosphoric acid and potash in whatever manner used. The result with nitrate of soda might very likely have been better had it been applied in fractional dressings during growth instead of all before planting; but it cannot be supposed, in view of what is known of the behavior of potash and phosphoric acid in the soil that any considerable loss occurred through applying all of the fertilizers containing them before planting.

The result of the use of fertilizers in this experiment is an apparent loss in all cases. This is no doubt absolute in the case of nitrate of soda, for experience teaches that this cannot be recovered in subsequent years. The phosphoric acid and potash, on the other hand, may make themselves felt in later years. The omission of the stover of course makes the loss apparently greater than was actually the case.

The loss is least on the potash and the greatest actual increase due to it exceeds the greatest due to either nitrogen or phosphoric acid, though the average as stated is nearly the same. A part of this apparent superiority, however, may be due to the fact that phosphoric acid and potash are compared to a lower average for nothings than phosphoric acid alone.

The conclusions which I draw from a study of the results are briefly as follows:

1. Nitrogen if used in soluble form should be applied to this soil in fractional dressings.

2. All three ingredients are needed in about equal degree.

3. Potash seems most likely to afford a chance for profit; but should be used with small quantities of phosphate and nitrogen.

4. Plaster appears to do no good. The actual decrease may be due to the fact that the comparison is influenced by Plot No. 8, which was unusually good while the plaster plot lies near Plot 12 which was the poorest.

5. Lime appears to have been beneficial.

FREETOWN.

SOIL TEST WITH FERTILIZERS ON CORN.

By S. P. Richmond.

Number of Plot.	FERTILIZERS. KIND.	Yield per Plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Sotver, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn, bushels. Hard.	Soft.	Stover, lbs.
1	Nothing,	72	26	69	19.2	5.8	1380			
2	Nitrate of Soda,	87	28	73	23.2	6.2	1460	5.9	.7	170
3	Dissolved Bone-black,	83	25	64	22.1	5.6	1280	4.8	—1.1	—10
4	Nothing,	58	25	60	15.5	5.6	1200			
5	Muriate of Potash,	49	22	55	13.1	4.9	1100	—2.3	—1.7	—130
6	{ Nitrate of Soda, Dissolved Bone-black,	94	21	76	25.1	4.7	1520	9.7	—1.9	290
7	{ Nitrate of Soda, Muriate of Potash,	76	21	76	20.3	4.7	1520	4.9	—1.9	290
8	Nothing,	57	34	63	15.2	7.6	1260			
9	{ Dissolved Bone-black, Muriate of Potash,	94	25	91	25.1	5.6	1820	10.7	—2.	570
10	{ Nitrate of Soda, Dissolved Bone black, Muriate of Potash,	115	20	115	30.1	4.4	2300	16.3	—3.1	1050
11	Land Plaster,	68	29	69	18.1	6.4	1380	3.7	—1.1	130
12	Nothing,	51	34	62	13.6	7.6	1240			
13	Barnyard Manure,	150	35	148	40.	7.8	2960	24.5	.4	1560
14	Lime,	65	34	65	17.3	7.6	1300	1.9	.2	—100
15	Nothing	65	32	78	17.3	7.1	1560			

Quantities per plot same as in Yarmouth.

The average of all the nothing plots is:—hard corn, 16.2 bushels; soft corn, 6.7 bushels; stover, 1328 pounds.

The field for this experiment was level; the soil a gravelly loam. It had been in grass for five years without manure, and the crops had been light. It was poor, as is shown by the average yield of the unmanured plots; and what is more important it was apparently of nearly even fertility throughout the field though plot No. 1 showed traces of the influence of a former manure heap. In July the following notes were made:—

Plot No. 13, decidedly best; color particularly good.

No. 10, ranks next, but clearly inferior.

No. 2, shows a distinct superiority over No. 1.

Nos. 11 and 14, appear a trifle better than Nos. 12 and 15.

It is worthy of note that the crop lay nearly flat at the time when these notes were made, having been blown down by a storm. In August the relative rating of the plots was substantially the same.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements. July 20.	Aug. 1.	Aug. 12.
		Inches.	Inches.	Inches.
1	Nothing,	35.9	44.9	54.5
2	Nitrate of Soda,	41.7	42.9	63.2
3	Dissolved Bone-black,	42.4	54.3	59.2
4	Nothing,	37.7	48.9	54.8
5	Muriate of Potash,	36.7	45.9	55.3
6	Nitrate and Bone-black,	46.1	56.6	61.8
7	Nitrate and Potash,	41.6	51.	57.2
8	Nothing,	41.5	52.7	60.3
9	Bone-black and Potash,	46.2	61.2	67.4
10	Nitrate, Bone-black and Potash,	50.7	63.7	68.9
11	Land Plaster,	42.1	53.	60.8
12	Nothing,	39.2	52.4	57.
13	Barnyard Manure,	57.3	73.2	76.5
14	Lime.	43.3	55.5	61.3
15	Nothing,	41.9	54.4	61.1

These measurements show that the estimates of relative standing above noted were generally correct. They do not show a relative falling off in the plots which received nitrate, with the advance of the season. This soil had apparently good retentive power.

COMPOSITION OF BARNYARD MANURE USED.

Moisture at 100° C.,	73.570	per cent.
Organic and volatile matter,	93.087	"
Ash,	6.913	"
Phosphoric acid,	0.189	"
Calcium oxide,	0.185	"
Magnesium oxide,	0.158	"
Potassium oxide,	0.487	"
Nitrogen,	0.338	"
Insoluble matter.	6.038	"

This manure was poorer than that used in most of our experiments; and yet it caused a comparatively large increase in the crop. Thus the average crop on unmanured plots stands sixth in eight experiments, while the crop on barnyard manure stands fifth. The average increase in hard corn in all the experiments due to barn-yard manure was 22.4 bushels; the highest in case of Yarmouth, 41.1 bushels; next in this experiment, 24.5 bushels. This large increase from manure perhaps indicates a need of other elements of plant food than those furnished by all the fertilizers used, or it may be that the organic matter of the manure is especially useful here.

SUMMARY OF WEATHER OBSERVATIONS,

June 15—Oct. 18, 1889.

Month.	Temperature in Open Air in Degrees Fahrenheit.									Monthly Range.	Rain-fall, inches.
	Means of daily.			Highest.		Lowest.		Greatest daily range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June.	82.	55.8	26.2	90.	30th	43	24th	36	23d	47	.43
July.	79.6	58.9	20.7	89.	14th	41	17th	43	17th	48	7.52
August.	77.4	55.5	21.9	83.	4,7,20th	42	27th	37	7th	41	4.67
Sept'mb'r.	70.8	54.2	16.6	82.	6th	34	28th	30	23d	48	3.88
October.	59.	39.4	19.6	71	4th	30	18th	34	2d	41	3.27
Season.*	74.3	53.8	20.5	90	June 30	30	Sept. 18	43	July 17	60	19.77

*126 days.

This summary appears to present no peculiarities worthy of note.

RESULTS OF THE ADDITIONS OF NITROGEN TO

	Nothing.	Phosphoric acid.	Potash.	Phosphoric acid and potash.	Average Result.
Hard Corn, bushels per acre,	5.9	5	7.2	5.6	5.9
Soft " " " "	.7	—1.8	—.2	—1.1	—.6
Stover, pounds " "	170	300	410	480	342.5

Value of net average increment, $2.93
Financial result, 1.07 loss

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Potash.	Nitrate of soda and potash.	Average Result.
Hard Corn, bushels per acre,	4.8	3.9	12.9	11.4	8.2
Soft " " " "	—1.1	—2.4	—.3	—1.2	—1.
Stover, pounds " "	—10	120	700	760	392.5

Value of net average increment, $3.87
Financial result, .93 loss

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosphoric acid.	Nitrate and phosphoric acid.	Average Result.
Hard Corn, bushels per acre,	2.3	—.9	5.9	6.5	2.3
Soft " " " "	—1.7	—2.4	—1.9	—1.2	—1.8
Stover, pounds " "	—130	120	580	760	332.5

Value of net average increment, $1.23
Financial result, 1.97 loss

RESULT OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard Corn, bush. per acre,	16.3	24.5	3.7	1.9
Soft Corn, " " "	—3.1	.4	—1.1	.2
Stover, pounds, " "	1050	1560	130	—100

Value of increment due to complete fertilizer $8.00
Financial result, 4.00 loss
Value of increment due to barn-yard manure, 13.00
Financial result, 12.00 loss
Value of increment due to plaster, 1.52
Financial result, .80 gain
Value of increment due to lime, .60
Financial result, .36 loss

The results of this experiment show that phosphoric acid was the most useful of the single ingredients. It caused the greatest average and the greatest absolute increase in the crop; and, though the result of its use either singly or in combination is invariably a money loss, this loss is upon the average small, and if the phosphoric acid, doubtless remaining in the soil is taken into account the result will be a gain. It is judged that this gain might have been made absolute "with complete fertilizer" by using a very small proportion of nitrate and potash.

Here (the same is true of all the experiments and the statement will not be repeated) as in the Yarmouth experiment it is noticeable that, as a rule, we recover in the increase in the crop but a small part of the plant food applied in the fertilizers used. One exception is to be noted; in the increase due to the use of "complete fertilizer" we recover as much nitrogen as is used, except in two cases, viz.: Hadley and Westfield. In view of the small increase generally caused by the addition of nitrate to phosphate and potash, however, we must conclude that the soil furnished much of this nitrogen.

The chief conclusions from the study of the results of this experiment are:—

1. Potash seems to have done very little good.

2. Nitrogen, though more beneficial than potash, seems to be required in but small quantity.

3. Phosphoric acid should be abundantly supplied together with smaller proportions of potash and nitrogen.

4. The differences apparently caused by the use of plaster and lime are too small to be significant, although plaster seems to have been slightly beneficial and its use seems to have paid.

MARBLEHEAD.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Wm. S. Phillips, Jr.

Number of Plot.	FERTILIZERS.	Yield per Plot 1-20 acre.			Yield per acre.			Gain or loss compared with Nothing Plots per acre.		
		Ears.			Shelled Corn bushels.			Shelled Corn bushels.		
	KIND.	Hard, lbs.	Soft, lbs.	Stover, lbs.	Hard.	Soft.	Stover, lbs.	Hard.	Soft.	Stover, lbs.
1	Nothing,	49	30	105	13.1	6.7	2100			
2	Nitrate of Soda,	69	35	151	18.4	7.8	3020	7.5	3.1	1040
3	Dissolved Bone-black,	60	31	108	16.	6.9	2160	5.1	2.2	180
4	Nothing,	33	12	93	8.8	2.7	1860			
5	Muriate of Potash,	95	25	221	25.3	5.6	4420	14.4	2.3	2190
6	Nitrate of Soda, Dissolved Bone black,	100	28	165	26.7	6 2	3300	15.7	3.0	1070
7	Nitrate of Soda, Muriate of Potash,	100	27	171	26.7	6.	3420	15.7	2.8	1190
8	Nothing,	49	17	130	13.1	3.8	2600			
9	Dissolved Bone black, Muriate of Potash,	74	22	180	19.7	4.9	3600	4.1	.4	1020
10	Nitrate of Soda, Dissolved Bone-black. Muriate of Potash	65	28	199	17.3	6.2	3980	1.7	1.8	1400
11	Land Plaster,	37	19	110	9.9	4.2	2200	—6.0	—2.0	—380
12	Nothing,	68	23	128	18.1	5.1	2560			
13	Barnyard Manure,	116	11	206	30.9	2.4	2120	19.1	—1.7	2010
14	Lime,	47	23	111	12.5	5.1	2220	.7	1.0	110
15	Nothing,	21	14	83	5.6	3.1	1660			

Average of nothing plots; hard corn, 11.7 bushels; soft corn 4.3 bushels; stover, 2156 pounds.

The field selected for this experiment was a high-lying piece of land just south of Forest river, near the place where it empties into Salem harbor. It had a considerable slope towards the river, i. e., towards the north. The soil was a fine gravelly loam, and proved to vary considerably in natural fertility in different parts of the field. The greater part had been in grass and unmanured for ten years, a small portion had been cultivated within five years; but had received little manure. Since that time it had been in grass unmanured.

In this experiment, which in almost all respects was excellently carried out, the fertilizer used on plots 6 to 10 inclusive was not applied exactly according to stakes. The growth of the crop showed that it was put in general, one row too far to the east. It was, however, thought best to weigh the crop according to the plots as staked, and to publish the results, although this accident, in a measure, obscures the effect of the fertilizers.

In July the following notes were made: Plot No 10 best as a whole; No 7, second; No. 13, third; No. 9, fourth; No. 5, fifth. It will thus be seen that potash appeared at this time most effectual among the ingredients of the fertilizers used; and the differences up to this point were decided. Between the other plots and the nothings the differences were much less noticeable.

In August the barn-yard manure was showing better, Nos. 10 and 9 were still showing well while No. 5 had relatively fallen back.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements. July 3.	July 17.	Aug. 10
1	Nothing,	12.6	23.7	58.4
2	Nitrate of Soda,	25.4	35.3	65.3
3	Dissolved Bone-black,	23.	35.1	61.
4	Nothing,	18.4	36.4	65.3
5	Muriate of Potash,	22.6	42.6	74.2
6	Nitrate and Bone-black,	26.2	38.4	76.7
7	Nitrate and Potash,	36.2	45.	84.7
8	Nothing,	17.4	27.1	56.6
9	Potash and Bone-black,	30.4	41.3	77.
10	Nitrate, Bone-black and Potash,	30.8	40.1	74.3
11	Land Plaster,	20.6	29.	58.6
12	Nothing,	15.	26.6	66.6
13	Barnyard Manure,	30.4	42.1	83.
14	Lime,	11.4	24.6	62.1
15	Nothing,	11.	25.1	57.

These measurements seem to indicate no relative falling off in the plots receiving nitrate of soda with the advance of the season. They further serve to confirm the favorable estimate placed upon the plots receiving potash.

ANALYSIS OF MANURE USED.

Moisture at 100° C.	56.710	per cent.
Organic and volatile matter,	87.526	" "
Ash,	12.474	" "
Phosphoric acid,	0.399	" "
Calcium oxide,	0.386	" "
Magnesium oxide,	0.223	" "
Potassium oxide,	0.489	" "
Nitrogen,	0.419	" "
Insoluble matter,	9.873	" "

This is a little below the average of manures used and the increase in hard corn is likewise below the average, viz.: 19.1 bushels, while the average is 22.4 bushels per acre.

SUMMARY OF WEATHER OBSERVATIONS,

June 9,—Nov. 1, 1889.

Month.	Temperature in Open Air in Degrees Fahrenheit.									Monthly Range.	Rainfall, inches.
	Monthly means of			Highest.		Lowest.		Greatest daily range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June.	82.	59.	23	93	30th	46	18th	29.5	18th	47	1.03
July.	84.8	60.8	24	99.5	21st	51.5	15th	28.5	17th	48	6.35
August.	83.8	53.	28.8	94	23d	49	27th	32.	28th	45	5.85
September	78.1	54.8	23.3	91.5	13th	41	27, 28th	24	1st	50.5	2.98
October.	63.4	40.	23.4	98.	4th	31	21st			67	3.86
Season.*	78.3	53.6	24.7	99.5	July 21	31	Oct. 21			68.5	20.07

*145 days.

This summary shows that at this station the temperature is more variable than at any other. It has the highest absolute maximum, 99.5 degrees; the lowest minimum, 31 degrees; the highest average daily range, 24.7 degrees, and the highest total range 68.5 degrees.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric acid.	Muriate of potash.	Phosphoric acid and potash.	Average Result.
Hard Corn, bushels per acre,	7.5	10.7	1.3	—2.4	4.3
Soft " " " "	3.1	.9	.4	1.3	1.4
Stover, pounds " "	1040	890	—1000	380	327.5

Value of net average increment, $2.66

Financial result, 1.34 loss

RESULTS OF THE ADDITION OF BONE-BLACK TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average Result.
Hard Corn, bushels per acre,	5.1	8.3	—10.3	—14.	—2.7
Soft " " " "	2.2	—.2	—1.9	—1.	—.2
Stover, pounds " "	180	30	—1170	210	--187.5

Value of net average decrease, $1.50

Financial result, 6.30 loss

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosphoric acid.	Nitrate and phosphoric acid.	Average Result.
Hard Corn, bushels per acre,	14.4	8.2	—.9	—14.	1.9
Soft " " " "	2.3	—.3	—1.8	—1.2	—.3
Stover, pounds " "	2190	150	840	330	877.5

Value of net average increment, $2.46

Financial result, .74 loss

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barnyard manure.	Land plaster.	Lime.
Hard Corn, bushels per acre,	1.7	19.1	—5.6	.7
Soft " " " "	1.8	—1.7	—.2	1.
Stover, pounds " "	1400	2010	—380	110

Value of increment due to Fertilizer,	$3.84
Financial result,	8.16 loss
Value of increment due to Manure,	$11.32
Financial result,	13.68 loss
Value of increment due to Lime,	.70
Financial result,	.26 loss
Value of decrease due to Plaster,	3.20
Financial result,	3.92 loss

The effect of the fertilizers was so obscured by the misapplication already mentioned that it seems hardly worth while to discuss the results. Especially does the fact that one entire row which received "complete fertilizer" stood outside the stakes bounding the plot affect the results.

The figures appear to indicate that potash was the ingredient which this soil most needed.

SHELBURNE.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Dole Bros.

Number of Plot.	FERTILIZERS. KIND.	Yield per Plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn Bushels. Hard.	Soft.	Stover, lbs.
1	Nothing,	101	24	136	26.9	5.3	2720			
2	Nitrate of Soda,	116	20	162	30.9	4.4	3240	3.9	— .5	640
3	Dissolved Bone-black,	136	17	148	36.3	3.8	2960	9.2	—1.1	360
4	Nothing,	102	20	124	27.2	4.4	2480			
5	Muriate of Potash,	148	15	161	39.5	3.3	3220	14.7	—2.6	850
6	Nitrate of Soda, Dissolved Bone-black,	146	26	168	38 9	5.8	3360	14.1	— .1	990
7	Nitrate of Soda, Muriate of Potash,	168	17	196	44.8	3.8	3920	20.	—2.1	1550
8	Nothing,	84	33	113	22.4	7.3	2260			
9	Dissolved Bone-black, Muriate of Potash,	142	15	178	37.9	3.3	3560	17.1	—3.	1390
10	Nitrate of Soda, Dissolved Bone-black, Muriate of Potash,	161	14	216	42.9	3.1	4320	22.1	—3.2	2160
11	Land Plaster,	83	29	118	22.1	6.4	2360	1.3	.1	190
12	Nothing,	72	24	104	19.2	5.3	2080			
13	Barn-yard Manure,	163	14	183	43.5	3.1	3660	22.1	—1.9	1120
14	Lime,	96	25	134	25.6	5.5	2680	4.3	.6	140
15	Nothing,	88	21	150	23 5	4.7	3000			

Average of the nothing plots ; hard corn, 23.8 bushels ; soft corn, 5.4 bushels ; stover, 2508 pounds.

The field for this experiment was upon an elevated tract in a hilly district, but was nearly level. The soil was a good medium loam and had been in grass without manure for five years. It appears to have been of tolerably even quality throughout the field.

When visited in July Nos. 13 and 10 appeared best and were about alike.

No. 9 was about as large as No. 10 but its paler color was very noticeable.

Between the other plots the differences were not striking, except in the case of No. 7 which appeared nearly as good as either 10 or 13.

Potash seemed, therefore, at this time to be producing the most marked results.

In August the relative standing was similarly judged.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements.			
		July 22.	Aug. 3.	Aug. 15.	Aug. 26.
		Inches.	Inches.	Inches.	Inches.
1	Nothing,	44.4	58.9	70.7	71.7
2	Nitrate of Soda,	46.	59.1	76.5	73.5
3	Dissolved Bone-black,	44.	59.2	74.5	76.6
4	Nothing,	38.4	54.4	72.9	71.8
5	Muriate of Potash,	48.3	62.7	74.8	72.2
6	Nitrate and Bone-black,	49.2	63.6	76.8	74.7
7	Nitrate and Potash,	52.8	66.2	78.2	77.2
8	Nothing,	37.8	46.1	66.2	70.
9	Bone-black and Potash,	51.2	66.4	78.2	82.1
10	Nitrate, Bone-black and Potash,	53.4	69.8	81.	73.4
11	Land Plaster,	43.3	53.5	66.9	72.5
12	Nothing,	34.6	43.5	60.	67.9
13	Barnyard Manure,	53.1	67.3	75.4	81.1
14	Lime,	41.5	52.4	69.3	72.3
15	Nothing,	42.6	55.6	71.8	74.5

These measurements show no falling off in the relative standing of nitrate of soda ; and confirm the estimate placed upon the plots which received potash.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	76.160 per cent.
Organic and volatile matter,	95.915 "
Ash,	4.085 "
Phosphoric acid,	0.218 "
Calcium oxide,	0.304 "
Magnesium oxide,	0.180 "
Potassium oxide,	0.804 "
Nitrogen,	0.570 "
Insoluble matter,	2.131 "

This manure on the whole stands first among all those used. It contains the highest percentages of both potash and nitrogen while phosphoric acid is about the average. It does not, however, cause an increase in proportion to its quality. This is almost exactly the average, viz.: 22.1 bushels of hard corn.

WEATHER OBSERVATIONS,

June 16—Sept. 25, 1889.

Month.	Temperature in Open Air in Degrees Fahrenheit.									Monthly Range.	Rainfall, inches.
	Means of daily.			Highest.		Lowest.		Greatest daily range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June.	76.3	55.5	20.8	84.5	29th	41	18th			43.5	1.18
July.	77.0	59.2	15.8	85.	1st, 8th	50	17th			35.	7.16
August.	72.3	54.6	17.7	81.	3d, 30th	43	28th			38.	4.03
Sept'm'r.	69.2	53.2	16.	82.	1st, 6th	35	22d			47.	3.79
Season.*	73.6	55.8	17.8	85.	July 8th	35	Sept. 22			50.	16.16

*102 days.

These figures seem to present no particulars worthy of especial note.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Results.
Hard Corn, bush. per acre,	3.9	4.9	5.3	5.1	4.8
Soft Corn, " " "	— .5	1	.4	— .2	.2
Stover, pounds, " "	640	630	700	760	682.5

Value of average net increment,	$3.33
Financial result,	.67 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Results.
Hard Corn, bush. per acre.	9.2	10.3	2.4	2.1	6.
Soft Corn, " " "	—1.1	.3	— .5	—1.1	.6
Stover, pounds, " "	360	350	540	600	462.5

Value of average net inciement, $3.21
Financial Result, 1.59 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phosphoric Acid.	Average Result.
Hard Corn, bush. per acre,	14.7	16.1	8	8	11.6
Soft Corn, " " "	—2.6	—1.7	—1.9	—3	—2.5
Stover, pounds, " "	850	910	1030	1160	987.5

Value of average net increment, $6.16
Financial result, 2.96 profit.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barn-yard Manure.	Land Plaster.	Lime.
Hard Corn, bush. per acre,	22.1	22.1	1.3	4.3
Soft Corn, " " "	—3.2	—1.9	.1	.6
Stover, pounds, " "	2160	1120	190	140

Value of net increment due to fertilizer, $12.52
Financial result, .52 gain.

Value of increment due to manure, $10.70
Financial result, 14.30 loss
Value of increment due to plaster, .92
Financial result, .20 profit
Value of increment due to lime, 2.12
Financial result, 1.16 profit

These comparisons make it evident that in this soil potash was the ingredient most needed. Alone and in all combinations it produced a profitable increase. The net average increment is sufficient to produce a profit of $2.96 while the result for both nitrogen and phosphoric acid is a loss. The "complete fertilizer" produces a more valuable crop than barnyard manure, and affords a profit, which might have been considerably larger had a part of the nitrate and bone-black been left out.

Both plaster and lime prove slightly beneficial and their use results in small apparent profit.

WESTFIELD.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Chas. F. Fowler.

Number of Plot.	FERTILIZERS. KIND.	Yield per Plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn Bushels. Hard.	Soft.	Stover, lbs.
1	Nothing,	12	7	24	3.2	1.6	480			
2	Nit ate of Soda,	23	9	32	6.1	2.	640	3.	.2	140
3	Dissolved Bone-black,	20	15	30	5.3	3.3	600	2 2	1.6	100
4	Nothing,	11	9	26	2.9	2.	520			
5	Muriate of Potash,	19	5	35	5.1	1.1	700	.8	— .7	120
6	Nitrate of Soda, Dissolved Bone black.	35*	9	62	9.3	2.	1240	5.1	.3	660
7	Nitrate of Soda, Muriate of Potash.	25	7	39	6.6	1.6	780	2.4	— .3	200
8	Nothing,	21	7	32	5.6	1.6	640			
9	Dissolved Bone-black, Muriate of Potash,	45*	7	53	12.	1.6	1060	7.3	— .3	450
10	Nitrate of Soda, Dissolved Bone-black, Muriate of Potash,	60*	6	71	16.	1.3	1420	11.3	— .5	810
11	Land Plaster,	24	9	37	6.4	2.	740	1.7	.2	130
12	Nothing,	14	9	29	3.7	2	580			
13	Barn-yard Manure,	80*	5	106	21.3	1.1	2120	16	— .2	1570
14	Lime,	17	9	28	4.5	2.	560	— .8	.7	10
15	Nothing,	26	3	26	6.9	.7	520			

*Estimated; part of ears stolen.

Average of nothings, hard corn, 4.4 bussels; soft corn, 1.6 bushels; stover 550 pounds.

This experiment was located on the so-called "plain-land" of the Connecticut valley. It is an old alluvial soil consisting of fine sand.

It is of great depths, and lies at such an elevation that it usually appears dry, though it does not have the reputation of drying badly in time of drought. The portion selected had lain fallow four years. It was very poor, but not apparently even in quality, nothing plots 8 and 15 were much better than the others. It should be stated that some ears of corn were stolen from this field. The percentage of loss was determined as closely as possible and corrections made accordingly on plots 6, 9, 10 and 13.

At the time the crop was visited in July the following notes were made:

No. 13 much better than any other.

No. 10 much better than any other except 13.

Nos. 6 and 9, though much inferior to No. 10, considerably better than the others, between which the differences are not very marked.

The observations in August though taken by another party rated the plots in precisely the same order.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of measurements.	
		July 28.	Aug. 9.
1	Nothing,	23.7	33.
2	Nitrate of Soda,	28.3	44.9
3	Dissolved Bone-black,	29.4	46.3
4	Nothing,	23.2	34.5
5	Muriate of Potash,	28.3	43.2
6	Nitrate and Bone-black,	36.5	59.8
7	Nitrate and Potash,	35.7	44.5
8	Nothing,	27.3	38.5
9	Bone-black and Potash,	37.8	54.8
10	Nitrate, Bone-black and Potash,	43.	60.5
11	Land Plaster,	30.4	51.8
12	Nothing,	24.1	40.5
13	Barn-yard Manure,	57.5	74.2
14	Lime,	29.3	43.4
15	Nothing,	25.3	39.4

These figures show a due agreement with the judgment of the relative standing of the plots recorded above. They seem to indicate especial benefit from the use of nitrogen and phosphoric acid and that the nitric acid is tenaciously held by this soil.

The barn-yard manure used in this experiment was not sampled; and we, therefore, have no analysis.

SUMMARY OF WEATHER OBSERVATIONS.

June 12—Nov. 1, 1889.

Month.	Temperature in open air in degrees Fahrenheit. Means of Daily. Max.	Min.	Rnge.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest daily range. Deg.	Date.	Monthly range.	Rain fall inch's
June.	79.	56.6	22.4	88.	30th	46.	18, 23.	28.	20th.	41.	1.67
July.	79.1	60.6	18.5	88.	8th.	50.	24th.	28.	24th.	38.	7.72
August.	74.3	54.	20.3	82.	31st.	44.	28th.	33.	30th.	38.	1.89
September	71.4	53.4	18.0	83.	7th.	37.	23d.	30.	5th.	46.	4.68
October.	56.5	37.2	19.3	71.	1st, 20th	24.	21, 22.	32.	18th.	47.	3.87
Season 142 days.	71.5	52.	19.5	88.	June 30 July 8	24.	Sept. 22	33.	Aug. 30.	64.	19.83

This summary shows a lower temperature at this place than at any other station except Yarmouth and the minimum recorded is below even that station.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard Corn, bush. per acre,	3	2.8	1.6	4	2.9
Soft corn, " " "	.2	—1.3	.5	— .2	— .2
Stover, pounds, " "	140	560	80	360	285

Value of net average increment, $1.76
Financial result, 2.24 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard Corn, bush. per acre,	2.2	2.0	6.3	8.7	4.8
Soft Corn, " " "	1.6	0	.4	— .2	.4
Stover, pounds, " "	100	520	330	610	390

Value of net average increment, $2.78
Financial result, 2.02 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phosphoric Acid.	Average Result.
Hard Corn, bush. per acre,	.8	— .5	4.8	6	2.8
Soft Corn, " " "	— .7	— .4	—1.8	— .7	— .9
Stover, pounds, " "	120	60	350	150	170

Value of average net increment, $1.28
Financial result, 1.92 loss.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barn-yard Manure.	Land Plaster.	Lime.
Hard Corn, bush. per acre,	11	16	1.7	— .8
Soft Corn, " " "	— .4	— .2	.2	.7
Stover, pounds, " "	810	1570	130	—10

Value of increment due to fertilizer, $5.94
Financial result, 6.06 loss.
Value of increment due to manure, $9.50
Financial result, $15.50 loss.
Value of increment due to plaster, $ .98
Financial result. .26 profit.
Value of decrease due to lime, $ .18
Financial result, 1.14 loss.

The differences brought out by these comparisons result in ranking the three ingredients of the fertilizers about as estimated during the period of growth. Phosphoric acid produces the largest increase, then come nitrogen and potash in the order named. The differences are, however, small; and the increase is, in no case, sufficient to pay for the fertilizer. Barn-yard manure does much better than "complete fertilizer" which indicates either a more general exhaustion than the latter can meet or a beneficial physical or chemical effect from the manure.

Plaster appears to be somewhat beneficial and produces an apparent small profit; but the difference is too small to have any special significance. It is very likely accidental and due to another cause. So also of the small apparent decrease where lime is used.

HADLEY.

SOIL TEST WITH FERTILIZERS FOR CORN.

By L. W. West.

No. of Plot.	FERTILIZERS. KIND.	Yield per Plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per Acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft	Stover, lbs.
1	Nothing,	60	*	81	16.	*	1620			
2	Nitrate of Soda,	72		87	19.2		1740	3.	*	140
3	Dissolved Bone-black,	70		77	18.9		1540	2.6		—60
4	Nothing,	61		79	16.3		1580			
5	Muriate of Potash,	90		100	24.		2000	10.4		650
6	{ Nitrate of Soda, Dissolved Bone-black	65		81	17.3		1620	3.7		270
7	{ Nitrate of Soda, Muriate of Potash,	79		104	21.1		2080	7.5		730
8	Nothing,	41		56	10.9		1120			
9	{ Dissolved Bone-black Muriate of Potash,	67		85	17.9		1700	7.3		540
10	{ Nitrate of Soda, Dissolved Bone-black Muriate of Potash,	65		93	17.3		1860	6 8		700
11	Land Plaster,	40		65	10.7		1300	.1		140
12	Nothing,	38		60	10.1		1200			
13	Barnyard Manure,	83		128	22.1		2560	12		820
14	Lime,	50		82	13.3		1640	1.5		–100
15	Nothing,	51		114	13.6		2280			

*Hard and soft corn were weighed together in this test. Average of nothing plots, shelled corn 13.4 bushels; stover, 1560.

In explanation of the very low yield in this experiment it is pertinent to state that the planting was done very late. The acre for this experiment lies in the large tract of plain land which is found north of the Holyoke range and is about two miles from the mountains. The soil is a heavy loam with clay subsoil. It had been in grass for eight years without manure. Except for the traces of the influence of a former pile of manure near one end, the soil proved tolerably even in quality. In July the appearance of the crop indicated that potash was proving much the most useful ingredient of the fertilizers. Then No. 10 was judged to be a little better than No. 13; No. 9 about as good as No. 10; and Nos. 7 and 5 very little inferior to 9 and 10. The other plots were considerably below those mentioned, but those which had received phosphoric acid seemed to promise a little better than the others. In August the relative standing was substantially unchanged, except for the barnyard manure plot which had outstripped the "complete fertilizer."

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements.				
		July 27.	Aug. 5.	Aug. 15.	Aug. 26.	Sept 5.
1	Nothing, ...	38.1	44.3	51.4	64.	65.1
2	Nitrate of Soda,.....	40.4	49.9	57.	65.6	66.7
3	Dissolved Bone-black..........	35.5	47.2	55.8	62.9	75.6
4	Nothing,....................	34.3	47.3	54.	61.4	63.4
5	Muriate of Potash............	36.4	43.3	55.5	62.2	66.7
6	Nitrate and Bone-black,........	35.6	44.2	54.5	57.8	65.7
7	Nitrate and Potash............	36.4	44.5	54.7	68.6	66.9
8	Nothing, ...	27.3	34.	41.7	43.7	52.7
9	Bone-black and Potash........	38.2	44.	56.4	65.2	66.6
10	Nitrate, Bone-black and Potash,	38.6	53.1	60.6	68.6	71.9
11	Land Plaster, ...	29.	34.7	39.7	47.2	52.7
12	Nothing, ...	34.8	39.4	47.2	55.3	63.7
13	Barn-yard Manure,....	42.2	51.3	66.3	74.3	72.8
14	Lime,........................	30.4	40.4	48.8	55.	58.5
15	Nothing, ...	35.6	45.5	49.6	56.5	61.5

These on the whole make evident the substantial accuracy of the estimates of relative standing above recorded.

ANALYSIS OF BARN-YARD MANURE USED.

Moisture at 100° C.,	73.470	per cent.
Organic and volatile matter,	96.671	"
Ash,	3.329	"
Phosphoric acid,	0.247	"
Magnesium oxide,	0.124	"
Calcium oxide,	0.322	"
Potassium oxide,	0.484	"
Nitrogen,	0.471	"
Insoluble matter,	2.285	"

This manure is very near the average composition of all those used in our experiments, the element nitrogen only standing higher among the important ingredients, and phosphoric acid and potash a little lower.

WEATHER OBSERVATIONS,

June 16—Sept. 25, 1889.

Month.	Temperature in Open Air in Degrees Fahrenheit. Monthly means of Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest daily range. Deg.	Date.	Monthly Range.	Rainfall, inches.
June.	78.9	57.7	21.2	89	29th	43	18th	28	23d	46	3.66
July.	80.5	59.2	21.3	90	1st	48	24th	32	7th	42	8.48
August.	81.1	55.4	25.7	86	30th	46	28th	31	30th	40	3.44
Sept'mb'r.	78.6	57.3	21.3	85	6th	36	28th	31	2nd	49	7.03
Season.*	79.9	57.4	22.5	90	July 1	36	Sept. 28	32	July 7	54	22.61

*114 days.

This shows a comparatively high degree of variability for every month; and a high absolute range of temperature for the season. This peculiarity on a soil as cold as the one used must have proved quite unfavorable to the crop.

RESULTS OF THE ADDITION OF NITROGEN

	To nothing.	To phosphoric acid.	To muriate of potash.	To phosphoric acid and potash.	Average result.
Corn, bush. per acre,	3.0	1.1	—2.9	—.5	.2
Stover, pounds, " "	140	330	80	160	177.5

Value of the net average increment, $ .44

Financial Result, $3.56 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID

	To nothing.	To nitrate of soda.	To muriate of potash.	To nitrate and potash.	Average result.
Corn, bush. per acre,	2.6	.7	—3	—.7	—.13
Stover, pounds, " "	—60	130	—110	—30	—20

Value of the net average decrease, $ .09

Financial Result, 4.89 loss.

RESULTS OF THE ADDITION OF POTASH

	To nothing.	To nitrate of soda.	To phosphoric acid.	To nitrate and phosphoric acid.	Average result.
Corn, bush. per acre,	10.4	4.4	4.8	3.	5.6
Stover, pounds, " "	650	590	600	430	567.5

Value of the net average increment, $3.37
Financial Result, .17 profit.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barnyard manure.	Land Plaster.	Lime.	
Corn, bush. per acre,	6.8	12	.13	1.5	
Stover, pounds, " "	700	820	140	—100	

Value of increment due to fertilizer, $4.12
Financial result, 7.88 loss
Value of increment due to manure, $5.72
Financial result, 19.28 loss
Value of increment due to lime, $ .40
Financial result, .56 loss
Value of increment due to plaster, $ .33
Financial result, .39 loss

These comparisons make it evident that potash is the only important ingredient of the fertilizer which did any appreciable good; but the increase caused by this is exceedingly small. A much smaller application must have proved equally efficacious.

The use of the complete fertilizer was very unprofitable, and resulted in a considerably smaller crop than that produced on barnyard manure. Neither lime nor plaster did any appreciable good on this soil.

WORCESTER.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Pliny Moore.

No. of Plot.	FERTILIZERS — KIND.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Ears. Soft, lbs.	Stover, lbs.	Yield per Acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing,	202	24	158	53.9	5.3	3160			
2	Nitrate of Soda,	200	34	163	53.3	7.6	3260	3.3	1.2	290
3	Dissolved Bone-black,	179	32	148	47.7	7.1	2960	—2.3	.8	—10
4	Nothing,	173	33	139	46.1	7.3	2780			
5	Muriate of Potash,	177	32	147	47.2	7.1	2940	1.6	—.7	—20
6	{ Nitrate of Soda, Dissolved Bone-black.	195	23	152	52.	5.1	3040	6.4	—2.7	80
7	{ Nitrate of Soda, Muriate of Potash,	190	25	168	50.7	5.6	3360	5.1	—2.2	400
8	Nothing,	169	37	157	45.1	8.2	3140			
9	{ Dissolved Bone-black Muriate of Potash,	192	38	144	51.2	8.4	2880	8.1	2.1	—40
10	{ Nitrate of Soda, Dissolved Bone black Muriate of Potash.	210	18	177	56.	4.	3540	12.9	—2.3	620
11	Land Plaster,	146	29	144	38.9	6.4	2880	—4.2	.1	—40
12	Nothing,	154	20	135	41.1	4.4	2700			
13	Barnyard Manure,	212	21	178	56.5	4.7	3560	21.2	—2.1	1010
14	Lime,	158	33	146	42.1	7.3	2920	6.8	.6	370
15	Nothing,	111	41	120	29.6	9.1	2400			

Average of nothings, hard corn 43.1 bushels; soft corn 6.9 bushels; and stover 2836 pounds.

The field selected for this experiment was a rather elevated southern slope with very moderate pitch. The soil was good medium loam. It had been in grass four years without manure, but proved to be very fertile. Unfortunately, however, it turned out to be quite uneven in quality; apparently deteriorating steadily from one side (Plot No. 1) to the other, as shown by the diminishing yield of the nothing plots. The effect of this inequality shows itself chiefly in the comparison of barn-yard manure with complete fertilizer; and is favorable to the former. It does not, I believe, materially influence the comparisons between nitrogen, phosphoric acid and potash.

In July, Plot No. 10 was judged to be superior to No. 13, and no striking difference was noted between the other plots. The influence of the fertilizer was apparently less noticeable here than in any other experiment, and quite naturally since the soil was already comparatively rich. The estimate of the relative standing and general effect of the fertilizers made in August was precisely the same.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average July 20. Inches.
1	Nothing,	52.6
2	Nitrate of Soda,	53.8
3	Dissolved Bone-black,	54.9
4	Nothing,	44.7
5	Muriate of Potash,	56.0
6	Nitrate and Bone-black,	52.9
7	Nitrate and Potash,	56.1
8	Nothing.	49.0
9	Bone-black and Potash,	55.7
10	Nitrate, Bone-black and Potash,	54.7
11	Land Plaster,	52.1
12	Nothing,	45.1
13	Barn-yard Manure,	53.1
14	Lime,	46.3
15	Nothing,	45.5

The experimenter in this case made but one set of measurements, of which the above are the averages. These appear to indicate that potash more than any other ingredient of the fertilizer was making itself felt at this time.

The manure used in this experiment was not sampled.

WEATHER OBSERVATIONS,

June 16—Sept. 28, 1889.

Month.	Temperature in Open Air in Degrees Fahrenheit.										Monthly Range.	Rainfall, inches.
	Monthly means of			Highest.		Lowest.		Greatest daily range.				
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date			
June.	77.7	56.3	21.4	85	29th	49	24th	26	22d		36	.64
July.	77.6	60.2	17.4	86	1st	52	16th	27	15th		34	8.25
August.	74.6	57.0	17.6	83	31st	47	28th	25	12th		36	3.11
Sept'mb'r.	70.6	53.1	17.5	83	5th	37	23d	28	4th		46	3.18
Season.*	73.9	55.9	18.0	86	July 1	37	Sept. 23	28	Sept. 4		49	15.18

*105 days.

This table shows a very light rain-fall for the latter half of June, and a very heavy one for July. The total for the season is smaller than at any other station. This, however, is in part accounted for by the fact that observations ended here earlier than at most stations. As a rule the rainfall in the eastern portion of the state was more evenly distributed throughout the season than at the stations in the western portion. All the latter were characterized by a very heavy fall in July.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Results.
Hard Corn, bush. per acre.	3.3	8.6	3.5	4.8	5
Soft Corn, " " "	1.2	—3.4	—1.6	—4.4	—2
Stover, pounds, " "	290	90	420	660	365

Value of average net increment. $2.33

Financial result, 1.67 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Results.
Hard Corn, bush. per acre.	—2.2	3	6.5	7.9	3.6
Soft Corn, " " "	.8	—3.8	2.8	— .1	—1.1
Stover, pounds, " "	—10	—210	—20	220	—5

Value of average net increment. $1.21

Financial result. 3.59 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phosphoric Acid.	Average Results.
Hard Corn, bush. per acre.	1.6	1.9	10.4	6.5	5.1
Soft Corn, " " "	— .7	—3.4	1.3	.3	— .6
Stover, pounds. " "	—20	110	—30	540	150

Value of average net increment, $2.22

Financial result, .98 loss.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizers.	Barn-yard Manure.	Land Plaster.	Lime.
Hard Corn, bush. per acre.	12.9	21.2	—4.1	6.8
Soft Corn, " " "	—2.3	—2.1	.1	.6
Stover, pounds. " "	620	1010	—40	370

Value of increment due to fertilizer,	$5.94
Financial result,	6.06 loss.
Value of increment due to manure,	$10.08
Financial result,	14.92 loss.
Value of decrease due to plaster,	$1.70
Financial result,	2.42 loss.
Value of increment due to lime,	$3.58
Financial result,	2.62 profit.

From these comparisons we see that none of the fertilizers used appear to have caused much increase in crop. Between nitrogen, phosphoric acid and potash there is no essential difference. This soil appears to have required one about as much as another; but gave a profit on none, whether used singly or in any combination. Both "complete fertilizer" and barn-yard manure gave considerable increase in crop; but in neither case in paying quantities. Even if we consider the manure as only half exhausted, we shall still have a loss on its use at the price allowed.

Lime alone, in this experiment, appears to have caused a paying increase; but this is small. Plot 14 was undoubtedly better naturally than plot 15. Still the yield on 14 was compared not with 15 but with the average product of 12 and 15. It, therefore, appears quite certain that the lime was moderately beneficial. This, indeed, we might naturally expect on a good soil rich in organic matter as this was.

AMHERST.

SOIL TESTS WITH FERTILIZERS FOR CORN.

Station Grounds.

No. of Plot.	FERTILIZERS. KIND.	Yield per Plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per Acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nitrate of Soda,	91	34	83	24.3	7.6	1660	2.7	3.6	220
2	Dissolved Bone-black,	91	29	97	24.3	6.4	1940	2.7	2.4	500
3	Nothing,	81	18	72	21.6	4.	1440			
4	Muriate of Potash,	177	20	149	47.2	4.4	2980	25.6	.4	1540
5	Lime,	99	24	87	26.4	5.3	1740	4.8	1.3	300
6	Nothing,*	72	22	70						
7	Barn-yard Manure,	205	25	210	54.7	5.6	4200	23.2	—.9	2120
8	Nitrate of Soda, Dissolved Bone-black	128	20	105	34.1	4.4	2100	2.7	—2.	20
9	Nothing,	118	29	104	31.5	6.4	2080			
10	Nitrate of Soda, Muriate of Potash,	187	25	151	49.9	5.6	3020	19.5	.1	930
11	Dissolved Bone-black Muriate of Potash,	206	26	198	54.9	5.1	3960	24.5	.4	1870
12	Nothing,	110	20	105	29.3	4.4	2100			
13	Land Plaster,	100	25	94	26.7	5.6	1880	—2.7	1.1	220
14	Nitrate of Soda, Dissolved Bone black Muriate of Potash,	221	25	209	58.9	5.6	4180	29.6	1.1	2080

*About one-fourth of Plot 6 pulled up by crows.

Average of nothings 27.5 bushels of hard corn; 5.1 bushels of soft corn and 1880 pounds of stover.

The acre for this experiment is on the old alluvial soil of the Connecticut valley. The field has a very slight slope south and west and is of such form that the arrangement of plots adopted was different from that followed in the other experiments. The plots were in two series, in each 150 feet long, and five rows in each. There were seven plots in each series and four in place of the usual five nothing plots. In each series the plots were numbered from the east side; the first in one series being No. 1 and in the other No. 8. It will thus be seen that the nothing plots in the different series were not opposite each other. The field had been in grass without manure for the past five years, and had been pastured the preceding year.

The soil is a fine yellow loam, underlaid, at the depth of a few feet by gravel or sand, and with perfect natural drainage. It proved to vary to a considerable degree in natural fertility in the two series; but such are the methods of comparison adopted that it is not believed this difference materially affects our conclusions. Each plot when between two nothings is compared with the average of the two. In other cases it is compared with the nearest nothing. No use is made of plot 6 in these comparisons.

This experiment was under our immediate observation throughout the season, and from a very early period it became evident that potash was proving much more beneficial than either phosphoric acid or nitrogen. No difference in relative standing of plots could be detected with advance in season. The plots which were ahead at the time of the first measurement ended ahead.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements.			
		June 26.	July 5.	July 15.	July 25.
1	Nitrate of Soda, ...	12.6	25.4	38.1	58.3
2	Dissolved Bone-black,...	13.4	25.0	39.5	52.2
3	Nothing,...............	12.0	21.0	35.5	48.2
4	Muriate of Potash,............	15.6	27.8	44.6	55.5
5	Lime, ...	12.8	22.8	34.4	44.6
6	Nothing,....	11.8	23.4	35.8	50.7
7	Barn-yard Manure,............	21.4	35.8	50.0	69.4
8	Nitrate and Bone-black........	15.8	28.8	37.2	57 5
9	Nothing,.....................	15.6	28.2	39.0	55.4
10	Nitrate and Potash, ...	20.0	33.8	48.6	69.4
11	Bone-black and Potash,........	21.8	34.0	51.1	71.2
12	Nothing,....	14.4	24.2	34.2	68.7
13	Plaster,............	17.6	25.4	36 0	50.5
14	Nitrate, Bone-black and Potash.	24.2	37.4	54.2	72.6

These figures are the averages of a very large number of actual determinations of the height of individual plants. They are chiefly interesting in that they make it evident that any slight advantage which the nitrate of soda gave was well sustained throughout the season. I judge that we should have obtained no better results had this fertilizer been applied in fractional dressings. This point will be tested hereafter.

ANALYSIS OF MANURE USED.

Moisture at 100° C.	73.470 per cent.
Organic and volatile matter,	85.900 " "
Ash.	14.100 " "
Phosphoric acid,	0.133 " "
Calcium oxide.	0.264 " "
Magnesium oxide,	0.182 " "
Potassium oxide,	0.615 " "
Nitrogen,	0.362 " "
Insoluble matter,	12.657 " "

This manure contains a little more potash and less phosphoric acid and nitrogen than the average of those used in our experiments. It should have proved exactly suited, as will be seen, to the requirements of this soil.

WEATHER OBSERVATIONS.

June 1—Nov. 1, 1889.

Month.	Temperature in Open Air in Degrees Fahrenheit.									Monthly Range.	Rainfall, inches.
	Monthly means of			Highest.		Lowest.		Greatest daily range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June.	76.2	57.	19.2	88.5	30th	38	7th	33	7th	50.5	3.85
July.	77.9	59.	18.9	86	8th	46.5	16th	30	22d	39.5	8.35
August.	76.5	54.	22.5	84	31st	40.5	29th	35.5	30th	43.5	2.69
Sept'm'r.	70.	52.8	17.2	82.5	6th	34.5	23d	45.5	29th	48.0	2.90
October.	55.	36.2	18.8	69.5	1st	21	24th	33.5	19th	48.5	4.10
Season.*	71.1	51.8	19.3	88.5	June 30	21	Oct. 24	45.5	Sept. 29	67.5	21.89

*153 days.

These figures are the result of observations taken at the State Experiment Station, the instruments of which are on the same level as our field and quite near it. We also determined rainfall by means of a gauge placed within a few yards of our field. The results agree substantially with those of the above table.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric acid.	Muriate of Potash.	Phosphoric acid and potash.	Average Result.
Hard Corn, bushels per acre,	2.7	0	—6.1	5.1	.4
Soft " " " "	3.6	—4.4	—.3	.8	—.1
Stover, pounds " "	220	—480	—610	210	—165

Value of average net decrease, $ .19

Financial result, 4.19 loss

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of Potash.	Nitrate and potash.	Average Result.
Hard Corn, bushels per acre,	2.7	0	—1.1	10.1	2.9
Soft " " " "	2.4	—6.	—.1	1.	—.6
Stover, pounds " "	500	—200	330	1150	445

Value of average net increment, $1.93

Financial result, 2.87 loss

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosphoric acid.	Nitrate and phosphoric acid.	Average Result.
Hard Corn, bushels per acre,	25.6	16.8	21.9	26.9	22.8
Soft " " " "	.4	—3.4	—2.1	3.1	—.5
Stover, pounds " "	1540	710	1370	2060	1420

Value of average net increment, $11. 86
Financial result, 8. 66 profit

RESULT OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard Corn, bush. per acre,	29.6	23.2	—2.7	4.8
Soft Corn, " " "	1.1	—.9	1.1	1.3
Stover, pounds, " "	2080	2120	—220	300

Value of increment due to fertilizer, $16.22
Financial result, 4.22 profit
Value of increment due to manure, $13.34
Financial result, 11.66 loss
Value of decrease due to plaster, $ .86
Financial result, 1.58 loss
Value of increment due to lime, $2.78
Financial result, 1.82 profit

These comparisons make it evident that this soil needed potash. Neither alone nor in any combination did nitrogen or phosphoric acid appear to do much good, and in some cases the result of their use was an apparent decrease in crop. In both cases with a single exception the results of their use were invariably a financial loss. This exception is plot 14 where the addition of bone-black appears to have caused an increase sufficiently great to pay for its use. From the fact, however, that the addition of bone-black to potash on plot 11 was not beneficial, it may be concluded that the increase apparently due to phosphoric acid in plot 14 was produced by accidental causes.

Potash, on the other hand, appears to have been always and everywhere greatly beneficial. Whether used alone or in any combination it invariably caused a large increase in crop and its use was always exceedingly profitable.

The lesson of this experiment is plain. For our soil, potash should, for the present, be the most prominent ingredient of every fertilizer used.

Lime appears to have caused a profitable increase in crop; but the gain is small and perhaps rather apparently than actually due to lime, for the product of plot 5 was compared with that of plot 3 which was the poorest nothing on the field.

The manure caused a large increase in crops, and allowing for unexhausted residue, its use proved profitable.

GENERAL SUMMARY.

Results of the Use of Potash: This ingredient has produced an average increase of crop varying from 1.9 bushels of hard corn per acre in Marblehead to 22.8 bushels in Amherst; and from 150 pounds of stover per acre in Worcester to 1420 pounds in Amherst. It has proved more useful in its average effect upon the production of hard corn than either nitrogen or phosphoric acid in four out of the eight experiments, viz.: Amherst, Shelburne, Hadley and Worcester, and in another it stands on an equality with nitrogen in this respect, viz.: Yarmouth. It has proved most effective in its effect upon the production of stover in four experiments, viz.: Amherst, Shelburne, Marblehead and Hadley.

Results of the Use of Phosphoric Acid: This ingredient has proved most effective in its average influence upon the production of hard corn in two experiments, viz.: Freetown and Westfield, and it has proved quite beneficial in two more, viz.: Shelburne and Yarmouth. In its average influence upon stover, it has proved most beneficial in one experiment, Freetown. Its average effects upon production of hard corn and stover vary respectively from a decrease of 2.7 bushels per acre in Marblehead to an increase of 8.2 bushels in Freetown for the former, and from a decrease of 187 pounds per acre in Marblehead to an increase of 462 pounds in Shelburne for the latter.

Results of the Use of Nitrogen: This element has in one case proved most beneficial in its average effect upon the production of hard corn, viz.: Marblehead. In one, it stands on an equality with potash, viz.: Yarmouth, and in three more it has proved quite beneficial in its average effect, viz: Freetown, Worcester and Shelburne.

In its average effect upon production of stover it stands first in Worcester and it has produced a comparatively large effect in Shelburne and Freetown. The average effect per acre for this element is as follows: hard corn from .2 to 6.2 bushels increase, stover from 165 pounds decrease to 682 pounds increase.

Comparative Effect of Potash, Nitrogen and Phosphoric Acid upon Production of Grain and Stover. As bearing upon the relative effect upon grain and stover production respectively of these ingredients of the fertilizers used, our figures afford some interesting data. We find that the grand average increase in hard corn and stover per acre taking all our experiments into account is as follows:

For potash,	hard corn,	6.51	bushels;	stover,	643.3	pounds.
For phosphoric acid,	"	3.56	"	"	211	"
For nitrogen,	"	3.72	"	"	287.6	"

Potash, then, gave an average increase over nitrogen as follows: Hard corn, 1.73 times; stover, 2.24 times. Over phosphoric acid, the average increase was respectively: hard corn, 1.83 times; stover, 3.05 times. It thus becomes evident that potash produces relatively more effect upon the yield of stover than upon that of grain, and that it greatly exceeds either nitrogen or phosphoric acid in this respect. Next to potash in its effect upon stover ranks nitrogen.

CONCLUSIONS.

1. The results of our experiments bring out in a striking manner the fact that soils vary widely in their requirements. They therefore confirm the position taken in my circular letter that results obtained in one locality, may be inapplicable in another; and appear to establish the wisdom of the policy of local soil tests.

2. It is evident that only when the farmer knows what his soil requires can he produce the best economical results. It is folly to continue the indiscriminate and blind use of fertilizers.

3. The best method of ascertaining what is needed in any given case to produce a particular crop is to put the question to the soil itself; and this method, though requiring care at all points, and caution in forming conclusions, is not in reality difficult. Such experiments should abundantly repay the investigator in the practical money value of the results.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 10.

Report on Special Fertilizers for Greenhouse Crops.

Report on Small Fruits.

OCTOBER, 1890.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1890.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College.

AMHERST, MASS

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

Henry H. Goodell, . .	*Director.*
William P. Brooks, . .	*Agriculturist.*
Samuel T. Maynard, . .	*Horticulturist.*
Charles H. Fernald, . .	*Entomologist.*
Clarence D. Warner, . .	*Meteorologist.*
William M. Shepardson, .	*Assistant Horticulturist.*
Herbert E. Woodbury, .	" "
Frank O. Williams, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

DIVISION OF HORTICULTURE.

SAMUEL T. MAYNARD.

SPECIAL FERTILIZERS FOR GREENHOUSE CROPS.

The question of the use of special fertilizers under glass is becoming one of great importance, and is attracting much attention among practical gardeners and scientific men.

Even the best and most skilled gardeners sometimes find that their soil, made up after the best formulas, fails to give the results expected. The plant food seems to be unavailable or the plant lacks the vigor to make use of it, and something more active is needed to give it a start.

To determine what special fertilizers will give the best results applied to crops under glass, a series of experiments were started in the winter of 1888—89, the results of which are deemed of sufficient value for publication, although a longer series of tests may somewhat modify the results thus far obtained.

The following experiments were made in two houses built side by side as nearly as possible alike, one heated with steam and the other with hot water. The space was divided into plots of equal size in each house with the same number and kind of plants in each, the aggregate number of blossoms from both plots being given with the kind of fertilizer used.

CARNATIONS—1888 AND 1889.

Six beds of thirty plants each were set in each house, the same kinds in each and all as nearly the same size and vigor of growth as possible. The soil was made moderately rich with stable manure and fine ground bone, and the special fertilizer applied in liquid form by dissolving one tablespoonful in a two-gallon can of water. The results are shown in the following table:

Plot No. 1.	Muriate of Potash,	gave 276	blooms.
" " 2.	Sulphate of Ammonia	" 314	"
" " 3.	Nitrate of Soda	" 309	"
" " 4.	Sulphate of Potash	" 356	"
" " 5.	Bone Black (Dissolved)	" 378	"
" " 6.	Ordinary Liquid Manure	" 195	"

SUMMARY OF RESULTS.

These results are very much in favor of bone black and sulphate of potash.

LETTUCE—1888 AND 1889 (*First Crop.*)

Five plots of Lettuce were planted on the side benches of each of the above mentioned houses and the same fertilizers applied. The results are as follows:

Plot No. 1. Muriate of Potash, growth medium, some mildew.
" " 2. Nitrate of Soda, growth small, badly mildewed.
" " 3. Sulphate of Ammonia, growth large and nearly free from mildew.
" " 4. Sulphate of Potash, growth fair, a little mildew.
" " 5. Bone Black (Dissolved), growth medium, some mildew.

In this case the results were the best when the Sulphate of Ammonia was used.

1888 AND 1889 (*Second Crop.*)

After the first crop was harvested the plots were planted again with the same kind of Lettuce, and the same fertllizers were used with the following results:

Plot No. 1. Muriate of Potash, growth medinm, some mildew.
" " 2. Nitrate of Soda, growth small and badly mildewed.
" " 3. Sulphate of Ammonia, growth small and badly mildewed.
" " 4. Sulphate of Potash, growth fair, some mildew.
" " 5. Bone Black (Dissolved), growth fine, free from mildew.

In this crop the sulphate of ammonia seemed to have lost its force, while the bone black that is perhaps not so quickly soluble gave the best results, with sulphate of potash second. The crop treated with nitrate of soda in both cases gave the poorest results and had the most mildew, which may perhaps be accounted for by the fact that nitrate of soda has the power of absorbing moisture from the atmosphere, and the increased amount of moisture in contact with the leaves may have caused a more rapid development of mildew.

1889 AND 1890.

In the same houses was planted another crop in new soil with twelve plots, fertilized and unfertilized alternating. The following fertilizers were used :

		Scale of Excellence of Crop.
Plot No. 1.	Sulphate Potash,	5
" " 2.	Nothing,	3
" " 3.	Sulphate of Ammonia,	1
" " 4.	Nothing,	3
" " 5.	Nitrate of Potash,	2
" " 6.	Nothing,	3
" " 7.	Nitrate of Soda,	3
" " 8.	Nothing,	3
" " 9.	Muriate of Potash,	4
" " 10.	Nothing,	3
" " 11.	Bone Black,	6
" " 12.	Nothing,	3

In this scale 1 indicates the greatest perfection of growth.

EXPLANATION.

In the houses where the above was grown an attempt was made to grow carnations and lettuce at the same time and the result was that the temperature was kept too high for the lettuce, more or less mildew having developed on all of the plots, but where the fertilizer was most active there was much less, and in the first and last experiment, that treated with the sulphate of ammonia, and in the second test, the bone black, gave the best results.

TOMATO PLANTS.

When the second crop of lettuce was taken off, the soil was carefully worked over in such a manner as to leave that of each plot in its respective place, and tomato seeds were sown.

		Scale of Excellence of Crop.
Plot No. 1.	Sulphate of Potash,	2
" 2.	Sulphate of Ammonia,	3
" 3.	Nitrate of Potash,	4
" 4.	Nitrate of Soda,	6
" 5.	Muriate of Potash,	5
" 6.	Bone Black, (dissolved)	1

RESULTS.

In this test there was a very marked difference between the plants treated with bone black and those treated with nitrate of soda, the former being fully six inches higher at the time the comparison was made, and much more advanced toward blossoming.

PANSIES.

To compare the effects of muriate of potash with the sulphate, thirty-six plants of a choice strain of pansies were set in two beds and treated by mixing the fine fertilizer with soil so as not to bring it in contact with the leaves. The result is as follows:

Plot No. 1. Treated with Muriate of Potash gave 806 blooms.
Plot No. 2. Treated with Sulphate of Potash gave 1363 blooms.

CARNATIONS

WITH COMBINED FERTILIZERS.

To learn the best combination for the carnation 13 plots were made, each of 10 of the same kind of plants. Using four pounds ground bone to each plot mixed with a well enriched soil as a basis, other fertilizers were applied as follows:

Plot.			No. of Blooms.
No. 1.	½ lb. Muriate of Potash,	½ lb. Sul. Ammonia,	130
No. 2.	½ " "	½ lb. N. Potash,	124
No. 3.	½ " "	½ lb. N. Soda,	124
No. 4.	½ " "	½ lb. Bone Black (dissolved)	154
No. 5.	½ " "	½ lb. Dried Blood,	134
No. 6.	½ " "	½ lb. M. Potash (excess),	118
No. 7.	½ lb. Sul. Potash,		132
No. 8.	½ " "	½ lb. Sul. Ammonia,	163
No. 9.	½ " "	½ lb. Nitrate Potash,	110
No. 10.	½ " "	½ lb. N. Soda,	133
No. 11.	½ " "	½ lb. Bone Black (dissolved)	161
No. 12.	½ " "	½ lb. Dried Blood,	113
No. 13.	½ " "	½ lb. Sul. Potash (excess),	128

In this test, the Sulphate of potash with the Sulphate of ammonia gave the best results, closely followed by the same form of potash combined with bone black; with the latter, and Muriate of potash third, while the poorest results were from Sulphate and Nitrate of potash, Sulphate of potash and dried blood and Muriate of potash in excess.

GENERAL SUMMARY.

Summing up the results we find that of the nitrates the Nitrate of potash has given the best results, but that the Sulphate of ammonia gives better results than either, especially in the production of a foliage crop.

Of the potash salts the sulphates give better results than the muriate.

Bone black shows a marked effect in increasing the number of blossoms.

INJURY TO THE PEACH BUDS.

In New England the great question to be solved in the cultivation of the peach is the protection of the buds from injury from the cold during the winter.

To learn when the buds were destroyed, observations of their condition were made every week from Dec. 1st, 1889, to March 13, 1890, and at each observation 500 buds were cut open and examined. On Dec. 21st the first buds were found injured. On Dec. 28th, 6% had been destroyed. From this time up to Jan. 22nd, no larger per cent. was found to be injured, the lowest temperature up to this time being 11° above 0°. On the 23rd of Jan. the temperature dropped to 8° above 0°, and Jan. 25th to 7° above 0°, but the evidence of injury did not show itself until Feb. 1st, when 14% were found injured. This state of injury remained until March 27, when 52% were found destroyed. Then on March 7th the temperature dropped to 6° below 0° and held nearly at 0° the following night, after which about 80% of the buds were found to be injured. This was the average of all the varieties examined, but some were more injured than others, and at the time of blossoming the average remained about the same.

The following table may be of interest as showing the amount of blossoms that opened on each variety:

Amsden & Alexander,	89.5%	Mrs. Brett,	10 %
Coolidge Favorite,	30 "	Reeves' Favorite,	1 "
Crawford's Early,	2 "	Red Cheek Melocton,	25 "
Crawford's Late,	2 "	Sally Wond,	20 "
Excelsior,	90 "	Schumaker,	80 "
Foster,	2 "	Stump,	25 "
Hale's Early,	70 "	Waterloo,	75 "
Large E. York,	75 "	Wager,	30 "
Morris White,	15 "	Wheatland,	40 "
Old Mixon,	3 "		

PROTECTION OF PEACH BUDS.

After another year of earnest effort to find something to protect the buds from the effects of the cold we must again acknowledge ourselves baffled. We have demonstrated that large peach trees can be loosened at the roots and laid down on the ground for winter protection and be again set up successfully, but we have thus far failed in saving the buds. We shall continue our efforts and if any grower can suggest any way that offers even the slightest hope of success, we will carefully test it; for the peach tree can be grown successfully in all parts of Massachusetts, and if some means could be found to save the buds from winter's cold, peach growing would be a profitable industry, supplying our markets with one of the choicest and most healthful of fruits.

THE PLUM CURCULIO ATTACKING THE PEACH.

When the young peaches had reached the size of small hickory nuts they began to drop from the trees in great numbers, and upon careful examination it was found that every one contained the larvae of the plum curculio, or some species closely related.

This trouble has been reported to us from several localities and should receive prompt attention from all fruit growers.

The ordinary method of destruction upon the plum trees by jarring should be tried on young trees, and paris green upon large ones soon after the fruit has set. As the peach foliage is easily injured not more than one pound of paris green should be used to 300 to 400 gallons of water.

STRAWBERRIES.

The strawberry crop for the past year was very variable. Some varieties that gave great promise in previous seasons doing poorly, while many that gave little promise before were very good. On the whole the crop was good, the berries averaging larger than for two years but the quality was rather below the average.

The following tables, arranged on the scale of from one to ten, give the results of our test. 1 represents the greatest degree of perfection:

VARIETY.	Quality.	Order of blossoming.	Order of ripening.	Size.	Yield.	Amount of Fruit set June 14.	VARIETY.	Quality.	Order of blossoming.	Order of ripening.	Size.	Yield.	Amount of Fruit set June 14.
Ada	5	5	3	4	9	8	Katie	5	4	3	8	9	9
Arlington	7	5	6	6	4	7	Kentucky	4	3	5	4	7	6
Augur's No. 70	3	4	4	6	5	8	King of the Earliest	5	2	4	6	8	10
Belmont	3	5	8	4	4	6	Lady Rusk	6	2	5	4	8	3
Beseck	5	4	5	7	9	8	Lennig's White	2	4	5	9	10	6
Bidwell	4	5	5	4	10	5	Lida	4	5	7	7	6	6
Bomba	7	2	3	4	7	3	Long John	7	4	3	5	8	5
Bubach	6	4	1	5	2	1	Logan	6	3	5	6	5	5
Burt	6	4	3	4	4	2	Louise	4	3	6	5	8	8
Cardinal	5	4	6	6	9	7	MacMahon	6	4	7	5	9	9
Carmichael	5	4	3	6	5	7	Manchester	9	5	7	4	8	8
Champion	9	3	6	5	7	6	May King	2	3	5	7	5	5
Chas. Downing	4	4	3	6	9	5	Miami	3	2	5	5	9	4
Clara	8	8	6	4	9	9	Miner's Prolific	5	5	3	5	7	6
Clingto	7	2	3	4	5	1	Monmouth	4	8	2	6	8	8
Cloud's Seedling	9	5	3	5	5	4	Mrs. Garfield	6	7	3	5	8	7
Cornelia	7	7	3	3	7	7	Nigger	8	3	3	6	9	6
Corville's Early	8	6	2	6	9	5	Ohio	9	4	3	5	7	6
Crawford	5	3	4	4	10	9	Old Iron Clad	7	5	6	6	9	7
Crescent	10	6	3	6	6	6	Ontario	5	6	6	4	8	7
Crystal City	3	2	1	5	10	8	Parry	5	4	3	8	9	9
Daisy	4	8	3	5	9	10	Pearl	6	2	3	6	8	6
Daniel Boone	6	5	6	6	8	9	Photo	6	4	4	6	10	8
Emerald	8	4	7	5	9	10	Pineapple	3	3	4	4	10	8
Eureka	8	2	5	4	9	8	Pioneer	1	8	6	5	9	8
Eva	5	5	5	5	10	9	Piper's Seedling	7	7	3	5	8	9
Excelsior	7	2	4	5	10	9	Porter's Seedling	8	4	3	5	6	3
Farnsworth	4	3	4	6	6	9	Prince of Berries	5	7	7	5	8	8
Gandy's Prize	5	4	4	3	5	7	Puritan	4	9	10	4	10	10
Gipsy	6	3	5	5	8	6	Seth Boyden	4	5	6	5	10	10
Glendale	8	4	6	5	9	7	Sharpless	5	9	7	3	9	9
Gold	4	5	7	5	10	10	Stayman's No. 1	8	2	4	5	5	4
Golden Defiance	5	8	7	5	9	6	Stayman's No. 2	7	2	5	5	7	7
Great American	5	3	4	5	9	6	Sucker State	9	7	4	7	8	6
Hampden	5	2	5	4	8	7	Summit	8	6	7	8	7	10
Hatfield	6	4	4	6	8	7	Sunapee	8	5	3	8	7	7
Haverland	4	3	5	5	6	5	Tippecanoe	5	8	5	8	8	8
Henderson	1	7	5	7	9	10	Triumph de Gand	2	7	7	7	9	10
Hervy Davis	1	6	7	7	10	10	Viola	2	3	6	4	9	9
Hoffman's Seedling	4	4	5	5	8	3	Warfield	9	2	4	6	5	3
Howard's No. 5	3	2	4	4	7	6	Wilson	9	4	2	5	5	9
Howard's No. 6	4	3	6	9	4	8	Wood House	10	3	1	5	7	6
Indiana	5	7	4	4	3	1	No. 11 Seedling	8	3	5	7	6	3
Itaska	4	4	3	8	10	10	" 12 "	4	4	4	6	8	8
James Vick	8	2	5	6	9	9	" 23 "	2	1	1	10	9	9
Jersey Queen	3	8	3	5	8	3	" 24 "	4	4	4	4	9	8
Jessie	4	3	4	4	8	5	" 28 "	3	7	5	7	4	4
Jewell	4	4	7	2	7	8	" 29 "	5	3	2	5	8	7
Jumbo	6	5	3	6	8	9							

REMARKS.

Space will not allow of extended remarks on all the varieties of promise that have been tested, but we will mention some of the most desirable.

Augur's No. 70, (Middlefield). This variety is very vigorous in growth producing large berries of perfect form and color. It is only of fair quality, but far superior to the Crescent class, and moderately productive. Another season is needed to fix its value, either for market or home use.

Belmont. A superb berry, but requires high culture, under which conditions it is profitable. The quality is good.

Bubach. This promises to be the most profitable variety. The plant is vigorous, having large, finely formed berries. It is very productive and as yet entirely free from rust. Quality only medium, but far better than the Crescent, Wilson or Warfield.

Gandy. For home use and a fancy market this variety is valuable on account of its large size and good quality and lateness in ripening, but it yields only a small crop.

Haverland. A variety of fine color, form and quality but seems deficient in vigor.

Jessie. Of fine quality and large size, but only moderately productive.

Warfield. Immensely vigorons and productive of medium sized berries, possessing a large amount of acid. The color and form is good, but on account of its size and the predominance of acid it will not be a general favorite in our markets. In quality it is equal to the Crescent and equally productive.

STRAWBERRIES IN HILLS.

The summers of 1888 and 1889 were so wet as to produce weeds in large quantities in most strawberry fields and the crop of weeds the past season has been so abundant that we can only conclude that clean cultivation was the exception rather than the rule.

We believe this condition of things can be remedied by growing the strawberry in hills, and that the crop would be much superior in size and quality, that the cost of thorough cultivation would be less, and that there would be less of the deterioration in varieties, than at present if the hill system were practiced.

To grow strawberries or any other fruit profitably, the labor of cultivation must be done in the most thorough and economical way. We now have cultivators and horse hoes by which cultivation of the soil can be done close up to small plants without injury and the removal of all runners can be quickly effected by running the wheel edge grass shears both ways of the rows. Even by hand, the expense cannot be much more than that of pulling out the small weeds from between the runners after they have so spread that the cultivator or hoe cannot be used, i. e. from Sept. 1st, to Nov. 1st. Another advantage of the hill system is that the soil can be more thoroughly stirred close up to the plant, which cannot be done if the runners are matted together.

It is hoped that growers who have practiced hill culture of the strawberry will give the results to the public, and that others may make a careful comparative test of the two systems. During the present season one half of each experiment plot has been grown in hills while the other is in the matted row. We hope to report the results next summer, and the comparative yield of each variety under both systems.

RASPBERRIES AND BLACKBERRIES.

The following varieties of raspberries have fruited this season, the results of which are given in the the following tables:

NAMES OF VARIETIES.	Quality.	Size.	Yield.	Amt. of Fruit Set.	Order of Blooming.	Order of Ripening.	No. of tenths of Canes winter-killed.
Belle de Fontaine	7	5	10	7	2	2	7
Brandywine	1	5	9	6	5	3	4
Caroline	2	5	3	3	5	4	1
Crimson Beauty	3	5	8	4	2	4	3
Crystal White	7	5	10	10	7	3	6
Cuthbert	8	3	5	1	6	6	1
Golden Queen	8	3	4	1	6	5	3
Hansel	2	3	5	2	5	1	5
Hastine	3	7	10	10	3	2	6
Highland Hardy	1	5	8	6	1	1	5
Marlboro	8	2	5	1	1	1	1
Rancocas	1	6	7	5	2	1	3
Scarlet Gem	4	4	9	10	2	1	0
Stayman's No. 5.	5	5	10	7	4	7	0
Superb	5	3	8	5	7	3	4
Thompson's Early Prolific	6	7	9	2	6	1	6
Thompson's Pride	4	5	7	8	3	1	1
Turner	4	7	5	4	2	4	0
White Mountain	4	4	10	10	6	3	4

The crop has not been large the past season owing to drouth in July, but it was of good quality and almost totally uninjured by long or frequent rains as in some previous years.

REMARKS.

Of the very new varieties the yield of fruit was not sufficient to enable us to judge fairly of their merits for market or home use. Of the older varieties the

Hansel was the first to ripen. The fruit is medium in size, of fine color and quality and moderately productive, especially valuable for home use.

Marlboro. This variety has again (under good cultivation) proved very profitable for market. The berry is very large, of light color, is firm and very productive. It is not of as good quality as the Hansel or the wild red raspberry but is a sweet berry of fair quality.

Cuthbert. While this is not a first class berry in quality, its vigor, size and productiveness makes it the most reliable raspberry for market or home use.

BLACK-CAP RASPBERRIES.

Owing to the wet weather of last year the *Anthraxnose** developed in large quantities on the canes and so injured them that in many localities the crop has been much less than in previous years, but prices ruled higher and the amount of money received from the crop has probably been up to the average.

Young plantations are not as liable to this disease as those that have fruited several years.

The following table gives the comparative merits of the different varieties :—

*Anthraxnose is a disease caused by a parasitic fungus growth on the canes near the ground. It appears in round dark brown or reddish patches, sometimes completely covering the cane and destroying it.

NAMES OF VARIETIES.	Quality.	Size.	Yield.	Amt. of Fruit Set.	Order of Blooming.	Order of Ripening.	No. of tenths of Canes winter-killed.
Ada	5	7	8	7	8	5	2
Carman	4	2	4	5	1	1	4
Cromwell	5	1	3	9	1	1	5
Crawford	4	3	5	3	4	6	2
Carhart	6	3	4	6	2	1	1
Gregg	8	2	6	4	3	5	3
Hale's Early	4	4	10	8	2	3	1
Hilborn	5	4	6	1	3	1	3
Naomi	3	2	9	6	4	1	3
Nemeha	7	1	3	1	4	6	2
Ohio	8	2	6	2	1	1	1
Palmer	5	5	9	9	3	2	0
Shaffer's Colossal	3	2	2	2	10	9	6
Springfield	2	4	7	3	1	1	3
Thompson's Sweet	2	3	9	4	6	4	1

BLACKBERRIES.

It is often a wonder to those who know the valuable qualities of the blackberry, and how easily it is grown that it is in so little demand for market and home use. It will thrive on the poorest soil with proper cultivation, the suckers may be easily kept from growing between the hills or rows by the plow, and it requires but little time and skill to so train and prune that the bushes may be kept in a compact form.

The following table gives the results of the varieties tested:

NAMES OF VARIETIES.	Quality.	Size.	Yield.	Amt. of Fruit Set.	Order of Blooming.	Order of Ripening.	No. of tenths of Canes winter-killed.
Agawam	1	5	4	1	1	1	3
Early Cluster	4	5	8	2	10	3	3
Early Harvest	8	6	9	2	8	1	3
Early King	5	6	10	6	10	4	1
Erie	7	1	3	1	10	4	2
Fred	7	5	9	9	6	8	0
Lucretia*	5	4	7	1	3	1	4
Minnewaski	7	2	6	3	10	1	0
Snyder	9	5	4	3	1	4	1
Stone's Hardy	8	4	7	4	2	4	0
Taylor's Prolific	3	4	3	1	10	6	2
Thompson's Mammoth	6	4	10	10	10	4	2
Wachusett	3	6	5	2	4	4	2
Western Triumph	5	3	9	5	10	7	3
Wilson's Early	8	2	4	1	6	3	2
Wilson Jr.	8	3	6	3	6	2	2

*Being a variety of the running Blackberry or Dewberry this ripened more than a week before the Agawam.

Agawam. This is early, productive and of the finest quality. Its medium size is the only objection to it, but unless the larger varieties like the Erie and Minnewaski shall prove hardy and productive, this is by far the most satisfactory variety for market or home use.

Erie. The fruit is of large size, fine form and fair quality. Thus far it has proved hardy and fairly productive. It promises to be very valuable.

Minnewaski. Similar to the Erie and equally promising.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 11.

Report on Strength of Rennet.

Report on Hay Caps.

Report on Flandres Oats.

Report on Prevention of Potato Rot.

Report on Fungicides and Insecticides on Fruits.

JANUARY, 1891.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE
1891.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
HERBERT E. WOODBURY, .	" "
FRANK O. WILLIAMS, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Agriculture.

William P. Brooks.

CONDITIONS AFFECTING THE STRENGTH OF THE STOMACH OF THE CALF FOR RENNET.

The investigation the results of which are stated in the following pages, was undertaken soon after the inauguration of work in the Agricultural Department of this Station, with the object of determining primarily the influence, if any, of length of time after eating upon the strength of the calf's stomach as a rennet. As the stock upon our own grounds was all pure bred and the calves therefore valuable for raising, it was considered best to purchase animals as opportunity offered from farmers in the neighborhood; and it was further decided to take them directly from the farms where purchased to the place of slaughter, a butcher's establishment near our station. It may be thought that an element of uncertainty as to conditions was thus introduced; but it is not thought that such was the case, for the calves were in all cases looked up by my assistants some time before slaughter, and the conditions under which, and the time when an animal would be taken explained. Every calf was taken from the farm to the butcher's by the assistant who was in all cases present when it was slaughtered, and superintended the taking of the rennet, which was immediately carried with all its contents (both ends being tied) in a clean covered pail to the laboratory. This work in 1889 was done by Mr. F. S. Cooley, and this year by Mr. F. O. Williams, Assistant Agriculturists respectively in these years. The description of the laboratory management by the chemist, Dr. C. A. Goessmann, is here inserted:

"The rennets, as soon as received, were emptied, turned inside out, and cleaned by placing in a large dish of water and allowing it to float therein for a few moments. In no case was water forced into the stomach, but particular care was taken to perform the washing as gently as possible, to prevent the loss of the delicate lining membrane which contains the curdling principle.

The stomachs were then reversed, filled with air to their full capacity and hung up to dry in a well ventilated room.

All the rennets received were successfully cured except No. 4, which was so badly cut that it was impossible to stretch it properly and it partially spoiled. It was sprinkled with salt to prevent further decomposition. A considerable portion remained sound and this served for the test recorded below.

Before the tests were made the rennets were taken down, stripped of fat and worthless parts and cut into small strips. In this condition they were spread out in a well ventilated room and allowed to air dry several days.

The rennet solutions were prepared by the Blumenthal process. In every case the same weight of rennet was taken and the final solution raised to the same volume, great care being taken to secure, as far as practicable, identical conditions in all cases. The results were obtained with fresh whole morning's milk."

While, as previously stated, the primary object was to determine the influence of the length of time between the last meal and slaughter upon the strength of the rennet: it was decided also to note the influence, if any, of age and breed: and averages designed to bring out differences due to those peculiarities will be later given. In respect to breed, however, it should be stated that all were grades. The individual proportion of the blood of the breed, under which an animal appears is a variable and in many cases an uncertain quantity. No attempt is made to state it.

I am aware of the fact that these averages are less satisfactory than they would be were the number of each breed, and of each age in each breed identical in each of the classes compared; and it was the original intention to continue the work until five animals of each age in each breed had been included; but in view of the fact that the work thus far done indicates chiefly a wide individual variation apparently without reference either to feeding, breed or age, it is not deemed best to continue the work. The individual differences within the classes are far greater than the differences between classes.

On similar grounds the results for breeds and for animals of different ages are not entirely satisfactory. All other conditions except the particular under comparison are not alike in each class, still it is deemed best to publish the results as they are and to discontinue the work as it does not promise to be sufficiently valuable to warrant its continuance.

The results of the laboratory examination of the rennets with particulars of age, breed, etc., are shown in the following tables:

CALVES SLAUGHTERED 1 HOUR AFTER EATING.

No.	Breed.	Age in Days.	Date of Slaughter.	Date of Rennet Test	Moisture per cent.	Parts of Milk at 37° C., curdled by 1 part of Rennet in 10 minutes. Air Dry.	Water free.
			1889	1889			
1	Holstein	29	Apr. 25	Sept. 4	7.20	7300	7974
4	Shorthorn	5	May 17	Sept. 4	7.56	10500	11359
5	Jersey	5	May 22	Sept. 4	7.80	28600	31019
				1890			
9	Holstein	5	Sept. 21	Jan. 27	6.75	25380	27217
8	Shorthorn	30		Jan. 27	6.17	18600	19823
17	Hereford	37	Oct. 29	Feb. 3	7.11	13620	14663
			1890				
20	Jersey	42	April 28	Nov. 12	7.60	10400	11255
28	Jersey	5	Aug. 30	Nov. 14	10.23	33300	37092
29	Jersey	5	Sept. 10	Nov. 17	7.76	36360	39418

AVERAGE: Air-dry, 1 part rennet to 20451 parts milk. Water free, 1 part rennet to 22091 parts milk.

CALVES SLAUGHTERED 5 HOURS AFTER EATING.

No.	Breed.	Age in Days.	Date of Slaughter.	Date of Rennet Test	Moisture per cent.	Parts of Milk at 37° C., curdled by 1 part of Rennet in 10 minutes. Air Dry.	Water free.
			1889	1889			
6	Shorthorn	30	June 13	Sept. 11	8.50	11800	12896
7	Shorthorn	42	June 21	Sept. 11	7.72	20000	21673
				1890			
10	Holstein	5	Sept. 26	Jan. 28	7.60	15090	16331
11	Jersey	5	Oct. 5	Jan. 28	8.56	17570	19215
13	Hereford	35	Oct. 22	Jan. 29	6.19	23200	24731
15	Shorthorn	35	Oct. 26	Feb. 3	5.20	14810	15622
16	Hereford	42	Oct. 26	Feb. 3	6.52	18600	19897
18	Holstein	28	Nov. 11	Feb. 3	7.63	19740	21371
			1890				
19	Jersey	5	Apr. 12	Nov. 12	9.85	39000	43261
21	Holstein	5	July 7	Nov. 12	9.91	32000	35520
22	Holstein	5	July 7	Nov. 12	9.09	19000	21993
30	Jersey	42	Sept. 10	Nov. 17	8.99	25000	27469

AVERAGE: Air-dry, 1 part rennet to 20484 parts milk. Water free, 1 part rennet to 23315 parts milk.

CALVES SLAUGHTERED 18 HOURS AFTER EATING.

No.	Breed.	Age in Days.	Date of Slaughter.	Date of Rennet Test	Moisture per cent.	Parts of Milk at 37° C., curdled by 1 part of Rennet in 10 minutes. Air Dry.	Water free.
			1889.	1889.			
2	Holstein	29	Apr. 30	Sept. 4	7.47	14300	15454
3	Shorthorn	5	May 4	Sept. 4	7.45	14800	15991
				1890.			
12	Holstein	5	Oct. 9	Jan. 29	6.74	18600	19944
14	Hereford	35	Oct. 22	Jan. 30	7.24	19740	21281
			1890.				
23	Holstein	5	July 18	Nov. 14	10.12	47000	53404
24	Jersey	28	July 18	Nov. 14	8.35	33300	36549
25	Holstein	42	July 26	Nov. 14	8.17	16000	17424
26	Holstein	42	Aug. 8	Nov. 14	8.86	14000	15251
27	Holstein	42	Aug. 15	Nov. 14	8.26	14300	15696
31	Jersey	42	Sept. 26	Nov. 17	8.08	30800	33616
32	Holstein	42	Sept. 26	Nov. 17	9.42	30800	34113

AVERAGE: Air dry, 1 part rennet to 23058 parts milk. Water free, 1 part rennet to 25338 parts milk.

CALVES SLAUGHTERED 30 HOURS AFTER EATING.

No.	Breed.	Age in Days.	Date of Slaughter.	Date of Rennet Test	Moisture per cent.	Parts of Milk at 37° C., curdled by 1 part of Rennet in 10 minutes. Air Dry.	Water Free.
			1890.	1890.			
33	Jersey	28	Oct. 10	Nov. 17	10.00	17400	19333
34	"	42	Oct. 10	Nov. 17	9.67	8300	9188

AVERAGE: Air-dry, 1 part rennet to 12850 parts milk. Water free, 1 part rennet to 14261 parts milk.

These results indicate a progressive increase in the strength of the rennet due to fasting in the three classes from one hour up to eighteen. The average number of parts of milk curdled by one part of water free rennet is: after one hour's fast, 22,091; after five hours, 23,315, and after eighteen hours, 25,338. The number of animals fasted thirty hours is too small to justify any comparison. The average for one part of water free rennet is 14,261 parts of milk. This though smaller than any other average is larger than the average of the first two animals in the first class and does not differ very materially from similar averages in the other two classes. We are not, therefore, justified in concluding that a fast of thirty hours is prejudicial to the strength of rennets.

The average amount of milk curdled by one part of water free rennet from the animals of the different breeds is as follows: Jersey, 27,945; Holstein, 22,665; Hereford, 20,143, and Shorthorn, 16,348. These figures appear to indicate a considerable difference in strength of rennet due to breed; and although the numbers of the different ages and for different lengths of fast in the breeds compared are not identical, yet it is not believed any injustice is done to either breed in respect to these points. This is made evident from the following tabular view showing the standing of the breeds in these respects. It will be seen that they are fairly well distributed as to length of fast and age.

LENGTH OF FAST.	JERSEY.	HOLSTEIN.	HEREFORD.	SHORTHORN.
1 hour	4	2	1	2
5 "	3	4	2	3
18 "	2	7	1	1
30 "	2			
AGE IN DAYS.				
5 days.	5	6		2
28 to 30 "	2	3		2
35 to 42 "	4	4	4	2

The differences within each of the breeds, as may be seen by reference to the tables indicating the strength of the rennets, are, however, larger than the difference between the breeds. Thus the extremes for Jerseys are 9188 and 43261; for Holsteins, 7974 and 53,404; for Herefords, 14,663 and 24731, and for Shorthorns, 11,359 and 21,673. Further, the average for the lowest five Jerseys is 17,292; for the highest six it is 36,826. The latter is more than twice the former, thus exceeding it in far greater proportion than this breed appears to excel the Shorthorn, which stands as the lowest breed. Similar averages in other breeds will show about equally great variations. It must be concluded, therefore, that our results are not such as to warrant any positive deductions as to differences in rennet strength due to breed.

The averages for the different ages are as follows: *Parts milk coagulated by one part water free rennet:*

From Calves	5 days old,	28,597.
" "	28 to 30 " "	19,057.
" "	35 " "	19,084.
" "	42 " "	20,558.

The range for these ages is as follows: For calves 5 days' old, 11,359 to 53,404; 28 to 30 days' old, 7974 to 36,549; 35 days' old, 14,663 to 24,731, and 43 days' old, 9188 to 34,113. Thus it appears that in each class there is a greater difference between the lowest and the highest than between the lowest and the highest classes. We must be cautious then, in drawing deductions from these figures; but it seems not unreasonable to conclude that the rennet is strongest in the calf under one week old, as indicated by the above averages.

Conclusions. First: Individuality appears to be the strongest factor in determining the strength of the rennet.

Second: Our average results indicate that fasting up to eighteen hours increases the strength of the rennet; but the variations in each class are so large that we are not warranted in considering our experiments a proof of the fact.

Third: That breed influences the strength of the rennet has not been established; though averages show a considerable variation which places those compared in the following order: Jersey, Holstein, Hereford and Shorthorn.

Fourth: The rennet of the calf under one week old is apparently stronger than that of an animal four weeks or more old.

TREATMENT OF POTATOES WITH LIME FOR THE PREVENTION OF ROT.

When our potatoes, after being dug, were found to be rotting badly, it was determined to try sprinkling thoroughly with lime, a method of treatment often advised. With this object in view four samples of a bushel each, of apparently sound tubers were selected from a pile which was rotting badly. These were placed in bushel baskets, and two baskets were put into a dry cellar and two into a well lighted and dry granary. The tubers put into one basket in each lot were thoroughly sprinkled with air-slaked lime, as they were put in; the other basket was untreated. This work was done on Sept. 17th; and the tubers remained undisturbed until Dec. 3d, when they were carefully examined. The results are shown in the following table:

TREATMENT WITH LIME FOR POTATO ROT.

	Potatoes kept in Cellar, Sept. 17th to Dec. 3rd.					Potatoes kept in Granary, Sept. 17th to Dec. 3rd.				
	Lime Used, lbs.	Total Weight, lbs.	Sound Tubers, lbs.	Soft Rot, lbs.	Dry Rot, lbs.	Lime Used, lbs.	Total Weight, lbs.	Sound Tubers, lbs.	Soft Rot, lbs.	Dry Rot, lbs.
Limed,	6	$55\frac{3}{4}$	$40\frac{3}{4}$	$8\frac{1}{2}$	6	4	$54\frac{1}{2}$	$42\frac{1}{4}$	$4\frac{1}{4}$	$7\frac{3}{4}$
Untreated,		53	40	$6\frac{1}{4}$	$6\frac{1}{4}$		$55\frac{3}{4}$	40	$5\frac{1}{4}$	$10\frac{1}{4}$

Conclusions: The differences in the amount of rot are very small. In the case of the cellar samples, the tubers untreated have kept slightly better than those which were limed; in the granary samples, the difference is in favor of liming. We are not justified in pronouncing either for or against the treatment.

It appears to me not unlikely that the quantity of lime used was too small, and when opportunity offers, the experiment will be repeated with varying amounts of this substance.

VARIETY TESTS OF OATS.

The seeds for these tests were sent on by the U. S. Department of Agriculture, with the request that we give them a trial. They arrived much too late in the season for planting, (May 21st) as was recognized by the Department officials, who, never-the-less, urged that we try them. All the seed received was sown May 24th, upon a medium loam, which had been in grass and pastured for three years, and which was in a fair state of fertility. It was ploughed in early spring and just before seeding it received at the rate of nitrate of soda, 160 lbs.: dissolved bone, 240 lbs.; and muriate of potash, 160 lbs. per acre spread broadcast and harrowed in. The seed was sown broadcast and harrowed in.

DES FLANDRES OATS.

The seed (9 qts.) was sown as above described upon one-fifth of an acre. The blades appeared above gronnd June 1st, growth was fair until about the time of blossoming when the crop became considerably rusted. It was cut and stooked Sept. 2d, and threshed in good condition Sept. 10th. It yielded 34 quarts of light oats and 270 lbs. straw.

JAUNE (yellow) DE FLANDRES OATS.

The seed (7 qts.) of this variety was sown upon one-seventh of an acre. Germination, growth and rust as in the first variety. It was harvested and threshed on the same dates, and yielded 28 quarts light oats and 250 lbs. straw.

Conclusions: No particular difference between the varieties was noticed. The crop of both was, of course, miserably small; but from the lateness of the season when they were planted, it would be unfair to compare them with common and standard sorts. Any variety would probably give a light crop planted as late as these were; and further it is pertinent to add that the past season was a very poor one, even for early planted oats in this section of the state. Rust in the early stages of the growth of the crop was very abundant.

COMPARATIVE TEST WITH HAY CAPS.

It was the purpose of the station to make an extended series of comparative trials of a few varieties of hay caps, during the past season; but the season was almost unparalleled in its freedom from rain and but a single opportunity to try the caps was afforded. The caps tried were of three varieties, viz.: Cotton caps untreated with any preparation for water-proofing; cotton caps, oiled; and "Symmes Patent Hay and Grain Cap," which is made of wood pulp and apparently oiled. This cap is stiff and in shape like a well flared bowl (spread 56 in. depth 18 in.) with fluted sides. There are eyelets in the edge; but it is claimed thatthis cap needs no fastening on. It is further claimed that its peculiar (fluted) form allows ventilation and that partly cured hay is less likely to heat under it than under ordinary water-proof caps.

The grass which was used for this test was cut on the morning of July 14th; it was nearly cured when cocked in the afternoon, and as the weather was threatening, a number of cocks were covered with each of the three kinds of caps, the cotton ones being held in place with wooden pins in the ordinary way. On the 15th, there was a thunder shower, the amount of precipitation being .03 inches. On the morning of the 16th, the caps were removed and the following observations recorded:

Plain Cotton Caps. Hay underneath slightly moist on top and in good condition below, having heated to a very slight extent only.

Oiled Cotton Caps. The caps themselves were very wet on both sides; hay at the top also quite wet, and just below, almost too hot to handle; heat extends nearly to the bottom of the cock.

"*Symmes' Patent Caps.*" Hay moist on top, and a little lower hot; but not as hot as under the oiled caps.

Conclusions. The condition of the hay under the plain cotton cap (heavy material) was decidedly the best; but it is recognized that with a heaver rain this might not be found to be the case. The "Symmes" caps are easily put on; but they are clumsy and heavy and to carry a quantity to a field and distribute them, requires far more labor than for the cotton caps. We used them somewhat during the season of 1889 and did not find them durable, nor sure to remain in place during strong winds. From our single test, the plain heavy cotton cap appears to be best. This experiment will be continued as opportunity allows.

Division of Horticulture.

Samuel T. Maynard.

Another season has demonstrated how dependent we are for profitable crops upon the absence of fungous diseases and injurious insects, and the necessity of safe and easily applied remedies. The apple crop though small would have been a very valuable one in Massachusetts but for the ravages of the codling moth and the appple scab, which have rendered thousands of barrels worthless. The pear crop has been seriously injured by the codling moth and pear or apple scab. The plum crop was almost a total failure on account of the ravages of the plum curculio and the black wart.

The grape crop, although on the whole one of the best ever harvested in New England, was in many sections seriously injured by the grape rot which injured the fruit, and the mildew which destroyed the foliage or so injured it as to retard ripening.

It is the belief of many practical fruit growers and market gardeners that from one-third to one-half of the entire products of the orchards and gardens of the state are destroyed by insects and fungous diseases.

During the season of 1889 experiments were carried on with fungicides and insecticides, the results of which were reported in Bulletin No. 7. Again the past season more extensive tests have been made which have given more marked results than those of 1889.

FUNGICIDES AND INSECTICIDES ON THE APPLE, PEAR AND PLUM.

For the past three seasons the apple scab (Fusicladium dendriticum) and the codling moth have rendered the small crop of apples in most parts of New England almost a total failure. The remedies suggested for the first, that of solutions of copper ,have been favorably reported upon in various sections of the country, while after the use of many suggested remedies it has become the general opinion among fruit growers that we must depend upon arsenical poisons to destroy insect pests. Both of these remedies are best applied in water, and as the expense of application must be reduced to the minimum the use of the two remedies combined seemed advisable. For this reason a series of experiments was undertaken to test the value of the various forms of copper solutions combined with Paris green (London purple having been found more injurious to the foliage of plants than Paris green, and white arsenic being thought too dangerous on account of its inconspicuousness.)

EXPERIMENT NO. I.

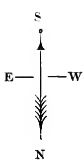
AMMONIACAL CARBONATE OF COPPER AND PARIS GREEN.

Formula:—3 oz. precipitated carbonate of copper dissolved in 1 qt. aqua ammonia (22° Baume) diluted with 28 gallons of water and one pound of Paris green to 500 gallons of the mixture.

The following diagram will illustrate the arrangement of the plots:

DIAGRAM OF PLOTS.

No. 1	o Anjou o Anjou o Bartlett o Clapp's	No. 1	o R. I. Greening o Baldwin
No. 2	o Anjou o Anjou o Bartlett o Clapp's	No. 2	o R. I. Greening o Baldwin
No. 3	o Anjou o Anjou o Bartlett o Clapp's	No. 3	o R. I. Greening o Baldwin
No. 4	o Anjou o Anjou o Bartlett o Clapp's	No. 4	o R. I. Greening o Baldwin
No. 5	o Anjou o Anjou o Bartlett o Clapp's	No. 5	o R. I. Greening o Baldwin [Small, no fruit.]



Mode of application.

The mixtures used in these experiments were applied with a "Field Force Pump" with a "cyclone" nozzle. This pump is strongly made and has stood the use of two summers very well. It was attached to a cask holding about 50 gallons. This was fastened to a stone-boat so as not to rock or roll, and when used was drawn about among the trees by one horse. This seems a better arrangement than to place the cask on a wagon, as it can be drawn in among closely planted trees and vines.

It required two men to work it, one to do the pumping and the other to direct the spray. To reach all parts of the tree without much loss of the liquid, the nozzle was attached to a pole about ten feet long.

When the Bordeaux mixture was used with this pump it was found necessary to strain the liquid to take out the coarse particles of lime, which clogged the nozzle and rapidly wore out the packings of the pump. Applications weie made as follows:

April 24th. Sprayed branches of trees in Plots Nos. 1, 3 and 5 with carbonate of copper solution. Plots Nos. 2 and 4 containing the same kind of trees were left as a check on the experiment.

This it will be observed was before the leaves were unfolded, the object being to destroy any spores at that time on the branches.

May 17th. Sprayed with Paris green, 1 lb. to 500 gallons of water.

As the Fusicladium (apple scab) was supposed not to develop until after the fruit was set, only Paris green was used for the purpose of destroying the codling moth.

May 21st. The application of May 17th was repeated as a heavy rain occurred on the previous day, May 20th.

May 29th. As the foliage was found very seriously injured, a precipitate of carbonate of copper was obtained of Prof. Charles Wellington from the college laboratory, which was thought to be a little less acid. The solution made from this is designated A. 1., while that made from the carbonate of copper obtained in the market is A. 2. Plots 1 and 3 were sprayed with A. 1., and Plot 5 with A. 2. Both were used with the ammonia and Paris green as per formula.

June 7th. Repeated spraying as on May 21st on the same plots.

June 17th. Sprayed apple trees in Plot No 5 with mixture A. 1. and pear trees in same plot with A. 2.

July 1st. Plots No. 1 and No. 3, apple sprayed with A. 2. Plots Nos. 1 and 2, pear sprayed with mixtuie A. 2.

July 31st. Sprayed both apple and pear trees in Plots No. 1 and No. 3 with A. 2; and Plot No 5 with mixture A. 1.

In the following table giving the results the pears are left out, as the trees fruited so unequally it was impossible to make any comparison. The foliage, however, was seriously injured upon all of the pear trees as well as the apple trees.

This injury was especially noticeable during moist cloudy weather from June 12th to the 24th, in which time many light showers occurred which, with the cloudy weather kept the foliage almost continually wet. No difference was noticed as to the amount of injury from solutions A. 1. and A. 2.

NAMES OF VARIETIES.		Total Fruit.	Number Good.	Number Wormy.	Per cent. Wormy	No. free from Scab.	Badly Scabby.	Slightly Scabby.	Per cent Badly Scabby.	Per cent Slightly Scabby.
No. 1	Greening	343	189	154	45	266	7	70	2	20
	Baldwin	1666	1197	469	28	1431	4	231	3	14
No. 2	Greening	172	17	155	90	148	2	22	1	13
	Baldwin	580	183	397	68	396	7	177	1	31
No. 3	Greening	382	287	95	25	328	10	44	3	12
	Baldwin	215	82	133	62	164	5	46	2	21
No. 4	Greening	177	15	162	92	144	3	30	2	16
	Baldwin	349	50	299	86	239	2	108	7	31
No. 5	Greening	102	49	53	52	54	4	44	4	43
	*Baldwin									

*Tree small, no Fruit.

RESULTS.

It will be seen by comparing the per cents given in this table that in Plot No. 1 which was treated there was only 38% of wormy apples, while in Plot No. 2 which was not treated there was 79%, and taking the average of the three plots treated we have only 43% of wormy apples where the applications were made, while in the plots untreated we have 84%, a saving of 41% by the use of the Paris green.

The use of the fungicide, however, has given us no results, although the same solution applied without the Paris green is reported to have given remarkable results at other stations the previous season.

EXPERIMENT NO. 2.

BORDEAUX MIXTURE AND PARIS GREEN.

Formula:—6 lbs. of Copper Sulphate dissolved in 16 gals. of water, to which is added 4 lbs. of fresh lime slacked in 6 gallons of water. To this mixture add Paris green in the proportion of 1 lb. to 500 gals.

To test the efficacy of the above mixture combined with Paris green, three large trees were selected that had blossomed abundantly, and one-half of each tree was carefully treated.

Several applications were made, beginning May 29th, at intervals of about two weeks, varying more or less with the condition of the weather.

In the following table are given the results:

NAMES OF VARIETIES.		Total Fruit.	Number Good.	Number Wormy.	% Wormy.	Number Free From Scab.	Badly Scabby.	Slightly Scabby.	% Badly Scabby.	% Slightly Scabby.
Red Russet,	1-2 Sprayed,	311	117	194	62	13	60	238	19	76
Red Russet,	1-2 Unsprayed,	711	424	287	40	392	81	238	11	61
Red Astrachan,	1-2 Sprayed,	405	365	40	10	73		332		82
Red Astrachan,	1-2 Unsprayed,	258	208	50	19	108		150		58
Roxbury Russet,	1-2 Sprayed,	979	469	510	52	730	44	205	5	21
Roxbury Russet,	1-2 Unsprayed,	913	541	372	41	631	31	251	3	27

RESULTS.

In this experiment no favorable results were obtained, either in the use of the Paris green or the Bordeaux mixture. This may be due in part to the lateness in the season when the tests began, but it is thought best to make record of the work for future reference and comparison with the results of others.

EXPERIMENT NO. 3.

AMOUNT OF INJURY TO FOLIAGE BY DIFFERENT PERCENTAGES OF PARIS GREEN.

In the experiments of previous years much injury had been done by the Paris green in burning the foliage. Similar reports were also received from other stations and the following experiments were instituted to determine, if possible, the quantity that might safely be used. For this purpose seven trees were selected.

No's 1, 2 and 3 of the variety known as Westfield-seek-no-further, No's 4 and 5, R. I. Greening and No's 6 and 7, Natural Fruit.

To No. 1 was applied the ammoniacal carbonate of copper mixture, as given in the previous formula, with 1 part of Paris green to 200 of the mixture.

To No. 2 was applied the same copper solution and 1 lb. of Paris green to 300 parts of the mixture.

No. 3. Check tree.

To No. 4 was applied the ammoniacal carbonate of copper solution and 1 lb. of Paris green to 400 gals. of the mixture.

No. 5. Check tree.

To No. 6 was applied a mixture composed of one ounce of carbonate of copper, 4 lbs. of quick lime and 22 gallons of water. With this mixture Paris green was used in the proportion of 1 lb. to 500 gallons.

To No. 7 was applied simply the ammoniacal carbonate of copper solution without any Paris green.

The above trees were sprayed May 29th, June 7th, June 17th, July 1st and July 31st. The last time no Paris green was used. The results are shown by the following table.

NAMES OF VARIETIES.	Total Fruit.	Number Good.	Number Wormy.	% Wormy.	Number Free From Scab.	Badly Scabby.	Slightly Scabby.	% Badly Scabby.	% Slightly Scabby.
Westfield Seek-no-further, No. 1,	992	823	169	17	925	4	63	1-2	6
Westfield Seek-no-further, No. 2,	591	418	173	29	509	5	77	1	13
Westfield Seek-no-further, No. 3*	519	198	321	62	335	7	177	1	34
Greening, No. 4,	2208	1524	684	31	1779	37	392	2	17
Greening, No. 5,*	2437	1071	1466	60	2130	102	205	4	8
Natural Fruit, No. 6,	1746	1052	694	40	1431	16	299	1	17
Natural Fruit, No. 7,*	260	30	230	88	239	1	20	1-2	7

*Check trees.

RESULTS.

Again the same results with the Paris green are obtained, as in the first experiment, reducing the injury from the codling moth to $29\frac{1}{4}\%$, while where no Paris green was used the per cent of wormy fruit was 70.

No beneficial results were obtained from the use of carbonate of copper or Bordeaux mixture. In fact, in every case the amount of scab is larger where the fungicides were used than where not used.

This result may be in part due to the injury resulting from the Paris green, which was especially noticeable where it was used at the rate of 1 lb. to 200 and 300 gallons of the liquid.

Where 1 lb. of the Paris green was used to 500 gallons of liquid, little or no injury to the foliage was noticed.

The effects of the above injury to the foliage must be to seriously weaken the vigor of the tree and it is probable that the scab fungus, under the same conditions of moisture and temperature, would develop most rapidly where the trees have the less vigor.

EXPERIMENT NO. 4.

KEROSENE FOR THE PLUM WART.

For several years past experiments have been made in this division to find a remedy for the plum wart (Plowrightia [Sphoeria] morbosa) and we have reported in previous bulletins on the efficacy of kerosene.

The past season a more extensive use of this remedy has been made and we are able to report our trees which have been treated, as almost entirely free from this pest.

In its application we have found that unless used with great care, the smaller branches were destroyed. The past season we have overcome this difficulty by applying the kerosene mixed with some pigment to form a thin paste so that it would not spread over the branches. If some bright colored pigment be used for this purpose it enables the person making the application to see at a glance, whether the wart has been previously painted or not and whether the remedy has been effectual.

When applied in the earlier stages of growth the wart is stopped at once and no disfigurement of the tree is noticed, while, at the same time, none of the summer spores are scattered, but when the wart becomes fully grown, the disfigurement will not be removed by the treatment, and the early summer spores will have already been scattered to other branches.

To be effectual, this application *must be made* as soon as the wart *begins to enlarge*, which is shown by a swelling on or under the bark, generally of a light brown color when the bark first bursts open, but becoming darker as it increases in development.

The kerosene paste is best applied with a small pointed paint brush and should be used on the wart only.

Examination of the trees must be made at intervals of from two to four weeks, according to the state of the weather.

If the weather be dry and clear few warts will be started, while if moist and warm they develop more abundantly.

SULPHATE OF COPPER FOR THE PLUM WART.

While the kerosene paste has proved satisfactory in the destruction of the plum wart, it requires close personal examination of every branch of every tree in order to destroy them all. This mode of treatment is not expensive but is one that few growers will take to kindly and some method requiring less close application has been sought in the various solutions suggested for other fungi.

Sulphate of Copper. To destroy all spores that might be attached to the branches, some of the trees in the station and college orchard were sprayed April 19th with sulphate of copper, 1 lb. to 22 gals. of water. All parts of these trees were thoroughly wet with the solution.

While it is difficult to determine positively, if the spores existing on the branches of the trees were destroyed by this application, from the small number of warts developed on the trees sprayed, we think that it was decidedly beneficial.

To destroy the plum curculio and the black wart at one operation, a second application of the same solution was made May 17th, to which Paris green was added at the rate of 1 lb. to 500 gals. of the solution.

This application so injured the foliage that subsequent applications of Sulphate of copper and Paris green were made in the form of the *Bordeaux Mixture.* This mixture was applied May 21st, May 29th, June 7th and 17th and July 19th and 29th. No injury could be discovered from the Paris green, even when the amount was as large as 1 lb. to 200 gallons.

Owing to the destruction of the fruit and the foliage by the first application, positive results could not be determined as to the effect of the Paris green upon the curculio, but in the case of trees that were treated with the Bordeaux mixture and Paris green only, a very large crop of fruit was matured while other trees not treated, lost all their fruit from the attacks of the curculio. The number of warts was *very decidedly* less where treated with the copper mixtures, than where untreated.

One thing our experiments have demonstrated beyond a question i. e., that plum trees, *leaves and branches*, may be kept covered *with mixtures of sulphate of copper, lime and Paris green for nearly the entire season without noticeable injury* and *we believe* that both the plum wart and plum curculio may be held in check by this remedy. Another season it is hoped that experiments may be made on a large scale in different localities throughout the state, to settle the question of the destruction of the plum curculio. The application of this remedy was made with the Field pump as upon the apple and pear trees.

ROTTING OF THE FRUIT.

In the above experiments no special application was made to prevent the rotting of the fruit, but a close comparison of the fruit of trees treated with the Bordeaux mixture, with those untreated, would indicate that the application of the above mixture was decidedly beneficial.

EXPERIMENT No. 5.

BORDEAUX MIXTURE FOR GRAPE MILDEW AND ROT.

In the station plots are planted two vines each, of about 100 varieties of grapes. Of these vines one of each variety was treated with the above mixture and the other left as a check vine by which to judge of the effects of the application. Some of these varieties have not fruited but those that produced fruit in sufficient quantity for comparison are given in the table below.

To destroy all germs that might be adhering to the canes before the leaves unfolded, all parts were thoroughly painted with a strong solution of sulphate of copper, April 2d and 3d.

As soon as the foliage was fully developed an application of sulphate of copper, one pound to twenty-two gallons of water, was made. This was on May 29th. Soon after this application it was found that the foliage was seriously injured and the next application made June 20th, was of the Bordeaux mixture. As the rose bugs were beginning to work, one pound of Paris green to 500 gallons of the mixture was added to this and other applications made July 19th and 28th.

The Paris green had no effect upon the rose bug, and hand picking was resorted to, to save the crop, but the effect of the Bordeaux mixture was so marked that at a long distance it was visible, not only preventing the mildew on the leaf but the rot of the berry, to which some varieties are almost invariably subject. The last application of this mixture was made July 28th, and yet at the time of ripening more or less of it was plainly visible on the foliage and the berry. In some cases enough remained on the berries to injure them somewhat for market

To determine if enough of the copper, which is more or less poisonous, remained upon the berries and stems to prove harmful, ten pounds of stems and ten pounds of detached berries were selected where it was most abundant, and analysis gave the following results:

	Copper Oxide.		Sulphate Copper.
10 lbs. stems contain	.00996 lbs.	=	.0200 lbs.
10 lbs. berries contain	.00031 lbs.	=	.0006 lbs

As the berry is the edible portion and as this result was obtained by selecting the fruit with the greatest amount of the mixture adhering the amount of copper oxide on the average fruit treated in this way cannot be seriously objectionable, except from its appearance.

The following table, giving the various qualities of the different varieties, is based upon careful comparison of each with such varieties as the Concord and Delaware, and shows fairly how they have behaved in our plots the past season.

In this table 1 indicates the highest degree of excellence.

NAMES OF VARIETIES.	Time of Ripening.		Color.	Keeping Qualities.	Adhesiveness to Stem.	Quality.	Beauty.	Size of Berry.	Size of Bunch.	Hardiness.	Vigor of Growth.	Freedom from mildew on sprayed vines.	Freedom from mildew on unsprayed vines.
Amber Queen.	Sept.	15	R	2	5	3	5	9	5	4	4	2	4
Ann Arbor, ...	''	20	B	1	3	7	6	9	5	2	4	1	1
Augusta.	''	17	R	7	6	5	3	3	4	3	4	2	4
Bacchus, ...		19	B	1	1	5	6	10	5	2	1	1	2
Beauty, ...	''	21	W	5	7	6	5	3	4	5	3	2	1
Berkman, ...	''	15	R	3	1	2	2	7	3	2	1	1	2
Centennial.	''	25	W	2	1	4	2	5	3	6	1	1	2
Champion, ...	''	10	B	9	8	6	5	5	3	1	4	2	4
Concord, ...	''	15	B	5	7	4	1	2	1	1	1	1	2
Cottage.		11	B	10	10	7	5	4	6	2	3	1	4
Delaware.		15	R	2	1	1	1	8	8	2	10	1	3
Dutchesse, ...	''	15	W	1	1	3	1	8	2	2	2	1	2
Early Victor.	''	10	B	8	9	6	5	6	3	1	4	1	4
Eaton.	''	20	B	9	5	6	1	1	2	2	3	1	2
Eldorado, ...	Oct	1	W	2	1	5	2	5	2	6	1	1	5
Empire State.	Sept.	20	W	2	1	4	2	5	3	3	2	1	9
Faith, ...	''	25	W	6	5	6	8	3	6	4	5	1	*
Hayes.	''	11	W	7	5	2	3	5	5	1	5	1	1
Highland, ...	Oct.	10	B	7	3	8	2	1	1	2	1	1	5
Janesville..........	Sept.	9	B	7	8	6	3	4	5	1	1	1	1
Jefferson.	''	25	R	1	7	7	2	3	2	6	4	1	6
Jessica, ...	''	18	W	8	8	4	7	5	7	4	7	2	10
Lady, ...	''	11	W	8	8	3	2	4	5	1	6	1	2
Lady Washington. ..	''	28	W	3	4	7	1	3	1	3	3	2	5
Lee's Prolific........	''	18	R	8	2	4	8	3	7	2	4	7	6
Lindley............	''	28	R	1	2	2	[illegible]	3	5	6	3	2	6
Martha, ...	''	15	W	7	6	3	4	5	5	1	5	1	1
Moore's Diamond. ..	''	13	W	2	3	5	4	8	3	1	5	1	*
Moore's Early.......	''	8	B	8	7	5	3	1	3	1	2	1	1
Niagara, ...	''	15	W	2	5	5	1	2	1	4	2	1	3
Oneida.	''	15	R	8	2	3	2	1	3	2	5	8	9
Pearl.	''	27	W	6	8	5	4	4	5	5	3	2	5
Pocklington.	''	20	W	2	6	3	1	1	2	3	2	1	1
Poughkeepsie Red...	''	20	R	1	2	2	4	8	5	2	3	1	1
Prentis, ...	''	28	W	3	5	5	3	4	5	5	8	1	2
Rochester, ...	''	20	R	3	7	1	1	2	2	2	4	2	*
Telegraph, ...	''	9	B	3	2	7	2	4	4	1	1	1	2
Ulster Prolific.		27	R	5	4	1	5	3	4	5	2	*	3
Vergennes.	''	18	R	3	1	3	3	2	3	2	2	4	10
Wilder, ...	''	12	B	5	7	3	1	1	1	4	3	1	4
Worden.	''	12	B	6	6	3	1	2	2	1	2	1	2
Wyoming Red.	''	10	R	1	1	5	3	4	5	1	2	3	5

*Only one vine in plot.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 12.

REPORT ON INSECTS.

APRIL, 1891.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1891.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
HERBERT E. WOODBURY, .	" "
FRANK O. WILLIAMS, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Entomology.

C. H. Fernald.

The history of the following insects and the methods of destroying or holding them in check, have been worked out at this Station or compiled from the most reliable sources. This last has been done because there have been so many demands for information about the common insects, as to cause the expenditure of a large amount of time in answering inquiries about them.

I have frequently been asked to recommend some plain, practical work on common insects, and take this opportunity to call the attention of our fruit growers to Saunders' Insects Injurious to Fruits, published by J. B. Lippincott & Co., Philadelphia, Penn., from whom it may be obtained by mail at $2.00 a copy. This valuable work contains a popular account with numerous illustrations of the insect enemies to our fruit trees, and the best methods of contending with them.

Numerous experiments on insecticides have been conducted during the past two years, but with such results that we do not feel ready to report them as yet.

We earnestly desire that all the farmers and fruit growers of the Commonwealth should write informing us what insects are most numerous and troublesome in their respective localities, and about what species they desire information.

THE BUD-MOTH.

Tmetocera ocellana (S. V.)

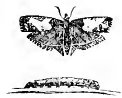


Fig. 1.

This insect, Fig. 1, is very abundant in some parts of Massachusetts, and has done a vast amount of damage to our fruit trees, much more than has been generally supposed. The minute brownish caterpillars eat out the inside of both leaf and flower buds, and not unfrequently those of grafted scions, and the failure of those grafts has generally been thought to have been caused by imperfect grafting.

These caterpillars make their appearance about half grown in early spring, when the buds of our fruit trees are beginning to swell, and eat their way into the bud thus destroying it. If one bud does not suffice they go to a second, and so on. When a terminal bud is destroyed, the growth is continued from a lateral one; and, as often occurs, the terminal bud of this lateral branch is destroyed by these minute caterpillars, thus giving a peculiar appearance to the older trees of an orchard, so that one can easily recognize the work of the bud moth by the irregular growth of the branches.

The moths emerge during the latter part of June or early in July and lay their eggs on the leaves of apple and various other trees. The young, as soon as hatched, feed on the leaves, and are about half grown when the cold weather comes on, and they hibernate in that stage.

To destroy these caterpillars it is desirable to gather all the leaves from under the infested trees in the fall and burn them, and also to shower the trees with one pound of Paris Green in one hundred and fifty gallons of water, in the spring when the buds first begin to swell.

This application will also prove valuable for the destruction of tent caterpillars and other early leaf eating insects.

The following technical account is prepared for those who desire a more complete history of the insect than is given above.

This species was first described briefly by the authors of the Vienna

Verzeichniss in 1776, page 130, under the name of *Tortrix ocellana*, and in the Supplement to the same report, page 318, they state that the larva feeds on horn-beam (*Carpinus betulus*). Fabricius described the moth more fully in his *Mantissa Insectorum*, Volume 2, page 228, (1887), and in 1794, in Part 2, Volume 3, of his *Entomologica Systematica*, page 255, he described the moth again under the name of *Pyralis luscana*. Why he changed the name is not apparent.

Hübner, sometime before 1811, in his Sammlung europäischer Schmetterlinge, figured this species on plate 3, figure 16, and gave it the name of *Tortrix comitana*, and in his Geschichte europäischer Schmetterlinge, Tortrices, gives on plate 3, fig. 1, *a*. the larva; and *b*, the pupa, on apple blossoms.

Bechstein, in his Naturgeschichte der schädlichen Forstinseckten, Part 3, page 774, (1805), describes the moth and says that it is seen rarely in forests in Germany in the month of June; and that the Vienna Verzeichniss states that the larva feeds on the white beech, (*Fagus sylvaticus*), thus making a mistake in the food plant by a misquotation.

Haworth, in his Insecta Britannica, Part 3, page 334, published in 1811, adopts Hübner's name and describes six different varieties of the moth, but makes no allusion to the early stages and food plants, which he would have done if he had known them, for, on the title page, he states that all known facts on the early stages are given.

Froelich, in his Enumeratio Tortricum, published in Germany in 1828, describes the moth but makes no allusion to the early stages.

Treitschke, in Die Schmetterlinge von Europa, Volume 8, page 40, (1830), describes this moth under the name of *Penthina ocellana*, and in the Supplement, Part 3, page 51, (1835), it is stated by Herr Moritz that there are two varieties; one with the middle of the fore wing wholly white, the caterpillar of which lives in *Sorbus aucuparia*. It is pale reddish gray, with black head and thoracic shield. Of the darker variety, the pupae have been found only on alder, but they probably live on other kinds of trees. In July the moths are frequently found in larch forests.

Stephens, in his Illustrations, Volume 4, page 92, (1834), describes this moth under the name of *Spilonota comitana*. He states that it is extremely abundant in the vicinity of London, and not uncommon in other parts of the country. The caterpillar feeds on the hornbeam, and the moth appears on the wing about the middle of June.

Duponchel, in the Histoire naturelle des Lépidoptères, Tome 6, page 203, (1834), described the moth under the name *Penthina luscana*, and referred to the account of the food plant given in the Vienna Verzeichniss, already mentioned.

Schmidberger, in Kollar's Insects Injurious to Fruit Trees, page 234, (1840), describes this insect under the name of *Tortrix* (*Penthina*) *ocellana*, but gives no description of the larva. He states that the eggs are laid singly on the fruit buds or leaf buds, during the month of June [in Austria], and that they do not hatch till the following spring, when the larva reaches its full size in four or five weeks, then pupates and emerges in May as a moth.

Guéneé, in his Index Methodicus, page 20, (1845), in a foot-note, says the larva is brownish with a black head and shield, and that it lives in the month of May in the topmost leaves of *Alnus*, twisted and drawn together.

Zeller, in Oken's Isis for 1846, describes the full grown larva very briefly, and states that it feeds on oak and alder.

Herrich-Shäffer, in his Schmetterlinge von Europa, Volume 4, page 234, (1849), says that it is on the wing at the end of June, and that the large light examples are from fruit trees, and that the smaller darker ones are from larch, the larvae being between the leaves.

Stainton, in his Manual of the British Butterflies and Moths, Volume 2, page 219, (1859), describes the moth under the name of *Hedya ocellana*, and says the larva is brown with the head and second segment black, and feeds "on various trees," "very common in the South of England but scarcer towards the North." Wilkinson, in his British Tortrices, published in the same year, describes it under the same name, and says the imago emerges in June and July, frequenting hedges and woods around London; and that the larva feeds on hornbeam, alder, mountain ash and probably on whitethorn. He repeats the description of the larva given by Guéneé.

Lederer, in 1859, in his Revision of the European Tortricids, page 367, established the generic name *Tmetocera* for this species, because of the notch in the upper side of the base of the antennae of the male.

Heinemann, in his Tortricina of Germany and Switzerland, page 206, (1883), after describing the moth, states that the larvae occur in May and June, on fruit and other deciduous trees, and the variety *laricana*, between the needles of larch.

Zeller, in the Entomologische Zeitung for 1873, page 129, describes his variety *laricana*, but gives nothing new of the larva of *Tmetocera ocellana* or of the larva of this variety.

I have two examples of the European variety *laricana* in my collection, but have never seen anything like them taken in this country, nor have I heard that any one here has bred *T. ocellana* larva or any variety of it from larch.

Taschenberg, in his work on Entomology for gardeners, published in Bremen in 1874, page 306, says that this species is very abundant everywhere, on the wing from June to August, and further says the caterpillar has sixteen feet, is reddish brown with the head blackish, in early spring upon the buds of different kinds of deciduous trees, and also upon apple and pear trees. In his further account he follows the statement of Schmidberger in Kollar's Insects, given above, and adds a list of five different species of Hymenopterous parasites that prey upon it.

The first account given of it in this country, so far as I can learn, was that by Harris in his Insects Injurious to Vegetation, First Edition, page 349, (1841), where he describes it under the name of *Penthina oculana*, but he does not give the early stages.

In 1860, Clemens describes this species in the Proceedings of the Philadelphia Academy of Natural Sciences, page 357, under the name *Hedya Pyrifoliana*. His description of the moth and also of the larva is very good, and he says "it inhabits the pear and plum trees."

Since that time many persons have written about it more or less fully, but nothing new has been given on its habits, so far as I have seen, and it has generally been supposed to pass the winter in the egg state. Mr. James Fletcher, in his Report for 1885 as Entomologist to the Department of Agriculture of Canada, page 24, writes, "I do not know for certain the life history of this little moth, but believe it passes the winter as a larva on the branches of apple trees, protected by a covering of silk."

For some years past I have observed the habits of this insect, and have been able to carry it through its transformations. The moths emerge between the last of June and the middle of July, though belated specimens are sometimes taken on the wing as late as the middle of August, and one was taken at this place August 25, 1889.

The fore wings expand about three-fifths of an inch. The head, thorax, and basal third of the fore wings, and also the outer edge and fringe are dark ash gray, the middle of the fore wings is cream white, marked more or less with costal streaks of gray, and in some specimens this part is ashy gray, but little lighter than the base. Just before the anal angle are two short horizontal black dashes followed by a vertical streak of lead-blue, and there are three or four similar black dashes before the apex, also followed by a streak of lead-blue.

The hind wings above and below and the abdomen are ashy gray. The under side of the fore wings is darker, and has a series of light costal streaks on the outer part.

The moths pair and the female lays her eggs, when in confinement, in clusters of from four to ten or eleven, often overlapping each other. They are oval, flattened, four-fifths of a millimeter long, and half as wide, sordid white with a narrow border of clear and transparent white, while the center of the eggs is one complete mass of minute granules. In about three days the center of the egg has grown darker, and the granules larger; and on either side there is a clear, white, oval space about one-third the length of the egg. In about two days more the outer edge of the center is the same color as in the last stage, and inside this is a narrow, lighter band, while in the center is seen the form of a cylindrical larva larger at one end, and both ends slightly curved towards each other; and in one or two days more the whole form of the larva is visible, the head, thoracic and anal shields being black. The egg stage lasts from eight to eleven days.

When the young larva hatches it does not eat the shell of its egg, but goes on to the tenderest leaves and almost immediately begins spinning a microscopic layer of silk, under which it eats the outer layer or epidermis of the leaf. The larva is then about three millimeters in length, of a creamy white color, with head, thoracic and anal shields blackish brown, and a few minute pale hairs on the body; the head is very large for the rest of the body. In a week the larva is nearly four millimeters long, light yellowish brown, with the head, thoracic and anal shields dark brown, and it eats minute holes through the leaf, its silken web now being visible to the naked eye. The larva gradually becomes a trifle more brownish, increases in size and enlarges its web along the side of the midrib.

Late in the fall the silken web is quite heavy and thick, and the larva deposits its excrements in little black pellets in the form of a tube, under the web, within which it hibernates during the winter. Not unfrequently two leaves are fastened together by the silk of the web, and sometimes a leaf is secured to a branch of the tree in the same manner.

About the first of May the larva measures seven millimeters when resting, and eight when in motion. It is cylindrical in form, with the head dark brown and of medium size. The body is dark yellowish brown, and the head, thoracic and anal shields very dark, polished brown. There are ten lighter brown protuberances on each segment, from each of which arises one pale hair. On the upper surface of the ninth segment is seen the double undeveloped reproductive organ of a light brown color. The legs are dark brown and the prolegs yellowish brown. About the first of June the larva is from ten to twelve millimeters in length, and the body has changed to a cinnamon rufous color. From the middle to the last of June it curls or draws together several leaves which it lines with silk, and in which it transforms to a pupa.

The pupa is seven millimeters long, brownish yellow, tapering from the head to the posterior end, with the wing cases dark brown. There are two rows of dark brown spines pointing backwards, across each abdominal segment. The spiracles and anal segment are dark brown. It remains in the pupa stage about two weeks and then the moth emerges.

Some years ago I found a most curious parasite attacking the larva of this species. It was a Hymenopterous insect of a pea green color, and was attached to the top and across the second segment of the larva, on the outside and entirely out of the way of harm, and there it grew fat at the expense of its host which died a lingering death. The parasite was determined for me by Mr. E. T. Cresson as *Phytodictus vulgaris* Cr.

The following food plants are reported for this country: apple, pear, plum, cherry, laurel-oak, and Prof. Harvey informs me that he has bred it from black-berry.

The food plants given in Europe are apple, pear, quince, Carpinus, Crataegus, Sorbus and Quercus.

SPITTLE INSECTS.

The frothy spittle-like masses—called frog-spittle, toad-spittle, snake-spittle, etc.—are formed by small insects belonging to the family Hemiptera or true bugs, and are seen adhering to the twigs and branches of shrubs and trees, and also to the stems of grasses and other plants.

During the early stages of its life, by means of special glands, this insect secretes an albuminous liquid and discharges it from the posterior end of the body, forcing bubbles of air into it after it has been used in respiration, probably. Fig. 2 shows a portion of a grass stem with the young insect in the frothy mass, magnified. At *a*, the insect is shown reaching out the hinder part of the body to secure a bubble of air. At *b*, the insect is allowing the bubble of air to escape in the fluid. At *c*, the mouth parts are shown like a sting piercing the grass. Fig. 3 represents the grass with two masses of froth on it at *a*, *a*, and a young insect exposed at *b*. These illustrations are from Morse's First Book of Zoölogy, and I am indebted to the publishers of that work for the use of them.

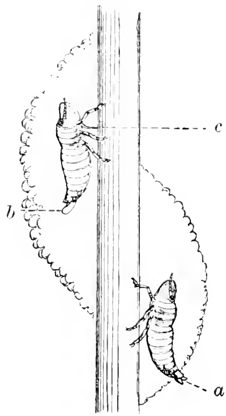


FIG. 2.

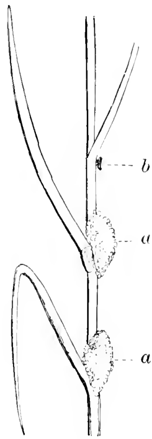


FIG. 3.

Two different species of spittle-insects are common on grass in Massachusetts, *Philaenus spumarius* (Linn.) and *Philaenus lineatus* (Linn.), and they also occur in Europe from which country they were probably introduced. Although these two insects feed on many different species of plants, it is said that they are strictly attached to grasses and low plants, and that they never occur on trees and shrubs except by accident.

It is not known where they lay their eggs, but as the females are provided with saw-like appendages connected with the ovipositor, it is probable that they cut slits in the stems of the plants near the ground, in which to deposit their eggs. I incline to the impression that they hibernate during the winter in the perfect state, and lay their eggs in early summer. This is true of the allied *Proconia costalis*, and *Heliochara communis*, which I have often found fully developed in early spring, just emerging from their winter quarters. The eggs are very large as compared with the size of the insect, and as but very few are laid, these pests are never liable to become excessively abundant. This insect remains in the frothy secretion during the early stages (*nymph*), but, after reaching the adult stage, does not make this secretion, and becomes very active. Although the wings are well developed it does not fly any great distance, but makes long leaps, and runs quickly, often with a peculiar sideways motion to the opposite side of the plant from the observer.

The Spume Spittle-insect, (*Philaenus spumarius* Linn.) is very variable in color, about one-fourth of an inch in length, of a clay-yellow color, and sprinkled more or less with brown, but some varieties are almost entirely brown. The female of this species lays from eight to ten long whitish eggs.

The Lined Spittle-insect, (*Philaenus lineatus* Linn.) is about one-fourth of an inch long, of an ochre yellow color, with a whitish stripe on the costa or outer edge of the wing covers, and a brownish stripe within and parallel to it. Some of the varieties are dark brown with a whitish costal stripe.

Although the mass of froth on the stems of grass is quite large it usually contains but a single insect which is so small, that it can injure the plant but very little, and it is very seldom that the pest is abundant enough to make any material difference in the hay crop.

Besides the above named species of Spittle-insects in Massachusetts, we have *Clastoptera proteus*, a common species on cranberry and blueberry bushes, *Clastoptera obtusa*, on the leaves and twigs of alder, *Aphrophora parallela*, on the twigs and smaller branches of pine, *A. quadrinota*, and *A. signoreti* on the grape vine, and *A. quadrangularis*, on grasses, weeds and blackberry twigs.

THE SQUASH BUG.

Anasa tristis (De Geer).

About the last of June or the first of July, when a few young leaves of the squash have started, the bugs come out of their hiding places, in crevices of walls or fences, where they have passed the winter. The insects pair and the females lay their eggs in little patches on the under-side of the leaves, fastening them to the leaf with a gummy substance. The eggs are rounded oval in form, about one sixteenth of an inch long and about one twenty-fifth of an inch wide, somewhat flattened on the portion attached to the leaf, and of a reddish or resin color.

The young bugs soon emerge, and are slaty gray above with several small black warts on the surface, and there is a greenish tinge to the under surface. As they grow older, they are more of a yellowish green color with the head slaty black. The young will be found of different sizes all summer, as the female does not lay her whole stock of eggs at one time.

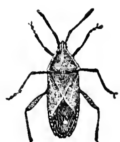


FIG. 4.

About the last of September, the bugs have attained their full growth, Fig. 4, about three-fifths of an inch long, and are ochre yellow with so many small punctures that it gives a dusky hue to the body. The full grown bugs when handled, and especially if crushed, give off a very strong odor.

In order to check the ravages of these insects, they should be sought for and killed when about to lay their eggs; but if any have escaped detection, the eggs may be discovered and crushed. Water drained from a barn yard is a good remedy as it tends to promote the vigor and luxuriance of the plants, thus rendering them less liable to suffer as much from the punctures of the bug.

The plants should be visited daily and searched, as the bugs remain quiet in the daytime on the stems, or on the ground under the leaves. Shingles, strips of board or other similar objects may be laid on the ground for the bugs to hide under, when they may be captured and destroyed. Experiments with kerosene emulsion have not thus far proved very successful.

THE PEA WEEVIL.

Bruchus pisi Linn.

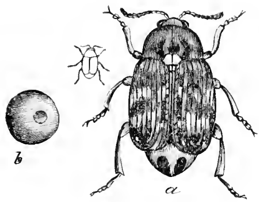


Fig. 5.

This insect, Fig. 5, natural size, enlarged at *a*, and an infested pea at *b*, is a native of this country, but is now common to nearly all parts of the world. It is easily distinguished from the other species of its family, by having a depressed head, a very short snout, and the antennae eleven jointed, straight and slightly thickened at the end. On the tip of the abdomen, which is somewhat longer than the wing covers, are two oval black spots which cause the remaining white portion to look something like a letter T.

It is about one-fifth of an inch long, of a rusty black color with more or less white on the wing covers, and a distinct white spot on the hinder part of the thorax.

The beetles begin to appear as soon as the peas are in blossom, and when the young pods form, the females lay their eggs on the outside of them, and as soon as the eggs hatch, the larvae, or grubs, —which are of a deep yellow color and have a black head,—make their way through the pods and into the nearest peas. Only one grub can be fully developed in each pea, and this one will not destroy the germ for peas will grow if they are infested, but the plant will be feeble, and the weevils will increase rapidly.

After the grubs are fully grown, they eat a circular hole out to the shell of the pea, and then complete their transformations. Some of the beetles emerge from the peas in the fall of the same year that they were hatched, if the summer has been long and hot; but as a general rule they remain in the peas during the winter, and do not issue till the new vines are growing.

The weevils can be killed by taking the peas that are to be kept for seed, and enclosing them in tight vessels with camphor; also by keeping the peas two years, taking care that the beetles do not escape. A good plan is to tie the peas in tight bags and hang them in an airy place till Christmas, and then, in order that they may not become too dry, put them in tighter vessels. The best way is to plant only sound peas.

THE BEAN WEEVIL.

Bruchus obsoletus Say.

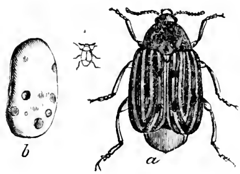


FIG. 6.

The general color of this weevil, Fig. 6, natural size, and enlarged at *a*, is tawny gray marked more or less with dull yellow, and it is less than a fourth of an inch long. Sometimes over a dozen are found in a single bean, Fig. 6, *b*. The female lays her eggs on the outside of the young pods, and as soon as they hatch, the young larvae, or grubs, bore through the pods and into the beans. They rarely injure the germ, and the beans will doubtless grow when only a few occur in a bean; but when the substance of the bean is destroyed, even though the germ is not touched, the bean either will not grow, or will produce only a feeble plant.

Before the larvae are transformed into beetles, they cut a circular hole out to the shell of the bean and can be easily seen in white or light-colored beans, after the final changes. Some of the beetles emerge in the fall, and the remainder in the spring; therefore the beans intended for seed should be tightly tied up in stout paper bags, so that the beetles cannot escape, and kept over till the second year when they will all be dead. It is better, however, to plant sound seeds only, and destroy all that contain the weevils.

THE MAY BEETLE.

Lachnosterna fusca (Fröhl.)

This insect, Fig. 7, 1, pupa; 2, larva; 3 and 4, the beetle, is commonly known as the May-beetle, June-beetle, dor-bug, etc. and is very common, making its appearance early in May or June. The body is oblong, oval, and from three-fourths to an inch in length, about one-half an inch in diameter, and of a dark chestnut-brown color, while the head and thorax are sometimes almost black, and the breast is covered with pale yellow hairs. These beetles remain at rest during the day and eat at night, feeding upon the fruit and leaves of different trees, often doing much damage. After living for about three weeks the female lays her eggs and then dies.

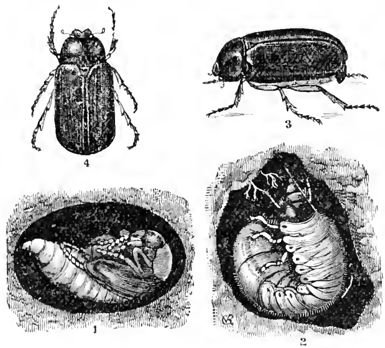


Fig. 7.

The eggs, from forty to fifty in number, are deposited among the roots of the grass in a ball of earth. They hatch in the course of a month, and the young larvae, or grubs, feed upon the rootlets of various plants. They are soft and white, with a horny head of a brownish color, and have six legs. When cold weather approaches, they burrow deeply in the ground and remain till spring. The grubs do not reach their full size till the third year, when they are about the size of a man's little finger. They rest on one side, slightly curved, and near the hinder end the contents of the digestive system are visible. They then construct an oval shaped cocoon, in which they change into pupae.

In the spring the perfect insects emerge, live about three weeks and then die. In the grub state they are very injurious to lawns, grass lands, and meadows, eating the roots of the grass and causing it to turn brown and die. They are also injurious to strawberries, eating the roots and destroying the plants.

On account of the underground life of the larvae, or grubs, of these beetles, they are hard to destroy. They have their natural enemies, but these are not sufficient, and other means must be employed to get rid of them. Various animals,—shrews, moles and others that burrow, destroy many. Certain birds,—robins, crows, blue-jays, black-birds, etc. also eat them, and the tiger beetles kill them. There is also a white fungus which sometimes grows in two long processes from the grubs, one on each side of the head, which destroys them.

Various artificial remedies have been suggested, as the mixing of wood ashes with the soil, which makes it very unpleasant for the grubs, and in some cases has proved very efficient. Shaking the beetles from the trees on to sheets and then burning them is recommended. This can be done best early in the morning. Late fall plowing has also been recommended, but to reach the grubs it must be deep, for they burrow down a considerable depth in order to pass the winter. Swine and domestic fowls are fond of the grubs, and will destroy them when allowed to have access to the infested field.

From experiments made by Mr. W. B. Alwood, it is probable that kerosene emulsion may be used successfully for the destruction of this insect while in the ground, but it is necessary to thoroughly drench the ground, for the purpose of reaching the grubs. This plan is well worth a trial on lawns, but it is doubtful if it would pay in fields.

THE PLUM CURCULIO.

Conotrachelus nenuphar (Herbst.)

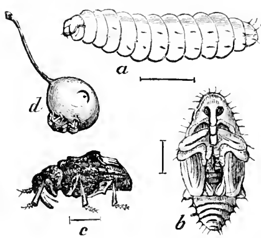


Fig. 8.

The plum curculio belongs to the group of snout-beetles or weevils, and is very injurious to cherry, quince, peach, and apple trees, as well as plum trees. The perfect beetle, fig. 8, c, is about one-fifth of an inch long, grayish-brown or black in color, while on the wing covers is a black shining hump behind which is a dull yellow band and a few white markings. The thorax and wing covers are roughened and uneven, and the snout is about as long as the thorax.

There is only one brood in a year. The beetles pass the winter in the perfect state, hiding under the loose bark of trees, rubbish, and in other convenient places; and are first seen in May or June when the fruit is fairly set. The female at once lays her eggs, from fifty to a hundred in number, in the young fruit, making a small hole with her snout, and depositing only one egg in a single plum. She then cuts a crescent shaped slit in front of the hole, fig. 8, *d*, thus undermining the egg and preventing the growing fruit from crushing it. The eggs are of an oblong-oval form, pearly white, and can be plainly seen with the naked eye. If the weather is warm, the eggs will hatch in three or four days, but if cold and rainy, they will remain sometimes over a week before hatching.

The young larvae, or grubs, fig. 8, *a*, are small, white and footless, and as soon as hatched eat their way to the centre of the fruit causing it to fall before it is ripe. The grubs are fully grown in from three to five weeks, being about two-fifths of an inch long, with a brownish head and a yellowish white body, with a pale line on each side, and a few minute black bristles. They now leave the fruit, burrow into the ground, pass into the pupa state, fig. 8, *b*, and in six weeks emerge as perfect beetles. These insects are natives of this country, and when first discovered fed on wild plums, and are now sometimes found upon them. As the insect feigns death when disturbed, by jarring the trees under which a sheet has been spread, a great many may be captured and destroyed. It has been recommended to allow poultry to run under the trees as they will eat the grubs and beetles, and thus hold them in check. It has also been recommended by some to shower the trees with Paris green in water as soon as the fruit is fairly set, and before the eggs are laid, so that the beetles in feeding on the leaves may be destroyed. Others claim that this is of no value, but my experiments thus far have not settled the point either way.

THE ONION MAGGOT.

Phorbia ceparum (Meig.)

Early in June a somewhat hairy fly, Fig. 9, may be seen flying about, and depositing its eggs on the leaves of the young onion plants, near the roots, Fig. 10.

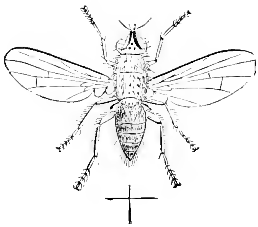


Fig. 9.

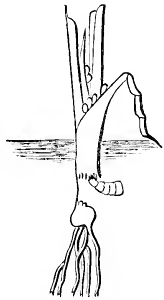


Fig. 10.

Dr. Fitch describes this fly as follows: "It has a considerable resemblance to the common house fly, though when the two are placed side by side, this is observed as being more slender in its form. The two sexes are readily distinguished from each other by the eyes which in the males are close together, and so large as to occupy almost the whole surface of the head, whilst in the females they are widely separated from each other. These flies are of an ash gray color, with the head silvery, and a rusty black stripe between the eyes, forked at its hind end. And this species is particularly distinguished by having a row of black spots along the middle of the abdomen or hind body, which sometimes run into each other, and then forming a continuous stripe. This row of spots is quite distinct in the male, but in the female is very faint, or is often wholly imperceptible. This fly measured 0.22 to 0.25 inches in length, the females being usually rather larger than the males." The eggs are white, smooth, somewhat oval in outline, and about one twenty-fifth of an inch in length. Usually not more than half a dozen are laid on a single plant, and the young maggot burrows downward within the sheath, leaving a streak of pale green to indicate its path, and making its way into the root devours all except the outer skin.

The maggots reach their full growth in about two weeks, when they are about one-third of an inch long, white and glossy, tapering from the posterior end to the head, which is armed with a pair of black, hook-like jaws. The opposite end is cut off obliquely, and has eight tooth-like projections around the edge, and a pair of small brown tubercles near the middle. Fig. 11, shows the eggs, larva, and pupa, natural size and enlarged.

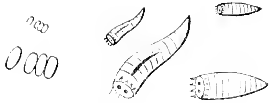


FIG. 11.

They usually leave the onions and transform to pupae within the ground. The form of the pupa does not differ very much from the maggot, but the skin has hardened and changed to a chestnut-brown color, and they remain in this stage about two weeks in the summer, when the perfect flies emerge. There are successive broods during the season, and the winter is passed in the pupa stage.

The following remedies have been suggested:

Scattering dry unleached wood ashes over the plants as soon as they are up, while they are wet with dew, and continuing this as often as once a week through the month of June is said to prevent the deposit of eggs on the plants.

Planting the onions in a new place as remote as possible from where they were grown the previous year has been found useful, as the flies are not supposed to migrate very far.

Pulverized gas lime scattered along between the rows has been useful in keeping the flies away.

Watering with liquid from pig pens collected in a tank provided for the purpose, was found by Miss Ormerod to be a better preventive than the gas lime.

When the onions have been attacked and show it by wilting and changing color, they should either be taken up with a trowel and burned, or else a little diluted carbolic acid, or kerosene oil, should be dropped on the infested plants to run down them and destroy the maggots in the roots and in the soil around them.

Instead of sowing onion seed in rows, they should be grown in hills so that the maggots, which are footless, cannot make their way from one hill to another.

THE CABBAGE BUTTERFLY.

Pieris rapae (Linn.)

In the New England States there are three broods of this insect in a year, according to Mr. Scudder, the butterflies being on the wing in May, July and September; but as the time of the emergence varies, we see them on the wing continuously through the season.

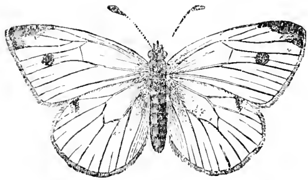


FIG. 12.

The expanded wings, Fig. 12, male, measure about two inches, are white above with the base dusky. Both sexes have the apex black and a black spot a little beyond the middle, and the female, Fig. 13, has another spot below this. The under side of the fore wings is white, yellowish toward the apex, and with two black spots in both sexes corresponding to those on the upper side of the female. A little beyond the middle of the costa, on the hind wings, is an irregular black spot on the upper surface, while the under surface is pale lemon yellow without marks, but sprinkled more or less with dark atoms. The body is black above and white beneath.

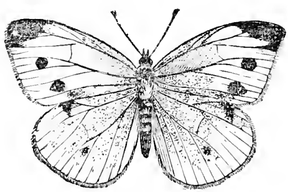


FIG. 13.

The caterpillars of this insect feed on the leaves of cabbage, cauliflower, turnip, mignonette, and some other plants.

The female lays her eggs on the under side of the leaves of the food plants, generally, but sometimes on the upper sides or even on the leaf stalks. They are sugar-loaf shaped, flattened at the base, and with the apex cut off square at the top, pale lemon yellow in color, about one twenty-fifth of an inch long and one-fourth as wide, and have twelve longitudinal ribs with fine cross lines between them.

The eggs hatch in about a week, and the young caterpillars, which are very pale yellow, first eat the shells from which they have escaped, and then spin a carpet of silk upon which they remain except when feeding. They now eat small, round holes through the leaves, but as they grow older change to a greenish color with a pale yellow line along the back, and a row of small yellow spots along the sides, and eat their way down into the head of the cabbage.

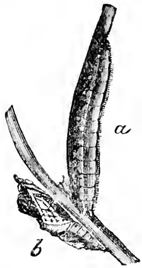


FIG. 14.

Having reached its full growth, the caterpillar, Fig. 14, *a*, which is about an inch in length, wanders off to some sheltered place, as under a board, fence-rail, or even under the edge of clapboards on the side of a building, where it spins a button of silk, in which to secure its hind legs, then the loop of silk to support the forward part of the body.

It now casts its skin changing to a chrysalis, Fig. 14, *b*, about three-fourths of an inch in length, quite rough and uneven, with projecting ridges and angular points on the back, and the head is prolonged into a tapering horn. In color they are very variable, some are pale green, others are flesh colored or pale ashy-gray, and sprinkled with numerous black dots. The winter is passed in the chrysalis stage.

After the caterpillar changes to a chrysalis, their minute parasites frequently bore through the outside and deposit their eggs within. These hatch before the time for the butterflies to emerge, and feeding on the contents, destroy the life of the chrysalis.

Birds and spiders are of great service in destroying these insects. The pupae should be collected and burned if the abdomen is flexible; but if the joints of the abdomen are stiff and cannot be easily moved, they should be left, as they contain parasites.

Several applications of poisons have been used, the best results being obtained from the use of pyrethrum as a powder blown on to the plants by a hand bellows, during the hottest part of the day, in the proportion of one part to four or five of flour.

As the eggs are laid at different times, any application, to be thoroughly tested, must be repeated several times.

THE APPLE-TREE TENT-CATERPILLAR.

Clisiocampa americana Harr.

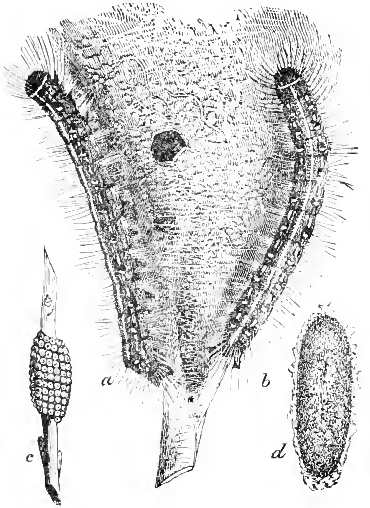


FIG. 15.

Large, white, silken web-like tents, Fig. 15, are noticed by the roadsides, in the early summer, on wild cherry trees, and also on fruit trees in orchards, containing numerous caterpillars of a blackish color with fine gray hairs scattered over the body.

This well known pest has been very abundant throughout the state for several years past, and the trees in many neglected orchards have been greatly injured by it, some being entirely stripped of their leaves. The trees in these orchards and the neglected ones by the roadsides form excellent breeding places for this insect, and such as are of little or no value should be destroyed. If this were well done, and all fruit growers in any given region were to destroy all the tents on their trees, even for a single season, the work of holding them in check or destroying them in the following year would be comparatively light.

The moths, Fig. 16, appear in great numbers in July, their wings measuring, when expanded, from one and a quarter to one and a half inches or more. They are of a reddish brown color, the fore-wings being tinged with gray on the base and middle, and crossed by two oblique whitish stripes.

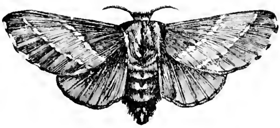


FIG. 16.

The females lay their eggs, about three hundred in number, in a belt, Fig. 15, *c*, around the twigs of apple, cherry and a few other trees, the belt being covered by a thick coating of glutinous matter which probably serves as a protection against the cold weather during winter.

The following spring, when the buds begin to swell, the eggs hatch and the young caterpillars seek some fork of a branch where they rest side by side. They are about one-tenth of an inch long, of a blackish color, with numerous fine gray hairs on the body. They feed on the young and tender leaves, eating on an average two apiece each day, therefore the young of one pair of moths would consume from ten to twelve thousand leaves; and it is not uncommon to see from six to eight nests or tents on a single tree, from which no less than seventy-five thousand leaves would be destroyed, a drain no tree can long endure.

As the caterpillars grow, a new and much larger skin is formed underneath the old one which splits along the back and is cast off. When fully grown, Fig. 15, *a* and *b*, which is in about thirty-five to forty days after emerging from the eggs, they are about two inches long, with a black head and body, with numerous yellowish hairs on the surface, with a white stripe along the middle of the back, and minute whitish or yellowish streaks which are broken and irregular along the sides; and there is also a row of transverse, small, pale blue spots along each side of the back.

As they move about they form a continuous thread of silk from a fleshy tube on the lower side of the mouth, which is connected with the silk producing glands in the interior of the body, and by means of this thread they appear to find their way back from the feeding grounds. It is also by the combined efforts of all of the young from one belt of eggs that the tents are formed.

These caterpillars do not feed during damp, cold weather, but take two meals a day when it is pleasant.

After reaching their full growth, they leave their tents and scatter in all directions, seeking for some protected place where each one spins its spindle shaped cocoon of whitish silk intermingled with sulphur colored powder, Fig. 15, *d*. They remain in these cocoons, where they have changed to pupae, from twenty to twenty-five days, after which the moths emerge, pair, and the females lay their eggs for another brood.

Several remedies have been suggested, a few of which are given below. Search the trees carefully, when they are bare, for clusters of eggs; and, when found, cut off the twigs to which they are attached, and burn them.

As soon as any tents are observed in the orchard they should be destroyed, which may be readily and effectually done by climbing the trees, and with the hand protected by a mitten or glove, seize the tent and crush it with its entire contents; also swab them down with strong soap-suds or other substances; or tear them down with a rounded bottle-brush.

Burning with a torch not only destroys the caterpillars but injures the trees.

It should be observed, however, since the caterpillars are quite regular in taking their meals, in the middle of the forenoon and afternoon, that they should be destroyed only in the morning or evening when all are in the tent.

Another remedy is to shower the trees with Paris green in water in the proportion of one pound to one hundred and fifty gallons of water.

THE FOREST TENT-CATERPILLAR.

Clisiocampa disstria (Hübner.)

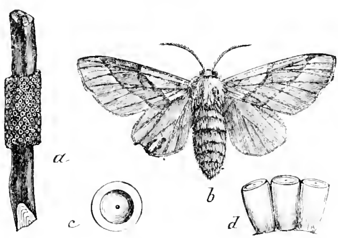


FIG. 17.

This species, commonly known as the Forest Tent-Caterpillar, closely resembles the Apple-tree Tent-caterpillar, but does not construct a visible tent. It feeds on various species of forest-trees, such as oak, ash, walnut, hickory, etc., besides being very injurious to apple and other fruit trees. The moth, Fig. 17, *b*, expands an inch and a half or more. The general color is brownish yellow, and on the fore-wings are two oblique brown lines, the space between them being darker than the rest of the wing. The eggs, Fig. 17, *c* and *d*, which are about one-twenty-fifth of an inch long and one-fortieth wide, are arranged, three or four hundred in a cluster, around the twigs of the trees, Fig. 17, *a*. These clusters are uniform in diameter and cut off squarely at the ends. The eggs are white, and are firmly fastened to the twigs and to each other, by a brown substance, like varnish, which dries, leaving the eggs with a brownish covering.

The eggs hatch about the time the buds burst, or before, and the young caterpillars go for some time without food, but they are hardy and have been known to live three weeks with nothing to eat, although the weather was very cold.

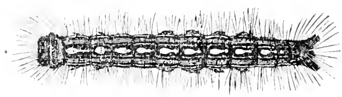


Fig. 18.

As soon as hatched they spin a silken thread wherever they go, and when older wander about in search of food. The caterpillars are about one and a half inches long when fully grown, Fig. 18. The general color is pale blue, tinged with greenish low down on the sides, and everywhere sprinkled with black dots or points, while along the middle of the back is a row of white spots each side of which is an orange yellow stripe, and a pale, cream yellow stripe below that. These stripes and spots are margined with black. Each segment has two elevated black points on the back, from each of which arise four or more coarse black hairs. The back is clothed with whitish hairs, the head is dark bluish freckled with black dots, and clothed with black and fox-colored hairs, and the legs are black, clothed with whitish hairs.

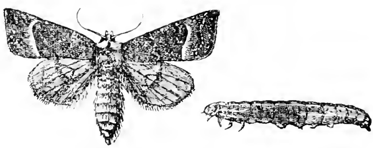
At this stage the caterpillars may be seen wandering about on fences, trees, and along the roads in search of a suitable place to spin their cocoons, which are creamy white, and look very much like those of the common tent-caterpillar, except that they are more loosely constructed.

Within the cocoons, in two or three days they transform to pupae of a reddish brown color densely clothed with short pale yellowish hairs. The moths appear in two or three weeks, soon lay their eggs and then die. The insects are not abundant many years in succession, as their enemies, the parasites, increase and check them.

Many methods have been suggested for their destruction, but the most available and economical are to remove the clusters of eggs whenever found, and burn them, and to shower the trees with Paris green in the proportion of one pound to one hundred and fifty gallons of water.

THE STALK-BORER.

Gortyna nitela Guen.



1 2

Fig. 19.

Fig. 20.

The perfect moth, Fig. 19, 1, expands from one to one and a half inches. The fore-wings are of a mouse-gray color tinged with lilac and sprinkled with fine yellow dots, and distinguished mainly by a white band extending across the outer part. The moths hibernate in the perfect state, and in April or May deposit their eggs singly on the outside of the plant upon which the young are to feed. As soon as the eggs hatch, which is in about a month, the young larvae, or caterpillars, gnaw their way from the outside into the pith.

The plant does not show any sign of decay until the caterpillar is fully grown, when it dies. The caterpillar, Fig. 19, 2, is about one and one-fourth inches long, of a reddish-brown color with whitish stripes along the body. The stripes on the sides are not continuous, and the shading of the body varies, being darker on the anterior than on the posterior portion. When fully grown, Fig. 20, the color is lighter and the stripes are broader. At this stage of life it burrows into the ground just beneath the surface, and changes into the pupa state. The pupa is three-fourths of an inch long, and of a mahogany brown color. The perfect moth appears about the first of September, and there is only one brood in a season.

The caterpillars feed in the stalks of corn, tomatoes, potatoes, dahlias, asters, and also in young currant bushes, besides feeding on many species of weeds. By a close inspection of the plants about the beginning of July, the spot where the borer entered, which is generally quite a distance from the ground, may be detected, and the caterpillar cut out without injury to the plant. This plan is impracticable for an extensive crop, but by destroying the borers found in the vines that wilt suddenly, one can lessen the number another year.

THE PYRAMIDAL GRAPE-VINE CATERPILLAR.

Pyrophila pyramidoides (Guen.).

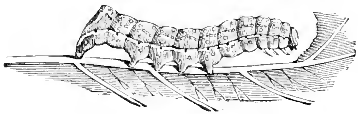


FIG. 21.

This caterpillar, Fig. 21, is generally found on grape vines early in June, but also feeds on apple, plum, raspberry, maple, poplar, etc. It is about an inch and a half in length, with the body tapering towards the head; of a whitish green color, darker on the sides; with a longitudinal white stripe on the back, broader on the last segments. Low down on each side is a bright yellow stripe, between this and the one on the back is another less distinct, and the under surface of the body is pale green.

The caterpillar is fully grown about the middle or the last of June, when it descends to the ground, draws together some of the fallen leaves, and makes a cocoon in which it soon changes to a mahogany-brown pupa.

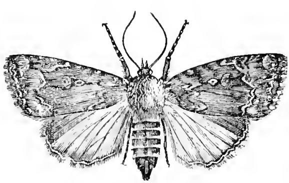


FIG. 22.

In the latter part of July the perfect moth, Fig. 22, emerges, measuring, when its wings are expanded, about one and three-fourths inches; the fore wings are dark brown shaded with lighter, with dots and wavy lines of dull white. The hind wings are reddish, or of a bright copper color, shading to brown on the outer angle of the front edge of the wing, and paler toward the hinder and inner angle.

The under surface of the wings is lighter than the upper, and the body is dark brown with its posterior portion banded with lines of a paler hue.

This pest may be destroyed by hand-picking, or by jarring the trees or vines on which they are feeding, when they will fall to the ground and may be crushed or burned.

THE GRAPE-BERRY MOTH.

Eudemis botrana (S. V.).

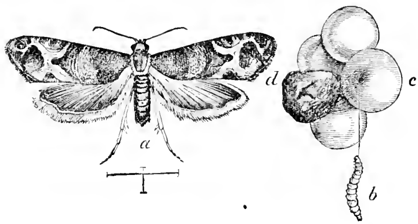


Fig. 23.

The moths emerge and fly early in June, and are quite small, measuring, when the wings are expanded, only two-fifths of an inch, Fig. 23, *a*, enlarged. The fore wings are purplish or slate brown from the base to the middle, the outer half being irregularly marked with dark and light brown.

These insects are two brooded and the first brood feeds not only on the leaves of the grape but on tulip, sassafras, vernonia and raspberry. The caterpillars of the second brood emerge when the grapes are nearly grown, and bore in them a winding channel to the pulp, continuing to eat the interior of the berry till the pulp is all consumed, Fig. 23, *d*, when, if not full grown, they draw one or two other berries close to the first and eat the inside of those.

The mature caterpillar, Fig. 23, *b*, measures about half an inch in length, is dull greenish with head and thoracic shield somewhat darker: the internal organs give the body a reddish tinge. It then leaves the grape and forms its cocoon by cutting out a piece of a leaf leaving it hinged on one side; then rolling the cut end over fastens it to the leaf, thus making for itself a cocoon in which to pupate. The pupa is dark reddish brown.

The second generation passes the winter in the pupa state, attached to leaves which fall to the ground; therefore, if all the dead and dried leaves be gathered in the fall and burned, also all the decayed fruit, a great many of these insects would be destroyed. As the caterpillars feed inside of the berry, no spraying of the vines with poisons would reach them. The caterpillar makes a discolored spot where it enters the berry, Fig. 23, *c*, therefore the infested fruit may be easily detected, and destroyed.

There is a small parasite that attacks this insect and helps to keep it in check. The insect has been known in Europe over a hundred years. It is not certain when it was introduced into America, but it is now found from Canada to the Gulf of Mexico, and from the Atlantic to the Pacific ocean.

THE CODLING MOTH.

Carpocapsa pomonella (Linn.)

This well known insect has a world wide reputation, and is now found wherever apples are raised.

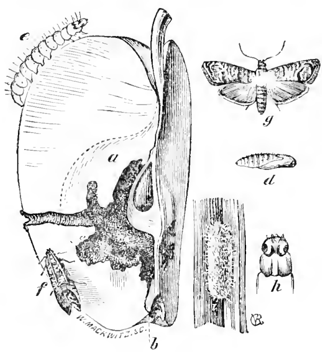


FIG. 24.

The moths are on the wing about the time the young apples are beginning to set, and the female lays a single egg in the blossom end of each apple. The fore wings of the moths when expanded, Fig. 24, *g*, (*f*, with the wings closed,) measure about half an inch across, and are marked with alternate wavy, transverse streaks of ashy gray and brown, and have on the inner hind angle a large, tawny-brown, horseshoe shaped spot streaked with light bronze or copper color. The hind wings and abdomen are light brown with a lustre of satin.

Each female lays about fifty eggs which are minute, flattened, scale-like bodies of a yellowish color. In about a week the eggs hatch and the tiny caterpillar begins to eat through the apple to the core, Fig. 24, *a*, pushing its castings out through the hole where it entered, Fig. 24, *b*. Often-times these are in sight on the outside in a dark colored mass, thus making wormy apples plainly seen at quite a distance.

The caterpillar is about two-fifths of an inch in length, of a glossy, pale yellowish white color, with a light brown head. The skin is transparent and the internal organs give to it a reddish tinge.

When mature the caterpillars, Fig. 24, *e*, top of head and second segment, *h*, emerge from the apples and seek some sheltered place, such as crevices of bark, or corners of the boxes or barrels in which the fruit is stored, where they spin a tough whitish cocoon, Fig. 24, *i*, in which they remain unchanged all winter, and transform to pupae, Fig. 24, *d*, the next spring, the perfect moths emerging in time to lay their eggs in the new crop of apples.

One good remedy is to gather all the fallen apples, and feed them to hogs; another is to let swine and sheep run in the orchard, and eat the infested fruit.

It has been recommended to place bands of cloth or hay around the trunks of the trees for the caterpillars to spin their cocoons beneath, and to remove them at the proper time, and put them in scalding water to destroy the worms.

By far the most successful method as yet adopted is to shower the apple trees with Paris green in water, one pound to one hundred and fifty gallons of water, when the apples are about the size of peas, and again in about a week.

THE CABBAGE LEAF-MINER.

Plutella cruciferarum Zell.

The cabbage leaf-miner is not a native of this country, but was imported from Europe.

The perfect moth, Fig. 25, *f*, with the wings expanded, (*h*, with the wings closed, *g*, a dark variety,) measures three quarters of an inch. The fore wings are ashy gray, and on the hinder margin is a white or yellowish white stripe having three points extending into the gray, thus forming, when the wings are closed, three diamond shaped white spots. Generally there is a dark brown stripe between the white and the gray. There are also black dots scattered about on the anterior part of these wings.

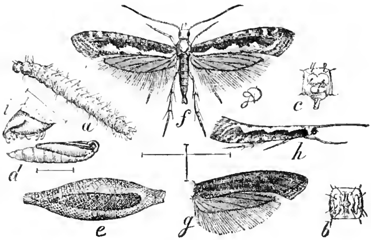


Fig. 25.

The hind wings are leaden brown, and the under side of all the wings is leaden brown, glossy, and without any dots.

The antennae are whitish with dark rings, and the abdomen white. There are two broods of this insect in this region, the moths of the first appearing in May, and those of the second in August. They hibernate in the pupa stage.

The caterpillars, Fig. 25, *a*, (*b*, the top and *c*, the side of a segment,) appear in June or July and September; they are small and cylindrical, tapering at both ends, pale green, and about one-fourth of an inch long. The head has a yellowish tinge, and there are several dark, stiff hairs scattered over the body.

When ready to transform, this caterpillar spins a delicate gauze-like cocoon, Fig. 25, *e*, made of white, silken threads, on the under side of a cabbage leaf. The pupa, Fig. 25, *d*, and *i*, the end of a pupa, is commonly white, sometimes shaded with reddish brown, and can be distinctly seen through the silken case.

The first brood is more injurious than the second, as it feeds on the young cabbage leaves before the head is formed, and this must surely stunt the growth and make weak, sickly plants; while the second brood feeds only on the outside leaves. The caterpillars are very active, wriggling violently when disturbed, and falling by a white silken thread.

Hot dry weather is favorable to them and enables them to multiply rapidly. Advantage has been taken of this fact, and spraying the plants thoroughly with water is strongly recommended. Prof. Riley states that the insects are very readily destroyed by pyrethrum. There are two species of spiders and a species of Ichneumon fly that destroy them.

THE GARTERED PLUME-MOTH.

Oxyptilus periscelidactylus (Fitch).

FIG. 26.

The caterpillars of this species draw together the young grape leaves, Fig. 26, *a*, in the spring, with fine silken threads, and feed on the inside, thus doing much damage in proportion to their size. These caterpillars, Fig. 26, *a*, and *e*, a segment greatly enlarged, are full grown in about two weeks, when they are about one-fourth of an inch long, pale green with whitish hairs arising from a transverse row of warts on each segment.

Early in June they transform to pupae, Fig. 26, *b*, which are pale green at first and change to dark brown. The surface is rough and the head is cut off obliqnely, while on the upper side near the middle are two sharp pointed horns, Fig. 26, *c*. They remain in this stage from a week to ten days, when the moths emerge.

The moths, Fig. 26, *d*, belong to the family commonly known as plume-moths or feather-wings, (PTEROPHORIDAE), from having their wings divided into feather-like lobes. When the wings are expanded they measure about seven-tenths of an inch across. They are yellowish brown with a metallic lustre, and have several dull whitish streaks and spots. The fore wings are split down the middle about half way to their base, the posterior half having a notch in the outer margin. The body is somewhat darker than the wings.

It is not known positively in what stage the winter is passed, but it is supposed to be the perfect or imago stage. The unnatural grouping and spinning of the leaves together leads to their detection, and they can be easily destroyed by hand picking and then crushing or burning them.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 13.

Directions for the Use of Fungicides and Insecticides.

APRIL, 1891.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1891.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

Henry H. Goodell, . .	*Director.*
William P. Brooks, . .	*Agriculturist.*
Samuel T. Maynard, . .	*Horticulturist.*
Charles H. Fernald, . .	*Entomologist.*
Clarence D. Warner, . .	*Meteorologist.*
William M. Shepardson, .	*Assistant Horticulturist.*
John S. Loring,	" "
Frank O. Williams, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

NOTICE. *Will the newspapers receiving this bulletin please print it in full, that the matter may be brought to the attention of the people as early as possible.*

Division of Horticulture.

S. T. MAYNARD.

The destruction of our fruits to so large an extent for the past few years by fungous pests and insects, shows us the *necessity* of using every remedy that we know of for the destruction of the causes of this loss.

The many letters received at this Station asking for specific instructions relating to the use of the best known fungicides and insecticides have led to the issue of this bulletin.

Our information is based upon the experiments made at this Station, those of the Department of Agriculture at Washington, the work of many other Stations of the country, and the practice of the large orchardists and vineyardists of the country, who have made successful use of the remedies.

The time which experiments have been carried on in this line, has not been sufficient to decide *in every case* and under *all conditions*, what may be the most economical and the safest remedy or mode of application, but enough has been learned to warrant the recommendation of the use of a few of the best known remedies, and we feel confident that if the directions are carefully followed and no unusual conditions present themselves, great benefit may be derived from their use.

FUNGOUS PESTS.

The fungous pests which the fungicides described are intended to destroy, the characteristics of which have been given in previous bulletins and in the agricultural press generally, are the Apple Scab (*Fusicladium dendriticum*), Pear Leaf Blight (*Entomosporium maculatum*),—which also causes the cracking of the fruit,—Plum Wart (*Plowrightia [Sphoeria] morbosa*), Rot of the Plum, Peach, and Cherry (*Monilia fructigena*), Downy Mildew and Brown Rot of the Grape (*Peronospora viticolor*), Black Rot of the Grape (*Laestadia Bidwellii*), Anthracnose of the grape vine (*Phaceloma ampelina*), Leaf Blight of the Strawberry (*Sphoerella fragariae*) and the Potato Leaf Blight and Potato Rot (*Peronospora infestans*).

INSECT PESTS.

The insects most injurious that can be destroyed by combined fungicides and insecticides are the codling moth (*Carpocapsa pomonella*), Tent Caterpillar (*Clisiocampa americana*), Canker Worm (*Anisopteryx vernata*), Plum Curculio (*Conotrachelus nenuphar*) Rose Beetle (*Macrodactylus sub-spinosus*), the Potato Beetle (*Doryphora decem-lineata*), and the Strawberry Crown Borer (*Tyloderma fragariae*).

FUNGICIDES (*Fungous Destroyers*).

Of the many substances suggested for the destruction of the above mentioned fungous growths, we recommend only those that are comparatively safe to use, and that have given decidedly beneficial results.

Sulphate of Copper, *Blue Vitriol.*

Formula. Dissolve 1 lb. of copper sulphate in 25 gallons of water. Used for spraying trees and vines before the leaves unfold *only*.

Sulphate of Iron, *Copperas.*

Formula. Dissolve 1 lb. of iron sulphate in 2 gallons of water.

Used for spraying trees and vines before the leaves unfold.

Bordeaux Mixture.

Formula. Dissolve 6 lbs. copper sulphate in two or three gallons of hot water. (If in a powdered form it will dissolve readily in cold water.) Slake 4 lbs. of fresh caustic lime in water enough to make a thin whitewash. When both are cool, pour the two mixtures together, stirring thoroughly, then add water enough to make 25 gallons of the mixture. Strain through a fine wire or cloth strainer before using.

This is used for the destruction of all the fungi mentioned, and may be applied before the leaves unfold, and to the foliage at any time without injury. It has been found that Paris green can be used, without injury to the foliage *in this mixture, many times* stronger than if used in water alone.

Ammoniacal Carbonate of Copper.

Formula a. Dissolve 6 oz. copper carbonate in 3 pints of liquid ammonia, strength 22°. Dilute with 25 gallons of water.

This is a cheap and easily applied liquid and is not injurious to the foliage *used alone* but Paris green *should not be used in this mixture*, as the ammonia will dissolve the arsenic and injure the foliage, even when used at the rate of 1 lb. to 500 gallons.

It is the best preparation to apply later in the summer, when the Bordeaux mixture would injure the appearance of the fruit by adhering to it.

Formula b. Mix *thoroughly* 6 oz. powdered ammonia carbonate and 1 oz. copper carbonate. Keep in air-tight vessels, and dissolve in 10 gallons of water when used.

This has the advantage of being quickly prepared and is inexpensive. It has not been so well tested in New England as formula a, and should be tried on *a limited scale* first before making the general application. *Never use Paris green with this mixture*, and applications should not be made *until the Paris green* in the Bordeaux mixture has been *washed out* somewhat by rains.

INSECTICIDES (*Insect Destroyers*).

We recommend but one insecticide in these instructions for the reason that we have had very unsatisfactory results from the use of the other arsenites, and others report much uncertainty in their results from the use of London purple and white arsenic.

FIG. 1.

METHODS OF APPLICATION.

Our cuts,* Figs. 1, 2 and 3, represent three forms of pumps that

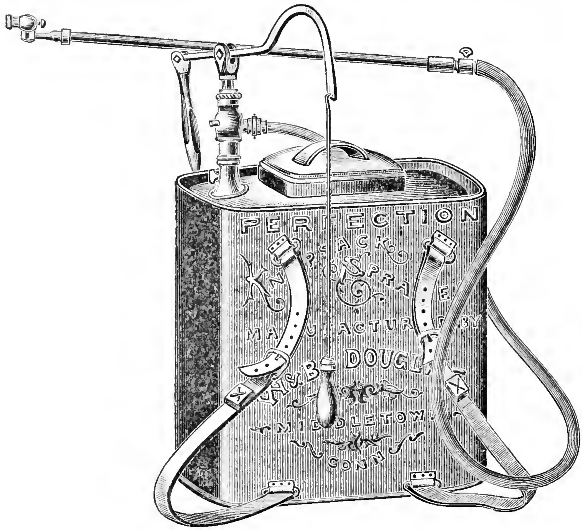


Fig. 2.

are the most useful under different conditions. Fig. 1 for the garden of a few vines or trees, Fig. 2, the Knapsack pump for the small vineyard or a few fruit trees, and Fig. 3, the pump for the large orchard or vineyard, where the liquid is to be carried some distance. The cask may be mounted either on end or on its side, on a stone-boat or wagon. These pumps may be obtained from dealers in agricultural implements and garden supplies.

Two kinds of nozzles are shown, the "Vermorel nozzle" attached to the Knapsack pump, which is one of the best, and the adjustable one attached to the large pump. Both give a fine spray, which is necessary for economy and success in the use of fungicides.

TREATMENT FOR THE APPLE.

1. Apply either the sulphate of copper, sulphate of iron, or the Bordeaux mixture before the leaves unfold to destroy any spores or germs of the apple scab that may adhere to the branches.

*These cuts were kindly loaned us by W. & B. Douglas of Middletown, Conn., and are not inserted here to advertise their pumps as the best, although we believe them to be thoroughly made and efficient for the work.

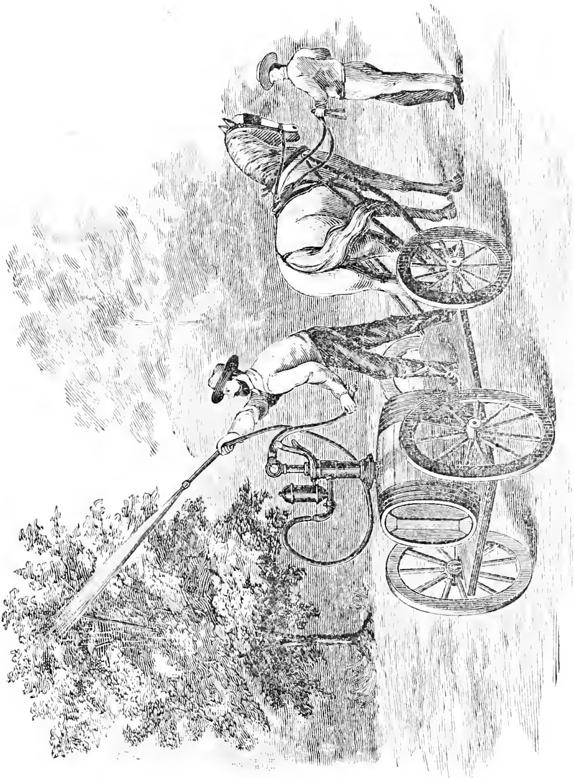


FIG. 3.

2. As soon as the petals have fallen, spray with the Bordeaux mixture *and Paris green, 1 lb. to 200 gallons*, of the mixture, for the insects and apple scab.

3. Apply the same mixture again in 8 or 10 days. Should it have *rained hard* within a few days of either spraying, another application must be made at once.

4. In about two weeks spray again with the same mixture.

5. Spray again in from two to four weeks, according to the weather, with the ammoniacal carbonate of copper, formula b, if it is found not to injure the foliage in a *trial test*, otherwise use *formula* a.

NOTE. Should the weather be clear with only light dews, one application of the Bordeaux mixture will remain effective for at least four weeks.

TREATMENT FOR THE PEAR.

For the leaf blight and the codling moth, the two most injurious pests attacking the pear, apply:

1. Bordeaux mixture, sulphate of iron, or sulphate of copper, before the leaves appear.
2. When the fruit has set, i. e., the petals have fallen, spray with the Bordeaux mixture and Paris green.
3. Repeat the spraying in eight or ten days.
4. Spray again with same mixture in two weeks.
5. Spray with ammoniacal carbonate of copper two or three weeks later.

The same care must be used in case of heavy rains in the use of Paris green as with the apple.

TREATMENT FOR THE PLUM.

To destroy the plum wart, the leaf blight, the rotting of the fruit, and the plum curculio, spray as follows:

1. Before the leaves unfold apply the same mixtures as for the apple and pear.
2. As soon as the petals have fallen, use the Bordeaux mixture and Paris green.
3. Spray again in eight or ten days.
4. Spray again in two weeks.
5. Use ammoniacal carbonate of copper, in about two weeks.
6. Apply same at intervals of two or three weeks, until the fruit begins to turn color.

TREATMENT FOR THE PEACH.

The peach crop is injured, when we are fortunate enough to have one in New England, by the plum curculio and the rotting of the fruit. The first spraying should be as for the other large fruits, but as the foliage is more easily injured than that of any other fruit, *begin the application* of the mixture recommended for the 2d and 3d spraying *one-half strength*, increasing to full strength if no injury occurs.

The 4th and 5th applications need be made only to the *early varieties*, as those ripening the last of August or September are seldom injured by the rotting of the fruit.

TREATMENT FOR THE CHERRY.

The plum curculio and rotting of the fruit are treated the same as on the peach, but the 5th application will not be needed, as the fruit ripens so early, and the 4th may be omitted with the *very early* varieties, should there be little rain.

TREATMENT FOR THE GRAPE.

1. Apply either preliminary mixture, though perhaps the Bordeaux mixture is preferable, before the leaves unfold.
2. Just before the blossoms open, use the Bordeaux mixture and Paris green for the "Rose Beetle."
3. Use the same mixture eight or ten days later, or as soon as the fruit has set.
4. Use the Bordeaux mixture *without* the Paris green, at intervals of about two weeks, up to August 1st.
5. Then make one or two applications of the ammoniacal carbonate of copper, according to the weather.

TREATMENT FOR THE STRAWBERRY.

1. Apply the Bordeaux mixture and Paris green as soon as the leaves begin to grow vigorously.
2. Use the Bordeaux mixture and Paris green just before the first blossoms open.
3. After the fruit has been gathered, if the bed is to be continued, make one application of the above mixture. The Paris green is included to destroy the "*Crown Borer*" which is injurious in some sections.

TREATMENT FOR THE POTATO.

To destroy the potato beetle and the blight and rot, apply the Bordeaux mixture and Paris green at intervals of about two weeks. Should heavy rains follow the application, it must be repeated, as is the case with the use of Paris green and plaster or water.

Should none of the potato beetles or their larvae appear, use only the Bordeaux mixture.

PREPARATION AND MIXING.

For the greatest economy three casks (kerosene or linseed oil barrels are good) are used. One cask is cut in two in the middle, the tubs made from the halves being used for dissolving the copper and lime. The second cask is used for stirring together the two mixtures, and the third cask for the attachment of the pump.

In the use of the Bordeaux mixture the liquid must be strained thoroughly, a cloth strainer being put over the barrel when the lime and the copper mixtures are poured together,and then again strained when poured into the pump cask.

CAUTION.

Animals should not be allowed under the trees or vines for a short time after the use of the Paris green mixture, although *no proof* has ever been found that they would be injured unless an unnecessary amount of the mixture was used. Chickens and young poultry might be injured by picking up the particles of lime and Paris green, but grown poultry have received no injury when allowed to run in the college vineyard and orchard where the trees were sprayed with the above mixtures, and the trunks painted with Portland cement and Paris green.

Paris green and all other arsenites should be kept out of the reach of children, irresponsible persons, and domestic animals.

We would advise the trial of the mixtures, on a small scale, *if a larger* amount of Paris green is used than is here recommended. We believe, however, that more frequent applications will give better results than an increased strength of the mixture.

NOTICE TO EXPERIMENTERS.

No experiment will be of any value unless some trees or vines of *the same kind* and in *the same condition* are left untreated, as check trees. Two or three trees under each treatment, a few grape vines, one or two rows of strawberries or potatoes, untreated will be sufficient, but such checks *must be provided* or it will be impossible to judge of the value of any application.

The season is advancing so rapidly that if the buds have burst and the leaves begin to show, use only the Bordeaux mixture for the first application. While it is not positively known that the sulphate of Copper and iron solutions will injure the foliage at this stage it is best to be on the safe side and use only the Bordeaux mixture which is certainly harmless, using the two other solutions on a few trees or vines only.

The top branches of high trees are best reached by using longer hose and fastening the nozzel at an angle of about 45° to a light pole 10 or 12 feet long, winding the hose around the pole a few times to better enable the operator to get around with it.

GIRDLING GRAPES.

BY JABEZ FISHER.

I send you the details and results of a repetition of the experiment furnished a year ago in girdling grapes. The same vines were treated as last year with some additional ones. The operation was performed July 18th and 19th, when the berries were as large as peas. The tool used was the small blade of an ordinary jackknife and it required fourteen hours' service by a fifteen years old boy to complete 648 girdles, the particular spots being marked in advance. A part of them were upon one of the two arms forming each vine, but the larger portion included both arms, leaving a few central shoots only, untreated. The ring of bark removed was from one-half to three-fourths of an inch in length.

The girdled grapes showed color Aug. 17th, and the ungirdled Aug. 25th. Those girdled were first sent to market Sept. 22d, and the others Oct. 3d, eleven days later, against ten days in 1889.

The analysis as made by Dr. C. A. Goessmann is here given:

Gathered Sept. 22d.	Girdled.	Not Girdled.
Moisture at 100° C.,	84.93	86.49
Ash,	.48	.47
Grape sugar,	9.29	7.36
Acid (Tartaric),	1.17	1.15

At this time the girdled grapes were fairly well ripened, very nearly as good as they became a week later, and better than those gathered Oct. 8th. They were sweet with about the right proportion of acid, while those not girdled were quite sour and uneatable.

The second gathering took place Oct. 8th near the close of the harvesting and the analysis follows:

Gathered Oct. 8th.	Girdled.	Not Girdled.
Moisture at 100° C.,	85.16	85.38
Ash,	.54	.59
Sugar,	9.12	6.65
Acid (Tartaric),	.74	.51

At this date the girdled grapes had lost a little of their sparkle, and the others had attained an apparently satisfactory amount of sugar with very little undue acid, and yet the analysis tells us that while the former had lost two per cent. of sugar with thirty-seven per cent. of acid, the latter had lost nearly ten per cent of the sugar that they held Sept. 22d when uneatable, but had also lost more than fifty per cent. of their acid. This would indicate that the absence of acid* is of more importance in rendering grapes palatable than the presence of sugar in excess, and it would seem that the ripening process involves more the lessening of acid than the increase of sugar.

The enlargement in size of berries from girdling was from twenty-five to forty per cent. and although upwards of five inches of rain fell between Sept. 6th and 18th, which caused many of the berries to split open and threatened destruction to the whole, the more favorable weather which followed suspended this resnlt and they went to market in good condition and were all sold before the others were ready to follow.

The fruit remaining on the vines of which one arm had been girdled was decidedly inferior to that on ungirdled vines, both in earliness of ripening and quality, insomuch reducing the advantages of the operation, while the fruit on the two to four central shoots between two girdled arms on the same vine was worthless, showing that there is some robbing of Peter to pay Paul and suggests whether it is possible to long continue the operation without injury to the ripening of the roots of the vine. The three years in which this treatment has been carried out has not developed as yet an answer to this question.

The Use of Sulphate and Muriate of Potash.

Upon one of three contiguous vineyards of an acre each, the form in which potash is applied has for four years been different from the others. A formula is compounded which is intended to supply 25 lbs. of phosphoric acid, 30 lbs. of nitrogen and 75 lbs. of potash to the acre, annually. Two of these vineyards have been furnished with potash in the form of muriate, and the other as a higher grade sulphate. Fruit was gathered from each of these vineyards Oct. 8th, the analysis of which is here given:

	Muriate of Potash.	Sulphate of Potash.
Moisture at 100° C.	85.38	85.11
Ash,	.59	.53
Sugar,	6.65	7.67
Acid,	.51	.71

The analysis of the ash follows:

	Muriate of Potash.		Sulphate of Potash.	
	In dry matter.	In ash.	In dry matter.	In ash.
Potassium Oxide,	1.55	42.61	1.68	46.28
Phosphoric Acid,	.34	8.63	.30	8.26
Nitrogen,	.78		.80	

The fruit was equally ripe in the two vineyards and while there appeared to be about the same proportion of sugar and acid, there was to the taste a slight preference for those treated with sulphate of potash, as if the vines in the other case had been somewhat overloaded, which was not the case.

*This is shown by the analysis of the Iona grape which most persons will pronounce an acid grape but which really contains more sugar than the Delaware.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 14.

FERTILIZERS FOR CORN.

MAY, 1891.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1891.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
JOHN S. LORING,	" "
FRANK O. WILLIAMS, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Agriculture.

William P. Brooks.

SOIL TESTS WITH FERTILIZERS.

During the season of 1890 Soil Tests with Fertilizers have been carried out under my supervision in the counties of Essex, Middlesex, Plymouth, Bristol, Barnstable, Worcester, Hampshire, Hampden, Franklin and Berkshire. Besides these we have had two acres in a similar experiment with corn upon our own grounds and several volunteer workers in different sections of the state. In the following pages will be found an account of the experiments in the several counties above named as well as of those on our own grounds and of one by a volunteer worker whose crop was more or less directly under our eyes during growth and which was weighed at harvest by my assistant.

The plan of experiment was similar to that followed in 1889 and it is described in detail in Bulletin No. 9 of this Station. One acre was used in each experiment and the crop was corn. In each acre were laid out fifteen plots (with one exception where there were fourteen) of one-twentieth of an acre each: and the fertilizers used were *nitrate of soda*, *dissolved bone-black*, *muriate of potash*, land plaster, lime and barn-yard manure. The first three mentioned fertilizers were selected as sources respectively of *nitrogen*, *phosphoric acid* and *potash* which are recognized to be essential elements of all fertilizers and manures,—often indeed they appear to be the only essential elements. The reason for selecting these materials is that they allow us to furnish essentials of plant food singly or in any desired combination. Other materials might serve the farmer's purpose equally well; but for our purpose we must have forms of fertilizers which enable us to trace results to definite causes.

In these experiments we, in effect, ask the soil:—"What must you have to enable you to produce a crop," and in proportion as natural inequalities of the soil and accidental causes of variation are avoided the answers are definite and valuable. Our experiments might be regarded as complete without the plots on which barn-yard manure, lime and plaster are used, in so far as affording an answer to the above question is concerned: but, for purposes of comparison, these extra plots are introduced.

The materials used were each applied at the following rates wherever employed:—

Per acre,	*Pounds.*
Nitrate of soda,	160
Dissolved bone-black,	320
Muriate of potash,	160
Lime,	160
Land plaster,	160
Barn-yard manure,	5 cords

The materials were all sampled and analyzed and the manure used was weighed, so that we are able to calculate the amounts of the essentials—nitrogen, phosphoric acid and potash—applied to the plots receiving this material, and thus to institute interesting comparisons with the plot receiving the same elements in the form of fertilizers. These comparisons will appear under the several experiments.

The fertilizers used:—

Nitrate of Soda.

Moisture at 100° C.,	.90 per cent.
Nitrogen,	15.70 " "
Sodium oxide,	34.66 " "

Dissolved Bone-black.

Moisture at 100° C.,	15.96 per cent.
Organic and volatile matter,	31.79 " "
Total phosphoric acid,	15.06 " "
Soluble " "	14.19 " "
Reverted " "	.18 " "
Insoluble " "	.69 " "
Insoluble matter,	7.27 " "

Muriate of Potash.

Moisture at 100° C.,	.43 per cent.
Potassium oxide,	50.97 " "
Chlorine,	48.64 " "
Insoluble matter,	.11 " "

Calcium Sulphate.

Moisture at 100° C.,	14.05 per cent.
Calcium oxide,	32.65 " "
Sulphuric acid,	41.90 " "
Insoluble matter,	2.22 " "

Lime.

Calcium oxide,	74.79 per cent.
Insoluble matter,	0.77 " "

The following comparison between the amounts of the essentials furnished by the fertilizers used and the amounts found in fifty bushels of corn and its usual proportion of stover and cobs is of interest:

	Furnished pounds.	*Required pounds.*
Nitrogen,	25.12	91
Phosphoric acid,	48.19	29
Potash,	81.55	63

It will be noticed that nitrogen is applied in far less amount than the crop requires, while phosphoric acid is applied in large and potash in moderate excess of the requirements of the crop.

The manures used in the several experiments varied widely; but all supplied far more nitrogen than the fertilizers, while the potash was in a number of cases much less. Herein, perhaps, lies, at least in part, the explanation of the fact that of the different elements of plant food potash seems to be more often proportionally deficient in soils than either phosphoric acid or nitrogen.

In all cases fertilizers and manures were evenly spread broadcast upon the ploughed land and harrowed in just previous to planting the seed.

The selection of seed was left to the individual experimenters, as it was felt that success would be more certain with varieties suited to the several localities and familiar to the cultivators. In most cases a variety of yellow flint corn was selected. The rows were in all cases three and a-half feet apart and hill planting was generally adopted.

Each experimenter was furnished with a standard maximum and minimum thermometer and a rain guage; and, although accidental breakages of instruments caused some irregularities, observations were generally kept up from the time of planting to the time of harvest. A summary of the record of each observer will be found under the account of his experiment.

Each experiment was visited twice either by myself or by my assistant, Mr. F. O. Williams, and the latter gentleman assisted in the harvest, weighed the crops on the several plots and took a sample from each in every experiment.

A large number of systematic measurements were taken by most of the experimenters. These were advised with a view to the study of the effects of the several fertilizers during different stages of the growth of the crop. The general method of measurement was to take every sixth to tenth hill (varying according to length of row) in the middle row of each plot. The leaves were straightened to the highest possible point, and from the tip to the ground was the height recorded. The records will be found under the appropriate experiments.

Before giving a detailed account of these experiments a few general explanations are necessary. In each experiment the weight of the entire product of each plot was taken, hard corn, soft corn, and stover separately. In converting hard corn into bushels 75 pounds of ears are considered equal to one bushel of shelled corn and in the case of soft corn, 90 pounds. In obtaining the value of the crop, hard corn is estimated at seventy-five cents and soft corn at thirty cents per bushel, and stover at $5 per ton. The bare cost only of fertilizers is taken into consideration in calculating profit or loss No account is made of the labor of applying. Nitrate of soda is estimated at $50 per ton; Dissolved bone-black at $30; Muriate of potash, at $40; Plaster, at $9; and Lime at $12: and barn-yard manure, at $5 per cord.

In determining gain or loss from any plot it is compared with the two nearest nothings, each being given a weight inversely proportional to its distance from the plot under comparison.

In the determination of the effect of each of the ingredients of plant-food—nitrogen, phosphoric acid and potash—four comparisons are made. For example in the case of nitrogen:

1. The crop where nitrogen alone is applied is compared with the average of the two nearest nothings.

2. The increase (*or decrease*) when nitrogen and phosphoric acid are used is compared with the increase (*or decrease*) where phosphoric acid only is used.

3. The increase (*or decrease*) where nitrogen and potash are used is compared with the increase (*or decrease*) where potash only is used.

4. The increase (*or decrease*) where nitrogen, phosphoric acid and potash are used is compared with the increase (*or decrease*) where the two latter only are used.

5. The results of the four comparisons are added, the sum divided by four, and the result is considered the average increase (*or decrease*) due to nitrogen.

Upon this average the profit or loss from the use of nitrogen is calculated, no allowance being made for unexhausted residue.

Similar comparisons and calculations are made for phosphoric acid and potash. The results for all these ingredients are shown in tabular form under each experiment.

For convenience of comparison with each other and with the results just mentioned the net results of the use of "complete fertilizer," barn-yard manure, plaster and lime are shown in another table, although this plan involves the repetition of some of the figures given in the general tabular view of the entire experiment. Below this table will be found a calculation as to financial result of the use of each. In this calculation no allowance is made for unexhausted residue of either manure or fertilizer. This omission undoubtedly makes the showing for manure more unfavorable than it should be. If we make the usual allowance of one-half, the manure will come much nearer paying for itself and for labor of application which, it should be remembered, has not been charged. The expression "complete fertilizer" is used in the ordinary sense, to designate a mixture which supplies nitrogen, phosphoric acid and potash.

MARBLEHEAD.

SOIL TESTS WITH FERTILIZERS FOR CORN.

By William S. Phillips, Jr.

No. of Plot.	FERTILIZERS.		Yield per plot 1-24 acre.			Yield per acre.			Gain or loss compared with Nothing Plots per acre.		
	KIND.	Pounds per acre.	Ears. Hard, lbs.	Ears. Soft, lbs.	Stover, lbs.	Shelled Corn bushels. Hard.	Shelled Corn bushels. Soft.	Stover, lbs.	Shelled Corn bushels. Hard.	Shelled Corn bushels. Soft.	Stover, lbs.
1	Nothing		66	10¾	104¼	21.1	2.9	2502			
2	Nitrate of soda	160	99	4	136	31.7	1.1	3264	11.	—1.1	532
3	Dissolved bone-black	320	66	5¼	154¼	21.1	1.4	3702	.7	—.4	740
4	Nothing		62½	3	133	20.	.8	3192			
5	Muriate of potash	160	97	3¼	202¾	31.	.9	4866	9.5	.3	1669
6	{ Nitrate of soda { Dissolv'd bone-bl'ck	160 320	87	4	142	27.8	1.1	3408	4.9	.6	189
7	{ Nitrate of soda { Muriate of potash	160 160	114	2½	154½	36.5	.7	3708	12.1	.4	475
8	Nothing		80½	½	135¼	25.8	.1	3246			
9	{ Dissolv'd bone-bl'ck { Muriate of potash	320 160	97	1½	212½	31.	.4	5100	3.4	.3	1924
10	{ Nitrate of soda { Dissolv'd bone-bl'ck { Muriate of potash	160 320 160	135	2	192	43.2	.5	4608	13.7	.4	1503
11	Land plaster		82	1	123	26.2	.3	2952	—5.1	.2	—83
12	Nothing	*5	103½	½	123½	33.1	.1	2964			
13	Barn-yard manure		146	½	215	46.7	.1	5160	15.1	0	2268
14	Lime	160	70½	½	99¼	22.6	.1	2382	—7.4	0	—438
15	Nothing		89	½	114½	28.5	.1	2748			

*Cords.

Average of nothing plots; hard corn, 25.7 bushels; soft corn, 0.8 bushels; stover, 2930 pounds.

The field selected for this experiment adjoined that used last year. It lies just south of Forest river, near Salem harbor and has a considerable slope towards the river, i. e., to the north. The soil is a fine gravelly loam for a long time in grass without manure.

The upper ends of the plots which run up and down the slope varied in natural fertility so much that we threw them out, taking the lower five-sixths of each plot only into account. The variety planted was eight-rowed yellow flint corn. The field was planted May 23d; stooked, Oct. 4th and 5th and husked Oct. 31st. It was well cared for throughout the season. In July, plot No. 10 appeared to be the best, while No. 13 was nearly equal to it. In August the position of these plots was reversed. Throughout the season Nos. 9, 7, 6, 5, and 2 were nearly even.

RESULTS OF MEASUREMENTS.

No. of Plot	FERTILIZER USED.	Average of Measurements.					
		June 9	June 19	July 1	July 14	July 25	Aug. 5
1	Nothing	3.5	8.3	16.1	37.1	53.2	75.3
2	Nitrate of soda	4.2	8.3	16.9	42.1	58.9	72.8
3	Dissolved bone-black	3.6	7.3	14.5	36.5	53.8	75.7
4	Nothing	3.5	6.3	13.2	34.5	49.6	71.9
5	Muriate of potash	3.4	7.5	15.	37.7	54.	76.9
6	Nitrate and bone-black	3.5	7.3	15.6	40.5	56.5	77.4
7	Nitrate and potash	3.8	8.2	17.4	40.5	57.7	78.
8	Nothing	3.1	6.8	13.9	37.7	55.5	77.
9	Bone-black and potash	3.7	8.3	16.7	40.	57.5	79.8
10	Nitrate, bone-black and potash	3.8	8.8	18.4	43.7	62.5	85.4
11	Land plaster	3.8	7.3	14.5	36.5	56.	74.3
12	Nothing	3.5	7.6	16.	33.3	53.2	74.8
13	Barn-yard manure	4.5	9.4	19.	43.7	61.7	85.9
14	Lime	3.2	6.8	14.5	34.3	53.	77.6
15	Nothing	3.3	7.	14.6	33.9	54.4	74.1

No important falling off in the condition of the plots receiving the fertilizers with the advance of the season is shown. The effect was early shown and well maintained in most cases.

ANALYSIS OF THE MANURE USED.

Moisture at 100° C.,	67.28 per cent.
Potassium oxide,	.387 "
Phosphoric acid,	.289 "
Nitrogen,	.388 "
Insoluble matter,	14.481 "

Mr. Phillips used 1376 lbs. of manure. At this rate per acre, the manure would supply:—nitrogen, 106.8 pounds; phosphoric acid, 79.5 pounds; and potash, 106.5 pounds. Plot 13 was manured at this rate, while plot 10 received chemicals, furnishing: nitrogen, 25.1 pounds, phosphoric acid, 48.2 pounds and potash, 81.6 pounds —one-quarter as much nitrogen, but little more than one-half as much phosphoric acid and four-fifths as much potash; and yet plot 10 gave a larger crop than thirteen, though not quite so large an increase over the neighboring nothings.

SUMMARY OF WEATHER OBSERVATIONS.

May 1 to Sept. 1, 1890.

Month.	Temperature in open air in Degrees Fahrenheit.										Monthly Range.	Rainfall, Inches.
	Means of Daily.			Highest.		Lowest.		Greatest Daily Range.				
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.			
May,	70.2	44.6	25.6	89	31st	36	11th	36	16th		53	6.83
June,	78.7	52.6	26.1	97	25th	45	9th	36	18th		52	4.20
July,	86.5	58.6	28.	103	16th	47	21st	39	11th		56	2.39
August,	86.8	56.	30.8	98	15th	47	24th	47	15th		51	3.67
Season,*	80.6	53.	27.6	103	July 16	36	May 11	47	Aug. 15		67	17.09

*124 days.

This year, as last, this station shows a wide degree of variability. It has the highest maximum and the greatest range for the months under observation.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	11	4.2	2.6	10.3	7.0
Soft corn, " "	–1.1	1.	1.	1.	.0
Stover, pounds "	532	–551	–1185	–421	–406
Value of net average increment,				$3.88	
Financial result,				.12 loss	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	.7	–6.1	–6.1	1.6	–2.5
Soft corn, " "	–.4	1.7	0	0	.3
Stover, pounds "	740	–343	264	1028	422
Value of net average increment,				$ .60	
Financial result,				5.40 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'ric Acid.	Average Result.
Hard corn, bushels per acre,	9.5	1.1	2.7	8.8	5.5
Soft corn, " "	.3	1.5	.7	–.2	.6
Stover, pounds "	1660	–57	1184	1314	1025
Value of net average increment,				$6.59	
Financial result,				3.39 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	13.7	15.1	–5.1	–7.4
Soft corn, " "	.4	0	.2	0
Stover, pounds "	1503	2268	–83	–437

	Fertilizer	Manure	Plaster	Lime
Value of increment due to	$13.47	$16.24		
Value of decrease due to			$3.72	$6.28
Financial result,	1.47 gain	8.76 loss	4.44 loss	7.24 loss

The results of the use of nitrogen and potash are quite similar in kind, though potash causes the larger and the only profitable increase. It is noticeable that both appear to cause a large increase over nothing, i. e., where used alone; but little increase where used with either of the other elements alone; and a large increase where used with both the others. This indicates, to my mind, a considerable degree of general exhaustion. The addition of nitrogen to potash alone could not increase the crop much because phosphoric acid was wanting; neither could a similar addition to phosphoric acid produce much increase because potash was wanting: but add nitrogen to both phosphoric acid and potash and the result is a considerable increase. Similar reasoning applies to potash. True, the large increase over nothing in the case of the use singly of either nitrogen or potash is inexplicable on this theory. I can but conclude that this increase was due to natural inequalities in the soil rather than to the fertilizer used.

Phosphoric acid does not appear to have been as much required as either of the other elements. That it decreased the crop as indicated in two cases is not supposed to be the case. This result must have been due to accidental causes. It is noticeable that the largest increase was where phosphoric acid was added to nitrogen and potash.

Complete fertilizer caused an increase sufficient to pay for itself and a little more, while both lime and plaster were used at a loss.

For this soil I should advise for corn a fertilizer rich in potash, containing materials to furnish per acre about:—potash, 80 pounds, nitrogen, 25 pounds, and phosphoric acid, 25 pounds.

With such manure as was used, I should advise the application of materials to furnish about 40 pounds of available potash per acre, say 80 pounds of muriate of potash.

CONCORD.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Frank Wheeler.

	FERTILIZERS.		Yield per plot 1-20 acre.			Yield per acre.			Gain or loss compared with Nothing Plots per acre.		
	KIND.	Pounds per acre.	Ears. Hard, lbs.	Ears. Soft, lbs.	Stover, lbs.	Shelled Corn bushels. Hard.	Shelled Corn bushels. Soft.	Stover, lbs.	Shelled Corn bushels. Hard.	Shelled Corn bushels. Soft.	Stover, lbs.
1	Nothing		244	1	335	65.1	.2	6700			
2	Nitrate of soda	160	262½	1½	345	70.	.3	6900	2.6	.1	153
3	Dissolved bone-black	320	255½	1	341	68.1	.2	6820	—1.6	0	27
4	Nothing		270	1	342	72.	.2	6840			
5	Muriate of potash	160	271¼	1	416¼	72.3	.2	8325	1.4	0	1622
6	Nitrate of soda Dissolved bone-bl'ck	160 320	262½	2	318¼	70.	.4	6365	.1	.2	—200
7	Nitrate of soda Muriate of Potash	160 160	293¾	2	459¾	78.3	.4	9195	9.5	.2	2767
8	Nothing		254	1	314½	67.7	.2	6290			
9	Dissolved bone-bl'ck Muriate of potash	320 160	275¼	2	400¼	73.4	.4	8005	7.	.1	2317
10	Nitrate of soda Dissolved bone-bl'ck Muriate of potash	160 320 160	294½	2	441	78.5	.4	8820	13.4	—.1	3735
11	Land plaster	160	239½	4½	315½	63.9	.1	6310	.2	.4	1827
12	Nothing		234	3	194	62.4	.7	3880			
13	Barnyard manure	*5	275½	7¼	366¼	73.5	1.6	7325	11.3	.3	2727
14	Lime	160	209¼	5	341¾	55.8	1.1	6835	—6.1	—.7	1518
15	Nothing		231¼	11	301¾	61.7	2.4	6035			

*Cords.

Average of the nothing plots; hard corn, 65.8 bushels; soft corn, 0.7 bushels; stover, 5949 pounds.

The field used for this experiment is nearly level; the soil a good sandy loam, with a smooth fine, almost loamy, sandy subsoil, changing to clear sand at a depth of 2½ to 3 feet, except in one corner where it is more compact or clayey, which probably affected in a slight degree unfavorably, one end of plots 11, 12, 13, 14 and 15. The land was in pasture until about twenty years ago. Since that time it had been alternately under the plough and in hay and had been ploughed once in from three to five years. For the last eight years it had been under high culture, being ploughed once in four years with a good dressing of manure and chemicals for sweet corn, and in hay the other three years with a yearly dressing of either manure or chemicals. It had been top-dressed the preceding fall and was in condition to bear a good crop without further manuring, as will be seen by reference to the yield of the nothing plots.

The experiment was admirably managed in every respect, not being hand hoed at all, and yet being kept almost perfectly free from weeds. The variety of corn was an eight-rowed, yellow flint. It was planted May 16th and 17th, in hills 3 feet 4½ inches apart each way, and three stalks were left in each hill. It was stooked Sept. 25th, and husked Nov. 20th.

Notwithstanding the high condition of the soil, the potash where-ever used produced a very perceptible improvement from the first. The nitrate of soda also showed itself, though to a less extent. Both in July and in August when visited, No. 10 was the best plot in the field. Next in order were 13, 9, 7, 6, and 5.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Averages of Measurements.			
		July 2	July 16	July 31	Aug. 30
1	Nothing,	33.	57.	76.	90.
2	Nitrate of soda,	36.	61.	77.	91.
3	Dissolved bone-black,	34.	59.	80.	88.
4	Nothing,	35.	59.	79.	90.
5	Muriate of potash,	36.	62.	80.	92.
6	Nitrate and bone-black,	33.	59.	78.	88.
7	Nitrate and potash,	35.	62.	80.	92.
8	Nothing,	34.	57.	72.	86.
9	Bone-black and potash,	35.	62.	82.	95.
10	Nitrate, bone-black and potash,	37.	64.	84.	96.
11	Land plaster,	30.	55.	75.	88.
12	Nothing,	29.	53.	69.	89.
13	Barn-yard manure,	36.	62.	83.	96.
13	Lime,	30.	54.	72.	88.
15	Nothing,	32.	55.	69.	90.

These figures afford no positive evidence of a comparative falling off in the plots receiving fertilizer with the advance of the season, except possibly in the case of plot 2, where nitrate of soda only was applied. This, considerably better than No. 1 July 16th, is but little superior in height, two weeks later.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	55.22 per cent.
Potassium oxide,	.346 "
Phosphoric acid,	.211 "
Nitrogen,	.290 "
Insoluble matter,	28.528 "

The load used weighed 1550 pounds. This furnished at the following rates, per acre; nitrogen, 89.9 pounds; phosphoric acid, 65.4 pounds and potash, 107.3 pounds. This causes an increase of only 11.7 bushels of hard corn per acre.

SUMMARY OF WEATHER OBSERVATIONS.

June 1st to Sept. 21st, 1890.

Month.	Temperature in open air in Degeees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Monthly Means of			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June,	76.3	51.3	25.0	87	11 & 30	40	3rd	40	10th	47	3.64
July,	83.4	55.1	28.3	94	31st	40	20th	39	22d	54	2.01
August,	79.4	54.9	23.5	88	17th	46	31st	37	17th	42	4.31
Sept.,	74.1	55.4	18.7	84	5th	45	19th	30	19th	39	4.61
Season,*	78.	53.8	24.2	94	July 31	40	June 3d July 20	40	June 10	64	14.57

*112 Days.

These records show a comparatively wide range of temperature at this station; and, as compared with most, low miminums for June and July, while in August the thermometer did not fall as low as at many of the stations.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result
Hard corn, bushels per acre,	2.6	1.7	8.1	6.4	4.7
Soft corn, " "	.1	.2	.2	–.2	.1
Stover, pounds "	153	–227	1145	1418	622

Value of average net increment,	$4.89
Financial result,	.88 gain

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	–1.6	–2.5	5.6	3.9	1.4
Soft corn, " "	0	.1	.1	–.3	0
Stover, pounds "	27	–353	695	968	334
Value of average net increment,				$1.82	
Financial result,				2.98 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosph'ic Acid.	Nitrate and Phos-ph'ic Acid.	Average Result.
Hard corn, bushels per acre,	1.4	6.9	8.6	13.3	7.6
Soft corn, " "	0	.1	.1	–.3	.0
Stover, pounds "	1622	2614	2290	3935	2615
Value of average net increment,				$11.86	
Financial result,				8.66 gain	

RESULT OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	13.4	11.3	.2	–6.1
Soft corn, " "	–.1	.3	.4	–.7
Stover, pounds "	3735	2727	1827	1518
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$18.69	$14.82	$4.83	
Value of decrease due to				$ .68
Financial result,	6.69 gain	10.18 loss	4.11 gain	1.64 loss

These comparisons make it evident that on this soil potash was the ingredient most needed; but it produces its most marked increase when used with nitrogen and phosphoric acid, and more when used with either of these singly than when used alone. A large share of the profit on its use is due to the increase in stover.

Nitrogen proves moderately beneficial, especially when added to a plot which had received also potash. It is probable that this influence is due to the quicker start which it gives to the crop, sustained by the potash later in the season.

It should be noticed that the "complete fertilizer" produces a much larger increase than the manure, although it furnishes less than one-third the nitrogen, only about two-thirds the phosphoric acid and four-fifths the potash supplied by the latter.

The "complete fertilizer" gives a considerable profit on its use; but in view of the facts that phosphoric acid seems to do very little good in any plot and that nitrogen causes but a comparatively small increase, it appears probable that a fertilizer differently compounded would have proved more profitable.

For this soil I should recommend fertilizers like those recommended for Marblehead, page 11, *whether to be used alone or with manure such as was used here.*

BRIDGEWATER.

SOIL TEST WITH FERTILIZERS FOR CORN.

By A. D. Copeland.

Number of plots.	FERTILIZERS. KIND.	Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing		3	12	34	.8	2.7	680			
2	Nitrate of soda	160	8	18	42	2.1	4.	840	1.2	1.1	133
3	Dissolved bone-black	320	10	17	45	2.7	3.8	900	1.7	.7	167
4	Nothing		4	15	38	1.1	3.3	760			
5	Muriate of potash	160	21	17	47	5.6	3.8	940	3.6	0	120
6	Nitrate of soda Dissolved bone-bl'ck	160 320	12	17	39	3.2	3.8	700	.2	—.4	—100
7	Nitrate of soda Muriate of potash	160 160	48	32	70	12.8	7.1	1400	8.9	2.4	460
8	Nothing		18	23	50	4.8	5.1	1000			
9	Dissolved bone-bl'ck Muriate of potash	320 160	52	29	85	13.9	6.4	1700	9.	1.1	670
10	Nitrate of soda Dissolved bone-bl'ck Muriate of potash	160 320 170	75	36	115	20.	8.	2300	15.	2.5	1240
11	Land plaster	160	24	33	63	6.4	7.3	1260	1.4	1.7	170
12	Nothing		19	26	56	5.1	5.8	1120			
13	Barn-yard Manure	*5	72	41	117	19.2	9.1	2340	11.5	2.8	993
14	Lime	160	30	32	65	8.	7.1	1300	—2.2	2.1	—273
15	Nothing		48	33	90	12.8	7.3	1800			

*Cords.

Average of the nothings: hard corn, 4.9 bushels; soft corn, 4.8 bushels; stover, 1072 pounds.

This experiment was located upon a level piece of land; the soil, a very poor, gravelly loam which had been in grass many years without manure. It was planted rather late, owing to illness, with an early variety of Dent corn. The arrangement was perfect and the field well adapted for the purpose; but germination was uneven and squirrels did considerable damage. There were many vacant hills, especially in plots 1 and 2. We, however, report the actual yield. The date of planting was June 9th; the crop was stooked Sept. 27th and husked Oct. 11th. Plot No. 15 was benefited by manure used on the land adjoining it.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements.					
		July 3	July 17	July 29	Aug. 9	Aug. 21	Sept. 3
1	Nothing.	6.7	10.9	19.7	34.3	51.6	61.
2	Nitrate of soda.	8.4	12.	24.3	40.1	55.1	63.2
3	Dissolved bone-black.	8.9	15.8	28.3	48.3	58.1	63.8
4	Nothing.	7.9	10.6	20.2	36.7	47.3	57.5
5	Muriate of potash.	8.6	19.	24.7	39.8	53.	65.
6	Nitrate and bone-black.	11.	17.	31.3	52.5	50.2	59.3
7	Nitrate and potash.	12.6	20.6	27.5	60.4	64.7	78.4
8	Nothing.	8.1	14.8	24.8	48.	57.5	69.6
9	Bone-black and potash.	10.1	19.	42.5	53.	68.6	78.7
10	Nitrate, bone-black and potash	13.5	22.5	58.8	68.	77.7	88.2
11	Land plaster.	8.7	16.8	35.1	42.5	55.	67.5
12	Nothing.	7.3	12.6	32.6	42.8	64.5	74.8
13	Barn-yard manure.	13.	21.9	48.9	65.	76.5	83.5
14	Lime.	8.3	12.8	36.1	42.6	55.4	69.2
15	Nothing.	8.1	16.2	35.8	43.8	58.7	67.8

In this experiment, too, nitrate of soda excels the adjacent nothings more in mid-season than at the close, indicating either that it had been washed away or entirely used up before the end of the season. We must be cautious about drawing deductions here, however, because the plants measured were not the same each time.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	76.37	per cent.
Potassium oxide,	.370	"
Phosphoric acid,	.368	"
Nitrogen,	.420	"
Insoluble matter,	7.835	"

This manure weighed 43 pounds to the cubic foot, 1376 pounds were used on the plot. This amount furnishes, per acre: nitrogen, 115.6 pounds; phosphoric acid, 101.3 pounds, and potash, 101.8 pounds. Yet on this poor land it increased the crop only about fourteen bushels per acre. The poorness of this result was doubtless largely due to the lateness of planting and the many vacancies in the field.

SUMMARY OF WEATHER OBSERVATIONS.

June 12 to September 29, 1890.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Means of Daily.			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June.	75.8	50.5	25.4	87	19th	42	16th	35	12th	45	1.99
July.	83.3	55.5	27.7	93	17th	43	19th	40	10th	50	1.33
August.	81.2	54.4	23.9	93	1st	42	26th	36	16th	51	2.38
Sept.,	74.2	50.1	24.2	86	7th	33	24th	35	22d	53	3.77
Season,*	79.1	53.9	25.2	93	July 17 Aug. 1	33	Sept.24	40	July 10	60	9.47

*109 days.

These observations indicate an unusually low range of temperature and a very light rainfall, conditions which must have seriously aggravated the other unfavorable conditions already mentioned.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	1.2	−1.5	5.3	6.	2.8
Soft corn, " "	1.1	−1.1	2.4	1.4	1.
Stover, pounds, "	133	−267	340	570	194
Value of average net increment,				$2.75	
Financial result,				1.25 loss	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing,	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	1.7	1.	5.4	6.1	3.1
Soft corn, " "	.7	−1.5	1.1	.1	.1
Stover, pounds "	167	−233	550	780	316
Value of average net increment,				$2.99	
Financial result,				1.81 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phosphoric Acid.	Aver. Result.
Hard corn, bushels per acre,	3.6	7.7	7.3	14.8	8.4
Soft corn, " "	0	1.3	.4	2.9	1.2
Stover, pounds "	120	327	503	1340	573
Value of average net increment,				$7.67	
Financial result,				4.47 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre.	15.	11.5	1.4	−2.2
Soft corn, " "	2.5	2.8	1.7	2.1
Stover, pounds "	1240	993	170	-273

	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$14.35	$11.37	$1.92	
Value of decrease due to				$1.59
Financial result.	2.35 gain	13.63 loss	1.20 gain	2.55 loss

These comparisons make it strikingly evident that this soil, almost exhausted as it was, was to a large degree specially exhausted. It needed nitrogen, phosphoric acid and potash: but the latter to a far greater degree than either of the others. They, if potash also was present, produced a considerable increase; but if it was absent, only a very small one. The two together are almost powerless to increase the crop. Potash, on the other hand, even alone causes considerable increase: with either nitrogen or phosphoric acid, the increase due to potash is doubled: with both of them and potash, the increase due to the latter is doubled yet again, amounting to no less than about seventeen bushels of corn per acre.

The "complete fertilizer" yields a small profit; and though furnishing but little more than one-fifth the nitrogen, but one-half the phosphoric acid and but four-fifths the potash contained in the manure used, gives a larger apparent increase than the latter. The real effect of the manure was, however, probably rather greater than the figures indicate, since one of the nothings with which it was compared, as already stated, felt the effect of the manure applied to the adjoining field.

For this soil, I should recommend a similar use of fertilizers to that suggested for Marblehead, page 11, but in larger amounts and with a somewhat larger proportion of phosphoric acid.

FREETOWN.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Silas P. Richmond.

Number of plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Yield per plot 1-20 acre. Ears. Soft, lbs.	Yield per plot 1-20 acre. Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Yield per acre. Shelled Corn bushels. Soft.	Yield per acre. Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Soft.	Gain or loss compared with Nothing Plots per acre. Stover, lbs.
1	Nothing		24	8	29	6.4	1.8	580			
2	Nitrate of soda	160	73	12	35	19.5	2.7	700	11.4	.8	—40
3	Dissolved bone-black	320	61	12	40	16.3	2.7	800	6.4	.7	—100
4	Nothing		43½	9½	53	11.6	2.1	1060			
5	Muriate of potash.	160	53½	14½	48	14.3	3.2	960	2.1	.6	—100
6	Nitrate of soda Dissolved bone-bl'ck	160 320	73½	13½	45	19.3	3.	900	6.5	—.1	—160
7	Nitrate of soda Muriate of potash	160 160	87	13	52	23.2	2.9	1040	9.9	—.6	—20
8	Nothing		52	18	53	13.9	4.	1060			
9	Dissolved bone-bl'ck Muriate of potash	320 160	83½	9½	50	22.3	2.1	1000	8.9	—1.5	—20
10	Nitrate of soda Dissolved bone-bl'ck Muriate of Potash	160 320 160	146½	4½	96	39.1	1.	1920	25.7	—2.1	940
11	Land Plaster	160	78	12	51	20.8	2.7	1020	8.5	0	80
12	Nothing		44	10	45	11.7	2.2	900			
13	Barn-yard manure	5*	288	7	135	76.8	1.6	2700	68.5	—.8	1800
14	Lime	160	73½	12½	50	19.6	2.8	1000	14.6	.2	100
15	Nothing		6	12½	45	1.6	2.8	900			

*Cords.

The average of all the nothing plots is: hard corn, 11 bushels; soft corn, 2.6 bushels; stover, 900 pounds.

The field is the same used last year for a similar experiment, when the nothings averaged: hard corn, 16.2 bushels; soft corn, 6.7 bushels, and stover, 1328 pounds.

The variety of corn selected was an eight-rowed yellow flint. The field was planted, May 13th, stooked Sept. 20th, and husked Nov. 3d. By mistake of Mr. Richmond the rows intervening between the plots were stooked one with each plot. This lessens the apparent effect of the fertilizers. Otherwise the experiment was correctly carried out, and all the work well done.

All through the season the plots were rated in the order of excellence shown at the harvest. 13 was from the first best, followed by 10, below which in the order named ranked 7, 9, 6 and 5.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements.			
		June 28	July 10	July 23	Aug. 6
1	Nothing,	8.9	16.6	23.3	42.7
2	Nitrate of soda,	11.2	20.6	30.4	48.2
3	Dissolved bone-black;	10.7	19.9	25.4	41.6
4	Nothing,	7.2	12.9	23.4	43.9
5	Muriate of Potash,	7.4	12.6	27.1	36.5
6	Nitrate and bone-black,	12.5	28.5	34.6	51.
7	Nitrate and potash,	12.6	24.5	36.9	51.5
8	Nothing,	9.1	17.3	32.	45.7
9	Bone-black and potash.	12.9	27.1	42.1	50.7
10	Nitrate, bone-black and potash,	15.6	31.8	45.2	58.3
11	Land plaster,	14.7	27.7	3.86	48.4
12	Nothing,	13.4	22.1	30.3	45.3
13	Barn-yard manure,	24.	46.4	57.3	70.8
14	Lime,	15.4	27.	34.2	49.
15	Nothing,	13.1	25.5	35.3	43.4

These figures indicate no considerable falling off in the plots receiving fertilizer with the advance of the season.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	72.53	per cent.
Potassium oxide,	.356	"
Phosphoric acid,	.226	"
Nitrogen,	.260	"
Insoluble matter,	6.735	"

The manure (32 cu. feet) used on the plot weighed 1850 pounds. At this rate it would supply, per acre: nitrogen, 96.2 pounds; phosphoric acid, 83.6 pounds, and potash, 131.7 pounds. It caused an apparent increase of about 69 bushels per acre, far greater than was produced by equally good manure on land as poor in other experiments. This very large increase may be in part due to the unexhausted residue of the manure applied to the same plot last year; but we have four other experiments affording similar conditions, viz. Worcester, increase about 21 bushels; Westfield, increase about 30 bushels; Amherst, increase about 26 bushels; and Shelburne, increase about 9 bushels. These differences are the more inexplicable in view of the fact that the manure used in Freetown last year was poorer than that used in most of our experiments, while that used in Shelburne was best. Under Freetown last year, I wrote the manure "caused a comparatively large increase in the crop. * * * This large increase from manure, perhaps, indicates a need of other elements of plant food than those furnished by all the fertilizers used, or it may be that the organic matter of the manure is especially useful here." In view of the result of the use of manure this year these remarks seem doubly pertinent now.

SUMMARY OF WEATHER OBSERVATIONS.

April 10th to Nov. 1st.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, inches.
	Monthly Means of			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
April,	57.8	34.6	23.2	75	25th	24	18th	33	22d	51	3.35
May,	64.3	45.7	18.4	74	15 & 20	34	12th	30	10th	40	5.79
June,	72.5	53.2	19.2	84	26th	41	3rd	36	10th	43	3.26
July,	78.8	58.4	20.4	91	17th	45	21st	34	10th	46	2.34
August,	77.4	58.9	18.6	88	1st	52	31st	33	16th	36	4.46
Sept.,	71.3	52.9	18.3	82	7th	34	25 & 30	32	19th	48	7.23
October,	58.2	40.2	18.	74	2d	29	22 & 23	31	2d	45	8.48
Season,*	69.2	49.9	19.3	91	July 17	24	Apr. 18	36	June 10	67	34.91

*205 days.

The chief peculiarity brought out by these figures is the abundant rainfall, which, especially for the month of June, is much above that for most stations, especially those in the western portions of the state. Can this have been more favorable for the action of the manure and less so for the fertilizers than conditions prevailing in Worcester, Shelburne and Amherst?

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	11.4	.1	7.8	16.8	9.
Soft corn, " "	.8	-1.2	-1.2	-.6	-.2
Stover, pounds "	-40	-60	80	960	235

Value of net average increment, $6.83

Financial result, 2.83 gain

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	6.4	-4.9	6.8	15.8	6.
Soft corn, " "	.7	.9	-2.1	-1.5	-1.
Stover, pounds "	-100	-120	80	960	205

Value of net average increment, $4.41

Financial result, .39 loss

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'c Acid.	Average Result.
Hard corn, bushels per acre,	2.1	-1.5	2.5	19.2	5.6
Soft corn, " "	.6	-1.4	-2.2	-2.	-1.3
Stover, pounds "	-100	20	80	1100	275
Value of net average increment,				$4.22	
Financial result,				1.02 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Plaster	Lime.
Hard corn, bushels per acre,	25.7	68.5	8.5	14.6
Soft corn, " "	-2.1	-.8	0	.2
Stover, pounds "	940	1800	80	100
	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$19.71	$52.21	$6.15	$10.53
Financial result,	7.71 gain	27.21 gain	5.43 gain	9.57 gain

The teaching of these comparisons is that this soil needed nitrogen, phosphoric acid and potash in about equal degrees. In the case of each the largest increase is produced when it is added to the two others. If either is withheld the full effect of no one is possible. Probably by selection of cheaper sources of nitrogen and phosphoric acid, corn could be produced by fertilizers on this land at a still larger profit. The phenomenal yield due to the manure has already been discussed.

It is noticeable that both lime and plaster produce a profitable increase in the crop. This is a surprise to me, and I can offer no explanation, unless it be due to the long continued action of the lime and plaster applied last year to the same plots. A similar result is found in Westfield; but not in Worcester, Shelburne or in Amherst, under similar conditions. I do not feel that I should be warranted in advising the use of either lime or plaster alone on this land in the hope of a profitable return. With other fertilizers or manures they would, I should think, prove profitable.

YARMOUTH.

SOIL TEST WITH FERTILIZERS FOR CORN.

By James Brydon.

No. of Plot.	FERTILIZERS. KIND.	FERTILIZERS. Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Yield per plot 1-20 acre. Ears. Soft, lbs.	Yield per plot 1-20 acre. Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Yield per acre. Shelled Corn bushels. Soft.	Yield per acre. Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Soft.	Gain or loss compared with Nothing Plots per acre. Stover, lbs.
1	Nothing		96½		117½	25.7		2350			
2	Nitrate of soda	160	109		112½	29.1		2230	4.1		—65
3	Dissolved bone-black	320	76½		104¾	20.4		2095	—3.8		—145
4	Nothing		88¼		109¼	23.5		2185			
5	Muriate of potash	160	112¾		105¾	30.1		2115	6.7		95
6	{ Nitrate of soda { Dissolv'd bone-bl'ck	160 320	76		114½	20.3		2290	—3.		435
7	{ Nitrate of soda { Muriate of potash	160 160	111		114½	29.6		2290	6.5		600
8	Nothing		86¼		76¼	23.		1525			
9	{ Dissolv'd bone-bl'ck { Muriate of potash	320 160	73¾		116¼	19.7		2325	—2.3		709
10	{ Nitrate of soda { Dissolv'd bone-bl'ck { Muriate of potash	160 320 160	116		136¼	30.9		2625	9.9		1017
11	Land plaster		84		107	22.4		2140	2.5		341
12	Nothing	5*	71		94½	18.9		1890			
13	Barn-yard manure		95		119¼	25.3		2390	6.8		250
14	Lime	160	81		84½	21.6		1690	3.5		—700
15	Nothing		66½		132	17.7		2640			

*Cords.

Average of nothing plots: hard corn, 21.8 bushels; stover, 2118 pounds. There was no soft corn on any of the plots in this experiment.

The field selected for this experiment on the farm of John Simpkins, President of the Barnstable Agricultural Society, is a part of a nearly level tract quite near the sea, another portion of which was used last year. The soil is a fine sandy loam, and varied considerably in fertility, steadily improving from one side to the other, as shown by the progressive increase in the yield of the nothing plots from 17 bushels at one extreme to 25 at the other. So far as known this field had never received much manure; it was cultivated last eight years ago and subsequently had been used as a pasture. The variety of corn selected was an eight-rowed, yellow flint. It was planted May 23d; stooked, Sept. 29th; and husked, Now. 4th. It was planted in hills 3½ feet apart, and three stalks were left to a hill. The crows pulled some so that there were a number of missing hills.

These were, however, quite evenly distributed in the different plots, and the vacancies cannot sensibly have affected the comparative yield. In July I ranked the plots as follows: 10, 13, 9, 2, 6, 5 and 7, basing my judgment on growth of stalk and leaf. In August they were judged by my assistant to rank in the following order: 10, 2, 9, 7, 5, 6, 13 and 4—the others considerably poorer. This crop suffered some from drought, especially in July.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements.				
		June 18	July 3	July 16	July 30	Aug. 13
1	Nothing	6.8	18.1	32.9	51.6	61.7
2	Nitrate of soda	6.6	17.4	36.5	50.8	67.3
3	Dissolved bone-black	5.3	16.2	29.7	45.	52.3
4	Nothing	5.6	13.9	32.2	49.7	63.4
5	Muriate of potash	5.8	16.2	38.	47.8	66.8
6	Nitrate and bone-black	7.7	19.	35.8	54.4	59.9
7	Nitrate and potash	7.4	18.1	35.5	47.2	56.6
8	Nothing	5.7	14.4	29.6	43.8	52.6
9	Bone-black and potash	7.3	19.6	37.	47.2	59.9
10	Nitrate, bone-black and potash	8.6	22.3	37.9	56.	65.6
11	Land plaster	5.3	12.	25.6	42.7	55.6
12	Nothing	5.1	10.6	20.9	36.9	47.2
13	Barn-yard manure	7.9	23.	36.	46.5	53.2
14	Lime	5.3	12.4	30.6	40.3	51.5
15	Nothing	5.	9.2	24.7	33.5	48.9

The figures confirm the substantial accuracy of my judgment of the plots; and they do not indicate any relative falling off with advance in season of the plots receiving nitrate of soda, as was the case last year on similar land. This difference is probably due to the fact that in July, 1889, there were 4.12 inches of rain at this station, and in August, 6.04; while in 1890 the rainfall for July was 1.23 inches, and for August, 3.33 inches.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	74.09	per cent.
Potassium oxide,	.089	"
Phosphoric acid,	.184	"
Nitrogen,	.412	"
Insoluble matter,	7.495	"

This manure weighed 2970 pounds to the load of 32 cu. ft. used on plot 13, and applied at this rate it would furnish to the acre: nitrogen, 244.7 pounds; phosphoric acid, 89.3 pounds; and potash, 52.9 pounds. In view of its composition and the results of this experiment it cannot be doubted that it would be good policy to use this manure in small quantities in connection with potash. Though very rich in nitrogen it gave a small increase in crop, apparently because there was not potash enough present.

SUMMARY OF WEATHER OBSERVATIONS.

June 1st to Nov. 1st, 1890.

Month.	Temperature in open air in Degrees Fahrenheit. Monthly Means of			Highest.		Lowest.		Greatest Daily Range.		Monthly Range.	Rainfall, Inches.
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June,	72.7	51.1	21.6	85	26th	44	16th	38	10th	41	4.68
July,	79.8	59.8	20.	94	17th	52	20th	37	10th	42	1.23
August,	78.1	59.7	18.4	88	16th	49	25th	28	8 & 16th	39	3.33
Sept.,	72.4	56.1	16.2	86	7th	39	30th	26	24th	47	6.43
Oct.,	58.	45.3	12.7	74	3d	35	29th	26	2d	39	0.00
Season,*	72.2	54.4	17.8	94	July 17	35	Oct. 29	38	June 10	59	15.67

*153 Days.

As last year, the temperature at this station is more equable than at our others. The thermometer runs neither so high nor so low as at most. The smallness of the rainfall is very noticeable during July and August,—the most critical months for the crop—and especially damaging upon a soil of this sandy character.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	4.1	.8	–.2	12.2	4.2
Stover, pounds "	–65	580	505	308	332
Value of net average increment,				$3.77	
Financial result,				.23 loss	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	–3.8	–7.1	–9.	3.4	–4.1
Stover, pounds "	–145	500	614	417	347
Value of net average decrease,				$2.00	
Financial result,				6.80 loss	

4

RESULTS OF THE ADDITION OF POTASH TO

	Nothing	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'ric Acid.	Average Result.
Hard corn, bushels per acre,	6.7	2.4	1.5	12.9	5.9
Stover, pounds "	95	665	854	582	549
Value of net average increment,				$5.50	
Financial result.				2.30 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	9.9	6.8	2.5	3.5
Stover, pounds "	1017	250	341	-700
	Fertilizer	Manure	Plaster	Lime
Value of net increment due to	$9.47	$5.39	$2.60	.70
Financial result.	2.53 loss	19.61 loss	1.88 gain	.26 loss

In studying the comparisons brought out by the first three of the above tables, it becomes evident that this soil was to a large degree generally exhausted. Nitrogen, phosphoric acid and potash were all needed. Each when used with the two others gives a larger increase than when used alone or with either one of the others. All are not equally deficient, however, but in order of necessity rank: potash, nitrogen and phosphoric acid. The paucity of the results due to manure used as shown by the last table is very striking. With only about one-tenth the nitrogen; a little more than one-half the phosphoric acid, and one and three-fifths times the potash in "complete fertilizer," we produce a much larger yield. Especially small is the increase of stover due to manure which, in view of the fact brought out by the experiments of both last year and this, that potash affects the growth of stem and leaf to a remarkable degree, I have no doubt was due to the deficiency of this element in both soil and manure.

For this soil I should advise a fertilizer strong in potash and nitrogen. The increase apparently due to lime I do not regard as of much significance, although since it was the same on an adjoining field last year, it perhaps indicates that it will pay to use a little.

WORCESTER.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Pliny Moore.

Number of plot.	FERTILIZERS. KIND.	Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing		151		100¾	40.3		2015			
2	Nitrate of soda	160	138		66½	37.		1330	—2.2		—465
3	Dissolved bone-black	320	140		60¼	37.5		1205	— .6		—370
4	Nothing		138		67¾	37.		1355			
5	Muriate of potash	160	169		108¾	45.1		2175	8.5		770
6	{ Nitrate of soda { Dissolved bone-bl'ck	160 320	153¼		77½	40.9		1550	4.6		95
7	{ Nitrate of soda { Muriate of Potash	160 160	158½		124¾	42.3		2495	6.4		990
8	Nothing		133		77¾	35.5		1555	9.9		
9	{ Dissolved bone-bl'ck { Muriate of potash	320 160	170½		97¾	45.5		1955			379
10	{ Nitrate of soda { Dissolved bone-bl'ck { Muriate of potash	160 320 160	191		131	50.9		2620	15.3		1022
11	Land plaster	160	136½		80¾	36.4		1615	.7		—4
12	Nothing		134		82	35.7		40			
13	Barnyard manure	*5	208		125	55.5		00	20.7		913
14	Lime	160	132		91½	5.2		1 30	1.2		297
15	Nothing		124		74	33.1		80			

*Cords.

Average of all the nothing plots: hard corn, 36.3 bushels; stover, 1609 pounds. There was no soft corn in this experiment.

This test was on the same acre as last year; a rather elevated southern slope with very moderate pitch. The soil is a good medium loam and previous to last year had been four years in grass without manure. Yellow flint corn was selected; planted in hills, May 16th; stooked Sept. 20th, and husked Nov. 5th. The yield of the nothing plots last year was quite variable; this year it was comparatively uniform and the average about 13 bushels less. Both in July and August plot 13 was judged to be the best, followed closely by 10, 9, and 5.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	69.37	per cent.
Potassium oxide,	.443	"
Phosphoric acid,	.187	"
Nitrogen,	.309	"
Insoluble matter,	1.468	"

This manure weighed 50 pounds per cubic foot, and at the rate used furnished 1600 pounds to the plot. This rate of application would supply, per acre: nitrogen, 98.9 pounds; phosphoric acid, 59.8 pounds; and potash, 141.7 pounds. It is noticeable that it produced a large increase both of corn and stover; that this soil needs potash, and that the manure is unusually rich in this element.

SUMMARY OF WEATHER OBSERVATIONS.

June 7th to Sept. 21st, 1890.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Monthly Means of			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June,	73.9	53.5	20.2	84	26th	44	10 & 13	34	10th	40	2.46
July,	74.4	54.4	20.	91	8 & 15th	46	9th	34	9th	55	3.23
August.	76.6	57.2	19.4	91	1st	49	31st	25	31st	42	6.63
Sept.	71.3	54.9	16.4	81	6th	46	20th	24	1st	35	4.70
Season.*	76.1	56.4	19.7	91	Jul 8,15 Aug. 1	44	June 10 & 13	34	June 10 July 9	57	17.02

*106 days. J. L. Ellsworth, Observer.

The temperature shows no striking peculiarities; but the rainfall was small both in June and July, and the crop suffered to some extent. When visited in July much of it was badly rolled.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result
Hard corn, bushels per acre,	–2.2	5.2	–2.1	5.4	1.6
Stover, pounds "	–465	465	220	643	126

Value of average net increment, $1.66

Financial result, 2.34 loss

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	–.6	6.8	1.4	8.9	4.1
Stover, pounds "	–370	560	–391	32	–42

Value of average net increment, $2.76

Financial result, 2.04 loss

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosph'ic Acid.	Nitrate and Phos-ph'ic Acid.	Average Result.
Hard corn, bushels per acre,	8.5	8.6	10.5	10.7	9.6
Stover, pounds "	770	1455	749	927	975
Value of average net increment,				$9.16	
Financial result,				5.96 gain	

RESULT OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	15.3	20.7	.7	1.2
Stover, pounds "	1022	913	-4	297
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$13.27	$16.77	.48	$1.58
Financial result,	1.27 gain	8.23 loss	.24 loss	.62 gain

The striking benefit of potash as compared with nitrogen and phosphoric acid is clearly brought out by these comparisons; although a considerable degree of general exhaustion is indicated by the comparatively large increase due to adding either nitrogen or phosphoric acid to both the other elements.

Here, as shown by the last of the above tables, the manure produced a larger increase than "complete fertilizer." It supplied about four times the nitrogen; one and a fourth times the phosphoric acid, and one and three-fourths times the potash furnished by the latter. That its richness in potash as compared with manure used by other experimenters makes it especially suited to this soil has been pointed out.

For corn on this soil I should recommend the use of fertilizer rich in potash and phosphoric acid and with a small percentage of nitrogen.

HADLEY.

SOIL TEST WITH FERTILIZER FOR CORN.

By L. W. West.

Number of plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Yield per plot 1-20 acre. Ears. Soft, lbs.	Yield per plot 1-20 acre. Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Yield per acre. Shelled Corn bushels. Soft.	Yield per acre. Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Soft.	Gain or loss compared with Nothing Plots per acre. Stover, lbs.
1	Nothing		71	30	148	18.9	6.7	2960			
2	Nitrate of soda	160	57	23	131	15.2	5.1	2620	—2.5	—1.2	—253
3	Dissolved bone-black	320	49	21	110	13.1	4.7	2200	—3.3	—1.3	—587
4	Nothing		57	25	135	15.2	5.6	2700			
5	Muriate of potash	160	198	27	229	52.8	6.	4580	39.	1.	2057
6	{ Nitrate of soda { Dissolved bone-bl'ck	160 320	82	24	145	21.9	5.3	2900	9.5	.9	555
7	{ Nitrate of soda { Muriate of potash	160 160	269	16	378	71.7	3.6	7560	60.7	—.2	5392
8	Nothing		36	14½	99½	9.6	3.2	1990			
9	{ Dissolved bone-bl'ck { Muriate of potash	320 160	226	9	317	60.3	2.	6340	44.1	—1.	3932
10	{ Nitrate of soda { Dissolved bone-bl'ck { Muriate of potash	160 320 160	281	12	349½	74.9	2.7	6990	52.1	—.1	4165
11	Land plaster	160	45	13	87	12.	2.9	1740	-17.4	.4	-1503
12	Nothing		134½	10½	183	35.9	2.3	3660			
13	Barn-yard Manure	*5	253	5	289	67.5	1.1	5780	35.7	—1.8	2393
14	Lime	160	88	14	146	23.5	3.1	2920	—4.2	—.5	—193
15	Nothing		88½	19	142	23.6	4.2	2840			

*Cords.

Average of nothing plots: hard corn, 20.6 bushels; soft corn, 4.4 bushels; stover, 2830 pounds.

The acre for this experiment is a part of the same large tract of plain land in which our experiment in Hadley was located last year, but it lies a little higher and is much better corn land. It is a heavy loam with clayey subsoil; and most of it had been several years in grass without manure. A small portion had more recently been ploughed, but it had also been in grass for about two years. The field proved uneven in quality, as shown by the wide variation in the yield of the nothing plots; but the variation occurs in such part of the field that the comparison of the nitrogen, phosphoric acid and potash is comparatively little affected. The seed, eight-rowed yellow flint corn, was planted May 22d; the crop was stooked Sept. 25th, and husked Oct. 16th. The stooks on plots 4, 5, 6, 7, and 8 were in part blown down by a storm and were not as dry as in other parts of the field. All through the season it was evident that the growth was far more benefited by potash than by any other element.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERT'ZER USED	Average of Measurements.							
		July 4	July 14	July 25	Aug. 4	Aug. 14	Aug. 25	Sept. 4	Sept. 14
1	Nothing, ...	17.3	23.	34.8	38.5	42.6	54.6	59.8	59.8
2	Nitrate of soda,	19.7	24.	34.3	38.	44.6	54.1	62.8	59.6
3	Dis. bone-black,	17.5	22.	30.3	34.	45.5	54.5	58.8	62.6
4	Nothing, ...	15.0	18.6	30.5	34.6	41.1	52.	61.5	52.8
5	Mur. of potash,	19.3	25.	37.5	45.3	56.5	69.6	84.0	76.5
6	Nit. & bone-bl'k,	21.5	26.6	37.6	40.5	42.5	53.3	60.8	65.8
7	Nitrate & pot'sh,	32.8	39.2	55.3	63.	76.8	86.1	93.3	91.0
8	Nothing, ...	23.1	28.6	39.6	41.6	43.3	54.	62.1	57.5
9	B'ne-b'k & pot'sh	32.5	39.1	53.6	64.1	74.5	86.1	89.6	89.5
10	Nit. b.-b. & pot'h	34.5	41.6	55.1	64.5	76.5	89.	92.5	94.1
11	Land plaster, ..	22.5	28.5	31.	36.1	42.3	53.6	56.8	57.3
12	Nothing, ...	22.2	28.1	43.	50.	56.	67.5	67.8	78.0
13	Barn-y'd manure	34.1	42.8	51.6	51.	77.3	86.3	89.6	88.8
14	Lime, ...	20.6	25.8	34.	37.8	44.	62.5	67.6	63.5
15	Nothing, ...	19.3	24.1	32.	39.1	51.6	56.8	72.1	70.8

These figures make evident in a striking manner the beneficial effects of potash. They do not indicate any progressive falling off where nitrate of soda was used with the advance of the season.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	78.83	per cent.
Potassium oxide,	.327	"
Phosphoric acid,	.184	"
Nitrogen,	.345	"
Insoluble matter,	3.139	"

The 32 cubic feet used weighed 1121 pounds and furnished at the rate, per acre: nitrogen, 77.4 pounds; phosphoric acid, 41.3 pounds, and potash, 73.3 pounds. The phosphoric acid and potash are in nearly the same proportion as in "complete fertilizer" and but little less in amount, while there is nearly three times as much nitrogen as in the fertilizer; and yet the total crop, as well as the apparent increase where manure was used was less than with the "complete fertilizer"; less also than where nitrate of soda and potash were used; and but little greater in amount and less in apparent increase than where potash alone or potash and bone-black were used.

SUMMARY OF WEATHER OBSERVATIONS.

May 18—Oct. 1, 1890.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall Inches
	Monthly means of			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
May,	72.4	45.4	27.	81	25th	36	23d	43	23rd	45	2.66
June,	77.6	53.2	24.4	89	25th	40	3d	37	10th	49	1.66
July,	81.9	57.5	24.4	92	31st	42	21st	36	10th	50	5.00
August,	79.	57.8	21.2	90	1st	43	25th	37	16th	47	5.08
Sept.,	70.7	50.4	20.3	80	3d	31	25th	35	3d	49	6.08
Season,*	76.8	53.8	23.	92.	July 31	31	Sept 25	43	May 23	61	20.48

*136 days.

Cold nights, as shown by the low minimums in every month and a very light rainfall in June are the most striking points brought out by these observations. The comparatively low temperature undoubtedly accounts for the somewhat large proportion of soft corn in this experiment; for the soil is naturally rather cold.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	–2.5	12.8	21.7	8.	10.
Soft corn, " "	–1.2	2.2	–1.2	.9	–.2
Stover, pounds, "	–253	1142	3335	233	1114
Value of average net increment,				$9.73	
Financial result,				5.73 gain	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	–3.3	12.	5.1	–8.6	1.3
Soft corn, " "	–1.3	2.1	–2.	.1	.3
Stover, pounds, "	–587	808	1875	–1227	217
Value of average net increment,				$1.54	
Financial result,				3.26 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'ic Acid.	Average Result.
Hard corn, bushels per acre,	39.	63.2	47.4	42.6	48.1
Soft corn, " "	1.	1.	.3	1.0	.3
Stover, pounds, "	2057	5645	4519	3610	3958
Value of average net increment,				$43.66	
Financial result,				40.46 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	52.1	35.7	–17.4	–4.2
Soft corn, " "	–.1	–1.8	.4	–.5
Stover, pounds "	4165	2393	–1503	–193
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$46.85	$30.43		
Value of decrease due to			$15.82	$3.57
Financial result,	34.85 gain	5.43 gain	16.54 loss	4.53 loss

The above comparisons shed no uncertain light upon the question, "What did this soil need to produce corn?" Alone and in every combination, potash produces a remarkable increase; but nitrate of soda, too, seems to have been required, for the combination of this with potash produces a much larger crop than potash alone. Phosphoric acid, on the other hand, does comparatively little good however used.

The manure produces a large increase; but I cannot doubt that a considerably lighter application with potash would have produced a far larger profit.

For this soil I am confident that the most profitable results would be attained by using light dressings of manure with a little quick-acting nitrogenous fertilizer and a considerable amount of potash.

WESTFIELD.

SOIL TEST WITH FERTILIZERS FOR CORN.

By Charles F. Fowler.

Number of plot.	FERTILIZERS. KIND.	FERTILIZERS. Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Yield per plot 1-20 acre. Ears. Soft, lbs.	Yield per plot 1-20 acre. Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Yield per acre. Shelled Corn bushels. Soft.	Yield per acre. Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Soft.	Gain or loss compared with Nothing Plots per acre. Stover, lbs.
1	Nothing		5¼	4¼	28	1.4	.9	560			
2	Nitrate of soda	160	21¾	5½	35¼	5.8	1.2	705	4.	.3	175
3	Dissolved bone-black	320	36¾	3¾	47½	9.8	.8	950	7.5	.2	450
4	Nothing		10	4½	23½	2.7	1.	470			
5	Muriate of potash	160	16½	5	40½	4.4	1.1	810	.9	.1	259
6	{ Nitrate of soda { Dissolved bone-bl'ck	160 320	92¾	5¼	67½	24.7	1.2	1350	20.5	.2	717
7	{ Nitrate of soda { Muriate of potash	160 160	28¾	5¾	54	7.7	1.3	1080	2.7	.3	366
8	Nothing		21¼	4½	39¾	5.7	1.	795			
9	{ Dissolved bone-bl'ck { Muriate of potash	320 160	70½	3	75	18.8	.7	1500	12.9	—.5	711
10	{ Nitrate of soda { Dissolved bone-bl'ck { Muriate of Potash	160 320 160	118½	1¾	103¼	31.6	.4	2065	25.6	—.9	1292
11	Land Plaster	160	47¼	7¼	56½	12.6	1.6	1130	6.4	.1	354
12	Nothing		23¾	7¼	38½	6.3	1.6	770			
13	Barn-yard manure	5*	135	3¾	151¾	36.0	.8	3035	30.6	—.7	2303
14	Lime	160	37¼	6	55¾	9.9	1.3	1115	5.3	—.1	422
15	Nothing		13¾	5¾	32¾	3.7	1.3	655			

*Cords.

Average of the nothing plots: hard corn, 3.8 bushels; soft corn, 1.2 bushels, and stover, 650 pounds.

This experiment was on the same acre as in 1889. I wrote of it then: It is the "so-called plain land" of the Connecticut valley. It is an old alluvial soil consisting of fine sand. It is of great depth, and lies at such an elevation that it usually appears dry, though it does not have the reputation of drying badly in time of drought. The portion selected had lain fallow four years. It was very poor, but not apparently even in quality; nothing plots 8 and 15 were much better than the others." This year nothing plot 12 also produces a yield considerably above 1 or 4; while 15 falls a little below 8 and 12.

Yellow flint corn was planted, in hills 4 feet apart in rows at the usual distance (3½ ft.). Three stalks were left to the hill. The crop was planted May 14th—16th, and husked Oct. 22d.

When visited in July the plots which appeared to have benefited much by the application made stood in the following order: 13, 10, 6, 9, and 3.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements. July 9	July 28	Aug. 7
1	Nothing, ...	17.5	17.8	21.8
2	Nitrate of soda, ...	22.4	24.8	44.1
3	Dissolved bone-black;	27.8	31.7	52.3
4	Nothing.	16.6	20.1	30.1
5	Muriate of Potash, ...	24.1	25.1	29.9
6	Nitrate and bone-black, ...	37.3	44.2	63.
7	Nitrate and potash, ...	23.7	28.6	43.3
8	Nothing, ...	19.4	23.2	33.6
9	Bone-black and potash, ...	34.7	42.4	64.5
10	Nitrate, bone-black and potash, ...	39.3	43.3	72.1
11	Land plaster, ...	24.2	32.4	46.8
12	Nothing, ...	19.2	22.7	38.8
13	Barn-yard manure	54.3	66.6	81.2
14	Lime, ...	28.2	28.8	49.8
15	Nothing.	19.2	22.7	31.1

Even on this sandy soil the effect of the nitrate of soda appears to be well maintained till the end of the season.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	78.82	per cent.
Potassium oxide,	.168	"
Phosphoric acid,	.193	"
Nitrogen,	.398	"
Insoluble matter,	4.541	"

The amount (32 cu. ft.) applied weighed 1720 pounds; and this application supplied at the rate: nitrogen, 136.9 pounds; phosphoric acid, 66.4 pounds, and potash, 57.8 pounds.

SUMMARY OF WEATHER OBSERVATIONS.

June 1st to Nov. 1st, 1890.

Month.	Temperature in open air in Degrees Fahrenheit. Monthly Means of Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest Daily Range. Deg.	Date.	Monthly Range.	Rainfall, inches.
June,	77.9			87	25th						2.30
July,	80.2			92	31st						6.35
August,	78.9			86	4th						6.09
Sept.,	71.2			81	1st						9.59
October,	59.4			73	4 and 5						6.34
Season,*	73.5			92	July 31						30.67

*205 days.

This record is incomplete on account of the breakage of the minimum thermometer, of which I was not notified. The rainfall here was comparatively heavy, which on such a soil must have proved an advantage to the crop.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	4.	13.	1.8	12.7	7.9
Soft corn, " "	.3	.4	.2	–.4	.1
Stover, pounds "	175	267	107	581	283
Value of net average increment,				$6.27	
Financial result,				2.27 gain	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	7.5	16.5	12.	22.9	14.7
Soft corn, " "	–.2	–.1	–.6	–1.2	–.5
Stover, pounds "	450	542	452	926	590
Value of net average increment,				$11.62	
Financial result,				6.82 gain	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'c Acid.	Average Result.
Hard corn, bushels per acre,	.9	–1.3	5.4	5.1	2.6
Soft corn, " "	.1	0	–.3	–1.1	–.3
Stover, pounds "	259	191	261	575	322
Value of net average increment,				$2.54	
Financial result,				.66 loss	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Plaster	Lime.
Hard corn, bushels per acre,	25.6	30.6	6.4	5.3
Soft corn, " "	–.9	–.7	.1	–.1
Stover, pounds "	1292	2303	354	422
	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$20.88	$26.77	$5.40	$4.74
Financial result,	8.88 gain	1.97 gain	4.68 gain	3.78 gain

Last year I wrote: "Phosphoric acid produces the largest increase then come nitrogen and potash in the order named. The differences are, however, small; and the increase is, in no case, sufficient to pay for the fertilizer. Barnyard manure does much better than 'complete fertilizer', which indicates a more general exhaustion than the latter can meet, or a beneficial physical, or chemical effect from the manure." These statements, except as to the amounts of the "differences" and the failure to "pay for the fertilizer" are exactly true of the results of this year. Phosphoric acid and nitrogen, however, produce larger increases than last year, and more than enough to pay for the material used. *The influence of potash upon the yield of stover is marked. With a far smaller increase in corn from use of potash than is due to use of nitrogen, we find a larger increase in stover.*

Both lime and plaster, this year, appear to have produced a profitable increase in crop. This was not true last year. The similarity of these results to those obtained in Freetown, also upon a very poor soil, has been already pointed out.

In view of the results of our two years' work upon this soil, it may be doubted whether a very profitable culture of corn upon it with fertilizer is possible. Still by introduction of clover in rotation, as a conserver of nitrogen, and the use of bone meal, fish, or similar materials with a little lime and potash to help out the clover as well as the corn, I should try it, were the land my own.

With such barnyard manure as was used in this experiment I think it would pay to use a plain super-phosphate on this soil; and for stover a little potash should be added.

SHELBURNE.

SOIL TEST WITH FERTILIZERS FOR CORN.

By G. F. Dole.

No. of Plot.	FERTILIZERS. Kind.	Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing		72¾	10½	86¾	19.4	2.3	1735			
2	Nitrate of soda	160	79¾	11	107¼	21.3	2.4	2145	2.	0	42
3	Dissolved bone-black	320	102¼	5½	94¼	27.3	1.2	1885	8.1	—1.4	—587
4	Nothing		71¾	12¼	142	19.1	2.7	2840			
5	Muriate of potash	160	84¼	9½	136¼	22.5	2.1	2725	4.2	—1.	159
6	Nitrate of soda Dissolv'd bone-bl'ck	160 320	110	4½	135½	29.3	1.	2710	11.7	—2.5	417
7	Nitrate of soda Muriate of potash	160 160	88¼	7¾	129	23.5	1.7	2580	6.7	—2.1	561
8	Nothing		60	18¾	87¼	16.	4.2	1745			
9	Dissolv'd bone-bl'ck Muriate of potash	320 160	98¼	10½	121¼	26.2	2.3	2425	9.8	—1.7	661
10	Nitrate of soda Dissolv'd bone-bl'ck Muriate of potash	160 320 160	90½	14½	122	24.1	3.2	2440	7.3	—.6	657
11	Land plaster		41¼	19½	88¼	11.0	4.3	1765	—6.1	.7	—36
12	Nothing	5*	65¾	15½	91	17.5	3.4	1820			
13	Barn-yard manure		97¼	9½	124¼	25.9	2.1	2485	9.1	—1.3	685
14	Lime	160	53½	18½	88	14.3	4.1	1760	—1.8	.7	—20
15	Nothing		57¾	15¼	88	15.4	3.4	1760			

*Cords.

Average of the nothing plots: hard corn, 17.5 bushels; soft corn, 3.2 bushels, and stover, 1980 pounds. This experiment was located on the same acre used in 1889, "an elevated tract in a hilly district, but nearly level. The soil is a good medium loam, and before used in this experiment had been in grass five years without manure." A yellow flint corn was selected, and planted in hills 3½ feet apart, each way, on May 27th; it was stooked Sept. 22d, and husked, Oct. 27th. The crows pulled some, especially on plots 13 and 14.

When visited in July the difference between the plots was not very marked; but 6, 10, 13, and 9 were considered best, and to rank about in the order named. Phosphoric acid then seemed to be doing most good.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Averages of Measurements. July 17	July 26	Aug. 6	Aug. 16
1	Nothing,	29.2	35.3	51.8	64.1
2	Nitrate of soda,	30.1	33.9	50.	66.1
3	Dissolved bone-black,	30.3	38.2	58.8	65.1
4	Nothing,	30.8	33.7	49.2	64.6
5	Muriate of potash,	31.6	39.7	54.3	69.6
6	Nitrate and bone-black,	32.6	39.9	58.8	68.5
7	Nitrate and potash,	30.9	37.8	55.5	69.8
8	Nothing,	27.5	32.5	45.6	61.6
9	Bone-black and potash,	33.6	40.4	57.3	73.9
10	Nitrate, bone-black and potash	32.5	39.4	54.9	68.7
11	Land plaster,	24.5	30.6	46.5	59.4
12	Nothing,	29.1	34.1	47.8	63.7
13	Barn-yard manure,	29.4	38.1	56.9	70.8
13	Lime,	28.8	32.1	48.2	59.8
15	Nothing,	27.2	30.2	47.	57.8

No falling off where nitrate of soda was used, is shown by these figures.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	79.99	per cent.
Potassium oxide,	.225	"
Phosphoric acid,	.136	"
Nitrogen,	.350	"
Insoluble matter,	.956	"

This manure weighed forty pounds per cubic foot, or 1280 pounds per plot. At this rate it would furnish, per acre: nitrogen, 89.6 pounds; phosphoric acid, 34.8 pounds; and potash, 57.6 pounds. It therefore supplied a comparatively small amount of these essentials, and when it is added that it was coarse and not well mixed with the soil, it will not be wondered that it produced less increase than that produced by manure in most of the experiments.

SUMMARY OF WEATHER OBSERVATIONS.

June 1st to Oct. 27th, 1890.

Month.	Temperature in open air in Degrees Fahrenheit. Means of Daily. Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest Daily Range. Deg.	Date.	Monthly Range.	Rainfall, Inches.
June,	74.8	52.9	21.8	84	25 & 30	39	2d	32	12th	45	1.92
July,	77.6	55.8	21.9	89	31st	42	20th	35	9th	47	5.19
August.	74.1	56.1	18.3	83	4th	41	24th	34	15th	42	8.60
Sept.,	68.8	49.8	19.	76	10th	32	24th	33	21st	44	6.28
Oct.,	56.4	37.8	18.7	71	1st	26	21st	30	12th	45	4.31
Season,*	70.3	50.6	19.7	89	July 31	26	Oct. 21	35	July 9	63	26.30

*109 days.

These observations show a comparatively low temperature, with very low minimums in every month, a wide range of variation and a heavy rainfall for every month except June.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	2.	3.6	2.5	–2.5	1.4
Soft corn, " "	0	–1.1	–1.1	1.1	–.3
Stover, pounds, "	42	1004	402	–4	361
Value of average net increment,				$1.79	
Financial result,				2.21 loss	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing,	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	8.1	9.7	5.6	.6	6.0
Soft corn, " "	–1.4	–2.5	–.7	1.5	–.8
Stover, pounds "	–587	375	502	96	97
Value of average net increment,				$4.20	
Financial result,				.60 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phosphoric Acid.	Aver. Result.
Hard corn, bushels per acre,	4.2	4.7	1.7	–4.4	1.6
Soft corn, " "	–1.	–2.1	–.3	1.9	–.4
Stover, pounds "	159	519	1248	240	542
Value of average net increment.				$2.36	
Financial result,				.84 loss	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	7.3	9.1	–6.1	–1.8
Soft corn, " "	–.6	–1.3	.7	.7
Stover, pounds "	657	685	–36	–20

	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$6.57	$7.69		
Value of decrease due to			$4.15	$1.10
Financial result,	5.43 loss	17.31 loss	4.87 loss	2.55 loss

Last year this soil responded most freely to potash. This year it is evidently more generally exhausted and gives less decisive results. There is not sufficient apparent increase to pay for either of the ingredients of the fertilizers used, nor for the manure; the loss is least on phosphoric acid. It appears to cause the largest increase, and accordingly the indication is that it should be a prominent ingredient of a fertilizer for this soil.

NEW LENOX.

SOIL TEST WITH FERTILIZERS FOR CORN.

By D. B. Dewey.

Number of plot.	FERTILIZERS.		Yield per plot 1-20 acre.			Yield per acre.			Gain or loss compared with Nothing Plots per acre.		
			Ears.			Shelled Corn bushels.			Shelled Corn bushels.		
	KIND.	Pounds per acre.	Hard, lbs.	Soft, lbs.	Stover, lbs.	Hard.	Soft.	Stover, lbs.	Hard.	Soft.	Stover, lbs.
1	Nothing		72	24½	102½	19,2	5.4	2050			
2	Nitrate of soda	160	79	9½	107	21.1	2.1	2140	0	—1.7	60
3	Dissolved bone-black	320	93	10	117	24.8	2.2	2340	1.9	—.1	230
4	Nothing		93	3	107	24.8	.7	2140			
5	Muriate of potash	160	138	2	244	36.8	.4	4880	11.6	—.7	2732
6	Nitrate of soda Dissolved bone-bl'ck	160 320	87	6½	103½	23.2	1.4	2070	—2.5	—.1	—85
7	Nitrate of soda Muriate of potash	160 160	142	1½	251½	37.9	.3	5030	11.8	—1.5	2867
8	Nothing		99½	10	108½	26.5	2.2	2170			
9	Dissolved bone-bl'ck Muriate of potash	320 160	127	7	112	33.9	1.6	2240	6.5	—1.2	255
10	Nitrate of soda Dissolved bone-bl'ck Muriate of potash	160 320 160	151	3½	153½	40.3	.8	3070	12.	—2.6	1270
11	Land plaster	160	90½	19½	114	24.1	4.3	2280	—5.1	.3	665
12	Nothing		113	20½	71½	30.1	4.6	1430			
13	Barn-yard manure	5*	120½	8½	136	32.1	1.9	2720	6.3	—3.1	1047
14	Lime	160	80	24½	80½	21.3	5.4	1610	—.1	.1	—307
15	Nothing		64	25½	108	17.1	5.7	2160			

*Cords.

Average of the nothing plots: hard corn, 23.5 bushels; soft corn, 3.7 bushels; stover, 1990 pounds.

The acre used in this experiment lies in a large plain of alluvial origin. The soil is a fine, compact loam, inclined to be clayey and cold. It had been a number of years in grass without manure.

The seed, a yellow flint variety, was planted in hills, 3 feet apart, on May 30th. It was thinned to four stalks. The crop was stooked

Oct. 12th and 13th, and husked Oct. 23d and 24th. A slight mistake was made in arrangement, four rows being put in each plot, one on either edge, and none in the space between the plots. This. while not vitiating the work to any great extent, makes the apparent increase due to the fertilizers less than the reality, because the outside rows in each plot were not fully under the influence of the materials supplied.

In July the plots which had received potash appeared to be doing distinctly better than the others, my assistant rating them in the order of excellence 13, 10, 7, 9, and 5, with the others considerably poorer. There was a considerable difference in the quality of the soil in the nothing plots; but this, as will be seen, affected chiefly the standing of the plot where manure was used.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements.		
		July 5	July 22	Aug. 8
1	Nothing	17.6	34.6	63.1
2	Nitrate of soda	19.6	38.3	60.6
3	Dissolved bone-black	19.3	37.6	60.7
4	Nothing	17.5	32.	55.3
5	Muriate of potash	24.9	43.6	74.1
6	Nitrate and bone-black	19.5	40.4	62.6
7	Nitrate and potash	25.2	44.4	69.1
8	Nothing	17.7	35.5	57.8
9	Bone-black and potash	23.5	41.9	67.8
10	Nitrate, bone-black and potash	27.	46.6	75.4
11	Land plaster	27.2	37.6	61.8
12	Nothing	20.9	35.8	56.
13	Barn-yard manure	27.	45.9	73.8
14	Lime	17.5	34.7	58.
15	Nothing	17.2	33.3	51.

These figures make evident the substantial accuracy of the judgment recorded above. The plot receiving nitrate of soda alone does not appear to retain its early supremacy over the nearest nothing; but the falling off is not serious as compared with most of the other plots. I do not feel warranted in concluding that it would have been better to apply this chemical in fractional dressings.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	73.18	per cent.
Potassium oxide,	.129	"
Phosphoric acid,	.156	"
Nitrogen,	.346	"
Insoluble matter,	7.456	"

One cubic foot weighed 50 pounds; that applied to the plot, therefore, by calculation, 1600 pounds. At this rate manure would supply per acre: nitrogen, 110.7 pounds; phosphoric acid, 49.8 pounds; and potash, 41.3 pounds.

SUMMARY OF WEATHER OBSERVATIONS.

June 9th to Oct. 1st, 1890.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Monthly Means of			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
June,	77.5	57.3	20.6	88	30th	45	21st	33	29th	43	.97
July,	80.9	56.1	24.8	92	8 & 15th	40	22d	38	22d	52	2.77
August,	77.9	57.8	20.2	87	5th	45	24th	34	15th	42	8.50
Sept.	71.2	50.7	20.5	86	4th	28	25th	36	30th	58	8.88
Season,*	76.9	55.4	21.5	92	Jul 8,15	28	Sept.25	38	July 22	64	21.12

*115 days.

These figures indicate a cool and dry growing season and a cool and wet season for filling and ripening.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	0	–4.4	.2	5.5	.3
Soft corn, " "	–1.7	0	–.8	–1.4	–1.
Stover, pounds "	60	315	135	1015	224

Value of net average increment, $ .47

Financial result, 3.53 loss

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	1.9	–2.5	–5.1	.2	–1.4
Soft corn, " "	–.1	1.6	–.5	–1.1	0
Stover, pounds "	230	–145	–2477	–1597	–947

Value of net average decrease, $3.35

Financial result, 8.15 loss

RESULTS OF THE ADDITION OF POTASH TO

	Nothing	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'ric Acid.	Average Result.
Hard corn, bushels per acre,	11.6	11.8	4.6	14.5	10.9
Soft corn, " "	–.7	.2	–1.1	–2.5	–1.
Stover, pounds "	2732	2807	25	1355	1730

Value of net average increment, $11.50

Financial result, 8.25 gain

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	12.	6.3	–5.1	–.1
Soft corn, " "	–2.6	–3.1	.3	.1
Stover, pounds "	1270	1047	665	–307

	Fertilizer	Manure	Plaster	Lime
Value of net increment due to	$10.80	$6.10		
Value of decrease due to			$1.82	.81
Financial result,	1.20 loss	18.90 loss	2.54 loss	1.77 loss

These comparisons make it evident that this soil most needed potash, which alone and in nearly every combination seems to have produced a profitable increase. Phosphoric acid does little or no good while nitrate of soda, especially when used where there is potash, does produce a small increase.

The manure, furnishing over four times the nitrogen, about the same amount of phosphoric acid, and but about one-half the potash that the complete fertilizer supplies does not produce as large a crop as the latter.

For this soil it is evident that for corn a fertilizer should be rich in potash; and that with such barnyard manure as was employed it would abundantly pay to use considerable of this material.

AMHERST.

SOIL TEST WITH FERTILIZERS FOR CORN.

Station Grounds—South Acre.

Number of plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Yield per plot 1-20 acre. Ears. Soft, lbs.	Yield per plot 1-20 acre. Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Yield per acre. Shelled Corn bushels. Soft.	Yield per acre. Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Soft.	Gain or loss compared with Nothing Plots per acre. Stover, lbs.
1	Nitrate of soda	160	173	9½	187½	46.1	2.1	3750	—.3	.1	-1100
2	Dissolved bone-black	320	194	4	179½	51.7	.9	3590	5.3	.7	-1260
3	Nothing		174	1	242½	46.4	.2	4850			
4	Muriate of potash	160	249	1½	229½	66.4	.3	4590	19.5	0	190
5	Lime	160	202	5¼	183	53.9	1.2	3660	6.4	.8	—290
6	Nothing		180	2¼	175	48.	.5	3500			
7	Barnyard manure	*5	238½	½	276	75.6	.1	5520	25.8	—.4	2014
8	Nitrate of soda Dissolved bone-bl'ck	160 320	200	1½	163	53.3	.3	3260	8.2	.1	130
9	Nothing		169	1	156½	45.1	.2	3130			
10	Nitrate of soda Muriate of potash	[60 160	214	1¾	211¾	57.1	.4	4235	8 6	.1	973
11	Muriate of potash Dissolved bone-bl'ck	160 320	263	½	244	70.1	.1	4880	18.3	—.2	1487
12	Nothing		207	1¾	176¼	55.2	.4	3525			
13	Land plaster	160	207	1	177	55.2	.2	3540	1.8	—.2	21
14	Nitrate of soda Dissolved bone-bl'ck Muriate of potash	160 320 160	283½	½	266	75.6	.1	5320	24.	—.4	1807

*Cords.

Average of the nothing plots: hard corn, 48.7 bushels; soft corn, .3 bushels; stover, 3751 pounds.

This is the same acre used last year in a similar experiment. Its soil is a fine yellow loam with gravel or sand at the depth of two to three feet. It is naturally well drained and warm and before taken up last year had been five years in grass without manure.

Last year the nothing plots averaged: hard corn, 27.5 bushels; soft corn, 5.1 bushels; stover 1880 pounds. It is noticeable that the production of the same plots this year has been much larger, a difference, probably, chiefly due to the more favorable season. The variety of corn was, however, different; an early dent, instead of yellow, eight-rowed flint as last year, and to this change the larger yield of this year may be in part due.

The seed was planted in hills May 13th; the corn stooked, Sept. 18th; and husked, Oct. 18th.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZER USED.	Average of Measurements. June 23	July 3	July 12	July 22	Aug. 1	Aug. 11	Aug. 21
1	Nitrate of soda, ...	13.6	27.5	39.3	54.6	73.6	92.8	98.3
2	Dis. bone-black, ...	13.7	28.5	40.4	52.2	78.4	94.6	96.4
3	Nothing, ...	12.3	26.8	38.7	50.8	69.9	85.8	89.9
4	Muriate of potash, ...	14.9	31.1	44.9	64.1	84.8	105.1	102.8
5	Lime, ...	12.6	26.1	39.9	52.9	70.6	89.6	95.9
6	Nothing, ...	11.2	25.6	42.1	49.4	71.1	88.2	92.7
7	Barn-yard manure. ...	17.6	34.4	54.6	74.5	95.7	108.7	104.2
8	Nit., bone-bl'k,&pot'sh	18.1	40.8	57.5	77.1	98.8	112.5	109.1
9	Land plaster, ...	16.7	33.7	49.1	68.7	93.	104.8	99.7
10	Nothing, ...	14.3	29.6	44.3	59.7	78.1	97.8	101.9
11	Bone-black & potash..	17.	35.7	51.8	69.3	92.6	107.9	108.4
12	Nitrate & potash, ...	13.7	29.2	44.	59.1	79.9	105.	107.4
13	Nothing, ...	12.	25.8	42.	50.5	70.9	96.7	98.8
14	Nitrate & bone-black, .	14.2	29.5	41.5	56.	74.1	100.9	98.8

These measurements do not show that any slight advantage due to the use of nitrate of soda was less apparent with the advance of the season.

ANALYSIS OF THE MANURE.

Moisture at 100° C.,	71.84	per cent.
Potassium oxide,	.204	"
Phosphoric acid.	.183	"
Nitrogen,	.319	"
Insoluble matter,	5.371	"

This manure was drawn from a livery stable in the village. The amount applied weighed 1200 pounds; and supplied at the rate per acre: nitrogen, 76.6 pounds; phosphoric acid, 43.9 pounds; potash, 49 pounds.

SUMMARY OF WEATHER OBSERVATIONS.

May 1st to Nov. 1st, 1890.

Month.	Temperature in open air in Degrees Fahrenheit. Monthly Means of Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest Daily Range. Deg.	Date.	Monthly Range.	Rainfall, Inches.
May,	67.58	44.65	22.93	79.	14th	32.	2d	33.	31st	47.	5.14
June,	76.25	53.08	23.17	86.5	30th	38.	3d	39.	10th	48.5	1.48
July.	79.74	56.24	23.50	92.	8th	41.	10 & 21	34.	6,12,21	51.	5.44
August,	76.65	57.23	19.42	86.	6th	41.5	25th	31.	16th	44.5	4.60
Sept.,	69.73	50.28	19.45	78.5	7th	29.5	25th	30.5	25th	49.	5.28
Oct.,	56.82	39.26	17.56	76.	1st	26.5	22d	34.	22d	49.5	6.89
Season,*	71.13	50.12	21.01	92.	July 8	26.5	Oct. 22	39.	Oct. 22	65.5	28.83

*153 Days.

These figures are the results of observations taken at the State Experiment Station, the instruments of which are nearly on the same level as our field and quite near it. The chief peculiarity of the record is the light rainfall for the month of June.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result
Hard corn, bushels per acre,	–.3	2.9	–10.9	5.7	.7
Soft corn, " "	.1	.6	.1	–.2	.2
Stover, pounds "	–1000	1390	783	320	348
Value of average net increment,				$1.30	
Financial result,				2.70 loss	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	5.3	8.5	–1.2	15.4	7.
Soft corn, " "	.7	0	–.2	–.5	.1
Stover, pounds "	–1260	1230	1297	834	525
Value of average net increment,				$6.28	
Financial result,				1.44 gain	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosph'ic Acid.	Nitrate and Phos-ph'ic Acid.	Average Result.
Hard corn, bushels per acre,	19.5	8.9	13.	15.8	14.3
Soft corn, " "	0	0	–.9	–.5	–.4
Stover, pounds "	190	2073	2747	1677	1672
Value of average net increment,				$14.07	
Financial result,				10.87 gain	

RESULT OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	24.	25.8	1.8	6.4
Soft corn, " "	–.4	–.4	–.2	.8
Stover, pounds "	1807	2014	21	–290
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$21.00	$22.98	$1.25	$3.99
Financial result,	9.20 gain	2.02 loss	.53 gain	3.03 gain

These comparisons make it evident that this soil still needs potash in greater amount than either of the other elements of plant food. Used alone it gives a more profitable result than that obtained on any other plot. The gain from its use alone on plot 4 amounts to no less than $14.66. Other plots gave larger crops; but no other equalled this one in point of profit on the fertilizer used. The result last year was similar; and it is true for both years that, even if labor be taken into account, the plot where potash alone was used gave the largest net profit.

Both phosphoric acid and nitrogen this year produced larger increase in crop than last. Both give larger increases when used with the other two elements than when used alone or with either of the other elements singly. The same was true last year: but the differences this year are larger than last, indicating a more general exhaustion of the soil. Phosphoric acid, indeed, when added to nitrate of soda and potash produces a very profitable increase in the crop and its average result is sufficient to produce a small profit.

Neither land plaster, nor lime produce any very marked effect this year, although, as in several other cases where lime has been used two years, the increase this year is greater than last.

Manure, used the second year upon the same plot, (the crop having therefore the advantage of any unexhausted residue from the application of last year, generally supposed to be considerable) produces a crop of grain of exactly the same size as "complete fertilizer," and two hundred pounds more stover. To secure these results, there were applied in the manure this year three times the nitrogen that was used in "complete fertilizer," one-twelfth less phosphoric acid and about three-fifths the amount of potash contained in the "complete fertilizer."

In view of the results of two years' work upon this soil, I cannot doubt that with barnyard or stable manure it will pay to use muriate of potash for corn upon this land.

If fertilizer only is to be used, I would recommend materials which will supply per acre about 80 pounds of actual potash, 30 pounds of phosphoric acid and 20 pounds of nitrogen in available forms.

AMHERST.

SOIL TEST WITH FERTILIZERS FOR CORN.

Station Grounds, North Acre.

Number of plot.	FERTILIZERS. KIND.	Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing		192		281	51.2		5620			
2	Nitrate of soda	160	200		285	53.3		5700	2.1		557
3	Dissolved bone-black	320	213	3	217	56.8	.7	4340	5.6	.6	—327
4	Nothing		192	½	209½	51.2	.1	4190			
5	Muriate of potash	160	260		287	69.3		5740	18.9		1625
6	{ Nitrate of soda { Dissolved bone-bl'ck	160 320	219	4½	216½	58.4	1.	4330	8.8	.9	290
7	{ Nitrate of soda { Muriate of potash	160 160	253	½	217½	67.5	.1	5430	18.7	0	1465
8	Nothing		180	½	194½	48.0	.1	3890			
9	{ Dissolved bone-bl'ck { Muriate of potash	320 160	277	½	287	73.9	.1	5740	26.	0	1777
10	{ Nitrate of soda { Dissolved bone-bl'ck { Muriate of potash	160 320 160	281		291	74.9		5820	27.1		1785
11	Land plaster	160	193		212	51.5		4240	3.9		132
12	Nothing		178		209	47.5		4180			
13	Barn-yard Manure	*5	302		325	80.5		6500	31.3		2197
14	Lime	160	189		221	50.4		4420	—.4		—7
15	Nothing		197	½	227½	52.5	.1	4550			

*Cords.

Average of the nothing plots: hard corn, 50.1 bushels; soft corn, .1 bushel; stover, 4486 pounds.

This acre was on similar soil to the "South acre" and not far from it. It was the original intention to use this crop for silage and it was sown in drills with a corn planter. It was, however, thinned to about six inches in the rows which were three and a half feet apart and was well eared: and as other crops had entirely filled the silo in which it was intended to place this, it was decided to stook and husk it. The variety of corn was the same as on the other acre. It was planted May 21st; stooked, Sept. 20th; and husked, Oct. 28th. The stand was remarkably uniform and even throughout the entire acre.

AVERAGE MEASUREMENTS.

No. of Plot	FERTILIZER USED.	Average of Measurements.						
		June 23	July 3	July 12	July 22	Aug. 1	Aug. 11	Aug. 21
1	Nothing	12.5	28.8	44.5	63.6	81.2	102.8	103.2
2	Nitrate of soda........	12.9	29.7	45.9	62.4	82.2	108.5	100.2
3	Dissolved bone-black..	10.9	26.6	41.9	70.2	77.4	101.1	101.2
4	Nothing	11.9	27.1	42.2	57.3	75.7	101.9	99.2
5	Muriate of potash.....	14.9	28.9	47.7	61.5	82.9	104.6	111.9
6	Nitrate and bone-black	13.5	28.6	41.3	59.8	79.4	100.7	101.1
7	Nitrate and potash	13.6	27.9	43.5	62.6	83.5	104.5	105.5
8	Nothing	10.4	24.8	37.6	52.1	74.8	100.5	97.4
9	Bone-black and potash	13.7	30.8	48.6	66.4	86.3	106.2	104.9
10	Nit., bone-bl'k & potash	13.3	29.6	44.6	62.7	87.6	103.3	106.1
11	Land plaster	13.1	25.8	41.6	58.1	76.8	97.8	96.1
12	Nothing	12.3	24.0	39.	54.2	71.3	100.5	97.5
13	Barn-yard manure	17.7	34.3	50.5	73.2	92.5	112.1	113.0
14	Lime	10.1	23.7	38.7	51.8	75.6	99.9	101.6
15	Nothing	12.1	22.2	39.6	58.	75.2	97.2	99.4

There is evidently no falling off in the plots receiving nitrate of soda with advance in the season; and I conclude that on this soil nothing would have been gained by fractional application of this fertilizer.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	53.41	per cent.
Potassium oxide,	.524	"
Phosphoric acid,	.435	"
Nitrogen,	.473	"
Insoluble matter,	3.476	"

The amount applied (32 cu. ft.) weighed 1535 pounds. It was good strong cellar manure on which hogs were kept; and made mostly by well-fed milch cows. At the rate used it supplied per acre; nitrogen, 145.2 pounds; phosphoric acid, 133.5 pounds, and potash, 160.9 pounds.

It excels all the other manures used in this set of experiments in the amount of phosphoric acid and potash; and is excelled by but one in the amount of nitrogen. Especially noticeable is the superiority in respect to potash, due perhaps largely to the fact that in our cellar the urine is entirely saved. The analysis indicates that this manure should produce a good crop and such it will be seen was the case.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	2.1	3.2	–.2	1.1	1.6
Soft corn, " "	0	.3	0	0	.1
Stover, pounds, "	557	617	–160	8	256
Value of average net increment,				$1.79	
Financial result,				2.21 loss	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	5.6	6.7	7.1	8.4	7.
Soft corn, " "	.6	.9	0	0	.4
Stover, pounds, "	–327	–267	152	320	–31
Value of average net increment,				$4.94	
Financial result,				.14 gain	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'ic Acid.	Average Result.
Hard corn, bushels per acre,	18.9	16.6	20.4	18.3	18.6
Soft corn, " "	0	0	–.6	–.9	–.4
Stover, pounds, "	1625	908	2104	1495	1533
Value of average net increment.				$16.73	
Financial result,				13.53 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	27.1	31.3	3.9	–.4
Soft corn, " "	0	0	0	0
Stover, pounds "	1785	2197	132	–7

	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$23.43	$27.40	$3.06	
Value of decrease due to				$ .30
Financial result,	11.43 gain	2.40 gain	2.34 gain	1.26 loss

The teaching of the results brought out by these comparisons is plain. This soil most needs potash for the profitable production of corn and this should be supplied to the full extent used in our experiments. The increase due to phosphoric acid is also considerable; but not sufficient to account for nearly all that applied. This, though required, need not be largely used. The nitrogen produces but an insignificant increase, and beyond possibly a little in available form to give the crop a start I should not recommend its use on this soil for corn. Neither lime nor plaster produce effects of any particular importance.

The manure produces a somewhat larger crop and a slightly larger increase than the "complete fertilizer": but at an enormously greater cost whether in money or in amounts of the chief essentials of plant food supplied. I bring the figures together for comparison.

Cost of manure,	$25;	Fertilizer, $12.
Nitrogen in manure,	145.2 pounds;	" 25.1 pounds.
Phosphoric acid in manure,	133.5 "	" 48.2 "
Potash in manure,	160.8 "	" 81.6 "

It will be observed that the fertilizer yields a much larger apparent profit on its use than the manure. The latter, however, has undoubtedly left the land in better condition than the former.

Far is it from my intention to imply that manure is not superior to fertilizer in many respects. This is a well known fact. I wish only to make evident that *to secure given results requires a vastly larger application of plant-food* than in the case of fertilizers; and further, to point out that *for corn on this soil, the profit may doubtless be enhanced by using manure in small amount in connection with potash, rather than by large applications of manure alone.* This plan is to be followed this year upon the general crop of the College Farm and the result will, in due season, be reported.

SUNDERLAND.

SOIL TEST WITH FERTILIZERS FOR CORN.

By G. L. Cooley. North Half-Acre.

No. of Plot.	FERTILIZERS. KIND.	Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing		42½	2	60½	22.7	.9	2420			
2	Nitrate of soda	160	75½	1	88½	40.3	.4	3540	14.6	—.3	867
3	Dissolved bone-black	320	48	7½	65	25.6	3.3	2600	-3.1	2.7	—327
4	Nothing		59½	1	79½	31.7	.4	3180			
5	Muriate of potash	160	99	1½	114½	52.8	.7	4580	21.9	—.1	1345
6	{ Nitrate of soda { Dissolv'd bone-bl'ck	160 320	66½	2	90	35.5	.9	3600	5.5	—.2	310
7	{ Nitrate of soda { Muriate of potash	160 160	58	3	169	30.9	1.3	6760	1.7	—.2	3415
8	Nothing		53	4	85	28.3	1.8	3400			
9	{ Dissolv'd bone-bl'ck { Muriate of potash	320 160	100	1½	121½	53.3	.7	4860	29.5	—2.6	1780
10	{ Nitrate of soda { Dissolv'd bone-bl'ck { Muriate of potash	160 320 160	107½	1	119½	57.3	.4	4780	38.1	—4.3	2020
11	Land plaster		33½	4½	60	17.9	2.	2400	3.1	—4.2	—40
12	Nothing	5*	19	17	53	10.1	7.6	2120			
13	Barn-yard manure		115	½	135½	61.3	.2	5420	48.3	—6.9	3200
14	Lime	160	19½	13½	38½	10.4	6.	1540	—5.6	—.7	—780
15	Nothing		35½	14	60½	18.9	6.2	2420			

*Cords.

Average of nothing plots: hard corn, 22.3 bushels; soft corn, 3.5 bushels; stover, 2708 pounds.

South Half-Acre.

Number of plot.	FERTILIZERS. Kind.	Pounds per acre.	Yield per plot 1-20 acre. Ears. Hard, lbs.	Soft, lbs.	Stover, lbs.	Yield per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.	Gain or loss compared with Nothing Plots per acre. Shelled Corn bushels. Hard.	Soft.	Stover, lbs.
1	Nothing		80½	1½	150	42.9	.7	6000			
2	Nitrate of soda	160	123½	1	161½	65.9	.4	6460	20.1	—.5	533
3	Dissolved bone-black	320	101	½	159½	53.9	.2	6380	5.3	—.9	527
4	Nothing		96½	3	144½	51.5	1.3	5780			
5	Muriate of potash	160	122	3	162	65.1	1.3	6480	11.	.5	695
6	{ Nitrate of soda { Dissolved bone-bl'ck	160 320	137½	2½	176	73.3	1.1	7040	16.6	.2	1250
7	{ Nitrate of soda { Muriate of potash	166 160	139½	3	177½	74.4	1.3	7100	15.1	.8	1305
8	Nothing		116	1	145	61.9	.4	5800			
9	{ Dissolved bone-bl'ck { Muriate of potash	320 160	120½	1	159½	64.3	.4	6380	4.4	—.1	875
10	{ Nitrate of soda { Dissolved bone-bl'ck { Muriate of Potash	160 320 160	134½	2	177	71.7	.9	7080	13.8	.4	1870
11	Land Plaster	160	121	2	147½	64.5	.9	5900	8.6	.3	985
12	Nothing		101	1½	115½	53.9	.7	4620			
13	Barn-yard manure	5*	128	½	115½	68.3	.2	6060	11.2	—.5	1013
14	Lime	160	96½	1	112½	51.5	.4	4460	-8.8	—.3	-1013
15	Nothing		119	1½	147½	63.5	.7	5900			

*Cords.

Average of nothing plots: hard corn, 54.7 bushels; soft corn, .7 bushel; stover, 5620 pounds.

This experiment, voluntarily undertaken by Mr. Cooley, is located on soil of alluvial formation—good, warm, corn land. The north and south halves of the field had been differently treated; the former was last manured five years ago; the latter, three years ago. Both had been in grass since last manured. It was found early in the experiment that the fertilizers were producing markedly different effects on the two halves of the field; and so it was decided to divide the acre equally by a line running across the plots, and to harvest and weigh separately. Such a difference between two pieces of land lying so near together is remarkable; but is accounted for in part by the difference in treatment above described, but largely also by the fact that the physical characteristics of the soil in the two sections are widely different.

Mr. Cooley took no measurements nor weather observations.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	60.61	per cent.
Potassium oxide,	.303	"
Phosphoric acid,	.244	"
Nitrogen,	.393	"
Insoluble matter,	23.168	"

This manure weighed 51¾ pounds per cubic foot, and by calculation the amount applied to the plot weighed 1656 pounds. At this rate it supplied per acre: nitrogen, 128.2 pounds; phosphoric acid, 80.8 pounds; potash, 100.4 pounds.

North Half Acre.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	14.6	8.6	–20.2	8.6	2.9
Soft corn, " "	–.3	–2.9	–.1	–1.7	1.3
Stover, pounds "	867	637	2070	240	954
Value of net average increment,				$4.81	
Financial result,				.81 gain	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	–3.1	–9.1	7.6	36.4	8.
Soft corn, " "	2.7	.1	–2.5	–4.1	–1.
Stover, pounds "	–327	–557	435	–1395	461
Value of net average increment,				$4.15	
Financial result,				.65 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phos-ph'c Acid.	Average Result.
Hard corn, bushels per acre,	21.9	–12.9	32.6	32.6	18.6
Soft corn, " "	–.1	.1	–5.3	–4.1	–2.4
Stover, pounds "	1345	2548	2107	1710	1928
Value of net average increment,				$17.12	
Financial result,				13.92 gain	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Plaster	Lime.
Hard corn, bushels per acre,	38.1	48.3	3.1	–5.6
Soft corn, " "	–4.3	–6.9	–4.2	–.7
Stover, pounds "	2020	3200	–40	–780
	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$30.43	$39.74	$ .81	
Value of decrease due to				$6.08
Financial result,	18.43 gain	14.74 gain	.09 gain	7.04 loss

The evidently uneven character of this half-acre tends to obscure results. The nothing plots varied from 10 bushels up to 31 bushels yield of hard corn per acre. Still the indication is strong that a fertilizer for corn must be rich in potash to give profitable returns on this land. The nitrate of soda also appears to have been more beneficial than in most of our experiments. Neither lime, nor plaster has apparently produced results of any significance.

The manure has produced a better crop and a larger apparent increase than the "complete fertilizer"; but in it were applied more than five times the nitrogen, nearly twice the phosphoric acid, and one and one-fourth times the potash furnished in the fertilizer.

South Half Acre.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosphoric Acid.	Muriate of Potash.	Phosphoric Acid and Potash.	Average Result.
Hard corn, bushels per acre,	20.1	11.3	4.1	9.4	11.2
Soft corn, " "	–.5	1.1	.3	.5	.4
Stover, pounds, "	533	723	610	995	715
Value of average net increment,				$9.75	
Financial result,				5.75 gain	

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing,	Nitrate of Soda.	Muriate of Potash.	Nitrate and Potash.	Average Result.
Hard corn, bushels per acre,	5.3	–3.5	–6.6	–1.3	–1.5
Soft corn, " "	–.9	.7	–.6	–.4	–.3
Stover, pounds "	527	717	180	565	497
Value of average net increment,				$ .10	
Financial result,				4.70 loss	

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of Soda.	Phosphoric Acid.	Nitrate and Phosphoric Acid.	Aver. Result.
Hard corn, bushels per acre,	11.	–.5	–.9	–2.8	.6
Soft corn, " "	.5	1.3	.8	.2	.7
Stover, pounds "	695	772	348	620	609
Value of average net increment,				$2.15	
Financial result,				1.05 loss	

RESULTS OF THE ADDITION TO NOTHING OF

	Complete Fertilizer.	Barnyard Manure.	Land Plaster.	Lime.
Hard corn, bushels per acre,	13.8	11.2	8.6	–8.8
Soft corn, " "	.4	–.5	.3	–.3
Stover, pounds "	1870	1013	985	--1013

	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$14.46	$10.22	$8.57	
Value of decrease due to				$8.78
Financial result,	2.46 gain	14.78 loss	7.85 gain	9.74 loss

On this half-acre the nitrate of soda appears to have been the most beneficial; but the large increase on plot 2 apparently caused by this fertilizer, I believe to be more apparently than truly so caused. It will be noticed that the yield of the nothing plot 1 by which the comparisons for plot 2 are most influenced is the smallest of any of the nothings. This, perhaps due to natural variation in the soil, makes the increase on plot 2 probably too large to represent the true effect of the nitrogen. With all due allowance for this probable magnification of the effect of nitrogen, however, I conclude from a study of the results that on this soil nitrate of soda was largely beneficial, while neither phosphoric acid nor potash appear to have been so.

The "complete fertilizer," although furnishing much less plant-food than the manure, as pointed out under the comparisons for the North half-acre; gave on this land a larger yield and a larger increase than the latter, and of course, costing less, proved much the more profitable.

GENERAL SUMMARY.

Results of the Use of Potash: This ingredient has produced an average increase of crop varying from .6 bushels of hard corn per acre in Marblehead to 48.1 bushels in Hadley; and from 275 pounds of stover per acre in Freetown to 3958 pounds in Hadley. It has proved more useful in its average effect upon the production of hard corn than either nitrogen or phosphoric acid in nine out of fourteen experiments, viz: New Lenox, Hadley, Worcester, Yarmouth, Concord, Bridgewater, Sunderland (north half), and Amherst (two experiments). It surpasses nitrogen in yield of hard corn in Shelburne and it exceeds phosphoric acid in this respect in Marblehead and Sunderland (south half). It has proved most powerful in its effects upon the production of stover in twelve experiments, viz: Marblehead, New Lenox, Shelburne, Hadley, Worcester, Yarmouth, Freetown, Concord, Bridgewater, Sunderland (north half), and Amherst (two experiments). It exceeds nitrogen in this respect in Westfield and similarly exceeds phosphoric acid in Sunderland (south half).

Results of the Use of Phosphoric Acid: This ingredient has proved most effective in its average influence on the production of hard corn in two experiments, viz: Shelburne and Westfield, and in one it has excelled potash, viz: Freetown. It has proved quite beneficial in four more, viz: Worcester, Sunderland (north half), Amherst (two experiments). In its average influence upon production of stover it has proved most beneficial in but one experiment, viz: Westfield. It excels nitrogen in this respect in Marblehead, Yarmouth, Bridgewater and Amherst (south acre). Its average apparent effects upon the production of hard corn and stover vary respectively from a decrease of 4.1 bushels per acre in Yarmouth to an increase of 14.7 bushels in Westfield for the former; and from a decrease of 947 pounds per acre in New Lenox to an increase of 590 pounds in Westfield for the latter.

Results of the Use of Nitrogen: This element has in three cases proved most beneficial in its average effect upon the production of hard corn, viz: Marblehead, Freetown, and Sunderland (south half). It has surpassed phosphoric acid in this respect in New Lenox, Hadley, Yarmouth, and Concord and is ahead of potash in Westfield. In its average effect upon the production of stover it stands first in Sunderland (south half); and it excels phosphoric acid in this respect in eight experiments, viz: New Lenox, Shelburne, Hadley, Worcester, Freetown, Concord, Sunderland (north half), and Amherst (north acre). The average effect per acre of this element is as follows: hard corn, from .3 to 11.2 bushels increase; stover, from 406 pounds decrease to 1114 pounds increase.

Comparative Effect of Potash, Nitrogen and Phosphoric Acid upon Production of Grain and Stover: As last year, our figures afford interesting data bearing upon the relative influence upon grain and stover production respectively of these ingredients of the fertilizers used. The grand average increase in hard corn and stover per acre taking all our experiments into account is as follows:

For potash,	*hard corn,*	*11.3*	*bushels;*	*stover,*	*1308*	*pounds.*
For nitrogen,	" "	*4.7*	"	"	*389*	"
For phosphoric acid,	" "	*3.6*	"	"	*162*	"

The increase due to potash, then, exceeded that due to nitrogen as follows: hard corn, 2.40 times; stover, 3.37 times. Over phosphoric acid the average increase was respectively: hard corn, 3.14 times; stover, 8.08 times. As I wrote last year: "*It thus becomes evident that potash produces relatively more effect upon the yield of stover than upon that of grain; and that it greatly exceeds either nitrogen or potash in this respect. Next to potash in its effect upon stover ranks nitrogen.*"*

CONCLUSIONS.

1. Our results show that soils differ widely in their requirements.

2. Potash, however, much more often proves beneficial or proves much more largely beneficial than either nitrogen or phosphoric acid.

3. Potash as a rule most largely increases the yield of both grain and stover; but its effect upon stover production is greater than upon grain production.

4. Barn-yard manures are, as a rule, relatively deficient in potash, probably because of the loss of a large proportion of the urine which contains about four-fifths of the total potash of the excretions.

5. The relative deficiency of many of our soils in potash may, I think, be largely accounted for from the following facts:—

a. Manures as a rule lack this ingredient, as just pointed out.

b. Farmers who have used commercial fertilizers have, as a rule, bought phosphates or fertilizers rich in phosphoric acid and containing little or no potash.

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*For comparison see Bulletin No. 9, page 47.

c. All fodders, pasture grasses, and hay are rich in potash, and our farmers have devoted a large share of their land to the production of these crops.

6. The relative deficiency of potash in so many soils, shown now by the results of the work of two seasons, I believe justifies the following general advice.

a. In breaking up sod land for corn particularly that which is in fair condition but which has been under ordinary farm management, if fertilizers only are to be used apply those which are rich in potash. Use materials which will supply, 80 to 100 pounds of actual potash, from 25 to 30 pounds of phosphoric acid, and from 15 to 20 pounds of nitrogen per acre.

b. If a special corn fertilizer is to be used, apply only a moderate quantity, say 400 to 500 pounds per acre, and use with it about 125 pounds of muriate of potash. It is believed this combination will produce as good a crop as 800 to 1000 pounds of "corn fertilizer;" and it will cost considerably less.

c. With ordinary barn-yard or stable manure for corn, use potash. I would recommend using about four cords manure and one hundred pounds of muriate of potash per acre.

d. For fodder or ensilage corn, use either in fertilizers or with manures about one-fourth more potash than above recommended.

e. In our experiments all fertilizers and manures have been applied broad-cast and harrowed in, and I believe this is the best method.

f. Although I recognize the danger of giving empirical directions of a general nature, the results of our work lead me to recommend with considerable confidence any one of the following mixtures per acre for corn.

I.

Muriate of Potash,	*175 lbs.*
Dissolved Bone Black,	*175 "*
Nitrate of Soda,	*100 "*

II.

Muriate of Potash,	*175 "*
Plain Superphosphate,	*150 "*
Bone Meal,	*100 "*
Dried Blood,	*175 "*

III.

Wood Ashes,	*1500* "
Bone Meal,	*100* "
Nitrate of Soda,	*100* "

IV.

Wood Ashes,	*1500* "
Dry Ground Fish,	*400* "

V.

Muriate of Potash,	*175* "
Dry Ground Fish,	*400* "

The ashes, bone meal or fish should be applied very early in spring or late in winter. Apply all these fertilizers broad-cast and harrow in. Do not mix a long time before use:—especially important in case of Nos. III and IV.

Of course these combinations might be indefinitely extended; but from what has been said as to the required amounts of the essentials,—potash, nitrogen and phosphoric acid, any farmer should be able to figure amounts and combinations for himself. Between combinations I, II, and V there should be little difference in cost. Combinations III and IV will probably cost from four to five dollars more. The elements other than potash and phosphoric acid contained in ashes, and their physical and chemical action in the soil will no doubt, in whole or part offset this increased cost.

During the past season we carried out on the station grounds one experiment of a similar nature to those described in these pages with *potatoes.* The records of this experiment have, unfortunately, been destroyed by fire; but they had been carefully studied and worked out, and I am able from memory to state the leading facts. The soil was similar to that used on our grounds for corn. Previous to the spring of 1889 it had been several years in grass without manure. It was then plowed and planted to sweet corn without manure or fertilizer. The crop was a very good one and even throughout the field. The land was plowed in the fall of 1889 and the experiment with potatoes laid out in the spring of 1890 precisely as for corn. The same arrangement of plots was used, and the same kinds and quantities of fertilizers. No plot gave an entirely satisfactory crop. The barn-yard manure gave the largest yield but not of the best quality. Quantity and quality considered, the complete fertilizer gave the most satisfactory results, but not the most profitable. Potash, for this crop as for corn, seemed to be most deficient in this soil. This is thus far the only experiment tried under my direction on potatoes and I am not justified in forming any sweeping conclusions. It, however, appears to me likely that the "special potato fertilizers" in the market furnish too small a proportion of potash. It will pay, I believe, to use them in moderate quantities, if at all, in connection with sulphate of potash for the heavier and muriate of potash for the lighter soils.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 15.

Experiments in Greenhouse Heating.
Special Fertilizers for Plants under Glass.
Report on Varieties of Strawberries.
Report on Varieties of Blackberries and Raspberries.

OCTOBER, 1891.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1891.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

HENRY H. GOODELL. . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
JOHN S. LORING,	" "
HENRY J. FIELD, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Horticulture.

SAMUEL T. MAYNARD.

EXPERIMENTS IN GREENHOUSE HEATING.

In Bulletins No. 4 and 8 were given the results of heating two greenhouses of similar construction, one by steam and the other by hot water. After two seasons of careful test with the same results each time, it was decided that, for houses of small or medium size, hot water gave the best results. For houses of large size, however, no satisfactory conclusions can be drawn until parallel experiments are made with more extensive houses and under similar conditions.

The two houses used for the above experiments being as nearly alike, in every way, as it is possible to construct them, it was determined to test the value of *over-bench* piping as compared with *under-bench* piping.

OVER-BENCH *VS.* UNDER-BENCH HEATING.

For this purpose in the two above mentioned houses were placed two hot water boilers of a standard make, and arranged so as to have the apparatus as complete and equal as possible.

In the *east* house the pipes were arranged *under* the benches while in the *west* house they were arranged *over* the benches.

A partition divides each house into two sections, designated in the tables "North Section" and "South Section," in the former (North Section) of which was grown coleus, roses and other plants requiring a high temperature, while in the latter (South Section) was grown lettuce, carnations and other plants requiring a lower temperature.

Upon the "flow" pipes were placed standard thermometers to register the temperature of the water as it passed from the boiler to the houses.

Observations were taken four times each day; at 7 A. M., 1 P. M., 6 P. M., and 9 P. M., beginning Dec. 1st and ending April 12th, the results of which are given in the following tables. Table No. 1 gives the results of the average daily observations for the month of January, while No. 2 gives the average temperature and total amount of coal consumed for the months of December, January, February, March and April.

Table No. 1.

HEATING RECORDS.

January, 1891.

UNDER-BENCH PIPING. EAST HOUSE. North Section.			South Section.			OVER-BENCH PIPING. WEST HOUSE.	North Section.			South Section.	
Aver. daily temperature of water	Aver. daily temperature of house	Amount of coal consumed daily	Aver. daily temperature of water	Aver. daily temperature of house	Date	Aver. daily temperature outside	Aver. daily temperature of water	Aver. daily temperature of house	Amount of coal consumed daily	Aver. daily temperature of water	Aver. daily temperature of house
131.25	66.5	92	113.75	45.	1	17.8	135.	65.75	116	107.5	46.5
97.5	61.5	136	88.75	46.25	2	31.	113.75	61.75	137	91.25	49.5
128.75	66.25	120	108.75	48.25	3	25.4	135.	62.75	160	107.5	50.5
111.25	63.	139	98.75	44.75	4	11.4	111.25	58.25	99	93.75	45.75
137.5	69.	120	101.25	48.5	5	23.4	142.5	67.	144	103.75	50.25
132.5	67.5	121	98.75	47.5	6	18.	127.5	63.	166	95.	49.5
120.	65.5	132	100.	48.5	7	21.8	137.5	65.75	134	87.5	50.75
116.25	65.75	179	101.25	49.	8	26.4	126.25	63.5	163	102.5	51.
152.5	71.25	155	123.75	48.5	9	17.4	152.5	69.	159	108.75	48.
137.5	71.	175	117.5	52.5	10	18.6	126.25	66.5	166	110.	53.5
146.25	71.75	136	110.	49.75	11	24.8	138.75	66.75	134	102.5	49.5
126.25	65.75	127	96.25	49.	12	35.2	126.25	67.75	155	88.75	48.
126.25	62.5	194	116.25	45.5	13	19.2	145.	61.75	196	90.	47.25
132.5	66.75	167	101.75	48.25	14	22.8	133.75	63.25	161	96.25	48.5
125.	67.75	136	108.75	51.	15	22.	137.5	62.5	142	95.	51.25
123.75	68.25	169	102.5	51.25	16	22.6	133.75	64-75	198	105.	51.75
143.75	61.	168	108.75	45.75	17	17.6	152.5	64.25	174	106.25	47.25
133.75	70.75	146	90.	48.75	18	30.8	133.75	62.25	145	86.25	47.5
128.75	73.5	104	975.	52.75	19	26.2	130.	67.5	100	92.5	53.25
105.	66.5	111	85.	49.75	20	27.6	116.25	64.	123	86.25	51.
118.75	65.75	92	96.25	48.75	21	29.6	126.25	61.75	94	83.75	48.5
121.25	62.25	106	98.25	48.25	22	23.	120.	63.	115	91.25	51.
98.75	64.	94	83.75	49.25	23	38.2	130.	62.75	101	85.	49.5
125.	63.5	85	91.25	49.5	24	35.6	103.75	60 5	92	86.25	51.5
115.	62.75	127	92.5	42.25	25	31.8	121.25	56.25	124	96.25	44.5
80.	63.	123	90.	46.75	26	26.6	107.5	58.25	120	91.25	47.25
	66.25	99	97.5	52.5	27	33.2	131.25	64.75	95	96.25	51.75
110.	67.25	98	85.	53.75	28	34.8	112.5	66.75	105	78.75	52.25
122.5	58.	102	93.75	45.75	29	32.4	106.25	58.75	101	90.	46.75
123.75	66.	128	91.25	49.5	30	39.2	107.5	59.75	130	81.25	48.5
138.75	64.	114	101.25	46.5	31	30.6	125.	60.75	110	92.5	46.75

Table No. 2.

AVERAGE TEMPERATURE BY MONTHS.

East House.				West House.			
North Section.		South Section.		North Section.		South Section.	
Average Water Temperature.	Average House Temperature.	Average Water Temperature.	Average House Temperature.	Average Water Temperature.	Average House Temperature.	Average Water Temperature.	Average House Temperature.
December.							
133.85	63.00	100.72	48.50	134.00	65.69	108.85	45.88
January.							
121.16	66.45	101.52	48.45	128.10	63.39	93.55	49.30
February.							
119.19	65.42	77.73	49.66	129.87	63.82	97.13	40.49
March.							
115.16	67.96	90.73	52.93	120.98	64.44	91.68	53.36
*April.							
114.75	66.46	102.12	59.83	116.94	68.35	102.80	60.00
Total average.							
120.81	64.66	94.56	51.86	125.98	65.14	99.00	51.61

COAL CONSUMED.

East House.		West House.	
Total lbs.	Av. per day, lbs.	Total lbs.	Av. per day, lbs.
December, 1890.			
4366	140.84	4946	159.54
January.			
3995	128.87	4159	134.16
February.			
3584	128.00	3782	135.07
March.			
3466	111.80	3402	109.74
*April.			
1357	113.08	1375	114.58
Total average.			
3354	124.52	3533	130.62

*12 days only.

RESULTS.

It will be seen by table No. 2, that while the average temperature of the water as it came from the boiler in the west house, with pipes over the benches, was 4.81° higher than that from the east boiler, where the pipes were under the benches, the *House* temperature was only .25° or $\frac{1}{4}$ of one degree higher.

This would indicate that there was a loss of heat from its escape through the glass before it could affect the atmosphere about the thermometers, which hung about midway between the walk and the glass.

We also see by table No. 2. that there was 179 lbs. more of coal consumed in heating the west house than in heating the east one.

It was observed that the circulation of the hot water in pipes *over* the benches was more rapid and regular than where the pipes run under the benches. This, however, might have been remedied, in a measure, had the boilers both been set in a pit or cellar. In this case, they were both placed only 2 feet below the level of the green-house floor.

EFFECT UPON THE GROWTH OF PLANTS.

The results of observations upon the growth of plants placed in these two houses are very marked and in favor of the under-bench piping.

Carnations. To determine this question the same number and kinds of plants were planted in the middle bench of both houses and treated, in every way, as to soil, watering and ventilation the same. As the blossom buds neared maturity each one was counted and a small tag attached, to show that it had been counted, so that anyone might pick the blossoms and not trouble to record every one cut. This was done every morning and the results of the winter's count is as follows:

Total number of blossoms counted in over-bench piped house.		4,372
" " " " " " under-bench piped	"	4,797

A difference of 425 in favor of the under-benched piped house.

Lettuce. The side benches of both houses were planted with lettuce early in the winter and careful weekly observations made as to the comparative growth. As there was more or less mildew in both houses, no accurate weight of the crop could be given, but that in the east or under-piped house was much the best, as were also seedling plants of lettuce, cabbage and tomatoes planted later.

Cuttings and Flower Seeds. The same kinds of cuttings and flower seeds were put into both houses and the results carefully noted. In every case the cuttings rooted more quickly and the seeds germinated more quickly and evenly in the under-piped house.

It was found where nearly matured or budded plants were placed in the two houses, that the blossoms came out more quickly where the pipes were *over* the benches than where *under* them.

DISTRIBUTION OF THE HEAT.

To determine the distribution of the heat through the houses by these two methods of piping, weekly observations were made at intervals during the winter, the results of which are given in the following table. Four observations were made each day.

TABLE No. 3.

EAST HOUSE.				WEST HOUSE.			
NORTH SECTION.		SOUTH SECTION.		NORTH SECTION.		SOUTH SECTION.	
Av. temp. over bench.	Av. temp. under bench.	Av. temp. over bench.	Av. temp. under bench.	Av. temp. over bench.	Av. temp. under bench.	Av. temp. over bench.	Av. temp. under bench.
Week ending January 31, 1891.							
63.89	84.23			60.75	60.46		
Week ending February 7, 1891.							
		49.39	48.83			49.39	36.10
Weeks ending March 14 and 21, 1891.							
65.27	64.30			62.85	59.90		
67.53	67.35			64.08	59.85		
Two weeks ending April 6, 1891.							
		56.89	53.31			55.87	50.93

In this case the difference in the temperature between the space under the benches and that over them is much more marked in the west house than in the east, showing that when the pipes are arranged over the benches the heat is not so evenly distributed through the houses as where arranged under the benches.

SPECIAL FERTILIZERS FOR PLANTS UNDER GLASS.

During the winter of 1889 and 1890, experiments were made with fertilizers applied to crops under glass, the results of which were given in Bulletin No. 10. The past winter the same experiments were repeated. For this purpose six plots were arranged in each of the two greenhouses used for testing systems for greenhouse heating, and planted about Sept. 20th, with the same kinds and number of carnations.

The number of blossoms produced by each plot was recorded as described in the experiment for testing systems of piping. Each plot had applied to the soil, soon after planting, one of the elements of plant food in the form used in the common commercial fertilizers. The greatest care was taken that the soil, watering, ventilation and all other conditions should be the same.

Observations were made for thirty-one weeks, the results of which are given in the following table:

Plot No. 1.	Muriate of potash,	produced	1261 blossoms
Plot No. 2.	Nitrate of soda,	"	1353 "
Plot No. 3.	Sulphate of ammonia,	"	1345 "
Plot No. 4.	Sulphate of potash,	"	1475 "
Plot No. 5.	Nitrate of potash,	"	1601 "
Plot No. 6.	Dissolved bone,	"	1069 "

RESULTS.

It will be seen that in this test the nitrate of potash gave the best results, the sulphate of potash the next best, and dissolved bone black the poorest result.

These results do not agree with those of the previous winter, as, in that test, bone black stood at the head of the list with sulphate of potash second.

After careful study of the conditions and surroundings, no satisfactory cause can be assigned for this difference, unless it be from the insoluble condition of the bone black which did not give good results in the previous tests until the latter part of the trial.

In five experiments made in this line, three have been in favor of bone black, one of sulphate of ammonia and one of nitrate of potash. Sulphate of potash has stood second in every one of them. The nitrate of soda and muriate of potash, in every case where the crop has had a tendency to mildew, have given poor results, owing probably to their power of holding moisture near the surface of the soil.

In the growth of the rose, lettuce and carnation a moist atmosphere or a very moist soil in contact with the plants especially *at night* must be avoided if success is expected, and therefore such fertilizers as nitrate of soda and muriate of potash would aggravate any such condition.

RERORT ON VARIETIES OF STRAWBERRIES.

The strawberry crop on the college grounds was about an average one the past season although the frosts cut off many of the early blossoms. The first picking for market was made June 15th, almost one week later than the average. Nearly all of the old varieties show more or less signs of degeneracy but some of the newer ones promise to more than replace them.

The following table gives the standing of each variety, as shown from their growth in two separate specimen beds and many of them in field culture. In these tables, 10 indicates the highest degree of excellence.

	Vigor of plants	Amount of rust	Firmness	Shape	Flavor	Color	Sweetness	Texture	Size	Produc'iveness	Time of blooming May	Rip'ning of first berry June
Arlington,	10	.05	9	6	7	M	1	10	2	4	6th	6th
Anger, No. 70,	10	.40	10	10	9	D	6	9	8	6	10th	13th
Beder Wood,	10	.08	10	9	7	L	2	8	6	9	1st	3d
Belmont,	10	.15	8	8	6	D	5	9	8	6	14th	14th
Beseek,	9	.07	6	9	7	L	8	8	6	2	7th	13th
Bessie,	10	.10	8	6	6	M	2	9	2	2	7th	7th
Bidwell,	9		8	6	7	D	6	8	7	2	2d	9th
Bomba,	7	.10	9	8	8		6	9	9	2	7th	9th
Bubach, No. 5,	8	.00	9	7	7		5	8	9	6	11th	12th
Bubach, No. 24,	10	.00	9	8	9	M	7	8	8	5	11th	9th
Bubach, No. 132,	9	.02	8	7	9	L	6	6	8	5	2d	9th
Burt,	9	.10	9	9	7	D	2	8	6	3	9th	9th
Carmichael,	3	.05	7	6	9	D	8	10	8	1	7th	11th
Chas. Downing,	5	.25	6	7	7	L	8	8	5	4	9th	13th
Clara,	5	.02	8	4	9	L	8	8	5	1	11th	14th
Clingto,	10	.02	8	4	4	D	3	8	6	3	9th	13th
Clouds Seedling,	10	.12	9	7	6	D	3	8	4	6	9th	7th
Covill's Early,	10	.50	8	8	8	D	7	9	2	1	1st	3d
Crawford,	10	.03	9	7	9	M	7	8	7	3	9th	10th
Crescent,	10	.01	9	8	7	L	5	9	5	9	9th	7th
Crystal City,	9	.05	7	6	8	D	7	8	5	1	7th	7th
Daisy,	4	.05	9	10	8	M	3	9	8	1	18th	11th
Emerald,	10	.25	8	2	7	L	5	8	4	1	7th	14th
Eureka,	10	.03	9	7	9	L	8	8	8	6	2d	3d
Farnsworth,	8	.20	8	7	9	L	7	9	8	4	10th	9th
Garritson,	1	.03	8	10	4	L	2	9	5	1	7th	13th
Gaudy,	7	.05	10	8	7	L	5	9	6	4	18th	18th
Glendale,	8	.05	10	9	7	D	2	8	7	4	11th	11th
Gold,	1	.01	10	10	8	L	4	9	5	1		18th
Great American,	7	.10	7	9	9	D	8	8	6	3	11th	12th
Hampden,	9	.02	9	9	8	M	7	8	8	3	10th	11th
Henderson,	8	.02	7	5	10	D	8	7	3	1	9th	5th
Hatfield,	10	.10	9	8	9	M	8	8	7	1	9th	10th
Haverland,	8	.01	8	7	10	L	8	8	8	9	2d	4th
Hoffmanns,	9	.05	9	8	7	D	5	7	6	3	9th	10th
Howard's No. 5,	9	.25	8	6	9	D	7	9	7	4	6th	5th
Howard's No. 6,	10	.25	9	7	9	M	6	9	4	4	9th	7th
Indiana,	10	.10	9	9	7	D	3	8	8	7	9th	7th
James Vick,	4		8	8	7	D	6	8	4	1	16th	11th
Jersey Queen,	8	.05	9	6	8	M	9	9	5	4	10th	14th
Jessie,	10	.02	9	8	9	M	6	9	7	2	7th	11th
Jucunda Improved,	8	.45	8	10	9	M	8	9	9	1	14th	12th
Kentucky,	10	.10	8	6	7	D	3	7	8	3	12th	13th
Lennings' White,	7	.30	8	10	9	W	8	7	3	1	9th	11th
Lady Rusk,	9	.02	7	6	9	D	7	8	4	3	10th	11th
Leroy,	10	.05	9	8	8	D	3	7	8	2	10th	13th
Logan,	9	.03	9	8	8	M	7	7	8	3	2d	12th

	Vigor of plant	Amount of rust	Firmness	Shape	Flavor	Color	Sweetness	Texture	Size	Product'veness	Time of blooming May	Ripen'ng of first berry June
Long John,	8	.05	9	6	9	D	8	7	5	2	1st	11th
Loudons,	10	.10	8	7	8	M	8	8	6	2	9th	14th
Louise,	6	.02	8	10	10	D	7	9	9	2	14th	14th
Lovett's Early,	6		8	7	9	M	7	8	4	5		11th
May King,	10		8	8	8	L	6	8	6	5	12th	13th
Miami,	9	.05	9	8	8	L	7	9	7	4	12th	13th
Miller's Seedling,	10	.10	7	4	7	M	5	8	6	6	14th	14th
Miner's Prolific,	5	.15	8	5	8	M	7	8	4	7	6th	10th
Michael's Early,	10	.20	6	7	9	L	8	6	6	5	2d	4th
Ohio,	10	.30	8	5	7	L	7	8	5	3	12th	17th
Ontario,	10	.10	7	8	10	L	9	8	7	3	13th	17th
Parker Earle,	10	.25	9	6	8	M	7	9	7	7	12th	15th
Parmenter's Seedling,	10	.05	7	2	7	M	5	7	8	7	10th	10th
Parry,	7	.10	7	5	7	D	3	8	2	2	9th	6th
Photo,	7	.20	10	9	8	M	6	10	10	5	10th	11th
Pineapple,	10	.02	8	4	10	L	9	8	7	3	18th	14th
Pioneer,	10	.10	9	8	9	M	7	10	9	2	9th	12th
Porter's Seedling,	10	.02	9	8	6	M	1	9	5	3	1st	12th
Royal Hautboy,	3	.10	9	9	1	D	6	8	3	1		
Sharpless,	10	.15	9	8	10	D	9	8	9	4	10th	15th
Shuster's Gem,	10	.05	9	8	9	L	8	9	8	7	8th	9th
Stayman's No. 2,	9	.15	7	3	4	M	1	9	5	5	10th	13th
Stayman's No. 1,	10	.10	7	3	6	L	5	8	5	9	5th	13th
Sunapee,	8	.35	8	8	9	D	7	8	3	2	10th	9th
Tippicanoe,	8	.25	10	8	9	M	10	10	6	1	10th	15th
Van Dieman,	9	.10	7	8	9	L	8	7	6	4	2d	4th
Viola,	10	.02	8	7	9	L	8	8	7	3	9th	12th
Warfield,	10	.01	10	9	5	D	1	8	7	10	9th	5th
White Novelty,	9	.35	4	10	7	W	8	3	3	1	13th	17th
Wilson,	7	.05	8	7	7	M	5	8	6	2	9th	6th
No. 1,	10	.15	8	8	7	D	6	7	4	5	9th	7th
No. 9,	10	.10	6	9	5	L	2	7	5	1	10th	13th
No. 10,	10	.05	7	9	9	L	7	8	8	3	10th	13th
No. 11,	10	.15	7	7	8	L	5	6	5	8	9th	6th
No. 12,	10	.10	8	9	8	L	5	6	5	2	10th	12th
No. 14,	4		6	3	8	D	8	6	1	2	1st	13th
No. 19,	10	.05	8	6	6	L	8	8	4	4	10th	12th
No. 20,	10	.10	7	5	7	M	7	8	5	5	8th	6th
No. 21,	10	.05	8	4	6	L	3	7	3	3	10th	13th
No. 23,	8	.08	8	6	8	L	6	8	3	3	8th	
No. 24,	8	.10	9	10	8	M	8	8	10	8	15th	17th
No. 28,	10	.02	9	6	8	M	6	6	3	5	10th	6th
No. 29,	10	.05	7	7	9	L	7	7	6	5	1st	8th
Excelsior,	10	.25	8	8	8	L	7	8	8	2	15th	14th
Gypsy,	10	.01	9	6	9	D	7	9	6	1	10th	10th
Seedling,	10	.10	8	3	5	M	3	8	2	2	8th	

A few of the most desirable or most largely advertised varieties should have special mention.

Beder Wood. This promises to be one of the best early berries, ripening as it does, with the very earliest. The fruit is of good size and color, productive and showy. It has a perfect flower, fine healthy foliage and can be used to fertilize any early kind.

Belmont. This fine variety, under certain conditions, gives satisfactory results, but under ordinary cultivation is not productive. Its quality, fine color and large size make it a valuble berry where it succeeds.

Bubach No. 5. This berry is of large size, perfect form and of fairly good quality. The plant is pistillate, vigorous and fairly productive. Foliage, large, dark green and perfectly free from rust. A very valuable variety for general cultivation.

Eureka. An early berry of good quality and one that continues to ripen for a long time. A good home or market berry.

Haverland. In our last year's plots this variety did not do as well as it was reported to have done in many other places, but this year it has redeemed itself and proves a superior variety in every way, except vigor of plant. It must be fertilized with some early variety like the Beder Wood or Michael's Early

Lady Rusk. This variety has not given the promise of what was claimed for it. The growth of plant is small, but the fruit is of good quality.

Lovett's Early. The only plants we had with which to study this variety were set late in the summer, and did not get established so as to give a satisfactory crop.

Middlefield, (Augurs No. 70). While this variety produces beautiful berries of good quality, it has not proved profitable here. For a fancy trade it may be valuable.

Michael's Early. Ripening with Beder Wood it seemed to promise equally well at the first of the season, but did not prove as productive, hardy, or of as good quality.

Parker Earle. This variety ripens with the latest; the berries are of good size, the plant vigorous and especially valuable for hill culture.

Parmenter's Seedling. When in blossom and even when the first berries ripened it promised to be one of the most productive, but failed, for some reason, to carry out its fruit, and the berries were of poor quality. Under different conditions it may behave better.

Van Dieman. A promising variety of good quality, but it requires another season to prove its merits.

No. 24. Of the seedlings produced on the college grounds, this one proves the best, having attracted much attention from those who are testing it in other places. One large grower pronounces it the most valuable variety on his grounds.

Select Varieties. For general purposes and the market the test of the past few years leads us to name the following varieties in order of their merit: Beder Wood, Bubach No. 5, Haverland, Belmont, Warfield, Eureka, Middlefield, Sharpless and Crescent.

INJURIOUS INSECTS.

The only insect specially injurious to the strawberry on the college grounds is the Black Paria (*Paria aterrima*), a minute brown insect about $\frac{1}{8}$ of an inch long, which eats the foliage, giving it the appearance of having been riddled with gunshot.

It appeared in the old beds here early in May, and has continued its ravages until the present date, Sept. 20th, though most of the injury occurred in August. It works more on old beds, but where old and new beds are planted side by side, and the old one is plowed under, the beetles migrate to the new one and feed upon their foliage.

The remedies suggested are paris green or hellebore. Experiments were made with the combined mixture of sulphate of copper and lime known as the "Bordeaux mixture," and paris green for the destruction of this insect and the leaf rust, but as yet no positive results have been obtained. As the beetle is a leaf eating insect we have good reasons to hope that either the paris green or the hellebore will prove an effectual remedy. Further experiments will be made the coming season, and it is hoped that any one who may have been successful in checking its ravages will report their methods, for if it continues to increase as it has in the two past seasons, strawberry growing will become a very uncertain business.

STRAWBERRY RUSTS.

Strawberry plants, as a rule, have been comparatively free from rust this season on the college grounds, though in some sections it has been abundant and wherever this condition of things exists there can be little profit in growing this fruit.

This disease is caused by a fungous growth (*Ramularia Fragariæ*) that appears in round red or brown spots on the leaves. When these are numerous the leaf function is destroyed and the plants are seriously weakened or die. Some varieties are more subject to its attack than others and all are more or less subject to it when we have very warm and moist weather during the early summer while the fruit is ripening, when the berries become small or fail to mature at all.

REMEDIES.

Vigorous growing varieties with thick dark green leaves, like the Wilson and Bubach No. 5, are less likely to be attacked than those with light green foliage, like the Charles Downing. Good cultivation and high manuring will also lessen the loss from this disease.

The use of the Bordeaux mixture is also advised, especially in combination with paris green which is recommended to destroy the "black paria." If applied as soon as the foliage begins to grow in the spring, say, about April 25th, and again in two weeks, or before the fruit has set, and then from July 1st to August 1st, at intervals of two weeks, we shall look for good results, though in our experiments the past season we were unable to prove that the paris green destroyed the above insect.

Any facts relating to either insect or fungous diseases or their remedies will be gladly received and reported upon.

REPORT ON VARIETIES OF BLACKBERRIES AND RASPBERRIES.

As with the strawberry, the crop of blackberries and raspberries the past season has been abundant and good. The first picking was about one week earlier than last season. The weather has not been favorable to the production of rusts, and insects have not been as abundant as usual, so that with a large yield and fair prices the crop has been a profitable one generally.

The following tables give the results of careful comparisons of the different varieties for the past season:

BLACKBERRIES.

VARIETIES.	Size.	Shape.	Firmness.	Flavor.	Productiveness.	Time of blooming.	Time of ripening.	Vigor of Canes.	Per cent. winter killed.
Lucretia.	8	8	5	6	9	May 25	July 11	10	.10
Wilson, Jr.	10	9	9	9	6	June 4	" 13	4	.40
Early Harvest	5	5	8	8	4	" 6	" 13	8	.50
Agawam.	8	9	9	10	10	May 23	" 14	10	.00
Early Cluster.	4	8	8	8	2	June 1	" 15	8	.30
Thompson's Early Mammoth.	10	9	9	8	2	" 4	" 15	8	.03
Wilson.	10	9	9	8	10	May 31	" 18	10	.05
Stone's Hardy.	9	9	8	10	4	May 30	" 18	10	.05
Early King.	8	8	6	7	4	June 4	"	6	.12
Erie	8	9	9	8	4	" 4	" 22	10	.20
Minnewaski.	8	9	9	6	5	" 4	" 23	9	.08
Fred.	7	10	7	6	4	May 27	" 24	8	.08
Western Triumph.	5	6	9	7	2	June 8	" 24	10	.08
Snyder.	7	9	7	6	10	May 37	" 16	10	.00
Taylor's Prolific.	7	9	8	10	10	May 27	" 25	10	.00
Wachusett.	6	9	9	10	7	May 27	" 18	8	.00

In these tables 10 signifies the highest degree of perfection.

The varieties fully tested that stand at the head of the list for profit or for home use we give, in the order of merit: *Agawam, Taylor's Prolific and Snyder.* Of the newer and most promising we give the following list in order of merit: *Erie, Minnewaski, Fred* and *Stone's Hardy.* *Early Harvest* and *Early Chester* should be discarded as they are not hardy. The other varieties given require further testing to prove their merits. *Wilson, Wilson, Jr.*, and *Thompson's Early Mammoth* require covering during the winter.

RED RASPBERRIES.

VARIETIES.	Color.	Size.	Shape.	Firmness.	Flavor.	Productiveness.	Time of blooming.	Time of ripening.	Vigor of canes.	Per cent. winter killed.
Thompson's Pride.	L R	7	9	10	9	8	May 23	June 19	6	.16
Hansel.	R	7	8	8	9	8	" 25	" 23	9	.00
Rancocas.	R	8	8	9	9	8	" 26	" 26	8	.33
Highland Hardy.	R	8	7	8	9	8	" 31	" 26	9	.00
Marlboro.	L R	10	10	10	9	9	" 27	" 28	10	.00
Brandywine.	R	6	6	7	9	6	" 28	" 28	5	.00
Thompson's Early Prolific.	R	8	10	8	9	7	" 31	" 29	5	.07
Hersteine.	R	7	8	7	8	6	" 31	" 29	6	.30
Belle de Fontaine.	R	9	8	8	9	9	" 28	" 29	9	.20
White Mountain.	Y	9	8	9	10	9	" 29	" 30	8	.18
Naomi.	R	8	9	9	8	8	" 27	" 30	6	.12
Superb.	D R	8	6	9	7	8	" 31	" 30	6	.00
Crystal White.	Y	3	5	3	6	5	June 1	July 1	3	.09
Golden Queen.	Y	10	10	9	10	10	" 1	" 3	10	.07
Scarlet Gem.	R	8	7	8	8	8	" 1	" 3	4	.12
Crimson Beauty.	R	7	8	7	6	7	" 7	" 6	9	.30
Cuthbert.	D R	10	10	10	10	10	" 5	" 6	10	.05
Excelsior.	R	8	7	9	9	7	" 9	" 6	3	.17
Stayman's No. 5.	R	9	10	9	9	9	" 7	" 8	7	.08

Under the column of color R. indicates red, L.R. light red, D.R. dark red and Y yellow.

The varieties recommended for profit are as follows in order of merit: *Marlboro*, *Cuthbert* and *Hansel*.

Those of the best quality and most desirable for home use, in order of merit are: *Hansel*, *Cuthbert*, *Superb*, *Thompson's pride*, *Marlboro* and *Golden Queen*.

BLACK CAP RASPBERRIES.

VARIETIES.	Size.	Shape.	Firmness.	Flavor.	Productiveness.	Time of blooming.	Time of ripening.	Vigor of canes.	Per cent. winter killed.
Cromwell,	9	10	9	10	9	May 25	June 26	7	.05
Springfield,	7	9	8	7	5	" 20	" 23	9	.10
Palmer,	9	10	10	10	8	" 23	" 23	10	.08
Ohio,	9	10	9	9	9	" 26	" 29	8	.08
Earhart,	7	8	8	9	10	" 25	" 29	10	.09
Hales Early,	4	6	8	8	7	" 29	July 1	4	.15
Carman,	9	10	10	9	9	" 31	" 3	8	.12
Ada,	8	8	9	6	7	June 1	" 3	9	.05
Thompson's Sweet,	4	9	8	10	6	" 2	" 4	4	.25
Hilborn,	8	8	8	9	8	" 2	" 5	7	.50
Nemeha,	10	10	10	10	10	" 1	" 7	10	.25
Gregg,	10	10	9	9	9	" 4	" 8	9	.25
Souhegan,	8	10	10	9	9	May 24	June 26	8	.05

In our markets for the past year or two the demand for blackcap raspberries has been so small and the supply so large that prices have ruled very low. It is, however, a healthful fruit and should be more used, and as it produces an enormous crop it can be grown at a profit even at a low price. Some varieties have suffered seriously from the anthraxnose, (*Macrosporium punctiform*), a fungus growth attacking the new canes near the ground. It appears first as a minute red spot on the cane that rapidly increases in size so as often to cover one-half or more of the circumference of the canes. When these spots are numerous and extend over a considerable length of it, the cane withers and dies, but if only a few spots appear the cane is only weakened and the fruit the next season is small and of poor quality, owing to the poor nourishment it receives from the weak canes. Nearly all varieties are more or less subject to its attack, but those especially free this season are *Souhegan*, *Palmer*, *Nemeha*, and the *Gregg*.

Cromwell, which did so superbly with us last season, is this year more attacked than any variety on the grounds, but it is hoped that this will not be a permanent fault.

The remedy suggested is spraying with the Bordeaux mixture, making the application at intervals of about two weeks from the starting into growth in the spring until the first of August. This may not be effectual, but as we know of no certain remedy, we may as well try those things that are useful on other plants for destroying fungus growths until their value is demonstrated. Further experiments will be made next season, the results of which will be given to the public in due time.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 16.

A Brief Summary of Results in Electro-Culture, gathered from various sources; also some Experiments made at the Station with LETTUCE grown under the influence of Dynamical Electricity.

JANUARY, 1892.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1892.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, . .	*Director.*
William P. Brooks, . .	*Agriculturist.*
Samuel T. Maynard, . .	*Horticulturist.*
Charles H. Fernald, . .	*Entomologist.*
Clarence D. Warner, . .	*Meteorologist.*
William M. Shepardson, .	*Assistant Horticulturist.*
Henry J. Field, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Department of Meteorology.

CLARENCE D. WARNER.

ELECTRICITY IN AGRICULTURE.*

It is well known that currents of electricity exist in the atmosphere. Clouds are charged and discharged. There is a constant change of electricity from earth to air and from air to earth, the latter being the great reservoir for all electricity. Hills, mountain peaks, trees, high chimneys, spires, in fact, all points elevated above the earth's surface assist greatly in charging and discharging the atmosphere. Again, if two iron rods are driven into the earth and connected by a copper wire with an electrometer in the circuit, the instrument is almost immediately affected, showing that currents of electricity are running through the ground. Now, what is the function of these atmospheric and ground electric currents? Many scientists are agreed that certain forms of precipitation are due to electrical action; but my observations have led me to believe conclusively that electricity is a potent factor in the economy of nature, and has more to do with the growth and development of plants than has hitherto been known. Davy succeeded in the decomposition of the alkalis, potash and soda, by means of electric currents. In our laboratories, water and ternary compounds are rapidly decomposed by the battery, and we may reasonably suppose, that that which is effected in our laboratories by artificial means, takes place in the great laboratory of nature, on a grander and more extended scale.

Plant food is carried throughout the plant by means of the flow of sap; these currents circulate through all the rootlets and center, as it were, in the stalk, carrying their tiny burdens of various elements and depositing them in their proper places. That this phenomenon of circulation is due to electricity cannot be doubted. Most plants grow more rapidly during the night than in the day. May not the following be a reason for this?

We have already mentioned how electric currents pass from air to earth and vice versa; at night the plant is generally covered with dew and the plant itself becomes a good conductor and consequently currents of electricity pass to each through this medium, and during the passage convert soil elements into plant food and stimulate the upward currents to gather up the dissolved elements and carry them to their proper places.

*As this bulletin is the first of several which may appear on the subject of electro-culture, it was thought proper to give a brief resumé of what has been done in this direction.

From the time electricity became a science, much research has been made to determine its effect, if any, upon plant growth. The earlier investigations gave, in many cases, contradictory results. Whether this was due to a lack of knowledge of the science on the part of the one performing the experiments, or some defect in the technical applications, we are not prepared to say; but this we do know, that such men as Jolabert, Nollet, Mainbray and other eminent physicists affirmed that electricity favored the germination of seeds and accelerated the growth of plants, while on the other hand, Ingenhouse, Sylvestre and other savants, denied the existence of this electric influence. The heated controversies and animated discussions attending the opposing theories stimulated more careful and thorough investigations, which established beyond a doubt that electricity had a beneficial effect on vegetation. Sir Humphrey Davy, Humboldt, Wollaston and Becquerel occupied themselves with the theoretical side of the question; but it was not till after 1845 that practical electro-culture was undertaken. Williamson suggested the use of gigantic electro-static machines, but the attempts were fruitless. The methods most generally adopted in experiments consisted of two metallic plates—one of copper and one of zinc—placed in the soil and connected by a wire. Sheppard employed the method in England in 1846 and Forster used the same in Scotland. In the year 1847 Hubeck in Germany surrounded a field with a network of wires. Sheppard's experiments showed that electricity increased the return from root crops, while grass perished near the electrodes, and plants developed without the use of electricity were inferior to those grown under its influence. Hubeck came to the conclusion that seeds germinated more rapidly and buckwheat gave larger returns; in all other cases the electric-current produced no result. Prof. Fife in England and Otto von Ende in Germany carried on experiments at the same time, but with negative results, and these scientists advised the complete abandonment of applying electricity to agriculture. After some years had elapsed Fichtner began a series of experiments in the same direction. He employed a battery, the two wires of which were placed in the soil parallel to each other. Between the wires were planted peas, grass and barley, and in every case the crop showed an increase of from thirteen to twenty-seven per cent. when compared with ordinary methods of cultivation.

Fischer of Waldheim, believing atmospheric electricity to aid much in the growth and development of plants, made the following tests:

He placed metallic supports to the number of about sixty around each hectare (2.47 acres) of loam; these supports were provided at their summit with electrical accumulators in the form of crowns surmounted with teeth; these collectors were united by metallic connection. The result of this culture applied to cereals was to increase the crop by half.

The following experiment was also tried: Metallic plates sixty-five centimeters by forty centimeters were placed in the soil. These plates were alternately of zinc and copper and placed about thirty meters apart, connected two and two, by a wire. The result was to increase from twofold to fourfold the production of certain garden plants. Mr. Fischer says, that it is evidently proved that electricity aids in the more complete breaking up of the soil constituents. Finally he says that plants thus treated mature more quickly, are almost always perfectly healthy and are not affected with fungoid growth.

Later, N. Specnew, inspired by the results arrived at by his predecessors, was led to investigate the influence of electricity on plants in every stage of their development; the results of his experiments were most satisfactory and of practical interest. He began by submitting different seeds to the action of an electric current and found that their development was rendered more rapid and complete. He experimented with the seeds of haricot beans, sunflowers, winter and spring rye. Two lots, of twelve groups of one hundred and twenty seeds each, were plunged into water until they swelled, and while wet the seeds were introduced into long glass cylinders, open at both ends. Copper discs were pressed against the seeds, the discs were connected with the poles of an induction coil, the current was kept on for one or two minutes and immediately afterwards the seeds were sown. The temperature was kept from 45° to 50° Fahrenheit, and the experiments repeated four times. The following table shows the results:

	Peas. Days.	Beans. Days.	Barley. Days.	Sunflowers. Days.
Electrified seeds developed in	2.5	3	2	8.5
Non-electrified seeds developed in	4	6	5	15

It was also observed that the plants coming from electrified seeds were better developed, their leaves were much larger and their color brighter than in those plants growing from non-electrified seeds. The current did not affect the yield.

At the Botanical Gardens at Kew, the following experiment was tried:

Large plates of zinc and copper (.445 meter and .712 meter) were placed in the soil and connected by wires, so arranged that the current passed through the ground; the arrangement was really a battery of (zinc | earth | copper). This method was applied to pot herbs and flowering plants and also to the growing of garden produce; in the latter case the result was a large crop and the vegetables grown were of enormous size.

Extensive experiments in electro-culture were also made at Pskov, Russia. Plots of earth were sown to rye, corn, oats, barley, peas, clover and flax; around these respective plots were placed insulating rods, on the top of which were crown shaped collectors—the latter connected by means of wires. Atmospheric electricity was thus collected above the seeds and the latter matured in a highly electrified atmosphere; the plots were submitted to identical conditions and the experiments were carried on for five years. The results showed a considerable increase in the yield of seed and straw, the ripening was more rapid and the barley ripened nearly two weeks earlier with electro-culture. Potatoes grown by the latter method were seldom diseased, only 0 to 5 per cent. against 10 to 40 per cent. by ordinary culture.

Grandeau at the School of Forestry at Nancy found by experiment that the electrical tension always existing between the upper air and soil stimulated growth. He found plants protected from the influence were less vigorous than those subject to it.

Macagno, also believing that the passage of electricity from air through the vine to earth would stimulate growth, selected a certain number of vines, all of the same variety and all in the same condition of health and development. Sixteen vines were submitted to experiment and sixteen were left to natural influences. In the ends of the vines under treatment, pointed platinum wires were inserted, to which were attached copper wires, leading to the tops of tall poles near the vines; at the base of these same vines other platinum wires were inserted and connected by copper wires with the soil. At the close of the experiment, which began April 15, and lasted till September 16, the wood, leaves and fruit of both sets of vines were submitted to careful analysis with the following results:

	Without conductor.	With conductor.
Moisture per cent.,	78.21	79.84
Sugar,	16.86	18.41
Tartaric acid,	0.880	0.791
Bitartrate of potash,	0.180	0.186

Thus we see that the percentage of moisture and sugar is greater and the undesirable acid lower in those vines subject to electrical influences than in those left to natural conditions. There are also experiments which prove the beneficial effects of electricity on vines attacked by Phylloxera.

The following experiments were made at this station: Several plots were prepared in the greenhouse, all of which had the same kind of soil and were subjected to like influences and conditions. Frames in the form of a parallelogram, about three feet by two feet, were put together; across the narrow way were run copper wires in series of from four to nine strands, each series separated by a space about four inches wide, and the strands by a space of one-half inch. These frames were buried in the soil of the plot at a little depth, so that the roots of the garden plants set would come in contact with the wires, the supposition being that the currents of electricity passing along the wires would decompose into its constituents the plant food in the vicinity of the roots and more readily prepare it for the plants. Two electric gardens were thus prepared and each furnished with two common battery cells, so arranged as to allow continuous currents to pass through each series of wires. Near each electric garden was a plot prepared in the same manner, save the electrical apparatus. We will call the two gardens A and B.

The place chosen for the experiments was in a part of the greenhouse which is given up largely to the raising of lettuce, and the gardens were located where much trouble from mildew had been experienced. The reason for this choice of location was to notice, if any, the effect of electricity upon mildew, this disease being, as is well known, a source of much trouble to those who desire to grow early lettuce. The soil was carefully prepared, the material taken from a pile of loam commonly used in the plant house.

Garden A was located where mildew had been the most detrimental; the experiments began the first of January and closed the first of April. For the garden, fifteen lettuce plants of the head variety were selected, all of the same size and of the same degree of vitality, as nearly as could be determined; the plants were set directly over the wires, so that the roots were in contact with the latter; the plants were well watered and cared for as in ordinary culture, and the fluid in the battery cells was renewed from time to time, that the current of electricity might not become too feeble. At the close of the experiments the following results were noted.

Five plants died from mildew, the others were well developed and the heads large. The largest heads were over the greatest number of wires and nearest the electrodes. It was further noticed that the healthiest and largest plants, as soon as the current became feeble or ceased altogether, began to be affected with mildew. On examining the roots of the plants it was found that they had grown about the wires, as if there they found the greatest amount of nourishment; the roots were healthy and in no way appeared to have been injured by the current, but, rather, much benefited by the electrical influences.

Beside garden A was prepared another plot of the same dimensions, having the same kind of soil and treated in like manner as the first, but the electrical apparatus and wires were wanting. At the close of the experiments only three plants had partially developed and two of these were nearly destroyed by mildew—one only was free from the disease. The results, therefore, show that the healthiest and largest plants grew in the electric plot.

In the second experiment, which we called B, twenty plants of the same variety of lettuce and of equal size were taken. The treatment given was the same as the plants in plot A received. Five plants only remained unaffected with mildew; seven died from the disease when they were half grown; the rest were quite well developed, but at the last part of the experiment began to be affected. Several heads were large, the largest being over the greatest number of wires and nearest the electrodes. Examination of the roots disclosed the same phenomena as in A.

Near plot B were also set twenty other plants, subjected to like conditions as the first, but without electricity; all but one died from mildew before they were half grown, the solitary plant that survived being only partly developed at the close of the experiment, and even this was badly affected with the disease.

Everything considered, the results were in favor of electricity. Those plants subjected to the greatest electrical influence were hardier, healthier, larger, had a better color and were much less affected by mildew than the others. Experiments were made with various grasses but no marked results were obtained.

The question would naturally arise whether there may not be a limit reached where electricity would completely overcome the attack of mildew and stimulate the plant to a healthy and vigorous condition throughout its entire growth. From the fact that the hardiest, healthiest, and largest heads of lettuce grew over the greatest number of currents and nearest the electrodes, it would seem that electricity is one of the agents employed by nature to aid in supplying the plant with nourishment and to stimulate its growth. To what extent plants may be submitted to electrical influence, or what strength of current is best suited to them and what currents prove detrimental to their development, have not been determined as yet, but it is desirable to continue this research until some definite information shall be gained on these points. Probably different varieties of plants differ greatly in their capacity for enduring the action of electric currents without injury—experiment alone must determine this.

It has been proved that the slow discharge of static electricity facilitates the assimilation of nitrogen by plants. Faraday showed that plants grown in metallic cages, around which circulated electric currents, contained fifty per cent. less organic matter than plants grown in the open air. It would seem from the researches of the latter physicist, that those plants requiring a large percentage of nitrogen for their development would be remarkably benefited if grown under electric influence.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 17.

Experiments with Fungicides and Insecticides.
Testing New Varieties of Grapes and Peaches.
Protection of Peach Buds.
Amount of Copper on Sprayed Fruit.
The Siberian Crab as a Stock.
Girdling Grape Vines.
Keeping Qualities of Grapes.
Report of Spraying Apparatus.
Outline of Work for 1892.

APRIL, 1892.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1892.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL, . .	*Director.*
WILLIAM P. BROOKS, . .	*Agriculturist.*
SAMUEL T. MAYNARD, . .	*Horticulturist.*
CHARLES H. FERNALD, . .	*Entomologist.*
CLARENCE D. WARNER, . .	*Meteorologist.*
WILLIAM M. SHEPARDSON, .	*Assistant Horticulturist.*
HENRY J. FIELD, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Horticulture.

SAMUEL T. MAYNARD.

EXPERIMENTS WITH FUNGICIDES AND INSECTICIDES.

The season just past has been one not generally favorable for the growth of fungous pests. Most of these parasitic plants require a moist, warm atmosphere and even liquid upon the surface of the part of the host plant attacked, for their development.* The dry weather during June and July was entirely unfavorable to such growths, so that our fruit and garden crops were more free from injury than usual, except such as matured late in the season. During the warm, wet weather of September, the grape mildew appeared in considerable quantities, too late, however, to affect the fruit seriously, and the apple scab, celery rust and some other fungous diseases appeared in many localities.

In Bulletin No. 13, we described the best fungicides, as far as was known, and the methods best adapted to their use in destroying fungi, outlining the work so as to obtain the best results.

To assist in settling the question of the general and economical use of fungicides, and combined fungicides and insecticides, a series of experiments was started in the different parts of the state under the supervision of expert fruit growers.

Among those taking part in this work were Dr. Jabez Fisher, Fitchburg; G. B. Andrews, Fitchburg; A. C. Hawkins, Lancaster; Benj. P. Ware, Clifton; H. A. Cook, Shrewsbury and E. A. Estabrook, Grafton. A series of experiments was also conducted at "Forest Orchard," Northboro.

Spraying apparatus was loaned and the chemicals supplied to each of the above parties, in consideration of careful and accurate work and a full report of the results. The places were visited in the spring to assist in planning and starting the work and at intervals during the summer to watch the progress of the experiments and note results. The reports of these experiments are given on subsequent pages.

*For a brief sketch of the history of the growth of the most destructive of these parasitic plants, see subsequent pages.

The fungicides used were BORDEAUX MIXTURE; *Formula*, 6 lbs. of sulphate of copper (Blue Vitriol) dissolved* in about 3 gallons of water, and 4 lbs. caustic lime slaked in water enough to make a thin lime wash. When cool the two substances were thoroughly mixed and diluted with water to 25 and 50 gallons of liquid.

AMMONIACAL CARBONATE OF COPPER; *Formula*. 6 oz. carbonate of ammonia and 1 oz. of carbonate of copper; 1 lb. of this mixture being dissolved in 25 and 50 gallons of water.

SULPHATE OF COPPER, (Blue Vitriol), 1 lb. dissolved in 25 gallons of water.

SULPHATE OF IRON, (Copperas), 1 lb. to 2 gallons of water.

The only insecticide used was Paris green, this being found less injurious to the foliage than any other arsenite.

EXPERIMENTS MADE ON THE COLLEGE GROUNDS.

During the past season, numerous experiments have been made to test the value of some of the more common fungicides and the combined use of fungicides and insecticides. Attention has been given principally to the apple scab, pear leaf blight, plum leaf blight, peach and plum fruit rot, plum black knot, grape powdery mildew and black rot, and the tent caterpillar, codling moth, and plum curculio.

The life history of the above fungi is briefly as follows:

APPLE SCAB. (*Fusicladium dendriticum.*)

This is a small parasitic plant everywhere causing the spotted apples so common in the crop of 1890. It is of a dark green or nearly black color and grows only in moist rather cool weather on the skin of the apple, not often penetrating much of the tissue below. When it attacks the apple early in the season the growth is stopped at that point and the fruit is gnarly or irregular, but when it comes after the fruit is nearly grown, it simply disfigures it. It is also very abundant on the leaves and twigs when the season is favorable to its growth. It sometimes also attacks the pear.

THE PEAR LEAF BLIGHT, (*Entomosporium maculatum.*)

Pear trees often lose their leaves in July or August and the fruit

* Blue Vitriol may be dissolved very quickly by suspending the crystals in a coarse sack or basket, in a pail or cask of water.

is spotted and cracked. This is caused by the above named parasitic plant. It first appears as a small reddish brown spot on the leaf or fruit, and if these are numerous or increase greatly in size, the leaf action is destroyed and it drops off; or the fruit is checked at the point attacked and it cracks, as is so often the case with the Flemish Beauty and some other varieties. It grows only under conditions of moisture and heat, and whole orchards often lose their foliage in a few days from its attack.

PLUM LEAF BLIGHT, (*Septoria cerasina.*)

This disease is sometimes called the shot-hole fungus, and is very destructive to plum orchards, causing the leaves to fall in August, often before the fruit is ripe, or the wood and fruit buds are mature. It appears first as small reddish spots, the centers of which, as they increase in size turn brown and decay, often falling out, leaving holes in the leaves, whence the name " shot-hole fungus."

BROWN FRUIT ROT, (*Monilia fructigena.*)

This is the common brown rot of the plum and peach attacking the fruit when it is almost ripe. We first notice a small brown spot on the fruit which rapidly increases until it destroys it. At first the surface of the fruit is smooth, but soon it is studded all over with little tufts or clusters of threads on the ends of which are numerous spores or seeds. These spores are easily carried by the wind from place to place and one rotting peach or plum may produce spores enough in a short time to destroy a large crop of fruit.

POWDERY MILDEW OF THE GRAPE, (*Peronospora viticolor.*)

During moist, warm weather, at any time from the middle of June to September, this disease may appear. The spores penetrate the tissues of the leaf, and their roots or feeding parts run through a comparatively large space, causing yellow spots, and followed after a short time by a powdery substance on the surface of the spots. This powdery substance is a mass of spores produced by the plant for its further reproduction, and when the weather is favorable it spreads rapidly and the leaves curl up and turn brown or drop off.

BLACK ROT OF THE GRAPE, (*Laestadia Bidwellii.*)

This fungus attacks the fruit and sometimes the leaves. It first appears as a light brown spot, spreading rapidly if the weather is warm and moist, and quickly covering the entire berry, which then presents a gray, brown color. When attacked early in the season, the berry shrivels and turns a dark blue or black color, but if it comes when the berries are nearly full grown, they soon rattle from the bunch when handled. It is found more or less throughout the country, but only locally in New England, and has not done serious injury until within a few years. It seems to be increasing in Massachusetts.

THE POTATO-ROT FUNGUS,

(*Phytophthora* [*Peronospora*] *infestans.*)

While closely related to the grape mildew it is placed by some authorities in another genus. It attacks both the foliage and the tuber, causing what is called the blight of the vines, in the one, and the rot of the tuber in the other. To the casual observer, its first appearance on the leaf is in the yellow spots and powdery or mealy substance on the surface, which is the fruiting stage of the plant that has been feeding in the substance of the leaf tissue. These spots soon turn brown and the whole plant becomes infested and dies. In moist, warm weather the growth of this fungus is so rapid that it requires but a few days to destroy acres of potato tops.

If the leaf spores come in contact with the tubers, or if the rooting or feeding parts of the fungus press through the stems to them, they rot, provided the warm, moist weather continues. In seasons when the atmosphere is cool, the tops are not attacked, and if the soil remains cool the tubers will often escape when the tops are destroyed.

BLACK WART OF THE PLUM AND CHERRY.

(*Plowrightia* [*Sphœria*] *morbosa.*)

The black excrescences called black knots or warts on the plum and some kinds of cherry trees, are the result of a fungous growth, the spores of which have germinated during moist weather of the early summer, and penetrated the tissues.

The excrescence is the growth of the fungus and the effort of the tree to overcome the injury. Spores are scattered from the surface of the wart in the summer and from little sacs during the winter and spring. It is the most serious pest attacking the plum trees.

EXPERIMENT NO. 1.

To prevent the apple scab, and destroy the tent caterpillar and codling moth, the apple trees in the different orchards were sprayed April 16th and 17th, some with sulphate of copper (Blue Vitriol), 1 lb. to 25 gallons of water, some with sulphate of iron (Copperas) 1 lb. to 2 gallons of water and others with the Bordeaux mixture.*

May 5th, sprayed with Bordeaux mixture and Paris green 1 lb. to 200 gallons.

May 21st, sprayed with same as above.

June 9th, " " " " "

July 10th, sprayed with ammoniacal carbonate of copper, 1 lb. to 25 gallons of water.

Aug. 13th, sprayed with same.

Results. The foliage of the trees sprayed showed much less scab fungus than that of those unsprayed, and the fruit was entirely free from the scab. In Plate 1, we have attempted to show by a photographic engraving the average results of this spraying. The specimen on the left is from a sprayed tree, that on the right from one unsprayed. The middle specimen is intended to show the result of the copper solutions on the fruit, which causes the breaking of the epidermis or skin of the apple, giving it a russet appearance, but is not very clearly brought out.

This appears upon almost all of the fruit sprayed, but does not injure it in general appearance because it is confined to the blossom end, and such fruit seems to keep as long as that not thus marked.

The tent caterpillars were largely killed by the Paris green used in the Bordeaux mixture May 5th and 21st, and the fruit on the sprayed trees showed about 20% less wormy specimens than that on the unsprayed ones.

EXPERIMENT NO. 2.

Pear trees were sprayed April 16th and 17th with the same concentrated solutions applied to the apple trees on the same date, and, while there was less leaf blight and wormy fruit than on the unsprayed trees, the results were not so marked as with the apple.

* For formulae of fungicides see page 12.

EXPERIMENT NO. 3.

Peach trees were treated to kill the winter spores of the "fruit rot" April 17th with the concentrated solutions of sulphate of copper and iron and the Bordeaux mixture; May 8th and June 6th, sprayed with the Bordeaux mixture and Paris green, one pound to 200 gallons for the "fruit rot" and plum curculio, which is often as injurious to the peach as to the plum. July 7th, sprayed with the ammoniacal carbonate of copper, one pound to twenty-five gallons of water.

Results. The foliage was somewhat injured by the spraying of June 6th, and very seriously by that of July 7th, but new leaves developed and the fruit matured in fine condition. Less rot appeared on the fruit sprayed than on that unsprayed, but no results were noticed from the Paris green in destroying the curculio, although there was less injured fruit than last season.

EXPERIMENT NO. 4.

Plum trees were sprayed with the strong solutions of copper and iron, and the Bordeaux mixture, April 16th, for "leaf blight," "fruit rot" and "black wart". May 12th, May 26th, June 11th, and July 20th, sprayed with the Bordeaux mixture, adding Paris green, one pound to 200 gallons of water, to destroy the plum curculio.

August 11th, sprayed with the ammoniacal carbonate of copper, one pound to twenty-five gallons of water.

Results. The trees sprayed retained their foliage much later than those unsprayed, as is shown by the illustration, plates VI, VII, and there was less rotting of the fruit. Only a few plum warts developed on the sprayed trees and those that appeared seemed to have become established the previous season.

To determine whether concentrated solutions of Paris green in the Bordeaux mixture could be used without injury to the foliage, it was applied in three proportions, 1 lb. to 50 gal., 1 lb. to 100 gal. and 1 lb. to 200 gal. After a close and careful examination no injury could be discovered from any of the solutions.

EXPERIMENT NO. 5.

Grape vines and all parts of the trellis were thoroughly sprayed for the mildew and black rot, April 23d, with the three concentrated solutions, sulphate of copper, sulphate of iron, and the Bordeaux

PLATE I.

SPRAYED. SPRAYED. UNSPRAYED.

VINE SPRAYED.

VINE UNSPRAYED.

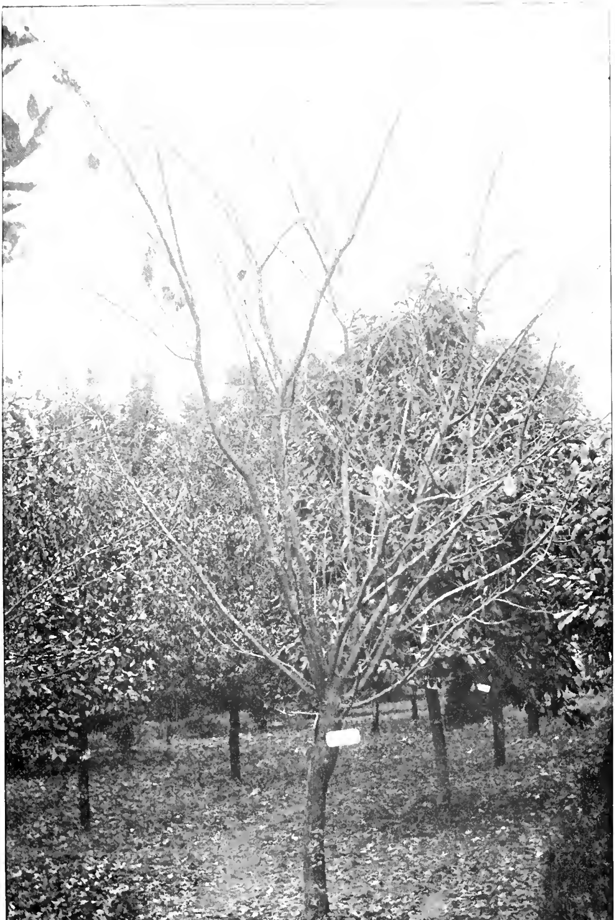
PLATE IV.

4 3 2 1

VINES NO. 1 AND 3 SPRAYED. NO. 2 AND 4 UNSPRAYED.

UNSPRAYED. SPRAYED.

MIDDLE ROW UNSPRAYED.



PLUM TREE NOT SPRAYED.

PLUM TREE SPRAYED.

SIBERIAN CRAB.

WILLIAMS FAVORITE.

SIBERIAN CRAB BUDDED WITH WILLIAM'S FAVORITE.

mixture, dividing the vineyards into three plots for this purpose, one kind being applied to each.

May 20th, just before the blossoms opened, and June 13th, just after the fruit had set, sprayed with the Bordeaux mixture with Paris green, one pound to 200 gallons.

July 6th, sprayed with the Bordeaux mixture alone, and Aug. 7th with the ammoniacal carbonate of copper. Had the weather been moist during July the ammoniacal carbonate would have been used about the 20th of the month.

In the experimental vineyard where over 120 varieties are planted, two vines of each kind, one vine was sprayed and the other not sprayed.

Results. The accompanying illustrations show the results better than can be done in any other way.

Plate 2 shows a vine sprayed, and Plate 3 one unsprayed. Plate 4 shows a part of one of the rows where the first vine was sprayed, the second unsprayed, the third sprayed, and the fourth unsprayed, etc. The benefit obtained was as marked throughout the vineyard, and could be seen as far as the vines could be distinguished from other objects. Plate 5 shows a bunch of fruit from a sprayed, and one from an unsprayed vine.

EXPERIMENT NO. 6.

POTATOES.

To test the value of combined fungicides and insecticides, a field of about one acre of potatoes was divided into twelve plots of six rows each. June 30th, sprayed all with Paris green, one pound to 200 gallons of water. July 14th treated as follows:

Row No. 1,	with Bordeaux mixture and Paris green,	1	pound to	100	gallons	water
" 2,	" same,	1	"	200	"	"
" 3,	" same,	1	"	50	"	"
" 4,	" Sulphate of copper,	1	"	12	"	"
" 5,	" " "	1	"	25	"	"
" 6,	" Ammoniacal carbonate of copper,	1	pound to	25	gallons	water
" 7,	" Parisgreen and Plaster,	1	"	200	pounds	
" 8,	" Sludgite.					
" 9,	Check.					

Nos. 10, 11 and 12 treated the same as Nos. 1, 2 and 3.

Aug. 10th, treated each row the same as above, except that rows No. 4 and 5, which were somewhat injured by the copper solution, were sprayed with the Bordeaux mixture and Paris green, one pound to 200 gallons, and No. 7 and 8 with the same, the plaster not being a fungicide and the sludgite not having had any effect on the potato beetles.

Results. August 14th, rows 1, 2, 3, 4 and 5 showed a little leaf blight; rows 7, 8, 10, 11 and 12 were entirely free, and row 9 very badly blighted. Row 6 showed serious injury from the ammoniacal carbonate of copper.

August 17th, rows 4, 7, 8, 10, 11 and 12 showed a little blight; rows 6 and 9, foliage nearly all dead. At the end of the season's growth, it was found that rows 4 and 5 remained green much the longest, showing that the sulphate of copper used July 14th retained its effect somewhat through the season.

No injury was noticed where Paris green was used with the Bordeaux mixture at the rate of one pound to fifty gallons of water.

REPORT OF DR. JABEZ FISHER,

FITCHBURG, MASS.

"My obligations are due to the Station for an equipment during the past season of materials and implements for the purpose of investigating the subject of spraying trees and plants with insecticides and fungicides, with a request to report all that could be learned that might be of use to fruit growers. The paucity of results renders it undesirable to give in detail all the operations that have been carried out, but in a general way I will attempt to give the gist of them.

Having suffered considerably for five previous years from various fungous diseases of the different fruits, I devoted considerable attention to preparatory, preventive treatment. The orchards being in grass, I burned the stubble about April 15th so far as possible, and then sprayed the trees with sulphate of copper solution one pound to twenty-five gallons. Three vineyards of an acre each were treated, one with sulphate of iron, one pound to two gallons; one with Bordeaux mixture, and one with sulphate of copper, one pound to twenty-five gallons, well sprayed over the vines and trellises from both sides. As soon as the petals had fallen, the trees were sprayed with Bordeaux mixture to which Paris green was added. Checks were left in all cases. The spraying was twice repeated later, using the mixture of carbonate of copper and carbonate of ammonia.

I have felt for some time that these preparations of copper were largely empirical and were not founded upon a sound scientific basis. The two substances used in the Bordeaux mixture were both fungicides, but when combined, the resultant bodies were only sulphate of lime and oxide of copper, neither of which seemed well adapted for the purpose.

Consider for a moment how a fungous germ or spore develops. It must first be deposited upon some portion of the living plant. This happens in spring time through the spores that have retained their vitality during the winter. They are set free by the warmth, moisture and consequent decay of the débris of the previous season, and float about in the atmosphere until they alight or rest upon the growing plant. If they remain without moisture they do not develop, but if moistened and kept wet for a few hours in a favorable temperature, they vegetate and insert what may be called their roots into the substance of the leaf bark or fruit, from which time they are able to continue development independent of extraneous moisture.

It is a well-known fact that in dry countries and also in dry seasons fungi do but little harm, but their maximum effects are found in muggy, hot, showery periods. Dews and fogs are especially favorable for fungoid development,and the popular belief is that such seasons produce the fungi. This is of course incorrect inasmuch as they exist only as a product of spores or seeds previously grown and matured. A most convincing illustration is afforded by the effect produced by an awning of any kind placed over a single grape trellis in a vineyard where fungoid growth is prevalent. This awning prevents the deposition of moisture upon the foliage immediately underneath it from rain or dew, and although the floating spores must necessarily be deposited there by the motion of the air, yet, under this awning, they never develop. Such a trellis remains an oasis of health in the midst of a desert of fungi. Now if the spore must have water present in order to germinate and grow it, would appear that if we could impregnate such water with some poisonous substance we might prevent this action. In fact, it has been found that many kinds of spores, and it is inferred that most of them, would be influenced in this direction by the presence of various solutions.

The one having the most energetic action is found to be some form of soluble copper. In the use of the sulphate it is known that one part of the metal in solution in one million parts of water will suspend entirely the germination and growth of many of these spores. The use of the Bordeaux mixture did not arise out of this knowledge, but the reverse. Bordeaux mixture had a fungicidal effect and investigations that followed this formation developed the fungicidal power of copper in solution.

How then can the effects of the insoluble oxide of copper in the Bordeaux mixture, and that remaining after the evaporation of the water and ammonia of Eau Celeste, as well as the insoluble carbonate, be explained? It is doubtless to be found in a very slight solubility of these substances in the infinitesimal amounts of ammonia and carbonic acid existing in rain water and that of dews.*

These considerations influenced me to try the effect of a soluble salt of copper in the place of, or in comparison with, these insoluble mixtures. After much experimenting I found that no injury arose from the application of a solution of sulphate of copper so weak as one pound to 800 gallons. Twice that strength would produce serious results on peach trees as late as July. It may be that other foliage may suffer at some seasons from the weaker dilution, but many plants will endure the stronger. I have used, the past summer, this solution of one pound to 800 gallons very largely, and in direct comparison with the other preparations of copper. The character of the season has been such that the results are not fully decisive on account of the unexpected, nearly entire, exemption from fungi. How much of this is due to my preparatory treatment I cannot determine as the checks furnish but little information. There was not a drop of rain and scarcely a sparkle of dew between the 4th and 17th of June, just the time when many of these spores are actively set free. The fungus on the leaf of the horse-chestnut, which has been very prevalent on my grounds for some seven years, did not show a spot. Anthracnose of the young canes of the grape which threatened the life of the vines

* While this is all very true, the success that has attended the use of the Bordeaux mixture, the fact that there is no danger from its injury to the foliage, and that it adheres so long to the surface of the leaves and fruit, always ready to give up the little soluble matter it contains to the moisture of dews and rains, makes it the most reliable and effectual fungicide we have thus far found.

Further experiments in the line suggested are being made by many of the experiment stations, which are sure, sooner or later, to formulate the best, safest and most economical fungicides and insecticides for general use, and Dr. Fisher's work the past year is of great value in this direction.

last year, was present only in a trifling degree. The same is true of the apple and pear scab, as well as rot and mildew of the grapes.

The checks on my own premises giving but little information, I learn from other growers that theirs have suffered considerably more than mine. On my three acres of Concord grapes I did not find a spot of peronospora (powdery mildew) on the foliage, and all of the berries affected could be put into a quart measure, while those affected with black rot would not exceed four quarts. I have one trellis of twenty-five different varieties many of which are quite prone to mildew, but I have never seen it so absolutely free from peronospora* only two leaves on a Delaware showing three small patches.

This trellis, as well as most of the others, was treated with the solution of copper sulphate, one pound to 800 gallons. In all that I have seen, either out of doors or under glass, there has been nothing to indicate that this solution is not fully as efficient as any other preparation of copper. The amount required for one acre at a single application is from one and one-half to two ounces, while the Bordeaux mixture uses from eighteen to twenty-four pounds. The solution is very cheap, clean and requires less labor and skill in its use than the others and is, moreover, entirely compatible with Paris green so that the two may be used together freely.

The unsatisfactory character of the apparatus for applying fungicides and insecticides in a water spray set me at work to devise some more simple and efficient substitute. I used the force pump, which the Station furnished, by attaching it to a barrel which was transported on a stone-boat. A stretch of twenty feet of hose was used, one end being supported upon the end of a light pole, twelve feet long. The nozzle, which was an adjustable one, was set at an angle of 45° from the handle, which made it easy to throw the spray in every direction. Three men operated it, one managing the spray, one running the pump, and the third caring for the horse. The last position was an important one, as the man was expected to keep the horse moving at such a pace as would permit a thorough spraying of every part of the foliage without wasting the liquid or drenching any part of the tree. I found that the combined efforts of the whole force was unable to do the work evenly. Parts of trees were over-supplied and portions were left entirely dry. Bordeaux mixture was

* Other vineyards in the state, though perhaps differently located, and under different cultivation and not sprayed with the sulphate of copper or iron before the foliage developed have suffered a good deal from this pest, but not as much as in former years.

largely found upon the first trees sprayed, while the remaining contents of the barrel grew constantly weaker. This came about for want of a satisfactory provision for keeping the mixture thoroughly stirred. The same effect must be produced in the use of Paris green but would not be visible.

To overcome these obstacles I have devised a plain, brass syringe of the following description. The barrel is fifteen inches long and the piston has a stroke of fourteen; the diameter is one and three-fourths inches, and it will hold somewhat more than a pint. The rose or nozzle is pierced with ninety-nine holes having a direction radiating from a point in the rear, the effect being to throw a spray twenty or more feet with a spread of six feet. The holes are of such a size that the spray is as fine as is compatible with the distance mentioned. My thanks are due to the well-known firm of R. T. Deakin & Co., Twelfth and Buttonwood Sts., Philadelphia, for the satisfactory way in which they have seconded my plans in the construction of this instrument, and at my solicitation they have undertaken to supply a demand for it. It is to be known as the "Hydrospray," and the retail price will be $5.00. If not obtainable at the usual places where such goods are sold it may be ordered direct from the firm. A cyclone nozzle for the same will be furnished for seventy-five cents extra, which will be found very useful under glass or in the garden for the perfect and economical application of fungicides and insecticides. It might be supposed that so simple an affair as the Hydrosprayer would be of little use to an extensive grower and in large orchards, but I found in actual trials that the same number of hands required to run a force pump could spray fully as much water or territory in a given time by them, and that in the quality and efficiency of the work they were far superior. Armed with one or more of these Hydrosprayers, a few pounds of sulphate of copper, and the same of Paris green, a fruit grower is prepared to meet most of the enemies that threaten him. For vineyard work and in the potato field a knapsack sprayer will be found very convenient on account of the easy transportation of the liquid, but the same objection applies to this as the large force pump, so that it is not well adapted to the use of Paris green or Bordeaux mixture.

To sum up the lessons of the season, as I recall them now, I will indicate the course which I propose to follow in the coming year. The first day in the spring when things are sufficiently dry, I shall gather all the stubble, weeds, grass and debris and burn it. This will dispose of a large proportion of the winter spores of the various fungi and some insects. I shall then spray all the trees, trellises and vines, and the surface of the ground where the fire has not run, with sulphate of copper, one pound to 100 gallons. This is before the development of the foliage when this strength is not objectionable. Just before the blossoms open I shall spray all the foliage with the solution, one pound to 800 gallons, to which I shall add Paris green, one pound to 200 gallons. The mode of operation is this: A fifty-gallon kerosene barrel, standing upright on a stone-boat is filled with water, to which is added one ounce of sulphate of copper previously dissolved, and drawn to the place where used. A three-gallon pail is filled from the barrel and a teaspoonful of Paris green weighing just one-fourth of an ounce is added. This is kept in suspension by stirring with the Hydrosprayer, or otherwise, at each filling. The latter is emptied of its contents upon the foliage with the necessary force, and refilled and emptied until the tree is fully covered. This spraying with both substances will be repeated as soon as all or nearly all the petals have fallen, and again at two different times, a week or more apart, making in all, four sprayings after foliation. In their relative importance I should place the burning and the spraying before foliation at the front for fungi, and the first spraying after blossoming for most insects, but for the best results none of them should be omitted. The month of June is the time for the appearance of the great bulk of both insects and fungi, and one hour's work at that season is worth a whole day later on.

TOMATO ROT.

During the early part of the winter, some 50 specimens of "rot" appeared in my forcing house, on tomatoes, nearly ready to ripen. I at once sprayed by means of the cyclone nozzle with copper sulphate (blue vitriol) 1 lb. to 1000 gallons of water. This was repeated in two days. There has been no increase of the disease since the application, and the spots seemed to dry up and the fungus not to penetrate the texture of the fruit at maturity.

[While this experiment is in no way conclusive, and further trial must be made to establish its value, the fact that so dilute a solution of copper sulphate is destructive to the spores of most fungi, and that even under glass it is not in any way injurious to the foliage, may lead to its use for the destruction of all fungi attacking the foliage and possibly by saturating the soil, for those attacking the roots.]

THE PEAR-TREE PSYLLA.

My orchard was seriously injured the past season by the pear-tree psylla, (*Psylla pyri*,) a minute winged scale like insect, that injures the trees by sucking their juices and is proving a serious pest whereever it gets a foot-hold. Its presence is first made known by what is called by some, honey dew, a sticky substance exuded by the insects and often causing the decay of the leaf, or possibly favoring the attack of the leaf blight fungus, which causes the leaves to fall. This insect has, in some instances, caused the death of large orchards and would in all cases, did not its natural enemies, wasps and hornet or untoward seasons prevent. We never can predict with certainty the outcome of one season from the results of tne last.

The best agent known for this class of insects is kerosene, which, for this purpose, must be made into an emulsion and if properly made and applied, it does no harm to the foliage.

My formula for this emulsion is ½ lb. of common yellow or rosin soap dissolved in a gallon of boiling water, to which is added two gallons of kerosene and the whole churned together by means of the Hydrosprayer or other syringe for three to five minutes, producing an emulsion, separating the kerosene into minute globules, the whole looking somewhat like whipped cream. One part of this emulsion added to nine or more parts of water is sprayed upon the foliage and kills the insect at once, without harm to the foliage. This is best applied in a dry atmosphere.

I applied this preparation to about four acres of pears, June 10th to 12th and again July 17th to 22d. The psylla appeared first June 8th, in considerable numbers, in the winged form, and honey dew followed in two or three days afterward. It has been supposed to live over winter in the egg like other forms of aphides, but I am very confident that in my case the perfect insect appeared first. Soon after the second spraying the honey dew mostly disappaared and the partially blighted leaves gradually resumed in some degree their natural color. Eggs and larvæ were found in considerable numbers on the leaves, but they did not thrive and gradually disappeared mostly without maturing. What the outcome is to be I can only guess. If the eggs are laid on the twigs in autumn, then kerosene emulsion, or perhaps a potash solution might be depended on to destroy them. If, as I am confident, they hibernate in the winged state, I should depend upon burning the stubble in the spring, and the use of kerosene emulsion whenever they showed themselves in numbers."

REPORT OF GEO. B. ANDREWS,

FITCHBURG, MASS.

Mr. Andrews treated apple, pear and plum trees and grape vines, upon which he reports as follows:

"*April 29th*, sprayed 50 plum trees with the Bordeaux mixture, the blossom buds being almost open at this time. Continued spraying until May 7th, treating 4000 grape vines, 100 apple, 100 pear and the above mentioned 50 plum trees.

The leaves of the apple trees were beginning to unfold, some of them being an inch long, and the bud moth abundant, so in treating these I used ½ lb. of Paris green to 100 gallons of the mixture.

May 19th, sprayed plum trees with the Bordeaux mixture and Paris green at the rate of ½ lb. to 100 gallons.

May 20th. sprayed pear trees, and *May 27th*, the apple trees with the same mixture.

June 9th, sprayed plum and pear trees and June 13th the apple trees with the Bordeaux mixture at one-half strength.

June 17th, sprayed grapes with the ammoniacal carbonate of copper, and again treated them with same the 25th. The Concords and Wordens showed some black rot and mildew.

July 8th, sprayed the Delaware vines with the Bordeaux mixture; and the Concords with the ammoniacal carbonate of copper, the 11th and 12th. At this time the former showed some of the powdery mildew on the foliage, and the two latter varieties increasing black rot.

July 11th and 12th, sprayed the plum trees with the ammoniacal carbonate of copper, for fungous growths, and the pear trees with the kerosene emulsion for the pear tree Psylla."

The results of these experiments, while not satisfactory in all particulars, in the case of the Delaware vines was very marked and also with the plum trees. The photographic view, Plate 6, shows three rows of Delaware vines. Those on the right and left of the picture were sprayed, while the middle one was not. The foliage of the two outside rows, and all the rows of this vineyard, except the middle one here represented, retained perfectly healthy foliage, and ripened a very fine crop of fruit perfectly, while the unsprayed row lost nearly all of its foliage and the fruit failed to ripen at all.

A large proportion of the crop of Wordens and Concords in one part of the vineyard was destroyed by the black rot. I visited the vineyard twice during the summer, and have never before seen this disease so destructive in any vineyard in New England. In New York state and the Lake Shore regions, vineyards are often as seriously injured as this one by this scourge.

Mr. Andrews asks me to account for this result, notwithstanding the fact that fungicides were used, and while I cannot so confidently explain the cause as I might, had I been on the ground and made more minute observation when this disease first began to appear, I will point out some of the sources of error in the time of application of the fungicides, and the conditions which favored the development of this destructive disease.

In the first place we must understand that this and most other parasitic fungi *grow only* under conditions of moisture and high temperature, and that the spores are destroyed *only* by coming in contact with the soluble copper solutions. Now, if at any time during the early summer, such conditions of temperature and moisture should occur after a rain that had removed the little soluble fungicide there may be in the Bordeaux mixture, the spores of the disease would grow rapidly and it would take but a few days to destroy all the fruit in a large vineyard.

Such conditions did occur between the first spraying of the vines, May 5th to 7th and June 17th. In that time there were 12 days when it was cloudy or rainy and high temperature prevailed for several days at a time at different intervals.

From May 9th to 11th the temperature ranged between 79° and 85° during the day time and 46° to 56° in the night. From May 20th to 23d it was 70° to 75° in the day time and 57° to 58° at night. From May 31st to June 4th it was 79° to 80° during the day, and 52° to 60° at night. From June 13th to 16th it ranged between 87° and 91° in the day time and between 57° and 66° at night.

If, during any of these intervals and especially the last, there was dew or moisture in small drops on the foliage, the spores would grow very rapidly, for the interval between the times of application of the fungicides was nearly six weeks, and even light rains in that time would have removed all the fungicides.

Then another precaution should have been taken, that of spraying the vines and trellises and perhaps the ground under them, with strong solutions of sulphate of copper or sulphate of iron before the leaves unfolded, to destroy all spores that might have survived the winter in these places.

The 50 plum trees, mentioned in Mr. Andrews' report, produced an astonishing crop of fruit. The trees were sprayed April 29th with Bordeaux mixture, May 19th and June 9th with the Bordeaux mixture and Paris green, and July 12th with the ammoniacal carbonate of copper.

The trees were heavily loaded with fruit, notwithstanding what seemed like heroic thinning. Very few black warts were found upon them and the fruit rotted very little.

The location was favorable in every way, being on an elevation and in rather light soil, and the weather very unfavorable for the development of the spores of the brown fruit rot. It is seldom that trees so heavily loaded with fruit escape this disease, and had there been rains and a higher temperature during the month of July, the last spraying of ammoniacal carbonate of copper would have been washed off and the fruit very likely have been destroyed by the rot. As no check trees were provided, there is some uncertainty as to the results of this experiment, but viewed in the light of the results obtained in similar experiments made at the Hatch station, we feel confident that the applications made assisted largely in preserving the crop, and preventing the growth of the black wart.

REPORT OF A. C. HAWKINS,

LANCASTER, MASS.

Mr. Hawkins treated plum trees only, and owing to the delay in receiving the pump and materials, was unable to make the application of the strong solutions of sulphate of copper or iron before the leaves unfolded. He reports as follows:

" I think the results would have been more satisfactory had the pump arrived in time to spray the trees before the buds had begun to open. Application of the Bordeaux mixture was made May 1st, 12th and the 28th. This experiment was on young trees, only three years old, that I did not wish to bear fruit, so no Paris green was used, as would have been the case if it was desired to protect the fruit from the plum curculio. All old warts had been cut off and burned before the spraying, and the new warts seemed to start into growth about the time the buds unfolded.

While I think the spraying destroyed many spores and prevented a large increase of the warts, those that had become established were not apparently affected. The old trees that had the warts cut off were headed back severely, and have thrown out a fine head comparatively free from warts. I have cut out all warts that appeared this season and shall spray early this spring, before the buds start."

REPORT OF BENJAMIN P. WARE,

MARBLEHEAD, MASS.

"Apple and pear trees and potatoes were treated as follows:

Apple. May *9th*, sprayed with the Bordeaux mixture, with Paris green 1 lb. to 120 gallons. June 12th, made second application. The petals had just fallen.

The results noticed were that the tent caterpillar and the canker worms were all killed and that no injury could be detected to the foliage, from the per cent. of Paris green used.

Very few apples were affected by the codling moth, and the Bordeaux mixture remained on the foliage the entire season.

Pears. May 9th, applied the Bordeaux mixture and Paris green, 1 lb. to 120 gallons, to Flemish beauty pear trees. The fruit had cracked badly for years, but this season not quite so badly.*

Potatoes. June 12th, sprayed a field of potatoes with Paris green, 1 lb. to 120 gallons of water. The Douglas barrel pump was used, mounted on a wagon, the horse going between two rows and the wheels between the next two on either side, and eight rows were sprayed at a time. The beetles were all killed and the pump worked to a charm."

REPORT OF H. A. COOK,

SHREWSBURY, MASS.

Mr. Cook treated grape vines, plum and peach trees, and reports as follows:

Grapes. "Sprayed vineyard, May 11th and June 13th with the Bordeaux mixture, four rows of 35 vines each being left as checks. The common knapsack pump was used to apply the mixture.

*It has been conclusively shown that the common fungi attacking our fruits, will grow at any time during the summer when the conditions of moisture and temperature are right. Rains quickly wash out the little soluble copper there is in the Bordeaux mixture, and it is not safe to depend upon one or two applications for the destruction of their spores during the three or four months when it is possible for them to grow. Had the trees been sprayed at intervals of about two weeks, varying the time according to the weather, up to Aug. 1st, more favorable results would probably have been obtained.

Although no further spraying was done the results were very marked in preventing the mildew and lessening the black rot. On the four rows unsprayed the black wart was much more abundant than on those sprayed.

Plum trees. Sprayed May 11th and 21st, June 1st, 5th and 13th. On two rows the Bordeaux mixture was used at the ordinary strength, two rows at one-half strength, and two rows were unsprayed.

The results noticed were, that there were a less number of warts on the sprayed trees than upon those unsprayed. The leaf blight did not seem to be affected, there being about the same amount on each plot and the leaves fell prematurely from all the trees alike.

Peach trees. Sprayed the trees May 11th and 23d and June 1st, 5th and 13th with the Bordeaux mixture, one-half strength. One row of four in the orchard was left as a check. This spraying was not beneficial, as those trees unsprayed looked the best, and there was some rot on all of them."

[In the experiment with grapes Mr. Cook seems to have made a happy hit, as the spraying of June 13th was just before hot, moist weather, when mildew and rot started vigorously in other places. It is not always possible to do this, and consequently more frequent applications must be made, in order to secure the surest results.

REPORT OF E. A. ESTABROOK,

GRAFTON, MASS.

Mr. Estabrook treated grape vines only. He reports as follows:

"April 28th, I sprayed several rows of vines with the sulphate of iron, one pound to two gallons of water. The buds had started so as to show the pink tinge of the leaves, and the mixture burned them somewhat. When the shoots were from six to twelve inches long with the young fruit-bud clusters showing, and some of them even in bloom, we sprayed a part of the same rows with the Bordeaux mixture at one-half full strength. Owing to a mistake, the mixture not being thoroughly stirred, some of the vines were seriously injured and the apparent results at the time discouraged me, so that no further spraying was done.

But subsequent results proved that even *that one* application of sulphate of iron and one of Bordeaux mixture was of great benefit. The fruit being far superior to that of adjoining rows not sprayed. These were Concords, and the adjoining rows of Wordens were similarly benefitted, but the next row of Moores Early, being more advanced in blossom at the time of spraying, had nearly all the fruit destroyed.

What seems remarkable to me is that a number of rows treated with only the sulphate of iron, should be so much superior and free from mildew and rot to those in the same location and not treated. Although my beginnings were disastrous, I think I have learned something and am full of enthusiasm to continue the work. Possibly in this immediate section, where the grape is not so liable to disease, a lesser strength of the Bordeaux mixture would be advisable, but think if the mixture is properly made it will not injure the foliage a particle.

My sprayer is intended to stir the liquid automatically, but I am afraid it does not work to perfection. It seems to me that if we can keep the foliage and fruit healthy until July that there would not be much need of treatment after that date.*

Altogether my crop of grapes was good, but the prices low. Sold some tons as low as 2c. per pound. They were Wordens and were sent to market just at the time of the "grape scare" in New York city. The later parts of the crop, mostly Concords, sold for 5c. per pound, or more."

REPORT OF EXPERIMENTS AT FOREST ORCHARD,

NORTHBORO, MASS.

At this place 500 peach, 500 plum, 100 pear, 300 small and 200 large apple trees, about 2000 grape vines, and several hundred black-cap raspberries were treated.

The application of concentrated solutions of sulphate of copper was made to one-half, that of sulphate of iron to the other half of each plot, before the leaves unfolded, and all subsequent spraying was done at intervals of about two weeks, varying somewhat with the weather.

Peach. All the trees blossomed and promised a large crop of fruit, but the frost of May 19th destroyed all but that of the early, white-fleshed varieties, like the Amsden, Waterloo, etc.

* This will depend very much upon the weather. The past season during the extremely warm, moist weather of September, the powdery mildew came upon the foliage of the unsprayed vines in the college vineyard in such quantities that, had it been in August, it would have ruined the crop. Taking the conditions one year with another it is very doubtful if we can hope for freedom from this disease and the black rot with less than five applications after the leaves have unfolded, three of the Bordeaux mixture and two of the ammoniacal carbonate of copper, or some wholly soluble fungicide.

The first application of the Bordeaux mixture, made May 13th, did not injure the foliage materially, but that of the 25th was so destructive that no further application was made until July 28th, when the fruit began to decay and the ammoniacal carbonate of copper was used at the rate of one-half pound to fifty gallons of water. This solution did not injure the foliage and checked the rotting of the fruit, although not wholly preventing it.

Plum. These trees bloomed very full, but the fruit was destroyed by the frost, and only one application of the Bordeaux mixture was made after May 19th. Very few black warts appeared and these were effectually destroyed by painting with the kerosene paste.*

The leaf blight attacked the foliage the latter part of August and all the leaves fell, leaving the trees bare for the rest of the season. This caused serious injury to the trees, and probably might have been prevented had they been sprayed once in July and again in early August. (See experiment on the college grounds, page 16, Plates VI, VII.

Apple. The first application of the Bordeaux mixture was made just before the blossoms opened, and Paris green, one pound to 200 gallons of the mixture, was added to destroy the tent caterpillar and bud moth which were abundant. Another application of the same was made soon after the petals had fallen, and a third June 20th.

The *results* of this work were the destruction of most of the tent caterpillars; and the fruit on the sprayed trees was more free from the larvae of the codling moth than that on unsprayed trees, although that upon both was less wormy than for many years previous.

The season was so unfavorable for the development of the apple scab that little difference could be detected between the amount upon the leaf or fruit of either those trees sprayed or unsprayed.

Blackcap Raspberries. The anthracnose or spot fungus of the raspberry nearly ruined a plantation of an acre or more of blackcaps last season, and about 200 plants were selected for treatment this season. This disease first appears as small brownish-purple spots on both old and new canes, generally near the ground. As the fungus increases in growth, the center of the spot becomes greyish brown, and if in large numbers on the canes they grow very weakly or die.

The sulphate of copper was applied the last of April, and later, two

* Ordinary kerosene oil mixed to a paste with French yellow, or any other dry pigment. Crude petreleum would do equally well, if it is thick enough so as not to spread over the branch very much when applied.

applications of the Bordeaux mixture were made. This treatment resulted in a much better growth and in very much less of the anthracnose on the plants sprayed than upon those unsprayed.

Potatoes. Two fields of potatoes, one of one-half acre and the other of one and one-half acres, were treated with Paris green to destroy the potato beetle, combined with the Bordeaux mixture, one pound to 200 gallons, to destroy the potato blight and rot fungus. Three applications were made and the results were that the beetles were killed and the potato vines where sprayed remained green much longer than those unsprayed. There was very little rot among the tubers of either. With the barrel pump, in a one-horse dump-cart, ten to twelve rows were sprayed at once and the work more cheaply and effectually done than it could have been in any other way.

VARIETIES OF GRAPES.

Of the 120 varieties of grapes grown in the experimental vineyard, 105 fruited the past season. Many of these are old kinds grown for comparison with the newer sorts.

Notwithstanding the host of new varieties sent out from all parts of the country, very few are found superior or even equal to the old standard sorts for general purposes. For New England we would name as the best for general planting the Concord, Worden, Moore's Early, Delaware, Brighton and the Lady.

Of those that are promising and that, after one or two years of continued good behavior, we can safely recommend for general cultivation are the Berckman, Lindley, Massasoit, Rochester, Salem, Wilder and Winchell (Green mountain). Many other new varieties are promising, but have not yet been fully tested in our vineyards.

We give a brief description of a few varieties that are not generally known, but that possess some desirable qualities.

Berckman. A small red grape resembling the Delaware in size of berry and bunch, but a little darker in color, and with the tough, dark green, mildew resisting foliage like the Clinton and the frost or pigeon grape. Not as sweet as the Delaware, but of a more winy flavor and ripens at the same time.

Brighton. A fine red grape of good size of berry and bunch and of fine quality. When planted by itself the blossoms sometimes fail to become fertilized, but if grown among other varieties it will set all the fruit it can mature. It ripens with the Concord.

Diamond (Moore's). A most beautiful white grape, bunch and berry large, and of good quality. Thus far it has been free from mildew and rot.

Eaton. A very large black grape, showy, but watery and of too poor quality to be desirable.

Empire State. This is a white grape with long bunches and berries of medium size. It is a late keeper and valuable, if the mildew to which it is subject can be prevented.

Pocklington. A most beautiful white grape of fair quality. A little later than the Concord, but for the past two years has matured perfectly.

Rochester. A reddish purple grape of the best quality. The bunch is very large, and the berries so numerous, that they are liable to crack sometimes when growing rapidly.

Rogers' Hybrids. Among these are some of the best grapes in quality in cultivation, and they are all late keepers. The Barry, Herbert, Lindley, Salem and the Wilder have done the best with us. By the use of the copper solution to destroy the mildew and the rot, to which they are much subject, these grapes may be successfully grown.

Vergennes. A large red grape of good quality and one of the best keepers. It mildews badly.

Winchell (Green mountain). A most delicions little green grape, very early, hardy and productive. It is moderately vigorous and has thus far proved free from disease.

KEEPING QUALITIES OF GRAPES.

To test the keeping qualities of the many kinds of grapes grown, small quantities of each were placed on trays and put into the fruit-room about October 1st.

Those that show the poorest keeping qualities are, Ann Harbor, August Giant, Champion, Concord, Early Victor, Eaton, Hayes, Janesville, Lady, Martha, Moore's Early, Nectar, Niagara, Pearl, Triumph and Worden.

Those keeping up to March 1st, in fair condition, are, Berckmann, Iona, Jefferson, Moore's Diamond, Prentis Roger's Nos. 3, 4, 9, 19, 28, 30, 33, 34, 39, 41 and 44, Salem, Vergennes, and Woodruff's Red.

VARIETIES OF PEACHES.

The past season is the first one for about ten years when there has been fruit enough to compare the merits of varieties for New England. We give the results of the comparison of eighteen varieties that fruited abundantly in the college orchard. A few other kinds produced a small number of specimens, but not enough to warrant a decision as to their value.

The *white fleshed* varieties which fruited, in the order of ripening, are as follows: Amsden, Alexander, Schumaker, Waterloo, Mountain Rose, Coolidge. Holland (local seedling), Oldmixon, Morris White and Stump. Of these the first four are so nearly alike, although varying slightly in minor details, that they should be given under one name.

The Coolidge, Oldmixon and Stump were the most productive and profitable.

The *yellow fleshed* varieties are Crawford's Early, Crawford's Late, Reeves' Favorite, Red Cheek Melocoton, Foster, Wheatland, Crosby (Excelsior), and Wager. Of these the Crawford's Late, Foster, Reeves' Favorite, Wheatland and Crosby (Excelsior) produced the best crop.

The Crosby (Excelsior) is a new variety which has attracted much attention, and is being advertised extensively as the most hardy yellow peach. It resembles the Wheatland closely. It originated in the eastern part of the state, and on the college grounds has borne four successive crops. It is of medium size, of a deep yellow color, with brilliant red spreading and splashed over the exposed side. In quality it is one of the best yellow fleshed peaches. Its small size, when the trees are allowed to overbear, and even under average ordinary cultivation seems, at this time, to be its only fault. To make the fruit even of average size heroic thinning must be practiced.

WINTER KILLING OF THE PEACH BUDS.

During the past ten years very few fruit buds have escaped destruction, but, if one-tenth of all that form develop into blossoms and set fruit, the trees would be so heavily loaded as to break down with the weight. To determine the time of this destruction, and to ascertain the number of buds which are destroyed, weekly observation of about 100 buds of each variety were made through the winter. The results of these observations show that the buds were largely destroyed before the middle of December, and generally before the temperature had reached 0°, or a few degrees below. When it has reached from 15° to 20° below the buds have nearly all been killed.

The following table shows the per cent of buds of several varieties killed March 1st for the past three years:

	1890	1891	1892		1890	1891	1892
Amsden,	15		37	Crawford's Early,	99	56	82
Coolidge,	20	45	23	" Late,	99		82
Holland, (local seedling)	97	50	59	Crosby, (Excelsior)	42	28	37
Morris White,	85		31	Foster,			70
Oldmixon,	99		92	R. Cheek Melocoton,	70		92
Schumaker,	10	44	37	Reeves,	99	97	79
Stump,	80	56	84	Wager,	70	68	50
Waterloo,	15		45	Wheatland,	60	59	25

PROTECTION OF THE BUDS.

For many years numerous experiments have been made at this station to discover some means for protecting the peach fruit-buds from injury by cold during the winter, but, although every kind of available covering material that suggested success has been used in protecting the trees in an upright position, they have proved valueless. For the past four seasons in November or early December the roots of about a dozen trees, two or more of a kind, have been loosened on the north and south sides, the trees laid over on the ground and some left uncovered and others covered with various protective materials.

The first experiment (1888 and 1889) resulted in the destruction of the buds by heating, the trees being covered too closely. In 1889 and 1890 the trees were covered with mats and other light material, and a large per cent of the buds were preserved. In 1890 and 1891 light covering was again used, the following table giving the comparative results between protected and unprotected trees.

Varieties.		Protected.	Unprotected.
Stump,	per cent of buds injured,	22	78
Reeves' Favorite,	" " "	23	97
Wager,	" " "	15	68

At the present date, March 12th, the same varieties unprotected show an average of 52% of the fruit buds destroyed, while those protected have only about 10% destroyed. Trees protected in this way are easily set up in the spring and grow well and mature a crop. Of the trees treated in this experiment, many were more than ten years old.

For the best permanent results, we would recommend previous preparation of the trees to be protected in this way, by cutting off all the roots on the north and south sides during the early summer. This will force the growth into the roots on the east and west sides, and they will be simply twisted a little in the process of bending over. The trees should be bent toward the south to avoid the direct rays of the sun on the trunk and main branches. Any covering of a coarse, light nature that will not compact may be used, but coarse, thin mats obtained from straw-hat factories have given us the best results. No covering should be put on the ground under the tree as the moisture from the ground seems necessary to perfect protection, and if the land is in turf the trees should be sprayed with the Bordeaux mixture or skim milk and Paris green to protect them from the field mice, which are very fond of them. The loosened soil should be pressed back firmly into place and a mound of earth be made over the upturned roots and the base of the trunk for protection.

PROTECTING YOUNG TREES FROM MICE.

Every year the question comes to us, "How shall I protect my young trees from mice?" For the benefit of those who may not have read our previous bulletins, we repeat the remedies that have proved wholly effectual upon the college grounds, and in other places where properly used, for the past six winters.

Late in the fall, before the snow comes on, paint the trunks of the trees, from eighteen inches to two feet from the ground, with a mixture of Portland cement and Paris green, one tablespoonful of the latter to a gallon of the paint. Only a small quantity of the paint should be mixed at a time, and it should be made thin enough to apply readily with a common paint brush. Mixed with skim milk the paint adheres better than if mixed with water.

THE SIBERIAN CRAB APPLE TREE AS A STOCK FOR GRAFTING.

The question is often asked, can the Siberian Crab (*Pyrus baccatus*) be used on which to graft successfully as a stock the varieties of larger apples (*Pyrus malus*).

To answer this question, about ten years ago, six small trees of the yellow Siberian crab and three of the Williams' Favorite were planted as represented in the following diagram. S. indicating Siberian crab, S.B. the same budded and W. Williams' Favorite:

S. W. S.B. S. W. S.B. S. W. S.B.

The trees were all of the same size as nearly as could be selected, and every third tree in the row was top-budded with the Williams' Favorite. The buds all grew well the first season, but the subsequent growth was very little, and at the end of ten years all were dead. The diameters of the three Siberian crabs were 4, 4½ and 6 inches, of the three Williams' Favorite, 3⅞, 3 and 3 inches, while none of the budded trees reached over ⅞ of an inch. Plates IX, X, XI illustrate the results of this test.

REPORT UPON GIRDLING GRAPES, BY DR. JABEZ FISHER,

FITCHBURG, MASS.

In my last communication on this subject, as printed in Bulletin No. 13, page 12, I used the following language: "Whether it is possible to long continue the operation without injury to the ripening of the roots of the vine. The three years in which this treatment has been carried out has not developed as yet an answer to this question."

Previous to the swelling of the buds last spring no difference could be detected, but soon afterward it was noticed that the vines which had been girdled the previous year broke unevenly, that the clusters of buds were smaller and the commencing growth of the canes less vigorous. This was intensified as growth progressed and became more and more apparent as the season wore on. While all were entirely healthy, the vines which had been girdled in 1890 showed a manifest lack of fruit and a smaller and weaker cane grown for fruiting in 1892. The favorable weather of September enabled these canes to make up their deficiency in some degree and at the close of the season they all look well and are perfectly ripened. None of them were girdled this year.

To determine the influence of last year's girdling I kept the fruit grown upon the different plots separate. Plot No. 1 had never been girdled; No. 2 had had one-half of each vine girdled, and No. 3 the whole of each vine. Each plot contained 120 vines and covered about 11,500 square feet. All were contiguous and fairly comparable with each other. After the leaves had fallen I measured with calipers the diameter of each cane of these 360 vines, 720 in all, at half their length (three feet) from the trunk.

In the following table, column one, 100 is assumed as the product of normal ungirdled vines. In columns two and three appear the percentages of the half-girdled and the full-girdled vines respectively. The difference between the total fruit and that denominated first-class consisted of small and fragmentary clusters which could be disposed of only at inferior prices. The quality of all was satisfactory.

	Ungirdled.	Half-girdled.	Full-girdled.
Total fruit,	100	83	62
First class,	100	77	59
Diameter of new canes,	100	97	87

Three years ago, when I commenced this series of experiments my object was to ascertain if the operation of girdling could be recommended for this climate. It seems to me that the results as here given go to show that wherever a grape will ripen fairly by the natural processes, girdling is a complete draft upon the future without prospect of means to pay it through the gains of the present. With me the increase in weight of the fruit was more than offset by the waste through split berries and the consequent extra time required to prepare the whole for market. There was no gain in price from the ten days' earliness. The Concord does not reach market soon enough to command early prices. If, therefore, there is nothing realized from the operation during the same season, and there follows a loss of nearly or quite fifty per cent in the value of the product in the succeeding one, then it can only be commended for situations where it is impossible to ripen the fruit naturally, and where after one season's girdling, the vines may be allowed a year in which to recover through generous feeding and entire abstinence from fruiting.

THE AMOUNT OF COPPER ON SPRAYED FRUIT.

GRAPES.

During the early autumn the board of health of New York city condemned several carloads of grapes as dangerous to the public health and ordered them destroyed, because they were slightly disfigured with the Bordeaux mixture which had been used by the growers to prevent mildew and rot. This caused a "scare" among the dealers and consumers and a serious fall in prices, which affected the market more or less for the rest of the season. To determine positively the amount of copper adhering to the grapes grown in the college vineyard, two lots of fruit, of ten pounds each, were selected, one from vines sprayed with the Bordeaux mixture throughout the season, and which were very badly disfigured, and the other from vines that were treated with the Bordeaux mixture up to the middle of June, then with two applications of the ammoniacal carbonate of copper and which were not in the least disfigured.

An analysis of these two samples was made at the State Experiment Station. In the first, sample No. 1, there was found only $\frac{2}{1000}$ of 1% of oxide of copper, an amount so small that one would need to eat from one-half to one ton of these grapes, stems, skins and all, to obtain the least injurious effect, and that, notwithstanding the fact that the bunches were selected from those having the largest amount of the copper mixture adhering to them.

In sample No. 2 *not a trace of copper* could be found. It would seem from the above that even under the most careless use of the copper solutions, no injurious effects need be feared, and that when properly applied there will not be a trace of copper left upon the fruit at harvesting.

APPLES.

Early in December, the *Pall Mall Gazette* of London, England, published an article headed "*American Apples. Alarming Allegations—Are They Doctored with Arsenic.*" Then the statement is made "that American orchardists use arsenic in such large quantities to protect their fruit from insects as to completely saturate it,and that the bloom or white powder found on the surface of American apples is arsenic, brought to the surface by evaporation, and if the fruit is eaten, this should be wiped off to avoid injurious effects. "That the delicate, unnatural (?) bloom of the American apples is due to arsenic, a drug that is largely used by people, especially the fair sex in America, to make the complexion fair," and other statements equally absurd and without a shadow of foundation. These statements were undoubtedly made in the interest of speculators for the purpose of injuring the sale of American apples in the English market.

To determine the amount of copper and arsenic adhering to the surface of apples (for it could not have been absorbed into the substance of the fruit) which had been sprayed three times with the Bordeaux mixture and Paris green, twenty apples, measuring one peck, were taken to the State Experiment Station for analysis. The amount of copper oxide found on these apples was fourteen ten-thousandths (.0014) of one gram, or twenty-two thousandths (.022) of one grain. This equals about five ten-thousandths (.0005) of one ounce to the barrel, or requiring two thousand barrels to yield one ounce of copper oxide. The specimens selected for this analysis were those with the roughest surface, to which would adhere more of the copper solution or Paris green than to the average apples.

Not a trace of arsenic could be detected in this analysis; as Paris green (average samples of Paris green contain about thirty-three parts of oxide of copper and sixty-one parts of arsenious oxide) was not used after July 1st, it was probably all washed off during the three months following, before the apples were gathered, which was October 1st.

When we consider the fact that probably not one fruit grower in one hundred throughout the country used Paris green at all, and that not one barrel in one thousand came from sprayed trees, the absurdity of the "scare" becomes still more apparent.

CONCLUSIONS.

Summing up the results of the work of the past season, we arrive at the following conclusions:

That the apple scab, pear leaf blight and cracking of the fruit, the peach and plum fruit rot, the plum leaf blight, and plum black wart, the grape powdery mildew and black rot, the raspberry anthracnose and the potato leaf blight and rot, may be wholly or largely prevented when the solutions of copper are properly applied;

That by the combined use of the Bordeaux mixture and Paris green the above fungi are prevented, the tent caterpillars and canker-worms are killed, and the injury to the apple and pear from the codling moth, and to the plum and peach by the plum curculio, may be largely prevented;

That if the spores of the plum wart become established in the tree, the copper solutions do not stop their growth, but that by painting with "kerosene paste" they are destroyed at once.

That the peach foliage is very susceptible to injury from copper solutions and that these solutions must be applied at from one-third to one-fourth the strength used upon the apple and pear;

That peach buds can be protected by bending the trees over to the ground and covering with some light, thin material;

That the amount of copper adhering to apples and grapes, that have been properly sprayed with copper solution, is so small that no injury can possibly occur from their free consumption.

That the Siberian crab apple tree does not make a good stock upon which to graft the varieties of our larger apples;

That girdling the grape vine during the season of 1890 in Dr. Fisher's vineyard resulted in a weakened growth and a diminished crop in 1891;

That young trees may be protected from injury by mice by painting with Portland cement and Paris green.

OUTLINE OF PLANS FOR USING FUNGICIDES AND INSECTICIDES FOR 1892.

FOR THE APPLE.

Spray for the destruction of the spores of the apple scab, and leaf blight, with sulphate of copper, (Blue Vitriol), one pound to twenty-five gallons of water, or sulphate of iron (Copperas) one pound to two gallons.

For the destruction of the tent caterpillar, canker worm and bud moth use the Bordeaux mixture, one-half strength, with Paris green, one pound to 150 gallons, just before the blossoms unfold, and for the same and the codling moth, as soon as the petals have fallen.

Make a third application of the Bordeaux mixture and Paris green in about two weeks from the time the petals fall should there have been heavy rains since the last application; then use the ammoniacal carbonate of copper, one pound to fifty gallons of water, at intervals of from two to four weeks, according to the weather, until the middle of August.

We would recommend the trial of sulphate of copper, one pound to 500 and 800 gallons of water, after the middle of June. Should no rain occur after the use of any fungicide or insecticide no further application need be made until it does rain, but if the interval has been long, spraying should immediately follow a heavy rain.

FOR THE PEAR.

For the pear scab, leaf blight and cracking of the fruit, and codling moth, the same treatment should be given as for the apple, except that no Paris green need be used until after the petals have fallen, and only two applications of that need be made.

If the pear tree psylla should appear, spray the trees thoroughly with the kerosene emulsion (see page 24), one part to twenty parts of water.

FOR THE PLUM.

We would advise the same treatment, as given to the apple and pear, for the plum leaf blight, black wart and the fruit rot. For the plum curculio, use the Bordeaux mixture, one-half strength, with Paris green, one pound to 200 gallons. One application of the ammoniacal carbonate of copper should be made after the middle of August, to prevent the rotting of the fruit and the leaf blight.

FOR THE PEACH.

To destroy the plum curculio, spray with the Bordeaux mixture, one-fourth strength, and Paris green, one pound to 200 gallons. For the fruit rot, spray with the ammoniacal carbonate of copper, one pound to fifty gallons of water. Try the sulphate of copper, one pound to 1000 gallons of water, for the fruit rot.

FOR THE GRAPE.

Spray with the concentrated solution of sulphate of copper every part of the vines and trellis before the buds unfold. Just before the blossom buds unfold, spray with the Bordeaux mixture, one-half strength, with Paris green, one pound to 100 gallons. As soon as the petals have fallen, spray again with the same; then at intervals of about two weeks use the ammoniacal carbonate of copper, one pound to twenty-five gallons. Try the sulphate of copper, one pound to 500 and 800 gallons of water at the same intervals.

FOR RASPBERRY AND BLACKBERRY.

For the anthracnose of the blackcaps, and the yellow rust of the blackberry, use the concentrated solution of sulphate of copper, before the buds open. Then spray with the Bordeaux mixture one-half strength or the ammoniacal carbonate of copper before the blossom buds unfold, and two or three times after the fruit has been gathered, at intervals of two or three weeks. The first disease attacks the canes principally and more attention in spraying should be given to them, than to the leaves.

FOR THE STRAWBERRY.

Spray with the Bordeaux mixture, one-half strength and Paris green 1 lb. to 100 gallons for the leaf blight and the "spotted paria," as soon as growth begins in the spring. Just before the blossoms open use the Bordeaux mixture same strength, *but no Paris green.* After the fruit has been gathered Paris green and the Bordeaux mixture should be used if the bed or field is to be carried through another season.

FOR THE POTATO.

As soon as the larvæ of the potato beetle begin to appear, spray with the Bordeaux mixture, one-half strength, and Paris green one lb. to 100 gallons. Use the same mixture as often as they appear in sufficient numbers to be injurious. If the weather should be warm and moist, applications should be made at intervals of from one to three weeks after the vines have blossomed, of the Bordeaux mixture, one-half strength or the ammoniacal carbonate of copper, one lb. to fifty gallons of water, even if there are no larvæ present. The sulphate of copper one lb. to 500 gallons should also be tried on a small scale to test its value.

SPRAYING APPARATUS.

PUMPS.

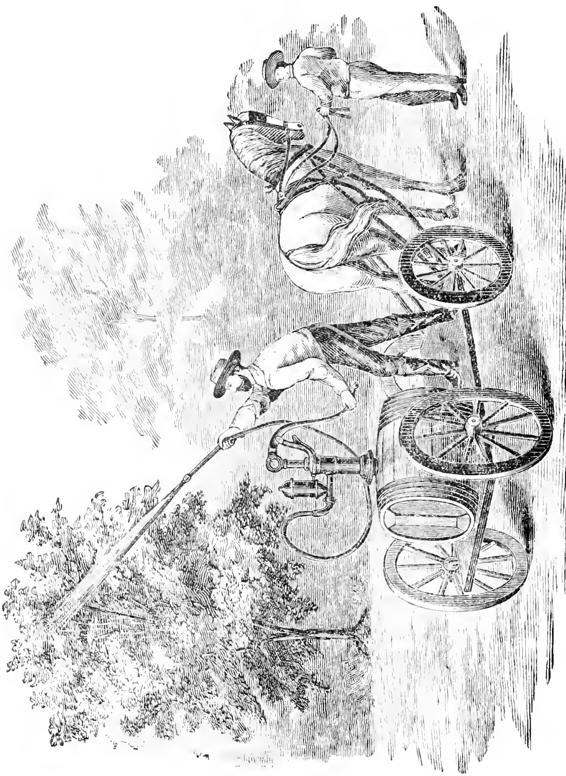


Fig. 1.

The pump attached to the cask, as in Fig. 1, was largely used for the work at the station, and is by far the most economical method of applying fungicides and insecticides on a large scale. The pump should be attached to the side of the cask and be mounted in a cart or on a stone-boat. To reach the highest trees, a piece of one-half inch gas pipe ten feet long, with hose coupling at each end, was used. If the Vermorel nozzle with the spray coming out on one side is used the pipe need not be bent, but if any of the adjustable straight nozzles be used the pipe should be bent, at the end, to an angle of about 45°.

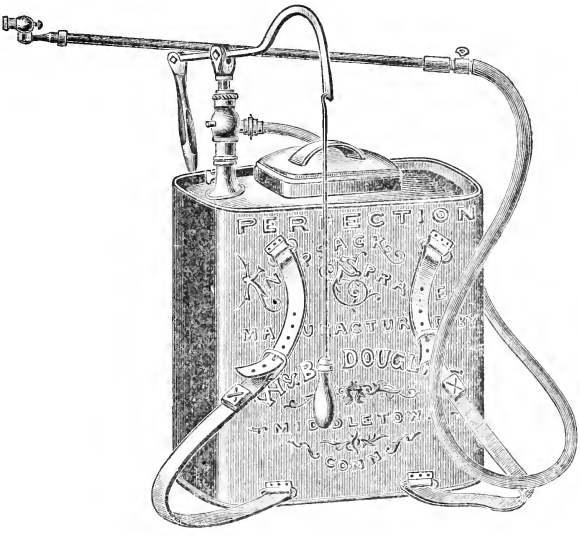


Fig. 2.

The *Knapsack* pump, Fig. 2, was found very useful where only a few small trees or vines were to be sprayed. A piece of three-eighths inch brass or iron pipe, six feet long with hose couplings attached, was found very useful in many cases.

The Hydrosprayer, recommended by Dr. Fisher, made by Robt. T. Deakin & Co., Philadelphia, Pa., Fig. 3, is a very useful instrument for applying clear liquids, but is not adapted to the use of the Bordeaux mixture. Any of the small garden or carriage pumps like Fig. 4 will answer for this work, if only a few vines or small trees are to be sprayed.

NOZZLES.

For applying the Bordeaux mizture, a nozzle with an adjustable opening must be used. Those found most useful are the "Vermorel" and the adjustable nozzle sold with the barrel pumps.

WHERE MATERIALS MAY BE OBTAINED.

Sulphate of copper and iron and Paris green, in small quantities, may be found at the drug stores generally, but purchased in this way they are very costly.

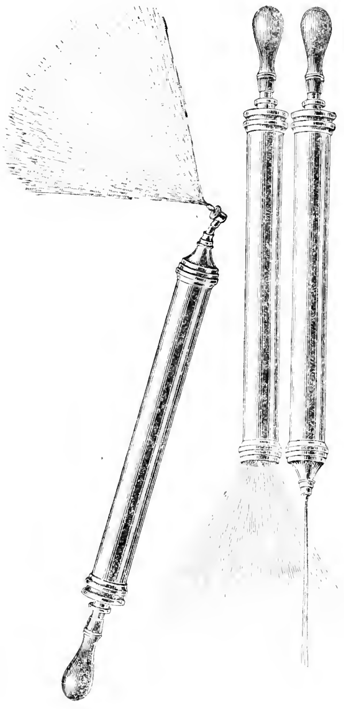


Fig. 3.

Dealers in seeds, agricultural and horticultural supplies, also keep the pumps and chemicals on hand.

The price of sulphate of copper, very nearly pure, should not be over four cents per pound in lots of 100 pounds or more. Good Paris green should be purchased for twenty-five cents per single pound, and twenty cents by the wholesale.

The ammoniacal carbonate of copper put up in air tight cans, cost last season, fifty cents per pound. It should be sold at a much lower price this season.

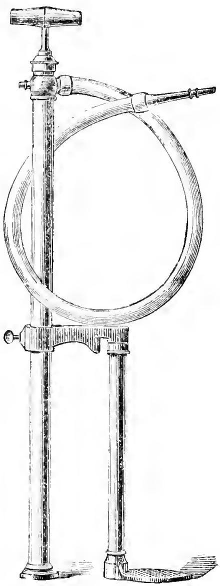


Fig. 4.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 18.

Fertilizers for Potatoes, Oats and Corn.

The Use of Muriate of Potash with Manures for Corn.

"Special Corn" Fertilizer *versus* Fertilizer richer in Potash.

Comparison of Corn and Millet as Grain Crops.

Proximate Composition of Potatoes as affected by Fertilizers.

Reports on Miscellaneous Crops: Oats, Hemp, Flax, English Wheats, Japanese Millets, and Beans.

APRIL, 1892.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1892.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL,	*Director.*
WILLIAM P. BROOKS,	*Agriculturist.*
SAMUEL T. MAYNARD,	*Horticulturist.*
CHARLES H. FERNALD,	*Entomologist.*
CLARENCE D. WARNER,	*Meteorologist.*
WILLIAM M. SHEPARDSON,	*Assistant Horticulturist.*
HENRY J. FIELD,	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

DIVISION OF AGRICULTURE.

WILLIAM P. BROOKS.

SOIL TESTS WITH FERTILIZERS.

During the season of 1891, Soil Tests with Fertilizers have been carried out under my supervision in the counties of Essex, Middlesex, Worcester, Hampshire and Franklin under the care of selected farmers; and, except in one instance, upon land which had already been used one or two years in a similar test. In all such cases the fertilizers were applied upon the same plots as in preceding years. The experiment in Worcester county was with oats, the rest with potatoes. Besides these we have had two acres in a similar experiment upon our own grounds, one in oats and one in potatoes, and a number of volunteer workers in different parts of the state who planted corn. In the following pages will be found an account of the experiments in the counties above named as well as of those on our own grounds and of two volunteer workers whose results seem to have been accurately determined.

The general plan of experiment was similar to that followed during the two preceding years and it is described in full in Bulletin No. 9 of this station. One acre was used in each experiment and this with one exception, (where there were fourteen) was laid out in fifteen plots of one-twentieth of an acre each, the unfertilized strips around and between the plots occupying the balance of the acre. The fertilizers used were *nitrate of soda*, *dissolved bone-black*, *muriate of potash*, land plaster, lime, and barn-yard manure. The first three mentioned fertilizers were selected as sources respectively of *nitrogen*, *phosphoric acid and potash*, which are recognized to be essential elements of all fertilizers and manures,—often indeed they appear to be the only essential elements. The reason for selecting these materials is that they allow us to furnish essentials of plant food singly or in any desired combination. Other materials might serve the farmer's purpose equally well; but for our purpose we must have forms of fertilizers which enable us to trace results to definite causes.

In these experiments we, in effect, ask the soil:—"What must you have to enable you to produce a crop," and in proportion as natural inequalities of the soil and accidental causes of variation are avoided, the answers are definite and valuable. Our experiments might be regarded as complete without the plots on which barn-yard manure, lime and plaster are used, in so far as affording an answer to the above question is concerned; but, for purposes of comparison these extra plots are introduced.

The materials used were each applied at the following rates where-ever employed:

Per Acre.	Pounds.
Nitrate of soda,	*160*
Dissolved bone-black,	*320*
Muriate of potash,	*160*
Lime,	*160*
Land plaster,	*160*
Barn-yard manure,	*5 cords*

The materials were all sampled and analyzed and the manure was weighed, so that we are able to calculate the amounts of the essentials—nitrogen, potash and phosphoric acid—applied to the plots receiving this material, and thus to institute interesting comparisons with the plot receiving the same elements in the form of fertilizers. These comparisons will appear under the several experiments.

The fertilizers used:—

Nitrate of Soda.

Moisture at 100° C.,	1.20	per cent.
Nitrogen,	15.81	"
Sodium oxide,	38.90	"

Dissolved bone-black.

Moisture at 100° C.,	18.50	per cent.
Organic and volatile matter,	44.48	"
Total phosphoric acid,	15.35	"
Soluble " "	14.87	"
Reverted, " "	.29	"
Insoluble " "	.19	"
Insoluble matter,	2.95	"

Muriate of Potash.

Moisture at 100° C.,	1.09	per cent.
Potassium oxide,	50.40	"
Chlorine,	49.28	"

Calcium Sulphate.

Moisture at 100° C.,	18.02 per cent.
Calcium oxide,	32.40 "
Sulphuric acid,	42.08 "
Insoluble matter,	2.35 "

Lime.

Calcium oxide,	88.64 per cent.
Insoluble matter,	4.71 "

For the purpose of comparison I include here figures showing the amounts of nitrogen, phosphoric acid and potash in the fertilizers used, and in the below stated quantities of the crops which have been under experiment.

	Furnished in fertilizer.	Contained in 50 bu. corn and the usual stover.	Contained in 100 bushels potatoes.	Contained in 50 bu. oats and 4800 pounds straw.
Nitrogen,	25.3 pounds	91 pounds	12.4 pounds	58.2 pounds
Phosphoric acid,	49.1 "	29 "	3.9 "	24.3 "
Potash,	80.6 "	63 "	17.6 "	85.4 "

It will be noticed that nitrogen is applied in considerably less amount than is required by either corn or oats; but in about double the amount in the potatoes. Phosphoric acid and potash, on the other hand, with one exception, (potash in the case of oats) are applied in quantities considerably in excess of the amounts found in good crops of the respective kinds under consideration.

Yet our experiments indicate that potash does not particularly benefit the oat crop, while it seems usually to be the most important ingredient of fertilizer for corn and potatoes.

The manures used in the several experiments varied widely; but with one exception (Shelburne) they supplied all the elements of plant food in much larger quantity than the "complete" fertilizer. The excess of nitrogen applied in the manure as compared with the fertilizers is especially large. In the fertilizer we supplied at the rate of about twenty-five pounds of nitrogen; in the manures, in different experiments:—111.9, 118.8, 69.4, 289.5, and 131.6 pounds per acre.

After ploughing, manures and fertilizers were in all cases spread broadcast and harrowed in, just previous to planting the seed.

Each experimenter was furnished with a standard maximum and minimum thermometer and rain guage; and, although accidental breakages of instruments caused some irregularities, observations were generally kept up from the time of planting to the time of harvest. A summary of the record of each observer will be found under the account of his experiment.

Each out-lying experiment was visited one or more times by my assistant or myself, and the weights and measurements were generally taken by my assistant. Mr. F. O. Williams served in this capacity until Sept. 1st, at which time his place was taken by Mr. H. J. Field.

Systematic measurements were taken in a number of the experiments, with a view to the study of the effects of the several fertilizers during different stages in the growth of the crop. Such measurements have not thus far revealed general laws of any great importance; but they have, as a rule, shown that the beneficial effects of nitrate of soda persist throughout the season. Only a few of such measurements, to illustrate this point, are published under the appropriate experiments in this report.

A few general explanations are necessary to an understanding of what follows. In each experiment, the weight of the product of each plot was taken; in experiments with oats of the straw and grain separately; with potatoes two grades were made, large and small or merchantable and unmerchantable, anything as large as an average hen's egg being included in the first class; with corn, the weights of hard and soft corn and of stover were separately taken. In converting into bushels, 32 pounds of oats, 60 pounds of potatoes and 75 pounds of hard corn on the ear are considered equal to one bushel. In obtaining the value of the crops, oats are estimated at fifty cents per bushel; oat straw, at eight dollars per ton; large potatoes, at fifty cents per bushel; small potatoes, at fifteen cents and hard corn at sixty-five cents.

The cost only of fertilizers is taken into consideration in calculating gain or loss. No account is made of the labor of applying. Nitrate of soda is estimated at $50 per ton; dissolved bone-black, at $30; muriate of potash, at $40; plaster, at $9; lime, at $12 and barn-yard manure, at $5 per cord.

In determining gain or loss from any plot it is compared with the two nearest nothings, each being given a weight inversely proportional to its distance from the plot under comparison.

In the determination of the effect of each of the ingredients of plant-food—nitrogen, phosphoric acid and potash—four comparisons are made. For example in the case of nitrogen:

1. The crop where nitrogen alone is applied is compared with the average of the two nearest nothings.

2. The increase (*or decrease*) when nitrogen and phosphoric acid are used is compared with the increase (*or decrease*) where phosphoric acid only is used.

3. The increase (*or decrease*) where nitrogen and potash are used is compared with the increase (*or decrease*) where potash only is used.

4. The increase (*or decrease*) where nitrogen, phosphoric acid and potash are used is compared with the increase (*or decrease*) where the two latter only are used.

5. The results of the four comparisons are added, the sum divided by four, and the result is considered the average increase (*or decrease*) due to nitrogen.

Upon this average the profit or loss from the use of nitrogen is calculated, no allowance being made for unexhausted residue.

Similar comparisons and calculations are made for phosphoric acid and potash. The results for all these ingredients are shown in tabular form under each experiment.

For convenience of comparison with each other and with the results just mentioned, the net results of the use of "complete" fertilizer, barn-yard manure, plaster and lime are shown in another table, although this plan involves the repetition of some of the figures given in the general tabular view of the entire experiment. Below this table will be found a calculation as to the financial result of the use of each. In this calculation no allowance is made for unexhausted residue of either manure or fertilizer. This omission undoubtedly makes the showing for manure more unfavorable than it should be. If we make the usual allowance of one-half, the manure will come much nearer paying for itself, and for labor of application which, it should be remembered, has not been charged. The expression "complete" fertilizer is used in the ordinary sense to designate a mixture which supplies nitrogen, phosphoric acid and potash.

MARBLEHEAD.

SOIL TESTS WITH FERTILIZERS FOR POTATOES,

by William S. Phillips, Jr.

No. of Plot.	FERTILIZERS.		Yield per Plot, 1-20 Acre.		Yield per Acre.		Gain or Loss compared with Nothing Plots per Acre.	
	KIND.	Pounds per Acre.	Large, Pounds.	Small, Pounds.	Large, Bushels.	Small, Bushels.	Large, Bushels.	Small, Bushels.
1	Nothing,		210	44	70.	14.67		
2	Nitrate of soda,	160	261	36	87.	12.	16.89	—2.22
3	Dissolved bone-black,	320	237	40	79.	13.33	8.78	—.45
4	Nothing,		211	40	70.33	13.33		
5	Muriate of potash,	160	248	40	82.67	13.33	17.42	—3.17
6	{ Nitrate of soda, Dissolved boneblack,	160 320	171	53	57.	17.67	—3.16	—2.
7	{ Nitrate of soda, Muriate of potash,	160 160	288	51	96.	17.	40.92	—5.83
8	Nothing,		150	78	50.	26.		
9	{ Dissolved bone-black, Muriate of potash.	320 160	340	60	113.33	20.	57.66	—6.
10	{ Nitrate of soda, Dissolved bone black, Muriate of potash,	160 320 160	372	59	124.	19.67	62.67	—6.33
11	Land plaster,	160	170	80	56.67	26.67	—10.33	.67
12	Nothing,		218	78	72.67	26.		
13	Barn-yard manure,	5*	408	52	136.	17.33	68.89	—9.
14	Lime,	160	164	68	54.67	22.67	—6.89	—4.
15	Nothing,		168	81	56.	27.		

*Cords.

Average of the nothing plots: large, 63.8 bushels; small, 21.4 bushels.

This experiment was on the acre used in a soil-test with fertilizers for corn in 1889. The land lay fallow during 1890; but the stakes were kept up and the fertilizers were applied upon the same plots as in the first year. The soil is a fine gravelly loam and previous to 1889 had been in grass many years without manure. It was in a low state of fertility, but fairly even throughout, as shown by the total yields of the nothing plots.

The variety of potatoes was the Early Puritan; the field was planted April 29 and harvested Oct. 27-28. The experiment was well carried out, and the crop carefully cultivated throughout the season.

Results of Measurements, 1891.

No. of Plot.	FERTILIZERS USED.	Average Measurements. June 4.	June 16.	June 30.
1	Nothing,	4.9	9.8	17.0
2	Nitrate of soda.	4.9	9.1	16.7
3	Dissolved bone-black,	5.1	9.0	16.3
4	Nothing,	4.9	9.1	19.5
5	Muriate of potash,	4.8	9.0	17.9
6	Nitrate and bone-black,	5.2	8.9	18.5
7	Nitrate and potash,	4.6	9.2	19.2
8	Nothing,	4.1	9.1	17.1
9	Bone-black and potash,	5.9	10.1	20.5
10	Nitrate, bone-black and potash,	5.6	10.1	22.7
11	Land plaster,	5.1	9.5	19.1
12	Nothing,	5.3	9.0	16.9
13	Barn-yard manure,	7.3	12.4	27.4
14	Lime,	4.4	8.7	18.7
15	Nothing,	5.3	9.4	19.3

These figures make evident two facts: first, that the influence due to the nitrate of soda was sustained throughout the period of the growth of the tops; and second, that the yield of tubers was not in all cases proportional to the growth of the tops.

Summary of Weather Observations, May 1 to Sept. 3, 1891.

Month.	Temperature in Open Air in Degrees Fahrenheit. Monthly Means of. Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest Daily Range. Deg.	Date.	Monthly Range.	Rainfall, inches.
May	70.8	42.1	28.7	92	22d	28	5th	47	22d	64	1.77
June	81.7	53.3	28.4	101	11th	40	4th	45	11th	61	3.72
July	83.4	55.84	27.56	94	13 & 21	47	27th	41	31st	47	2.92
Aug.	85.3	58.	27.3	101	10th	47	1st	40	13th	54	3.53
Sept.	85.5	53.9	31.6	100	17th	44	30th	48	30th	56	2.58
Season.	81.34	52 63	28.7	101	June 11 Aug. 13	28	May 5	48	Sep. 30	73	14.52

152 day's.

This station, as in previous years, shows a high degree of variation; and as in previous years also shows the highest temperature recorded at any of our stations. The rainfall was well distributed and the amount was adequate to the requirements of vegetation; and the season on the whole was favorable to the crop.

Analysis of Manure Used.

Moisture at 100° C.,	69.58 per cent.
Phosphoric acid,	.34 "
Potassium oxide,	.49 "
Nitrogen,	.38 "
Insoluble matter,	11.49 "

This manure weighed 46 pounds per cubic foot; the plot received 32 cubic feet, 1472 pounds. Such manuring would supply per acre: nitrogen, 111.9 pounds; phosphoric acid, 100.1 pounds; and potash, 144.3 pounds. It produced a net increase in crop at the rate of almost exactly sixty bushels per acre. When we remember that one-hundred bushels of potatoes, on the average, contain only nitrogen, 12.4 pounds; phosphoric acid, 4 pounds; and potash, 17.6 pounds, this result seems especially insignificant.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Large, bushels per acre,	16.89	—11.94	23.50	5.01	8.37
Small, " "	—2.22	—1.55	—2.66	—.33	—1.69

Value of net average increment, $3.94.

Financial result, 0.06 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Large, bushels per acre,	8.78	—20.05	40.24	21.75	12.68
Small, " "	—.45	.22	—2.83	—.50	—.89

Value of net average increment, $6.21.

Financial result, 1.41 gain.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Large, bushels per acre,	17.42	24.03	48.88	65.83	39.04
Small, " "	—3.17	—3.61	—5.55	—4.33	—4.16

Value of net average increment, $18.90.

Financial result, 15.70 gain.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barn-yard manure.	Land Plaster.	Lime.
Large, bushels per acre,	62.67	68.89	—10.33	—6.89
Small, " "	—6.33	—9.00	—.67	—4.00

	Fertilizer.	Manure.	Plaster.	Lime.
Value net increment due to	$30.39	$33.10		
Value of decrease due to			$5.07	$4.05
Financial result,	18.39 gain	8.10 gain	5.79 loss	5.01 loss

These comparisons make it evident that potash was much more beneficial than either phosphoric acid or nitrogen. Alone and in every combination it much more than pays for itself; but it is far more effective when phosphoric acid is present than when used alone, and produces a yet larger increase when used in conjunction with both phosphoric acid and nitrate of soda, thus indicating a high degree of general exhaustion in this soil. Only when the other important elements are supplied also can the potash produce its maximum effect. The "complete" fertilizer though supplying only: nitrogen, 25 pounds; phosphoric acid, 48 pounds; and potash, 81 pounds, gave a net increase of about 56 bushels of potatoes, while the manure although supplying five and one-half times the nitrogen, more than twice the phosphoric acid, and almost twice the potash, produced a net increase of only about sixty bushels. The profit on the use of the fertilizer was much larger than on the manure, although the latter has undoubtedly left the soil in the better condition.

Neither lime nor plaster appears to have been beneficial, though it is not to be supposed that these fertilizers were the actual cause of the inferiority—as compared with the nothings—of the crops where they were applied.

A potato fertilizer for such soil as this should contain nitrogen, phosphoric acid and potash, and I should judge that materials furnishing per acre: nitrogen, 30 pounds; phosphoric acid, 60 pounds, and potash, 100 pounds, might give a profitable crop.

CONCORD.

SOIL-TEST WITH FERTILIZERS FOR POTATOES,

by Frank Wheeler.

No. of Plot.	FERTILIZERS. KIND.	Pounds per Acre.	Yield per Plot, 1-20 Acre. Large, Pounds.	Small, Pounds.	Yield per Acre. Large, Bushels.	Small, Bushels.	Gain or Loss compared with Nothing Plots, per Acre. Large, Bushels.	Small, Bushels.
1	Nothing,	—	201	38¾	67.	12.92		
2	Nitrate of soda,	320	205¼	43¾	68.42	14.58	.67	1.88
3	Dissolved bone-black,	640	183	36½	61.	12.17	—7.50	—.30
4	Nothing,	—	207¾	36¾	69.25	12.25		
5	Muriate of potash,	320	284¼	36½	94.75	12.17	26.39	.07
6	{ Nitrate of soda, Dissolved bone-black,	320 640	201½	35½	67.17	11.83	—.29	—.13
7	{ Nitrate of soda, Muriate of potash,	320 320	318	34¾	106.	11.58	39.43	—.23
8	Nothing,	—	197	35	65.67	11.67		
9	{ Dissolved bone-black, Muriate of potash,	640 320	362	39	120.67	13.	58.69	1.25
10	{ Nitrate of soda, Dissolved bone-black, Muriate of potash,	320 640 320	406¾	39½	135.58	13.17	77.28	1.34
11	Land plaster,	320	174¼	35¼	58.08	11.75	3.47	—.17
12	Nothing,	—	152¾	36	50.92	12.		
13	Barn-yard manure,	*5	388½	55¼	129.50	18.42	72.30	6.17
14	Lime,	320	187	55¼	62.33	18.42	—1.14	5.92
15	Nothing,	—	209¼	38¼	69.75	12.75		

*Cords.

Average of the nothing plots: large, 63.9 bushels; small, 12.3 bushels.

The acre used in this experiment is the same as was used for a similar experiment with corn in 1890, when the average of the nothing plots was at the rate of 65.8 bushels of shelled corn per acre. The field is nearly level, the soil a good sandy loam, with loamy subsoil changing to sand at two and one-half to three feet, except in one corner where it is rather heavier. It is naturally even in quality throughout, as indicated by the yield of the nothing plots except at the corner above alluded to, which apparently affects unfavorably one end of plots 11, 12, 13, 14 and 15. Plot 15, however, gives practically as good a crop as any of the nothings this year.

In this experiment double the usual amount of fertilizer was applied, viz.; at the following rates per acre: nitrate of soda, 320 pounds; dissolved bone-black, 640 pounds; muriate of potash, 320 pounds; lime, 320 pounds; and plaster, 320 pounds. This departure from the usual practice was in deference in part to the wishes of the experimenter who, being a good farmer, hated to see a small crop on his land. Personally, I considered that it would be of interest to note whether the use of increased amounts of fertilizers would result in greater effects upon the crop, while the indications of the results as to the special requirements of the soil would be the same. In view of the increase over the nothing plots obtained by the use of the ordinary amounts of fertilizers in other experiments, it may be doubted whether the extra fertilizer in this experiment was of any great benefit. In our other experiments in 1891, the "complete" fertilizer used in the usual amounts caused increases in crop as follows: Marblehead, 56.4 bushels; Shelburne, 54 bushels; Hadley, 99 bushels; and Amherst, 64.7 bushels. In Concord with double amount the increase was 78.6 bushels.

The variety of potato selected was Early Beauty of Hebron; the seed was cut to one or two good eyes and planted April 20th, in drills $3\frac{1}{2}$ feet apart, the pieces 18 inches apart in the drills. The experiment was well carried out in every respect; the work of cultivation being performed almost entirely by horse power. The crop was dug on September 5th, and was all sorted and weighed by the same person.

Summary of Weather Observations, May 1 to July 22, 1891.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Monthly Means of.			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
May	66.37	40.	26.37	87	11th	23	6th	48	26th	64	1.66
June	79.52	49.67	29.85	98	16th	31	5th	48	10th	67	3.33
July	83.18	53.14	30.04	94	13th	44	12th	44	12th	50	1.32
Season*	75.57	46.88	28.59	98	June 16th	23	May 6	48	May 26 J'ne 10	75	6.31

*83 days.

These observations ended rather earlier than intended on account of the breakage of one of the thermometers; but the growth of the crop had been then nearly completed and the observations were not resumed. This table shows an unusually light rainfall both in May and July and this must have somewhat lessened the crop. The vines were also injured by frosts in May which entirely destroyed some plants and injured all more or less.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	64.09
Phosphoric acid,	.29
Potassium oxide,	.395
Nitrogen,	.44
Insoluble matter,	20.01

The manure used in this experiment weighed 1350 pounds and therefore supplied at the rate of nitrogen, 118.8 pounds; phosphoric acid, 73.3 pounds; and potash, 106.7 pounds per acre.

It produced a total increase in crop at the rate of 78.5 bushels per acre. "Complete" fertilizer supplying nitrogen, 48 pounds; phosphoric acid, 96 pounds, and potash, 160 pounds, produced an increase of 78.6 bushels, a considerably larger proportion of which were merchantable. It is evident from a comparison of the above figures that the fertilizer must have left in the soil a much larger residue of potash and phosphoric acid than the manure, while the latter has undoubtedly left some organic nitrogen behind.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Large, bushels per acre,	.67	7.21	13.04	18.59	9.88
Small, " "	1.88	.17	—.30	.09	.46

Value of average net increment, $5.01.

Financial result, 2.99 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Large, bushels per acre,	—7.50	—.96	32.30	37.85	15.42
Small, " "	—.30	—2.01	1.18	1.57	.11

Value of average net increment, $7.73.

Financial result, 1.87 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Large, bushels per acre,	26.39	38.76	66.19	77.57	52.23
Small, " "	.07	—2.11	1.55	1.47	.25

Value of average net increment, $26.15

Financial result, 19.75 gain.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barn-yard manure.	Land plaster.	Lime.
Large, bushels per acre,	77.28	72.30	3.47	—1.14
Small, " "	1.34	6.17	—.17	5.92

	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$38.84	$37.08	$1.71	$0.32
Financial result,	14.84 gain	12.92 loss	0.27 gain	1.60 loss

A study of these comparisons reveals the fact that this soil is becoming generally exhausted, but to a far greater extent of potash than of either of the other elements. Neither of these produces an increase sufficient to pay for itself either alone or in combination the one with the other; but each when used alone with potash produces a profitable increase in the crop. The fact that each produces its maximum effect when used with both the others shows that all were to some extent required. Potash appears to have been the element "in minimo". Even when used alone it produces a profitable increase; but its beneficial effect is greater with either of the other elements than alone, and greatest with both the others. *For potatoes on this soil a fertilizer similar to that recommended for Marblehead (p. 59) should give a profitable increase.*

It may be doubted, however, whether the materials used in these soil tests are those which are best suited for this crop. Sulphate of potash is admitted to be superior to the muriate, and it is not unlikely that the nitrogen should, in part at least, be supplied in a less soluble form. Neither lime nor plaster appears to have been especially beneficial.

SHELBURNE.

SOIL TEST WITH FERTILIZERS FOR POTATOES,

by G. F. Dole.

No. of Plot.	FERTILIZERS.		Yield per Plot, 1-20 Acre.		Yield per Acre.		Gain or Loss compared with Nothing Plots, per Acre.	
	KIND.	Pounds per Acre.	Large, Pounds.	Small, Pounds.	Large, Bushels.	Small, Bushels.	Large, Bushels.	Small, Bushels.
1	Nothing.		15	35	5.	11.67		
2	Nitrate of soda,	160	22	35	7.33	11.67	1.45	—.11
3	Dissolved bone-black,	320	91	50	30.33	16.67	23.56	4.78
4	Nothing,		23	36	7.67	12.		
5	Muriate of potash,	160	75	38	25.	12.67	15.75	.84
6	{ Nitrate of soda, { Dissolved bone black,	160 320	200	51	66.67	17.	55.83	5.33
7	{ Nitrate of soda, { Muriate of potash,	160 160	123	42	41.	14.	28.58	2.50
8	Nothing,		42	34	14.	11.33		
9	{ Dissolved bone-black, { Muriate of potash,	320 160	84	29	28.	9.67	12.83	—2.08
10	{ Nitrate of soda, { Dissolved bone-black, { Muriate of potash,	160 320 160	113	49	37.67	16.33	21.33	4.16
11	Land plaster,	160	59	41	19.67	13.67	2.17	1.09
12	Nothing,		56	39	18.67	13.		
13	Barn-yard manure,	*5	185	29	61.67	9.67	44.78	—2.77
14	Lime,	160	58	40	19.33	13.33	4.22	1.44
15	Nothing,		40	34	13.33	11.33		

*Cords.

Average of the nothing plots: large, 11.7 bushels; small, 11.9 bushels.

The acre used in this experiment is the same that was employed in similar experiments with corn in 1889 and 1890. In the first year the nothing plots gave an average yield of 29.2 bushels of shelled corn; in 1890 an average of 20.7 bushels; and this year the average yield is only 26.6 bushels of potatoes, more than one-half of which are below merchantable size.

The variety of potatoes selected was the Early Rose. They were planted May 14, two feet apart, in rows three and one-half feet apart, and dug September 1st. The experimenter wishing to increase his chance of a crop, and thinking it would not affect the results of the experiment, applied a special potato fertilizer to the rows separating plots. It is perhaps needless to say that he did this without consultation with station authorities, but inasmuch as such fertilizer may be supposed to have affected all plots equally if at all, it is thought best to publish the results. The lateness of planting, caused by illness, no doubt in part accounts for the poorness of the crop. Observations and measurements taken at different times throughout the growing season resulted in ranking the plots from an early date in the order in which the harvest showed them to stand.

SUMMARY OF WEATHER OBSERVATIONS, MAY 14 TO SEPT. 1, 1891.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Monthly Means of.			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
May	66.9	41.6	25.3	75	23rd	28	19th	35.5	29th	47	.17
June	74.	53.9	20.1	89	16th	34.5	5th	33	10th	53.5	2.92
July	74.3	54.5	19.8	86	13 & 14	43	27th	31	10th	43	5.30
August	75.2	56.5	18.7	86	11th	48	2nd	29	8th	38	3.45
Season*	73.3	52.8	20.5	89	June 16	28	May19	35.5	May19	61	11.84

*110 days.

The light rainfall in May and June is the most striking peculiarity brought out by these figures, and this feature of the season acting in conjunction with the low temperature several times occurring in May must have injured the crop somewhat, though less seriously than had the dry weather occurred later.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	79.28	per cent
Phosphoric acid,	.22	"
Potassium oxide,	.28	"
Nitrogen,	.35	"
Insoluble matter,	3.08	"

This manure weighed 31 pounds per cubic foot, and at the rate used would supply per acre nitrogen, 64.9 pounds; phosphoric acid 43.6 pounds and potash 55.6 pounds. It thus appears to have been a light and comparatively poor manure supplying considerably less potash and phosphoric acid, but more nitrogen than "complete" fertilizer.

In spite of this evident inferiority it apparently caused a larger increase in crop than the fertilizer.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Large, bushels per acre,	1.45	32.28	12.83	8.50	13.76
Small, " "	—.11	.53	1.66	6.24	2.08

Value of average net increment, $7.19.
Financial result, 3.19 gain.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Large, bushels per acre,	23.56	54.39	—2.92	—7.25	16.94
Small. " "	4.78	5.44	—2.92	1.66	2.24

Value of average net increment, $8.81.
Financial result, 4.01 gain.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Large, bushels per acre,	15.75	27.13	—10.73	—34.50	— .59
Small, " "	.84	2.61	—6.86	—1.17	—1.15

Value of average net decrease, $0.46.
Financial result, 3.66 loss.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barn yard manure.	Land Plaster.	Lime.
Large, bushels per acre,	21.33	44.78	2.17	4.22
Small, " "	4.16	—2.77	1.09	1.44
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$11.29	$21.97	$1.25	$2.33
Financial result,	0.71 loss	3.03 loss	0.53 gain	1.37 gain

These comparisons make it evident that the results of this experiment are worthless in so far as the indication of the plant food requirements of the crop is concerned. Plot six gave a much better crop than any other receiving fertilizer. There appears no sufficient reason why this should have been so. This peculiarity makes it appear that either nitrogen or phosphoric acid used with the other alone, produced a larger increase in crop than when used with the other and potash. When it is noted that potash under some conditions has given an increase, this becomes the more strange; and we are driven to conclude that the variations in crop on these plots have been largely caused by accidental variations in conditions beyond our control. Last year this soil responded most freely to phosphoric acid. The same appears to be the teaching of the experiment of this year, although nitrate of soda is not far behind the dissolved boneblack in its apparent beneficial effect. Neither lime nor plaster produced effects sufficiently great to indicate any important benefit from their use, although both appear to have paid for themselves.

HADLEY.

SOIL TEST WITH FERTILIZERS FOR POTATOES,

by L. W. West.

No. of Plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per Acre.	Yield per Plot, 1-20 Acre. Large, Pounds.	Yield per Plot, 1-20 Acre. Small, Pounds.	Yield per Acre. Large, Bushels.	Yield per Acre. Small, Bushels.	Gain or Loss compared with Nothing Plots per Acre. Large, Bushels.	Gain or Loss compared with Nothing Plots per Acre. Small, Bushels.
1	Nothing,		191	58	63.67	19.33		
2	Nitrate of soda,	160	279	31	93.	10.33	29.44	—9.22
3	Dissolved bone-black,	320	244	51	81.33	17.	17.89	—2.78
4	Nothing,		190	60	63.33	20.		
5	Muriate of potash,	160	461	25	153.67	8.33	84.17	—9.
6	{ Nitrate of soda, { Dissolved bone-black,	160 320	311	31	103.67	10.33	28.	—4.33
7	{ Nitrate of soda, { Muriate of potash,	160 160	620	35	206.67	11.67	124.84	—.33
8	Nothing,		264	28	88.	9.33		
9	{ Dissolved bone-black, { Muriate of potash,	320 160	577	33	192.33	11.	102.50	.34
10	{ Nitrate of soda, { Dissolved bone-black, { Muriate of potash,	160 320 160	567	41	189.	13.67	97.33	1.67
11	Land plaster,	160	239	26	79.67	8.67	—13.83	—4.66
12	Nothing,		286	44	95.33	14.67		
13	Barn-yard manure,	*5	513	24	171.	8.	77.67	—6.67
14	Lime,	160	265	26	88.33	8.67	—3.	—6.00
15	Nothing,		268	44	89.33	14.67		

*Cords.

Average of the nothing plots: large, 79.9 bushels; small, 15.6 bushels per acre.

The land used in this experiment was newly broken sod, similar to that employed in the soil tests with fertilizers on the same farm in 1889 and 1890. The soil is of alluvial origin, a moderately heavy loam, with a clay sub-soil. The yield of the different nothing plots shows it to have been of tolerably even quality throughout the field, although best in the vicinity of the plots occupied by "complete" fertilizer, barn-yard manure, lime and plaster. Since the increase on these plots is obtained by comparison with the two nearest nothings in each case, it is not thought that this leads to any unfairness in the deductions made from the results.

The potatoes (Beauty of Hebron) were planted April 13th and dug Sept. 9th. The experiment was well conducted throughout, although unavoidable causes led to planting plots ten to fifteen inclusive, three or four days later than the others. The superiority of the plots which had received potash was evident from an early stage in the growth of the crop.

Summary of Weather Observations, April 13 to Oct. 10, 1891.

Month.	Temperature in open air in Degrees Fahrenheit. Means of Daily. Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest Daily Range. Deg.	Date.	Monthly Range.	Rainfall, Inches.
April	63.8	37.3	26.5	81	28th	25	13th	35	24th	56	1.49
May	70.8	42.3	28.5	90	11th	25	6 & 7	46	10th	65	2.68
June	79.	52.7	26.3	96	17th	37	5th	40	9th	59	4.82
July	79.6	55.3	24.3	91	14 & 15	43	28th	36	18th	63	5.43
August	81.7	58.5	23.2	93	12th	44	16th	35	16th	49	4.91
Sept.	78.1	51.8	26.3	96	22d	38	9th	39	21&22	58	2.70
Oct.	72.8	44.6	28.2	88	5th	33	10th	38	6th	55	.76
Season*	76.1	50.1	26.	96	June 17 Sept. 22	25	Apr. 18 May 6, 7	46	May 10	71	22.79

*182 days.

The light rain-fall of April and May is the chief peculiarity brought out by these figures. This, combined with the frosts during the latter month, had an unfavorable influence upon the crop.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	58.18	per cent
Phosphoric acid,	.51	"
Potassium oxide,	.85	"
Nitrogen,	.87	"
Insoluble matter,	9.85	"

This manure weighed 52 pounds per cubic foot; and at the rate used supplied therefore, per acre: nitrogen, 289.5 pounds; phosphoric acid 169.7 pounds; and potash, 282.8 pounds. It was described as "fat cattle" manure, and it is the richest among all the samples of manures, which have been used in these experiments that have been analyzed. It apparently produced less increase in crop than "complete" fertilizer, which supplied only about one-twelfth as much nitrogen, one-third as much phosphoric acid, and two-sevenths as much potash. Experiments will be continued upon this acre, and the future effects of this large surplus of food applied in the manure will be looked for with interest.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Large, bushels per acre,	29.44	10.11	40.67	—5.17	18.76
Small, " "	—9.22	—1.55	8.67	1.33	-.19

Value of net average increment, $9.35.

Financial result, 5.35 gain.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Large, bushels per acre,	17.89	—1.44	18.33	—27.51	1.82
Small, " "	—2.78	4.89	9.34	2.00	3.36

Value of net average increment, $1.41.
Financial result, 3.39 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Large, bushels per acre,	84.17	95.40	84.61	69.33	83.38
Small, " "	—9.00	8.89	3.12	6.00	2.25

Value of net average increment, $42.03.
Financial result, 38.83 gain.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barn-yard manure.	Land Plaster.	Lime.
Large, bushels per acre,	97.33	77.67	—13.83	—3.00
Small, " "	1.67	—6.67	—4.66	—6.00
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$48.92	$37.84		
Value of decrease due to			$7.62	$2.40
Financial result,	36.92 gain	12.84 gain	8.34 loss	3.36 loss

The teaching of the results of these comparisons is perhaps somewhat less obvious than it would have been, had plot 10 been planted at the same time as plots 1 to 9. There appears no other sufficient reason why 10 should have given a poorer crop than 9, since nitrate of soda which was added to the fertilizer used on 9, in other cases proved quite beneficial. Still the teaching of the results of the experiment, as a whole, is clear. This soil stands in greater need of potash for potatoes than of either of the other ingredients of the fertilizers used. It is significant that the requirements of corn on similar soil, as shown by the experiments of 1889 and 1890 were the same. In view of the confirmatory results of the experiments of three successive years upon it, a very marked deficiency of potash in this soil cannot reasonably be doubted.

Neither lime nor plaster benefited the crop of potatoes of this year; and the same was true of the influence of these substances upon the corn crops of the two preceding years.

For this soil, a potato fertilizer should have about the same composition as recommended for Marblehead (p. 56.)

AMHERST.

SOIL TEST WITH FERTILIZERS FOR POTATOES,

Station Grounds (North Acre).

No. of Plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per Acre.	Yield per Plot. 1-20 Acre. Large, Pounds.	Yield per Plot. 1-20 Acre. Small, Pounds.	Yield per Acre. Large, Bushels.	Yield per Acre. Small, Bushels.	Gain or Loss compared with Nothing Plots per Acre. Large, Bushels.	Gain or Loss compared with Nothing Plots per Acre. Small, Bushels.
1	Nothing,		77	13	25.67	4.33		
2	Nitrate of soda,	160	79	14	26.33	4.67	3.44	—.11
3	Dissolved bone-black,	320	107	17	35.67	5.67	15.56	.45
4	Nothing,		52	17	17.33	5.67		
5	Muriate of potash,	160	190	12	63.33	4.	46.16	—.92
6	{ Nitrate of soda, Dissolved bone-black,	160 320	97	19	32.33	6.33	15.33	2.16
7	{ Nitrate of soda, Muriate of potash,	160 160	184	15	61.33	5.	44.50	1.58
8	Nothing,		50	8	16.67	2.67		
9	{ Dissolved bone-black, Muriate of potash,	320 160	148	10	49.33	3.33	33.91	—.17
10	{ Nitrate of soda, Dissolved bone-black, Muriate of potash,	160 320 160	175	19	58.33	6.33	44.16	1.99
11	Land plaster,	160	47	20	15.67	6.67	2.75	1.50
12	Nothing,		35	18	11.67	6.		
13	Barn-yard manure,	*5	455	19	151.67	6.33	132.33	.77
14	Lime,	160	86	16	28.67	5.33	1.67	.22
15	Nothing,		104	14	34.67	4.67		

*Cords.

Average of the nothing plots: large, 21.2 bushels; small, 4.7 bushels per acre.

This experiment was tried upon the north acre which served for a soil test with corn in 1890. The soil is a warm medium loam, with gravel at the depth of two to three feet. Previous to last year it had been several years in pasture without manure.

The seed was cut to two good eyes, and the pieces were planted twenty inches apart in rows which were three and one-half feet apart. The variety was the Beauty of Hebron and the seed was raised in Aroostook county, Maine. It was planted April 21st. and the crop was harvested Sept. 12th. The seed had been cut ready for planting about two weeks earlier; but a heavy fall of snow, April 5th, delayed the work. The result was that the seed sprouted unevenly and considerable of it failed to make plants strong enough to live. There were accordingly many vacant spaces in all the plots; but as these were about equally divided among the plots, no attempt at correction for missing plants has been made. The crop was also somewhat injured by frost.

The superiority of the plots where potash had been used became apparent early in the season.

Results of Measurements, 1891.

No. of Plot.	FERTILIZERS USED.	Average Measurements. June 16.	July 16.	Aug. 20.
1	Nothing,	7.4	11.1	14.3
2	Nitrate of soda,	7.7	12.3	15.8
3	Dissolved bone-black,	7.6	11.5	14.4
4	Nothing,	7.7	11.1	15.2
5	Muriate of potash,	8.9	13.9	21.6
6	Nitrate and bone-black,	9.4	13.0	17.6
7	Nitrate and potash,	8.5	12.2	20.6
8	Nothing,	6.4	10.6	15.3
9	Bone-black and potash,	7.5	11.9	20.5
10	Nitrate, bone-black and potash,	10.8	14.8	22.1
11	Land plaster,	8.2	11.0	15.5
12	Nothing,	7.2	9.9	15.6
13	Barn-yard manure,	13.1	17.9	29.8
14	Lime,	8.4	10.8	15.6
15	Nothing,	9.1	12.4	16.3

These measurements afford no evidence that the beneficial effect of the nitrate of soda was any less toward the close than at the beginning of the season of growth.

Summary of Weather Observations, April 17 to Sept. 30, 1891.

Month.	Temperature in Open Air in Degrees Fahrenheit. Monthly Means of. Max.	Min.	Range.	Highest. Deg.	Date.	Lowest. Deg.	Date.	Greatest Daily Range. Deg.	Date.	Monthly Range.	Rainfall, inches.
April	66.64	39.80	26.84	77	30th	26	26th	42	30th	51	.15
May	67.53	42.53	25.00	86	10th	25	6th	49	10th	61	1.82
June	77.62	53.02	24.60	93	16th	34.5	5th	43.5	8th	58.5	4.61
July	76.66	55.08	21.58	89	13th	42	28th	35	10 & 17	47	5.09
Aug.	78.77	58.89	19.88	90	11th	46	1st	31	31st	44	3.67
Sept.	74.80	53.88	20.92	89	18th	37	9th	34	10 & 20	52	2.22
Season. 167 days.	74.36	51.59	22.77	93	June 16	25	May 6	49	May 10	68	17.56

These figures bring out two prominent facts: the dryness of the spring, and the low temperature experienced during April and May. The retarding effect upon growth was serious.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	75.75 per cent.
Phosphoric acid,	.32 " "
Potassium oxide,	.57 " "
Nitrogen,	.47 " "
Insoluble matter,	1.37 " "

The amount applied (32 cu. ft.) to plot 13, weighed 1400 pounds, and at this rate per acre it would furnish: nitrogen. 131.6 pounds; phosphoric acid, 89.6 pounds; and potash, 159.6 pounds.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic. acid.	Muriate of potash.	Phos.acid and potash.	Average result.
Large, bushels per acre,	3.44	—.23	—1.66	10.25	2.95
Small, " "	—.11	1.71	2.50	2.16	1.56

Value of net average increment, $1.71
Financial result, 2.29 loss.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Large, bushels per acre,	15.56	11.89	—12.25	—.34	3.71
Small, " "	.45	2.27	.75	.41	.97

Value of net average increment, $2.00
Financial result, 2.80 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and phos. acid.	Average result.
Large, bushels per acre,	46.16	41.06	18.35	28.83	33.60
Small, " "	—.92	1.69	—.62	—.17	—.005

Value of net average increment, $16.80
Financial result, 13.60 gain.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barn-yard manure.	Land plaster.	Lime.
Large, bushels per acre,	44.16	132.33	2.75	1.67
Small, " "	1.99	.77	1.50	.22
	Fertilizer.	Manure.	Plaster.	Lime.
Value of net average increment due to	$22.38	$66.28	$1.60	$0.87
Financial result,	10.38 gain	41.28 gain	0.88 gain	0.09 loss

These comparisons make evident the fact that for potatoes, as for corn last year, potash should be a prominent ingredient of the fertilizer used. Neither nitrogen nor phosphoric acid gave results of any great importance, while potash alone, and in every combination, produced a profitable increase.

In this experiment, contrary to the general result, the manure gave a much better crop than "complete" fertilizer. This may have been, in part, due to its superior quality, but it is believed that the superiority was chiefly due to the greater degree of moisture in the soil of this plot as compared with the others which received fertilizers. This larger water supply may have been, in part, due to the physical effect of the manure, but it was, undoubtedly, in part also a natural difference due to location. Neither lime nor plaster produced results of any significance.

On this soil the fertilizer recommended on page 56 should prove well adapted for the potato.

GENERAL SUMMARY.

For convenience of comparison the figures showing the average effects of the several ingredients of the fertilizers used are brought together.

These figures together with others showing the grand average effect apparently due to each of the three ingredients are shown in the table below.

AVERAGE EFFECTS OF THE INGREDIENTS OF THE FERTILIZER UPON THE POTATO CROP.

	NITROGEN, Bushels per Acre.		PHOSPHORIC ACID, Bushels per Acre.		POTASH, Bushels per Acre.	
	Large.	Small.	Large.	Small.	Large.	Small.
Marblehead,	8.37	—1.69	12.68	—.89	39.04	—4.16
Concord,	9.88	.46	15.42	.11	52.23	.25
Shelburne,	13.76	2.08	16.94	2.24	—.59	—1.15
Hadley,	18.76	—.19	1.82	3.36	83.38	2.25
Amherst,	2.95	1.56	3.71	.97	33.60	.05
Grand Average Increase for all Experiments.	10.74	.44	10.11	1.16	41.55	.57

It will be observed that the potash of the fertilizers in every experiment, save one, (Shelburne) proved much more beneficial in its average effect upon the crop than either nitrogen or phosphoric acid and the indication is, therefore, that it should be relatively more abundant in fertilizers especially designed for this crop than is usually the case. The twelve special potato fertilizers, the analyses of which are given in the Eighth Annual Report of the State Experiment Station contain, on the average: nitrogen, 3.4; phosphoric acid, 10.69; and potash, 6.36 per cent. With one exception, they do not differ widely from each other in the proportions of these constituents. That one contains about the same proportion of nitrogen and phosphoric acid as the others, but has much more potash, viz. : 10.16 per cent.

The table below is of interest in considering the results of the use of "complete" fertilizer on plot 10 in our several potato experiments. This table is designed to make possible a comparison between the plant food removed by the crop and that applied.

PLANT FOOD IN POTATOES COMPARED WITH THAT APPLIED.

	Required by 100 bushels.			Applied in "Complete Fertilizer" per acre, lbs.
	Tubers, lbs.	Usual proportion of tops, lbs.	Total, lbs.	
Nitrogen,	12.4	4.9	17.3	25.3
Phosphoric acid,	4.	1.6	5.6	49.1
Potash,	17.6	4.3	21.9	8.06

The increase on "complete" fertilizer was at the following rates per acre, in the several experiments in bushels of 60 pounds: Marblehead, large, 62.67; small, 6.33: Concord (with double the amount of fertilizer) large, 77.28; small, 1.34: Shelburne, large, 21.33; small, 4.16: Hadley, large, 97.33; small, 1.67: Amherst, large, 44.16; small; 1.99. The average increase was at the rate of 60.6 bushels of merchantable potatoes and .6 bushels of unmerchantable potatoes per acre.

The above table shows that we applied much more nitrogen, phosphoric acid and potash than is contained in one hundred bushels of potatoes and the normal amount of tops for a crop of that size; viz. about one and a half times the nitrogen, nine times the phosphoric acid and four times the potash. (In Concord we applied double these amounts). All of these elements were applied also in soluble forms, and yet we approach an increase of even 100 bushels in but one of these experiments, while the average is only 61 bushels. The poverty of the results in comparison with the application of plant food suggests that there is something wrong. We cannot, it is true, expect to recover in our crops all the plant food we apply to the soil, but we should certainly expect to do better than we have done in these experiments. I am not prepared, however, to say how this can be done, even if it be possible. For the present, I can only suggest either that the forms in which some or all of the various elements are supplied are unsuited to the potato crop, or that the method of application (broadcast) is not the best. That the latter is the case I cannot believe. I have already suggested that the potash required by this crop should, in accordance with the general practice, be offered in the form of sulphate rather than chloride, although it is usually held that this is more important in its relation to quality than to quantity. The chloride (muriate) may give as large a crop; but it will be of inferior quality.

The increase in bushels per acre, caused by the use of five cords of manure in the several experiments is as follows:—Hadley, large, 68.8, small, 9; Concord, large, 72.3, small, 6.2; Shelburne, large, 44.8; small, –2.8; Hadley, large, 77.7, small, –6.7; Amherst, large, 132.3, small, .8. The average increase in large potatoes is 79.2 bushels; the average net decrease in small potatoes is 2.3 bushels. The average net increase then is 77 bushels, against 61.2 bushels for the "complete" fertilizer.

Viewed from the standpoint either of profit or recovery of plant food applied to the soil, these results are even less satisfactory than those with "complete" fertilizer.

WORCESTER.

SOIL-TEST WITH FERTILIZERS FOR OATS,

by Pliny Moore.

No. of Plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per Acre.	Yield per Plot, 1-20 Acre. Total, lbs.	Yield per Plot, 1-20 Acre. Straw, lbs.	Yield per Plot, 1-20 Acre. Grain and Chaff, lbs.	Yield per Plot, 1-20 Acre. Grain, lbs.	Yield per Acre. Straw, lbs.	Yield per Acre. Grain, Bushels.	Gain or Loss compar'd with Nothing Plots, per Acre. Straw, Pounds.	Gain or Loss compar'd with Nothing Plots, per Acre. Grain, Bushels.
1	Nothing,		102	62.5	47	39.5	1250	24.69		
2	Nitrate of soda,	160	180	140.	47	40	2800	25.	1413	3.33
3	Dissolved bone-black,	320	118	76.	50	42	1520	26.25	—3	7.61
4	Nothing,		108	83.	36	25	1660	15.62		
5	Muriate of potash,	160	137	111.	35	26	2220	16.25	520	.08
6	Nitrate of soda, Dissolved bone-bl'k,	160 320	218.5	157.5	72	61	3150	38.13	1410	21.41
7	Nitrate of soda, Muriate of potash,	160 160	208.5	181.5	49	27	3630	16.88	1850	—.36
8	Nothing,		119.5	91.	34	28.5	1820	17.81		
9	Dissolved bone-bl'k, Muriate of potash,	320 160	131.	97.	42	34	1940	21.25	125	3.05
10	Nitrate of soda, Dissolved bone-bl'k, Muriate of potash,	160 320 160	204.	161.	56	43	3220	26.88	1410	8.29
11	Land plaster,	160	108.	80.5	35	27.5	1610	17.19	—195	—1.80
12	Nothing,		121.	90.	40	31	1800	19.38		
13	Barn-yard manure,	*5	238.5	186.5	61	52	3730	32.50	1827	13.95
14	Lime,	160	106.	82.	27	24	1640	15.	—367	—2.71
15	Nothing,		132.5	105.5	34	27	2110	16.88		

*Cords.

Average of the nothing plots: straw, 1728 pounds; grain, 18.9 bushels per acre.

The acre used in this experiment is one which has been used in a similar soil test with fertilizers for corn for the two years preceding the last. It is an elevated tract of land, and the soil which is of glacial origin, is a medium gravelly loam. When first taken up for experiment, the soil in different parts of the field differed considerably in fertility. This difference has now nearly disappeared, and if we except plot number 1, the yield of grain on which is large as compared with the straw, the nothing plots are nearly alike.

The variety of oats sown was the common white, and two and one-half bushels per acre were put in broadcast on May 12th. Mixed grass and clover seeds were sown at the same time. The crop was cut early in August and threshed August 14th.

SUMMARY OF WEATHER OBSERVATIONS, MAY 23 TO AUGUST 15, 1891.

Month.	Temperature in open air in Degrees Fahrenheit.									Monthly Range.	Rainfall, Inches.
	Monthly Means of.			Highest.		Lowest.		Greatest Daily Range.			
	Max.	Min.	Range.	Deg.	Date.	Deg.	Date.	Deg.	Date.		
May	68.8	45.2	23.6	76	23 & 26	39	24th	34	23rd	37	.52
June	74.9	53.4	21.5	92	17th	40	5th	35	27th	52	3.29
July	76.7	55.9	20.8	87	14 & 15	47	28th	30	12th	40	2.71
August	79.7	58.3	21.4	91	12th	46	1st	30	13th	45	1.30
Season*	75.7	54.3	21.4	92	J'ne17	39	May24	35	May27	53	7.85

*84 days.

The season was unusually dry, and the yield was undoubtedly diminished from this cause.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	69.79 per cent
Phosphoric acid,	.102 "
Potassium oxide,	.132 "
Nitrogen,	.206 "
Insoluble matter,	23.82 "

This manure weighed 50½ pounds per cubic foot and at the rate used, therefore, would supply per acre: nitrogen, 66.6 pounds; phosphoric acid, 33 pounds; and potash, 42.7 pounds. This application furnishes rather more than twice the nitrogen and about one-half the phosphoric acid and potash furnished by the "complete" fertilizer, and it produces a better crop than the fertilizer.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Oats, bushels per acre,	3.33	13.80	—.44	5.24	5.48
Straw, pounds "	1413	1413	1330	1285	1360

Value of net average increment, $8.18.
Financial result, 4.18 gain.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Oats, bushels per acre,	7.61	18.08	2.97	8.65	9.33
Straw, pounds "	—3	—3	—395	—440	—210

Value of net average increment, $3.83.
Financial result, 0.97 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Oats, bushels per acre,	.08	—3.69	—4.56	—13.12	—5.32
Straw, pounds, "	520	437	128	0	271

Value of net average decrease, $1.58.
Financial result, 4.78 loss.

RESULTS OF THE ADDITION TO NOTHING OF

	Complete fertilizer.	Barn-yard manure.	Land Plaster.	Lime.
Oats, bushels per acre,	8.29	13.95	—1.80	—2.71
Straw, pounds "	1410	1827	—195	—367

	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$9.79	$14.28		
Value of decrease due to			$1.68	$2.82
Financial result,	2.21 loss	10.72 loss	2.40 loss	3.78 loss

These comparisons indicate that the nitrogen of the fertilizers used was the most important element for this crop. The results are to a certain degree, however, perplexing. It is difficult to understand why the addition of nitrogen to muriate of potash, or to muriate of potash and phosphoric acid should not produce even greater benefit than its use in other plots. That the nitrate of soda should prove especially beneficial to spring grain is, however, in strict accordance with the results obtained by European and American experimenters generally, and affords a striking illustration of the often observed fact that the manurial requirements of crops cannot be determined by a study of the composition of their ash. There is a close general resemblance in ash composition between oat straw and oats on the one hand, and corn stover and corn on the other; and yet the manurial requirements of the two crops on the same soil would appear to be widely different.

Oats in common with other crops which make the chief part of their growth early in the season, derive great benefit from a spring application of nitrogen in available form. Corn, on the other hand, growing most rapidly during July and August, appears to be able to derive most of its nitrogen from the soil, probably from the products of the decay and nitrification of the nitrogenous organic matter of the soil.

The acre which was used for this experiment was used in 1889 and 1890 in a soil-test of a similar kind with fertilizers for corn, and previous to that time had been several years in grass without manure. In both years, the results of the experiment with corn indicated much the greatest benefit from potash.

AMHERST.

SOIL-TEST WITH FERTILIZERS FOR OATS.

Station Grounds (South Acre).

No. of Plot.	FERTILIZERS. KIND.	FERTILIZERS. Pounds per Acre.	Yield per Plot, 1-20 Acre. Total, lbs.	Yield per Plot, 1-20 Acre. Straw, lbs.	Yield per Plot, 1-20 Acre. Grain and Chaff, lbs.	Yield per Plot, 1-20 Acre. Grain, lbs.	Yield per Acre. Straw, lbs.	Yield per Acre. Grain, Bushels.	Gain or Loss compar'd with Nothing Plots, per Acre. Straw, lbs.	Gain or Loss compar'd with Nothing Plots, per Acre. Grain, Bushels.
1	Nitrate of soda,	160	171.5	118.5	59.5	53.	2370	33.13	950	15.
2	Dissolved bone-black,	320	100.	71.	32.5	29.	1420	18.13		
3	Nothing,		100.	71.	32.5	29.	1420	18.13		
4	Muriate of potash,	160	120.	81.5	44.5	38.5	1630	24.06	267	5.20
5	Lime,	160	100.	60.5	44.	39.5	1210	24.69	—97.	5.11
6	Nothing,		95.	62.5	40.	32.5	1250	20.31		
7	Barn-yard manure,	*5	287.	225.5	68.	61.5	4510	38.44	3260	18.13
8	Nitrate of soda, Dissolved bone-black	160 320	150.	103.5	53.5	46.5	2070	29.06	940	12.50
9	Nothing,		83.	56.5	33.	26.5	1130	16.56		
10	Nitrate of soda, Muriate of potash,	160 160	157.	109.5	51.5	47.5	2190	29.69	1030	12.82
11	Muriate of potash, Dissolved bone-black	160 320	120.	78.5	44.5	41.5	1570	25.94	380	8.75
12	Nothing,		89.	61.	34.5	28.	1220	17.50		
13	Land plaster,	160	83.	57.5	30.	25.5	1150	15.94	—70.	—1.56
14	Nitrate of soda, Dissolved bone-black Muriate of potash,	160 320 160	200.	147.	56.5	53.	2940	33.13	1720	15.63

*Cords.

Average of the nothing plots : straw, 1255 pounds ; grain, 18.1 bushels per acre.

The variety of oats planted was the Early Race Horse, and the seed was sown with the Missouri grain drill on April 17th, seventy-two quarts being used on the acre. With the oats were sown mixed grass and clover seeds ; viz. : Timothy, 12 pounds ; red-top, 8 pounds ; red clover, 6 pounds ; white clover, 2 pounds ; and alsyke clover, 3 pounds. The oats were cut, July 21st, bound and stooked on the 22d, and threshed on the 27th.

RESULTS OF MEASUREMENTS, 1891.

No. of Plot.	FERTILIZERS USED.	Average Measurements.		
		June 16.	June 25.	July 14.
1	Nitrate of soda,	24.7	33.9	41.2
2	Dissolved bone-black,	19.0	26.5	35.0
3	Nothing,	15.8	25.5	33.0
4	Muriate of potash,	21.5	27.2	36.6
5	Lime,	18.0	23.9	35.1
6	Nothing,	18.4	25.2	35.0
7	Barn-yard manure,	39.3	46.4	56.8
8	Nitrate and bone-black,	30.9	37.7	43.4
9	Nothing,	19.1	26.6	33.7
10	Nitrate of soda and muriate of potash,	23.0	34.9	42.7
11	Muriate of potash and bone-black,	21.2	29.6	39.8
12	Nothing,	18.4	25.0	33.1
13	Land plaster,	17.7	24.4	32.7
14	Nitrate, bone-black and potash,	37.4	39.6	52.2

The superiority of the plots which received nitrate of soda, it will be observed, manifested itself very early in the season, and was well sustained throughout the period of growth.

ANALYSIS OF MANURE USED.

Moisture at 100° C.,	74.54	per cent
Phosphoric acid,	.416	"
Potassium oxide,	.548	"
Nitrogen,	.495	"
Insoluble matter,	1.13	"

The manure applied to plot 7 weighed 1110 pounds, and at this rate per acre it would supply: nitrogen, 110 pounds; phosphoric acid, 92.4 pounds, and potash, 121.7 pounds. The grain on the plot where this manure was used lodged badly in two or three spots of considerable size.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Oats, bushels per acre,	15.00	12.50	7.62	6.88	10.50
Straw, pounds "	950	940	763	1340	998

Value of average net increment, $9.24.

Financial result, 5.24 gain.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Oats, bushels per acre,	0.	—2.50	3.55	2.81	.96
Straw, pounds "	0.	—10.	113	690	198

Value of average net increment, $1.27
Financial result, 3.53 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and phos. acid.	Average result.
Oats, bushels per acre,	5.20	—2.18	8.75	3.13	3.73
Straw, pounds "	267	80	380	780	377

Value of average net increment, $3.38.
Financial result, 0.18 gain.

RESULTS OF THE ADDITION TO NOTHING OF

	"Complete" fertilizer.	Barn-yard manure.	Land plaster.	Lime.
Oats, bushels per acre,	15.63	18.14	—1.56	5.11
Straw, pounds "	1720	3260	—70.	—97.
	Fertilizer.	Manure.	Plaster.	Lime.
Value of increment due to	$14.70	$22.11		$2.17
Value of decrease due to			$1.06	
Financial result,	2.70 gain	2.89 loss	1.78 loss	1.21 gain

It will be noticed from a study of these comparisons that the results of the use of nitrate of soda in this experiment are precisely similar to those obtained in Worcester (p. 76). It proves more useful than either phosphoric acid or potash; and, as in Worcester, gives less increase when used either with muriate of potash alone or with muriate of potash and phosphoric acid than on the other plots.

Our experiments with oats then, although limited in number, strongly indicate the advisability of applying a small quantity of nitrate of soda for this crop.

The manure gives a larger crop than "complete" fertilizer; but it must be remembered that this land has received the same treatment for three years; and that during that time the plot to which manure has been applied has received about seven times as much nitrogen and much more phosphoric acid and potash than the plot which has been dressed with "complete" fertilizer.

Conclusions: It is not common in the practice of the farmers of this state to use either fertilizers or manure for the oat crop; but in view of the results of these experiments, it seems probable that the application of a light dressing of nitrate of soda would pay, except in cases where the soil is already very rich.

The potash applied. although not benefitting the crop of oats, has evidently had a very important influence in strengthening the catch of clover. Wherever the potash has been applied, there the clover is clearly much stronger than on any of the other plots, not even excepting that where manure has been used. When the importance of clover as a fodder crop and as a means of fixing the free nitrogen of the atmosphere is remembered, the wisdom of using potash as a top dressing when land is seeded with this crop is sufficiently evident.

WILBRAHAM.

SOIL TESTS WITH FERTILIZERS FOR CORN,

by F. E. Clark.

No. of Plot.	FERTILIZERS.		Yield per Plot, 1-20 Acre.		Yield per Acre.		Gain or Loss compared with Nothing Plots per Acre.	
	KIND.	Pounds per Acre.	Ears, Hard, lbs.	Stover, Pounds.	Shelled Corn, bu. Hard.	Stover, Pounds.	Shelled Corn, Bushels	Stover, Pounds.
1	Nothing,		128	123	34.13	2460		
2	Nitrate of soda,	160	137	133	36.53	2660	1.96	253
3	Dissolved bone-black.	320	130	108	34.66	2160	—.36	193
4	Nothing,		133	115	35.46	2300		
5	Muriate of potash.	160	153	160	40.80	3200	5.81	935
6	{ Nitrate of soda. { Dissolved bone-black.	160 320	153	125	40.80	2500	6.27	270
7	{ Nitrate of soda. { Muriate of potash,	160 160	228	220	60.80	4400	26.73	2205
8	Nothing,		126	108	33.60	2160		
9	{ Dissolved bone-black. { Muriate of potash,	320 160	197	186	52.53	3720	19.46	1560
10	{ Nitrate of soda, { Dissolved bone-black. { Muriate of potash.	160 320 160	238	206	63.47	4120	30.94	1960
11	Land plaster,	160	116	106	30.93	2120	—1.06	—40
12	Nothing,		118	108	31.46	2160		
13	Barn-yard manure,	5*	258	350	68.80	7000	35.74	4780
14	Lime,	160	132	112	35.20	2240	.54	—40
15	Nothing,		136	117	36.26	2340		

*Cords.

Average of the nothing plots: hard corn, 34.2 bushels; stover, 2284 pounds.

This experiment. voluntarily undertaken by Mr. Clark, was carried out on good corn land. (alluvial with a gravelly subsoil) which had been six years in grass (pasture) without manure. The soil, as indicated by the nearly equal yields of all the nothing plots, appears to have been of quite uniform quality throughout.

The manure used in this experiment was not sampled for analysis, neither were weather observations taken. In other respects, the experiment was conducted precisely as are those immediately under my control; and the work appears to have been very faithfully executed throughout. There was practically no soft corn in the field, and all was weighed together.

RESULTS OF MEASUREMEMTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements.	
		June 20th.	July 20th.
1	Nothing,	14.9	55.0
2	Nitrate of soda,	12.5	56.6
3	Dissolved bone-black,	13.4	54.4
4	Nothing,	14.5	53.4
5	Muriate of potash,	16.3	56.0
6	Nitrate and bone-black,	13.0	56.4
7	Nitrate and potash,	14.6	56.4
8	Nothing,	13.0	49.5
9	Bone-black and potash,	16.2	63.4
10	Nitrate, bone-black and potash,	16.4	62.9
11	Land plaster,	10.6	50.6
12	Nothing,	11.3	47.2
13	Barn-yard manure,	20.7	75.2
14	Lime,	12.2	54.0
15	Nothing,	11.6	49.2

These figures show that the potash plots early showed a superiority which the harvest proved them to have fully maintained.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Hard corn, bu. per A.,	1.96	6.63	20.92	11.48	10.25
Stover, lbs. per A.,	253	77	1270	400	500

Value of average net increment, $7.91.
Financial result, 3.91 gain.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Hard corn, bu. per A.,	—.36	4.31	13.65	4.21	5.45
Stover, lbs. per A.,	193	17	625	—245	148

Value of average net increment, $3.91.
Financial result, 0.89 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Hard corn, bu. per A.,	5.81	24.77	19.82	24.67	18.77
Stover, lbs. per A.,	935	1952	1367	1690	1486

Value of average net increment, $15.92.
Financial result, 12.72 gain.

RESULTS OF THE ADDITION TO NOTHING OF

	"Complete" fertilizer.	Barn-yard manure.	Land Plaster.	Lime.
Hard corn, bu. per A.,	30.94	35.74	—1.06	.54
Stover, lbs. per A.,	1960	4780	—40	—40
	Fertilizer.	Manure.	Plaster.	Lime.
Value of net increment due to	$25.01	$35.18		$0.25
Value of decrease due to			$0.79	
Financial result,	13.01 gain	10.18 gain	1.51 loss	0.71 loss

These comparisons indicate the surpassing importance of potash for corn upon this soil, thus confirming the general result of the work with corn during the two preceding years. In view of the almost universal response of corn to this fertilizer upon soils of so many different classes and of all degrees of fertility, and in so many widely separated localities, the conclusion that it should be a prominent ingredient of fertilizers used for this crop appears to me irresistible.

Nitrate of soda also, in this experiment, appears to have been much more than usually beneficial, and more than paid for itself wherever used in combination with potash.

A fertilizer supplying per acre: nitrogen, 25 to 30 pounds; potash, 75 to 80 pounds, and perhaps 25 pounds of phosphoric acid, should give profitable crops of corn on such a soil as this.

HADLEY.

SOIL TEST WITH FERTILIZERS FOR CORN,

by L. W. West.

No. of Plot.	FERTILIZERS. Kind.	FERTILIZERS. Pounds per Acre.	Yield per Plot, 1-20 Acre. Ears, Hard, lbs	Yield per Plot, 1-20 Acre. Stover, Pounds.	Yield per Acre. Shelled Corn, bu. Hard.	Yield per Acre. Stover, Pounds.	Gain or Loss compared with Nothing Plots, per Acre. Shelled Corn, Bushels. Hard.	Gain or Loss compared with Nothing Plots, per Acre. Stover. Pounds.
1	Nitrate of soda,	160	152	155	40.53	3100	21.06	1680
2	Dissolved bone-black,	320	114	131	30.40	2620	10.93	1200
3	Nothing,		73	71	19.47	1420		
4	Muriate of potash,	160	83	93	22.13	1860	2.33	330
5	Nitrate of soda, Dissolved bone-black,	160 320	147	125	39.20	2500	19.06	860
6	Nitrate of soda, Muriate of potash,	160 160	168	144	44.80	2880	24.33	1130
7	Nothing,		78	93	20.80	1860		
8	Muriate of potash, Dissolved bone-black,	160 320	60	129	16.00	2580	—4.80	720
9	Nitrate of soda, Dissolved bone-black, Muriate of potash,	160 320 160	125	218	33.33	4360	12.53	2500
10	Barn-yard manure,	*5	155	147	41.33	2940	20.53	1080

*Cords.

Average of the nothing plots: shelled corn, 20.1 bushels; stover, 1640 pounds.

The results of this experiment, voluntarily undertaken by Mr. West, have been placed at my disposal. It will be noticed that the plan followed is not exactly similar to that employed in our regular "soil tests," a smaller number of nothing plots being introduced and the lime and plaster being omitted. The experiment has, however, been carefully carried out and the results appear to be of interest as illustrating a rather unusual condition of soil.

The soil is described by Mr. West as a light, sandy one. The crop was planted in the usual manner, in rows three and one-half feet apart, on May 22d and 23d. The season was favorable to the crop and it was husked and weighed the last of October, being at that time in fine condition.

RESULTS OF MEASUREMENTS.

No. of Plot.	FERTILIZERS USED.	Average of Measurements. July 20.	July 31	Aug. 10.	Aug. 21.
1	Nitrate of soda,	49.0	60.7	83.7	90.7
2	Dissolved bone-black,	46.7	68.0	84.2	91.0
3	Nothing,	38.0	49.5	60.2	76.0
4	Muriate of potash,	38.5	52.7	71.2	83.0
5	Nitrate and bone-black,	47.3	70.5	82.3	85.0
6	Nitrate and potash,	48.5	66.5	83.7	92.8
7	Nothing,	43.3	52.9	64.0	74.2
8	Bone-black and potash,	51.0	60.8	85.0	90.2
9	Nitrate, bone-black and potash,	60.0	77.7	93.5	99.2
10	Barn-yard manure,	49.5	73.5	86.0	92.5

These figures show that the highly beneficial effect of the nitrate of soda, proved by the harvest, manifested itself early in the season and was well sustained until its close. Indeed, the plots which received this fertilizer continued, as a rule, to gain as compared with the nothing plots, throughout the season. July 20th, the corn on the four plots which had received nitrate of soda averaged 10.5 inches taller than that on the two nothing plots. On August 21st, the difference between the same sets of plots was 16.8 inches in favor of the plots which had received nitrate of soda. This result then does not indicate that there has been any great disadvantage in applying this fertilizer all at one time, just before planting the seed; and it should be remembered that this soil is a "light sandy" one, and that there was a full average amount of rain during June, July and August.

RESULTS OF THE ADDITION OF NITROGEN TO

	Nothing.	Phosph'ic acid.	Muriate of potash.	Phos. acid and potash.	Average result.
Hard corn, bu. per A.,	21.06	8.13	22.00	17.33	17.13
Stover, lbs. per A.,	1680	—340	800	1780	980

Value of net average increment, $13.58.

Financial result, 9.58 gain.

RESULTS OF THE ADDITION OF PHOSPHORIC ACID TO

	Nothing.	Nitrate of soda.	Muriate of potash.	Nitrate and potash.	Average result.
Hard corn, bu. per A.,	10.93	—2.00	—7.13	—11.80	—2.50
Stover, lbs. per A.,	1200	—820	390	1370	535

Value of net average decrease, $0.29.

Financial result, 5.09 loss.

RESULTS OF THE ADDITION OF POTASH TO

	Nothing.	Nitrate of soda.	Phosph'ic acid.	Nitrate and Phos. acid.	Average result.
Hard corn, bu. per A.,	2.33	3.27	—15.73	—6.53	—4.17
Stover, lbs. per A.,	330	—550	—480	1640	235

Value of net average decrease, $2.12.
Financial result, 5.32 loss.

RESULTS OF THE ADDITION TO NOTHING OF

	"Complete fertilizer."	Barn-yard manure.
Hard corn, bu. per A.,	12.53	20.53
Stover, lbs. per A.,	2500	1080
	Fertilizer.	Manure.
Value of increment due to	$14.39	$16.04
Financial result,	2.39 gain	8.96 loss

These comparisons show clearly that nitrate of soda was most beneficial on this soil. This result, contrary to that obtained in most of our experiments with corn, may perhaps have been due to the poverty of this soil in organic matter, the decay of which could furnish the nitrogen needed by the crop. That the potash usually so beneficial on soils of this class, should have failed to benefit the crop cannot easily be accounted for.

THE RESULTS OF THE ADDITION OF POTASH TO BARN-YARD MANURE FOR CORN.

In bulletin number 14, of this station, (p. 60) among other *conclusions* will be found the following: " *With ordinary barn-yard or stable manure for corn, use potash. I would recommend using about four cords of manure and one hundred pounds of muriate of potash per acre.*"

This advice was given in view of the results of two seasons' work in testing soils in various parts of the state (full accounts of which will be found in bulletins 9 and 14) but it was thought best to test the method upon our grounds. Further deliberation and consultation with representative farmers, led to a slight modification in the quantities both of manure and fertilizer. It was decided to use the manure at the rate of three cords and the potash at the rate of 124 pounds per acre, in comparison with twice the above named amount of manure alone per acre.

For this experiment an acre of land upon the station grounds was selected. This land previous to 1889 had been used as a pasture for several years without manure; in 1889 it was planted with corn without manure; and in 1890, it was used in a soil test with fertilizers for potatoes, a large portion of the land without manure and most of the balance with the application of only small quantities of fertilizers furnishing only one or two elements. The soil was, therefore, in a low state of fertility; it must have been considerably poorer than the average corn lands of the state; and in proportion to its unusual poverty, it was unfavorable to the manure and potash. The organic matter ordinarily present in the soil must usually supply a considerable proportion of the nitrogen needed by the corn crop when fertilizers are used, but in this soil, cultivated two years without manure, there could not have been a large amount of organic matter.

The acre was divided into four equal parts, the divisions of this year running across those of last season, so that the fact that the treatment of different plots last year was unlike, cannot have affected the comparisons of this year. The different sections of the field were numbered, and numbers 1 and 3 received manure at the rate of six cords per acre, while sections 2 and 4 received manure at the rate of three cords and potash at the rate of 124 pounds per acre.

The treatment of the different sections of the field and the crops obtained are shown in the following table.

MANURE ALONE *versus* MANURE AND POTASH.

Sections, Area ¼ A. each.	Manures applied.		Yield.		Yield per acre.	
	Barn-yard manure.	Muriate of potash.	Ears of corn, lbs.	Stover, pounds.	Shelled corn, bu.	Stover, pounds.
1	1½ cords		1173	960	61.1	3840
2	¾ "	31 pounds	1108	945	57.2	3780
3	1½ "		1143	950	61.5	3800
4	¾ "	31 pounds	1055	915	55.4	3660

Yield per acre,

(average of 1 and 3) shelled corn, 61.3 bu'ls; stover, 3820 lbs.

(" " 2 " 4) " " 56.3 " " 3720 "

Value of crop per acre, (1 and 3)	$49.40
" " " (2 " 4)	45.90
Cost of manure per acre, (1 and 3)	30.00
" " and potash per acre, (2 and 4)	17.64

Difference in value of crop per acre, in favor of 1 and 3,	3.50
" " cost " manure per acre against 1 and 3,	12.46
Balance in favor of manure and potash,	*8.96*

These figures and comparisons show that the manure alone produced slightly the better crop, but estimating manure at $5 per cord and muriate of potash at $45 per ton, shelled corn at 65 cents per bushel, and stover at $5 per ton we find that the manure and potash, although producing a slightly less valuable crop, gave a financial result nearly $9 better than manure alone. The experiment, then, appears to establish the soundness of the advice alluded to in the early part of this article.

One further point, however, must be considered, viz.: the present condition of the soil. For the purpose of making calculations on this point, the manures used on the various sections of the acre were carefully weighed, sampled and analyzed. The intention was to use manure of precisely the same character on all the sections, and it was all taken from the same pile; but the weights and results of analyses reveal the fact that it was far from being of even quality. The differences are shown below.

Number of pounds manure applied per acre, (1 and 3)	30,988
" " " " " " (2 " 4)	19,730

Plant food in manure in pounds per acre:

(1 and 3) nitrogen, 161; phosphoric acid, 96; potash, 130
(2 " 4) " 112; " " 82; " 114

The manure applied to 2 and 4 was by measure exactly one-half that applied to 1 and 3; but because heavier and of better quality it was equivalent to considerably more than half.

The comparisons showing the relative financial standing of the two systems of manuring, therefore, indicate too great an advantage on the side of the manure and potash.

To the manure applied to 2 and 4, muriate of potash (50% actual potash) at the rate of 124 pounds per acre was added. The soil thus treated, therefore, has received a total of 176 pounds of potash per acre. Sections 1 and 3, then, have received 49 pounds of nitrogen and 14 pounds of phosphoric acid per acre more than 2 and 4, while the latter have received 46 pounds per acre more of potash. The unexhausted manurial residue in the soil of 1 and 3 is, therefore, worth more than in the soil of 2 and 4. It is proposed to continue this acre in a similar experiment for a series of years.

SPECIAL CORN FERTILIZERS *versus* A FERTILIZER CONTAINING A LARGER PROPORTION OF POTASH.

In bulletin 14 of this station (p. 60) I express the opinion that the special corn fertilizers in the market contain too small a proportion of potash, and an experiment has been made upon the grounds of the station during the past season to test this point. For this purpose, one-half an acre of land, used some five years previous to 1890 as a pasture without manure, was selected. In 1890, this land was sown with millet for which a moderate application of fertilizer, supplying about twenty-five pounds of nitrogen; forty pounds of phosphoric acid, and eighty pounds per acre of potash, was made. This half-acre was divided into two equal sections, and to the soil of section 1 we applied a fertilizer supplying nitrogen, phosphoric acid and potash in the same quantities in which these ingredients would be supplied by an application at the rate of 800 pounds per acre of a fertilizer having the average composition of seven selected "special corn fertilizers" which are among the most common and most widely used. For the soil of section 2, we applied a fertilizer containing a much smaller amount of phosphoric acid, and much more potash. The fertilizers applied as well as the resulting crops and other details are shown in the following table:

COMPARISON OF FERTILIZERS FOR CORN.

Section.	Fertilizer applied, pounds.	Supplied in fertilizer, pounds.	Cost of fertilizer per acre.	Yield per acre. Shelled c'rn, bu	Yield per acre. Stover pounds	Value of crop per acre.
1 (¼A.)	Nitrate soda, 37 Dis. b'ne-b'lk, 142 Muriate p't'sh, 18	Nitrogen, 5.9 Phos. acid 22.7 Potash, 9	$13.66	55	4100	$48.05
2 (¼A.)	Nitrate soda, 22 Dis. b'ne-bl'ck, 75 Muriate p't'sh, 50	Nitrogen, 3.5 Phos. acid, 12 Potash, 25	$10.70	56	4300	$49.30

It will be noticed that the combination of fertilizers containing the more potash, and costing almost three dollars per acre less than the others, produced slightly the better crop. The financial advantage in favor of this combination amounts to $4.21, not a large saving, it is true, but certainly worth looking after. These two combinations of fertilizers must have left in the soil residues of about the same value. The first supplied the more nitrogen but this will not be retained. It also supplied the greater amount of phosphoric acid; but this is offset by the greater amount of potash supplied by the second combination.

This experiment, then, appears to indicate the correctness of the opinion that the so-called "special corn fertilizers" contain the elements of plant food in unsuitable proportions for our common soils. There is, especially, too much phosphoric acid and too little potash. *Farmers can, I believe, do better as a rule than to buy them. They should rather buy the materials needed and mix for themselves.*

In view of the confirmatory results of the past year's work as compared with that of previous years, I renew with increased confidence the recommendations for the application of fertilizers for corn, made in bulletin 14 of this station.

a. In breaking up sod land for corn, particularly that which is in fair condition but which has been under ordinary farm management, if fertilizers only are to be used, apply those which are rich in potash. Use materials which will supply, 80 to 100 pounds of actual potash, from 25 to 30 pounds of phosphoric acid, and from 15 to 20 pounds of nitrogen per acre.

b. If "special corn fertilizer" is to be used, apply only a moderate quantity, say 400 to 500 pounds per acre, and use with it about 125 pounds of muriate of potash. It is believed this combination will produce as good a crop as 800 to 1000 pounds of "corn fertilizer," and it will cost considerably less.

c. With ordinary barn-yard manure or stable manure for corn, use potash. I would recommend using about four cords of manure and 100 pounds of muriate of potash per acre.

d. For fodder or ensilage corn, use either in fertilizers or with manures about one-fourth more potash than above recommended.

e. In our experiments all fertilizers and manures have been applied broadcast and harrowed in, and I believe this is the best method.

f. Although I recognize the danger of giving empirical directions of a general nature, the results of our work lead me to recommend with considerable confidence any one of the following mixtures, per acre, for corn.

I.

Muriate of potash,	175 pounds.
Dissolved bone-black,	175 "
Nitrate of soda.	100 "

II.

Muriate of potash,	175 pounds.
Plain superphosphate,	150 "
Bone-meal,	100 "
Dried blood,	175 "

III.

Wood ashes,	1500 pounds.
Bone-meal,	100 "
Nitrate of soda,	100 "

IV.

Wood ashes,	1500 pounds.
Dry ground fish,	400 "

V.

Muriate of potash,	175 pounds.
Dry ground fish,	400 "

The ashes, bone-meal or fish should be applied very early in spring or late in winter. Apply all of these fertilizers broadcast and harrow in. Do not mix a long time before use;—especially important in case of Nos. III. and IV.

Of course these combinations might be indefinitely extended; but from what has been said as to the required amounts of the essentials, potash, nitrogen and phosphoric acid, any farmer should be able to figure amounts and combinations for himself. Between combinations I., II. and V. there should be little difference in cost. Combinations III. and IV. will probably cost from four to five dollars more. The elements other than potash and phosphoric acid contained in ashes, and their physical and chemical action in the soil will no doubt, in whole or part, offset this increased cost.

SPECIAL CORN FERTILIZER *versus* FERTILIZER RICHER IN POTASH FOR MILLET.

The yield of seed from one of our varieties of millet during the seasons of 1889 and 1890 had been so large that it was considered desirable to compare it with corn as a grain crop and in order not unnecessarily to duplicate experimental areas, it was decided to apply to one-half acre of this millet equal amounts of fertilizers of exactly the same kind, and in the same manner as in the experiment on the half-acre of corn last described. The results were similar to those obtained with the corn. The fertilizer richer in potash and costing at the rate of $10.70 per acre, produced a crop on one-quarter of an acre, at the rate of 76.8 bushels of seed and 4420 pounds of straw per acre; while the other fertilizer (the average of seven "special corn fertilizers") costing at the rate of $13.66 per acre, gave a crop on one-quarter of an acre at the rate of 72 bushels of seed and 4344 pounds of straw per acre. The average of the "special corn fertilizers" costing within four cents of three dollars more per acre, gave a crop worth at least (at current prices for common millet) $6.38 less per acre than the fertilizer richer in potash—a net advantage in favor of the latter fertilizer of $9.34. This result affords further evidence, therefore, of the correctness of my conclusion in regard to fertilizers. They are undoubtedly, as a rule, too poor in potash.

COMPARISON OF CORN AND MILLET AS GRAIN CROPS.

It is impossible to publish at present an exact comparison of this millet and corn as grain crops, as the necessary analytical work has not been completed. We have also in progress at this time experiments for the comparison of meals made from these two grains as food for milch cows as well as others for comparison of millet straw with corn stover. In the light of the results of analyses of these products—both grain and straw—and of these feeding experiments we shall be able to make exact comparisons.

For the present I desire simply to call attention to the fact that the millet has enormous cropping capacity. It gave us to the half-acre, 37.2 bushels of seed, weighing 47 pounds per bushel, while the corn gave us 30.6 bushels of shelled grain. The millet straw weighed 2191 pounds; the corn stover, (by no means as dry) 2100 pounds. The millet straw chopped, crushed, moistened and sprinkled with meal is readily eaten by both horses and cattle; but it does not appear to be equal to the corn stover in feeding value. The millet seed, as shown by the results of foreign analyses, appears to resemble oats very closely in composition. So far as our experience in feeding it has gone, the meal from it appears to equal corn-meal in feeding value for milk production. The fertilizers, it will be remembered, were the same for the two crops. The labor cost considerably more for the millet than for the corn. The crop, however, was cultivated in drills and hand-hoed and weeded, while in ordinary farm practice by judicious rotation it would be possible to secure good crops by sowing broadcast without cultivation. The cost of threshing also is high when the work is done by hand as it does not thresh easily. On a large scale the work could doubtless be done by machine at a much lower cost. In short, I believe the labor cost per acre can be brought as low as for corn.

Our seed was sown in drills fourteen inches apart, at the rate of about two quarts per acre. It was planted May 14th; cut and stooked Sept. 18th, and threshed Oct. 5th and 7th.

COMPOSITION OF POTATOES AS AFFECTED BY FERTILIZERS.

It was thought desirable with a view to the study of the effect of fertilizers upon the composition and quality of the potato, to have moisture and starch determinations made in a series of samples taken from all the different plots of some of our soil-test acres. With this end in view, medium tubers of good appearance were selected from the crop of each plot in three of our experiments, viz.: Hadley, Shelburne, and Amherst. The soil in Hadley was a moderately heavy loam of alluvial origin, and last year was the first season it had been under such an experiment. In Shelburne, the soil of glacial origin was a medium gravelly loam, much drier than the Hadley soil. It is part of an elevated tract of land in a hilly region, and last year was the third in such an experiment. The soil in the several plots, therefore, must have been thoroughly under the influence of the special treatment to which each had been subjected. In Amherst the soil of alluvial origin, was a medium loam thoroughly well-drained and inclining to be dry. It was what is ordinarily spoken of as good corn land, with particles so fine that it is not apt to suffer from drought. The past season was the second in a soil-test experiment, and the soil of the several plots, therefore, must have been fairly well under the influence of the special fertilizers used on each. For these determinations, a sample amounting to two quarts was picked up from different parts of the middle row of each plot. The entire sample was in each case used in making the determinations which should, therefore, fairly represent the merchantable tubers in the several plots. The table below shows the analytical results.

Moisture and Starch in Potatoes.

Fertilizer used.	Amherst. Variety, Beauty of Hebron. Moist're per cent	Amherst. Starch per cent	Shelburne. Variety, Early Rose. Moist're per cent	Shelburne. Starch per cent	Hadley. Variety, Beauty of Hebron. Moist're per cent	Hadley. Starch, per cent
Nothing,	79.37	14.40	78.08	19.45	80.11	14.94
Nitrate of soda,	79.47	15.54	77.62	19.04	80.06	17.22
Dissolved bone-black,	80.46	15.11	76.90	20.16	79.27	15.23
Nothing,	81.84	11.73	77.80	17.88	79 84	15.27
Muriate of potash,	82.32	11.92	77.96	18.15	79.95	14.76
{ Nitrate of soda, Dissolved bone-black,	80.35	14.31	77.37	19.23	78.83	15.38
{ Nitrate of soda, Muriate of potash,	81.08	14.79	79.99	17.62	79.64	17.45
Nothing,	80.09	14.38	77.08	19.95	79.34	16.35
{ Muriate of potash, Dissolved bone-black,	83.61	11.24	79.73	15.24	79.69	15.02
{ Nitrate of soda, Dissolved bone-black, Muriate of potash,	79.83	14.13	79.77	15.29	81.17	14.11
Land plaster,	80.14	15.59	77.88	18.83	78.45	16.07
Nothing,	79.42	18.81	77.46	17.57	78.07	14.64
Barn-yard manure,	82.21	11.87	79.24	17.27	78.65	15.91
Lime,	80.31	12.89	76.10	21.51	78.90	17.03
Nothing,	80.64	11.14	77.89	20.64	79.73	14.74

It becomes evident from a study of these figures that quality of soil or variety, probably chiefly the former, produces considerable differences in the percentages of moisture and starch as shown by the great superiority of the Shelburne samples.

For better study of the influence of the various treatments, the results of these moisture and starch determinations have been variously combined and averaged as shown in the tables below.

Fertilizer as Affecting Moisture and Starch in Potatoes.

Averages.	Amherst. Moist're	Amherst. Starch	Shelburne. Moist're	Shelburne. Starch	Hadley. Moist're	Hadley. Starch
General average,	80.74	13.86	78.19	18.52	79.45	15.67
Average of nothing plots,	80.27	14.09	77.66	19.10	79.42	15.19
Nitrate (alone)	79.47	15.54	77.62	19.04	80.06	17.22
Phosphoric acid (alone)	80.46	15.11	76.90	20.16	79.27	15.23
Potash (alone)	82.32	11.92	79.96	18.15	79.95	14.76
Average of plots receiving nitrate, 4 plots,	80.18	14.69	78.69	17.79	79.93	16.04
Average of plots receiving phosphates, 4 plots,	81.06	13.70	78.44	17.48	79.73	15.54
Average of plots receiving potash, 4 plots,	81.71	13.02	79.86	16.57	80.11	15.34
Manure (alone),	82.21	11.87	79.24	17.27	78.65	15.91
"Complete" fertilizer (alone)	79.83	14.13	79.77	15.29	81.17	14.11

Grand general average						
Moisture,		79.46	per cent;	starch,	16.02	per cent.
Grand average of:						
Nothing plots,	moisture,	79.12	"	"	16.13	"
Plots receiving:						
Nitrate of soda alone,	"	79.05	"	"	17.27	"
Phosphoric acid "	"	78.88	"	"	16.83	"
Potash "	"	80.74	"	"	14.94	"
All plots receiving:						
Nitrate of soda	"	79.60	"	"	16.17	"
Phosphate	"	79.74	"	"	15.57	"
Potash,	moisture,	80.56	per cent;	starch,	14.98	per cent.
Manure,	"	80.23	"	"	15.02	"
"Complete" fertilizer,	"	80.26	"	"	14.51	"

The differences brought out by these figures are not large, but it is thought they are significant. It is true, as a general rule, (see reports of these experiments: Amherst, p. 47; Shelburne, p. 31; and Hadley, p. 40) that the percentage of moisture is greater and that of starch less in proportion as the crop is larger; but there are several exceptions to this rule, notably, the potash plots in Shelburne which, although giving a light yield, show a low quality, also the manure plot in Shelburne which gives a large crop of better quality than the much smaller crop on the potash plots.

The number of determinations made is insufficient, and the differences are too small to justify very positive conclusions; but our results indicate a *favorable effect* of *nitrate of soda* and the *dissolved bone-black* upon the quality; for where these fertilizers are used the average of *moisture is lower*, and that of *starch higher*, than either the *general average*, the *average of the nothings*, the *average of plots where other fertilizers were used*, or the *average of plots where manure was used*.

It is often asserted that fertilizers will produce a crop of better quality than manure. In two out of three experiments, the potatoes grown on manure show a higher percentage of starch than those grown on "complete" fertilizer; and the average is considerably above that for "complete" fertilizer, viz., 15.02 per cent, against 14.51 per cent. This unfavorable result from the use of fertilizer may have been due to the form of potash used, viz., the muriate.

The *influence* of *this salt* appears to have been *decidedly unfavorable* to *starch formation*. The average per cent of starch where it was employed is lower than under any other treatment. We have above three averages illustrating its effect, viz.: potash alone, 14.94 per cent; all plots which received any potash, 14.98 per cent, and "complete" fertilizer, 14.51 per cent. These are the only averages which are below fifteen per cent, and the general average is a little above sixteen per cent. That the *muriate of potash* is distinctly *unfavorable* to *starch formation* then, it seems *can hardly be doubted.* It must be remembered, however, on the other hand that this salt is generally favorable to production, and that, as a rule, quality is inversely proportional to quantity.

REPORT ON TRIAL OF MISCELLANEOUS CROPS.

During the past year a number of varieties of different farm crops have been cultivated on our grounds for the purpose of testing their value for general cultivation. The soil on which they were grown is a medium loam, well drained and warm. It is in a comparatively low state of fertility; but all parts alike received a broadcast application of a mixed fertilizer containing for each acre: nitrate of soda, 150 pounds; dissolved bone-black, 200 pounds, and muriate of potash, 200 pounds. This fertilizer was thoroughly harrowed in. All these crops were cultivated to such an extent as was necessary to prevent the growth of weeds. An account of each follows:

OATS, *Variety, Early Race Horse. Seed imported from Japan, where it had been cultivated five years.*

This seed had originally been imported into Japan from England, when it weighed 46 pounds to the bushel. It gave magnificent crops in northern Japan, 70 bushels per acre being not uncommon. We received but a very small quantity of this seed and it was sown in rows eighteen inches apart. The area sown was .0269 acre, the crop amounted to only 23 quarts of grain weighing 20 pounds, and 100 pounds of straw. Per acre the crop, at this rate, would amount to 3717 pounds of straw, and 26.7 bushels of grain, weighing only 27.8 pounds per bushel. This crop was sown April 23d, cut Aug. 7th, and threshed Aug. 11th.

OATS, *Variety, Early Race Horse. Seed cultivated one year on the farm, originally from Henderson & Co.*

The area sown amounted to .02756 acre. The manner of sowing and the dates of planting, cutting and threshing were the same as for the Japanese seed. The product amounted to 162.5 pounds of straw and 32.5 quarts of grain weighing 37.5 pounds, or at the rate per acre of 5897 pounds of straw and 36.8 bushels of grain weighing 36.9 pounds per bushel.

OATS, *Variety, Black Tartarian. Seed from Japan where it had been cultivated five years.*

This seed was imported into Japan from England, and at that time weighed 38 pounds to the measured bushel. The seed was sown in the same manner as the other variety of oats, and the area amounted to .0677 acre. The yield was 415 pounds of straw and four bushels and six quarts of seed, weighing 87 pounds. Per acre this yield would amount to 6130 pounds of straw and 60.9 bushels of seed weighing only 20.8 pounds to the measured bushel. This crop was planted April 7th; cut Aug. 17th, and threshed Aug. 25th.

Conclusions. None of our oat plots have given an altogether satisfactory yield, but the Early Race Horse, American seed, has made a fair yield of grain, while the Black Tartarian is apparently a fine variety for green fodder or hay on account of its vigorous growth and heavy yield of forage. It should be remarked in passing, that the Early Race Horse, "American seed," is only two or three generations from imported English seed which, although generally later than American varieties, gives a more satisfactory yield of heavier grain than varieties long cultivated here.

MILLET, "*Panicum crus-galli.*" This seed was imported from northern Japan where this grain is considerably used as human food. It was planted rather thinly, in rows one foot apart. the area planted amounting to .0129 acre. The yield was 170 pounds of straw and 17 quarts of seed. This is at the rate of 13,177 pounds of straw, and 41.3 bushels of seed, weighing 56.5 pounds per bushel. The seed is much larger and heavier than that of ordinary millet, and when ground into meal must make an excellent feed. It would also (judging from the difficulty experienced in protecting it from birds) seem finely suited for bird seed. It is probable that its chief value, if further trial shall show it to be desirable, may be found to be in its suitability for green forage or for the silo.

I hardly think it will make good hay as it is coarse and rather harsh, though, of course, if sown more thickly broadcast it would be finer and more succulent. The bulk and weight produced are enormous, as will be noted from the figures above given, viz.: straw, six and one-half tons per acre. The seed was planted May 13th; the crop was cut and stooked Sept. 14th; drawn to barn, Oct. 3d, and threshed Oct. 9th.

MILLET, "*Panicum miliaceum.*" The seed was imported from northern Japan, where this grain is somewhat used as human food. It was planted in rows eighteen inches apart, the area sown amounting to .0147 acre. The yield was 184 pounds of straw and 43 quarts of seed, weighing 53 pounds, or at the rate of 13,334 pounds of straw and 91.4 bushels of seed weighing 39.5 pounds per bushel. This yield of seed is surely a remarkable one, especially since a considerable amount was lost through the ravages of birds (which prefer it to any other millet) as well as by rattling out, for, unlike common millet, this threshes very easily. The seed is smaller and, as will be noted, lighter than that of our other millets; but if the yield shall prove as a rule as heavy as this year, this millet may prove a useful grain crop. Considerable difficulty would, however, be found in protecting the crop from birds. It is thought that this will prove a valuable crop for green fodder or for the silo. The yield of forage is very large, the *very dry straw* weighing at the rate of about six and three-quarters tons per acre.

The seed of all our millets constitutes an excellent grain for hens. Scattered in the straw it is provocative of a vast amount of that industrious scratching so essential to keep "biddy" in health and fine laying condition in winter.

HEMP. Small areas of two varieties of seed from Japan were cultivated. Both ripened seed, and their cultivation here would undoubtedly prove a possibility, It is gravely doubted whether it would pay; but steps to test that point will be taken the coming season.

FLAX. At the request of the United States Department of Agriculture, an experiment in flax culture was undertaken during the past season. The seed was of three varieties, Belgian Riga, White Blossomed Dutch, and Pure Riga; and was furnished by the Department. Three-fourths of an acre of our best land was devoted to the crop, one-half bushel of seed of each variety being sown broadcast on April 29th.

The soil is a warm, well drained loam, and it had been cultivated in hoed crops for two years with great care, and it was believed would be as free from weeds as any land on the farm. The result did not justify our conclusion; for the growth of weeds was very rank; and in spite of one hand-weeding, the crop was nearly stifled. This fact no doubt accounts in large part for the unsatisfactory nature of our results.

This land had been ploughed the previous fall, and during the winter had received an application of barn-cellar manure, at the rate of about six cords per acre. This application would not have been made had we known for what the land would be used. After ploughing in the spring we applied to the entire area cotton-seed meal 500 pounds; muriate of potash, 150 pounds; and nitrate of soda, 100 pounds. The growth of both weeds and flax was very luxuriant and a considerable portion of the crop lodged.

We obtained 41 quarts only of seed and 650 pounds of straw. The "Pure Riga" variety stood up much better than either of the others and from this quarter acre we abtained 21 quarts of seed.

Our total expenses for labor amounted to $40.30; the crop can be worth but a very few dollars. This experiment does not, perhaps, prove that profitable flax culture is impossible in Massachusetts, because our failure was due in large part to the unsuitability of the land; but it has satisfied me that we have no land upon our farm which can profitably be used in raising this crop, the returns from which, even under the best conditions are far below those which may confidently be looked for from other crops requiring but a very small proportion of the labor required by this. Hand weeding a flax crop sown broadcast, hand pulling, etc., are not likely to prove remunerative under present conditions.

Wheats. Several varieties of winter wheats sent us by the celebrated English seedsmen, Carter & Co., at the request of the United States Department of Agriculture have been under trial. They were sown in drills, one foot apart, upon medium loam and gave a yield at the rate of from about six to twelve bushels per acre. All these wheats are late as compared with American varieties and more susceptible to rust. They do not appear to be suited to our climate.

The destruction of our records by fire makes it impossible to compare the varieties by name. We could do so by numbers, of course, but the results are not deemed of sufficient importance to deserve more extended notice.

Japanese Varieties of Beans. The varieties of beans which we have had under cultivation all belong to two distinct classes, known to the Japanese respectively,as "*Adzuki*" or "*Shozu*," the latter name meaning "small bean" and "*Omame*" or "*Daidzu*" both the latter names meaning "large bean." The beans of the first class are a distinct species, *Phaseolus radiatus* and are used by the Japanese almost entirely in confections. They are characterized by a remarkably thin skin, and are generally boiled, put through a sieve, and variously sweetened and colored though also prepared in other ways. An enormous quantity of these confections is eaten by persons of all ages and classes.

The beans belonging to this class have been sometimes incorrectly designated Soja beans by American writers. This bean has fair cropping capacity as will be seen by the detailed reports which follow. In composition, it resembles our common American varieties, being much poorer in both albuminoids and fat than the soja beans.

An analysis of a red variety raised here in 1890 has been made and the results are shown below. For comparison I give also the composition of the common kidney bean according to Anderson:

	RED ADZUKI. *Phaseolus radiatus.* Per cent.	KIDNEY BEAN. *Phaseolus vulgaris.* Per cent.
Water,	14.82	13.00
Dry matter,	85.18	87.00
Crude Protein,	20.23	19.75
" Fat,	.75	1.22
" Nitrogen free extract,	56.63	62.27
" Fibre,	3.83	
Ash,	3.74	3.56

Whether the beans of this class will prove valuable here may be doubtful. They are certainly unusually attractive in appearance; but it is not likely that the Japanese bean confections, which nearly all foreigners in Japan regard as decidedly flat and insipid, will ever come into favor here. This bean, therefore, must compete with our garden and field beans for popular favor, as it is of no especial value as a fodder plant.

The beans of the second class ("*Daidzu*") belong to a distinct genus and by some authorities are named *Soja hispida*, whence the common designation soja (sometimes soya) bean; by other authorities, the species is named *Glycine hispida* which name, probably, has the claim of priority. The name "soja" or "soya" has undoubtedly been taken from the name "soy" given to a sauce (used extensively as a condiment), in the manufacture of which this bean is largely used. The name given to the Japanese variety of this sauce is "*shoyu*." This bean is also extensively used in many ways in Japan as human food, and is also largely employed as food for horses and cattle.

It has been said that this bean is the richest known vegetable substance. "In point of nutriment the soy bean is of all vegetables nearest to meat," says Rein. A sample of beans grown here in 1890 has been submitted to analysis, with results shown below:

SOYA BEAN.

Glycine hispida.

	Per cent.
Water,	11.53
Dry mattter,	88.47
Crude protein,	34.49
" fat,	16.45
Nitrogen free extract,	26.90
Crude fibre,	4.40
Ash,	6.55

This sample shows an unusually high percentage of ash, probably because the vines were threshed with the roots to which considerable earth adheres.

Experiments in various parts of the country and at our State Experiment Station, have abundantly shown the value of some of the varieties of this species as fodder crops; but the varieties most commonly cultivated are large late sorts which will not usually ripen seed here. Several of the varieties which I have had under cultivation, having been taken from northern Japan (Sapporo), ripen seed here with as great certainty as the kinds of corn under common cultivation. It is believed that some of these varieties will prove valuable grain crops. The yield, it is true, cannot be expected to equal that of corn; but the grain is far richer, and because of the high percentage of protein it contains it is fitted to take the place of bran, cotton-seed meal and linseed meal for which our dairymen yearly pay out so much money.

It should further be remembered that if the results of modern investigations on this point are not misleading, this plant must be able to take most of its nitrogen from the air which must vitally affect the question of its economy as a farm crop. Most of our crops are nitrogen consumers. This, being a nitrogen gatherer, should enable the farmer to dispense in large measure with purchased nitrogenous fertilizers.

This bean has been ground into a fine meal by a local miller, both in 1890 and 1891. A large part of the crop of 1890 was made into meal, but this together with most of our seed was destroyed by fire, so that the contemplated feeding experiments were, for the time being, made impossible. From the crop of the past season, however, we have had a small quantity of meal made, and this is now being used in a feeding experiment with milch cows in comparison with an equal quantity of cotton-seed meal. The results thus far obtained indicate that the bean meal is superior to the cotton-seed meal for cream production. I had supposed it might be necessary to mix this meal with corn meal, bran or some similar food to induce cows to eat it; but, as far as tried, they eat the raw meal at once without any admixture. This grain should also prove valuable in the feeding both of sheep and swine.

The detailed results of the cultivation of the varieties under trial, during the past season, will now be given. All were planted rather thinly in rows two and one-half feet apart. According to the size of the variety, there should be from about five to seven plants to the foot.

Class "Adzuki," Phaseolus radiatus: Two varieties, white and red, were under cultivation. The white occupied 11.83 sq. rds., and yielded 1.6 bushels of beans, or at the rate of 21.7 bushels per acre. The red variety occupied 13.18 sq. rds. and yielded 2.25 bushels of beans, or at the rate of 27.3 bushels per acre. We have invariably found the red varieties superior to the white in productive capacity, and in beauty of appearance. The seed of these varieties was kindly sent us by Prof. Georgeson of the Kansas Experiment Station, as our original stock had been destroyed by fire. The seed was planted May 14th, the crop pulled Oct. 3d, and threshed Oct. 23d.

Class Second, Soya Beans, Jap. "Daidzu," Glycine hispida, Variety "Eda." Seed received from Prof. Georgeson, planted May 14th, crop pulled Oct. 3d, and threshed Oct. 23d. The area occupied by this variety was 20.3 sq. rds., the yield was 1.06 bushels, or at the rate of 8.37 bushels per acre. This is one of the poorest varieties we have had under cultivation.

Variety "Kuiske." Seed received from Professor Georgeson, planted and harvested as above. Area, 9.13 sq. rds., yield 26 qts, or at the rate of 14.26 bushels per acre. This variety also appears to be inferior to our original stock.

Variety, Medium Early White; seed originally from Sapporo. The past season is the third that this variety has been cultivated upon our grounds. The area the past season was 37.17 sq. rds., the yield 5.4 bushels, or at the rate of 23.25 bushels per acre. In previous years we have had crops at the rate of 22.5, 25, 27 and 35 bushels per acre. As we had but a very small quantity of seed, the seeding of the past season was thinner than is desirable for a full crop from the land. I believe that crops of about 30 bushels per acre of this variety may be safely anticipated. The dates of planting, etc., of this variety were the same as in the case of the varieties described above.

Variety, Medium Black; seed imported from Sapporo; area, .76 sq. rd., planted May 13th; pulled Oct. 13th, and threshed Oct. 25th. The yield was six and one half pounds, or at the rate of 22.8 bushels of 60 pounds per acre. The growth of vine was ranker than in most of the other sorts, and this may make this variety valuable for fodder.

Variety, Medium White; seed imported from Sapporo; planted, etc., as above. Area occupied, .76 sq. rd.; yield, 5.5 pounds, or at the rate of 19.5 bushels per acre. In explanation of the comparatively small yield of this variety, as well as of the preceding, it should be stated that as we had but a mere handful of the seed, it was planted very thinly. This variety, I believe, is essentially, perhaps identically like our original stock.

Variety, Medium Green; seed from Sapporo; planted, etc., as above; area, .76 sq. rd., yield, 8.5 pounds, or at the rate of 30.2 bushels, of 60 pounds per acre. This is apparently a very vigorous and productive variety, and may prove a valuable acquisition.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 19.

REPORT ON INSECTS.

MAY, 1892.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1892.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

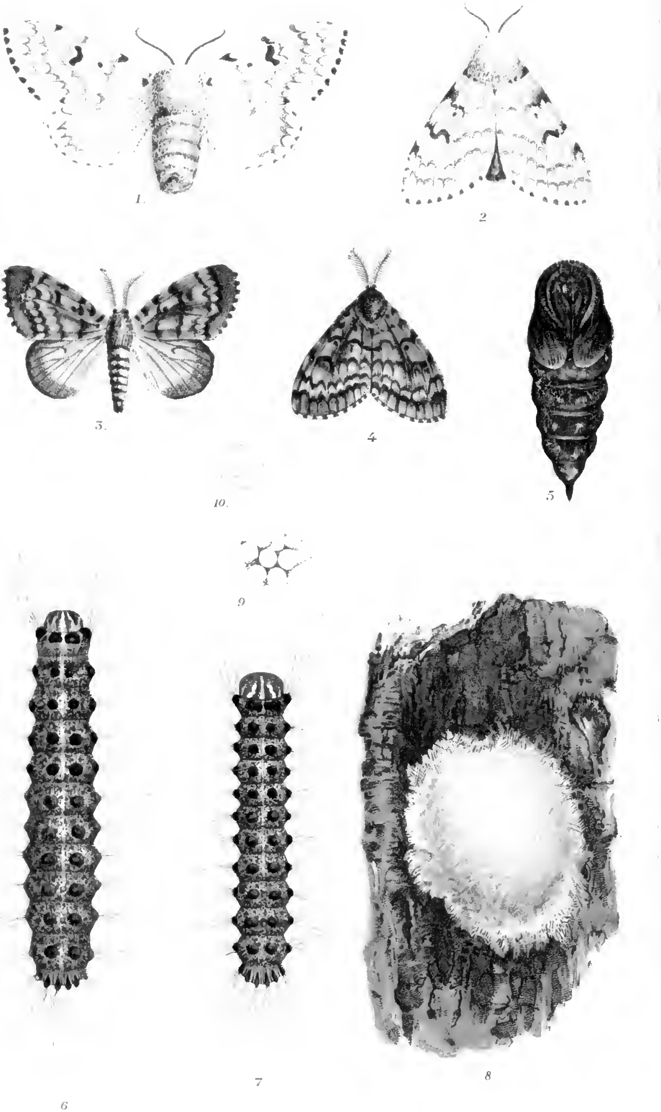
Its officers are:—

Henry H. Goodell, . .	*Director.*
William P. Brooks, . .	*Agriculturist.*
Samuel T. Maynard, . .	*Horticulturist.*
Charles H. Fernald, . .	*Entomologist.*
Clarence D. Warner, . .	*Meteorologist.*
William M. Shepardson, .	*Assistant Horticulturist.*
Henry J. Field, . .	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.



Drawn by Joseph Bridgham

Heliotype Printing Co. Boston

GYPSY MOTH

EXPLANATION OF PLATE I.

GYPSY MOTH (Ocneria dispar, L.)

Fig. 1.—Female with the wings spread.

2.—Female with the wings folded.

3.—Male with the wings spread.

4.—Male with the wings folded.

5.—Pupa.

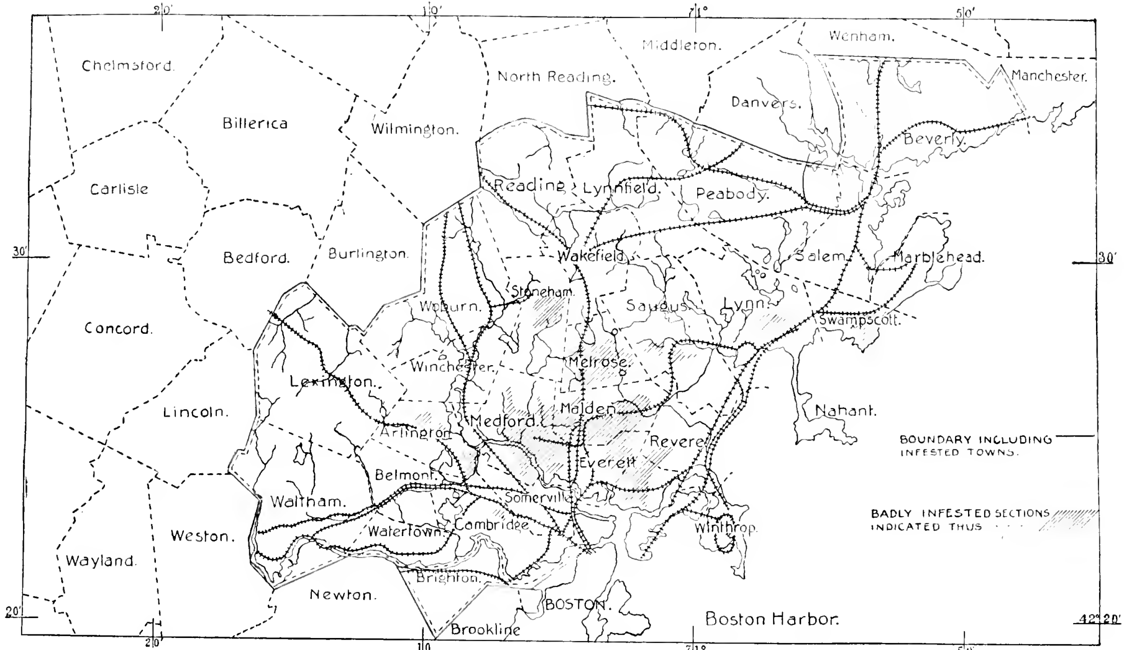
6.—Caterpillar, } *Full grown.*

7.—Caterpillar, }

8.—Cluster of eggs on bark.

9.—Several eggs enlarged.

10.—One egg greatly enlarged.



MAP OF THE REGION FOUND INFESTED IN 1891.

This area contains about 200 sq. miles.

Division of Entomology.

C. H. Fernald.

THE GYPSY MOTH.

Ocneria dispar, L.

This insect was introduced into this country about the year 1868, by Mr. L. Trouvelot, now residing in Paris, France, but then living near Glenwood, Medford, where he attempted some experiments in raising silk from our native silkworms. I was informed that Mr. Trouvelot brought a cluster of gypsy moth eggs from Europe, and, having opened the box, took out the eggs and laid them on the sill of an open window, when the wind blew them out and he was not able to find them.

Distribution.

From this center they have now been distributed more or less abundantly in twenty-nine cities and towns in the eastern part of Massachusetts, as published in the report of Mr. E. H. Forbush, Field Director in charge of the work of destroying this moth. See map.

I am under great obligations to Mr. Forbush for permission to use such of his field notes as I desire, and also to the Gypsy moth Committee for permission to use the plates in this paper.

The gypsy moth has frequently been reported in other towns and even in other states; but, upon investigation, these reports have proved incorrect.

The gypsy moth has been reported in Japan, but Mr. Butler of the British Museum, one of our best authorities in such matters, states that what is called the gypsy moth in that country, represents three different species, neither of which is the true gypsy moth of Europe and Massachusetts.

Food Plants.

This insect has been found in Medford and vicinity feeding on apple, plum, cherry, quince, elm, linden, locust, maple, balm of

Gilead, beech, birch, oak, willow, poplar, wisteria, poison ivy, chestnut, catalpa, holly, Norway spruce, arbor vitae, corn, grass and clover.

It has a wide distribution in the old world, and is said to feed there upon nearly all the plants mentioned above, and also upon apricot, lime, pomegranate, hornbean, hazel, larch, azalea, fir, myrtle, rose, cabbage and many others.

Habits of the Moth.

The female moth, Plate I, figs. 1 and 2, does not fly readily, and only in an obliquely downward direction, so that the chances of rapid distribution in this stage are small. The males, plate I, figs. 3 and 4, fly mostly during the day, and not later than 10 o'clock in the evening. They are not attracted to lights, and as their mouth parts and digestive system are undeveloped, they do not eat in this stage of their existence, and therefore cannot be attracted to fires nor traps baited with liquid food.

The females move about but little after emerging from the pupa cases, and they frequently mate with the other sex within half an hour after they emerge, although it requires from one-half to three-quarters of an hour for their wings to expand fully. They begin to lay their eggs in about two hours, and it requires about two hours and a half to complete this act.

Date of Laying Eggs.

The date of laying the eggs varies a great deal owing to the difference in time of the emergence of the moths. The earliest date recorded last year was July 7th, and the latest was Sept. 28th, but by far the greatest number were laid about the middle of July. The development goes on within the egg during the summer and autumn, so that fully formed caterpillars are found in the eggs in the fall; but they do not hatch until the following spring.

Date of Hatching of the Eggs.

The eggs hatch from about the 20th of April to the middle of June, according to their location; those in warm, sunny places hatching early, while those in cool places, as under stones, hatch later in the season. The young caterpillars remain on the egg mass about twenty-four hours before beginning to eat the leaves of their food plant.

When the caterpillars are about half-grown, they become gregarious in their habits, feeding by night and resting in clusters during the day, head either up or down, on the shady side of the trunk, on the underside of branches, under loose bark, in hollows of the trees, under boards, stones, or any suitable shelter on the ground.

The injury these caterpillars are able to do is shown in the plates given herewith. A very comprehensive account of the work of destroying this insect in Massachusetts is given by Mr. Forbush in the Report of the Gypsy Moth Committee to the Legislature.

The following descriptions have been prepared and are given here by request:

The Egg.

The eggs, plate I, figs. 9 and 10, are nearly globular, about one-eighteenth of an inch in diameter, of a dark salmon color, with a smooth surface; and are laid in oval or rounded clusters, plate I, fig. 8, containing from 400 to 500 eggs covered with the yellowish hair from the under side of the abdomen of the female. These clusters of eggs are deposited on the underside of the branches, on the trunks of trees, often below the surface of the ground where it has shrunk away from the tree, on fences, stone walls, the sides of buildings, and in every conceivable place where the female moths happen to be when they are ready to lay their eggs. They are laid about the middle of July, but do not hatch until the following spring in the latter part of April and early in May, though many hatch much later, especially those in sheltered places; so that there is a succession of young caterpillars through the spring and early summer.

The Larva.

When a caterpillar hatches it is cylindrical, gradually tapering backward from the second segment. The head is smaller than the second segment, pitchy black with a shining surface, and with a few whitish hairs scattered over the surface. The general color of the body is brownish yellow with a dark brownish spot on the subdorsal line, on the forward part of each segment from the fourth to the twelfth inclusive. The thoracic shield on the top of the second segment is long and narrow, and extends across the top of the segment. It is of the same color and texture as the head, and there are numerous short white hairs arising from behind it, and also from the front edge of the segment. A large tubercle arises from the side of the segment in the lateral line, from which long hairs arise, some of which are nearly half as long as the body. The third to the twelfth segments inclusive have each a tubercle on the subdorsal line, just behind the brown spots, from which arise diverging, whitish hairs. On the lateral and stigmatal lines, on each segment, is a tubercle from which arise hairs nearly two-thirds as long as the body. The last segment has a row of small tubercles across the hinder part, from which hairs arise. The spiracles are pale yellow, and the legs are of the same color as the body. The true legs are marked on the outside with black, while the prolegs on the seventh, eighth, ninth, tenth and eleventh segments have a few hairs scattered over the surface. In about six hours after hatching, the body of the caterpillar changes to smoky brown, and the legs to sordid white.

In four days after hatching they molt, after which they are about one-fifth of an inch in length; the head remains the same in form and color as before molting, but the body changes to a burnt-sienna color with all of the tubercles and most of the hairs black, and the prolegs are irregularly marked with black.

In five days more they molt a second time, after which their length is a little over one-third of an inch. The head is small, somewhat flattened, and shining black, with a few dark hairs scattered over the surface. The general color of the body is shining dark brown, and a cluster of diverging, dark, spine-like hairs arises from the tubercles. The lateral tubercles on the second segment are very large. The hairs arising from the tubercles on the second and thirteenth segments are quite long, while those on the tubercles along the sublateral and stigmatal lines are long and of a whitish color. The dorsal line is yellowish brown and very much broken, giving the appearance of a large spot on each segment. The lateral lines are dull yellowish white.

Eleven days later the third molt occurs, after which the length is half an inch. The head is of medium size, black, with short, brownish white hairs. The general color of the body above is velvety black, with large hemispherical, slate gray tubercles with numerous small black tubercles over the surface, and from each of these small tubercles arises a cluster of short brownish white hairs mixed with a few black ones. The dorsal line is pale ochraceous reddish, enlarged into small grayish spots on the middle of the sixth, seventh and eighth segments; while on the ninth, tenth and eleventh segments are larger orange colored spots. On each side of the dorsal line, on the front edge of the fifth, sixth, seventh and eighth segments, is a small light yellow tubercle. The lateral line is pale yellow and below this the surface is ashy, mottled with dark brown.

Trees stripped by caterpillars of the Gypsy Moth.
ARLINGTON, MASS., JULY 9, 1891.

View of woodland infested by the Gypsy Moth.
SWAMPSCOTT, MASS., AUGUST 5, 1891.

Apple orchard stripped by caterpillars of the Gypsy Moth.
SWAMPSCOTT, MASS., AUGUST 5, 1891.

The fourth molt occurs nine days after the third, and the length is then nearly an inch. The head is pale primrose mottled with dark brown, and has a large brown spot on each side of the central line, and another on each side of the clypeus, at the base. A few light brown hairs are scattered over the surface. The general color of the upper side of the body is velvety black sprinkled with white. The tubercles on each side of the dorsal line, on the second, third, fourth, fifth and sixth segments are larger than in the last molt, and of a French blue color. Below the lateral lines the surface is sordid white mottled with black. The tubercles above and below the stigmatal lines are dark yellowish, and from those above the stigmatal line arise dark brown hairs, while from those below the line the hairs are light brown. The under side of the body, and the legs and prolegs are dark brown.

The fifth molt occurs in nine days after the fourth, when they are from one and one-eighth to one and one-half inches in length. The head is of a creamy buff color, thickly mottled with dark velvety brown, leaving the light ground color showing along the middle line on top, and two stripes on each side, as in plate I, figs. 6 and 7. The antennae are pale yellow ; mandibles, dark brown ; clypeus much depressed, and of a very pale orange color, the labrum or upper lip white with a few pale yellowish hairs scattered over the surface.

The general color of the body is cream white thickly sprinkled with black. The ground color shows in the dorsal and lateral lines which are somewhat broken. The tubercles on each side of the dorsal line, from the second to the sixth inclusive, are blue and give rise to short black spines. On each side of the remaining segments, except the last, the tubercles are dark crimson. On the top of the tenth and eleventh segments, on the dorsal line, is a small cylindrical fleshy tubercle without hairs or spines, the top of which is slightly inverted. It is uncertain what is the function of these organs, but it is quite possible they are scent organs. On the second and third segments, on the lateral and stigmatal lines, is a reddish yellow tubercle giving rise to yellowish hairs and black spines ; and on these same segments, on the stigmatal line, is a tubercle similar to the above, which gives off long pale yellow hairs and a few black spines. On each of the remaining segments, on the stigmatal lines, are two reddish yellow tubercles joined in one, the upper giving off black hair-like spines, and the lower, black spines and yellowish hairs mixed. There is a row of reddish yellow tubercles, on the sub-stigmatal line, which give off pale yellow hairs curving downwards. On the posterior edge of the last segment are four bluish white tubercles giving rise to black spine-like hairs. The spiracles are oval, pale yellow, and encircled with black. The legs are dark crimson, and the prolegs flesh colored and streaked with reddish brown. They are subject to some variation in the ground color, as seen in plate I, figs. 6 and 7.

THE PUPA.

The pupæ of the males vary in length from three-fifths to four-fifths of an inch, including the cremaster or blunt spine at the end of the abdomen; while those of the females vary from three-fifths to one and two-fifths inches. Fig. 5, plate I, was taken from one of extraordinary size. The following description was made from the study of thirty-nine males and one hundred and twenty-one females. They vary in color from chocolate to dark reddish brown. They are cylindrical or fusiform, rounded anteriorly and tapering posteriorly to the cremaster which is armed at the tip with a cluster of minute hooks. The covers to the various parts of the body, as the wings, legs, antennæ, etc., are plainly marked, those of the antennæ being very wide, especially in the males. At the front edge of the thorax, on each side, is an oval, dark reddish brown velvety spot very distinct in some examples, but nearly invisible in others. Ocher yellow hairs arranged in groups occur on the eye, head and palpi covers, across the collar and thorax, and in ten equidistant rows along the abdominal segments. Some of the hairs in the groups across the collar and thorax are dark brown. The abdominal segments are more or less punctured, and the hairs arise in small circles. At the base of the cremaster on the ventral side is an elliptical depression with curved ridges on each side. In the males, on the middle of this segment, in front of the depression, is a small raised tubercle with a longitudinal slit on the top of it; while in the females this tubercle is wanting, but on the extreme front edge of this same segment, there is a fine longitudinal slit; but the surface at this place is not raised.

THE IMAGO.

The following description was made from thirty males and thirty-seven females. The males measure from one and one-half to two inches between the tips of the expanded wings. The ground color of all the wings is brownish yellow varying in intensity in different examples, but somewhat lighter beneath. The head, thorax, antennæ and upper side of the palpi are grayish brown, inclining to mouse color in some specimens. The under side of the entire body, legs and palpi is somewhat lighter than the under side of the wings.

The markings on the fore wings are dark brown, and are as follows: The half line starts from the costa, near the base of the wing, and extends half way across the wing. The transverse anterior line arises from the basal fourth of the costa, and crosses the wing as a scalloped line. Just outside of this line, on the cell, is the small orbicular spot. The reniform spot is crescent shaped and, resting on the outer end of the cell, extends across its entire width. The median shade is quite obscure, but is bent out around the end of the cell, and toothed along the outside. The transverse posterior line arises from the outer fourth of the costa, is somewhat curved and toothed on the veins, and terminates just within the anal angle. The subterminal line, a little outside, is similar to the transverse posterior line and parallel with it. The terminal space is usually somewhat darker than the rest of the wing, and all the cross-lines are heavier on the costa than elsewhere. The fringe is cut with dark brown between the veins.

The hind wings have a faint discal lunule at the end of the cell, and the terminal shade is darker brown than the rest of the wing. The upper side of the abdomen is of the same color as the upper side of the hind wings, and has a row of brownish spots along the middle.

The outside of the third and fourth joints of the tarsi, and the ends of the femora on the upper side are brown; the fore and middle tibiae are pale mouse colored on the outside.

The females measure from one and one-half to two and one-half inches between the tips of the expanded wings. The entire body and wings above and beneath are yellowish white, except the abdomen beneath, and towards the end above, which are pale yellow. The markings of the fore wings are dark brown or nearly black, but vary much in intensity in different specimens, being almost entirely obliterated in some examples. The half line at the base of the wing, the orbicular and reniform spots, the costal end of the transverse lines and the black spots in the cilia are quite pronounced. The form and position of the lines and spots are the same as in the males. The fore wings are longer, narrower and more pointed than in the males. The hind wings have a faint discal spot and subterminal line which is toothed along the outside on the veins, and the cilia have black basal spots between the veins.

The antennae and legs are dark brown, but the hair on the femora and tibiae is yellowish white.

Parasites.

Numerous parasites were discovered last summer preying upon the eggs and larvae of the gypsy moth. The following species, determined by Prof. Herbert Osborn, were found destroying the eggs: *Trombidium bulbipes* Pack.; *Nothrus* sp. near *ovivorus* Pack. "This species differs from that described by Dr. Packard in having but two capitate appendages on the cephalothorax." *Phloeothrips* sp. Prof. Osborn says of this last species: "These cannot be identified positively, though they may be the larvae and pupa of *P. mali.* They agree well with Riley's brief description of his *Thrips philloxerae*, but these are undoubtedly *Phloeothrips.*"

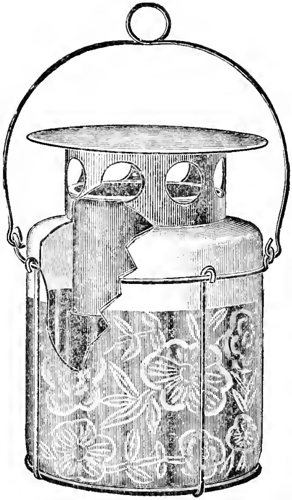
The following species were bred from the pupae of the gypsy moth: *Theronia melanocephala* Br.; *Pimpla pedalis* Cress.; and an undescribed species of *Meraporus*, the last kindly determined for me by Mr. L. O. Howard. Besides these, several species of Diptera were bred, but they have not yet been determined. *Podisus spinosus* Dall., black ants and spiders were found in considerable numbers destroying the larvae, and no less than ten different species of birds were observed feeding on the caterpillars.

BARNARD'S INSECT TRAP.

Early in April, 1891, Mr. W. C. Barnard, of Worcester, Mass., sent six of his "Monitor Moth and Insect Traps" for trial here at the Station. These were prepared according to directions, and hung in trees in the orchard and gardens.

These traps are glass jars, with a tin arrangement on top with holes around the side, near the top, through which the insects find their way to the inside of the jar which is partly filled with an odorous liquid strongly attractive to insects. The outside of the glass jar has flowers painted upon it with luminous paint.

Wishing to test the value of the flowers, I wrote to Mr. Barnard



BARNARD'S MOTH TRAP.

who kindly sent me two unpainted traps which were put in the same place, and near the others, so that they would have an equal chance with them. The comparison between the painted and unpainted traps, showed that the unpainted traps collected quite as many insects as those that were painted, and therefore the painting is a needless expense.

The traps were hung out April 21, and the insects collected from them each day and determined. This was continued until Sept. 15, when the work was closed up. It was not easy to make specific determinations of the insects that had been soaked in the liquid in the traps, but they were determined as accurately as possible with the following results: Beetles, 680 specimens; wasps and bumble-bees, 1024 specimens; butterflies and moths, 17,590 specimens; flies of various kinds, 59,376 specimens. A few plum curculios were taken, but the greater number of the beetles were *Ips fasciatus* which is a species said to be injurious. There were but a few butterflies and sphinx-moths, and only one tent caterpillar moth, which was undoubtedly an accidental capture. These traps attract only such insects as are able to eat, and, as the tent caterpillar, gypsy moth, and many others of the same family have their mouth parts and digestive system atrophied or rudimentary so that they do not eat anything in the moth stage, they are not attracted to these traps nor to any sources of food. There was not a single codling moth nor borer of any kind taken in these traps during the season. Nearly all of the lepidoptera or moths taken belong to the Noctuidae or cut-worms which are for the most part injurious. The Diptera or flies represented many different families, some of which are beneficial, while others are injurious. A large percentage of them belong to the *Tachinidae* or parasitic flies, and as the traps caught and destroyed so many of these insects which are our best friends, as they destroy injurious insects, I am compelled to say that I believe the traps did more harm than good. The number of parasitic flies captured during the season was much larger than the entire number of injurious insects taken during the same time.

As the majority of the injurious insects taken in these traps fly in the night only, and most of the flies that are beneficial fly in the day-time, I would advise those who use the traps to leave them out only during the night, taking them in or having them closed during the day, so that no insect can get into them. If this is done I think they will prove very useful.

EXPERIMENTS WITH PARIS GREEN ON APPLE TREES.

In the fall of 1890, twelve apple trees were set out in the green-house connected with the Insectary. This greenhouse is divided into two sections by a partition across the middle, and six of the trees were set out in the ground in each section. In the following spring these apple trees had become well established, and on May 18, 1891, the leaves being well grown, they were showered with Paris green in water, in the proportion of one pound to 130 gallons of water. This was applied with a Johnson pump and a No. 2 Nixon nozzle.

One section of the greenhouse was kept dry and cool, while the other was kept as damp and muggy as possible, for the purpose of determining whether different climatic conditions would in any way affect the burning of the foliage by the Paris green. In watering these trees, three in each section were showered from above so that the foliage was thoroughly wet, while the others were watered at the roots, and the foliage was not wet during the entire time of the experiment. No apparent difference could be observed in the effect on the foliage between those trees which were showered from above and those which were not; but there was a marked difference between the foliage on the trees in the two sections of the greenhouse. In the section which was kept cool and dry, the foliage was scarcely burned at all, while in the one which was kept damp and warm, it was very badly burned. We conclude, therefore, that Paris green burns the foliage much more in warm, damp weather, than when it is dry and cool; and further, that simple showers do not cause the Paris green to burn the foliage perceptibly.

PLANT LICE AND RED SPIDERS ON ROSE BUSHES.

Twelve potted rose bushes of different varieties were placed in the Insectary greenhouse last April; and, as they were infested with plant lice and red spiders, those insects were allowed to multiply till the lice literally covered every green twig, and more or less of the surfaces of the leaves; and the red spiders had become exceedingly numerous on the leaves.

A pailful of kerosene emulsion was prepared, and each rose bush was inverted and dipped into it, and held there about a quarter of a minute, or long enough to allow the emulsion to reach every insect on the bush. In immersing it in this way, the pot was held in the left hand, with the right hand over the top to prevent the earth from falling out. An examination of the bushes, two days later, failed to reveal a single plant louse or red spider, and none appeared on them during the remainder of the season, thus proving that the work was thorough and effectual.

When rose bushes are too large to be treated in this way, they may be showered.

KEROSENE EMULSION.

This most useful insecticide is prepared in the following manner. One-quarter of a pound of common bar soap is dissolved in two quarts of boiling water, and, while still hot, four quarts of kerosene oil are added, and the whole mixture churned through a small hand force pump with a small nozzle turned into the pail. This churning must be continued about five minutes, until the whole forms a creamy white mass which becomes jelly-like when cool. Care must be taken to have the solution of soap *hot* when the kerosene is added to it and the churning done, but it must not be near a fire.

Before applying this emulsion to the plants, it should be diluted with water in the proportion of one quart of the emulsion to nine quarts of water, which must be thoroughly mixed. The above will make sixty quarts of the insecticide ready for use, but the emulsion will keep for a long time without injury, and may be diluted when needed for use.

This insecticide is said to be one of the best substances for the destruction of vermin on domestic animals and in hen houses.

EXPERIMENTS WITH PARIS GREEN ON TENT CATERPILLARS.

Wishing to determine the smallest amount of Paris green that would destroy one of our common insect pests, I selected the common tent caterpillar (*Clisiocampa americana* Harr.) to experiment upon.

One Pound of Paris Green to 100 Gallons of Water.

First Molt.

April 29, 1891, at 3 P. M. sprayed a branch of apple tree with Paris green and water in the above proportions (1 lb. to 100 gals.), and placed 15 young caterpillars upon the leaves. At 11-30 A. M. April 30, two were dead, at 1-30 P. M., four more had died, and at 9 A. M. May 1, all were dead.

Second Molt.

April 29, at 4 P. M. sprayed a similar branch with the same preparation, and placed 10 one-third grown caterpillars upon the leaves. At 3-30 P. M., April 30, one was dead, at 9 A. M., May 1, four more had died, and at 3 P. M., all were dead.

Third Molt.

April 30, at noon, sprayed as above, and placed 15 two-thirds grown caterpillars on the leaves. All were dead at 8 A. M., May 1.

Fourth Molt.

April 30, at noon, sprayed as above, and placed 15 full-grown caterpillars on the leaves, and all were dead at 10 A. M., May 1.

One Pound Paris Green to 150 Gallons Water.

First Molt.

April 29, 1891, at 4 P. M., sprayed a branch of apple tree with Paris green in water (1 lb. to 150 gals.), and placed 15 young caterpillars upon it. At 8 A. M., April 30, several were dead; at 9-30, two more were dead; at 1-10 P. M., four more had died, and at 9 A. M., May 1, all were dead.

Second Molt.

April 30, at 9-30 A. M., sprayed in the same manner, and placed 15 caterpillars on the leaves. May 1, at 8 A. M., five were dead; at 9-30, two more had died, and at 10 A. M. all were dead.

Third Molt.

April 30, at 9-30 A. M., sprayed as above and placed 15 caterpillars on the leaves. At 8 A. M., May 1, three were dead; at 9-30, two more had died, and at 11 A. M. all were dead.

Fourth Molt.

April 30, at 11 A. M., sprayed as above and placed 15 caterpillars on the leaves, and at 8 A. M. May 1, all were dead.

One Pound Paris Green to 200 Gallons Water.

First Molt.

May 4, at 4 P. M., sprayed a branch of apple tree with Paris green and water in the above proportions, and placed 15 young caterpillars on the leaves. At 8 A. M. May 2, all were dead.

Second Molt.

May 1, at 4 P. M., sprayed in the same manner, and placed 15 caterpillars on the leaves. At 8 A. M., May 2, all were dead.

Third Molt.

May 1, at 4 P. M., sprayed as above and placed 15 caterpillars on the leaves. At 8 A. M., May 2, none were dead, though all seemed stupid, but at 8 A. M., May 4, all were dead.

Fourth Molt.

May 1, 4 P. M., sprayed as above and placed 15 full-grown caterpillars on the leaves. At 8 A. M., May 5, one was dead, and at 8 A. M., May 4, all were dead.

One Pound Paris Green to 250 Gallons Water.

First Molt.

May 1, at 4-30 P. M., sprayed a branch with the above preparation and placed 15 young caterpillars upon the leaves. At 8 A. M., May 2, several were dead, and at 8 A. M., May 4, all were dead.

Second Molt.

May 1, at 4-30 P. M., sprayed in the same manner, and placed 15 caterpillars upon the leaves. At 8 A. M., May 2, several were dead, and at 8 A. M., May 4, all were dead.

Third Molt.

May 1, 5 P. M., sprayed as above, and placed 15 caterpillars on the leaves. At 8 A. M., May 2, two were dead, and all were dead at 8 A. M., May 4.

Fourth Molt.

May 1, 5 P. M., sprayed in the same manner, and placed 15 caterpillars on the leaves. At 8 A. M., May 2, one was dead, and the others very stupid. At 8 A. M., May 4, all were dead.

One Pound Paris Green to 300 Gallons Water.

First Molt.

May 1, at 3 P. M., sprayed a branch of apple tree with the above preparation, and placed 15 young caterpillars upon the leaves. At 8 A. M., May 3, all were dead.

Second Molt.

May 1, at 3-30 P. M., sprayed as above, and placed 15 caterpillars on the leaves. At 8 A. M., May 3, all were dead.

Third Molt.

May 1, at 3-45 P. M., sprayed as above, and placed 15 caterpillars on the leaves. At 8-30 A. M., May 3, all were dead.

Fourth Molt.

May 1, at 5 P. M., sprayed in the same manner, and placed 15 caterpillars on the leaves. At 8-30 A. M., May 3, all were dead.

One Pound Paris Green to 400 Gallons Water.

First Molt.

May 2, at 11-30 A. M., sprayed a branch with the above preparation of Paris green and water, and placed 15 young caterpillars upon it. At 8 A. M., May 4, all were dead.

Second Molt.

May 2, at 11-30 A. M., sprayed in the same manner, and placed 15 caterpillars on the leaves. At 8 A. M., May 4, five were dead and the others seemed stupid. At 8 A. M., May 5, all were dead.

Third Molt.

May 2, at 1-15 P. M., sprayed as above, and placed 15 caterpillars on the leaves. At 8 A. M., May 4, all were dead.

Fourth Molt.

May 2, at 1-45 P. M., sprayed as above, and placed 15 caterpillars on the leaves. At 8 A. M., May 4, all were dead.

One Pound Paris Green to 500 Gallons Water.

Second Molt.

May 5, at 3 P. M., sprayed a branch of apple tree with Paris green in water (1 lb. to 500 gals.), and placed 15 caterpillars on the leaves. May 7, at 8-30 A. M., four were dead; May 8, at 11 A. M., three more; May 9, at 9 A. M., four more; May 11, at 9-30 A. M., one more, and May 12, at 9-30, all were dead.

Third Molt.

May 5, at 3 P. M., sprayed in the same maner, and placed 15 caterpillars on the leaves. May 7, at 9 A. M., four were dead; May 8, at 11 A. M., four more; May 9, at 8 A. M., three more, and May 11, at 9 A. M., all were dead.

Fourth Molt.

May 25, at 9 A. M., sprayed as above, and placed 15 caterpillars on the leaves. May 28, at 8 A. M., five were dead; May 29, at 8 A. M., five more had died, and June 1, at 9 A. M., all were dead.

One Pound Paris Green to 600 Gallons Water.

Second Molt.

May 2, at 2 P. M., sprayed a branch of apple tree with the above preparation, and placed 15 caterpillars on the leaves. May 6, at 8 A. M., three were dead; May 7, at 8 A. M., two more had died, and May 9, at 8 A. M., all were dead.

Third Molt.

May 4, at 2 P. M., sprayed in the same manner, and placed 15 caterpillars on the leaves. May 5, at 8 A. M., one was dead; May 6, at 8 A. M., four more had died, and May 7, at 8 A. M., all were dead.

Fourth Molt.

May 25, at 10 A. M., sprayed as above, and placed 15 caterpillars on the leaves. May 28, at 8 A. M., three were dead; May 29, at 8 A. M., two more; June 1, at 9 A. M., three more; June 2, at 9 A. M., one more, and June 4, at 8. A. M., all were dead.

One Pound Paris Green to 700 Gallons Water.

Second Molt.

May 9, at 10 A. M., sprayed a branch of apple tree with the above proportion of Paris green and water, and placed 15 caterpillars on the leaves. May 11, at 9 A. M., six were dead; May 12, at 9 A. M., two more, and May 13, at 8-30 A. M., all were dead.

Third Molt.

May 9, at 11 A. M., sprayed as above, and placed 15 caterpillars on the leaves. May 11, at 9 A. M., five were dead; May 13, at 9 A. M., two more had died, and May 14, at 8 A. M., all were dead.

Fourth Molt.

May 25, at 10 A. M., sprayed as above, and placed 15 nearly grown caterpillars on the leaves. May 28, at 8 A. M., two were dead; May 29, at 8 A. M., one more; June 1, at 9 A. M., one more; June 2, at 9 A. M., one more, and June 5, at 8 A. M., all were dead.

One Pound Paris Green to 800 Gallons Water.

Second Molt.

May 7, at 3 P. M., sprayed with the above preparation, and placed 15 caterpillars on the leaves. May 8, at 10 A. M., two were dead; May 9, at 8 A. M., three more had died, and May 13, at 9-30 A. M., all were dead.

Third Molt.

May 7, at 3-30 P. M., sprayed as above, and placed 15 caterpillars on the leaves. May 11, at 9 A. M., four were dead; May 12, at 9 A. M., four more, and May 14, at 8 A. M., all were dead.

Fourth Molt.

May 20, at 11 A. M., sprayed as above, and placed 35 caterpillars on the leaves. May 23, at A. M., six were dead; May 24, at 11 A. M., nine more; May 25, at 8 A. M., seven more; May 26, at 8 A. M., four more; May 28, at 8 A. M., six more, and May 29, at 8 A. M., all were dead.

One Pound Paris Green to 900 Gallons Water.

Second Molt.

May 11, at 4 P. M., sprayed with the above preparation, and placed 15 caterpillars on the leaves. May 14, at 8-30 A. M., four were dead; at 5 P. M., one more; May 16, at 9 A. M., nine more, and May 18, at 8 A. M., all were dead.

Third Molt.

May 11, at 3 P. M., sprayed as above, and placed 15 caterpillars on the leaves. May 14, at 8-30 A. M., one was dead; May 15, at 9

A. M., four more; May 16, at 9 A. M., five more; May 18, at 8-30 A. M., three more, and May 20, at 9 A. M., all were dead.

Fourth Molt.

May 20, at 10-30 A. M., sprayed as above, and placed 15 caterpillars on the leaves. May 22, at 8 A. M., two were dead; May 23, at 8 A. M., four more; May 24, at 11 A. M., five more; May 25, at 8 A. M., two more, and May 26, at 8-30 A. M., all were dead.

One Pound Paris Green to 1000 Gallons Water.

Second Molt.

May 13, at 2 P. M., sprayed a branch of apple tree with the above proportions of Paris green and water, and placed 50 caterpillars on the leaves. May 15, at 9 A. M., three were dead; May 16, at 10 A. M., eleven more; May 17, at 3 P. M., eight more; May 18, at 9 A. M., seven more; May 19, at 10 A. M., five more; May 20, at 9 A. M., twelve more, and May 21, at 8 A. M., all were dead.

Third Molt.

May 13, at 2-30, P. M., sprayed in a similar manner, and placed 50 caterpillars on the leaves. May 15, at 9-30 A. M., three were dead; May 16, at 9 A. M., five more; May 17, at 3 P. M., four more; May 18, at 10 A. M., seven more; May 19, at 8 A. M., six more; May 20, at 9 A. M., two more; May 21, at 9 A. M., two more; May 23, at 8 A. M., five more; May 24, at 11 A. M., nine more; May 26, at 8 A. M., two more, and June 1, at 9 A. M., all were dead.

Fourth Molt.

May 20, at 10 A. M., sprayed as above, and placed 25 caterpillars on the leaves. May 23, at 8 A. M., four were dead; May 24, at 11 A. M., five more; May 25, at 8 A. M., nine more; May 26, at 8-30 A. M., three more; May 29, at 8-30 A. M., three more, and June 1, at 9-30 A. M., all were dead.

The following table shows the proportions of Paris green and water used, and the time required to kill all the caterpillars in each molt.

TABLE.

Proportion of Paris Green to Water.	First Molt. Days.	Second Molt. Days.	Third Molt. Days.	Fourth Molt. Days.
1 pound to 100 gallons,	2	2	1	1
" 150 "	2	1	1	1
" 200 "	1	1	3	3
" 250 "	3	3	3	3
" 300 "	2	2	2	2
" 400 "	2	3	6	2
" 500 "		7	6	7
" 600 "		7	3	10
" 700 "		4	5	11
" 800 "		6	7	9
" 900 "		7	9	6
" 1000 "		8	19	12

CONCLUSIONS.

A careful consideration of these experiments leads us to the conclusions: 1st. That the smallest proportions, as 1 lb. to 800 or 1000 gallons, require so long a time to kill the caterpillars that they might wander off, or that showers might wash the Paris green from the trees before they would eat enough to kill them. 2d, That the large or nearly grown caterpillars are quite as readily killed by any of the proportions used in these experiments as those just hatched, or in early molts. 3rd, The proportions of one pound of Paris green to 100 gallons of water, or one pound to 150 gallons sprayed upon apple trees, in experiments that have been conducted here for three years past, have burned the foliage to such an extent as to injure the trees very materially; and these experiments lead us to conclude that the most suitable proportions to be used on apple trees in this region, and perhaps throughout the state, are one pound of Paris green to 200, 250 or 300 gallons of water.

CRANBERRY INSECTS.

The cranberry industry of Massachusetts is very large, and is increasing in importance every year. It is principally confined, however, to Barnstable, Plymouth and Bristol counties, where the climate seems to be peculiarly adapted to the growth of cranberries; but I can see no reason why suitable bogs in other parts of the state may not be successfully utilized for this purpose.

The *Yarmouth Register* of Dec. 20, 1890, gives the most complete statistics regarding this industry that I have been able to find. They were prepared by the editor, from data furnished by Mr. C. H. Nye, the Superintendent of the Old Colony Railroad, and indicate the number of barrels shipped and awaiting shipment on that road, for a period of eight years, as follows:

Cranberries shipped and on hand, Dec. 1,	1883,	32,079 barrels.
" " " " "	1884,	30,536 "
" " " " "	1885,	66,063 "
" " " " "	1886,	83,500 "
" " " " "	1887,	80,128 "
" " " " "	1888,	80,131 "
" " " " "	1889,	92,080 "
" " " " "	1890,	89,886 "

To this may be added the yield in Massachusetts for 1891, which has been estimated at 157,000 bbls. I do not know what average price was obtained for cranberries last fall, but think I am safe in estimating the value of last year's crop as high as $1,000,000. It is a difficult matter to estimate the loss caused by insects, over the entire cranberry region, but some of the cranberry growers told me that there was good reason to believe that the insects destroyed, on an average, one-half of the crop on the bogs that cannot be reflowed. This seems a large estimate, but, unless tobacco or some other insecticide is used on such bogs, it will not be many years before the insects will multiply to such an extent that the cultivation of cranberries on these bogs will be entirely profitless.

Early in 1891, I prepared and sent out a circular to all the cranberry growers whose names and addresses I could obtain, and received answers from a large percentage of them.

The following are some of the questions with their answers.

"*What area have you under cultivation?*"

The answers given to this question ranged from one-fourth of an acre to 314 acres. The highest numbers undoubtedly referred to corporation bogs where the individual owned a share in several, as the largest cultivated bog contains only 160 acres.

"*Are you troubled with insects?*"

Eighty-five per cent answered yes; fifteen per cent, no.

"*If so, what are they?*"

"Millers," "fire worm," "vine worm," "blackhead," "fruit worm," "berry worm," "tip worm," "cut worm," "girdle worm," "root worm," "span worm" and "spittle insects."

"*Have you used tobacco as an insecticide?*"

Of those who had used tobacco, 82 per cent reported good results and 18 per cent, bad or doubtful results.

"*If so, how many applications have you made in a year and with what results?*"

Of those who answered this question, 24 per cent had made one application; 40 per cent, two applications; 12 per cent, three; 18 per cent, four; 3 per cent, six; and 3 per cent, seven applications. 79 per cent of these reported good results; 11 per cent, doubtful, and 10 per cent, bad results.

"*Do you believe tobacco acts as a fertilizer?*"

81 per cent answered yes; 19 per cent, no

"*Do you believe that an excessive use of tobacco can injure the vines in any way?*"

67 per cent answered yes; 33 per cent, no.

"*Have you ever used kerosene emulsion to destroy cranberry insects; and, if so, with what results?*"

Only nine persons reported having used kerosene emulsion, four of whom reported good results, and five, bad. The trouble with these last, however, was that they did not make the emulsion properly, or did not apply it at the right time.

"*Have you ever used Paris Green on cranberry vines to destroy the insects; and, if so, what was the result?*"

Thirteen persons stated that they had used Paris green, with good results, and eight, with bad results; but these last did not use it properly. The use of this insecticide is discussed later in this paper.

"*Have you ever used London purple; and, if so, with what result?*"

Two persons report good results with this insecticide, and seven, bad.

"*Have you a prejudice against the use of Paris green or London purple because of their poisonous properties?*"

52 per cent answer yes; 48 per cent, no.

"*Have you ever known any accident from their use; and, if so, what?*"

Seventy-two persons answer no; two, yes. These two cases were the result of gross carelessness, and can in no way be used as an objection to the careful use of Paris green as an insecticide on cranberries, potatoes, or any other plants.

"*Have you ever tried any other insecticide; and, if so, what was it, and what was the result?*"

Twelve persons report trying various other substances, but the results were not such as to recommend them for general use.

"*Have you water so that you can reflow your bog to destroy the insects?*"

51 per cent have water; 34 per cent have no water, and 15 per cent have water on a part of their bogs.

"*If so, when do you let it on, and how long do you keep it on?*"

One person reflows just before the blossoms burst, and again when the fruit is set, and keeps the water on 24 hours. Two reflow any time before blossoming. Five reflow when the worms appear. One reflows two or three times before July 1, and keeps the water on from 6 to 12 hours. Six let the water on in April; nineteen in May; eleven in June, and one, July 1.

2	persons	keep	the	water	on	12 hours.
1	"	"	"	"	"	20 "
16	"	"	"	"	"	24 "
2	"	"	"	"	"	24 to 48 hours.
6	"	"	"	"	"	36 hours.
1	"	"	"	"	"	36 to 48 hours.
1	"	"	"	"	"	48 hours.
1	"	"	"	"	"	48 hours to 5 days.
3	"	"	"	"	"	3 days.
1	"	"	"	"	"	20 days.

This last was probably a mistake in answering the circular.

"*Do you practice the late holding of water on your bog; and, if so, when do you draw it off?*"

65 per cent answer yes; 35 per cent, no.

6	persons	draw	off	the	water	April 1.
1	"	"	"	"	"	1 to 10.
2	"	"	"	"	"	15.
1	"	"	"	"	"	20.
1	"	"	"	"	"	25.
1	"	"	"	"	"	28.
5	"	"	"	"		May 1.
1	"	"	"	"	"	1 to 15.
1	"	"	"	"	"	1 to June 1.
4	"	"	"	"	"	10.
4	"	"	"	"	"	15.
1	"	"	"	"	"	15 to June 1.
1	"	"	"	"	"	20.
1	"	"	"	"	"	20 to 25.
3	"	"	"	"	"	27 to 30.
8	"	"	"	"		June 1.
1	"	"	"	"	"	3.
1	"	"	"	"	"	6.
1	"	"	"	"	"	15.

"*Do you believe this destroys the eggs of insects on the leaves?*"

44 per cent answer yes; 56 per cent, no. Several think it will destroy the eggs if the water is warm. Some think that the longer the water is held, the more eggs will be destroyed.

"*Do you believe that the late holding of water injures the vines in any way?*"

53 per cent answer yes; 47 per cent, no. Some say that the only injury it does is to make the fruit late.

"*What do you think is the most desirable time in the spring to draw off the water, whether you have water for the second flow or not?*"

7	say	April 1.	
2	"	"	1 to 15.
1	"	"	1 to 20.
1	"	"	1 to May 1.
2	"	"	10.
1	"	before April 15.	
4	"	April 15.	
3	"	"	20.
1	"	"	20 to 30.
1	"	"	20 to May 10.

12	say	May 1.
2	"	" 1 to 10.
1	"	" 1 to 15.
1	"	" 1 to 20.
1	"	" 12.
7	"	" 15.
1	"	" 15 to 25.
1	"	" 15 to June 1.
3	"	" 20.
1	"	" 23.
2	"	" 25.
1	"	" 30.
1	"	last of May to June 1.
7	"	June 1.
1	"	June 12.
3	"	" as soon as all danger from frost is past."
1	"	May 25, for old vines; April 1, for young vines.

"*The eggs of the fire worm, vine worm, or black head, as it is called, in different places, are laid in the fall, and do not hatch till spring. Do you think, therefore, that an isolated bog could be cleared of them by destroying the vines, taking care not to injure the roots, in the fall or spring, and waiting for the vines to grow again?*"

77 per cent answer yes; 23 per cent, no. Several add, "in some cases."

"*Can a bog be burned in the fall so as to thoroughly destroy all the leaves having eggs upon them, without injuring the roots?*"

65 per cent answer yes; 35 per cent, no. Many add that it can be safely done if the ground is wet or frozen.

"*Can this be done in the spring without injury to the roots?*"

70 per cent answer yes; 30 per cent, no.

"*What will it cost per acre to burn a bog?*"

The answers to this question ranged from "a few matches" to $30.00, but the majority ranged from $1.00 to $5.00.

"*How long would you have to wait for a crop after burning the vines on a bog?*"

11	persons	answered	1 year.
1	"	"	1 to 2 years.
26	"	"	2 years.
5	"	"	2 to 3 years.

13	persons anwered	3 years.	
3	" "	3 to 4 years.	
1	" "	4 to 5 years.	
1	" "	4 years.	
1	" "	" forever, unless the roots were under water."	

"*If you do not think it safe to burn the vines on a bog, do you believe they could be cut, raked off and burned, without injuring the roots, even if left uncovered by the water during the winter?*"

85 per cent answer yes; 15 per cent, no. Some think it will depend much on whether the winter is mild or severe.

"*What do you think would be the cost per acre to cut, remove, and burn the vines?*"

The answers range from $5.00 to $100.00, but the majority range from $5.00 to $15.00.

The object of the last seven questions was to learn whether a badly infested bog could be cleared of the insects at a moderate cost without destroying the roots of the plants; and how much time would elapse before it would bear again. In case of a somewhat isolated bog, this might pay, but if it be near one that is infested, it is doubtful if it would prove a success.

When a new bog is made it is very important that vines to restock it should be obtained from some bog which is not infested, as they are set out at a time when the eggs of the vine worm are on the leaves; and if the vines are obtained from an infested bog, the new one will be stocked, not only with plants, but with insects also.

From the replies received and from my own observations on the bogs over the entire Cape, it seems that the vine worm does by far the greatest amount of damage, and that the fruit worm stands next in the list. The span worm is occasionally quite destructive, but I found only two bogs last summer on which it had done much damage; one at Pleasant Lake, owned by Mr. Cyrus Cahoon, and one in Carver, under the supervision of Hon. A. D. Makepeace to whom I am under obligations for much valuable information. Specimens of the span worm were sent here to the Insectary, but the studies on them have not yet been completed, and therefore no report can be made on them at this time. I recommended the application of Paris green in water, one pound of the former to 150 gallons of the latter, and two quarts of glucose or molasses. The object of the glucose was to cause the Paris green to adhere to the leaves and prevent it from being washed off so readily by showers. Mr. Makepeace has informed me that it did not appear to be very successful; but when I visited the bog, the span worms were nearly grown and the application was made later, probably too late to give good results.

Mr. Cahoon had applied Paris green to his bog nearly a week earlier, and when I visited it two days after the application was made, I was able to find but three or four living span worms on the bog, showing that the insecticide had proved effectual.

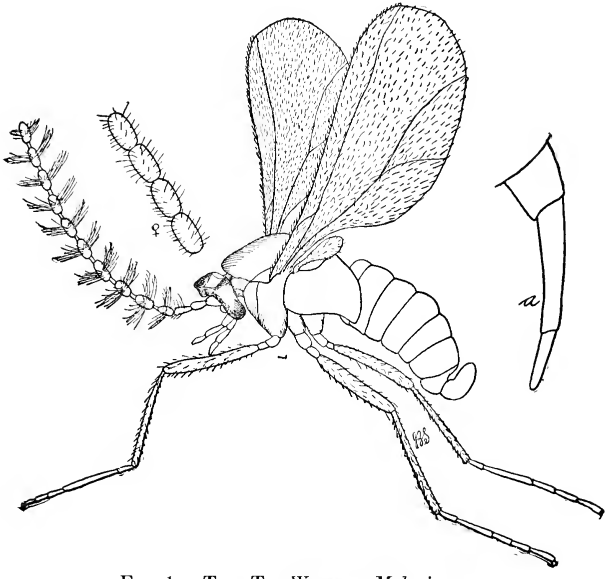


FIG. 1. THE TIP WORM. *Male imago.*
Antennal structure of female shown at left; *a.* ovipositor of female. Greatly enlarged. (After Smith.)

The tip worm (*Cecidomyia vaccinii* Smith) fig. 1, greatly enlarged, is comparatively common on the Cape bogs, and some people think they do much harm; but this is very doubtful, for if the tip worm destroys the terminal bud, lateral buds will develop into shoots the next year, and will give a crop of fruit. See fig. 2.

FIG. 2. WORK OF TIP WORM.

a. Cranberry vine—tip gone completely; *b.* vine showing appearance of infested tip; *c.* Loose-strife infested with tip worm; *d.* the same, showing flower buds struggling out; *e.* tipped vines, with forming fruit buds at axils of leaf. (After Smith.)

The other insects have not been sufficiently studied to report upon them at this time.

THE VINE WORM.

Rhopobota vacciniana, Pack.

This insect, known as the vine worm, fire worm or blackhead, was abundant on nearly every bog visited last summer, which had not been reflowed, or thoroughly treated with some insecticide.

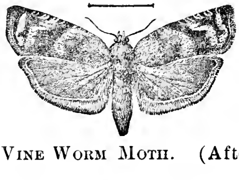


FIG. 3. VINE WORM MOTH. (After Riley.)

The moths, fig. 3, do not fly readily, but start up before one as he walks along, and then settle at once upon the vines. This habit prevents their spreading rapidly of their own accord. On the occasion of my first visit to the bogs at Yarmouth Farms, in June, 1890, the second brood of moths was out, and as we walked over the bog, they would start up by hundreds and settle immediately upon the vines.

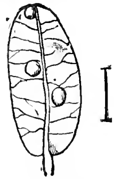


Fig. 4. Leaf Showing Eggs. (After Smith.)

They lay their eggs on the under side of the leaves, as shown in fig. 4, which is much enlarged, the line at the right indicating the true length of the leaf. Three eggs are shown in the figure, which are enlarged the same as the leaf.

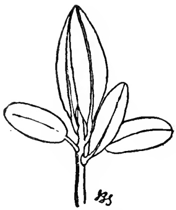


Fig. 5. First Web of Larva. (After Smith.)

Vine worms were received here at the Station, from Yarmouth Farms, June 2, 1890, which were fed on cranberry leaves and passed their transformations, the moths emerging June 10th. These moths paired and the females laid their eggs June 12th. The eggs are elliptical in outline, very much flattened, about one-thirtieth of an inch long, nearly the color of the yolk of a hen's egg, in the middle, but transparent around the edge. Under a microscope the surface is granulated, and has a few raised lines which form hexagons over the surface.

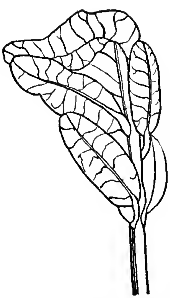


Fig. 6.
Runner with larval web. (After Smith.)

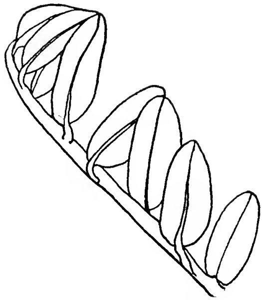


Fig. 7
Upright with larval web. (After Smith.)

The fully-grown larva, fig. 8, *a*, is nearly half an inch long, with the head and top of the next segment behind it jet black. The rest of the body is green with fine hairs scattered over the surface.

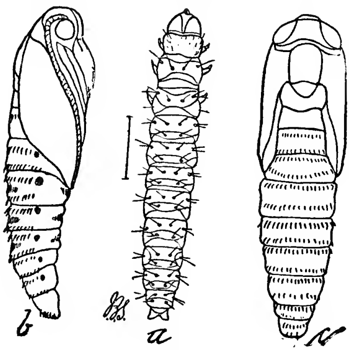


Fig. 8.
a, Larva; *b*, *c*, pupa from side and back. Much enlarged. (After Smith.)

The pupa, fig. 8, *b* and *c*, side and back view, greatly enlarged, is about one-fifth of an inch long, of a yellowish brown color, and the segments have a row of minute spines along each edge. The abdomen is blunt at the end which is furnished with a series of minute hooks.

The moth, fig. 3, much enlarged, has an expanse of wings of nearly half an inch, and is dark ashy gray tinged with brownish, and has oblique bands of a lighter color across the fore wings; while the hind wings are of a uniform dark smoky brown color.

On May 20th, 1891, some vine worms were received from Yarmouth Farms, and placed on growing cranberry vines in the Insectary. They fed until May 25th, when they changed to pupae, most of them in the sand, but one spun a white silken cocoon between the leaves on the plant, and changed to a pupa within it. After remaining in the pupal state seven or eight days, the moths emerged, and, after pairing, the females laid their eggs on the under side of the leaves. These eggs remain on the leaves during the winter and hatch in the spring.

Capt. N. B. Burgess of Yarmouth Farms, one of the most intelligent cranberry growers of Cape Cod, and to whom I am much indebted for numerous courtesies and great assistance in my studies on these insects, has constructed insect cages in which he has for several years kept cranberry plants growing, and has bred the vine worm, fruit worm and tip worm. By this means he has been able, in a comparatively short time, to learn the life history and habits of these insects in a very practical way.

Capt. Burgess informed me that the eggs of the vine worm, which were laid in the fall of 1890, hatched in his observation cages from April 23rd to May 1st, 1891; that the pupae were discovered in his cages and also on the bog June 1st, and from that time up to the 10th, when the moths first appeared; and eggs were discovered June 16th. The hatching of the eggs in the spring is retarded by the late holding of water; and, as the vines on one part of the bog may be out of water while other parts are submerged, the eggs will accordingly hatch at different times.

REMEDIES.

The cheapest and most effectual remedy for the vine worm is undoubtedly to reflow the bog after the eggs hatch; but, where this cannot be done, it is necessary to use insecticides. Mr. Makepeace, however, does not favor reflowing, as he thinks this injures the keeping qualities of the berries, and he therefore uses tobacco as an insecticide, even on bogs which he could reflow if he chose to do so.

I have not experimented with tobacco as the use of it is so well understood that it seemed unnecessary. A few, however, report unsatisfactory results with it, but it is possible that they did not use it at the right time or in a proper manner.

EXPERIMENTS WITH PARIS GREEN.

Seven vine worms were placed on growing cranberry plants, and ample time given them to web themselves up between the leaves; then, on June 22d, the plants were sprayed with Paris green in water in the proportion of one pound to 200 gallons. The spray was a very fine mist, and continued only until the plants were thoroughly wet. On the next day two were dead, and on the following day all were dead. An examination showed that they were enclosed by the leaves which were drawn together by their silk; and that they had eaten holes through the leaves, and when they reached the outside, they ate some of the poison and were killed by it.

A similar experiment was performed with seven other vine worms on growing plants, but they were showered with Paris green in water in the proportion of one pound to 300 gallons, and in two days they were all dead. As these experiments were performed with great care, and the insects very carefully watched throughout, there could be no mistake in the matter.

Wishing to ascertain what proportions of Paris green or London purple in water could be sprayed upon cranberry vines without injuring them, a plot of vines in the Insectary was sprayed with Paris green in water in the proportion of one pound to 150 gallons, and a similar plot with the same proportion of London purple in water, and no injury whatever resulted to the leaves. There was no fruit on these vines.

Similar plots were sprayed with Paris green and London purple respectively, in the proportion of one pound to 100 gallons, but without injuring the leaves.

A similar experiment was performed, using one pound of each of the above poisons to 75 gallons of water, and this injured the leaves; the Paris green only a very little, while the London purple destroyed about one-half of the leaves on the vines.

These experiments prove that it is not safe to use more than one pound of Paris green or London purple to 100 gallons of water on cranberry vines; and also that a much smaller proportion, as one pound to 200 or even 300 gallons, is amply sufficient to kill the vine worm.

The best results in the use of Paris green are obtained by mixing about two quarts of glucose, or (if that can not be obtained) molasses with 150 gallons of water and one pound of Paris green, and applying with a force pump and nozzle which throws the mixture in the form of the finest mist, and continuing till the plants are thoroughly wet but stopping before it begins to run off from them. As the Paris green is only in suspension in the water, it should be carefully stirred during all the time the spray is being thrown upon the plants.

Many of the cranberry growers who have tried Paris green for the vine worm report unfavorably, stating that it killed the worms but it injured the vines; and most of them informed me that they used a teaspoonful to a pail of water. Now, an ordinary pail cannot be carried about over a bog with more than two gallons of water in it. A teaspoonful of Paris green is an indefinite quantity. I therefore took a teaspoonful heaped up as full as it would hold, and very carefully weighed it in delicate balances. It weighed half an ounce, which in two gallons of water would be in the proportion of one pound to 64 gallons, which, as shown above, would injure the leaves. I then took a teaspoonful of Paris green somewhat heaped up and found that it weighed three-eights of an ounce which in two gallons of water would be equal to the proportion of one pound to 85 gallons, which would injure the leaves. I then filled the teaspoon and stroked it off with a stick leaving it only level full, and found that it contained just one-fifth of an ounce, which in two gallons of water would be in the proportion of one pound to 160 gallons, and if the Paris green is to be measured in a teaspoon, it should be taken level or even full only, for a pail of water.

THE FRUIT WORM.

Mineola vaccinii, Riley.

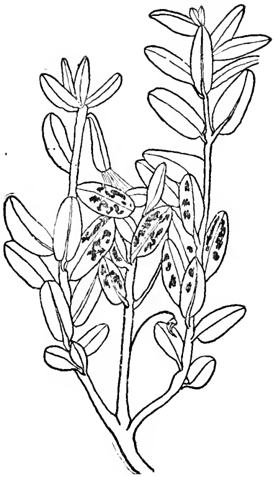


FIG. 9.
Web of second brood, showing their method of feeding. (After Smith.)

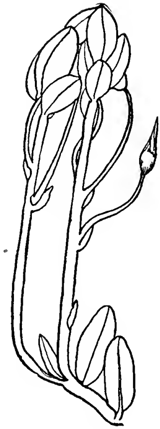


FIG. 10.
Web of second brood, inclosing buds of two uprights. (After Smith.)

This moth appears on the bogs about the time the berries are beginning to set, from the first to the middle of July, according as the season is early or late. They lay their eggs at the blossom end of the young berry, often beneath one of the triangular lobes of the calyx. The egg, fig. 11, b and c, is very much flattened, of a pale yellow color, and hatches in five or six days after it is laid. For a day or two it feeds on the outside of the berry, in the calyx, after which it makes its way into the berry, eats out the seed chamber, and then migrates to another. "The larva, fig. 11, d, reaches maturity in September, sometimes not being fully grown at picking-time. It is then rather more than half an inch in length, of a bright green color, usually with a reddish tinge on the back. The head is narrower than the first segment, and is of a paler, more yellowish color, except the mouth which is brown. The segments are transversely wrinkled and are clothed with a few sparse and rather long hairs." (Smith.)

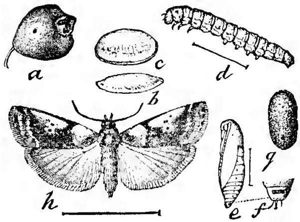


FIG. 11.

a, Berry, showing egg; *b*, *c*, egg from side and top; *d*, larva; *e*, pupa; *f*, its tip; *g*, cocoon. All enlarged. (After Riley.)

When fully grown, the larva leaves the berry and, descending to the ground, spins its cocoon, fig. 11, *g*, in the sand, within which it changes to the pupa, fig. 11, *e*, in which state it remains till the following July, when the moth, fig. 11, *h*, emerges and lays its eggs on the young berries.

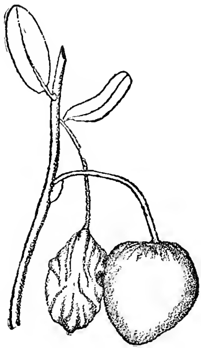


FIG. 12.

Work of berry worm, showing shriveled berry fastened to a sound one newly attacked. (After Smith.)

The best remedy that suggests itself for this insect is to spray the vines with Paris green, glucose and water in the same proportions and in the same manner as for the vine worm. The spraying should be done as soon as the blossoms are all off, and the berries are generally set.

Mr. Franklin Crocker of Hyannis, to whom I am greatly indebted for assistance in my studies on the cranberry insects, keeps a supply of pumps and other apparatus suitable for spraying bogs, as well as insecticides for that purpose.

There seems to be a prejudice among the cranberry growers against the use of Paris green as an insecticide, but when they realize how small an amount is used, and that this is entirely washed off before picking time, they will see that there is no possible chance for an accident. As evidence that the poison is soon removed, I will state the fact that a cherry tree was sprayed with Paris green in water, in Cambridge last summer, to destroy the gypsy moths; and four days afterwards, the fruit was picked and canned. The regulation Paris green scare then occurred, and two jars of the canned cherries were sent here to the Experiment Station and Dr. Goessmann made an analysis of the contents of each jar; but in neither of them was there found the slightest trace of arsenic or copper, and therefore they contained no Paris green whatever.

In closing this preliminary paper on the study of the cranberry insects, I take the opportunity to thank Prof. J. B. Smith for the use of some of the illustrations used in this paper, and it affords me pleasure to say that so far as my studies have already gone, they quite agree with the observations of Prof. Smith.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 20.

REPORT ON INSECTS.

JANUARY, 1893.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1893.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are:—

HENRY H. GOODELL, LL.D.,	*Director.*
WILLIAM P. BROOKS, B. SC.,	*Agriculturist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
CLARENCE D. WARNER, B. SC.,	*Meteorologist.*
WILLIAM M. SHEPARDSON, B. SC.,	*Assistant Horticulturist.*
MALCOLM A. CARPENTER, B. SC.,	*Assistant Horticulturist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Entomology.

C. H. FERNALD.

The insects treated of in this bulletin have been selected at the request of the Massachusetts Society for Promoting Agriculture, by whose liberality the edition has been increased to more than three times as many copies as could otherwise have been published; and, as a result, it will be sent to thousands of our citizens whose names are not now on our mailing list, including members of Village Improvement and other local societies.

These insects have been bred and experimented upon at the Insectary for several years past, and they have been described in the publications of the Department of Agriculture and some of the Experiment Stations, as well as elsewhere, so that it is now almost impossible to give anything new, but we have attempted to give a brief digest of what has been learned of their habits here and elsewhere.

There has been such culpable negligence on the part of many of our people with regard to the tent caterpillar, that there can be no doubt that some legislation is needed to compel the negligent to destroy this pest on all the trees on their own land, and thus prevent it from extending to the trees in the surrounding orchards. Provision should be made for the destruction of tent caterpillars on all public lands as well as in the forests, and village improvement societies should urge such action in town meetings as shall make it the duty of the superintendent of roads to destroy all the tent caterpillars on the trees and shrubs along the sides of the roads.

The wild cherry trees are the natural food plant of the tent caterpillar, and while some advocate their destruction because they serve as a breeding place for them, others think they may serve a useful purpose in drawing the moths to them where the caterpillars may be easily destroyed the following year.

CANKER–WORMS.

There are two different species of insects in Massachusetts known by the name of canker-worm, one of which is the spring canker-worm, (*Paleacrita vernata*, Peck.) Figs. 1 and 2, and the other is the fall canker-worm (*Anisopteryx pometaria* Harr.) Figs. 3 and 4.

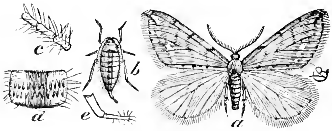


FIG. 1. SPRING CANKER-WORM.

a, Male moth; *b*, female moth, natural size; *c*, joints of her antennae; *d*, joint of her abdomen showing the spines; *e*, her ovipositor, enlarged.—After Riley.

The spring canker-worms emerge from the ground as soon as the snow is gone or even earlier in the spring. The wingless females, Fig. 1, *b*, crawl up the trunks of trees most actively in the evening when they pair with the males, Fig. 1, *a*, which are flying about at that time. The females then crawl out upon the branches and deposit their eggs in irregular clusters, in the crevices or under loose pieces of bark, by means of the long ovipositor, Fig. 1, *e*.

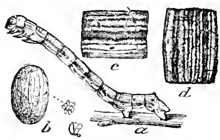


FIG. 2. SPRING CANKER-WORM.

a, Full-grown larva; *b*, egg, enlarged, the natural size shown in the small mass at one side; *c*, an enlarged joint, side view; *d*, the same, back view, showing the markings.—After Riley.

The eggs, Fig. 2, *b*, natural size and enlarged, are oval in outline, about one-thirtieth of an inch long, of a delicate pearly yellowish color, and hatch about the time the leaves burst from the buds.

The larvae or young caterpillars have three pairs of true legs, situated on the three segments following the head, and two pairs of abdominal legs, and therefore move by alternately looping and extending their bodies, and are known as loop-worms, inch-worms, or measuring-worms. When fully grown they are from seven-tenths to eight-tenths of an inch in length, of a dark brown color, with five broken lines of a lighter color running lengthwise, Fig. 2, *a*.

At this time, and even while small, they often let themselves down from the trees by a silken thread and hang suspended in the air, much to the annoyance of persons passing under the trees. They are also caught by passing vehicles and carried to places more or less remote, thus greatly facilitating their distribution.

After they are fully grown and done feeding, they descend to the ground and burrow to the depth of three inches or more, where they spin a fragile cocoon of dull yellowish silk within which they transform to pupae, and remain in this state till the following spring, when the moths emerge, ascend the trees and lay their eggs for another generation. A few of the individuals, however, emerge in the fall and lay their eggs, but these do not hatch till the following spring.

The male, Fig. 1, *a*, is of a pale ash color with a paler broken band across the fore wings, near the outer margin, and three interrupted brownish lines between that and the base. The hind wings are of a very pale ash color or very light gray, with a darker dot near the middle. The female, Fig. 2, *b*, is wingless and of the same color as the male.

The fall canker-worms (*Anisopteryx pometaria*, Harr.) emerge from the ground late in the fall, after the leaves have fallen from the trees and frosts have appeared. The females climb the trees attended by the males which hover around on the wing. After the mating of the moths, the females lay their eggs side by side in regular masses, Fig. 3, *e*, often as many as a hundred together, in an exposed situation on the twigs or branches of the trees. Sometimes the females, by mistake, crawl up on the side of a building and deposit their clusters of eggs on the exposed surface.

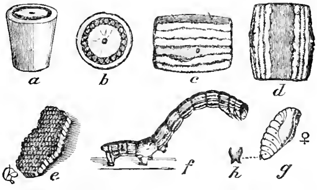


Fig. 3. Fall Canker-Worm.

a, *b*, Egg, side and top views; *c*, *d*, joints of larvae, side and top views, showing markings, enlarged; *e*, cluster of eggs; *f*, full grown larva; *g*, female pupa, natural size; *h*, cremaster enlarged.—After Riley.

The eggs are in the form of a truncated cone, and attached by the smaller end, while the other end has a dark rim with a depressed center, Fig. 3, *a* and *b*. These hatch in the spring at about the same time as the other species, and the larvae have similar habits to those of the spring species.

The mature larvae are nearly an inch long, varying in color from a greenish yellow to dark brown, with pale stripes running lengthwise; and they differ from the other species still further in having three pairs of abdominal legs, Fig. 3, *f*. After they are done feeding, they descend from the trees and burrow into the ground where they pass their transformations, and the moths emerge late in the fall.

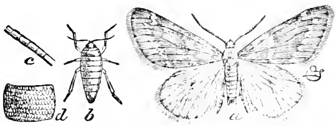


FIG. 4.—FALL CANKER-WORM.

a, Male moth; *b*, female moth, natural size; *c*, joints of her antennae; *d*, joints of her abdomen—enlarged.—After Riley.

The males have well developed wings which expand nearly an inch and a half, and are of a pale gray or ash color. The forewings have two rather irregular whitish bands across them, and the hind wings have a faint blackish dot on the middle and a more or less distinct whitish band outside of it, Fig. 4, *a*. The females are pale gray or ash color and about three-tenths of an inch long, Fig. 4, *b*.

REMEDIES.

As the females are wingless and pass their transformations under ground, and are obliged to crawl up the trunks of the trees to deposit their eggs, one method is to prevent their ascent by putting bands of heavy paper around the trunks, and painting them with some sticky preparation, as printer's ink, or tar softened with oil.

Another method is to put a trap of zinc or tin around the trunks of the trees in such a manner as to prevent the females from ascending the trees. Care must be taken in putting the bands and traps around the trees, to have them fit so tightly that neither the female moth nor the newly-hatched larvae can find a passage beneath.

Probably the most effectual method is to shower the trees with paris green in water as soon as the eggs have hatched in the spring.

THE APPLE-TREE TENT-CATERPILLAR.

Clisiocampa americana, Harr.

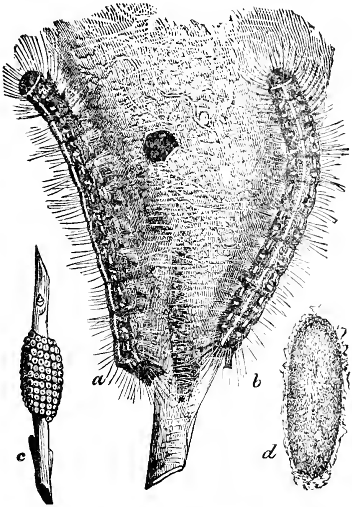


FIG. 5. APPLE-TREE TENT-CATERPILLAR.

a and *b*, full grown caterpillars resting on the tent; *c*, belt of eggs; *d*, cocoon, all natural size.—After Riley.

This species was described in bulletin No. 12, of this Station, and is prepared again with additional facts and illustrations for publication at this time. It has been so very abundant and destructive throughout the Commonwealth for several years past as to attract very general attention. The large whitish, silken, web-like tents, Figs. 5 and 6, *d*, formed by these insects have been very unsightly objects on the fruit trees in our orchards and along the road sides, as well as on wild cherry trees in all our forests where these trees are allowed to grow.

The amount of damage which this insect has done is far greater than is generally supposed.

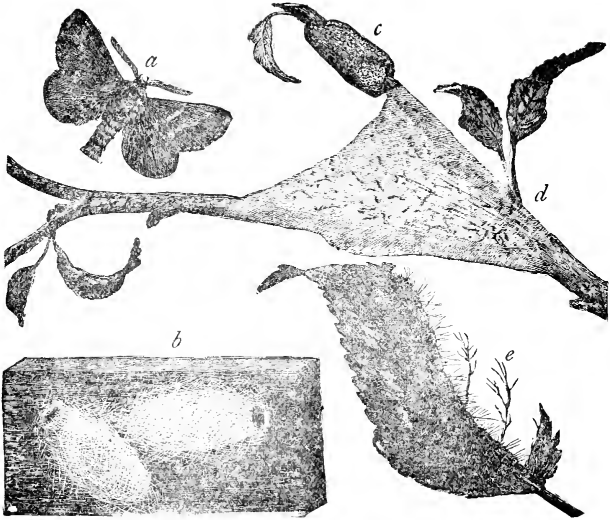


FIG. 6. APPLE-TREE TENT-CATERPILLAR.

a, Male moth; *b*, cocoons; *c*, belt of eggs; *d*, a small tent; *e*, full grown caterpillar,—all natural size.—After Comstock.

The female moth, Fig. 7, lays her eggs, about three hundred in number, in a belt, Fig. 5, *c* and 6, *c*, around the twigs of apple, cherry and several other kinds of trees, covering them with a thick coating of dark brown glutinous matter which probably serves as a protection during the winter.

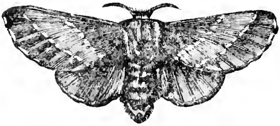


FIG. 7. APPLE-TREE TENT-CATERPILLAR.

Female moth, natural size.—After Riley.

The following spring, when the buds begin to swell, the eggs hatch and the young caterpillars seek some fork of a branch where they spin their tent and remain when not feeding. They are about one-tenth of an inch long, of a blackish color, with numerous fine gray hairs on the body. They feed on the young and tender leaves, eating on an average two apiece each day, therefore the young of one pair of moths consume from ten to twelve thousand leaves; and it is not uncommon to see from six to eight tents on a single tree, the caterpillars of which destroy more than seventy-five thousand leaves by the time they cease feeding. They do not go out of their tents to eat in damp cold weather, but appear to take two meals a day when it is pleasant. As the caterpillars grow, they molt or cast off the old skin which splits along the back. In from thirty-five to forty days after hatching, they reach their full growth, Fig. 5, *a* and *b*, Fig. 6, *e*. They are then about two inches long and have a black head and body with numerous yellowish hairs over the surface. There is a white stripe along the middle of the back, with minute whitish or yellowish broken and irregular streaks along the sides, and a row of small, transverse, pale blue spots along each side of the back.

As they crawl about, they spin a continuous thread of silk from a minute fleshy tube, on the lower side of the mouth, which is connected with the silk-producing glands within the body, and by means of this thread they appear to find their way back from the leaves to their tent which is formed by the combined efforts of all the caterpillars in the community.

After reaching their full growth, about the middle of June, they leave their tents and scatter in all directions, seeking some protected place where they spin their spindle-shaped cocoons of whitish silk intermingled with sulphur-colored powder, Figs. 5, *d* and 6, *b*. They change to the pupal state within these cocoons, and remain in them from twenty to twenty-five days. In July the moths emerge and, after mating, the females lay their eggs around the twigs of trees where they remain through the winter and hatch in the early spring, when the buds on the trees begin to open.

The moths measure from one and a quarter to one and a half inches or more between the tips of their expanded wings. They are of a reddish brown color, the fore wings being tinged with gray on the base and middle, and crossed by two oblique whitish stripes, Fig. 6, *a*, male, Fig. 7, female.

REMEDIES.

Search the trees carefully, when they are bare, for clusters of eggs and when found, cut off the twigs to which they are attached and burn them.

As soon as any tents are seen in the orchard or elsewhere, they should be crushed with their entire contents, or swabbed down with strong soapsuds or other substance, or torn down with a round bottle-brush, or burned with a torch on the end of a pole. This work of destroying the caterpillars in their tents should be done early in the morning, late in the afternoon or on a cold wet day when they are all in their tents.

When the trees are infested with canker worms or other leaf-eating insects, as well as tent caterpillars, or when these are numerous, it will be better to spray the trees with paris green in water in the proportion of one pound of the former to 150 to 250 gallons of the latter.

THE FALL WEB-WORM.

Hyphantria cunea, Drury.

This native American insect is very abundant throughout Massachusetts, forming unsightly webs over the ends of the branches of fruit and nearly all other deciduous trees, in August and September, and are supposed by many to be the apple-tree tent-caterpillar, but these form their tents during the early part of the season, in April and May.

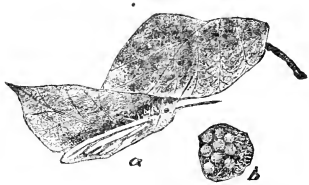


FIG. 8. FALL WEB-WORM.

a, Moth in position on leaf laying eggs, side view; *b*, eggs enlarged.—After Riley.

The moths are on the wing in July, and lay their eggs, about five hundred in number, in clusters on the leaves near the end of a branch, Fig. 8. These eggs, which are spherical, about one-twentieth of an inch in diameter, and of a bright golden yellow color, have the surface of the shell marked with indentations like the surface of a thimble. They hatch in about a week or ten days and the young caterpillars at once spin a web over themselves, and by their combined efforts enclose leaves enough for their present needs, but when this supply is exhausted they extend their web over a fresh supply, and this is continued till many of these webs are a yard or more in length and a foot or more in diameter. When numerous, they do a great deal of damage, sometimes destroying all the leaves on a tree.

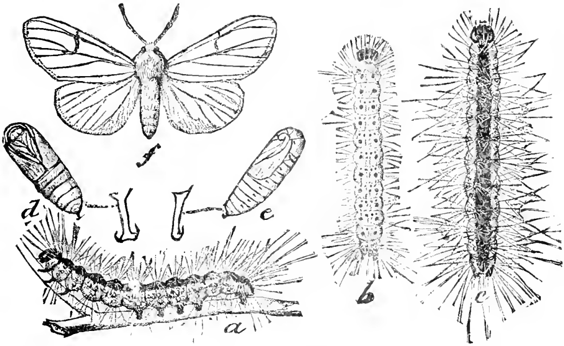


FIG. 9. FALL WEB-WORM.

a, Dark caterpillar, seen from side; *b*, light caterpillar from above; *c*, dark caterpillar from above; *d*, pupa from below; *e*, pupa from side; *f*, moth.—After Riley.

In the latter part of August or early in September, these caterpillars reach their full growth, and are then about an inch and a half long with the body greenish yellow dotted with black. There is a bright yellow stripe along each side, and a broad blackish stripe along the back in some specimens, as shown in Fig. 9, *b*. They are thinly clothed with grayish hairs which arise from black and orange colored tubercles. They now leave their web and scatter in all directions seeking some place in which to change to pupae, usually in some crevice under the bark, or under ground. When they have reached a satisfactory shelter they spin a slight cocoon of silk intermixed with hair from their own bodies, and within these cocoons they transform to pupae, Fig. 9, *d* and *e*, where they remain till the following June or July when the moths emerge. There are said to be two broods in a year in the South but only one in the North. I have seen no satisfactory evidence that there is more than one brood in Massachusetts.

The moths are snow white with the first two joints of the fore legs yellow, and the outer joints of all the legs broadly ringed with black

The wings expand from an inch and an eighth to an inch and three-eighths. Fig. 9, *f*, represents an unusually large moth of this species. The moths in this State, as a rule, have pure white fore wings, but sometimes, especially further south, they are more or less dotted or spotted with dark brown or black as shown in Fig. 10, *a* to *j*. I have never taken a spotted example in Massachusetts and only one in Maine. Possibly the normal northern form is pure white and the southern form spotted.

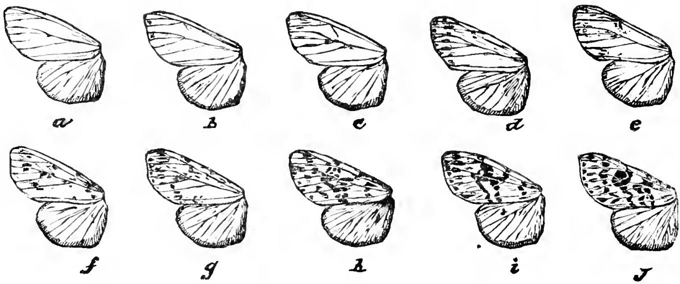


FIG. 10. FALL WEB-WORM.

a–j. Wings of a series of moths, showing the variations from the pure white form to one profusely dotted with black and brown.—After Riley.

The Fall Web-worm has numerous enemies among the birds and predacious and parasitic insects, but even with all these checks, they are numerous enough to do a vast amount of injury, and their unsightly webs are far too numerous on our fruit and ornamental trees.

A series of experiments was made on this insect with paris green at the Insectary the past season, but with negative results. Paris green in water was showered upon a branch having a web on it, but the mixture failed to penetrate the web and wet the enclosed leaves, and only those that ate the leaves outside of the web were killed. I do not see how this method can be really serviceable except when they feed outside of their web. I am of the opinion that the most practical, and at the same time the cheapest way to destroy these insects, is to crush them in the webs when they are within reach, or to cut off the small branches containing the webs with long pruning shears, and burn or crush them.

THE TUSSOCK MOTHS.

There are three different species of Tussock Moths in Massachusetts, the first of which is the most common and is known as the White-marked Tussock-moth (*Orgyia leucostigma*, A. and S.). This insect is a native of this country and was figured and described by Abbot and Smith in 1797. Since that time it has received the attention of nearly all of our entomologists.

The eggs of this species, laid on the cocoon of a female attached to a twig of tulip-tree, was brought to the Insectary, April 22, 1891. They were arranged in an irregular cluster containing about 225 in number and were covered by a white, glistening, frothy substance. The eggs are globular with a slight depression on the top, about one twenty-fifth of an inch in diameter and are yellowish white with a pale brown spot on the top and a ring of the same color around it.

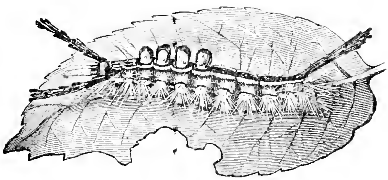


FIG. 11. WHITE-MARKED TUSSOCK-MOTH.
Full grown caterpillar.—After Riley.

These eggs hatched May 10, and the caterpillars passed their molts (the description of which is omitted here) and reached maturity June 15. The full grown caterpillars, Fig. 11, are about an inch and an eighth in length, of a bright yellow color, sparingly clothed with long, fine yellow hairs on the sides of the body, and having four short, thick, brush-like, yellowish tufts on the top of the fifth and the three following segments, two long black plumes or pencils extending forward from the sides of the second segment, and a single plume on the top of the twelfth segment. The head and top of the second segment and also two retractile tubercles on the top of the tenth and eleventh segments are bright red; there is a narrow black or brownish stripe along the top of the back and a wider dusky stripe on each side of the body.

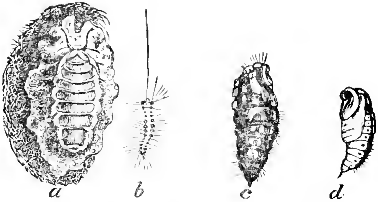


FIG. 12. WHITE-MARKED TUSSOCK-MOTH.

a, Female on cocoon; *b*, young caterpillar; *c*. female pupa; *d*, male pupa.—After Riley.

On June 15, they commenced spinning their cocoons and the moths emerged June 21. After mating, the females laid their eggs on the old cocoon which they usually attach to a leaf adhering to a branch of the tree. These eggs of the second generation hatched July 8, passed their transformations, and pupated August 10. The moths of this brood emerged August 23, and laid their eggs which remained through the winter and hatched the next spring, thus giving two generations a year in this State. Fig. 12, *a*, represents the cocoon partially covered with the egg cluster upon which is represented the wingless female moth; *b*, a young caterpiller suspended by a thread; *c*, a female pupa, and *d*, a male pupa.

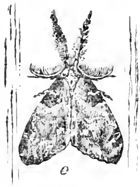


FIG. 13. WHITE-MARKED TUSSOCK-MOTH.

Male.—After Riley.

The male, Fig. 13, expands about an inch and a quarter, and is of a dull ashy gray color with several wavy dark brown lines crossing the fore wings which are whitish along the front edge with a small black spot near the apex and a small white spot near the anal angle. The antennae are heavily fringed. The females are lighter gray than the males and have no wings, only the rudiments of them being visible. The body is oval in outline and quite plump before the eggs are laid, Fig. 12, *a*.

This species feeds on the leaves of nearly all deciduous trees, and fir, spruce, larch and cypress.

The second species is called the Willow Tussock Moth (*Orgyia definita*, Pack.) and was for a long time confounded with the preceding species with which the male and female moths agree very closely, but there are marked differences in the other stages.

The eggs are laid in the fall in clusters on the old cocoon adhering to the branches of trees, and covered with hair from the abdomen of the female, which enables one to distinguish them from the white, froth-covered eggs of the white-marked Tussock-moth or the naked eggs of the following species.

The full grown caterpillar has the head and body pale yellow with an almost colorless stripe along the middle of the back. This stripe is narrow, and greenish on the third and fourth segments, widening and enclosing the yellow, dorsal brush-like tufts on the fifth, sixth, seventh and eighth segments, narrowing on the ninth, tenth, eleventh and twelfth segments, enclosing the two retractile tubercles, and is absent on the last segment. There is a narrow subdorsal and a fainter stigmatal band. These bands vary in color from dark brown to black, and there is a velvety-black spot between the tufts on the top of the sixth, seventh and eighth segments. The tubercles are all pale yellow, and a long pencil of black hairs inclining forward arises from each side of the second segment, while a similar one of light brown and black hair inclines backward from the top of the twelfth segment. The other hair is long, thin and white.

This species feeds on the leaves of the willow, oak, maple and many other trees.

The third species of Tussock Moth is the common European *Orgyia antiqua*, Linn. This species has long been known in this country, but was supposed to be distinct and was described by Dr. Fitch as the Modern Vaporer Moth (*Orgyia nova*), and again by Mr. Henry Edwards from Californian specimens as *Orgyia badia*.

The female is wingless like the other species, and lays her eggs without any covering on the old cocoon which is fastened to the branch of a tree. A cluster of these eggs was received from Fitchburg, Mass., April 14, 1891, on a branch of quince, and began to hatch April 22. The caterpillars reached their full growth and began to spin cocoons June 15. The first moths emerged June 25, and eggs were laid July 5, which hatched on the 15, but the caterpillars died before reaching maturity. Whether there are more than two broods in this State I am unable to say.

The detailed descriptions of the various stages of these moths have been omitted as they would have but little interest for those for whom this bulletin was especially prepared.

This insect is said to feed in Europe on plum, apple, mountain ash, rose, apricot, raspberry, bilberry, heath, hornbeam, hazelnut, alder, willow, beech, birch, oak, pine and many other plants.

In this country it has been found feeding on the leaves of rose, plum, apple, quince, thorn, aspen, and birch.

REMEDIES.

As these three Tussock Moths are so similar in their general habits they may be dealt with alike. They all pass the winter in the egg stage on the old cocoons fastened to the branches of the trees, and are easily seen during the fall, winter and spring while the trees are bare when they may be removed and destroyed. If, however, they have been neglected and allowed to hatch, the caterpillars may be destroyed by spraying the trees with paris green in water, in the proportion of one pound of the former to 150 or 200 gallons of the latter.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 21.

REPORT ON FRUITS.

APRIL, 1893.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE
1893.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.*
Clarence D. Warner, B. Sc.,	*Meteorologist.*
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Malcolm A. Carpenter, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Horticulture.

SAMUEL T. MAYNARD.

The work of this division for the year of 1892 has been, largely, the comparative tests of new varieties of fruits, the combatting fungous diseases and the use of fungicides and insecticides combined.

The season was, as a whole, less favorable for the growth of fungous diseases than that of 1891, but enough of nearly all the most destructive species were found for full experiment and all insect life seemed more than usually abundant.

The fungicides used and found most satisfactory, were the copper salts, sulphate and carbonate of copper, the *Bordeaux mixture* proving much safer and more effectual than any other.

Many patented or compounded fungicides put upon the market with large claims for their value have been tried but none of them have proved as effectual as the copper solutions, while some of them were of no value whatever.

The following are the fungicides found most effective:

Bordeaux Mixture. Formula, 6 lbs. Copper Sulphate (Blue Vitriol), Caustic Lime (Unslacked Lime) 4 lbs. Dissolve the copper sulphate in three or four gallons of water. (The best way to do this is to suspend it, in a coarse sack or basket, in the water where it will dissolve in from 1 to 2 hours.)

The Lime is slaked in another tub or vessel with water enough to make a thin lime-wash (or white wash). When the liquids are cool, pour into one cask, thoroughly mixing, and dilute to make 50 gallons of liquid. Before putting into the pumps strain through a fine strainer or sieve.

If a large quantity is to be used, 25 lbs. or more of the copper sulphate may be dissolved at once and the proper quantity taken out as needed.

Ammoniacal Carbonate of Ammonia.

Formula a. 1 oz. Copper Carbonate,6 ozs. Ammonium Carbonate. Dissolve the two together in water and dilute to 10 or 20 gallons of liquid.

Formula b. 1 oz. Copper Carbonate, 1 pint liquid ammonia 26°. Make a paste of the first with a little water and gradually pour over the ammonia until a clear blue liquid is formed. Dilute to 10 or 20 gallons of liquid.

Copper Sulphate. (Simple Solution.)

Formula a. 1 lb. Copper Sulphate to 25 gallons of water. This solution is used for spraying trees, shrubs and vines before the leaves unfold.

Formula b. 1 lb. of Copper Sulphate to 1000 gallons of water. This is found as strong as can be used under all circumstances, upon the foliage of fruit trees without injury.

PUMPS.

The "knapsack" is found an economical pump for gardens and small vineyards or for a small number of trees, but when large vineyards or orchards of considerable size are to be treated the large pumps attached to a cask or tank are by far more economical.

COMPARATIVE TESTS OF VARIETIES OF SMALL FRUITS.

STRAWBERRIES.

The strawberry crop of 1892, in most sections of the State, was very unsatisfactory. Those beds not fully protected by mulch were seriously injured during the winter, while drought at the time of ripening materially reduced the crop.

Choice fruit sold for high prices, while the ordinary grades, which were perhaps not inferior to that of the average season, notwithstanding the limited supply did not bring more than the average price for such fruit.

This condition of affairs is a forcible illustration of the necessity on the part of the grower of employing every means possible to produce better fruit.

We may give it as an axiom in fruit growing, "That good fruit increases the demand, while poor fruit decreases the demand." The more good fruit a community has the more it wants and the prices rule high when the fruit is of superior quality.

It costs less per quart to pick and market fruit when the size and quality is superior, and the successful fruit grower is the one who, by energy and vigilance, provides the necessary conditions of soil, cultivation and protection from fungous and insect pests.

In testing the varieties of fruits in the experiment plots, the conditions are made, as nearly as possible, like those under which they are grown by the practical business fruit grower.

These plots are arranged so that each variety shall have, as nearly as possible, the same conditions. A part of the plants of each variety are grown in hills while the same number are allowed to grow into the matted row.

When a variety shows decided merits after two or more seasons' trial in the plots, it is planted in the field and given the same careful attention as to yield, etc. as it received in the plots until its value is established.

To test the hardiness of varieties all were left uncovered during the winter of 1891 and 1892. The results of the trials for the season of 1892 are given in the following table:

STRAWBERRIES.

EXPLANATION OF TABLE.

Sex, p, pistillate; s, staminate, or bisexual.
Winterkilling is given in per cent.
Yield is given in pounds and ounces for 12 plants in hills, and the mean made by 12 other plants.
Quality, m, medium; g, good; p, poor.
Size, v l, very large; l, large; m, medium; s, small.
Firmness, f, firm; m, medium; s, soft.

VARIETY.	Sex.	Per cent of Winterkilling.	Date of Bloom'ng		Date of Ripening		Date of last picking		Quality.	Yield		Size.	Firmness.
										lbs.	ozs.		
Arlington	p	.00	May	7	June	10	June	29	p	2	15	s	f
Barton's Eclipse	p	.08	"	13	"	10	July	2	m	9	9	l	m
Beder Wood	s	.06	"	9	"	10	"	2	g	6	12	m	f
Belmont	s	.16	"	18	"	18	"	5	g	1	5	l	f
Beseck	s	.25	"	9	"	20	"	2	p	0	7	s	m
Boynton	p	.00	"	13	"	8	"	2	m	6	13	l	f
Bubach No. 5	p	.25	"	14	"	10	June	29	g	5	10	l	f
Bubach No. 24	s	.18	"	14	"	14	"	27	g	0	9	l	f
Bubach No. 132	s	.12	"	9	"	13	"	29	m	2	12	l	f
Burt	s	.24	"	13	"	14	July	2	m	4	11	m	f
Champion	p	.20	"	13	"	13	"	9	p	3	2	l	s
Chas. Downing	s	.15	"	9	"	14	"	2	g	5	15	m	s
Clara	s	.55	"	18	"	20	"	2	m	0	15	m	f
Cornelia	p	.16	"	26	"	22	"	2	m	3	4	m	f
Crawford	s	.40	"	14	"	16	"	2	p	0	4	m	f
Crescent	p	.00	"	9	"	10	"	2	g	7	15	m	f
Dutton	p	.16	"	16	"	18	June	29	p	1	2	l	f
Edgar Queen	p	.00	"	9	"	12	July	2	g	9	3	l	f
Eleanor	s	.16	"	18	"	20	"	2	g	0	10	l	m
Emerald	s	.04	"	13	"	13	June	27	m	0	5	m	f
Eureka	p	.24	"	5	"	10	July	5	g	2	15	l	f
Farnsworth	s	.28	"	9	"	11	June	27	p	3	14	m	f
Florence	s	.24	"	14	"	20	July	5	p	6	6	l	f
Felton	s	.10	"	18	"	18	"	2	g	2	7	l	f
Gandor	s	.30	"	16	"	14	"	5	m	4	6	l	f
Gandy	s	.12	"	16	"	18	"	5	g	4	7	l	f
Garritson	p	.20	"	14	"	16	June	29	m	2	8	l	f
Glendale	s	.12	"	14	"	18	July	2	g	2	6	m	f
Golden Defiance	p	.24	"	18	"	20	"	5	m	5	2	l	f
Gov. Hoard	s	.04	"	13	"	14	"	2	g	2	4	l	m
Gypsy	p	.04	"	13	"	9	"	2	g	3	6	m	f
Hatfield	s	.20	"	13	"	11	June	29	g	2	9	l	f
Haverland	p	.04	"	13	"	9	July	2	g	6	2	l	f
Henderson	s	.20	"	18	"	20	"	2	g	2	8	m	m
Hinsmore	s	.15	"	14	"	18	"	9	g	4	10	l	f
Howard's No. 6	p	.00	"	13	"	10	"	2	g	8	3	m	f
Indiana	s	.00	"	5	"	10	June	29	m	5	14	m	f
Jersey Queen	s	.12	"	13	"	14	July	5	m	5	0	l	f
Jessie	s	.12	"	7	"	13	June	29	g	3	3	l	f
Jucunda	s	.16	"	18	"	16	"	29	g	1	12	m	f
Lady Rusk	p	.20	"	13	"	13	July	5	m	5	5	m	m
London	s	.15	"	14	"	14	"	2	g	6	3	l	f

STRAWBERRIES CONTINUED.

VARIETY.	Sex.	Per cent of Winterkilling.	Date of Bloom'ng		Date of Ripening		Date of last picking.		Quality.	Yield lbs.	Yield ozs.	Size.	Firmness.
Mammoth	s	.24	May	14	June	10	July	2	p	2	2	l	s
Margaret	p	.04	"	5	"	7	June	29	p	3	8	s	m
Martha	p	.04	"	5	"	14	July	2	g	13	1	l	m
Miami	p	.16	"	13	"	14	"	2	p	7	3	m	f
Michel's Early	s	.00	"	18	"	10	June	21	m	3	14	m	m
Middlefield	p	.12	"	18	"	14	July	2	g	5	3	l	f
Miller's Seedling	s	.00	"	18	"	16	"	9	p	3	7	m	m
Miner's Prolific	s	.24	"	7	"	17	June	29	g	3	8	l	f
Moore	s	.20	"	18	"	20	"	29	g	1	5	l	m
Mrs. Cleveland	p	.04	"	5	"	10	"	29	m	4	1	m	f
Mt. Holyoke	s	.00	"	9	"	8	"	29	m	4	8	v l	m
Our Choice	p	.20	"	16	"	20	July	2	m	4	13	l	f
Pacific	p	.20	"	14	"	11	"	5	m	6	14	l	f
Parker Earle	s	.06	"	9	"	8	"	9	g	9	7	l	f
Parmenter's Seedling	p	.04	"	13	"	14	"	5	p	8	11	l	m
Pine Apple	s	.12	"	18	"	17	"	9	g	2	12	l	m
Pioneer	s	.20	"	13	"	14	"	2	m	1	5	m	f
Pomona	s	.08	"	9	"	11	"	9	m	5	6	l	f
Porter's Seedling	s	.16	"	25	"	10	June	29	m	3	2	m	f
Price's Seedling	s	.25	"	25	"	8	"	27	p	1	1	s	f
Puritan	s	.25	"	19	"	21	"	29	m	0	11	m	f
Sadie	p	.04	"	5	"	8	July	2	p	8	10	s	f
Saunders	s	.02	"	24	"	14	"	2	g	7	14	l	f
Seedling No. 6	s	.04	"	13	"	13	"	2	m	10	0	m	f
Seedling No. 10	s	.28	"	5	"	13	"	2	g	4	3	m	m
Seedling No. 11	p	.20	"	16	"	12	"	5	p	6	8	s	m
Seedling No. 23	s	.12	"	13	"	9	"	2	g	3	15	s	f
Seedling No. 24	s	.08	"	18	"	18	"	9	m	8	13	l	f
Seedling No. 28	s	.40	"	14	"	11	June	29	g	3	8	m	f
Seedling No. 29	p	.12	"	5	"	8	July	9	m	4	1	m	m
Seedling No. 34	s	.05	"	5	"	9	June	27	p	1	1	s	f
Seedling No. 35	s	.08	"	9	"	13	July	2	p	4	5	m	f
Seedling No. 40	s	.40	"	5	"	10	June	29	p	2	13	m	m
Seedling No. 41	s	.50	"	14	"	10	"	29	p	0	10	s	s
Seedling No. 42	s	.25	"	16	"	11	"	29	p	1	15	m	f
Seedling No. 44	s	.45	"	9	"	13	"	29	g	2	5	m	m
Seedling X	p	.20	"	13	"	13	July	5	g	9	5	l	m
Seedling XX	s	.04	"	5	"	8	June	29	m	7	0	m	m
Sharpless	s	.16	"	13	"	14	July	2	g	3	12	v l	f
Shaw	s	.04	"	19	"	20	"	2	g	2	5	l	m
Shuster's Gem	p	.08	"	5	"	8	"	2	m	6	3	m	f
Standard	p	.18	"	13	"	13	"	5	g	2	1	m	f
Stayman's No. 1	p	.12	"	13	"	11	"	2	m	10	9	m	m
Stayman's No. 2	p	.28	"	16	"	14	"	2	m	5	11	m	m
Tippecanoe	p	.12	"	13	"	11	"	2	g	7	2	l	f
Triumph	s	.44	"	5	"	8	June	29	g	1	10	m	f
Van Deman	s	.04	"	5	"	7	"	27	g	7	13	m	m
Viola	s	.12	"	13	"	13	July	2	m	4	13	l	f
Waldron	p	.04	"	13	"	13	"	5	p	1	7	m	f
Walton	p	.04	"	5	"	14	"	5	p	3	13	m	m
Warfield	p	.08	"	13	"	11	June	27	p	6	11	s	f
Williams	p	.04	"	16	"	14	July	9	g	8	12	l	f
Wilson	s	.25	"	5	"	9	June	29	m	2	8	s	f
Wolverton	s	.00	"	24	"	16	July	5	m	12	11	v l	m

The varieties that on the whole give the most promise of value for home use or for market are as follows:

Beder Wood. This variety has proved one of the best *very early berries* for general cultivation, and, especially, as a fertilizer for very early pistillate kinds. It is not quite as large as the market demands, but it runs larger in size than the Crescent and Haverland and is very productive and of good quality.

Belmont. In a rich soil, and under very favorable conditions, this variety has given good satisfaction, but under the ordinary average conditions it is unprofitable.

Bubach, No. 5. The large size of the fruit, hardiness of the plant and its productiveness, render this variety valuable for a near market. It is not, however, a perfect berry, being soft and not of the best quality.

Edgar Queen. This variety has fruited with us only one year, but its vigor of plant, large size of fruit, productiveness and good quality make it very promising.

Haverland. As an early, productive variety, of good size and quality, this is one of the best. It has long slender fruit stalks that lie upon the ground, so that the fruit is often injured by coming in contact with the soil.

Martha. This was one of the most noticeable varieties in the plots when it fruited for the first time in 1892. Medium in size, wonderfully productive, of good color and quality, if it continues to do as well in the future, it will be a valuable addition to our list of market berries.

Parker Earle. On account of its vigor of plant, productiveness and lateness in ripening, this variety is becoming well established as profitable for market. It is one of the best for hill culture.

Parmenter's Seedling. When in blossom and while the fruit is small, this variety has stood ahead of all others in promise of productiveness, but it lacks the vigor of growth to perfect its crop. Under other conditions it may prove more valuable.

Seedling No. 24. This chance seedling has attracted considerable attention in some sections. It is as late as the Gandy, as large, of perfect form and more productive than the latter variety. The berry is firm, of perfect form, and fair quality, but the hull often separates from the berry in picking. Its firmness, however, is such that even in this state, it ships a long distance in good condition.

Wolverton. This variety fruited with us for the first time the past season and proved, perhaps, more promising than any other kind. Further tests, however, must be made to determine its merits.

Leaf Blight.

Scarcely a variety grown suffered as much with this disease the past season as in previous summers. To ensure freedom from injury by this disease, the Bordeaux mixture should be used; 1st, as soon as the new leaves begin to appear, 2d, just before the blossoms open and 3d, in a much diluted form just before the first fruit ripens. If the plantation is allowed to fruit more than one year, spraying should be done twice, at an interval of two or three weeks, after the fruit has been gathered.

New plantations should be sprayed twice or three times during the month of July, according to the weather. If dry weather prevails, two applications will be all that are needed, but if it should be warm and moist, at least three should be made.

Insects (*Spotted Paria*).

This little insect, known as the "Strawberry flea," among many growers, has appeared in some sections of the State and is doing serious injury. The beetle is about $\frac{1}{8}$ of an inch long by $\frac{1}{16}$ wide, of a dark brown color, each wing cover being spotted with two black spots, and is only seen by close examination. Its presence may be easily detected by the new leaves being full of small holes, like "shot holes," which they have made. They sometimes appear in such numbers as to destroy all the leaves, especially on old beds. The only remedies found thus far to be of any value are to use Paris green with the two first applications of the Bordeaux mixture, 1 lb. to 200 gallons of the mixture, (*this should never be used after the blossoms have opened*) and to plow under all old plants as soon as the fruit has been gathered. The second remedy necessitates the annual planting of new beds, but this is thought to be the more profitable method by many large growers.

RASPBERRIES.

The winter of 1892 was especially severe on the canes of the red raspberries and scarcely a plantation could be found in the State where most of the canes were not winter-killed. At what time during the winter the injury occurred,it is not easy to determine, on account of the difficulty in ascertaining whether the canes are injured until they begin to grow, but it is probable that it was done during severe drying winds when the canes and ground were frozen.

To prevent this injury and to ensure a crop every year the canes must be bent over and covered with soil. One or two plantations where the soil was heavily mulched report but little injury, while several others similarly treated were as seriously injured as where not mulched at all. The labor of covering is small, and if the work is properly done certain protection is secured.

The following table gives the comparative results of the trial of the diffierent varieties during the past season.

RED RASPBERRIES.

In this table 1 indicates the greatest perfection of quality, size, etc., and greatest freedom from disease.

VARIETY.	Winterkilling.	Date of Blooming	Date of Ripening	Disease.	Yield.	Quality.	Firmness.
Brandywine,	2	June 10	July 5	1	4	1	3
Crimson Beauty,	3	June 9	July 1	1	8	3	3
Cuthbert,	5	June 7	July 8	1	1	5	2
Golden Queen,	5	June 14	July 12	1	3	5	4
Hansel,	3	June 7	June 27	1	4	2	3
Marlboro,	6	June 8	July 8	1	2	6	1
Rancocas,	2	June 6	July 4	1	3	3	3
Superb,	6	June 10	July 6	1	6	5	5
Thompson's Early Prolific,	5	June 7	July 1	1	7	2	4
Thompson's Pride,	2	June 9	June 27	1	7	3	5
Victor,	9	June 15	July 5	1	10	6	4
White Mountain.	8	June 15	July 14	1	10	4	4

No new varieties have thus far been found superior to the old standard sorts. Those to be recommended for planting in Massachusetts are as follows: Marlboro, Hansel and Cuthbert. Thompson's Early Prolific proves to be early and of good quality, but we were unable to test its productiveness, on account of the injury of the canes by the winter.

BLACK-CAPS.

VARIETY.	Winterkilling.	Date of Blooming.	Date of Ripening.	Disease.	Yield.	Quality.	Firmness.
Ada,		June 10	July 15	2	3	4	5
Carman,	1	June 7	July 4	1	3	2	3
Cluster,	0	June 12	July 15	1	2	3	6
Crawford,	0	June 15	July 8	1	3	2	3
Cromwell,	5	June 9	July 1	6	9	2	3
Earhart,	3	June 5	July 1	5	9	4	4
Hilborn,	5	June 8	July 8	1	1	5	3
Lovett,	2	June 6	July 5	1	7	1	4
Nemeha,	3	June 15	July 13	1	2	3	4
Ohio,	2	June 10	July 7	1	4	5	1
Palmer,	1	June 5	July 1	3	2	2	1
Progress,	0	June 6	July 1	2	5	2	3
Souhegan,	0	June 6	July 1	3	3	1	4
Springfield,	1	June 4	June 28	6	4	2	5
Thompson's Sweet,	3	June 15	July 8	4	14	2	3

The crop of black-cap raspberries was very good, the canes being but little injured by the winter. Another season will be required to prove whether any of the new kinds are more valuable than the old standard sorts.

The only varieties seriously injured by the anthracnose of "red spot fungus," are given in the order of amount of the disease,—Cromwell, Earhart, Springfield, Thompson's Sweet.

The remedies found most successful for this disease are Solution of Copper sulphate and the Bordeaux mixture.

Copper Sulphate, 1 lb. to 25 gallons, should be sprayed over the canes before the buds start. As soon as the leaves are fully unfolded apply the Bordeaux mixture, and make a second application of the same before the blossoms are open.

If insects attack the blossom buds before opening, as is reported in some sections, apply 1 lb. of Paris green to 200 gallons of the Bordeaux mixture.

Never use Paris green after the blossoms have opened.

BLACKBERRIES.

Unlike the raspberry, the canes of the blackberry, of almost all varieties, were not injured at all during the winter of 1892 and the finest crop known for many years was produced in all sections of New England.

For profit, a variety must be of large size, vigorous and productive and ripen early.

In the following table will be found the report of the behaviour of both old and new varieties:

VARIETY.	Winterkilling.	Date of Blooming.	Date of first Ripening	Disease.	Yield.	Quality.	Firmness.
Agawam,	1	June 6	July 16	1	1	1	4
Early Cluster,	1	June 8	July 8	4	4	5	4
Early King,	1	June 9	July 14	2	10	6	3
Erie,	3	June 15	July 25	1	10	6	2
Fred,	3	June 8	July 25	1	10	4	3
Lucretia,	8	June 9	July 15	1	8	2	2
Minnewaski,	2	June 15	July 21		9	3	2
Snyder.	1	June 6	July 21	4	8	3	2
Stone's Hardy,	2	June 8	July 30		10	5	4
Taylor.	2	June 6	July 21	3	7	1	3
Wachusett,	1	June 6	July 21	6	9	1	3
Western Triumph,	4	June 15	July 30	5	10	4	3
Wilson,	2	June 8	July 30	1	9	5	2

Again we have to report the Agawam and Taylor as being the most satisfactory.

The Erie is a large fruited variety,but on account of its late ripening and poor quality will not prove profitable.

The Snyder is very hardy, vigorous, productive, of good quality and is valuable for a local market, but in shipping to market where the fruit must stand from one to two days it so changes color as to be very unsalable.

The Wachusett has become so subject to disease that in most localities it must be discarded. Spraying as for the black-cap raspberry, should be practiced on all varieties to prevent the development of the yellow rust so common to the last mentioned variety.

THE GRAPE.

Another season has passed in which the grape has generally escaped fungous diseases, and frosts held off until October, enabling almost all varieties to ripen perfectly. Upon high land, with southern exposure, frosts seldom destroy the foliage until near the 1st of October and there are few seasons when most varieties of out-door grapes are not well ripened by that time.

On elevated land the vine is less subject to the attack of mildew and rot,and with the sharp competition with western growers,no one can hope for success in grape growing, unless the most favorable locations are selected.

The vineyard set apart for purposes of experiment on the college grounds is located on somewhat elevated ground, sloping slightly to the southwest. Two or more vines of the same variety are planted side by side, one of which is subject to special treatment for fungous diseases or insect pests while the other is used as a check, for comparison.

Records are made of the treatment and condition of the vines at frequent intervals, and in the fruit cellar the keeping qualities are determined by examinations made about once in two weeks.

The following table gives the average records of the season.

Explanation of Table. 1 stands for perfection of quality, hardiness, and freedom from disease, etc., while 10 indicates the opposite qualities; l stands for large, s small, m medium, b black, r red and w white.

VARIETY.	Hardiness.	% of Disease.	Size of Bunch.	Size of Berry.	Color.	Quality.	Adhesiveness.	Keeping Quality.	Date of Ripening
Agawam (Rogers No. 15)	3	3	l	l	r	2	1	2	Sept. 26
Amber,	2	1	s	m	w	6	4	6	Oct. 3
Amber Queen,	3	1	m	s	r	6	4	6	Sept. 18
Antoinette,	1	1	l	l	w	5	8	6	Sept. 30
Armenia (Rogers No. 39)	3	2	l	l	b	5	1	2	Sept. 26
Arnold's No. 1,	3	1	l	l	b	8	2	3	Oct. 3
Arnold's No. 2,	3	1	s	s	b	7	4	4	Sept. 30
Augusta,	2	1	l	l	w	7	6	7	Sept. 30
August Giant,	3	1	m	l	b	8	2	7	Sept. 30
Bacchus,	1	1	s	s	b	9	3	5	Oct. 3
Barry (Rogers No. 43),	1	2	m	m	b	5	2	3	
Beauty,	2	1	m	s	r	2	8	8	Sept. 15
Belinda,	1	2	m	m	w	4	9	8	Sept. 20
Berckman,	1	1	m	s	r	3	2	4	Sept. 26
Black Eagle,	2	1	l	l	b	5	2	4	Sept. 20
Brighton,	1	1	l	l	r	1	1	1	Sept. 22
Catawba,	3	1	l	m	r	2	1	1	Oct. 3
Caywoods No. 50,	1	1	s	m	b	9	5	8	Sept. 20
Centennial,	4	4	m	s	r	4	2	7	Sept. 30
Champion,	1	1	m	m	b	9	6	10	Sept. 6
Charter Oak,	1	1	m	l	r	9	10	6	Sept. 20
Clinton,	1	1	m	s	b	5	2	2	Sept. 30
Concord,	1	2	l	l	b	2	3	7	Sept 20
Concord Muscat,	1	2	s	s	w	10	4	8	Sept. 25
Cottage,	1	4	m	m	b	8	7	9	Sept. 20
Creveling,	1	1	m	m	b	6	6	7	Sept. 15
Cynthiana,	1	1	m	s	b	9	1	3	Sept 30
Delaware,	2	1	m	s	r	1	1	2	Sept. 25
Delaware Muscat,	5	2	m	s	r	6	3	6	Sept. 20
Diana,	5	1	m	m	r	3	1	1	Oct. 5
Eaton,	1	1	l	l	b	4	3	7	Oct. 30
Early Victor,	1	2	s	s	b	5	3	8	Oct. 6
Eldorado,	2	1	l	m	w	3	2	5	Oct. 26
Elsinburgh,	3	1	m	s	b	8	2	4	Oct. 20
Elvira,	1	1	m	s	w	3	4	5	Oct. 30
Empire,	2	3	m	m	w	2	4	5	Oct. 30
Essex (Rogers No. 41),	4	1	l	m	r	4	2	3	Oct. 26
Esther,	2	1	m	m	w	3	1	5	Oct. 15
Etta,	4	1	m	m	w	6	5	4	Oct. 3
Excelsior,	2	1	m	m	b	5	3	8	Oct. 3
Faith,	1	1	s	s	w	4	2	8	Sept. 20
Goethe (Rogers No. 1),	2	1	l	l	r	2	1	1	Oct. 5
Golden Drop,	3	3	s	s	w	4	4	5	Sept. 15
Golden Gem,	2	2	s	s	w	4	4	5	Sept. 20
Grein's Golden,	1	1	m	l.	w	3	4	7	Sept. 30
Grein's No. 2,	1	3	m	m	w	7	6	6	Sept. 30
Hartford Prolific,	1		l	m	b	6	2	8	Sept. 10
Hayes,	1	4	m	m	w	3	4	7	Sept. 26
Herbert (Rogers No. 44),	1	3	l	l	b	2	1	1	Sept. 20
Highland,	3	2	l	l	b	2	1	1	Oct. 3
Ideal,	1	1	m	m	b	3	1	4	Sept. 20
Iona,	4	1	l	m	r	1	1	1	Oct. 5
Janesville,	1	1	m	m	b	9	2	7	Sept. 6
Jefferson,	3	1	m	m	r	1	1	1	Sept. 30
Jessica,	2	4	s	s	r	4	2	6	Sept. 30
Jewell,	2	1	s	s	b	3	2	3	Sept. 15
Lady,	1	4	m	m	w	4	5	8	Sept. 20
Lady Washington,	4	1	l	l	w	3	5	7	Oct. 5

VARIETY.	Hardiness.	% of Disease.	Size of Bunch.	Size of Berry.	Color.	Quality.	Adhesiveness.	Keeping Quality.	Date of Ripening
Lee's Prolific,	1	2	m	m	r	5	3	6	Sept. 20
Lindley (Rogers No. 9)	1	2	l	m	r	2	1	1	Sept. 26
Martha.	1	1	m	m	w	2	5	8	Sept. 25
Massasoit (Rogers No. 3),	1	1	l	l	r	3	1	2	Sept. 26
Merrimac (Rogers No. 19)	2	2	l	l	b	4	2	2	Sept. 26
Mills,	3	1	l	l	b	2	1	1	Sept. 30
Montifore,	1	1	l	s	b	7	8	5	Sept. 20
Moore's Diamond,	1	2	l	l	w	2	4	8	Sept. 20
Moore's Early,	1	1	m	l	b	5	5	4	Sept. 10
Moyer,	1	3	s	s	r	3	4	8	Sept. 2
Nectar,	4	1	m	s	b	5	1	2	Sept. 20
Niagara,	2	1	l	l	w	2	7	8	Sept. 30
Norfolk,	2	2	m	m	r	7	3	7	Sept. 26
Norman,	2	2	m	m	b	7	2	5	Sept. 30
Northern Muscat,	2	1	m	m	b	9	4	8	Sept. 30
Norton's,	1	1	l	s	b	8	3	6	Sept. 30
Oneida,	2	3	l	l	r	4	1	3	Sept. 20
Oriental,	2	1	m	m	r	3	1	3	Sept. 30
Peabody,	1	1	m	m	b	7	1	2	Sept. 20
Pearl,	3	1	l	m	w	6	4	9	Oct. 5
Perkins,	1	1	m	l	r	5	7	8	Sept. 25
Pizzaro,	4	2							No fruit
Pocklington,	2	3	m	l	w	3	6	8	Sept. 18
Poughkeepsie,	2	2	l	s	r	2	2	7	Sept. 18
Prentis,	2	4	m	m	w	3	3	4	Sept. 30
Rebecca,	3	5	m	m	w	3	4	5	Sept. 30
Requa (Rogers No. 28),	3	1	l	m	r	5	2	1	Sept. 26
Rochester,	1	1	l	s	r	2	4	8	Sept. 26
Rockwood,	1	1	l	m	b	6	4	9	Sept. 20
Rogers No. 30.	1	1	s	m	r	9	3	5	Sept. 15
Rogers No. 32,	1	3	m	m	b	6	5	3	Sept. 20
Rogers No. 33,	2	2	l	l	b	4	1	2	Sept. 20
Rogers No. 34,	1	2	l	l	b	3	1	1	Sept. 20
Salem (Rogers No. 53),	1	2	l	l	r	2	1	1	Sept. 26
Secretary,	3	1	m	m	b	5	1	2	Oct. 3
Seedling No. 5,	3	4							No fruit
Seedling No. 7,	2	2							No fruit
Seedling No. 9,	4	3							No fruit
Seedling No. 10,	5	3							No fruit
Seedling No. 15,	2	2	m	m	b	5	3	5	Sept. 20
Seedling No. 18,	6	2	m	s	b	4	1	1	Sept. 20
Seedling No. 19,	4	1	m	m	r	3	5	9	Sept. 20
Seedling No. 42,	8	1	l	m	w	3	1	2	Sept. 22
Seedling No. 44,	1	1	m	m	w	5	2	3	Sept. 12
Telegraph,	1	1	m	m	b	9			Sept. 6
Transparent,	4	1	s	s	w	8	2	5	Oct. 3
Triumph,	3	1	l	l	w	6	2	5	Oct. 3
Ulster,	3	2							No fruit
Vergennes,	1	8	l	l	r	4	1	1	Sept. 26
Victoria,	1	1	m	m	w	5	5	7	Sept. 26
Walter,	5	1	m	m	b	7	5	5	Sept. 20
Wilder (Rogers No. 4),	1	2	l	m	b	2	1	2	Sept. 26
Winchell (Green Mountain),	1	1	l	m	w	1	2	3	Sept. 2
Witt,	2	1	m	m	w	3	2	4	Sept. 26
Woodruff Red,	2	1	m	l	r	5	5	7	Sept. 30
Worden,	2	1	m	l	b	5	9	8	Sept. 24
Wyoming Red,	3	3	m	m	r	5	3	8	Sept. 15

Of the varieties to be recommended for New England, we give a brief description:

Berckman's. This is a small grape like the Delaware in size and color, but with foliage like the Clinton, entirely free from the attack of mildew. It is not so sweet as the former, but has more of the vinous flavor.

Brighton. An early grape producing large bunches of medium sized berries of the best quality. The vine is hardy and little subject to attack from mildew. If planted alone it sometimes fails to fertilize well and only a few berries mature on each bunch, but if planted with other varieties, this difficulty is overcome.

Concord. This variety has not yet been superseded by any of the new kinds for market purposes.

Delaware. Except for the tendency to lose its foliage by mildew, this variety would be one of the hardiest and best grapes for home use or market, and now that we feel sure we can protect it from this disease by the use of the Bordeaux mixture, it can be recommended for general planting by those who will attend to the matter at the proper time.

Iona. As a choice table grape of the highest quality, this variety is one of the best. It can be grown, however, only by close attention to the use of fungicides, as it is much subject to mildew and the black rot.

Lindley. (Rogers No. 9.) By the use of fungicides any of these hybrids can be grown in this section. This is one of the best of the numerous varieties known as "Rogers hybrids."

Moore's Early. This is the earliest of all the good black grapes that have been fully tested. Although not quite as vigorous as the Concord it is perfectly hardy and under good care yields heavy crops, is less liable to injury from fungous diseases than the latter variety, and has proved profitable for market. A new black variety as early, hardy and productive and of better quality would be a great acquisition to New England grape growers.

Winchell (Green Mountain). Of all the new varieties of recent introduction we think this is by far the most valuable for home use; its value for market is yet to be proved. It is one of the first to ripen, the vine is fairly vigorous and productive, bunch of good size and berry a little larger than the Delaware. In quality it is one of the best and is a fairly good keeper.

Worden. This variety is thought by many to be superior to the Concord. It is so nearly like that variety in growth of vine, form, size and quality of fruit that only by close inspection can the difference be detected. It is certainly earlier and that for New England is very decidedly in its favor. Some growers report it more subject to cracking after rain storms.

MILDEW AND BLACK ROT.

Again we are able to report very decided success in the use of copper solution in preventing mildew and black rot, and we feel sure that even those varieties most subject to the attack of these diseases can be made to grow in perfect health. For the best results we would recommend the following treatment:

1st. Spray the vines and trellises and the ground under them with the solution of copper sulphate, Formula a, before the leaves unfold.

2d. As soon as the leaves are well expanded spray with the Bordeaux mixture one-half strength, *i. e.* 50 gallons of water to the regular formula.

3d. Just before the blossoms open, spray again with the Bordeaux mixture, adding 1 lb. of Paris green to 100 gallons of the mixture.

4th. Soon after the fruit has set, spray again with the Bordeaux mixture, and repeat at intervals of from two to four weeks according to the weather, up to about August 1st. Should the weather be dry and cool the longer interval will be sufficient,but if hot, moist or rainy, application should be made not less than once in two weeks. After a heavy rain it is best to make an application at once, if it is near the time for spraying.

5th. After August 1st, one or two applications of the ammoniacal carbonate of copper should be made at intervals of from 2 to 4 weeks, as further use of the Bordeaux mixture would disfigure the fruit.

PEACH.

The peach orchards connected with this station, and many others in the State, did not blossom as full as in 1891, but a fair crop of fruit was set. Generally, throughout the State, the crop was of greatly inferior quality, owing to the effect of drought and cold weather at the time of ripening.

The trees experimented with were sprayed before the leaves unfolded, with the Copper Sulphate Solution, formula a, and again just after the fruit was set, with dilute Bordeaux mixture, *i. e.*, 100 gallons of water to the standard formula. Paris green was added, 1 lb. to 200 gallons, at this time to destroy the curculio, but very few of the peaches were attacked by them. At the time of the ripening of the fruit of early varieties the trees were sprayed once with the Ammoniacal Copper Carbonate reduced by adding water enough to make 50 gallons of liquid with formula a.

RESULT.

The dilute Bordeaux mixture and Paris green did not injure the foliage and may be considered safe to use on the peach, while the dilute ammoniacal copper carbonate checked materially the rotting of the fruit, though not wholly preventing it.

TREATMENT RECOMMENDED FOR 1893.

1. Spray trees before the leaves or flower buds unfold, with Copper Sulphate, formula a.

2. As soon as the petals have fallen, spray with dilute Bordeaux mixture, *i. e.*, 100 gallons of water to standard formula, adding Paris green 1 lb. to 200 gallons of the mixture.

3. When the fruit has reached two-thirds size, spray with dilute Ammoniacal Copper Carbonate, *i. e.*, 50 gallons of water to formula a or b.

4. Should no injury occur to the foliage, spray again in about two weeks if rains have occurred, if not, no further spraying need be done until it has rained.

CONDITION OF PEACH BUDS MARCH 20, 1893.

Another winter has passed and the buds are, thus far, much less injured than for many years. The trees were examined every week from December 1st to April 1st, and from 50 to 100 buds of each variety cut open at a time.

The following table gives the average per cent of buds of each variety that were destroyed March 20th, 1893:

VARIETY	Dec.	Jan.	Feb.	March.
Reeves' Favorite,	.015	.120	.245	.28
Wager,	.005	.072	.095	.10
Wheatland,	.060	.144	.182	.21
Crosby (Excelsior),	.022	.040	.055	.06
Stump,	.060	.102	.160	.20
Red Cheeked Molocoton,	.015	.100	.195	.25
Oldmixon,	.010	.204	.220	.32

PLUM.

The plum trees in the station orchard have improved in healthfulness and vigor during the past two or three years. The crop was the best for several years and the black wart less abundant.

The trees were treated in the same way as the peach, except that more Paris green was used for the destruction of the plum curculio, and the Bordeaux mixture was used at full strength.

Very few warts appeared; the few found were promptly destroyed by painting with kerosene paste or by cutting out with the knife.

TREATMENT RECOMMENDED FOR 1893.

1. Spray with copper sulphate, formula a, before the flower buds swell very much.

2. Use Bordeaux mixture with Paris green 1 lb. to 100 gallons, as soon as the petals fall.

3. Spray again with same in one week or 10 days.

4. Use Bordeaux mixture at intervals of from two to four weeks according to the weather until the fruit is nearly grown.

5. When the fruit begins to color, spray once or twice with the ammoniacal carbonate of copper, either formula a or b.

PEAR.

The most destructive diseases attacking the pear are the leaf-blight and the cracking of the fruit, which are caused by the same parasitic fungous growth. It appears at any time from July 1st to Sept. 1st, when the weather is very hot and moist, and if very abundant, causes the leaves to fall, or, if it attacks the fruit, results in the cracking so common to the Flemish Beauty and some other varieties.

Both of these difficulties may be overcome by the use of the copper solutions used as for the apple, except that no Paris green need be used at the first spraying with the Bordeaux mixture.

The treatment to be recommended for 1893 will be the same as for the apple with the above exception.

THE APPLE.

Many trees in the station orchard were treated during the past season to prevent injury from the apple scab and the codling moth and other insects. All the trees were sprayed with the copper sulphate, formula a, before the leaves unfolded. As soon as the leaves and blossom buds were well advanced the Bordeaux mixture was used, adding Paris green one pound to 200 gallons, to destroy the tent-caterpillar, bud moth and canker worm. A second application of the same mixture, with Paris green one pound to 100 gallons, was applied, as soon as the petals had fallen, to destroy the codling moth and a third application of the same two weeks later.

At intervals of from two to four weeks the Bordeaux mixture alone was applied to prevent the apple scab until August 1st, when one or two applications of the ammoniacal copper carbonate, formula a, was made.

RESULTS.

The results of this work, an average from all the trees treated, were as follows:

Per cent of wormy apples on trees sprayed was	.17
Per cent of wormy apples on trees unsprayed was	.82
Per cent of scabby apples on trees sprayed was	.03
Per cent of scabby apples on trees unsprayed was	.51

RESULTS WITH COPPER SULPHATE SOLUTION.

There is more or less trouble experienced in the use of the Bordeaux mixture, by clogging of the pumps or nozzles, unless great care is taken in straining the mixture before it is put into the pumps, and this has led to experiments in the use of the simple solution of copper sulphate which makes a clear liquid from which there can be no clogging. It is a well known fact that even as dilute a solution of copper sulphate as one part to 3000 parts of water will destroy the spores of most of the common parasitic fungi, and many trees were treated with this solution in two proportions with the following

RESULTS.

1. Used at a strength of 1 lb. to 500 gallons of water the foliage was seriously injured.

2 At the rate of 1 lb. to 800 gallons the foliage escaped serious injury.

3. It was found that Paris green could not be safely used with either of these solutions.

4. That the codling moth did less injury to the fruit when sprayed with these solutions than when unsprayed.

TREATMENT RECOMMENDED FOR 1893.

1. Spray with Copper Sulphate, formula a, before the buds unfold.

2. Use the Bordeaux mixture with 1 lb. of Paris green, 1 lb. to 100 gallons just before the blossoms unfold for the tent caterpillar, canker-worm and bud-moth larvae.

3. As soon as the petals have fallen repeat the spraying with last mentioned solution and again in about two weeks, for the codling moth.

4. Use the Bordeaux mixture alone at intervals of from two to four weeks until August 1st.

5. Spray with the Ammoniacal Carbonate of Copper once or twice should the weather during August be moist and cool. If the weather should be dry no further spraying need be done.

POTATO BLIGHT AND ROT.

The potato blight and rot fungus, which causes the vines to die before maturity and the tubers to rot, is one of the greatest obstacles to the profitable growth of this crop in all parts of the country.

The fungus which causes all this injury is closely related to the grape mildew which we are able to destroy by the use of copper solutions.

To test the value of these solutions in preventing the potato blight and rot, a field of about one acre was selected and divided into two sections with check rows running through the middle. The west half was sprayed with the Bordeaux mixture one-fourth strength, i. e. 100 gallons to standard formula, and the east half with copper sulphate solution 1 lb. to 800 gallons of water.

Paris green was used at the rate of 1 lb. to 200 gallons of the mixtures.

Three applications were made to each plot at intervals of from two to three weeks from July 1st to Aug. 28th.

RESULTS.

1. The vines on the east half were all dead Aug. 28th, while those on the west half remained green until Sept. 16th.

2. The crop was dug Sept. 23d and 24th, yielding as follows:

West half,	merchantable potatoes,	4426 lbs.
" "	small potatoes,	431 lbs.
" "	less than 1% of decayed tubers were found.	

East half,	merchantable potatoes,	2759 lbs.
" "	small potatoes,	494 lbs.
" "	about 3% of the tubers were decayed.	

TREATMENT RECOMMENDED FOR 1893.

1. As soon as the potato beetles begin to appear in large numbers spray with Bordeaux mixture and Paris green, 1 lb. to 100 gallons.

2. When the larvae begin to appear, spray again with the Bordeaux mixture and Paris green, 1 lb. to 200.

3. Continue the use of the Bordeaux mixture at intervals of from two to three weeks until the tops begin to die from maturity, adding Paris green at the rate of 1 lb. to 200 gallons as long as the larvae of the potato beetle continue to appear.

For this work the barrel pump, mounted in a one-horse cart, is the most economical, the horse going between two rows and the wheels between the two outside rows. From eight to twelve rows may be sprayed at one time.

RUST ON THE BLACK OR ITALIAN POPLAR.

The black poplar is one of the most rapid and stately growing trees that we have. There are many trees on the college grounds, started from cuttings in 1873, that now measure more than 18 inches in diameter, and up to 1891 were entirely uninjured by any species of fungous or insect life.

A year ago last summer and fall (1891) the rust came on in such abundance that the leaves were yellow from the quantity of spores appearing on the surface, and dropped very early in the season. The injury to the tree was so great that the immature lower branches were nearly killed during the winter.

To determine if this rust could be prevented the lower branches and leaves were sprayed, some with the Bordeaux mixture and some with the copper sulphate solution, 1 lb. to 1000 gallons of water. Check trees were left without spraying.

Five applications were made of each with the following

RESULTS.

No rust was found on the trees sprayed with the Bordeaux mixture and the leaves remained green much longer than those of the unsprayed trees, which were badly affected with the rust. The trees sprayed with the copper solution were not as badly affected as those unsprayed.

TREATMENT FOR 1893.

1. Spray the lower branches thoroughly with the copper sulphate solution, formula a, before the leaves unfold.

2. About July 1st spray with the Bordeaux mixture and repeat the spraying at intervals of from two to three weeks according to the weather until Sept. 15th. If it be warm and moist, at the shorter interval and if clear and dry, the longer one.

3. We would also suggest the same treatment for the European Linden, which, in some sections, is subject to a similar disease.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 22.

REPORT ON FRUITS.

OCTOBER, 1893.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
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1893.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

HENRY H. GOODELL, LL.D.,	*Director.*
WILLIAM P. BROOKS, B. SC.,	*Agriculturist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
CLARENCE D. WARNER, B. SC.,	*Meteorologist.*
WILLIAM M. SHEPARDSON, B. SC.,	*Assistant Horticulturist.*
MALCOLM A. CARPENTER, B. SC.,	*Assistant Horticulturist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

DIVISION OF HORTICULTURE.

SAMUEL T. MAYNARD.

REPORT ON SMALL FRUITS.

The season of 1893 has on the whole been favorable to a large crop of small fruits in Massachusetts, although in some sections the drouth seriously reduced the yield. The season opened late and the weather during the summer was such, that all fruits ripened considerably later than in 1892. Little or no loss among the small fruits was occasioned by attacks of insects or fungi, the dry season having been unfavorable to the development of the latter, while the former were less abundant than usual.

In this Bulletin we shall confine ourselves to the comparison of the different varieties of small fruits, especially the newer sorts, reporting upon one hundred and eight varieties of strawberries, fourteen varieties of blackberries, twenty varieties of blackcap and twenty varieties of red raspberries.

All of the above were planted in a soil of even composition, each variety being under the same conditions of cultivation, manuring, training, etc. The fruit of all varieties was gathered on the same day and carefully weighed, the comparative size, quality, etc., being determined by frequent comparison and testing. It is found a very difficult matter to determine accurately the place, as to quality, that a variety should occupy, but by the combined results of frequent tests made by different persons we feel that as far as it is possible we have arrived at correct conclusions. It is well known that many varieties vary very much in different seasons and under different conditions of soil and manuring, and in cases where doubt has arisen as to the value of any variety, its behavior in other localities has been used as a factor in making up the report.

In the following tables we give the results of the test of those varieties which have been planted long enough to produce a full crop, leaving many new kinds that have borne only a partial crop for a future Bulletin.

STRAWBERRIES.

One hundred and eight varieties fruited in our experimental plots the past year. These were largely new kinds, but included some of the old standard sorts grown for comparison, all of the inferior varieties of last season having been discarded.

Twenty-five plants are set in each plot, twelve of them being grown in hills, while the other thirteen are allowed to grow into the matted row. The crop was a little later than that of last season. The fruit was picked, carefully weighed and compared in size, color, form, quality, etc., with the old standard sorts.

EXPLANATION OF TABLE.

Sex—p. pistillate, s. staminate, or bisexual.

Winterkilling is given in per cent.

Vigor of growth is given in per cent, taking the most vigorous plants for a standard of 100.

Yield is given in pounds and ounces for twenty-five plants, twelve of which were kept in hills and thirteen allowed to grow into matted rows.

Size—v. l., very large; l., large; m., medium; s., small.

Form—r., roundish; c., conical; r. c., roundish conical; c. f., coxcomb form; r. c. f., roundish coxcomb form.

Quality—g., good; v. g., very good; m., medium; p., poor.

Firmness—f., firm; m., medium; s., soft.

Color—l., light; d., dark; m., medium.

VARIETY.	Sex.	Percent Winterkilling.	Vigor.	Date of Blooming.	Date of Ripening.	First Picking.	Last Picking.	Yield.		Size.	Form.	Quality.	Firmness.	Color.
				May	June	June	July	lbs.	ozs.					
Alabama,	S	.00	90	18	12	14	5	5	2	s	r	p	m	l
Barton's Eclipse,	P	.20	65	17	13	15	5	10	7	l	r c	g	m	d
Beder Wood,	S	.08	80	11	10	12	5	8	13	m	r	g	f	m
Bebee,	S	.33	20	19	15	16	9	2	11	l	r	g	f	d
Belle la Crosse,	S	.18	55	18	16	20	8	5	15	l	r c	g	m	d
Belmont,	S	.12	70	22	14	20	8	4	0	l	r c	v g	f	d
Beverly,	S	.18	100	19	14	16	9	17	7	l	r c	g	f	d
Boynton,	P	.12	75	15	12	14	8	12	6	s	r c	m	f	l
Bubach No. 5,	P	.12	50	19	12	15	5	10	6	l	r c f	g	f	m
Chas. Downing,	S	.25	40	18	14	17	8	8	15	l	r c	v g	f	l
Cornelia,	S	.08	50	23	18	20	9	6	14	m	r	m	f	m
Crawford,	P	.25	25	17	12	12	8	4	2	m	r	v g	f	m
Crescent,	P	.00	60	19	12	14	8	10	11	m	r	m	m	l
Dew,	S	.00	40	24	20	22	9	6	3	v l	c f	g	f	m
Dutton,	S	.08	45	22	17	20	8	6	3	l	c f	v g	f	l
Edgar Queen,	P	.04	60	22	15	15	8	9	6	l	r c	g	m	m
Eleanor,	S	.04	45	23	18	20	5	3	1	m	c	g	m	l
Enhance,	S	.00	45	17	13	15	9	11	2	l	r	p	m	d
Felton,	S	.12	60	18	14	20	5	3	4	l	r f	g	f	d
Florence,	S	.12	60	20	18	20	8	8	0	m	r c	g	f	d
Gandor,	S	.12	60	22	15	20	9	11	14	l	r c	m	v f	m
Gandy,	S	.25	70	23	18	20	5	5	8	l	r c	g	f	m
Gillespie,	S	.00	65	21	16	17	8	6	12	l	c	v g	f	l
Glendale,	S	.04	50	22	19	20	8	4	13	m	c	g	f	m
Gov. Hoard,	S	.04	75	20	14	20	5	9	0	l	r	m	m	m
Greenville,	P	.00	100	21	15	18	5	18	4	l	r	m	m	m
Haverland,	P	.00	55	13	12	12	8	10	8	l	c	g	f	l
Hinsmore,	S	.00	85	22	15	17	5	4	11	l	r	g	f	m
Howard's No. 9,	P	.04	45	17	14	15	5	4	8	l	r	g	s	l
Howard's No. 10,	S	.00	40	15	12	12	3	3	11	l	r	m	m	l
Howard's No. 20,	S	.00	70	23	15	17	3	3	5	l	r	g	m	m
Howard's No. 37,	S	.00	35	17	13	14	June 30	1	14	l	r	g	f	l
Howard's No. 53,	S	.00	65	19	18	20	July 5	5	1	l	r	g	m	l
Howard's No. 76,	P	.00	55	23	18	20	9	8	6	l	r	m	f	m
Howard's No. 145,	S	.08	65	18	14	15	5	6	3	m	r c	m	m	d
Howard's No. 149,	P	.00	60	17	14	15	8	13	13	l	r	m	s	l
Howard's No. 250,	S	.08	40	16	15	15	5	3	14	l	r	m	s	l
Howard's No. 278,	P	.04	60	22	15	20	5	6	2	l	r	g	m	d
Howard's No. 13,	S	.04	60	15	13	16	June 30	4	10	m	r	g	s	l
Howard's No. 28,	P	.33	50	24	18	20	July 8	3	4	l	r	g	m	l
Howard's No. 87,	S	.08	55	19	14	16	3	3	8	m	r	g	m	d
Howard's No. 116,	S	.08	55	22	17	20	8	3	2	m	r	g	f	m
Howard's No. 117,	S	.16	65	15	15	17	5	7	6	l	r	g	f	m
Howard's No. 122,	S	.00	40	22	18	20	8	8	4	l	r	g	f	l
Howard's No. 157,	S	.08	10	18	16	17	1	1	2	m	c	m	m	m

Howard's No. 13 to Howard's No. 157: Plants set late in the season

VARIETY.	Sex.	Percent Winterkilling.	Vigor.	Date of Blooming.	Date of Ripening.	First Picking.	Last Picking.	Yield.		Size.	Form.	Quality.	Firmness.	Color.
				May	June	June	July	lbs	ozs.					
Howard's No. 300,		.35	15	22	15	17	5	2	8	m	r	g	f	d
Howard's No. 354,	S	40	15	22	15	17	3	3	10	m	r	g	f	l
Howard's No. 501,	S	.10	25	20	16	17	8	5	14	l	r	g	f	m
Iowa Beauty,	S	.18	60	18	15	15	8	14	4	l	r	g	f	m
Jucunda Improved,	S	.00	60	22	14	16	8	10	10	l	r	g	f	m
Lady Rusk,	P	.20	30	22	18	20	8	8	7	l	r	m	f	m
Leader,	S	.18	30	19	15	16	8	3	2	l	r	g	f	d
London,	S	.12	50	18	16	17	8	9	9	l	r	g	f	m
Lovett's Early,	S	.08	35	19	10	12	3	6	6	m	c	m	f	m
Margaret	P	.12	40	15	10	12	June 30	3	10	s	r	p	m	m
Martha,	P	.00	75	20	19	19	July 8	10	12	m	r	p	f	d
Michel's Early,	S	.12	80	15	11	12	June 30	8	10	m	r c	g	f	l
Middlefield,	P	.20	60	23	16	16	July 9	7	12	l	r	g	m	d
Miller's Seedling,	S	.04	80	23	19	20	5	2	15	m	r	m	f	m
Miner's Prolific,	S	.33	20	23	18	21	8	2	9	m	r	m	f	d
Moore,	S	.18	75	22	20	20	8	4	9	l	r	g	f	m
Mrs. Cleveland,	P	.04	75	22	16	17	5	10	8	l	r	m	m	l
Mt. Holyoke,	S	.00	50	19	17	17	8	6	4	l	c f	g	m	l
Norwood,	S	.12	25	20	14	15	5	6	3	m	r	m	m	l
Ohio Centennial,	P	.08	50	23	20	20	10	11	14	v l	c f	g	m	l
Oliver,	S	.08	95	22	20	24	12	6	12	l	r	g	f	m
Our Choice,	P	.12	70	19	15	20	5	8	15	m	r	m	f	l
Pacific,	P	.04	90	18	13	15	9	14	15	l	r c	m	f	d
Parker Earle,	S	.05	90	24	16	20	9	12	8	l	c	g	f	m
Parmenter's Seedling,	P	.04	75	17	14	15	5	6	8	m	r c	m	f	l
Pioneer,	S	.20	20	17	15	15	3	2	9	m	r	g	m	d
Pomona,	S	.08	80	19	14	15	9	8	6	l	r	v g	m	m
Price's Seedling,	S	.02	55	17	13	15	5	4	13	s	r	m	m	m
Rheil's No. 1,	P	.04	60	17	11	12	8	22	4	m	r	p	s	l
Sadie,	P	.04	60	17	11	12	8	12	10	m	r	m	f	d
Sandoval,	S	.18	20	17	12	14	5	3	0	m	r	m	m	m
Saunders,	S	.04	35	24	18	18	5	10	15	l	r	m	f	m
Seedling No. 24,	S	.18	40	23	20	20	9	7	7	l	r	g	f	d
Seedling No. 34,	S	.04	35	16	12	12	3	4	0	s	r	p	f	m
Seedling No. 35,	S	.12	35	19	14	16	8	5	9	m	r	g	f	m
Seedling No. 40,	S	04	75	15	14	14	8	8	8	l	r	g	f	m
Seedling No. 41,	S	.20	10	19	14	20	3	1	12	m	r	m	f	m
Seedling No. 42,	S	.00	30	22	16	20	5	5	11	m	r c	m	f	m
Seedling No. 44,	S	.18	30	22	13	15	June 30	3	13	m	r	m	f	m
Seedling No. 45,	S	.08	20	17	13	20	July 3	5	10	m	r	m	f	d
Seedling X,	P	.04	35	15	13	14	8	6	8	l	r c	p	m	m
Seedling XX,	S	.20	20	15	11	12	June 30	1	12	m	r	m	f	m
Sharpless,	S	.12	80	22	15	17	July 5	9	3	l	c f	v g	f	l

Plants set late in the season. (Howard's No. 300, No. 354, No. 501)

VARIETY.	Sex.	Percent Winterkilling.	Vigor.	Date of Blooming.	Date of Ripening.	First Picking.	Last Picking.	Yield.		Size.	Form.	Quality.	Firmness.	Color.
				May	June	June	July	lbs.	ozs.					
Shaw,	S	.04	60	23	18	20	8	4	11	l	c f	g	f	l
Shurtleff Seedling,	S	.00	45	20	14	14	3	4	1	m	r	m	f	l
Shuster's Gem,	P	.04	55	13	12	12	8	10	10	m	r c	g	f	m
Smeltzer's Early No. 2,	S	.04	50	17	12	12	3	4	0	m	r c	p	m	m
Standard,	P	.04	40	15	13	17	9	7	3	m	r	m	f	m
Stayman's No. 1,	P	.04	45	21	14	15	8	10	5	m	r c	m	f	l
Stayman's No. 2,	P	.18	20	22	15	15	9	4	15	m	r c	m	f	m
Stevens,	S	.04	40	13	9	12	June 30	3	6	m	r	p	f	m
Sunnyside,	P	.04	45	23	16	20	July 9	12	6	l	r	m	f	l
Townsend's No. 20,	P	.00	50	23	15	20	8	10	12	l	r	g	f	d
Triumph,	S	.04	10	18	14	20	3	2	0	l	r	g	m	d
Van Deman,	S	.12	15	15	10	12	June 30	3	7	l	r	g	m	d
Waldron,	P	.08	25	20	15	15	July 5	3	14	m	r	m	f	l
Walton,	P	.08	25	15	14	17	8	3	8	l	c	m	f	l
Warfield,	P	.00	35	15	11	12	3	11	12	m	r c	m	m	d
West Lawn,	P	.00	40	20	14	15	3	7	2	l	r c	m	f	m
Williams,	S	.00	35	22	14	16	5	10	5	l	r c	g	f	d
Wilson,	S	.04	25	15	14	15	June 30	4	1	m	r	m	m	d
Wolverton,	S	.00	55	22	15	16	July 5	10	15	l	r c	g	f	m
Yale,	S	.00	10	22	18	20	8	5	8	m	r	g	f	m
Yankee Doodle,	P	.00	25	22	14	17	3	5	7	l	r	g	f	l

The above table gives the behavior of all the varieties as far as can done by figures, but the following deserve special mention:

Beder Wood. We still place this at the head of the list of very early berries and as a fertilizer for the early pistillate varieties. In quality and size it is not up to the standard demanded by our best markets, and during the fall it has shown some rust on the foliage.

Beverly. This medium early variety proves very productive, hardy and of good quality.

Bubach No. 5. Vigorous, productive, and the berry of large size, it is rather soft for long shipment, however, and not of the best quality.

Haverland. Very productive, early and of good quality, but the berries are often injured during wet weather by the long weak fruit stalks bending over so that the fruit rests on the soil.

Iowa Beauty. This is the first year this variety has fruited in our plots. The berries are large, of good form and quality, and the plant vigorous and productive.

Greenville. We can but wish that this variety was of better quality. It is very vigorous and productive and will probably be profitable for market.

Michel's Early. Ripening with the Beder Wood, it is of good quality and will be valuable for home use, though not for a too critical market, on account of its rather small size.

Mrs. Cleveland. Berries of fine color and good quality, and the plant vigorous and fairly productive.

Pacific. Vigorous, fairly productive, and of good size and quality.

Parker Earle. Very vigorous, but late in ripening, productive and the berry of good size, form and quality.

Rheils No. 1. This gave the largest yield of any variety fruiting the past season, but the berry was rather small and not of good quality

Shuster's Gem. A very early variety resembling Michel's Early, but a little more productive and valuable for home use.

Warfield. This very vigorous and hardy variety produces large crops of berries of medium size, but rather poor quality. The color and form are good and it proves a profitable market sort where berries of extra size are not demanded.

Of the new varieties planted in the spring of 1893, but not yet fruited sufficiently to determine their value, we would mention the following:

Howard's Seedlings. This collection, consisting of some six hundred varieties, was originated by Mr. A. B. Howard of Belchertown, Mass. Many of them show decided merit, especially those originated in 1890 and 1891 from seed of the Belmont fertilized by the Haverland. They are the result of cross fertilization under glass, in which Mr. Howard has shown especial skill, and if they continue to do as well under other conditions as they have on the grounds of the originator, we may hope to report from among them a berry of the finest quality, large size and great productiveness.

Marshall. This variety, originating with Mr. Marshall Ewell of Marshfield, Mass., has attracted more attention than any variety introduced for many years. The berries are large, of fine form, good color and excellent quality and there only remains, in order to determine its value for general planting, the question of its growth and productiveness, and freedom from disease, under the ordinary conditions of soil and cultivation.

STRAWBERRY LEAF BLIGHT.

All the varieties tested have been grown by the annual system, i.e., only one crop being taken from each planting. In this way we have escaped with very little injury from the above disease, which is so destructive to the older varieties, especially in beds of more than one season's growth. A portion of each plot was sprayed at intervals during the summer with the Bordeaux mixture, but no marked results were obtained.

THE "STRAWBERRY FLEA" OR BLACK PARIA.

Rotation and the annual system seem the best means for combatting the attacks of insects, especially the above insect and the larvae of the May beetle or June bug. The former probably does as much injury in its larval state as in its perfect form and the new plantations should be made, if possible, at some distance from the old bed.

THE MAY BEETLE OR JUNE BUG.

The plants set last spring for fruiting in 1894 were somewhat injured by this insect. The land on which they were planted was occupied by strawberries in 1892 and after the berries were gathered the plants were turned under and the land sown with barley. This crop, after maturing, was plowed under just before winter and early in the spring the land was heavily manured and set with the new plants for fruiting in 1894. About the middle of July the "white grubs" began to work badly and many of the plots were seriously injured.

The eggs of this beetle are laid only on land where their larvae can find an abundance of roots of some herbaceous plant like the grass or strawberry to feed upon, and never where the land is clear of much plant growth during the latter part of May or early June, as is the case with any hoed crop. If our plants had been set on land that was free from fibrous roots the previous June they would have escaped. The larvae require two years to complete their growth, and infested land should never be set with strawberry plants until it has been clean cultivated with some other crop for one year or better for two years.

BLACKBERRIES.

The blackberry plants came through the winter with little injury from cold and gave promise of a large crop, but this was materially lessened by the drouth at the time of ripening. Fifty plants are set in each plot or row running east and west on a slope to the west. The soil at the upper end of the row is of a medium loam, that in the middle a heavy moist loam, and that at the lower end is gravelly, with a hardpan subsoil, thus giving very favorable conditions under which to test the different varieties.

This is the third season from planting, and most of the varieties were in their best condition for fruiting. The plants were set 6x6 feet apart each way, and the land was kept cultivated in both directions during the entire season. The following table gives the result of the trial of varieties.

EXPLANATION OF TABLE.

The winterkilling and the amount of disease found on each variety are given in per cents. The letters used to designate size, quality and firmness are the same as used in the table of strawberries.

VARIETY.	Per cent Winterkilling.	Date of Blooming.	Date of Ripening.	Disease.	Yield from Fifty Plants.	Quality.	Firmness.	Size.
		June	July		Qts.			
Agawam	.00	1	16	.00	35.5	v g	m	l
Early Cluster	.33	8	19	.00	24.0	p	f	m
Early King	.08	9	14	.00	9.5	p	f	l
Erie	.80	9	25	.00	1.9	p	f	l
Fred	.05	9	25	.04	3.5	p	f	l
Lucretia Dewberry	.90	7	15	.00	16.5	g	s	l
Minnewaski	.12	10	24	.00	4.1	m	f	l
Snyder	.00	4	20	.05	28.2	g	f	l
Stone's Hardy	05	5	21	.00	4.8	p	f	m
Taylor	05	5	24	.00	37.5	v g	f	l
Wachusett	.10	5	21	.10	16.2	v g	f	m
Western Triumph	.03	9	26	.00	1.5	p	f	m
Wilson	.40	9	25	.00	8.2	p	f	l

The following varieties should have special mention:

Agawam. This variety has been somewhat variable as to yield this season. On young plantations it was less than that of the Snyder and Taylor, but on older plantations it far exceeded them.

Erie. This variety was very much injured by the winter in the station plots, and in other localities it was killed to the ground. Unless the plants are covered with soil for protection during the winter, it will be of no value for New England.

Snyder. But for the fact that the berries soon change to a reddish color after picking, this variety would be placed second on the list of market varieties, on account of its vigor, earliness in ripening, hardiness and productiveness. In quality it is not as good as the Agawam or Taylor.

Taylor. If this variety ripened as early as the Agawam it would be even more valuable than that variety for market. It is equally hardy and productive, but is about one week later in ripening. For home use it is certainly one of the best.

Wachusett. This variety has been seriously injured by the red or orange rust on most plantations in the state, and as it is of smaller size and less productive than the Agawam or Taylor, we would not advise planting it.

Lucretia Dewberry. Without winter protection this variety will be of little value in New England, but if the canes are tied to stakes during the summer, and are laid down and covered with soil or litter during the winter it can be successfully grown. The amount of work involved by this method and the fact that some of the high blackberries ripen nearly as early will prevent its being grown for market.

BLACK-CAP RASPBERRIES.

In our large cities there is less demand for this fruit than formerly, but in the smaller cities and towns there is still a good market and the crop proves profitable. The number of quarts that can be produced per acre is much larger than that of the red raspberry, the crop matures in much less time and the cost of gathering is consequently less. It cannot be continued on the same land as long as the red raspberry or blackberry, on account of disease and insects, but as a full crop may be obtained at two years from planting, rotation is easily practiced.

The varieties reported upon in the following table are planted upon the same slope occupied by the blackberry and red raspberry, one variety being planted between two rows of the latter, to keep the kinds from spreading from row to row, as they otherwise would. The distance of planting is the same as the blackberry (6x6 ft.).

The results given are for fifty plants of each kind.

EXPLANATION: Figures, letters and dates have the same significance as in the table of blackberries.

VARIETY.	Per cent Winterkilling.	Date of Blooming.	Date of Ripening.	Disease.	Yield from Fifty Plants	Quality.	Firmness.		Size.
		June	July		Qts.				
Ada	.10	12	17	.00	10.7	v p	f		m
Carman	.10	5	4	.10	45.5	g	f		l
Cluster	.05	5	2	.00	62.5	p	f		l
Corinth	.10	7	10	.00	58.1	m	f		m
Crawford	.10	9	5	.10	29.5	m	f		l
Cromwell	.05	3	June 30	.50	31.0	g	m		m
Earhart	.00	6	July 4	.20	25.8	p	f		l
Gregg	.20	8	9	.20	25.0	m	f		l
Hilborn	.05	7	10	.00	138.7	g	f		l
Lovett	.05	7	7	.00	41.2	m	f		m
Nemeha	.18	5	11	.40	13.1	m	f		l
Ohio	.03	7	10	.00	91.6	v g	f		m
Palmer	.05	2	2	.10	46.3	g	m		l
Progress	.07	1	2	.00	36.2	v g	f		l
Souhegan	.08	2	2	.00	64.0	g	f		m
Springfield	.00	1	June 30	.30	16.6	p	f		s
Brackett's Seedling	.00	7	July 8	.00	18.7	m	f	Plants 1 year old.	l
Kansas	.05	5	4	.00	45.3	v g	f		l
Older	.00	4	5	.00	9.7	g	f		m
Smith's	.05	5	5	.00	10.6	m	f		l

Among the varieties that have given the best results we would mention the following:

Hilborn. By far the most vigorous and productive variety tested, it is of good quality and size, and firm enough to ship well. Its only fault for market is its lateness in ripening, but this is not an objection for the home garden.

Ohio. Not quite so productive as the last, and with larger seeds, but with a little sweeter pulp.

Souhegan. This still stands at the head of the list of very early varieties, and on account of its earliness is one of the most profitable for market. If the Cromwell were not so subject to disease it would be a very close rival, if not superior to this variety.

Kansas. Although this variety has fruited but one season, it shows so much promise that we give it special mention. It is vigorous, productive, free from disease, and of the best quality.

RED RASPBERRIES.

One of the most popular fruits in our market, there is always a demand for choice grades at profitable prices. By the introduction of new varieties the time of fruiting has been so much extended that home-grown berries may be found in our markets from the time native strawberries are beginning to become scarce until blackberries are abundant.

The canes during the past winter were almost uninjured by the cold, but in 1891 they were killed to the ground in many places while in others the plants were almost killed out at the roots, which illustrates the fact that in order to secure a crop every year, the canes must be in some way protected. This protection can most easily and cheaply be provided by bending them over and covering with soil. First loosen the ground on the south side of the plants, then with a hard pull, to loosen the plant a little at the collar, bend the canes over and throw enough earth upon them to hold them in place. After the plants of the row or field have thus been bent down, a heavy plow, turning a furrow upon them on each side, completes the work. The canes should always be bent down toward the south, that the sun may not shine so directly upon them as if bent toward the north.

The following table gives the results of the season's trial:

EXPLANATION: Figures, dates, etc., the same as in preceding tables.

VARIETY.	Per cent Winterkilling.	Date of Blooming.	Date of Ripening.	Disease.	Yield from Fifty Plants.	Quality.	Firmness.	Size.
		June	July		Qts.			
Belle de Fontaine	.03	10	8	.10	20.8	p	f	l
Brandywine	.05	6	5	.00	33.3	g	s	s
Crimson Beauty	.05	7	2	.00	35.2	g	s	s
Cuthbert	.08	9	5	.00	151.7	m	s	l
Golden Queen	.05	9	9	.00	96.0	m	s	l
Gladstone	.15	8	6	.20	11.1	p	s	m
			June					
Hansell	.08	4	30	.00	80.0	v g	s	m
			July					
Herstine	.10	6	5	.10	18.7	g	s	m
Highland Hardy	.05	8	7	.00	25.0	v g	f	s
Marlboro	.12	5	2	.00	82.5	m	f	l
Naomia	.50	7	8	.10	12.5	p	v s	s
Rancocas	.10	2	2	.10	59.5	m	m	s
Scarlet Gem	.10	8	5	.00	18.8	p	s	s
Stayman's No. 5	.15	5	9	.00	4.1	m	f	m
Thompson's Early Prolific	.05	4	1	.00	37.5	v g	f	m
			June					
Thompson's Pride	.05	2	30	.00	80.0	v g	m	m
			July					
Victor	.30	12	9	.05	35.6	p	m	l
White Mountain	.20	12	10	.10	1.8	p	s	m
Japanese Wineberry	.75	20	20	.10	0.6	p	s	s

The varieties that have proved the most important are as follows:

Cuthbert. We think no variety that has thus far been introduced will yield so many quarts per acre as this. It is rather soft for long shipment and not of as good color as the Hansell, Marlboro, or Thompson's seedlings.

Golden Queen. This proves the most valuable yellow raspberry. It is especially so for home use, but on account of its color not so valuable for general market purposes.

Hansell. Up to the present time this has been one of the best for home use on account of its earliness and hardiness, but it is too small and soft for market.

Marlboro. Were the quality of this variety better it would be valuable for home use. It is of large size, early, of good color, and under good cultivation productive in many localities and valuable for market.

Thompson's Early Prolific. As hardy and early as the Hansell, it is of larger size, as good in quality and nearly as productive, and we consider it superior to the latter variety.

Thompson's Pride. Like the last, this variety is perfectly hardy, vigorous, and productive. In size and quality it is better than the above and perhaps the more promising of the two, for either home use or market.

Japanese Wineberry. This variety should be mentioned for its want of merit, rather than for any value whatever that we have been able to discover in it. It produces but little fruit and that of very poor quality, judged by the standard of our red raspberry. As a curiosity or from a prospective value of its use in crossing with our red or black-cap varieties it is of some interest, but it never should have been sent out as a fruit for either home use or market.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 23.

ELECTRO-CULTURE.

DECEMBER, 1893.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1893.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.*
Clarence D. Warner, B. Sc.,	*Meteorologist.*
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Malcolm A. Carpenter, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Archie H. Kirkland,	*Assistant Entomologist.*
Charles P. Lounsbury,	*Assistant Entomologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Meteorology.

ELECTRICITY IN AGRICULTURE.

CLARENCE D. WARNER.

The influence of atmospheric electricity upon the growth and development of plants has long been recognized, but just what the relation is, experiment has not yet fully determined. To solve this problem, one would naturally turn to batteries, study the effect of currents produced chemically, and from these results draw conclusions regarding electricity produced in the atmosphere. Experiments have been made with plants by erecting tall poles crowned with teeth having metallic connections with the earth and some good results have been obtained through this method. In other cases, plates of zinc and copper sunk in the earth and connected with a copper wire along which various vegetables were planted have likewise increased the growth to a marked degree.

Of the experiments carried on thus far, many contradictory results have been shown. In 1859, Helmert experimented with seeds of the pine tree, peas and lettuce, using copper and zinc plates connected with an exposed copper wire; he found an earlier germination of the pine tree seeds, but no acceleration in growth; the peas and lettuce were much benefited, the leaves and blossoms being healthier and the peas were greatly improved.

Fichtner experimented in the same manner with barley, peas, summer wheat and buckwheat; the increase in yield was from sixteen to one hundred and twenty-seven per cent higher than in ordinary culture.

Blondeau found that apples, pears and peaches, ripened and mellowed earlier under the influence of electricity, seeds germinated quicker, plants grew faster, the stalks were stronger and the color of a darker green.

In 1882, Tschinkel showed that seeds germinated from six to eight days earlier in soil through which an electric current had circulated, the plants having a quicker and healthier growth. Tschinkel thought this was due to the decomposition of salts and other constituent parts of the soil.

Professor Holdefleisz experimented with copper and zinc plates and batteries carrying on the two experiments simultaneously, and selected for this trial sugar beets and potatoes. The row subjected to the battery current did not show any unusual benefit in quantity or quality, but the row with copper and zinc plates gave an increase of fifteen per cent in beets, and twenty-four per cent in potatoes. The cost of the apparatus for this experiment was trivial.

Oberamtman Braune experimented with the copper and zinc plates and battery currents and his results confirmed those of Professor Holdefleisz.

The most extensive experiments in the employment of electricity in agriculture, however, were carried on by Professor Wollny of Munich. Summer rye, radishes, rape seed and potatoes were selected. He claims to have received negative results in most cases. He found no variation in the germination of seed or in the growth of plants. The potatoes showed an increase of six per cent in quantity and a slight improvement in quality, and after various experiments, Professor Wollny came to the conclusion that direct application of electricity was harmful to plants.

During the experiments mentioned above, there was little or nothing done to determine the quantity of electric current used at any given time. In some special cases, however, a galvanometer was employed to prove the existence or non-existence of a current, but there was no apparatus used for noting the exact number of amperes or volts.

We may reasonably suppose that some plants are very susceptible to the effects of electricity and thereby would be injured by a small amount, while other varieties are capable of enduring a strong current and even under its influence take on a healthy appearance and develop an abnormal growth. Hence, it is just as important to understand the exact quantity of electricity to which the plants are subjected as it is essential to know the existence of the electric current.

Some of the negative results recorded by Professor Wollny and others, may undoubtedly be ascribed to a lack of knowledge of the exact point where the favorable influence stops and the unfavorable begins, but as this point may vary with different varieties, intelligent investigation can be made, only by carefully studying the effects of currents of known strength.

Considerable work has been done toward investigating the influence of electric light on the growth and development of plant life, and experiments in Europe and America (at Cornell University in particular) show that certain plants are much benefited, while other varieties are injured or not at all affected by the powerful rays of the arc light.

Two years since, experiments dealing with electricity only were begun at this station and the bulletin issued at that time contained the results of growing lettuce under the immediate influence of an electric current generated by several cells of the common fluid battery. The plots experimented with were small, but the results were so encouraging that it was deemed important to try the experiment on a more extensive basis. The first garden was not furnished with electrical apparatus for determining at any given time the quantity of current circulating through the wires, hence, there was no definite way of ascertaining to how strong a current the plants were subjected. There were times when the current was stronger than at other periods, as a renewal of the chemicals would produce a more powerful action for a season, which would gradually decrease. Thus the effect of an electric current of a given number of amperes continued for a specified time could not be determined intelligently, for only the results of the combined effects of currents of different strengths could be considered.

To obviate this difficulty it was decided to arrange a garden and equip it with apparatus by which the current could be entirely controlled and measured. For purpose of comparison, two plots of ground were prepared, side by side, each 6x20 feet—one to be used with, the other without electricity. In this paper these plots will be designated as the electric and non-electric gardens.

The soil was a rich loam, well spaded, and the plots so situated that the rows of the non-electric were the continuation of those of the electric garden, with a space of about twenty inches lying between the two. Around the electric bed, or garden, was constructed a frame-work, made of 2x4 inch timbers, on which were fastened porcelain insulators, four inches apart; a continuous, non-insulated copper wire (No. 15) was strung on these porcelain insulators, as shown in illustration, Fig. 1, and the whole structure was then buried so that the wire should be two inches below the surface of the ground. Near at hand was a transformer, a small house in which were placed switches, meters, voltmeter, ammeter, reducer and resistance lamps. The interior of the house, together with the electrical instruments may be seen as illustrated in Fig. 6. When the apparatus was put in place, perfect control of the currents was obtained throughout the whole time the experiment was in progress. Electricity was generated by the dynamo at the electric light station, the current was alternating and was applied nightly, from time of turning on the current at the generating house until after eleven o'clock, or about four hours daily, from June 10th to October 1st, inclusive.

The following table shows the variation of the current from June 10th, the beginning of the experiment, to July 13th, after which time the current was at its maximum, viz: thirty-nine amperes, and remained at this point from July 13th to September 30th. The voltage varied from fifteen as a minimum to fifty-three as a maximum.

JUNE.

Date.	Amperes.
10	12
11	12
12	12
13	12
14	15
15	16
16	16
17	16
18	16
19	16
20	16
21	16
22	21
23	22
24	22
25	22
26	22
27	22
28	22
29	26
30	26

JULY.

Date.	Amperes.
1	26
2	26
3	26
4	26
5	30
6	31
7	35
8	35
9	35
10	35
11	35
12	35
13	39

The ground having been prepared, was planted June 8th, with seeds of the following varieties:

1—Parsnips, Large Sugar or Hollow Crown;
2—Lettuce, Silver Ball;
3—Carrot, Early Shorthorn;
4—Turnip, Sweet German;
5—Beet, Egyptian Turnip;
6—Salsify, Long White;
7—Radish, Early French Breakfast;
8—Onion, New Pearl;
9—Radish, White Strasburg;
10—Turnip, Purple Top White Globe.

The seeds were sown in drills midway between the wires; no fertilizer whatever was used and if there was any difference in the fertility of the soil it was in favor of the non-electric plot; throughout the period of investigation and study both plots were subjected to identical treatment, save in the application of the electric current.

As before mentioned, electricity was first applied June 10th, the current being twelve amperes, as it was thought proper to use a small quantity at the start, that the effect of the stronger current might be more intelligently studied as the experiment proceeded. Throughout the period the ground was kept well watered in order that it might act as a good conductor. June 11th, the plants in the electric plot began to appear—purple top white globe turnips ahead. The turnips made rapid growth, those in the electric bed growing faster than those of the non-electric. June 12th, other plants broke through the surface in both plots; beets appeared in each plot on the 14th, and on the 16th, parsnips were seen peeping through the soil of the electric garden. A full history of the vegetables will be found in the following pages, the different varieties being treated in the order given above.

PARSNIPS, Large Sugar or Hollow Crown.

As stated, June 8th was the day on which both plots were planted and the parsnips were sown, four rows in each bed, at the end where the electric current entered the ground. The plants began to appear June 16th in both plots—electric garden ahead, and from the first showed rapid growth; the foliage was rank and when harvested was nearly twice as high as that of the non-electric plot; the roots, also, were larger and showed a marked difference in favor of electricity. Why such rank growth of tops should have taken place at this end of the plot we cannot say, unless, when the current entered the ground the plants were subjected to greater electric influence. It was also noticed that those plants in the immediate vicinity of the point where the current emerged from the ground by the return wire, grew faster and were much larger than those at a greater distance from the electrodes. (The same peculiarity was also observed in the experiment made with lettuce two years since, and may be found in the first article of this series, Bulletin No. 16, on Electro-Culture.) The following table gives the weights of plants at time of harvesting October 31st:

With electricity.			Without electricity.	
lbs.	ozs.		lbs.	ozs.
17	10	Roots,	14	5
17	0	Tops,	10	0
34	10	Total,	24	5

Here it will be noticed that in the electric plot, for every pound of roots, very nearly a pound of tops was produced, while in the other case, for every pound of tops, 1.43 pounds of roots grew, but the difference in the totals is 10 pounds, 5 ounces, in favor of electricity.

LETTUCE, Silver Ball.

The next two rows were given to lettuce, but unfortunately very few plants appeared. This must undoubtedly be ascribed to poor seed, for the partial failure was in both plots and especially in the non-electric. After it was assured that no more plants would appear these few were left to grow as they would and the remainder of the space was set out with beets. The lettuce although growing at a disadvantage and overshadowed by the transplanted beets, developed with an apparent difference in favor of electricity. In this case, however, the plants were not weighed.

CARROT, Early Shorthorn.

This vegetable was given the third place in the gardens and from the first grew rapidly, the tops in the electric bed surpassing for a season in luxuriance those of the non-electric bed. When the roots

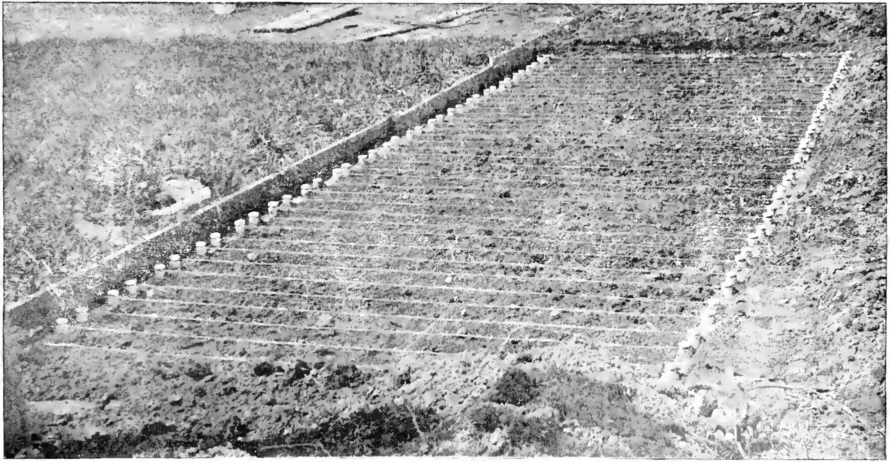


FIGURE 1.

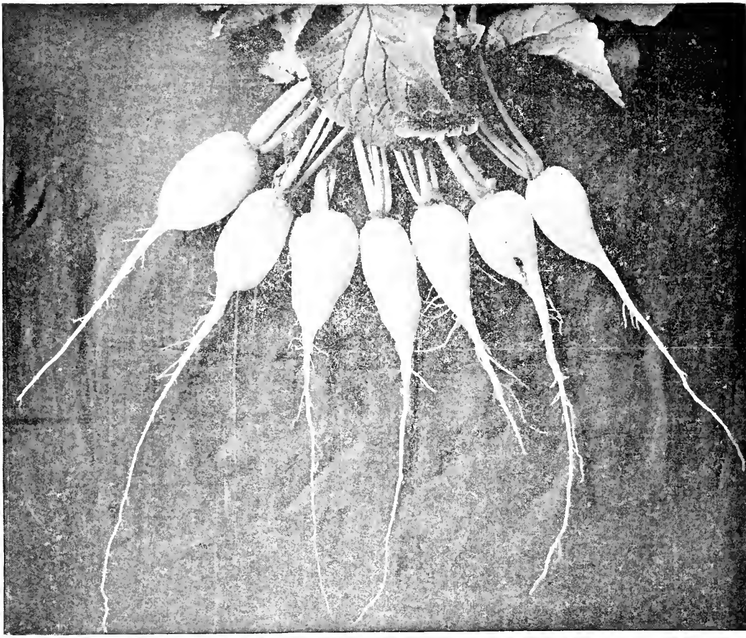


FIGURE 2.

FIGURE 4.

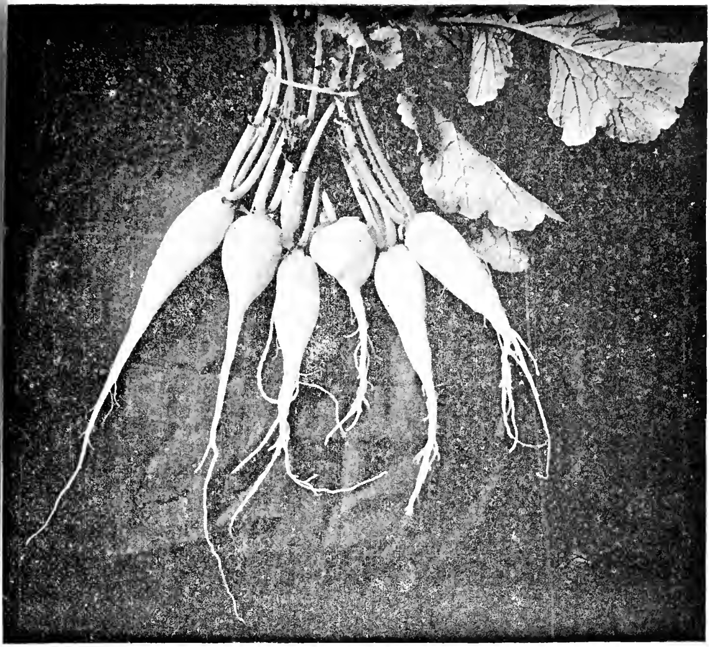


FIGURE 3.

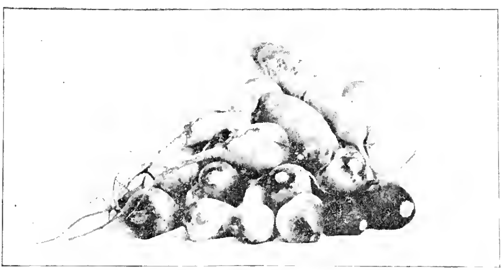


FIGURE 5.

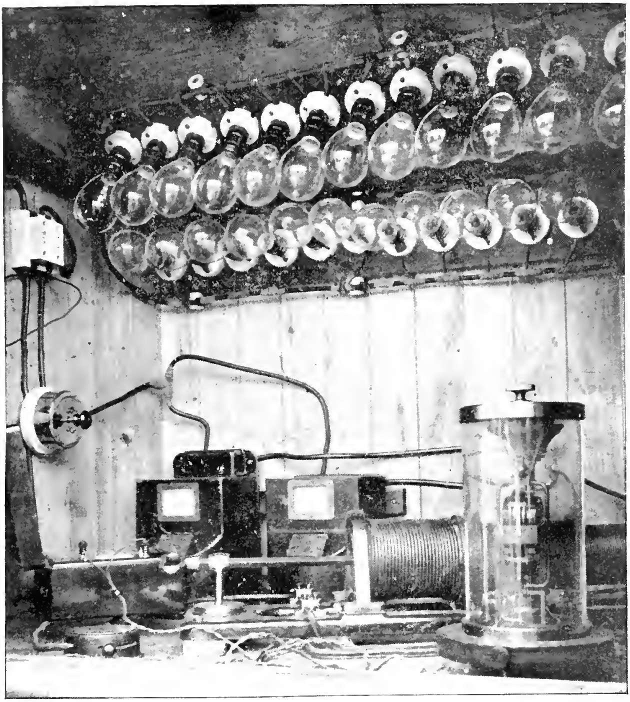


FIGURE 6.

were harvested, there was no difference in the weight of the tops grown on the two plots, although a difference of 12 ounces appeared in the weight of the roots as the following statement shows:

With electricity.			Without electricity.	
lbs.	ozs.		lbs.	ozs.
13	12	Roots,	13	0
1	8	Tops,	1	8
15	4	Total,	14	8

TURNIP, Sweet German.

This variety was sown in the centre of the two plots and like all the others the electrics showed rapid growth at first and for some time were far ahead of the non-electrics. In due time, however, the latter took a sudden start, outstripping those of the electric bed, and on October 31st, when all were harvested, the following results were obtained, with 6 pounds, 12 ounces, in favor of the non-electric plot; also, the roots of the non-electric turnips were larger and better developed. Throughout the experiment, the plants in both gardens had a most vigorous, healthy appearance.

With electricity.			Without electricity.	
lbs.	ozs.		lbs.	ozs.
23	0	Roots	28	8
6	12	Tops,	8	0
29	12	Total,	36	8

BEETS, Egyptian Turnip.

Following the Sweet German Turnip, two rows of seeds of the above named vegetable were sown, the plants appearing in both plots on the 14th. Almost from the first the beets in the non-electric bed led in growth and development. When harvested, (October 31st) the results given below were obtained:

With electricity,			Without electricity.	
lbs.	ozs.		lbs.	ozs.
3	8	Roots,	7	8
1	7	Tops,	1	12
4	15	Total,	9	4

Or a gain of more than 4 pounds (roots and tops) in favor of the non-electric vegetables ; here it is noted that the weight of the foliage differed very little, while the weight of the roots differed largely. When these rows were thinned, eighteen of the best plants were set in that part of the beds where the lettuce had failed. In both gardens these were planted four inches apart, those transplanted to the electric plot being placed in direct contact with the wire. This for a time seemed to stimulate the growth, but the results show that the non-electric garden produced the best crop.

With electricity.			Without electricity.	
lbs.	ozs.		lbs.	ozs.
6	0	Roots,	7	8
2	0	Tops,	1	12
—	—		—	—
8	0	Total,	9	4

There being 1 pound, 4 ounces, in favor of the non-electric bed. It will also be noticed that the foliage growing on the 6 pounds of roots in the electric garden, weighed more than that growing on the 7 pounds, 8 ounces, of roots in the non-electric garden. Hence it would seem, that electricity has a tendency to develop the foliage of plants.

SALSIFY, Long White.

From the first the salsify grew more rapidly in the electric plot and one peculiar feature was especially noticeable, viz. : That one-third of the row grew more rapidly than the rest—the foliage was more luxuriant and the roots developed faster. A search for the cause of this marked difference was made, and it was found that in sowing, the seed of this one-third of the row had been accidentally planted in close contact with the wire, while the remaining two-thirds of the row was two inches from the wire on either side. The experiment resulted as given below :

With electricity.			Without electricity.	
lbs.	ozs.		lbs.	ozs.
2	6	Roots,	1	10
1	11	Tops,	1	8
—	—		—	—
4	1	Total,	3	2

In this case the increased weight of roots was in favor of electricity while there was little difference in the weight of tops.

RADISH, Early French Breakfast.

Next to the parsnips the radishes gave the best results; they grew rapidly, the electric garden always ahead; the tops were rank and the roots were crisp. July 12th the entire crop was harvested, carefully washed and weighed with the following showing:

With electricity.			Without electricity.	
lbs.	ozs.		lbs.	ozs.
5	4	Roots,	4	2
4	5	Tops,	2	14
—	—		—	—
9	9	Total,	7	0

Or 2 pounds, 9 ounces, in favor of electricity.

The twelve largest roots from the electric garden, with the tops, weighed 1 pound, 4 ounces; without the tops, 3-4 pound. The twelve largest roots from the non-electric garden, with the tops, weighed 1 pound, 3 ounces; without the tops, 3-4 pound; that is, in this case, no difference was found in the weight of the roots.

ONION, New Pearl.

The onion plants came up in both beds and grew finely for a time, then blasted and not one developed, either electric or non electric, this being the only case of all the vegetables tested where no tangible results were obtained.

RADISH, White Strasburg.

The White Strasburg Radish seemed to do better than the Early French Breakfast Radish; they grew faster and developed more rapidly, and on June 8th the best radishes to be found in each plot were pulled, washed and weighed. It was found that the six largest roots taken from the electric plot weighed two ounces more than the six largest taken from the non-electric plot. They were larger individually, the tap root longer, the flesh of a finer flavor, of better quality, more brittle, and in every way superior to those raised without the aid of electricity. Fig. 2 shows the seven largest electric radishes, and Fig. 3 gives a view of the six largest non-electric radishes pulled on this date. Again, on July 11th, six radishes were taken from the same rows and the scales showed an increased weight in favor of the electric current. August 8th, thirty radishes (the largest to be found) were pulled from each bed, washed and weighed as formerly, and those taken from the electric garden were found to weigh 7 pounds, 4 ounces, against 6 pounds, 7 ounces, the weight of the thirty non-electric radishes. The six largest roots of the above named thirty radishes weighed as follows: Electric, 2 pounds, 8 ounces; Non-electric, 2 pounds, 3 ounces, or 5 ounces in favor of electricity. The two largest radishes from the electric row weighed 14 ounces, while the two largest from the non-electric row weighed 10 ounces, or 4 ounces favoring electricity. One row of this variety was allowed to continue to grow in each plot and produce seed. During this time there was a marked difference in the growth of the entire plant and always in favor of the electric current. Figs. 4 and 5 give a view of the thirty radishes—electric and non-electric respectively.

TURNIP, Purple Top White Globe.

Last of all in the plots came the Purple Top White Globe Turnip, and three days after the seeds were sown, (June 11th), plants appeared; this variety was sown near the return wire and was the first to break through the soil in the electric plot; plants in the non-electric bed did not appear until the 14th. It was noticed that a very rapid growth took place, the largest turnips growing near the point where the wire emerged from the ground, the tops being rank and luxuriant. Photographs were taken of plants from each plot, but one negative unfortunately was injured and some of the data lost; hence, the exact percentage in favor of electricity could not be determined.

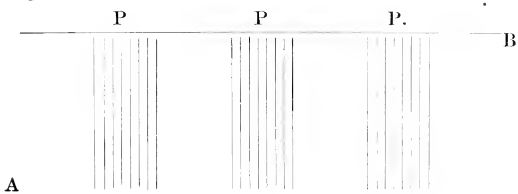
PEAS.

After the French Breakfast Radishes were harvested the ground was prepared and sown to a small early pea of the American Wonder variety. In order to test whether the seed coming in close contact with the wire, and hence the electric current, would be injured, the seeds were carefully planted about one inch apart, touching the wires, then covered with earth to the depth of one inch. The seeds were planted July 12th and the vines blossomed August 4th. The plants in the electric plot appeared above ground three days before those not under the influence of electricity; the plants in both gardens grew rapidly, but those in the electric bed developed a finer foliage and blossomed from three to four days sooner than those in the non-electric bed. The fruit was allowed to ripen and dry on the vines, hence, the weight of the green product was not determined, the test, principally, being to ascertain, (as before stated), whether or not the delicate seedling would be injured by a strong electric current. Most of the time the plants were subjected to a current of thirty-nine amperes with a voltage of fifty-three and at no time were injurious effects discovered, but rather, strong stimulating power was apparent.

TOMATOES.

Near the electric and non-electric gardens were a number of tomato plants which had been set in the regular kitchen garden. The fruit was green and quite well developed, when on August 3d, six plants were selected in the row, of uniform size and of the same variety—the Champion. It was desired in this case to determine whether electricity hastened or retarded the ripening of the fruit and three of the six plants chosen were provided with electricity in the following manner:

An insulated wire was placed on each side of these three plants; at intervals of one and one-half inches the insulation was cut away and eight cross wires of copper were fastened to the laterals as seen in the figure.



Note.—A and B, terminals. P P P, cross wires placed among the roots of the plants.

These eight non-insulated wires were placed among the roots of the plants to be tested and when finally placed in position were three inches below the surface of the ground. A current of thirty-nine amperes was used throughout this experiment. Particular tomatoes on each plant were carefully watched and when the fruit began to turn red, those subjected to electricity invariably ripened three or four days earlier than those growing in the natural way.

A similar experiment was tried some time since by others with the same result. The question whether or not electricity would develop a stronger growth of vines and fruit if applied from the time of setting out the plants, cannot be answered at this writing, but basing our opinion on results gained in growing other vegetables with electricity, we believe it safe to affirm that tomatoes, like any other plants, would be materially benefited, the effect being to produce a stronger growth of vines and larger fruit if submitted to the electrical influence from the very first. However, this conclusion must not be too hastily accepted as true, for direct experiment alone can settle the question.

CONCLUSION.

From the summary of results recorded in the foregoing pages the following may be gathered:

(a) That when subjected to electrical influences some varieties of seeds germinate more quickly and certain plants blossom sooner;

(b) That some kinds of vegetables have a tendency to enlarge their roots, while others grow a large amount of tops;

(c) That plants standing near the electrodes develop a larger growth of roots and foliage;

(d) That tomatoes ripen sooner;

(e) That the vegetables experimented with were not at all injured by a current of thirty-nine amperes with a voltage of fifty-three, but rather were stimulated in growth.

Furthermore, we would add, that growing vegetables by electricity can hardly be considered practical. The experiments referred to with tall poles crowned with teeth for collecting the electricity of the atmosphere, or where copper and zinc plates were used, cost very little as compared with the expense of growing plants with the aid of electric currents generated by batteries or dynamos. The method of collecting and using atmospheric electricity might be employed with a possibility of the farmer being well paid by an increased growth of cereals and some varieties of vegetables; but when batteries and dynamos are employed, the cost of instruments, wires, increased amount of labor, resulting from a net-work of lines, in addition to the expense of generating the electricity used, would render the undertaking too expensive for the everyday farmer. The increase in crops would scarcely pay for the trouble and outlay; but, be this as it may, it is very apparent that electricity does to a certain degree influence the growth and development of plants. What the results of the foregoing experiments would have been had the plants, during their growth been subjected to continuous electrical influences cannot be foretold.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 24.

INSECTICIDES.

THE HORN FLY.

APRIL, 1894.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1894.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.*
Clarence D. Warner, B. Sc.,	*Meteorologist.*
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Malcolm A. Carpenter, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Archie H. Kirkland,	*Assistant Entomologist.*
Charles P. Lounsbury,	*Assistant Entomologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

DIVISION OF ENTOMOLOGY.

C. H. FERNALD.

During the past season a series of experiments was performed with various insecticides on some of our common and troublesome insects, for the purpose of determining what proportions could be used to destroy the insects without injury to the foliage.

A NEW INSECTICIDE.

ARSENATE OF LEAD.

This substance was first proposed as an insecticide by Mr. F. C. Moulton, in 1892, while acting as chemist in Malden, under Mr. E. H. Forbush, Field Director, in charge of the work of destroying the gypsy moth.

The formula generally used in its preparation was arsenate of soda 29.93 per cent and acetate of lead 70.07 per cent by weight. These substances were weighed out separately and put into a hogshead containing 150 gallons of water, when chemical reaction took place which resulted in the formation of arsenate of lead, a very fine, white precipitate which is much lighter than Paris green.

A series of experiments was performed with this substance on the tent caterpillar (*Clisiocampa americana*), in proportions varying from $\frac{1}{4}$ lb. to 150 gal. of water, to 24 lb. to 150 gal., and in no case was the foliage injured.

June 5. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 24 lb. to 150 gal., and sleeved in ten tent caterpillars. This was done by drawing a bag made of cheese cloth over the end of the branch and tying it on so tightly that none of the insects could escape. On the 6th, two died; on the 7th, one; on the 8th, six; and on the 9th, the remaining one died.

June 5. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 12 lb. to 150 gal., and sleeved in ten caterpillars. On the 9th, all were dead.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 6 lb. to 150 gal., and the next day sleeved in ten caterpillars. On the 8th, all were dead.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 3 lb. to 150 gal., and the next day sleeved in ten caterpillars. On June 9th, all were dead.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 2 lb. to 150 gal., and the next day sleeved in ten caterpillars. The first two died on the 6th, and the last two on the 10th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 1½ lb. to 150 gal., and the next day sleeved in ten caterpillars. On the 6th, five were dead and the last two died on the 9th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of 1 lb. to 150 gal., and the next day sleeved in ten caterpillars. On the 6th, one was dead; by the 9th, nine were dead; the remaining one survived until the 12th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of ¾ lb. to 150 gal., and the next day sleeved in ten caterpillars. The first two died on the 5th, and the last one on the 10th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of ⅗ lb. to 150 gal., and the next day sleeved in ten caterpillars. On the 6th the first one died, and the last one on the 16th, though all but this one were dead on the 11th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of ½ lb. to 150 gal., and the next day sleeved in ten caterpillars. On the 8th, seven died, and the last one on the 17th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of $\frac{3}{8}$ lb. to 150 gal., and the next day sleeved in ten caterpillars. The first one died on the 6th, and the last one on the 17th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of $\frac{3}{10}$ lb. to 150 gal., and the next day sleeved in ten caterpillars. On the 8th, the first one was dead, and the last one died on the 16th.

June 3. Sprayed a branch of an apple tree with arsenate of lead in water in the proportion of $\frac{1}{4}$ lb. to 150 gal., and the next day sleeved in ten caterpillars. One caterpillar died June 6th, one on the 8th, one on the 9th, one on the 10th, two on the 11th, one on the 13th, and the last one on the 20th.

CONCLUSIONS.

A careful examination of all the details of this work, some of which do not appear above, leads to the conclusion that the smaller proportions, as $\frac{3}{5}$ pound or less to 150 gallons of water do not kill the caterpillars as quickly as is desirable, for so much time elapses between the application of the insecticide and the death of the caterpillars, that many of them might wander away from the poisoned food when not confined; also heavy rains might wash the poison off so thoroughly that the caterpillars could recover and pass their transformations.

The larger proportions seem unnecessary and would, of course, be rather expensive for general field work, but some such proportions as 1, $1\frac{1}{2}$, or 2 pounds to 150 gallons of water would prove entirely satisfactory so far as we can judge from these experiments as well as from other very extensive experiments which have been performed on the gypsy moth, both here in the Insectary and at Malden in the field.

Experiments were performed on the Colorado potato beetle (*Doryphora decemlineata*), with arsenate of lead in the proportions of $\frac{1}{4}$, $\frac{3}{10}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{5}$, $\frac{3}{4}$, 1, $1\frac{1}{2}$, 2, 3, and 6 pounds to 150 gallons of water. Portions of potato stems were set in bottles of water, under breeding cages in the Insectary, and nine partly grown larvae of this insect were placed on each. These experiments were carried on in duplicate, and cages with larvae on unsprayed food were placed by the side of them as a check.

The proportion of $\frac{3}{5}$ pound and less to 150 gallons of water did not prove satisfactory, for although many of the larvae were soon killed some remained alive after eight days.

The proportions above $\frac{3}{4}$ pound to 150 gallons of water proved entirely satisfactory, as they killed all of the larvae within three days, and in no case did the arsenate of lead injure the foliage.

HOW TO PREPARE ARSENATE OF LEAD.

A convenient way to prepare this insecticide is to put 11 ounces of acetate of lead and four ounces of arsenate of soda into a hogshead containing 150 gallons of water. These substances quickly dissolve and form arsenate of lead, a fine, white powder which remains in suspension in water.

It is highly desirable to add two quarts of glucose, or if that cannot be obtained, two quarts of molasses to each 150 gallons of water used, for the purpose of causing the insecticide to adhere to the leaves.

The experiments with this insecticide both here and in Malden last summer indicate that it will remain on the trees for a long time, even after quite heavy rains.

WHERE TO OBTAIN THIS INSECTICIDE.

The acetate of lead and arsenate of soda from which the arsenate of lead was made for the experiments at Malden and also at this place, were obtained of Billings, Clapp & Co. of Boston, Mass. They furnish a good quality of arsenate of soda at eight cents a pound and acetate of lead at fourteen cents a pound in twenty-five pound quantities. It is possible that cheaper grades would give equally good results. It should be borne in mind that acetate of lead, arsenate of soda, and arsenate of lead are all poisonous and should be used with as great care as Paris green.

ADVANTAGES OF THIS INSECTICIDE.

It is too early to say that this is a better insecticide than Paris green, under all circumstances and for all insects, but it has the advantage of being readily seen on the leaves, so that one can tell at a glance which have and which have not been sprayed, which is often of great convenience.

Another advantage is that it is lighter than Paris green, and does not settle so quickly, and as a result can be distributed more evenly over the foliage. Still another advantage is that it can be used in large proportions, if necessary even up to 25 pounds to 150 gallons of water without injury to the foliage. Many fruit-growers dislike Paris green on account of its injuring the foliage. This is undoubtedly because they use too large a proportion, or else because they do not keep it properly stirred all the time they are using it. If they should use arsenate of lead, no such trouble would arise; but to secure an even distribution, this also should be kept constantly stirred.

ORIENTAL FERTILIZER AND INSECT DESTROYER.

This insecticide is manufactured and sold by Bigelow & Co. of Chicago, at 75 cents a gallon. The analysis of this substance, made for me by Dr. Lindsey of the State Experiment Station, indicates that it is composed of arsenate of soda, chloride of potash, nitrate of soda, and some caustic soda in solution in water.

A long series of experiments was carried on with this substance on the tent caterpillar, Colorado potato beetle, and rose beetle, but it proved unsatisfactory as it injured the foliage very badly when used in the proportion recommended by the manufacturer, and when used in smaller proportions it did not destroy the insects.

ARSENATE OF SODA.

This substance has been recommended by various parties as an insecticide, and it was tested with the following results:

June 2. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of 3 lb. to 150 gal., and sleeved in ten tent caterpillars. On the 4th, the leaves were very badly burned, and on the afternoon of the 5th, the caterpillars were all dead.

June 2. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of 2 lb. to 150 gal., and sleeved in ten caterpillars. On the 4th, the leaves were very badly burned, and the caterpillars were all dead on the 5th.

June 2. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of 1 lb. to 150 gal., and sleeved in ten caterpillars. On the 4th, the leaves were very badly burned, and all the caterpillars were dead on the 7th.

June 2. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of $\frac{1}{2}$ lb. to 150 gal., and sleeved in ten caterpillars. On the 4th, the leaves were badly burned, and the caterpillars were all dead on the 7th.

June 2. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of $\frac{1}{4}$ lb. to 150 gal., and sleeved in ten caterpillars. On the 4th, the leaves were very badly burned, and the caterpillars were all dead on the 7th.

June 6. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of $\frac{1}{6}$ lb. to 150 gal., and sleeved in ten caterpillars. On the 11th, the last of the caterpillars died. On the 17th, the leaves were slightly burned and a few days later they were considerably burned.

June 6. Sprayed a branch of an apple tree with arsenate of soda in water in the proportion of $\frac{1}{8}$ lb. to 150 gal., and sleeved in ten caterpillars. On the 8th, one caterpillar died; 10th, two died; 11th, one died; 12th, one died; 14th, four died; 18th, the last one died. On the 17th, the leaves were slightly burned.

CONCLUSIONS.

All the proportions of arsenate of soda experimented with, from 3 pounds to 150 gallons down to $\frac{1}{8}$ pound to 150 gallons of water, injured the leaves more or less. The smallest proportion used, ($\frac{1}{8}$ pound to 150 gallons) while injuring the leaves to some extent, required twelve days to kill all of the caterpillars, even when confined where they could obtain nothing to eat but the poisoned leaves.

It appears therefore from this experiment that arsenate of soda cannot be used as an insecticide except in exceedingly small proportions, and then the caterpillars live so long that rains are very liable to wash off the poison and they recover from the effects of what little they may have taken.

PARIS GREEN AND LIME.

A series of experiments with Paris green and freshly slaked lime in about equal parts, was performed on tent caterpillars sleeved in on the branches of an apple tree. The spraying was done as in the previous experiments with the Woodason Liquid Spraying Bellows which serves admirably where a small amount of spraying is to be done.

June 5. Sprayed a branch of an apple tree with Paris green and lime in the proportion of 6 lb. of each to 150 gal. of water, and sleeved in ten tent caterpillars upon the branch. June 6th, one died; on the 7th, one died; on the 8th, five died; on the 9th, two died; and the last one died on the 14th. The leaves were not injured.

June 5. Sprayed a branch of an apple tree with Paris green and lime in the proportion of 3 lbs. of each to 150 gal. of water, and sleeved in ten caterpillars. On the 8th, seven died, and the remaining three died on the 9th. The foliage was not injured.

June 5. Sprayed a branch of an apple tree with Paris green and lime in the proportion of 2 lbs. of each to 150 gal. of water, and sleeved in ten caterpillars. On the 6th, four were dead; the rest died two days later. None of the leaves were injured.

June 5. Sprayed the branch of an apple tree with Paris green and lime in the proportion of 1½ lb. of each to 150 gal. of water and sleeved in ten caterpillars. On the 6th, two were dead; on the 9th, four; on the 10th, two; on the 11th, the rest were dead. Foliage not injured.

June 5. Sprayed a branch of an apple tree with Paris green and lime in the proportion of $1\frac{1}{5}$ lb. of each to 150 gal. of water, and sleeved in ten caterpillars. One died on the 6th; four on the 8th; two on the 9th; one on the 10th; one on the 14th: and the last on the 18th. Leaves not injured.

June 5. Sprayed a branch of an apple tree with Paris green and lime in the proportion of 1 lb. of each to 150 gal. of water, and sleeved in ten caterpillars. One died on the 7th; one on the 8th; one on the 10th; one on the 12th; one on the 17th; one on the 18th; and the rest on the 19th. Foliage not injured.

CONCLUSIONS.

A comparison of these experiments with those made on the tent caterpillar with Paris green alone, in 1891, and published in bulletin No. 19 of this Station, seems to indicate that Paris green and lime together act more slowly than Paris green alone. It is undoubtedly true that the lime unites with the soluble arsenic, forming a compound which is insoluble in water, and this is why it is less injurious to the foliage, but does it not render it less poisonous to insects? I do not wish to express a positive opinion in this matter without further investigation.

JAMESTOWN WEED (*Datura stramonium*) AS AN INSECTICIDE.

This plant has been recommended as an insecticide, and my attention was especially called to it last summer by Mr. A. I. Hayward who stated that he had apparent success in destroying cut worms with it. He informed me that he steeped it in water and sprinkled it around the plants.

One ounce of the dried leaves obtained from the druggist was steeped in a pint of water for four hours and this liquid was sprayed on potato leaves on which larvae of the Colorado potato beetle were feeding, but it did not affect them. It was also tried on rose beetles and the caterpillars of *Vanessa milberti*, but entirely without effect. These experiments were repeated by using the liquid diluted to $\frac{1}{4}$ of the full strength, but without success.

I had no opportunity to try this substance on cut-worms, but I do not understand how it could kill them beneath the ground if it is simply sprinkled on the ground, when it did no injury to the larvae of the Colorado potato beetle even when they were immersed in it.

THE HORN FLY.

(*Haematobia serrata R.-Desv.*)

The Horn Fly has now become so abundant in many parts of Massachusetts and is giving so much trouble that at the winter meeting of the Board of Agriculture, held at Great Barrington in December, 1893, it was voted to request the entomologist of the Hatch Experiment Station to prepare a bulletin giving information concerning this insect, with illustrations and remedies.

The Horn Fly was first described by Robineau-Desvoidy in 1830, from southern Europe, and at the present time is not uncommon on cattle in England, but is believed to be harmless as stated by Mr. G. H. Verrall, in the Entomologist's Monthly Magazine, Vol. 29, p. 291, 1893.

The first report of its occurrence in this country, so far as I am able to learn, was by Dr. S. W. Williston in the Entomologica Americana, Vol. 5, p. 181, 1889, where he states that the first specimens of this remarkable fly were sent to him by Prof. Cope, through Prof. Comstock, nearly two years previous, or in 1887. In 1888, it was reported in New Jersey, Pennsylvania, Delaware, Maryland and West Virginia ; in 1891, in Massachusetts, Mississippi and Kentucky ; in 1892, in Michigan, Canada, Louisiana and Iowa, and it is now pretty well distributed over the United States.

COMMON NAMES.

This insect has been called the Horn Fly because of its habit of resting on the horns of the cattle. Other common names are the Cattle Horn Fly, the Cow Horn Fly, the Texas Fly, the Buffalo Fly, and the Buffalo Gnat.

POPULAR DESCRIPTION OF THE FLY.

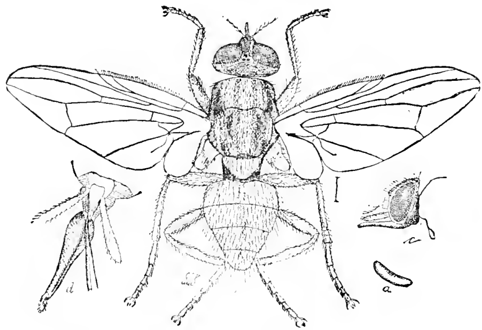


FIGURE 1.—a, egg; b, imago; c, head from the side; d, mouth parts. All greatly enlarged. (After Smith.)

This fly (Fig. 1. b) resembles the common house fly in general appearance, but is much smaller, being about one-third of an inch long. " It is of a dark gray color with a yellowish sheen, and the body is covered with minute black bristles. The head consists almost entirely of the dark-red, silvery-edged eyes, but bears on its lower surface the black dagger-shaped tongue which is the cause of so much torture to cattle."

LIFE HISTORY OF THE INSECT.

The female deposits her eggs (Fig. 1, a) singly on fresh cow manure, usually during the warm part of the day. The eggs are about one-twentieth of an inch long and of a brownish color. They hatch in about 24 hours and the young maggots burrow down into the dung where they feed, and reach their full growth in about a week, when they are of the form shown in Fig. 2, 1. They then descend into the ground where they change to the pupal stage (Fig. 2, 2). This stage lasts about a week, in the summer, when the flies emerge, but the last brood of the season passes the winter under ground in this stage. I do not know how many broods occur in this state, but Mr. Howard found that the time from the laying of the eggs to the appearance of the fly was about two weeks, and he therefore estimated that there were seven or eight annual generations in the region of Washington, D. C. The flies of the first brood appear in the spring and succeeding generations occur throughout the summer.

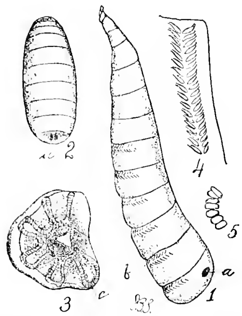


FIGURE 2.—1, larva; a, anal stigmata; b, motor processes. 2, pupa; a, anal stigmata or tubercle—all enlarged. 3, anal tubercle still further enlarged, showing the ridges; c, still further enlarged at 5. 4, motor processes of larva still further enlarged.

(After Smith.)

HABITS OF THE INSECT.

This insect confines its attacks to horned cattle, and not only worries them during the day, but, according to the observations of Prof. Smith, keeps it up during the night, whether they are in the barn or in the pasture. During the early part of the season, and when they are numerous, they cluster, when resting, around the base of the horns, often covering them for a distance of two inches or more. The horns are not the only resting places, for toward night they are said to settle in vast numbers upon the back, between the head and fore shoulders, where they cannot be reached by either the head or tail.

While feeding, the flies work their way down through the hair, so as to reach the skin, but they are exceedingly shy, and fly away at the slightest disturbance. The bites seem to produce great irritation and sores are frequently formed where the animals rub themselves against trees or other objects.

DAMAGE CAUSED BY THE HORN FLY.

It has been claimed by some that this insect has caused the death of animals, but there does not seem to be satisfactory evidence that the assertion is true. A careful examination of the statements to this effect by Mr. Howard leads him to believe that the flies alone will never cause the death of an animal. In regions badly infested by the Horn Fly, stock has often been tormented to such an extent as to cause the animals to grow poor and to yield a much smaller quantity of milk than otherwise; the reduction in some cases is reported to be from one-third to one-half.

REMEDIES.

As the larvae or young of this insect feed on the partly liquid substance of the fresh dung, Prof. Smith recommends sending a boy over the pasture every other day to spread out all the cow dung so that it may dry quickly and thus destroy all the eggs and larvae in it. He also states that a sprinkling of lime over the cow dung would answer the same purpose. Prof. Riley and Mr. Howard, in a special bulletin on the Horn Fly, issued by the Department of Agriculture, under preventive applications say as follows: "Almost any greasy substance will keep the flies away for several days. A number of experiments were tried in the field, with the result that train-oil alone, and train-oil with a little sulphur or carbolic acid added, will keep the flies away for from five to six days, while with a small proportion of carbolic acid it will have a healing effect upon sores which may have formed. Train-oil should not cost more than from fifty to seventy-five cents per gallon, and a gallon will annoint a number of animals. Common axle grease, costing ten cents per box, will answer nearly as well, and this substance has been extensively and successfully used by Mr. William Johnson, a large stock dealer at Warrenton, Va. Tallow has also been used to good advantage. The practice of smearing the horns with pine or coal-tar simply repels them from these parts. Train-oil or fish-oil seems to be more lasting in its effects than any other of the substances used."

They also recommend spraying the animals with kerosene emulsion to kill the flies. Mr. H. A. Morgan, entomologist of the Louisiana Experiment Station, who experimented on the Horn Fly in 1892, after spraying the animals with six different preparations, one of which was kerosene emulsion, says he obtained the best results with an emulsion made the same as the kerosene emulsion, but in which he substituted fish-oil for kerosene and in the same quantity. He states that he had equally good results with a weaker emulsion of fish-oil, made as follows: "Dissolve one-half pound of common hard soap in one gallon of boiling water, and while still hot add two gallons of fish-oil, which is thoroughly mixed with the water by churning the whole solution together for four or five minutes. It may be thoroughly mixed by forcing the liquid through a large syringe or force pump for the same length of time. After being thoroughly agitated so as to have the appearance of milk, dilute, using 15 to 20 parts of water to every one part of the solution."

NATURAL ENEMIES.

Mr. W. H. Ashmead, in the Proceedings of the Entomological Society of Washington has published the description of a new species of Spalangia which belongs to one of the parasitic groups of the Hymenoptera, under the name of *Spalangia haematobiae*, and states that it was described from a single specimen reared by Dr. Riley, Sept. 13, 1889, from the Horn Fly larva. This little parasite is only about $\frac{1}{12}$ inch long, but many of the most useful parasites on other insects are equally small. It is highly desirable that this parasite should multiply and distribute itself over the country to such an extent as to hold this European invader, the Horn Fly, in check, and reduce them to comparatively harmless numbers.

In August, 1892, Prof. J. B. Smith stated that the Horn Fly was not more abundant in New Jersey than the ordinary cattle fly (*Stomoxys calcitrans*). It is possible that the parasites are at work in that state on the Horn Fly.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN No. 25.

Fungicides and Insecticides.

Tests of Grapes.

APRIL, 1894.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE
1894.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

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Its officers are:—

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SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
CLARENCE D. WARNER, B. SC.,	*Meteorologist.*
WILLIAM M. SHEPARDSON, B. SC.,	*Assistant Horticulturist.*
MALCOLM A. CARPENTER, B. SC.,	*Assistant Horticulturist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
ARCHIE H. KIRKLAND,	*Assistant Entomologist.*
CHARLES P. LOUNSBURY,	*Assistant Entomologist.*

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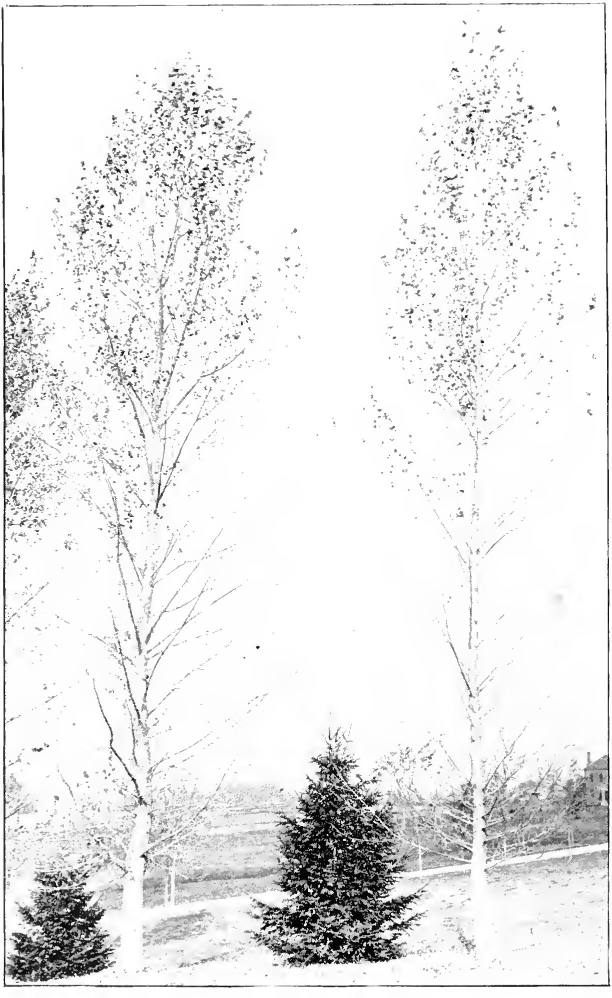

FIG. 1. UNSPRAYED.

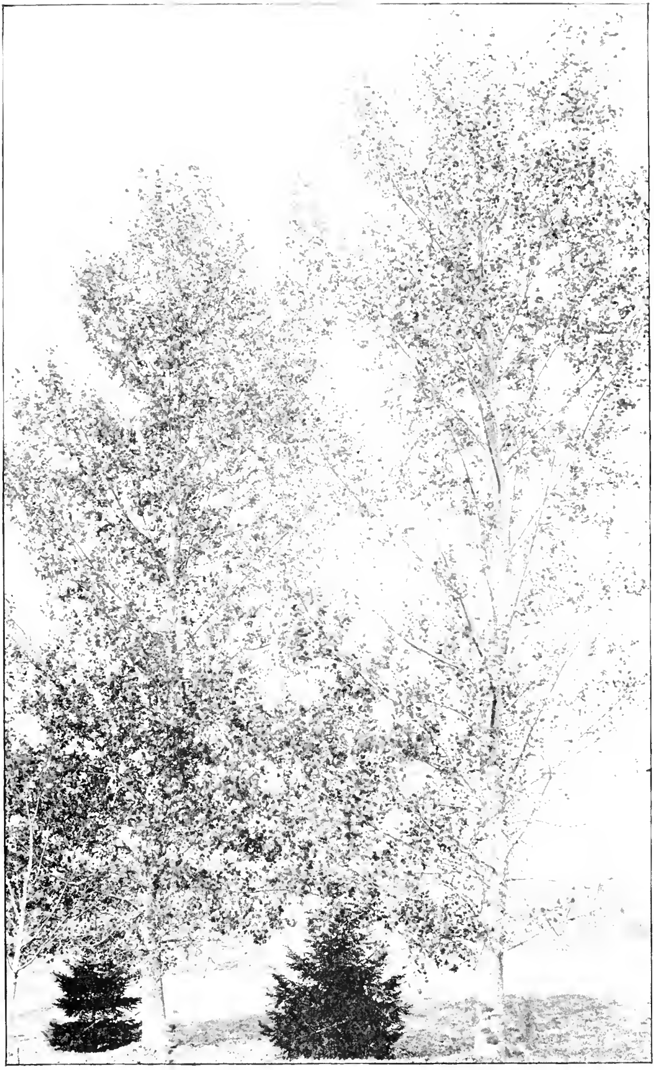

FIG. 2. SPRAYED.

Division of Horticulture.

S. T. Maynard.

SPRAYING TO DESTROY INSECTS AND FUNGI.

SUGGESTIONS FOR THE SEASON OF 1894.

As the season of growth approaches the question comes to us, in the form of frequent letters, " What shall I do to protect my fruit and other crops from fungous and insect enemies?" This question we shall attempt to answer in this bulletin. The past year has again demonstrated the fact that we cannot expect perfect products nor large yields from any crop without doing something to protect it from these enemies. Seasons differ very much in the prevalence of insect life or fungous growth, in some the crops being almost exempt from injury from one or the other or both. During a cool, dry season the fungi grow very slowly, if at all, while if hot, moist weather prevails they develop with wonderful rapidity. The same may be said of insect life, and could we predict with certainty what the season is going to be, we could frequently dispense with the use of fungicides and insecticides. But we cannot in any way now known to science foretell whether insects and fungous growths are to be abundant or not, and are therefore compelled to prepare our engines of destruction and have our insecticides and fungicides ready upon the foliage and fruit at the time when such enemies are likely to appear.

In preparing this bulletin, our formulas and directions are based upon the numerous experiments made at this station; the successful practice of practical fruit growers in various sections of this and other states, and a careful review of the work of other stations during the past season in protecting their fruit and garden crops from the attacks of insects and fungi.

As these generally appear about the same time it is found economy wherever possible, to combine the fungicides and insecticides, thereby materially reducing the cost.

For general purposes we consider the Bordeaux mixture the best fungicide until the fruit reaches the size when it will be disfigured by it, after which the ammoniacal carbonate of copper should be used. We also consider Paris green the best insecticide.

FORMULAS.

BORDEAUX MIXTURE.

4 lbs. Copper Sulphate or Blue Vitriol.
4 lbs. Fresh Unslaked Lime.
25 to 50 gallons of water.

Directions for Making.

Dissolve the copper sulphate in two gallons of hot water in a wooden tub or pail, and let it stand until cool, or suspend in a basket or sack in a tub or pail of cold water. Slake the lime with water enough to make a thin whitewash. When both are cool, pour the lime through a strainer of gunny cloth or fine wire sieve, into the copper solution and mix thoroughly.

When ready to use it, add water enough to make (a) 25 gallons, or (b) 50 gallons of the mixture, and again strain before pouring into the barrel or knapsack pump. Application should be made through a Vermorel or adjustable nozzle which will give a fine spray or mist.

In making this mixture care must be taken that the lime thoroughly precipitates the copper, for if much of the copper still remains in solution it will burn the foliage, especially that of the peach and cherry, and sometimes the plum.

To avoid this danger, obtain from your druggist a small quantity of yellow prussiate of potash and dissolve it in water in a small bottle. Before using the Bordeaux mixture add a few drops of this substance, and if a brown color is produced add more lime until no reaction takes place, when the solution will be safe to use upon any kind of foliage.

If much of this mixture is to be used, five or ten times the quantity of each substance may be prepared and kept in separate vessels, the proper quantity being taken out when needed.

AMMONIACAL CARBONATE OF COPPER.

Copper Carbonate, 3 ounces,
Ammonia, enough to dissolve the Copper,
Water, 40 gallons.

Directions for Making.

Dissolve the copper carbonate in the ammonia, using only enough to dissolve all of the powder, and dilute with water to 25 gallons before using. (The ammonia found at drug stores, and at other places, varies so much in strength that the exact quantity cannot be given.) Larger quantities of the copper carbonate may be dissolved at a time if desired, but it must be kept in glass-stoppered bottles until needed. Copper carbonate is rather expensive, but may be made by taking

Copper Sulphate, 2 lbs.
Soda Carbonate (Sal-Soda), 2½ lbs.

Dissolve separately and pour together. Stir thoroughly and the copper will be precipitated in the form of carbonate, while the soda will remain in solution. Pour off the water and dry the precipitate and use the quantity required as above directed. In this form, not counting the labor, the cost of the copper carbonate will be only about one-third that of the commercial article.

COPPER SULPHATE SOLUTION.

1 pound Copper Sulphate,
25 gallons of water.

Dissolve at any time before using, and apply to all kinds of fruit trees and plants before the buds unfold, to destroy the winter spores of injurious fungi.

INSECTICIDES.

PARIS GREEN.

While London purple and other substances may be used successfully in combination with the above fungicides, we prefer Paris green from the certainty of results attending its application. By the use of the Bordeaux mixture as a medium for carrying and holding Paris green to the surface of the plant, as well as by neutralizing any acid that it may contain, very much better results may be obtained, than if used alone. With the above mixture, Paris green may be used at the rate of one pound to 50 or 100 gallons, while in water alone it cannot be safely used upon the foliage of the apple stronger than one pound to 200 or 300 gallons of water, and on the peach stronger than one pound to 300 or 400 gallons.

KEROSENE EMULSION.

½ pound of common, hard Soap,
2 gallons Kerosene.

Directions for Making.

Dissolve the soap in hot water, pour in the kerosene and stir or churn with a syringe or hand pump, until the mixture forms a smooth buttery paste. Dilute with water to from fifteen to twenty-five gallons.

SPRAYING CALENDAR.

THE APPLE.

1st Time. Spray with copper sulphate solution before the buds unfold to destroy any winter spores. It is possible that the Bordeaux mixture would have results quite as good or better if used at this time, on account of its firm adherence to the branches and bud scales.

2d Time. Just before the blossoms open, spray with the Bordeaux mixture and Paris green, one pound to 100 gallons, for the apple rust, codling moth, bud moth, canker worm, and tent caterpillar.

3d Time. Within one week after the petals have fallen, make another application of the same, for the same insects and the apple scab which may now appear if the weather is favorable.

4th Time. In from ten days to two weeks, according to the weather, use the Bordeaux mixture alone.

Should the weather be dry and the temperature low no fungous growths wlll probably appear, when the longer interval may elapse, but if it should be warm and moist the apple scab is likely to appear and the copper should be on the foliage and fruit in sufficient quantity to prevent its spores from germinating.

5th Time. Under ordinary conditions, during the month of July, only one application of the Bordeaux mixture need be made, and this should be at from two to four weeks from the last application.

6th Time. After the fruit is nearly grown only the ammoniacal corbonate of copper should be used, and unless the weather be very wet one application will be sufficient.

THE PEAR.

1st Time. Before the leaves unfold use the copper sulphate solution for the leaf blight, cracking of the fruit, and the pear scab.

2d Time. Apply the Bordeaux mixture and Paris green, one pound to 100 gallons, before the blossoms open, for the codling moth.

3d Time. As soon as the petals have fallen, repeat with mixture as last used.

4th Time. From two to four weeks after the last spraying, according to the weather, use the Bordeaux mixture alone for leaf blight, cracking of the fruit, and pear scab.

5th Time. Should the weather be very warm and moist, make an application of the Bordeaux mixture from the first to the middle of August.

If the pear tree *Psylla* appears, use the kerosene emulsion as soon as the first one is detected, making a second and third application at intervals of five to seven days. The best time to make these applications is probably from May 1st to June 1st.

This insect causes the blackness on the leaves and branches during the summer and injures the trees very seriously by sucking the juice from the tender shoots, leaves and petioles. It is so minute as to be detected only by the closest examination, and our orchards are often infested and seriously injured before we are aware of its presence.

THE PEACH.

1st Time. Use the copper sulphate solution before the leaves appear, the same as for the apple and pear.

2d Time. About one week after the petals have fallen, spray with the Bordeaux mixture and Paris green, one pound to 200 gallons, for the plum curculio and shot-hole fungus.

NOTE.—*Test the Bordeaux mixture carefully with the yellow prussiate of potash before using. If it shows no red or brown reaction when a few drops of this substance are poured into it no harm to the foliage need be feared, but if the brown color appears, more lime should be added until no reaction takes place.*

3d Time. For the early varieties that are subject to the brown rot, apply the ammoniacal carbonate of copper, about a week before the fruit begins to soften.

THE PLUM.

1st Time. Treat with the copper sulphate solution before the leaves appear.

2d Time. Use the Bordeaux mixture and Paris green, one pound to 100 gallons, just before the petals open, for the curculio and black wart.

3rd Time. Repeat the above as soon as the petals have fallen.

4th Time. Repeat the same in from five to seven days if the trees have set a crop of fruit.

5th Time. Spray with the Bordeaux mixture alone, in from ten days to two weeks.

6th Time. Just before the fruit begins to ripen, spray with the ammoniacal carbonate of copper.

THE QUINCE.

1st Time. Use the copper sulphate solution before the leaves unfold, for the leaf blight.

2d Time. After two or three weeks, use the Bordeaux mixture for leaf blight.

3d Time. Repeat the same application in from two to three weeks.

THE CHERRY.

1st Time. Apply copper sulphate solution before the leaves unfold.

2d Time. When the petals have fallen, use Bordeaux mixture and Paris green, one pound to 200 gallons.

3d Time. Repeat the same in from five to seven days.

4th Time. After the fruit has been gathered, repeat the same.

THE GRAPE.

1st Time. Spray with copper sulphate solution just before the leaves unfold.

2d Time. Just before the blossoms open, spray with Bordeaux mixture and Paris green, one pound to 100 gallons, making an effort to cover the clusters of buds with as much as possible, for the "rose bug" and mildew.

3d Time. As soon as the petals have fallen, repeat same application.

4th Time. Apply same, in from five to seven days.

5th Time. Use Bordeaux mixture alone, in from two to four weeks, according to the weather.

6th Time. After the grapes are from-one half to two-thirds grown, use the ammoniacal carbonate of copper.

7th Time. Should the season continue very warm and moist, a second application of the above may be needed, but generally one application will be sufficient.

THE CURRANT AND GOOSEBERRY.

1st Time. Spray with the Bordeaux mixture as soon as the currant worm begins to work. This will probably kill many of the currant worms and prevent all fungous growths. Paris green may be used at this time, *if its application does not occur after the fruit has set, when great danger of serious poisoning would be incurred.*

2d Time, Use powdered hellebore, one ounce to five gallons of water, in from three to five days.

3d Time. When the second brood begins to work, use the hellebore as above.

4th Time. When the fruit begins to color, use pyrethrum or Persian insect powder, one ounce to five gallons of water. This will be more effective if used just before dark. If the gooseberry bushes show signs of mildew, use the Bordeaux mixture until nearly grown, then the ammoniacal carbonate of copper. One application of each will generally be effectual.

THE RASPBERRY AND BLACKBERRY.

1st Time. Use the copper sulphate solution before the foliage appears.

2d Time. Apply the Bordeaux mixture and Paris green, one pound to 200 gallons, for the destruction of leaf-eating insects, red rust and anthracnose.

3d Time. As soon as the fruit has been gathered apply the Bordeaux mixture for the leaf blight, which is very destructive to some varieties.

THE STRAWBERRY.

1st Time. As soon as the plants begin to make growth, spray with the Bordeaux mixture and Paris green, one pound to 200 gallons, for the leaf blight and the strawberry "Flea beetle" or Black Paria.

2d Time. Just before blossoms open, repeat the same application.

3d Time. If the bed is to fruit another year give another spraying of the same as soon as the fruit is harvested. Young plantations should be sprayed after the first application, as directed above, and an additional spraying be given them in August.

THE POTATO.

1st Time. As soon as the potato beetle has laid its eggs, spray with the Bordeaux mixture and Paris green, one pound to 100 gallons, using the barrel or knapsack pump.

2d Time. In from one to two weeks, or when the larvae of the potato beetle become abundant, spray again with the same.

3d Time. Repeat as above and at same interval.

POTATO SCAB.

It is claimed by good authorities that by the use of corrosive sublimate, one ounce to eight gallons of water, in which the seed potatoes are soaked, from one to one and one-half hours, before planting, this disease may be prevented. We have made no experiments in this line, but, as this disease is one of the greatest drawbacks to the successful cultivation of the potato, and as the cost of treatment is so small, we would urge every one to make a careful test of this remedy.

Corrosive sublimate is *one of the most deadly poisons*, and should be used with the greatest caution, and never be left where children or irresponsible persons would be likely to get hold of it. This will also apply to Paris green, London purple, or any other arsenical poison. In the use of fungicides and insecticides it must be borne in mind that if the season is favorable we *may* escape injury from insect and fungous pests, but if we fail to make the application of remedies at the proper time and the conditions are unfavorable, fungi may become so firmly established or insects may increase so rapidly that it will be impossible for us to dislodge them before they have done serious injury. The only safe course therefore is to make the first applications at the proper time and renew them when rains or other conditions render it necessary.

REPORT ON POPLAR RUST.

(*Melampsora populina.* Jacq.)

For several years the row of black or Italian poplars (*Populus nigra*) which extends from the Botanic museum to the main college buildings, and which have made an almost phenomenal growth, have been seriously injured by this fungous growth.

It first appears during the hot, moist weather of July and August, and when abundant and appearing at the earlier date kills many of the branches. Its work is largely confined to the lower branches where dew and moisture are more abundant and where the spores are more likely to reach the leaves.

Soon after being attacked, the leaves assume a yellowish color, and upon close examination numerous clusters of yellow spores are seen on the under side. These spores are produced in untold numbers and are soon scattered by the wind. Coming in contact with other leaves, they so rapidly spread the infection that in a few days, from the product of a few clusters the whole tree is affected. The leaves soon turn yellow and fall to the ground, where, after they have become brown, may be found in place of the yellow masses of spores, numerous black clusters in which are produced the winter spores. These, surviving the winter, come in contact with the new leaves in the spring or summer, germinate, and undergo their round of existence.

RESULTS OF THE USE OF FUNGICIDES.

To check this disease the trees were sprayed with the Bordeaux mixture July 26th, 28th, and August 11th, and 25th. The result of this spraying is shown in the following cuts made from photographs, Fig. 1 showing the trees unsprayed, and Fig. 2 those that were sprayed.

All of the trees were employed in this test, every other three being sprayed. In every case the results were the same, i. e., the three trees treated having perfectly healthy foliage, while those not sprayed were badly diseased. The results are not as plainly shown in the photographs as was actually the case owing to the delay in obtaining the pictures; the leaves of the poplar being constantly in motion several attempts had to be made extending over a period of several days, before a satisfactory negative could be obtained, and in the meantime the leaves were ripening rapidly and many had fallen from the trees that were sprayed.

PUMPS AND MATERIALS.

Spraying pumps and materials are now kept for sale by nearly all dealers in seeds and agricultural and horticultural supplies, and can be obtained from them at reasonable prices. While there are many different kinds of pumps advertised, and while nearly all of those put on the market by the large manufacturers who make a specialty of spraying pumps, are good, it is best, however, to buy those made as near home as possible, on account of the repairs and replacement of parts necessitated by breakage which may occur when least expected.

RESULTS OF SPRAYING IN 1893.

The fruit trees on the college grounds were sprayed at the regular intervals during the season, using the copper sulphate solution before the leaves unfolded, leaving some trees unsprayed for the sake of comparison. The results of this work we give in as brief form as possible.

APPLES.

After the first spraying, as stated above, with the copper sulphate solution, the dates of application were as follows: June 1st and 16th, with Bordeaux mixture and Paris green; July 12th and Aug. 10th, with the Bordeaux mixture alone.

Results.

As the season was unfavorable for its growth, little of the apple scab appeared, but on a few R. I. Greenings it was found late in the season. On the unsprayed trees about 50% of the fruit showed some scabs, while that from the sprayed trees was not disfigured at all. On the unsprayed trees, taking an average of seven varieties, nearly 50% of the fruit contained the larvae of the codling moth, while on the sprayed trees only 10% was affected. The yield of the unsprayed trees averaged three bushels to the tree, while the sprayed trees averaged from ten to twelve bushels.

PEARS.

Owing to the extreme dryness of the month of June, no leaf blight appeared on the leaves and no application of fungicides or insecticides was made until it was discovered that the pear tree *Psylla* had gained a foot-hold. The kerosene emulsion was applied July 4th and 11th, but it being too late in the season it had but little effect. At least three applications of the kerosene emulsion should be made from May 1st to June 1st, to be effectual.

PEACHES.

All the peach trees on the college grounds blossomed and set a crop of fruit, and to protect it from the plum curculio the trees were sprayed with the Bordeaux mixture and Paris green very soon after the petals had fallen. This application so injured the foliage that no further treatment was attempted.

It has since been learned that if more lime had been added to make the fungicide neutral or alkaline no injury would have taken place.

CHERRIES.

For many years the cherry crop on the college grounds has been almost a total failure, on account of the wormy fruit caused by the larvae of the plum curculio and the rotting of the fruit when almost ripe. To prevent this condition, the trees were sprayed May 26th, 29th and June 16th, with the Bordeaux mixture and Paris green, one pound to 100 gallons.

Results.

On unsprayed trees no perfect fruit matured, all being more or less irregular in form and containing worms, while on the sprayed trees the fruit was smooth and nearly free from worms.

The fungicide, not having lime enough in it, injured the foliage more or less, but none of it fell off and the crop was matured. It is, therefore, important that the yellow prussiate of potash test be used before applying the Bordeaux mixture on the cherry or the peach.

PLUMS.

The plum trees were sprayed April 3d with the copper sulphate solution; May 26th, 29th and June 5th, with the Bordeaux mixture and Paris green, one pound to 200 gallons; June 14th, July 26th and Aug. 10th, with the Bordeaux mixture alone, and Sept. 9th, with the ammoniacal carbonate of copper, for the plum curculio, shot-hole fungous, black wart, and the brown fruit rot.

Results.

On all of the sprayed trees, the leaves remained healthy until the end of the season, few or no warts appeared and the fruit was not injured by the curculio, but, owing perhaps to the long interval elapsing between the last two applications, the fruit rotted somewhat.

On the unsprayed trees the foliage was not as perfect and dropped off earlier, more warts appeared, and the fruit was entirely destroyed by the curculio.

In the few cases where warts did appear they were painted at once with thick white lead made liquid enough with kerosene to apply easily, thus preventing the spores that form on the surface of the warts during the summer, from developing and carrying the disease to other trees.

Fungicides and insecticides were applied to the *Quince*, *Raspberry*, *Blackberry*, *Currant*, *Gooseberry*, and *Strawberry*, with successful results, but the records are such that no exact statement can be made. We feel warranted, however, in the assertion that if the routine given in the spraying calendar be followed with good judgment, serious injury to the above crops will be prevented.

REPORT ON VARIETIES OF GRAPES FRUITED IN 1893.

The past season, at this station, owing to the hot, dry weather and the lateness of frosts in the fall, was unusually favorable for the perfect maturing of nearly all varieties. Fungous growth was also less abundant and destructive than in former years.

One hundred and twenty-five varieties fruited in the station plots. Two vines of a kind, whenever it has been possible to obtain them, have been planted together, one of which has been treated with fungicides and insecticides, while the other has been kept as a check to determine the value of the treatment.

In the college vineyard of one acre, where only a few varieties are grown, numerous experiments in a practical, business way have been carried on to test the most promising of the results obtained in the plots.

The following table gives the results of the examination and observation relating to one hundred and sixteen varieties which produced fruit enough for the various tests.

EXPLANATION OF TABLES.

This table is made on the scale of 1 to 10, 1 indicating the highest degree of excellence, hardiness, and freedom from disease, while 10 signifies the opposite. l stands for large, m for medium, and s for small.

BLACK VARIETIES.	Hardiness.	Disease Unsprayed.	Disease Sprayed.	Size of Bunch.	Size Berry.	Quality.	Adhesiveness.	Keeping Quality.	Date of Blooming.	Date of Ripening.
Ann Harbor	1	3	1	m	s	6	4	5	June 19	Oct. 8
Armenia (Rogers' No. 39)	1	2	1	l	l	4	2	3	" 18	Sept. 14
Arnold's No. 1	2	5	1	l	m	8	2	3	" 22	Oct. 4
Arnold's No. 2	1	2	1	m	s	7	4	5	" 14	Sept. 20
Arnold's No. 16	2	4	1	s	s	7	3	6	" 18	Sept. 28
August Giant	1	6	2	l	l	9	1	7	" 20	Oct. 5
Bacchus	1	2	1	m	s	7	1	2	" 15	Oct. 10
Black Eagle	1		1	l	l	3	2	4	" 18	Sept. 12
Caywood's No. 50	1	1	1	m	m	5	5	8	" 17	Sept. 13
Champion	1	1	1	m	m	9	8	10	" 10	Aug. 30
Clinton	1	1	1	m	s	5	2	3	" 10	Sept. 20
Concord	1	2	1	l	l	3	6	6	" 18	Sept. 20
Cottage	1	1	1	m	m	8	9	9	" 20	Sept. 15
Creveling	1		1	m	m	7	9	9	" 17	Sept. 15
Cynthiana	1		1	m	s	9	8	5	" 19	Oct. 9
Eaton	1	2	1	l	l	4	7	7	" 18	Oct. 4
Early Victor	1	2	1	m	s	7	6	8	" 10	Aug. 30
Elsinburgh	1	2	1	m	s	8	2	5	" 24	Sept. 25
Excelsior	1	3	1	m	m	5	3	7	" 24	Oct. 14
Hartford Prolific	1	1	1	m	m	8	4	8		
Herbert (Rogers' No. 44)	1	4	1	l	l	2	1	1	" 15	Sept. 17
Highland	1	2	1	l	l	3	2	2	" 19	Oct. 14
Ideal	1		1	m	m	3	5	6	" 22	Oct. 9
Janesville	1	2	1	m	m	9	6	8	" 8	Aug. 31
Jewell	5		1	s	s	2	2	3	" 22	Sept. 9
Merrimac (Rogers' No. 19)	1	1	2	l	l	3	1	1	" 17	Sept. 20
Mills	3	2	1	l	m	2	1	1	" 25	Oct. 5
Montifore	1	1	1	l	m	7	8	5	" 14	Sept. 15
Moore's Early	1	1		m	l	5	7	8		
Nectar	2	1	1	s	s	2			" 25	
Norman	1	2	1	m	m	7	4	5	" 15	Sept. 30
Northern Muscat	1	1	1	m	m	9	4	6	" 18	Sept. 30
Norton's	1	1	1	l	s	7	3	5	" 24	Sept. 20
Peabody	1		1	l	m	2	3	7	" 18	Sept. 10
Pizzaro	2	1	1	m	s	7	6	6	" 17	Sept. 28
Rockwood	1		1	l	m	3	3	8	" 19	Sept. 14
Rogers' No. 32	1	5	1	m	m	4	4	4	" 19	Sept. 22
Rogers' No. 33	1	1	1	l	l	2	3	5	" 18	Sept. 14
Rogers' No. 34	1	3	1	l	l	3	1	2	" 19	Sept. 14
Secretary	2	1	1	m	m	5	1	7	" 14	Oct. 9
Seedling No. 15	1		2	m	m	5	7	7	" 20	Sept. 22
Seedling No. 18	1		2	m	s	4	5	1	" 18	Sept. 21
Standard	1		1	l	l	3	2	4	" 14	Sept. 18
Telegraph	1	1	1	m	m	9	6	9	" 10	Aug. 29
Union Village	1		1	m	m	4	3	4	" 18	Sept. 18
Wilder (Rogers' No. 4)	2		1	m	m	2	1	1	" 19	Sept. 12
Worden	1	1	2	l	l	3	9	9	" 19	Sept. 12

RED VARIETIES.	Hardiness.	Disease Unsprayed.	Disease Sprayed.	Size of Bunch.	Size Berry.	Quality.	Adhesiveness.	Keeping Quality.	Date of Blooming.	Date of Ripening.
Agawam (Rogers' No. 15),	2	4	1	l	l	2	2	4	June 18	Sept. 20
Amber Queen,	1	4	1	m	s	5	6	8	" 19	Oct. 1
Berckman,	1	2	1	m	s	2	1	3	" 19	Sept. 26
Brighton,	1	1	1	l	l	1	1	1	" 24	Sept. 22
Catawba,	1		1	l	m	1	1	1	" 25	Oct. 20
Centennial,	2	2	1	m	s	4	1	6	" 19	Sept. 20
Charter Oak,	1		1	m	l	9	10	9	" 18	Sept. 28
Delaware,	2		1	m	s	1	3	4	" 17	Sept. 22
Delaware Muscat,	3	1	1	m	s	7	2	6	" 17	Sept. 20
Diana,	4		1	m	m	4	3	5	" 20	Sept. 26
Essex (Rogers' No. 41),	1	1	1	l	m	2	1	2	" 20	Sept. 8
Goethe (Rogers' No. 1),	1	2	1	l	l	2	3	3	" 20	Oct. 20
Iona,	3		1	m	m	1	1	1	" 25	Oct. 5
Jefferson,	1	2	1	m	m	9	6	8	" 23	Oct. 7
Lee's Prolific,	1	1	1	m	m	6	4	5	" 11	Sept. 17
Lindley (Rogers' No. 9),	1	4	1	l	m	2	1	1	" 20	Sept. 20
Massasoit (Rogers' No. 3),	1	5	1	l	l	3	2	2	" 19	Sept. 20
Moyer,	1	3	1	s	s	2	4	8	" 12	Sept. 2
Norfolk,	1	7	2	m	m	8	5	7	" 19	Sept. 20
Oneida,	1	8	1	l	l	2	1	1	" 24	Sept. 26
Oriental,	1	1	1	m	m	2	1	3	" 19	Oct. 4
Perkins,	2	1	1	m	l	6	9	8	" 14	Oct. 4
Poughkeepsie,	1	3	1	m	m	1	8	8	" 20	Sept. 25
Requa (Rogers' No. 28),	1	4	1	l	m	3	1	1	" 18	Sept. 20
Rochester,	1		1	l	s	1	4	7	" 18	Sept. 20
Rogers' No. 30,	2	1	1	s	m	6	3	5	" 18	Sept. 9
Salem (Rogers' No. 53),	1	6	2	l	l	2	2	2	" 18	Sept. 22
Seedling No. 19,	1		1	m	m	6	9	9	" 20	Sept. 18
Ulster,	1		1	m	m	1	1	1	" 14	Oct. 4
Vergennes,	1	7	1	l	l	1	2	1	" 19	Sept. 20
Walter,	2	1	1	s	m	3	2	3	" 15	Oct. 15
Woodruff Red,	1	1	1	m	l	5	7	5	" 16	Oct. 4
Wyoming Red,	1	2	1	s	m	5	8	6	" 16	Sept. 12
WHITE VARIETIES.										
Amber,	1	1	1	s	m	6	4	6	" 25	Oct. 7
Antoinette,	1	2	1	l	l	5	9	7	" 19	Oct. 7
Augusta,	1	5	1	l	l	8	10	8	" 15	Oct. 7
Belinda,	1	2	1	m	m	5	10	8	" 19	Oct. 2
Brilliant,	1	1	1	m	m	6	6	8	" 17	Oct. 1
Concord Muscat,	2	2	1	s	s	10	5	8	" 18	Oct. 15
Duchess,	1	2	1	m	m	2	2	4	" 24	Sept. 20
Eldorado,	1	2	1	l	m	3	2	3	" 19	Sept. 19
Elvira,	1	6	2	m	s	5	4	8	" 17	Oct. 4
Empire State,	1	7	1	m	m	4	4	3	" 19	Oct. 10
Esther,	1	1	1	m	m	3	9	9	" 16	Sept. 25
Etta,	1	2	1	m	m	6	6	4	" 14	Oct. 14
Faith,	1	1	1	s	s	6	5	8	" 18	Sept. 8
Golden Drop,	2	2	1	s	s	4	4	4	" 20	Sept. 10
Golden Gem,	2	2	1	s	s	4	2	4	" 16	Sept. 14

WHITE VARIETIES.	Hardiness.	Disease Unsprayed.	Disease Sprayed.	Size of Bunch.	Size Berry.	Quality.	Adhesiveness.	Keeping Quality.	Date of Blooming.	Date of Ripening.
Grein's Golden,	1	3	1	m	l	3	7	6	June 15	Oct. 1
Grein's No.2,	1	2	1	m	m	7	5	7	" 14	Oct. 3
Hayes,	1	4	2	l	m	2	8	8	" 19	Sept. 29
Jessica,	2	7	1	s	s	3	6	6	" 14	Sept. 10
Lady,	2	4	1	m	m	4	7	8	" 21	Sept. 20
Lady Washington,	1	4	1	l	l	3	8	7	" 20	Oct. 15
Martha,	1	1	1	m	m	6	4	5	" 23	Sept. 30
Moore's Diamond,	1	4	2	l	l	1	6	6	" 19	Sept. 30
Niagara,	1	2	1	l	l	3	7	8	" 19	Sept. 30
Pearl,	1	5	1	l	m	6	5	9	" 14	Oct. 7
Pocklington,	1	1	1	m	l	4	6	7	" 20	Sept. 28
Prentis,	1	5	1	l	m	4	3	2	" 16	Sept. 18
Rebecca,	4	2	1	m	m	3	4	6	" 27	Oct. 5
Seedling No. 42,	2		1	l	m	1	1	1	" 18	Sept. 20
Seedling No. 44,	1		1	m	m	2	3	2	" 18	Sept. 20
Transparent,	1	5	2	s	s	8	5	8	" 16	Oct. 10
Triumph,	2	5	1	l	l	6	7	9	" 23	Oct. 7
Victoria,	1	3	1	m	m	5	8	7	" 19	Oct. 1
Wilding,	1		1	s	s	6	5	7		
Winchell (Green Mt.),	1	2	1	l	m	2	5	5	" 12	Sept. 2
Witt,	1	1	2	m	m	3			" 14	Sept. 26

CONDITION OF THE PEACH BUDS MARCH 20, 1894.

As in previous years the fruit buds of the peach were examined weekly from Dec. 1st to the expiration of severe weather, March 20th. One hundred buds of each variety being examined at a time. The following table gives the results for the winter of 1893 and 1894.

Variety.	Per Cent of Buds Destroyed. Dec. 30th, 1893.	Jan. 30th, 1894.	Feb. 30th, 1894.	March 20th 1894.
Crawfords Early,		.94		100
Crawfords Late,		.92		.99
Crosby (Excelsior),	.345	.415	.46	.775
Oldmixon,	.49	.895	.93	.99
Red-cheeked Melosoton,	.71	.90	.935	100
Reeves' Favorite,	.72	.88	.89	.95
Stump,	.81	.86	.88	.96