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HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 61.

THE ASPARAGUS RUST IN MASSACHUSETTS.

APRIL, 1899.

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,
1899.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
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Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
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Fred W. Mossman, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Philip H. Smith, B. Sc.,	*Assistant in Foods and Feeding.*
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Herbert D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
Arthur C. Monahan,	*Observer.*

The co-operation 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.

PLATE I.

BOTANICAL DIVISION.

G. E. Stone and R. E. Smith.

The Asparagus Rust in Massachusetts.

Various varieties of asparagus have been under cultivation for a great many centuries, and even as far back as the time of Pliny it is mentioned as being in the highest state of cultivation. It has been under cultivation in England and France for some hundred years, where it has been highly esteemed, and from which countries it was introduced into America by the early colonists. We find it occurring in Massachusetts at a very early period and Josselyn, in his "New England Rarities," published in 1672, says that "Sparagus thrives exceedingly." It is also known that the Huguenots, who settled at Oxford, Mass., in the year 1686, were skilled horticulturists and that they brought with them from their mother country, France, the best types of vegetables, fruits, and flowers, which they cultivated with a skill quite unknown to their English contemporaries. Among the various vegetables which they brought with them was the asparagus, and its plants after having been set out some two hundred years ago can at the present time be seen, or at least plants originating from the same stock, growing spontaneously year after year over the ruins of the original settlement of this remarkable people.

The cultivation of asparagus, however, was extremely limited in Massachusetts during the 17th and 18th centuries, it being confined to the private gardens of the more progressive and well-to-do families, and even at the beginning of the present century its cultivation was not at all common. As to that matter, it is probably within the bounds of accuracy when we affirm that even seventy-five years ago the number of asparagus beds in a typical Massachusetts town would not exceed two or three. At the present time, however, this condition of affairs has been entirely changed and asparagus ranks as one of the most highly esteemed vegetables which go to the table. Asparagus beds are now found in every private garden of any pretence, and the production of this vegetable for the large markets in Massachusetts to-day utilizes many hundred acres of fertile land and provides occupation with fair returns to a large number of market-gardeners. According to some recent statistics pertaining to market-gardening in Massachusetts it is shown that the increase in the production of vegetables during the period from 1885 to 1895 has been 22%, and while there are no special data given concerning asparagus this product will undoubtedly rank among the first in its increase.

The growing of asparagus on a large scale in Massachusetts is confined to certain towns; it being most extensively grown in those possessing a light sandy soil. The largest growers are situated in the eastern sections of the state, near the large markets. In the vicinity of Concord there are some 400 acres of asparagus under cultivation which largely supply the Boston markets, and 100 acres or more are also controlled by the South Eastham Asparagus Co. on Cape Cod. The annual income from asparagus alone in Concord is estimated at $100,000.

The Asparagus Rust.

The asparagus rust has been known in Europe for a great many years, and since the time of the elder de Candolle, who was the first to study it nearly a century ago, the rust has been known to be caused by a fungus which has borne the name *Puccinia Asparagi* D. C. It is known to occur in most of the countries of Europe and mention is made of it in all the principal publications on the continent relating to the diseases of plants. The first mention of the asparagus rust in the United States was by Harkness, who claimed to have observed it on the Pacific coast in 1880, although there appears to be some doubt whether the genuine rust, *Puccinia Asparagi*, was ever really found there. The first mention of it in the Eastern states was in the fall of 1896. Prof. Halsted was the first to call attention to it and we shortly afterwards observed it in this State on the beds at the Massachusetts Agricultural College. It was learned at that time that it was distributed over New England, Long Island, New Jersey, and Delaware, where it had become firmly established, and the next year it had spread to the large asparagus beds in South Carolina, but so far as we are aware, little if any but black spores (teleutospores) were noted in 1896 in Massachusetts, and no perceptible damage resulted to the marketable crop in 1897 as a result of the rust during 1896.

The fact, however, that the rust should appear over so large an area at practically the same time is rather astonishing, and if the infection started from a single point or even from distant places in this country, it is interesting as showing how quickly a fungus like this can spread over a large area in so short a time. There appears to be some doubt among practical growers in some localities in regard to the first appearance of the rust in 1896. We have recently learned from a number of different people residing on Cape Cod that it has been known there for some years, but it is impossible at the present time to procure absolute proof in regard to the reliability of this assertion. Some of the evidence in regard to these ideas may not be out of place here. One correspondent on the Cape writes as follows: "We have had the asparagus rust in this town for four or five years, but to no great extent until 1897;" and another gentleman from the same locality states that "The asparagus rust has been seen in this vicinity for a number of years," and that "Last year (1897) every one had it." The following from the Cape is along the same line. "I am confident that I have had the rust on my beds longer than 1896 * * * * and I feel certain that I had the disease two years before the growers in Concord." Or in other words as far back as 1894. At first we were strongly inclined to regard these ideas as mistaken ones, but as they appeared to be universal and strongly believed we became convinced that there might be some truth in them. Nevertheless it is not unlikely that in some instances certain other things have been mistaken for the rust or confused with it. It is well known that the young succulent stems of the asparagus as they are cut for the market frequently show reddish or rusty blotches upon their stems, and we have observed the same blotches upon the more mature plants just below the surface of the soil. These reddish blotches seem to occur upon plants grown in some soil more abundantly than upon others, and we are told that this is the reason why asparagus is not grown in some localities. It is not unlikely that these blotches have been mistaken for the genuine rust. This view of the matter appears to have some support in the statement which we have received ; namely, that the asparagus rust has been observed by one grower as occurring as early as April and May, which is quite contrary to all of our observations and to those of growers throughout the State. It is quite possible that this observer had in mind the rusty appearance of the stems, which so far as we are aware has no connection with the genuine rust.

Notwithstanding this however, it does not necessarily prove that the genuine rust did not exist here previous to 1896, inasmuch as it would be quite natural for one who saw the rust the first time to associate everything with it which resembled it. The impression is so strong among certain growers on the Cape that the rust existed there before 1896 that we are inclined to believe that this assertion is true, as it would seem to account more satisfactorily for the sudden outbreak in the middle states which occurred in 1896. The fierce and prolonged north-east winds and storms peculiar to that region could readily drive the rust spores in the direction of Long Island and New Jersey, where the rust when first discovered had secured a good foothold.

In 1897, the rust (uredospores) appeared early in some sections of this State and as a result of that summer's occurrence it completely incapacitated the asparagus plants—so far as the function of assimilation was concerned—which caused considerable alarm to asparagus growers. The date of the first appearance of the rust in 1897 as reported at Concord, Mass. was July 11th, and in the course of a few days the tops of the infected plants were completely brown. Few beds at Concord escaped the rust during the summer of 1897, and the injury resulting from it was quite marked. During the past season (1898) the rust did not make its appearance until September, in which instance the black spores (teleutospores) predominated. There is, however, one exception to this statement, and that is an instance where the rust (uredospores) appeared in July on a bed at Concord which was practically ruined in 1897, although none of the other beds in this locality during the same season showed any evidence of the red spores or summer stage, notwithstanding the fact that they were subject to infection. It should be stated, however, in connection with the rust, that in the majority of places in Massachusetts it has never occurred during the summer, but on the other hand it is only the black spores (teleutospores) which have predominated, and these only making their appearance late in the season. While the statement holds good in regard to localities, it must be understood that it is not valid when we take into consideration the number and size of the asparagus beds which were affected. It unfortunately happened that the rust was most severe in those localities where asparagus is cultivated most extensively.

During the past season this division has made use of every opportunity to gather data concerning the rust, as well as to experiment upon control methods, and a number of days have been spent in looking over the various fields.*

Life History of the Asparagus Rust.

Puccinia Asparagi D. C.

The asparagus rust is caused by a fungus of the above name which is one of the true rusts or Uredineae. Like many other rusts, it appears in three different stages or forms of development. The first of these forms, called the *aecidial* or cluster cup shape, appears in early spring, but, since at that time the asparagus is being cut for market, the fungus is able to develop only upon such scattering stalks as are allowed to remain and grow up,and consequently is not at all noticeable at this season. Indeed we have never observed it in this state and know it only from the descriptions of Halsted† and others. In this stage the fungus produces little eruptions on the surface of the affected plants, each of which is a minute cavity in which numerous spores are developed in the form of long chains, which break up into separate roundish spores at maturity. These spores are carried by the wind to other plants and produce on them the second form of the rust.

SUMMER OR RED RUST STAGE. (UREDO.)

The rust is by far the most destructive in the red rust stage which appears in July and August. The plants in the main bed have been allowed to grow up by this time and if badly affected soon appear

*We wish here to acknowledge our indebtedness to Mr. C. W. Prescott and Mr. Wilfred Wheeler and especially to Mr. Thomas Hollis who extended to us every hospitality while at Concord.

†Bull. 129, New Jersey Agr'l Exp't Sta.

as if scorched by fire, having a dry and withered appearance and being of a reddish brown color. The fungus consists as usual of numerous fine filaments which grow through the tissue of the plant just beneath the surface, robbing it of its nourishment and thus interfering with its vital processes. Upon the surface appear numerous little blisters which soon burst open and discharge a reddish brown powdery substance, consisting of the red or *uredospores* of the fungus. These spores fly off as a cloud of fine dust when badly rusted plants are disturbed. They are carried in enormous quantities to all neighboring plants where they germinate and spread the disease.

THE FALL OR BLACK RUST STAGE. (TELEUTO.)

The third form of the rust appears in September and October on plants which have survived thus far. It is characterized by the appearance of small black excrescences upon the surface of the affected plants, which are clusters of the spores of this stage. These spores are very thick walled and thus suited to their function of surviving over winter. They remain dormant until spring when they proceed to germinate and reproduce the disease, now in the spring stage.

While this is the normal course of development of this fungus it is by no means certain that it is confined to such a course, and in fact circumstances seem to indicate that it is not. In the case of the closely related wheat rust, *Puccinia graminis* Pers., we know that it is able to pass the winter and reproduce itself again in the spring in at least four different ways, viz.: 1st, by the regular process of teleutospores lying over winter and producing aecidia in the spring; 2nd, by uredospores which survive the winter and produce the summer and fall forms in the succeeding season; 3rd, by teleutospores producing the summer stage directly without the intervention of the spring form; and 4th, by the fungus itself remaining alive in the tissues of plants and proceeding into growth again the next season. That the asparagus rust is able to reproduce itself from year to year in some or all of these ways in addition to its regular course of development seems extremely probable in view of the history of its occurrence in this State. We have, as already mentioned, never observed the spring form, and, while it may occur, we believe it to be extremely rare. The red rust form, as elsewhere pointed out, has never been found in numerous places where the black rust came on later, or the two have appeared together in September when the tops had begun to ripen and die a natural death. This frequent appearance of the black, fall stage of the rust in places where no trace has been found of the two stages which should precede it, must, it seems to us, be explained in one of the following ways: Either the earlier stages did occur, but were not observed, these being quite scarce perhaps, or the spores came from a distance and produced the black rust, or, finally, the rust is able to skip over some of its stages as is the wheat rust. The first two of these suppositions cannot, of course, be absolutely contradicted, but, since careful and repeated examinations made of our bed here at the college during two summers failed to reveal any trace of the rust before Sept. 15th, we feel fully convinced that not a single particle of the spring or summer stage had developed. Furthermore, if the fungus can and does pass through its full course of development in all cases of its occurrence, that is if the spring and summer stages always occur before the fall stage can develop, there would seem to be no reason why they should not be abundant and common rather than exceptional. There were certainly enough teleutospores produced in the fall of 1897 to infect every plant in the State the following spring, but since such infection did not take place and the rust appeared in scarcely a single instance before the fall stage came on in September, the conclusion seems reasonable that one or more of the cases mentioned in connection with the wheat rust must have occurred. In beds where the teleutospores were produced in 1897, these spores, which evidently failed to infect the plants in the spring of 1898, may have retained their vitality until late summer and then have produced the rust in the fall stage, accompanied in some cases by a few belated uredospores. Another supposition is that the fungus remained alive over winter in the plant tissue, not producing spores again until September. This occurs in the wheat rust and several others. The hollyhock rust, (*Puccinia Malvacearum* Mont.) affords an instructive example in this connection. This rust produces only teleutospores. If an affected plant be brought into the hot house in midwinter and forced into growth, the rust will at once break out upon it, showing that the filaments of the fungus were still alive in the rootstock, and in the small, half evergreen leaves which are found in the hollyhock. The large fleshy rootstock of the asparagus plant affords an excellent opportunity for a similar occurrence. We have in several instances found fungous filaments growing in young asparagus stems near the base and also in affected roots. We are not, however, prepared to say that they were those of *Puccinia Asparagi* or that they were not those of some other fungus having no connection with the rust whatever. It is at any rate an interesting question whether the asparagus rust cannot in this way become perennial and approach a life history closely resembling that of *Puccinia Malvacearum.*

We allude in discussing "The probable cause of the severe outbreak of the rust," to the reasons why the earlier stages of the fungus are so infrequent. It is apparently the ability of the healthy and vigorous plant to resist infection by the rust which confines its appearance to late summer and fall when the part of the plant above ground is beginning to lose its vitality by the normal process of approaching death. Thus, though unable to follow its complete course of development, the fungus manages to adapt itself to circumstances sufficiently to reproduce itself from year to year, and goes on, or will go on as long as possible, awaiting the opportunity for its complete development which a season unfavorable to the growth of the plants would give.

Amount of Damage Caused by the Rust.

The economic importance of asparagus is such that a serious malady affecting it means a great loss to those market-gardeners making it a specialty. Heretofore it has generally been acknowledged that the asparagus plants in this country have been particularly free from fungous diseases, although they have been more or less subject to the ravages of insects. The fact that the asparagus plant can persistently exist for two hundred years in an isolated neglected spot such as we have already alluded to is an excellent indication of its hardiness and adaptation to our climate. The rust in this State having been most severe in 1897, the damage to the crop would naturally be felt the most during the past season (1898). It should be stated here, however, that no perceptible damage has occurred to the asparagus in those localities where only the fall outbreak has occurred, which, with some few exceptions, is the only manner in which the rust has manifested itself in Massachusetts up to the present time. This stage of the rust, (teleutospore stage), makes its appearance so late that it cannot affect appreciably the assimilating processes of the plant, and its appearance at this season of the year is largely a secondary affair connected with the natural dying of the tops.

When plants are affected in a similar way with the red spores (uredospores), the effect upon the plant during the following season is quite marked. As a rule asparagus growers in this section stop cutting for the market about the 1st of July, and by the middle of July, when the summer stage generally first commences to show itself, the tops are not fully grown, and it is only a matter of a few days before they are completely covered with red pustules, which give the plants a burned appearance and make them of little further use as assimilative organs. It does not require very much intelligence to comprehend the fact that if the plant's assimilating organs are incapacitated during the two most important months in the year, viz. July and August, there will be a lack of reserve material in the roots for the succeeding year's crop. Such, in fact, has been the condition of those plants which suffered from the effect of the rust during July and August of last year. The loss, however, as might be expected has been variable, bearing a direct relation to the severity of the attack. In the town of Concord, where we have been able to get reliable data concerning the amount of asparagus cut in the year '98, and that cut last year ('97), we have found that the loss experienced by different growers varies from 15 to 80 per cent. The bed which showed a loss of 80 per cent had hardly a sound root remaining last year as a result of the severe attack during 1897. Asparagus growers on the Cape have also experienced a loss of 20 to 25 per cent as a result of the rust. The lateness of the 1898 season would appear to account for some of this, but even when this is deducted there was probably not far from 20 per cent loss due to the rust alone. Generally, however, it might be stated that the loss experienced was something like 20 to 25 per cent.

There is still another source of loss to asparagus growers which is more important than that represented by the mere falling off of a single year's crop. We refer to the great injury which the roots received on account of the rust. We have observed many beds in which large numbers of roots were nearly dead, and, as they are not likely to recover from this effect, the loss from this source will not be replaced until new plants are set out and matured.

We have noticed that many of these affected roots show a tendency to throw up small insignificant shoots as if they were endeavoring to recover, but this recovery is more apparent than real, and it would be the wisest policy for growers to dig them up and replace them with new plants.

The Probable Cause of the Severe Outbreak.

In considering the asparagus rust in the U. S. it is not only proper to pay some attention to the source of contagion, but to the cause of the severe outbreak. We have already alluded to the fact that the rust has been known in Europe for many years, and that it was introduced from that country into the U. S., and although the rust was first noticed in 1896 we are not justified in stating at what time the disease first actually appeared. It may have been here only a few months previous to the general outbreak, or it may have existed much longer in a restricted locality, only waiting for a favorable opportunity to become widely disseminated.

To us, however, it is rather astonishing that the rust has not shown itself here long before this, as many of the other European fungous diseases have done. We know from the very earliest records that the greater majority of our troublesome weeds made their appearance in America at the time of the first settlement, and wherever the colonists wandered these old country weeds, which were so familiar to them at home, were among the first immigrants to meet them. And what would apply to weed seeds would seem to apply with greater force to the smaller and more numerous fungous spores. It is, indeed, difficult to understand why the enormous traffic existing between Europe and America at the present time is not the means of introducing every form of plant life that can possibly thrive in this country.

So far as our observations extend here in Massachusetts there appear, however, to be other causes of the rust, or at least the severe outbreak of it, which should be taken into consideration. We are of the opinion that the asparagus plants were in the most favorable condition during the summer of 1896 for a severe outbreak to occur. The seasons of 1895 and 1896 were exceedingly dry, so much so that the larger majority of plants adapted to dry soils were great sufferers, while the season of 1897 was equally abnormal for it was a season of excessive rains. After an inspection of the localities where the summer stage of the rust appeared during 1897, and in fact these are the only places where the rust has done any harm although the fall stage during the same season was abundant everywhere, we found that in every instance the beds were confined to light sandy soil with little capacity for holding water. In every town where the soil was heavier and possessed more water-retaining property only the fall or injurious stage has been found. During the early part of the present season we became convinced that the severity of the rust was caused by the unhealthful conditions of the asparagus beds, a feature which appeared to us in almost every instance to be due to the enormous drain upon the plants, caused by the two excessively dry seasons of 1895 and 1896.

On the strength of these ideas and from the general appearance of the asparagus plants which we examined last summer, we repeatedly expressed the opinion to growers that there would be, in all probability, no summer stage of the rust that season, but that they might expect the fall stage. This prediction has been amply fulfilled, there being but one exception to it, as far as we have been able to learn, and that was where the summer stage appeared on a bed where the roots were all half dead from the effects of the rust in 1897, and which showed a loss of 80% in last spring's crop.

The fall stage of the rust has also been much less abundant than at any time since it was introduced. There are many beds only slightly affected at the present time, and some of those that we know were formerly subject to the fall stage have not a particle on them this year. There is a large bed upon the college grounds which has been badly infected with the fall stage of the rust ever since 1896, but which at the present time is almost entirely free from it. While we are convinced that the severe attack of the rust was due to excessive dryness, this may not have been in every case the sole cause of it, and it is not unlikely that the extremely abnormal rainy season of 1897 had something to do with aggravating the trouble.

Asparagus plants may become unhealthy from other causes such as would result from poor treatment, and in such cases they may become susceptible to rust. We do maintain, however, that perfectly vigorous plants are not likely to have the summer stage of the rust, or, in other words, to suffer from it, and our examinations of the asparagus beds in this state have convinced us of this. We have seen, too, many instances in connection with the rust, as with other diseases, where infection is dependent upon the vigor of the plant.

Realizing that it would be well to get the idea of growers upon certain points, we addressed a number of circular letters to various parts of the State. Besides asking a number of questions in regard to differences of infection existing between moist and dry soil, etc., we incidentally referred to the dry seasons of 1895 and 1896 as being the cause of the outbreak. A quotation from one of these letters will suffice to show how these conclusions are regarded. Among other things the writer states "Yours of Nov. 16 received with pleasure and I feel that I have been enlightened much by its contents * * * * I feel confident that the asparagus rust was caused by dry weather." All of the data which we have been able to procure fully justify these conclusions.

Methods of Treating the Rust.

At the present time little can be said in regard to a positive and practical method of controlling the rust during seasons of severe outbreak by means of spraying, although we are of the opinion that it can be kept in check by other methods. Some experiments have been made at different stations along the line of spraying, and the practice of burning has been resorted to by various growers.

BURNING THE AFFECTED TOPS.

The practice of burning the affected tops was recommended by Drs. Halsted and Sturgis, and also by ourselves, as a possible prevention from further infection. This method of treatment was based largely upon a knowledge of the general life history of rusts, as well as from the point of view of hygienic principles. The burning method, moreover, has been tried in Europe, or at least recommended, and as the rust is entirely new to this country we felt justified in adopting measures mentioned by those who have had the rust to deal with for many generations. We have only recommended the burning of infected plants late in the fall when they are thoroughly dead and dried out, as it appeared to us by so doing we would destroy millions of the spores and lessen the chance of infection next year. It must, nevertheless, be said that we have never observed the slightest benefit from burning the infected tops at any season of the year, but, on the other hand, we have had cases brought to our attention where the tops were cut and burned in August, which resulted not only in a useless expenditure of labor, but in a decided injury to the plants. It has been found that if a crop of asparagus tôps is cut down in mid-summer a new crop will take its place, and the latter will in the course of a few days be as badly affected as the first. In this instance we not only get two crops of infected tops where we would naturally get only one, but we allow the plant to draw upon its reserve material to a degree that is quite unnecessary, and sure to make itself felt in the succeeding crop. The burning of the tops in the summer is, moreover, not an easy task, inasmuch as they are laden with sap and do not show a tendency to dry out readily. The asparagus growers in some parts of the state who have tried the burning method in summer are not at all pleased with it, and we are convinced that their judgment upon this practice is sound.

SPRAYING.

The most extensive experiments reported as yet on the spraying of asparagus for the rust, are those by Professor Halsted, in New Jersey. He experimented with the standard Bordeaux mixture, and also with the same solution in combination with soda, potash, etc. His best results showed only a difference of about 25% between the treated and untreated plants, or in other words, a gain of this amount as a result of spraying. Without following these experiments any further it must be admitted that the small gain obtained by spraying is not encouraging.

Some experiments in spraying were conducted by ourselves, the past summer, at three different places, and the result in each series was negative. One of the experiments was made in connection with Wilfred Wheeler, at Concord. Two rows of asparagus were sprayed with each of the following solutions, and two rows were left in between the sprayed ones as normals or checks for comparison. The solutions used were Potassium permanganate, Potassium sulfid, Saccharate of Lime, and Bordeaux mixture. Four applications were made in all. The first one was in July before any rust had appeared, and it was continued throughout August. An examination and comparison of the sprayed and unsprayed plants in September showed them to be equally infected with teleutospores (the uredospores did not appear), although it appeared as if there was a little less upon the Potassium sulfid rows. The two other series of experiments tried gave no better results. The spraying was done with a knap-sack sprayer, provided with a Vermorel nozzle, and after the first application we became convinced that the practice was of little importance on account of the difficulty in making the solution stick to the plant. For successful spraying of asparagus a finer nozzle is required than any that is now in the market. In some other experiments carried out on a small scale we succeeded in practically covering the asparagus plants with solutions, when they were put on with an ordinary cylinder atomizer, and the lime solutions showed excellent sticking qualities, but with the ordinary coarse nozzle the solutions would run off of the glossy epidermal covering of the plant very readily.

Should the spraying of asparagus ever become a necessity as a means of preventing the rust, which we greatly question, then some apparatus which can be strapped to a horse's back should be used. The narrow space between the rows forbids the use of the ordinary mounted appliances, and if spraying is to be carried on upon a large scale it would be better to have the spraying mixture carried in some manner on the horse's back. In this way it would be possible to carry some thirty or forty gallons of mixture through the narrow rows. In conclusion it must be confessed that experiments along the line of spraying are not encouraging, for the reason that the asparagus plant is a difficult one to reach as well as to cover thoroughly with ordinary solutions applied with the present style of nozzle.

CULTIVATION AND IRRIGATION AS A MEANS OF CONTROLLING THE RUST.

From what has been said in regard to the practice of burning the affected asparagus tops and the unsatisfactory results which have been obtained from spraying, it would not be out of place here to pay some attention to other methods of control. Even should the practice of spraying give promise of better results, it would not be a method which would satisfy the best growers. Spraying crops to control diseases is not the sole end of gardening, and the most that can be said of the practice, in many cases, is that it is only tentative. Any one who has had an opportunity to examine the crops of the most successful gardeners, such as have been handled by specialists for years, knows that they do prevent diseases merely by a correct system of cultivation, while crops from the same stock in the hands of a novice are too often a sorry sight to behold. We have already pointed out that the injury to asparagus plants, as a result of rust, has been confined to dry soils, although there are cases where beds in close proximity showed remarkable differences as to infection. We have observed two beds separated from each other by a distance not exceeding ten feet, where in one case the summer stage of the rust was abundant and greatly reduced the bed, while in the other no rust was present except the fall stage. The soil in both beds was apparently the same, at least so far as superficial observation could determine, but the plants were of a different age and evidently possessed differences as to vigor. Similar conditions could be observed in all the badly infected regions in 1897, and even in the single instance where the red rust appeared the past summer the other beds in the vicinity, notwithstanding the fact that they were continually subject to infection, never showed any of the rust till late in the fall. The only deduction to be drawn from such facts is that robust and vigorous plants, even when cultivated on apparently dry soil, are capable, as it were, of resisting the summer or injurious stage of the rust.

Most asparagus growers, as a rule, fertilize their crop abundantly with various commercial fertilizers. We have never, however, been able to observe any particular ill effect from the kinds in use, although it might be more advantageous, in extremely dry places, to use fertilizers containing considerable amounts of organic matter, in order to give the soil more water-retaining properties. In a season of excessive dryness such as 1895 and 1896, irrigation could in many instances which we have observed be resorted to with very little expense. This would keep the plants in a normal and vigorous condition during such seasons, and had this practice been resorted to twice or three times in 1895 and 1896 the summer or injurious stage of the rust would have been held in check. The severe outbreak in 1897 we consider as sporadic in its nature, and we are of the opinion that there will be very little occurrence of this disease, except during seasons of extreme conditions, which occur generally at intervals of some years. With proper plant food and good cultivation, and without the plants being subject to extreme conditions, there is no reason in our judgment why the asparagus rust need give us any concern.

The Asparagus Rust in Europe.

That the rust has long been known in Europe is apparent from the fact that it was first described there, although, like many other of our worst pests of the field and garden, it appears to have never become so troublesome in the Old World as with us. The disease is described in most of the German and English books on plant diseases, but we have been told by several well known German botanists that it has no practical importance with them, occurring only rarely and not at all extensively. Certainly no such general epidemic of the disease as has recently occurred in this country ever appeared in Europe.

A Natural Enemy of the Rust.

Another parasitic fungus has been observed in many cases in connection with the summer and fall stage of the rust, which does not, however, attack the asparagus plant but lives upon the rust fungus itself. It is therefore beneficial rather than harmful, since it must act to a greater or less extent as a check upon the development and spread of the disease. This fungus is one called *Darluca Filum* Cast. It consists of filaments which grow in amongst those of the rust and develop in the pustules of rust spores little black conceptacles in which the spores of the parasite are produced. These spores are somewhat smaller than those of the rust and ooze out upon the surface of the rust spots in great quantities, giving them a mouldy appearance. We found this parasite especially abundant upon the summer stage of the rust in 1897, as well as upon the fall stage both this year and last. Halsted (loc. cit.) and Johnson* have also reported its occurrence and it could no doubt be found wherever the rust has appeared. It is interesting to note that we have also found the same parasite upon specimens of the rust from Roumania, where the asparagus plant is said to grow wild. It is possible that this is at least one of the agencies which have prevented any extensive development of the rust in Europe.

Halsted (loc. cit.) also describes another parasite, *Tubercularia persicina* Ditt., which he has observed upon the spring form of the asparagus rust. We have found several other fungi upon asparagus plants, but they were mostly such as had already been weakened by the rust and we do not consider these as diseases of any practical importance. What appears to be the "leopard spot" disease

*Bull. 50, Maryland Agri'l Experiment Station.

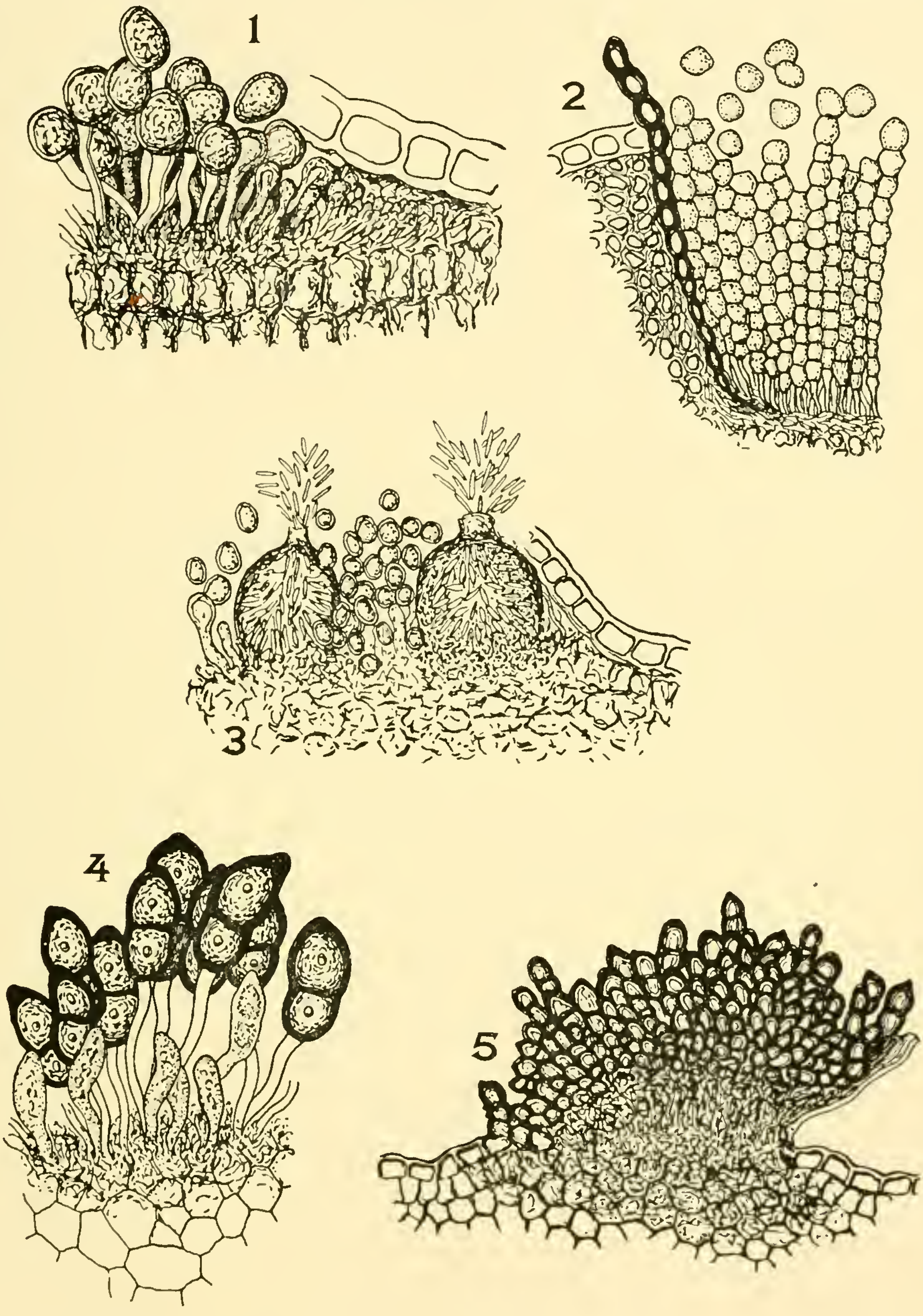


PLATE II.

described by Johnson (loc. cit.) has been not uncommon, but we could not see that it caused any appreciable injury beyond that already done by the rust.

Conclusions.

The asparagus rust is caused by a parasitic fungus which was named *Puccinia Asparagi* by the elder de Candolle nearly a century ago.

The asparagus rust has occurred in Europe for some centuries but the exact time that it was introduced into this country is unknown.

The rust was first called attention to as occurring in the Eastern United States by Prof. Halsted of New Jersey in the fall of 1896, although there is a possibility of its having existed on Cape Cod one or two years previous to this time.

The severe outbreak of the asparagus rust is due to conditions of the plants brought about largely by the excessive drought during the seasons of 1895 and 1896, and in all probability the severity of the attack was aggravated to some extent by the excessive rains of 1897.

The rust as an injurious factor has been limited to only a few places in Massachusetts, although especially affecting the asparagus regions.

The injurious effects of the rust have been confined to dry, sandy soils possessing little capacity for holding water. Where the soil is heavier, possessing more water-retaining qualities, the rust has caused no perceptible harm.

The injurious effect of the rust is apparent only when the summer stage occurs, viz., the red spores or uredospores which develop during July and August.

The fall stage of the rust, known as the black or teleuto, has been prevalent all over Massachusetts since 1896, but this form has caused no appreciable harm and is disappearing.

The loss experienced from rust in Massachusetts this season, caused by the severe uredospore infection of 1897, was from 15 to 80 per cent in the yield of the marketable crop. The average loss will equal 20 to 25 per cent.

The practice of burning the affected tops in the summer has resulted in injury, and no benefit has manifested itself from burning in the fall.

The results obtained by spraying asparagus are not encouraging.

The various asparagus beds on moist soils do not appear to be affected with the summer stage of the rust and consequently are not injured, being able, as it were, to resist the summer stage although the tops of the plants are affected with the fall stage during their period of natural death.

The best means of controlling the rust is by thorough cultivation in order to secure vigorous plants, and in seasons of extreme dryness plants growing on very dry soil with little water-retaining properties should if possible receive irrigation.

From a knowledge of the occurrence of the rust in Europe and from observations made in this State we are led to believe that the outbreak of the asparagus rust is of a sporadic nature, and is not likely to cause much harm in the future, provided attention is given to the production of vigorous plants.

EXPLANATION OF PLATES.

Plate I.

Asparagus stem with fall or teleuto stage of the rust; somewhat enlarged.

Plate II.

Fig. 1. Portion of a cluster of summer or uredospores. ×225.

Fig. 2. Portion of one of the aecidial cups or spore clusters of the spring stage, with chains of spores. ×150.

Fig. 3. Spore bearing conceptacles of the parasitic Darluca in a cluster of uredospores. ×75.

Fig. 4. Teleutospores. ×225.

Fig. 5. Cluster of teleutospores. ×75.

Plate I. and Plate II. Figs. 1, 3, 4 and 5 are original.

Plate II. Fig. 2 copied from Halsted.

HATCH EXPERIMENT STATION

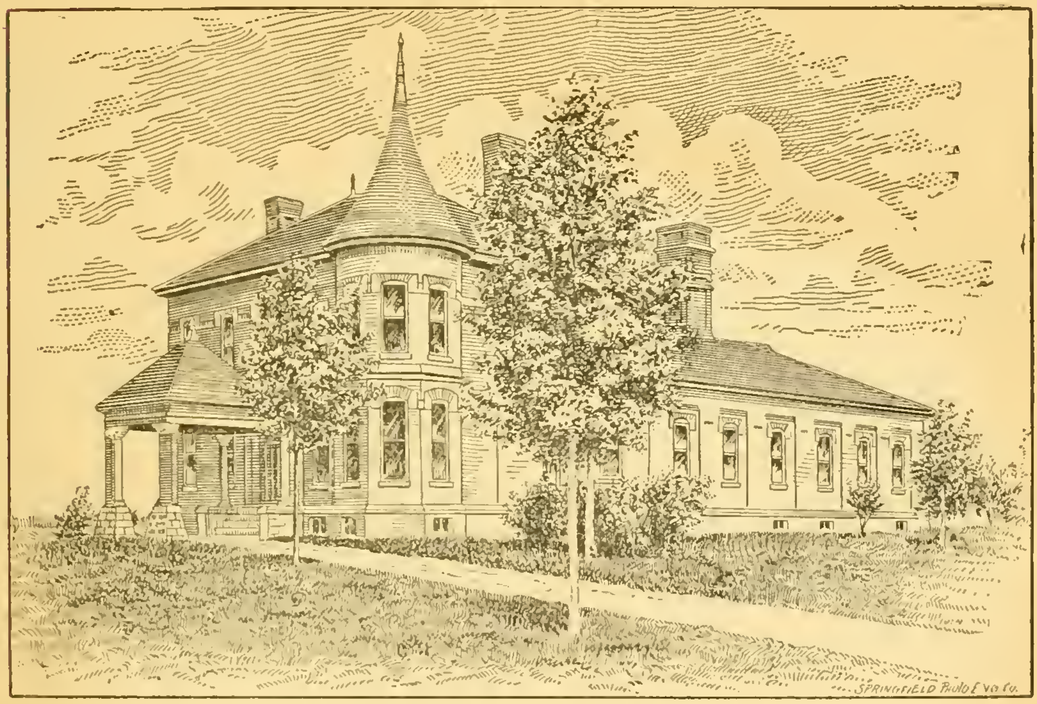
OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 62.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1899.



CHEMICAL LABORATORY.

JULY, 1899.

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,
1899.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann, B. Sc.,	*Assistant Chemist* (Fertilizers).
Samuel W. Wiley, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, M. Sc.,	*First Chemist*(Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Philip H. Smith, B. Sc.,	*Assistant in Foods and Feeding.*
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Herbert D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
Arthur C. Monahan,	*Observer.*

The co-operation 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 CHEMISTRY.

C. A. GOESSMANN.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

678-682. I. Received from Boston, Mass.
II. Received from Concord, Mass.
III. Received from North Amherst, Mass.
IV. Received from Hadley, Mass.
V. Received from Boston, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.20	14.17	12.12	15.00	1.64
Potassium oxide,	7.28	7.89	6.72	5.98	5.22
Phosphoric acid,	1.88	1.52	1.41	1.28	1.40
Calcium oxide,	34.36	32.38	52.32	34.61	41.28
Insoluble matter,	9.36	8.12	8.67	11.18	5.25

683-687. I. Received from Northfield, Mass.
II. Received from Worcester, Mass.
III. Received from Arlington, Mass.
IV. Received from North Amherst, Mass.
V. Received from Concord, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.47	12.06	11.45	12.76	7.95
Potassium oxide,	6.86	6.96	7.56	6.00	8.36
Phosphoric acid,	1.52	1.66	1.74	1.40	1.92
Calcium oxide,	37.30	40.14	33.59	35.84	34.24
Insoluble matter,	13.32	10.83	11.35	7.68	13.57

688-690. I. Received from Asylum, Mass.
II. Received from Amherst, Mass.
III. Received from Amherst, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	6.84	10.92	10.26
Potassium oxide,	8.40	5.62	4.98
Phosphoric acid,	2.18	1.28	1.62
Calcium oxide,	36.08	32.38	35.18
Insoluble matter,	9.54	16.67	12.99

COTTON SEED HULL ASHES.

691-695. I. Received from Southwick, Mass.
II. Received from Southwick, Mass.
III. Received from Westfield, Mass.
IV. Received from Agawam, Mass.
V. Received from Agawam, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.88	7.12	10.11	6.90	10.53
Potassium oxide,	25.56	26.56	29.16	21.94	23.42
Phosphoric acid,	7.87	7.18	9.72	7.04	9.16
Calcium oxide,	11.99	9.48	7.44	*	*
Insoluble matter,	12.93	14.09	10.67	20.29	17.64

NITRATE OF SODA.

696-697. I. Received from Milford, Mass.
II. Received from Hudson, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	.50	.68
Nitrogen,	15.30	15.41

MURIATE OF POTASH AND KAINITE.

698-699. I. Muriate of Potash received from Hudson, Mass.
II. Kainite received from Milford, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	1.40	2.69
Potassium oxide,	45.85	10.90
Calcium oxide,	*	3.60
Magnesium oxide,	*	2.94
Chlorine,	*	8.03

*Not determined.

TANKAGE AND GROUND BONE.

700-704. I. Tankage received from Concord, Mass.
II. Tankage received from Northampton, Mass.
III. Ground Bone received from Holden, Mass.
IV. Ground Bone received from Holden, Mass.
V. Ground Bone received from Hingham, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.60	7.50	3.29	2.87	5.68
Total phosphoric acid,	8.32	24.48	27.96	21.70	22.06
Reverted phosphoric acid,	3.76	5.16	6.08	4.10	4.62
Insoluble phosphoric acid,	4.56	19.32	21.88	17.60	17.44
Nitrogen,	8.37	2.46	2.81	3.07	4.17

COTTON SEED MEAL (Fertilizer).

705-707. I. Received from South Deerfield, Mass.
II. Received from South Deerfield, Mass.
III. Received from North Hatfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.80	6.12	8.12
Nitrogen,	6.37	6.92	6.50

708-710. I. Received from South Deerfield, Mass.
II. Received from Southwick, Mass.
III. Received from South Deerfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.90	4.70	5.21
Nitrogen,	6.55	6.59	7.09

FLAX MEAL (Fertilizer).

711. Received from North Hatfield, Mass.

	Per Cent.
Moisture at 100° C.,	7.15
Nitrogen,	5.38

WOOL REFUSE.

712. Received from Methuen, Mass.

	Per Cent.
Moisture at 100° C.,	5.71
Organic and volatile matter,	79.90
Phosphoric acid,	.32
Potassium oxide,	1.52
Nitrogen,	4.60
Calcium oxide,	2.03
Insoluble matter,	13.01

ACID PHOSPHATES.

713. Received from Hudson, Mass.

	Per Cent.
Moisture at 100° C.,	10.86
Potassium oxide,	*
Total Phosphoric acid,	16.21
Soluble Phosphoric acid,	6.88
Reverted Phosphoric acid,	3.25
Insoluble Phosphoric acid,	6.08
Nitrogen,	*

COMPLETE FERTILIZERS.

714-717. I. Received from Sunderland, Mass.
II. Received from Bridgewater, Mass.
III. Received from Merrimac, Mass.
IV. Received from Holden, Mass.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	12.32	3.80	25.14	10.55
Potassium oxide,	4.00	9.54	.62	7.90
Total Phosphoric acid,	10.88	8.24	none	8.06
Soluble Phosphoric acid,	2.94	*	—	4.60
Reverted Phosphoric acid,	6.02	1.58	—	1.92
Insoluble Phosphoric acid,	1.92	6.66	—	1.54
Nitrogen,	2.62	6.01	.17	1.78

*Not determined.

718-721. I., II. and III. Received from Holden, Mass.
IV. Received from Hadley, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	10.10	13.89	10.91	9.62
Potassium oxide,	7.98	9.92	7.76	4.86
Total Phosphoric acid,	5.88	8.58	11.12	14.32
Soluble Phosphoric acid,	2.38	5.96	*	8.70
Reverted Phosphoric acid,	2.52	1.34	9.64	2.48
Insoluble Phosphoric acid,	.98	1.28	1.48	3.14
Nitrogen,	.88	2.38	3.69	2.94

JADOO FIBRE.

722. Received from Amherst, Mass.

	Per Cent.
Moisture at 100° C.,	11.53
Organic and volatile matter,	88.40
Phosphoric acid,	1.24
Potassium oxide,	.48
Nitrogen,	.97
Calcium oxide,	3.50
Insoluble matter,	4.05

SOILS. (Test for Chlorine desired.)

723-727. I.,II.,III.,IV.and V. Received from Brookline, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	30.82	13.60	33.63	25.11	20.25
Organic and volatile matter,	38.22	28.20	40.73	33.61	29.30
Chlorine,	.008	.01	.008	.006	.006

728-731. I., II. and III. Received from Brookline, Mass.
IV. Received from Weymouth, Mass.

	Per Cent I.	II.	III.	IV.
Moisture at 100° C.,	32.75	38.20	37.62	4.83
Organic and volatile matter,	45.47	49.87	49.87	10.25
Phosphoric acid,	*	*	*	.105
Potassium oxide,	*	*	*	.23
Nitrogen,	*	*	*	.23
Calcium oxide,	*	*	*	.32
Chlorine,	.17	.008	.22	*

*Not determined.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
195	Tobacco Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Holyoke.
357	Tobacco Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Sunderland.
1	Cotton Hull Ashes "Light",	American Cotton Oil Co., New York City,	No. Hadley.
2	Cotton Hull Ashes "Dark",	American Cotton Oil Co., New York City,	No. Hadley.
5	All Soluble,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
130	All Soluble,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
7	Grain Grower,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
128	Grain Grower,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
183	Complete Potato Manure,	H. J. Baker & Bro., New York City,	Fall River.
260	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York City,	Springfield.
97	High Grade Potato and Root Manure,	W. J. Brightman & Co., Tiverton, R. I.,	So. Seekonk.
66	Bowker's Early Potato Manure,	Bowker Fertilizer Co., Boston, Mass.,	So. Seekonk.
169	Bowker's Early Potato Manure,	Bowker Fertilizer Co., Boston, Mass.,	Fall River.
76	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
104	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Fall River.
105	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
165	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
94	Stockbridge's Top Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Attleboro.
151	Stockbridge's Top Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
163	Stockbridge's Top Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Fall River.
153	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
298	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Fitchburg.
54	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Attleboro.
98	English Lawn Dressing,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
152	English Lawn Dressing,	Bradley Fertilizer Co., Boston, Mass.,	Lowell.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
195-357	Tobacco Fertilizer,	4.28	4.32	4.5-5.5	—	3.58	11.26	14.84	14-16	3.58	5-8	8.76	10-11*
1	Cotton Hull Ashes "Light,"	11.60	—	—	—	6.26	.26	6.52	8.	6.26	—	32.80	25.
2	Cotton Hull Ashes, "Dark,"	9.27	—	—	—	7.50	2.30	9.80	8.	7.50	—	22.68	25.
5-130	All Soluble,	3.07	2.94	2.88-3.70	3.58	4.40	4.82	12.80	10-12	7.98	8-10	5.82	4.5*
7-128	Grain Grower,	6.54	2.09	1.65-2.47	4.10	4.40	4.04	12.54	10-12	8.50	8-10	2.68	2-3
183	Complete Potato Manure,	11.21	3.67	3.3-4.11	4.60	2.46	.44	7.50	6-8	7.06	5-7	10.00	10-12
260	A. A. Ammoniated Superphosphate,	14.69	2.67	2.47-3.30	8.80	2.40	.90	12.10	11-13	11.20	9-12	2.94	2-3
97	High Grade Potato and Root Manure,	11.23	3.30	3-30-4.13	3.70	4.22	3.08	11.00	9-13	7.92	8-11	7.18	7-8
66-169	Bowker's Early Potato Manure,	9.84	3.31	3.30	5.28	3.16	2.44	10.88	9.	8.44	7.	7.20	7.
76-104-105-165	Bowker's Lawn and Garden Dressing,	7.97	4.27	3-4	2.54	3.14	4.94	10.62	8-10	5.68	6-8	5.36	5-6
94-151-163	Stockbridge's Top Dressing,	16 38	5.36	4.75-5.75	3.28	3.40	2.86	9.54	6-9	6.68	4-6	6.22	6-7
153-298	High Grade Fertilizer,	7.99	2.48	2.25-3.25	4.12	2.92	3.02	10.06	10-13	7.04	8-10	4.06	4-6
54	X. L. Superphosphate,	13.78	2.63	2.5-3.25	4.60	4.30	2.94	11.84	11-14	8.90	9-11	2.40	2-3
98-152	English Lawn Dressing,	9.34	4.52	4.95-5.78	1.16	3.96	1.54	6.66	6-8	5.12	5-7	3.16	2.5-3.5

*Sulphate of Potash, the source of Potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
103	Bradley's Complete for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
178	Bradley's Complete for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Attleboro.
180	Bradley's Complete for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
258	Bradley's Complete for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Northampton.
134	Bradley's Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Lowell.
209	Bradley's Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Northampton.
29	Ammoniated Bone Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	So. Deerfield.
283	Ammoniated Bone Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	Pittsfield.
318	Ammoniated Bone Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	Pittsfield.
49	Fish Bone and Potash,	Hiram Blanchard, Eastport, Me ,	Amherst.
3	A. A. Complete Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Amherst.
237	A. A. Complete Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Springfield.
37	C. M. Hubbard & Co., Formula X,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Montague.
214	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Springfield.
69	Great Planet Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	So. Seekonk.
248	Great Planet Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
285	Bay State Potato,	Clark's Cove Fertilizer Co., Boston, Mass.,	Hinsdale.
82	High Grade Bay State Special Potato,	E. Frank Coe Co., New York City,	Taunton.
84	Bay State Ammoniated Superphosphate,	E. Frank Coe Co., New York City,	Taunton.
245	Bay State Ammoniated Superphosphate,	E. Frank Coe Co., New York City,	Dighton.
87	Fish and Potash,	E. Frank Coe Co,, New York City,	Taunton.
217	Excelsior Guano,	E. Frank Coe Co., New York City,	W.Springfield.
251	Ammoniated Bone Superphosphate,	E Frank Coe Co., New York City,	Westfield.
254	Tobacco and Onion,	E. Frank Coe Co., New York City,	W.Springfield.
243	Church's Fish and Potash "D",	Daniel T. Church, Tiverton, R. I.,	New Bedford.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilezers.												
103-178-180 258	Bradley's Comp. for Potatoes and Veg'bles,	11.66	2.73	3.3-4.12	4.96	3.56	2.30	10.82	9-13	8 52	8-11	5.68	7-8
134-209	Bradley's Potato Manure,	11.91	2.94	2.5-3.25	4.22	3.54	2.10	9 86	8-11	7.76	6-8	5.82	5 6
29-283-318	Ammoniated Bone Phosphate,	6.20	1.84	1.65-2.47	3.84	3.92	5 42	13.18	10-12	7.76	8-10	2.82	2-3
49	Fish, Bone and Potash,	14 49	3.61	4.47	—	2.60	4.52	7.12	5.12	2.60	—	5 49	6.
3-237	A. A. Complete Manure,	6.24	3.47	3.28-4.10	6.90	2.26	.62	9.78	9 12	9.16	8-10	7.74	7.56 8.65
37	C. M. Hubbard & Co., Formula X	7.82	4.69	4-5	3.70	1.92	3.20	8.82	7-9	5.62	7-9	10.04	8 9
214	Ammoniated Wheat and Corn Phosphate,	10.79	1.60	2-3	3.64	5.80	2.40	11.84	11 15	9 44	10-13	2.40	1.60-2.70
69-248	Great Planet Manure,	10.59	3.08	3.30-4.12	4.24	3.50	2 50	10.24	9-12	7.74	8-11.5	8.92	7-8
285	Bay State Potato.	14.79	2.48	2.47-3.20	2.92	2.70	4.40	10 02	7-11	5.62	6-9	4.56	5-6
82	High Grade Bay State Special Potato,	11.07	2.59	2.-2 5	5.74	3.04	1.92	10 70	9-11	8.78	8-11	6.86	6-7
84-245	Bay State Ammoniated Superphosphate,	10.73	1.81	1.65-2.00	7.62	2.68	1.62	11.92	11-13	10.30	9-12	2.20	2.25 3.25
87	Fish and Potash,	10.66	2.11	2-3	3 54	2.90	3.20	9.64	7-10	6.44	6-8	2.34	2-3
217	Excelsior Guano,	8.62	3.08	3.5-4.00	7.54	1.36	1.80	10.70	10-12	8.90	9-12	5.38	6-8
251	Ammoniated Bone Superphosphate,	10.87	2.08	2-2.80	7.42	1.84	2.18	11.44	11-12	9.26	9-12	2.70	1.83-2.00
254	Tobacco and Onion,	8.96	4.5	3.2-4.	6.66	1.54	1.66	9.86	8-10	8.20	6-8	7.50	8-9
243	Church's Fish and Potash "D,"	12 37	2.21	2.07-2.88	1.54	4.34	4.86	10.74	7.5-10.5	5.88	6-8	2.68	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
336	Potato Phosphate,	Cleveland Dryer Co., Cleveland, Ohio,	Monson.
337	Cumberland Superphosphate,	Cumberland Bone Phosphate Co., Portland, Me.,	Monson.
93	Potato and Root	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Fall River.
132	Darling's Farm Favorite,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Lowell.
281	Darling's Farm Favorite,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord.
212	High Grade Fertilizer "Star Brand",	Great Eastern Fertilizer Co., Rutland, Vt.,	Springfield.
44	High Grade Special for Spring Crops,	Lister's Agricultural Chemical Works, Newark, N. J.,	Amherst.
147	High Grade Special for Spring Crops,	Lister's Agricultural Chemical Works, Newark, N. J.,	Middleboro.
46	Success Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Amherst.
141	Success Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Middleboro.
282	Success Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Lincoln.
292	Sanderson's Potato Manure,	Lucien Sanderson, New Haven, Conn.,	Hinsdale.
12	Swift's Lowell Animal Brand,	Lowell Fertilizer Co, Lowell, Mass.,	Sunderland.
124	Swift's Lowell Animal Brand,	Lowell Fertilizer Co., Lowell, Mass.,	Lowell.
223	Swift's Lowell Animal Brand,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.
15	Tobacco Manure,	Lowell Fertilizer Co., Lowell, Mass.,	Sunderland.
21	Swift's Lowell Bone Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Sunderland.
154	Swift's Lowell Bone Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Lowell.
126	Mapes Potato Formula,	Mapes Formula & Peruvian Guano Co., New York City,	New Bedford.
317	Mapes Potato Formula,	Mapes Formula & Peruvian Guano Co., New York City,	Greenfield.
356	Tobacco Ash Constituents,	Mapes Formula & Peruvian Guano Co., New York City,	So. Deerfield.
79	Root Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
174	Root Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	New Bedford.
257	Root Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Springfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
336	Potato Phosphate,	14.84	2.00	2.-2.95	8.00	1.98	1.92	11.90	10-13	9.98	8 10	3.20	3-4
337	Cumberland Superphosphate,	13.62	2.38	2.-2.80	4.94	3.38	2.94	11.26	10-13	8.32	8-10	2.32	2 3
93	Potato and Root,	11.25	2.71	2 80	7.22	2.14	1.36	10.72	10.	9.36	9.	8.04	7.
132-281	Darling's Farm Favorite,	10.49	2.47	2.06	7.80	2.12	1.34	11.26	8.	9.92	7.	5.56	5.
212	High Grade Fertilizer "Star Brand,"	13.59	1.90	.82-1.60	7.52	2.16	2.30	12.08	9-15	9.68	8-12	3.46	2-4
44-147	High Grade Special for Spring Crops,	12.54	1 86	1.85	6.93	3.00	2.43	11.36	10.	9.93	8.50	10.00	10.00*
46-141-282	Success Fertilizer,	14.37	1.47	1.23-1.65	6.40	1.48	2.97	10.85	9.50-11	7.88	—	2.00	2-3
292	Sanderson's Potato Manure,	8.94	1.93	1.65-3.30	3.02	4.45	4.53	12.00	9-10	7.47	5-6	5.38	6-7
12-124-223	Swift's Lowell Animal Brand,	10.45	2.31	2.46.3.25	7.58	1.31	1.28	10.17	10-12	8.89	9-12	4.68	4-5
15	Tobacco Manure,	6,53	4.98	4.94-5.76	4.92	5.17	.76	10.85	7-10	10.09	6-9	10.26	8-10
21-154	Swift's Lowell Bone Fertilizer,	7.76	1.80	1.65-2.50	4.78	1.84	1.98	9.60	9-12	6.62	8-10	3.11	3-4
126-317	Mapes Potato Formula,	9.55	3.72	3.71-4.12	3.17	3.10	3 45	9.72	—	6.27	8.	7.24	6-8*
356	Tobacco Ash Constituents,	11.12	.70	.50	—	1.25	3.74	4.99	5.70	1.25	—	15.88	15.
79-174-257	Root Fertilizer,	12.18	3 53	3.3-4.1	6.04	2.25	3.15	11·44	10-12	8.29	8-11	6.16	6-8

*Sulphate of Potash, the source of Potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
80	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
137	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	New Bedford.
115	Soluble Pacific Guano,	Pacific Guano Co., Boston, Mass.	Newburyport.
171	Potato Special,	Pacific Guano Co., Boston, Mass.,	Newburyport.
225	Special Potato Manure,	Pacific Guano Co., Boston, Mass.,	Northampton.
192	Plantene,	A. W. Perkins & Co., Rutland, Vt.,	New Bedford.
290	High Grade Universal,	Packer's Union Fertilizer Co., New York City,	Van Deusen.
323	High Grade Universal,	Packer's Union Fertilizer Co., New York City,	S. Williamst'n.
313	High Grade Potato Manure,	Packer's Union Fertilizer Co., New York City,	VanDeusen.
335	High Grade Potato Manure,	Packer's Union Fertilizer Co., New York City,	S. Williamst'n.
222	Superphosphate,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
252	Complete Manure for Top Dressing,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
55	Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
239	Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
279	Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
81	Plymouth Rock Brand,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
268	A. A. Brand,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
269	P. and P. Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
27	Potato Manure,	Quinnipiac Co., Boston, Mass.,	Hatfield.
210	Potato Manure,	Quinnipiac Co., Boston, Mass.,	Springfield.
31	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Hatfield.
63	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	So. Seekonk.
90	Market Garden Manure,	Quinnipiac Co., Boston, Mass ,	So. Seekonk.
155	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Fall River.
207	Potato Phosphate,	Quinnipiac Co., Boston, Mass.,	Springfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
80-137	Fish and Potash,	7.12	2.66	2.5-3 5	2.46	1.79	4.22	8.47	8-9	4.25	--	2.04	3-4
115	Soluble Pacific Guano,	11.51	1.66	2.25 3.00	4.48	4.04	3 88	12.40	10.50-16	8.52	8.5 12	2.32	2 3.5
171	Potato Special,	13.83	2.10	2.06	4.40	3.66	3.84	11.90	9-13	8 06	8-11	3.04	3-4 50
225	Special Potato Manure,	11.31	2.49	2.47-3.30	3.28	3.35	2.12	8.75	7-10	6.63	5-7	5.34	5 6
192	Plantene,	14.34	5.38	5 57	6.96	2.66	.56	10.18	10	9.62	9.	3.62	6.
290-323	High Grade Universal,	14.16	.98	.82-1.64	6.06	2.34	1.28	9.68	9-15	8.40	8-12	5 15	5-8
313-335	High Grade Potato Manure,	11.67	2.24	2.06-2.33	5.65	1.97	1.59	9.21	9-14	7.62	9-12	7.22	6-8
222	Superphosphate,	9.13	2 32	2 06-2.47	3 88	2.48	5.58	11.94	8-12	6.36	8-10	2.20	2-3
252	Complete Manure for Top Dressing,	4.62	4.73	4.12-4 94	1.46	2.46	5 55	9.47	7-9	3 92	5-6	8.38	7-9
55-239-279	Potato Fertilizer,	12.16	3 71	3.29 4.12	4.30	4.35	1.38	10.03	9-13	8.65	8-11	8.36	7-8
81	Plymouth Rock Brand,	6.58	2.82	2.47-3.29	1.16	5.06	2.86	9.08	9-13	6.22	8-11	4.52	4-4.25
268	A. A. Brand,	10.63	4.59	4.53-5.76	3.94	4.73	—	8.67	8-11	8.67	7-9	10.32	8-10
269	P. and P. Potato Fertilizer,	9.12	2.10	1.64-2.47	2.60	4.24	1.92	8.76	7-10	6.84	6-9	5.86	5.5-6.5
27-210	Potato Manure,	9.22	2 56	2.47-3.30	4.60	1.74	2.18	8.52	7-11	6.34	6-9	5.26	5-6
31-63	Quinnipiac Phosphate,	13.12	2 53	3.47-3.30	5 24	4.02	3.02	12.28	10-14	9.26	9-12	2.45	2-3
90-155	Quinnipiac Market Garden,	11.05	3.41	3.30-4.12	4.98	3.20	2.44	10.62	9-13	8 18	8-11	6.80	7-8
207	Potato Phosphate,	4.81	2.94	2.05-2.86	2.94	4.14	3.88	10.96	9-14	7.08	8-12	4.82	3-4

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
43	Animal Fertilizer,	N. Roy & Son, South Attleboro, Mass.,	Amherst.
85	Essex Potato Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Taunton.
286	Essex Potato Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Pittsfield.
287	Hubbard's Potato Phosphate,	Rogers & Hubbard Co., Middletown, Conn.,	Hinsdale.
127	Practical Potato Special,	Read Fertilizer Co., New York City,	Amesbury.
341	Practical Potato Special,	Read Fertilizer Co., New York City,	Holden.
172	Vegetable and Vine,	Read Fertilizer Co., New York City,	Amesbury.
343	Vegetable and Vine,	Read Fertilizer Co., New York City,	Holden.
175	Read's Potato Manure,	Read Fertilizer Co., New York City,	Amesbury.
345	Read's Potato Manure,	Read Fertilizer Co., New York City,	Holden.
173	Tucker's Special Potato,	Henry F. Tucker & Co., Boston, Mass.,	Newburyport.
284	Tucker's Special Potato,	Henry F. Tucker & Co., Boston, Mass.,	Dalton.
187	Wilcox Potato, Onion and Tobacco Manure,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
181	Potato Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fall River.
312	Americus Corn Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
293	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Williamstown.
	Chemicals.		
208	Cotton Seed Meal,	American Cotton Oil Co., New York City,	Springfield.
184	Bowker's Dissolved Bone Black,	Bowker Fertilizer Co., Boston, Mass.,	Attleboro.
26	Prime Cotton Seed Meal,	Elbert & Gardner, New York City,	Hatfield.
13	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
17	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
19	Dissolved Bone Black,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
11	Muriate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
213	Muriate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Springfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
43	Animal Fertilizer,	4.77	3.84	3-4	—	4.80	11.44	16.24	16-17	4.80	—	4.79	4-5
85-286	Essex Potato Fertilizer,	9.31	2.13	2.-2.12	3.32	5.94	5.32	14.58	11-13	9.26	9-10	5.31	5-6
287	Hubbard Potato Phosphate,	11.85	2.21	2.-2.5	7.68	2.42	3.08	13-18	10-12	10.10	9-10	4.88	5-6
127-341	Practical Potato Special,	10.10	.88	.83	2.38	2.52	.98	5.88	5-6	4.90	4-5	7.98	8-10
172-343	Vegetable and Vine,	10.55	1.78	1.65 2.00	4 60	1.92	1.54	8.06	7-9	6.52	6-8	7.90	8-10
175-345	Read's Potato Manure,	13.89	2.47	2.5-3.00	5 96	1.34	1.28	8.58	8-9	7.30	7-8	9.92	10-12
173-284	Tucker's Special Potato,	10 96	2.03	2.06-2.89	4.98	2.29	1.84	9.11	9-13	7.27	8-11	6.26	6-7
187	Wilcox Potato, Onion and Tobacco Manure,	12.30	3.98	3.30-4.30	4.02	3.60	2.44	10.06	8-19	7.62	7-9	6.60	6-7
181	Potato Phosphate,	11.19	2.45	2.47-3.30	2 30	2.96	3 70	8.96	7-11	5.26	6-9	5.41	5 6
312	Americus Corn Phosphate,	14.01	2.16	2.06-2.88	5.04	3.98	3.32	12.34	10-15	8.02	9-12	1.74	1.5-2.5
293	Corn Fertilizer,	14.25	1.80	1.64-2.00	6.60	1.72	1.84	10.16	9-14	8.32	8-12	2.32	2-3
	Chemicals.												
208	Cotton Seed Meal,	7.83	7.13	7.	—	—	—	—	—	—	—	—	—
184	Bowker's Dissolved Bone Black,	12.42	—	—	13.56	2.44	.64	16.64	16-18	16.00	15-18	—	—
26	Prime Cotton Seed Meal,	7.10	7.01	7.	—	—	—	—	—	—	—	—	—
13	Nitrate of Soda,	.56	15.68	15.66-16.48	—	—	—	—	—	—	—	—	—
17	Muriate of Potash,	.57	—	—	—	—	—	—	—	—	—	50.60	50.54-54.70
19	Dissolved Bone Black,	13.98	—	—	13.90	3.38	—	17.28	16-18	17.28	16-18	—	—
11-213	Muriate of Potash,	1.25	—	—	—	—	—	—	—	—	—	48.32	50.54-54.70

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Tankage and Bone.		
88	Tankage,	Butchers' Rendering Co., Fall River, Mass.,	Amherst.
342	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
39	Pure Ground Bone,	Thomas Hersom & Co., New Bedford, Mass.,	Amherst.
139	Pure Ground Bone,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
40	Pure Meat and Bone,	Thomas Hersom & Co., New Bedford, Mass.,	Amherst.
121	Pure Meat and Bone,	Thomes Hersom & Co., New Bedford, Mass.,	New Bedford.
161	Fine Bone,	Hargraves Manufacturing Co., Fall River, Mass.,	Fall River.
241	Tankage,	Lowe Bros. & Co., Fitchburg, Mass.,	Fitchburg.
24	Blood, Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
201	Steamed Ground Bone,	McQuade Bros., West Auburn, Mass.,	Amherst.
347	Steamed Ground Bone,	McQuade Bros., West Auburn, Mass.,	Holden.
52	Pure Ground Bone,	Thomas L. Stetson, Randolph, Mass.,	Amherst.
202	Fine Ground Bone,	E. H. Smith, Northboro, Mass ,	Amherst.
38	Pure Ground Bone,	Sanford Winter, Brockton, Mass.,	Amherst.
51	Ground Bone Fertilizers,	A. L. Warren, Northboro, Mass.,	Amherst.
303	Crude Tankage,	H. G. Woodward, Greenfield, Mass.,	Greenfield.
348	Pure Fine Bone,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
366	Hubbard's Strictly Pure Fine Bone,	Rogers & Hubbard Co., Middletown, Conn.,	Hingham.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Mechanical Analysis.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Fine Bone.	Fine Medium.	Medium	Coarse Medium.
								Found.	Guaranteed.	Found.	Guaranteed.				
	Tankage and Bone.														
88	Tankage,	5.65	5.27	—	—	5.00	11.64	16.64	—	5.00	—	11.30	25.76	34.61	28.33
342	Pure Ground Bone,	3.52	2.27	2-3	—	6.34	20.86	27.20	27-29	6.34	—	74.20	24.50	1.30	—
39-139	Pure Ground Bone,	3.17	1.46	1.5-2	—	6.78	21.50	28.28	27-28.50	6.78	—	50.79	29.39	18.20	1.62
40-121	Pure Meat and Bone,	4.73	4.81	4-5	—	4.20	14.14	18.34	16-16.5	4.20	4-5	36.37	34.40	25.50	3.73
161	Fine Bone,	9.07	3.27	—	—	4.62	18.62	23.24	—	4.62	—	25.22	23.90	21.94	28.94
241	Tankage,	4.33	4.70	4-5	—	3.17	17.68	20.85	20-22	3.17	—	20.00	13.00	13.00	54.00
24	Blood, Bone and Meat,	7.41	5.70	5.77-7.41	—	—	—	12.86	10-12	—	—	80.80	18.00	1.20	—
201-347	Steamed Ground Bone,	2.87	3.07	2.78	—	4.10	17.60	21.70	24.52	4.10	—	55.90	25.70	16.20	2.20
52	Pure Ground Bone,	5.52	4.06	3.5-4.5	—	5.74	16.64	22.38	20-21	5.74	—	29.57	27.20	34.08	9.15
202	Fine Ground Bone,	3.50	3.99	2.88-3.71	—	3.84	18.30	22.14	21-23	3.84	—	63.70	33.10	3.20	—
38	Pure Ground Bone,	4.15	4.04	4-5	—	4.58	16.06	20.64	20-22	4.58	—	26.22	23.63	22.10	28.05
51	Ground Bone Fertilizer,	5.18	3.92	3.85	—	5.12	17.60	22.72	24.70	5.12	—	19.20	37.23	25.90	17.67
303	Crude Tankage,	4.47	4.09	—	—	5.52	17.38	22.90	—	5.52	—	11.00	6.80	9.20	73.00
348	Pure Fine Bone,	3.81	2.70	2.47-3.30	—	6.86	18.32	25.18	20-23	6.86	—	58.30	28.40	13.30	—
366	Hubbard's Strictly Pure Fine Bone,	5.68	4.17	3.5-4.	—	4.62	17.44	22.06	22-23	4.62	—	74.20	20.60	1.90	—

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1899. Cents per pound.
Nitrogen in ammonia salts,	15.0
" nitrates,	12.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.0
" " " fine bone and tankage,	14.0
" " " medium bone and tankage,	10.0
Phosphoric acid soluble in water,	4.5
" " soluble in ammonium citrate,	4.0
" " in fine ground fish, bone and tankage,	4.0
" " in cottonseed meal, castor pomace and wood ashes,	4.0
" " in coarse fish, bone and tankage,	2.0
" " insoluble (in water and in am. cit.) in mixed fertilizers,	2.0
Potash as Sulphate, free from Chlorides,	5.0
" " Muriate,	4.25

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy action, exert as a rule, a decided influence on their selling price.

The market value of fertilizing ingredients like other merchandise is liable to changes during the season. The above stated values are based on the condition of the fertilizer market in centers of distribution in New England, during the six months preceding March 1899.

HATCH EXPERIMENT STATION

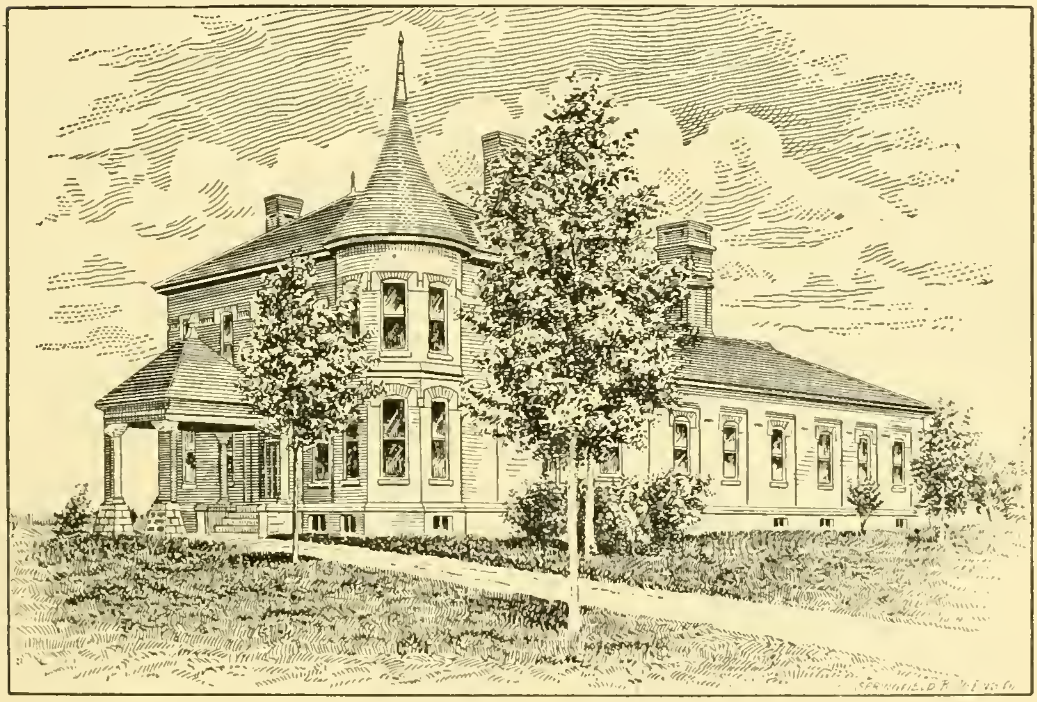
OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 63.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1899.



CHEMICAL LABORATORY.

NOVEMBER, 1899.

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,
1899.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

HENRY H. GOODELL, LL. D.,	*Director.*
WILLIAM P. BROOKS, PH. D.,	*Agriculturist.*
GEORGE E. STONE, PH. D.,	*Botanist.*
CHARLES A. GOESSMANN, PH. D., LL. D.,	*Chemist* (Fertilizers).
JOSEPH B. LINDSEY, PH. D.,	*Chemist* (Foods and Feeding).
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
J. E. OSTRANDER, C. E.,	*Meteorologist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
RALPH E. SMITH, B. SC.,	*Assistant Botanist.*
HENRI D. HASKINS, B. SC.,	*Assistant Chemist* (Fertilizers).
CHARLES I. GOESSMANN B. SC.,	*Assistant Chemist* (Fertilizers).
SAMUEL W. WILEY, B. SC.,	*Assistant Chemist* (Fertilizers).
EDWARD B. HOLLAND, M. SC.,	*First Chemist* (Foods and Feeding).
FRED W. MOSSMAN, B. SC.,	*Ass't Chemist* (Foods and Feeding).
BENJAMIN K. JONES, B. SC.,	*Ass't Chemist* (Foods and Feeding).
PHILIP H. SMITH, B. SC.,	*Assistant in Foods and Feeding.*
GEORGE A. DREW, B. SC.,	*Assistant Horticulturist.*
HERBERT D. HEMENWAY, B. SC.,	*Assistant Horticulturist.*
HENRY T. FERNALD,	*Associate Entomologist.*
ARTHUR C. MONAHAN,	*Observer.*

The co-operation 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 CHEMISTRY.

C. A. GOESSMANN.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

732-736. I., II., III., IV. and V. Received from Concord, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.09	3.40	10.49	14.60	7.82
Potassium oxide,	6.32	7.54	6.26	7.96	4.82
Phosphoric acid,	1.54	1.51	1.28	1.47	1.43
Calcium oxide,	30.32	34.64	32.88	32.88	31.44
Insoluble matter,	13.62	15.76	13.94	8.40	7.82

737-741. I. and II. Received from North Amherst, Mass.
III. " " Falmouth, Mass.
IV. " " Leeds, Mass.
V. " " Beverly, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	14.64	10.99	12.08	13.67	21.39
Potassium oxide,	5.50	4.61	7.28	7.98	7.76
Phosphoric acid,	.95	.82	1.40	1.26	1.72
Calcium oxide,	35.80	37.08	33.32	29.46	25.80
Insoluble matter,	15.88	17.90	9.83	11.06	10.34

742-746. I. Received from Amherst, Mass.
II. and III. " " Hillsboro, Mass.
IV. " " North Amherst, Mass.
V. " " Concord, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	17.31	2.76	16.94	18.07	8.43
Potassium oxide,	4.78	4.87	4.80	4.74	8.26
Phosphoric acid,	1.80	1.40	1.34	1.28	1.02
Calcium oxide,	30.29	46.70	41.67	34.32	33.90
Insoluble matter,	12.42	10.02	7.76	5.05	13.39

747-751. I. Received from Beverly, Mass.
II. " " Northfield Farms, Mass.
III. and IV. " " Concord, Mass.
V. " " Sunderland, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	33.31	15.02	12.63	12.52	18.42
Potassium oxide,	2.67	3.50	4.20	4.74	4.75
Phosphoric acid,	.30	.82	.82	.92	1.28
Calcium oxide,	25.73	23.23	27.19	27.39	31.10
Insoluble matter,	12.34	27.31	23.67	26.14	10.24

752-756. I. Received from Reading, Mass.
II. " " North Amherst, Mass.
III. " " Lexington, Mass.
IV. " " Amherst, Mass.
V. " " Bolton, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	3.11	17.71	12.68	9.77	3.11
Potassium oxide,	3.48	4.40	4.96	6.47	6.46
Phosphoric acid,	.43	1.04	1.68	1.64	2.17
Calcium oxide,	23.81	31.80	33.48	33.22	33 33
Insoluble matter,	39.91	10.14	10.75	14.74	14.33

757-760. I. Received from Boston, Mass.
II. " " South Swansea, Mass.
III. " " Fitchburg, Mass.
IV. " " Worcester, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	4.81	11.03	8.43	12.60
Potassium oxide,	6.90	5.56	6.54	4.72
Phosphoric acid,	1.66	2.05	1.15	1.15
Calcium oxide,	38.31	29.87	30.65	38.31
Insoluble matter,	11.25	15.50	12.59	8.45

761-765. I. Sulphate of Potash and Magnesia received from Amherst, Mass.
II. Muriate of Potash received from Amherst, Mass.
III. " " " " " W.Sp'gfield, Mass.
IV. " " " " " Springfield, Mass.
V. Sulphate of Potash " " Amherst, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.98	3.25	1.25	2.24	.81
Potassium oxide,	24.05	49.24	48.32	52.10	49.55

766-768. I. Dissolved Bone Black received from Amherst, Mass.
II. Spent " " " " Hingham. "
III. Acid Phosphate " " Amherst. "

	Per Cent. I.	II.	III.
Moisture at 100° C.,	12.42	1.16	12.27
Total Phosphoric acid,	16.64	31.02	15.42
Soluble " "	13.56	*	10.88
Reverted " "	2.44	1.96	3.52
Insoluble " "	.64	29.06	1.02

769-770. I. Dissolved Bone Meal received from Amherst, Mass.
II. Steamed " " " " " "

	Per Cent. I.	II.
Moisture at 100° C.,	4.88	3.65
Total Phosphoric acid,	15.40	24.82
Soluble " "	8.18	*
Reverted " "	3.00	7.46
Insoluble " "	4.22	16.36
Nitrogen,	2.14	2.55

*Not determined.

COTTON SEED MEAL.

771-774. I. Received from West Springfield, Mass.
II. " " South Deerfield, Mass.
III. and IV. " " Montague, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	7.83	5.43	5.84	7.13
Nitrogen,	7.13	7.07	7.25	6.85

775-777. I. Received from Montague, Mass.
II. and III. " " Sunderland, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	5.47	7.68	8.96
Nitrogen,	7.18	7.00	6.50

778-780. I. Asparagus received from Amherst, Mass.
II. Velvet Beans " " North Amherst, Mass.
III. Leaves and stems of Velvet Beans, received from Amherst, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	94.17	11.19	5.88
Total Phosphoric acid,	.108	.92	*
Potassium oxide,	.329	1.42	*
Nitrogen,	.330	3.56	2.86

781-782. I. and II. Hen Manure received from Amherst, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	52.58	52.75
Total Phosphoric acid,	.69	.63
Potassium oxide,	1.12	.43
Nitrogen,	.46	.42

*Not determined.

SLUDGE AND SOOT.

783-784. I. Sludge received from Brockton, Mass.
II. Soot " " East Walpole, Mass.

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	21.44	16.98
Total Phosphoric acid,	.86	.23
Potassium oxide,	.16	.17
Calcium oxide,	1.13	slight trace
Nitrogen,	1.31	.77†
Insoluble matter,	*	54.55

COMPLETE FERTILIZERS.

785-789. I., II. and III. Received from Fitchburg, Mass.
IV. and V. " " Concord, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.55	5.88	6.06	7.71	2.69
Potassium oxide,	14.12	9.48	12.50	7.08	19.68
Total Phosphoric acid,	4.32	2.10	3.92	1.68	15.49
Soluble " "	1.58	1.08	2.26	trace	.52
Reverted " "	1.80	.82	1.20	.22	6.44
Insoluble " "	.94	.20	.46	1.46	8.53
Nitrogen,	5.85	9.56	5.60	.028	4.96

790-794. I. and II. Received from Concord, Mass.
III. " " Billerica, Mass.
IV. and V. " " Dighton, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.01	7.83	3.93	3.56	4.00
Potassium oxide,	7.58	8.46	2.96	9.08	8.12
Total Phosphoric acid,	12.37	8.00	16.04	10.54	8.78
Soluble " "	2.67	4.32	1.98	2.04	5.44
Reverted " "	4.10	2.69	5.44	2.26	1.98
Insoluble " "	5.60	.99	8.62	6.24	1.36
Nitrogen, " "	4.06	4.72	2.19	3.38	4.54

†In form of cyanogen compounds.

795-799. I. Received from Plymouth, Mass.
II. " " Montague, Mass.
III. " " Springfield, Mass.
IV. " " Bridgewater, Mass.
V. Peruvian Guano, received from Boston, Mass.

	Per Cent.				
	I.	II.	III.	IV.†	V.
Moisture at 100° C.,	6.66	4.22	5.39	9.88	13.09
Potassium oxide,	5.18	13.70	2.98	4.66	1.52
Total Phosphoric acid,	10.02	10.84	16.50	1.48	31.52
Soluble " "	5.60	*	.78	*	1.97
Reverted " "	1.68	7.83	5.36	*	7.67
Insoluble " "	2.74	3.01	10.36	*	21.88
Nitrogen,	2.77	.28	4.76	3.27	2.56

800-804. I. Received from South Amherst, Mass.
II. " " South Lincoln, Mass.
III. " " South Byfield, Mass.
IV. " " West Springfield, Mass.
V. " " Hatfield, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.83	4.98	2.91	12.18	9.98
Potassium oxide,	3.82	None	None	6.16	7.36
Total Phosphoric acid,	9.72	23.42	11.54	11.44	12.02
Soluble " "	*	*	*	6.04	.90
Reverted " "	3.76	5.48	2.82	2.25	6.00
Insoluble " "	5.96	17.94	8.72	3.15	5.12
Nitrogen,	1.74	3.62	1.43	3.53	5.18

SOILS.

805-808. I. and II. Received from Boston, Mass.
III. " " Williamstown, Mass.
IV. " " Hampden, Mass.

*Not determined.
†Calcium oxide, 26.65. Insoluble matter, 11.75.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	1.82	1.79	13.06	1.48
Potassium oxide,	.25	.22	.28	.13
Phosphoric acid,	.38	.42	.27	.23
Calcium oxide.	1.15	.71	.42	.39
Nitrogen,	.35	.37	.31	.20

809-811. I. Received from Hampden, Mass.
II. " " Bridgewater, Mass.
III. " " Amherst, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	3.72	4.36	14.73
Potassium oxide,	.08	.08	.24
Phosphoric acid,	.29	.08	.11
Calcium oxide,	.44	.28	.32
Ferric and Aluminum oxide,	*	.98	*
Nitrogen,	.39	.22	*

MUCKS.

812-814. I., II.† and III.‡ Received from Southboro, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	74.44	80.01	25.73
Potassium oxide,	.02	.024	.16
Phosphoric acid,	.05	.02	.13
Calcium oxide,	.34	.07	.33
Nitrogen,	.53	.21	.13

PLASTER.

815. Received from Amherst, Mass.

	Per Cent.
Moisture at 100° C.,	3.95
Calcium oxide,	34.64
Insoluble matter,	8.11

†Underlaying No. I.
‡Underlaying No. II.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
200	Concentrated Jadoo Liquid,	American Jadoo Co., Philadelphia, Pa.,	Boston.
364	Concentrated Jadoo Liquid,	American Jadoo Co., Philadelphia, Pa.,	Amherst.
196	Eagle Brand for Grass and Grain,	W. H. Abbott, Holyoke, Mass.,	Holyoke.
6	Bone and Blood,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
8	Ammoniated Bone and Potash,	Armour Fertilizer Works, Chicago. Ill.,	Amherst.
125	Ammoniated Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
9	Blood, Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
135	Blood, Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
360	Complete Tobacco Manure,	E. India Chem. W'k's, H. J. Baker & Bro., P'rs, N. Y. City,	Sunderland.
377	Standard Un X Ld Fertilizer,	E. India Chem. W'k's, H. J. Baker & Bro., P'rs, N. Y. City,	Springfield.
108	Breck's Market Garden Manure,	Joseph Breck & Sons, Boston, Mass.,	Boston.
242	Fish and Potash,	Wm. E. Brightman, Tiverton, R. I.,	New Bedford.
62	Farm and Garden Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Attleboro,
68	Potatoes and Vegetables,	Bowker Fertilizer Co., Boston, Mass.,	Attleboro.
129	Stockbridge's Corn and Grain,	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
148	Stockbridge's Onion Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
156	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
162	Bone and Wood Ash Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
182	Unleached Wood Ashes,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
244	Paul Mixture, " Special Fertilizer,"	Bowker Fertilizer Co., Boston, Mass.,	Dighton.
306	Corn Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Orange.
309	Potato and Vegetable Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Williamstown.
316	Sure Crop Bone Phosphate,	Bowker Fertilizer Co., Boston. Mass.,	Fitchburg.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
200-364	Concentrated Jadoo Liquid,	98.68	.09	.06	.01	—	—	.01	.003	.01	.003	.27	.0076
196	Eagle Brand for Grass and Grain,	7.94	2.77	3-4	—	4.82	10.38	15.20	14-18	4.82	5-8	13.03	10-11*
6	Bone and Blood,	5.16	6.42	5.76-6.58	1.16	2.84	8.18	12.18	10-12	4.00	5-7	—	—
8-125	Ammoniated Bone and Potash,	7.49	3.07	2.47-3.29	3.58	4.40	4.22	12.20	8-10	7.98	6-8	2.21	2-3*
9-135	Blood, Bone and Potash,	7.58	4.85	4.11-4.94	6.24	2.34	1.94	10.52	10-12	8.58	8-10	7.46	7-8*
360	Complete Tobacco Manure,	5.37	4.47	4.53-5.35	4.22	1.10	1.16	6.48	5-6	5.32	4-5	10.72	10-11*
377	Standard Un X Ld Fertilizer,	11.50	2.51	1,80-2.30	6.42	2.56	1.12	10.10	9-10	8.98	8-10	2.94	2 25-3.25
108	Breck's Market Garden Manure,	14.46	2.50	2.5-3.25	4.02	4.10	3.64	11.76	11-14	8.12	9-11	2.36	2-3
242	Fish and Potash,	16.32	2.28	2.07-2.90	2.44	2.94	3.20	8.58	7.5-10.5	5.38	6-8	2.44	2-3
62	Farm and Garden Phosphate,	10.02	1.81	1.5-2.5	2.92	5.30	2.84	11.06	10-14	8.22	8-10	2.16	2-3
68	Potatoes and Vegetables,	10.38	2.63	2.25-3.55	3.46	4.04	4.02	11.52	10-13	7.50	8-10	4.08	4-6
129	Stockbridge's Corn and Grain,	8.55	3.32	3-4	6.24	2.79	2.33	11.36	10-12	9.03	7-9	7.13	7-9
148	Stockbridge's Onion Fertilizer,	8.53	4.98	4.5-5.5	3.24	3.36	3.94	10.54	8-10	6.60	6-8	6.46	5-6
156	Hill and Drill Phosphate,	12.85	2.56	2.35-3.25	6.14	3.60	3.12	12.86	12-13	9.74	9-11	2.32	2-3
162	Bone and Wood Ash Fertilizer,	4.82	2.00	1.50-2.50	—	7.40	4.14	11.54	8-10	7.40	6-8	2.70	2-3
182	Unleached Wood Ashes,	10.97	—	—	—	—	--	1.40	1.	—	—	7.40	4.
244	Paul Mixture, "Special Goods,"	6.07	3.40	—	1.56	3.06	6.26	10.88	—	4.62	—	2.18	—
306	Corn Phosphate,	7.75	1.87	1.5-2.5	3.00	4.78	3.30	11.08	10-12	7.78	8-10	2.24	2-4
309	Potato and Vegetable Phosphate,	11.83	1.89	1.5-2.5	3.08	5.24	2.94	11.26	11-13	8.32	9-11	1.97	2-4
316	Sure Crop Bone Phosphate,	11.45	1.20	.75-1.50	4.68	4.44	2.78	11.90	11-12	9.12	9-10	2.03	2-4

*Sulphate of Potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
321	Market Garden Manure,	Bowker Fertilizer Co., Boston, Mass.,	Williamstown.
325	Soluble Animal Fertilizer	Bowker Fertilizer Co., Boston, Mass.,	Williamstown.
326	Bowker's Ten Per Cent.,	Bowker Fertilizer Co., Boston, Mass.,	Williamstown.
32	Dry Ground Fish Guano	Bradley Fertilizer Co., Boston, Mass.,	Hatfield.
56	Potato Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Attleboro.
65	Bradley's Strawberry Manure,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
114	Bradley's Corn Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Newburyport.
133	New Method Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Danvers.
138	Complete Manure for Corn and Grain,	Bradley Fertilizer Co., Boston, Mass.,	Drnvers.
144	Eclipse Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Newburyport.
157	Complete Manure with 10 per cent Potash,	Bradley Fertilizer Co., Boston, Mass.,	Newburyport.
158	Niagara Phosphate,	Bradley Fertilizer Co., Boston, Mass,,	Attleboro.
179	Columbia Fish and Potash,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
185	Fish and Potash (B),	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
307	Circle Brand Extra Fine Ground Bone and Potash,	Bradley Fertilizer Co., Boston, Mass.,	Pittsfield.
102	Breck's Lawn and Garden Dressing,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
34	Complete Fertilizer for Roots,	Berkshire Mills Co., Bridgeport, Conn.,	So. Deerfield.
35	Cumberland Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	So. Deerfield.
36	Potato Phosphate,	Berkshire Mills Co,, Bridgeport, Conn.,	So. Deerfield.
50	Fish Scrap No. 2,	Hiram Blanchard, Eastport, Me.,	Amherst.
106	Complete Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
376	Tankage,	Bartlett & Holmes, Springfield, Mass.,	Springfield.
216	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y,,	Springfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
321	Market Garden Manure,	10.94	2.59	2.25-3.25	5.38	2.60	3.58	11.56	7-10	7.98	6-8	9.22	10-12
325	Soluble Animal Fertilizer,	5.67	2.79	2.5-3.5	3.10	3.92	3.08	10.10	10-14	7.02	8-11	3.92	4-5
326	Bowker's Ten Per Cent.,	8.40	1.09	.75-1.50	1.66	4.84	2.64	9.14	—	6.50	6-8	10.06	10-12
32	Dry Ground Fish Guano,	11.39	8.23	7.43-9.	—	3.26	4.92	8.18	7-9	3.26	—	—	—
56	Potato Fertilizer,	13.32	2 09	2-3	4.66	3.96	3.02	11.64	11-14	8.62	9-11	3.13	3.25-4.35
65	Bradley's Strawberry Manure,	11.85	2.68	2.5-3.9	4.98	1.30	2.48	8.76	8-11	6.28	6-8	5.28	5-6
114	Bradley's Corn Phosphate,	11.37	2.44	2.06-2.68	1.80	5.60	5.24	12.64	10-14	7.40	9-12	1.60	1.5-2.5
133	New Method Fertilizer,	14.62	.88	.82-1.52	5.76	3.26	2.28	11.30	10-12	9.02	8-10	2.26	2.15-3.25
138	Complete Manure for Corn and Grain,	9.42	4.15	3.30-4.12	5.50	6.36	2.44	14.30	13-16	11.86	12-14	2.60	3-4
144	Eclipse Phosphate,	15.40	1.59	1-2	4.56	5.34	3.08	12.98	12-15	9.90	10-12	1.50	1.5-2.5
157	Complete Manure with 10 per cent Potash,	11.80	3.05	3.30-3.13	5.50	1.24	2.26	9.00	7-12	6.74	6-10	10.86	10-12
158	Niagara Phosphate,	15.38	1.11	.82-1.65	5.12	2.70	2.04	9.86	8-11	7.82	7-9	1.48	1.08-1.63
179	Columbia Fish and Potash,	14.65	2.79	1.65-2.3	2.04	3.38	2.48	7.90	6-9	5.42	5-7	2.38	2-3
185	Fish and Potash (B),	15.06	2.84	2.07-2.90	1.86	3.14	3.50	8.50	7.5-10.5	5.00	6-8	2.05	2-3
307	Circle Br'd Fine Ground Bone and Potash,	7.27	2.49	1.85-2.68	1.68	2.62	12.20	16.50	10-13	4.30	6-8	1.90	2-3
102	Breck's Lawn and Garden Dressing,	6.51	4.20	4.12-4.94	1.66	3.06	1.66	6.38	5-6	4.72	5-6	5.48	5-6
34	Complete Fertilizer for Roots,	14.43	3.05	2.47-3.30	5.30	2.74	3.96	12.00	10-12	8.04	8-10	5.76	6-8
35	Cumberland Phosphate.	6.98	—	—	.90	8.80	3.28	12.98	12-14	9.70	10-12	2.11	2-3
36	Potato Phosphate,	9.66	2.52	1 65-2.47	.38	3.20	8.06	11.64	8-10	3.58	6-8	4.02	4-6
50	Fish Scrap No. 2,	1.03	4.14	4.47	—	1.64	1.54	3.18	5.15	1.64	—	—	—
106	Complete Animal Fertilizer,	4.69	3.91	3.30-4.12	—	4.72	11.12	15.84	14-17	4.72	—	6.64	7-8
376	Tankage,	6.17	4.21	4.12-4.94	—	6.70	12.74	19.44	17-18	6.70	—	—	—
216	Vegetable Bone Superphosphate,	7.78	4.45	5-6	2.96	2.44	3.88	9.28	7-9	5.40	6-7	5.33	5.94-8.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
234	Potato and Tobacco Grower,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Springfield.
253	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Springfield.
350	Crocker's Special Potato Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Worcester.
351	Potato. Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Worcester.
367	General Crop Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Amherst.
186	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	So. Seekonk.
344	King Philip Guano,	Clark's Cove Fertilizer Co., Boston, Mass.,	Spencer.
282	Bay State Fertilizer, G. G.,	Clark's Cove Fertilizer Co., Boston, Mass.,	Hudson.
96	Grass and Grain Fertilizer,	E. Frank Coe Co., New York City,	Taunton.
189	Excelsior Potato Manure,	E. Frank Coe Co., New York City,	Taunton.
203	Columbian Potato Manure,	E. Frank Coe Co., New York City,	Westfield.
224	Special Potato Fertilizer,	E. Frank Coe Co., New York City,	Westfield.
346	Corn and Grain Phosphate,	Cleveland Dryer Co., Boston, Mass.,	Monson.
354	Grass Fertilizer,	Cleveland Dryer Co., Boston, Mass.,	Monson.
264	Blood, Bone and Potash,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord.
272	Special Formula,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Bridgewater.
340	Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
380	Tobacco Grower,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Leominster.
379	Imperial Liquid Plant Food,	Eastern Chemical Co., Boston, Mass.,	Boston.
273	Wood Ashes,	William E. Fyfe & Co., Clinton, Mass.,	Concord.
359	Canada Unleached Wood Ashes,	E. McGarvey & Co., London, Ontario, Can.,	Sunderland.
232	Canada Hard Wood Ashes,	F. E. Hancock, Walkerton, Ontario, Can.,	Amherst.
45	Special Tobacco Fertilizer,	Listers Agricultural Chemical Works, Newark, N. J.	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
234	Potato and Tobacco Grower, ...	8.34	3.05	3.29-5.00	4.04	2.86	1.80	8.70	7-10	6.90	6-8	4.94	5.4-6.5
253	New Rival Ammoniated Superphosphate,...	14.50	1.57	1.23-2.00	7.12	3.24	2.30	12.66	11-15	10.36	10-12	2.01	1.60-3.
350	Crocker's Special Potato Manure,..........	9.84	4.48	3.70-4.50	4.60	2.54	4.40	11.54	8-10	7.14	8-10	4.32	5.40-6.40
351	Potato, Hop and Tobacco Phosphate, ...	10.88	2.35	2-3	6.06	3.22	2.44	11.72	10-12	9.28	10-12	2.88	3.25-4.30
367	General Crop Fertilizer,..................	9.74	1.20	.82-1.64	3.46	3.44	1.36	8.26	8-12	6.90	7-10	1.14	1.08-2.50
186	Bay State Fertilizer,.....................	13.67	2.63	2.47-3.30	6.14	3.42	1.82	11.38	10-14	9.56	9-12	2.04	2-3
344	King Philip Guano, ...	13.58	1.30	1.03-1.64	6.48	2.22	2.30	11.00	9-12	8.70	8-10	2.09	2-3
382	Bay State Fertilizer G. G., ...	11.58	2.25	1.85-2.03	5 24	3.40	3.64	12.28	10-13	8.64	8.5-11	2.00	2-3
96	Grass and Grain Fertilizer,...............	13.53	.97	.80-1.00	6.14	2.08	2.96	11.18	10.6-11.6	8.22	8 5-10.5	1.76	1.5-2.5
189	Excelsior Potato Manure,................	8.33	2.62	2.5-3.00	7.04	1.72	2.04	10.80	9-13	8.76	8-11	7.38	8-10*
203	Columbian Potato Manure,......	10 89	1.37	1.20.1.60	6.48	2.78	2.00	11.26	10.5-13.5	9.26	8.5-10.5	2.50	2.5-3.5*
224	Special Potato Fertilizer, ...	13.64	1.79	1.65-2.45	7.60	2.06	1.72	11.38	10-12	9.66	8-11	3.60	4.74-5.05*
346	Corn and Grain Phosphate,...............	14.01	2.06	2-2.30	7.50	2.16	2.50	12.16	10.5-14.5	9 66	9.5-12.5	1.50	1.5-2.5
354	Grass Fertilizer,.........................	7.87	4.10	3.91-4.74	2.28	2.94	1.66	6.88	6-9	5.22	5-7	2.50	2 3
264	Blood, Bone and Potash,..................	8.08	4.19	4.12	4.56	2.98	1.68	9.22	8	7.54	7	7.58	7.5
272	Special Formula, ...	8.34	3.43	3.30	5.44	2.62	3.20	11.26	10	8.06	7	6.16	6
340	Animal Fertilizer, ...	7.69	3.58	3.30	5.38	2.46	4.32	12.16	10	7.84	8	4.18	4
380	Tobacco Grower, ...	8.24	5.19	4.94	4.34	2.60	1.66	8.60	8	6.94	7	9.74	10
379	Imperial Liquid Plant Food,..........	90.04	3.58	1	1.38	—	—	1.38	1	—	—	2.02	1
273	Wood Ashes, ...	10.54	—	—	—	—	—	1.10	1-3	—	—	4.48	4.5-8
359	Canada Unleached Wood Ashes,...........	13.48	—	—	—	—	—	1.51	1-2	—	—	4.53	5-8
232	Canada Hard Wood Ashes,................	12.29	—	—	—	—	—	1.86	—	—	—	7.24	—
45	Special Tobacco Fertilizer,................	14.73	1.71	1.65-2.47	6.52	2.16	2.96	11.64	8.5-10	8.68	—	3.94	4-5

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
47	Special Potato Fertilizer,	Listers Agricultural Chemical Works, Newark, N. J.,	Amherst.
140	Special Potato Fertilizer,	Listers Agricultural Chemical Works, Newark, N. J.	Middleboro.
274	Special Potato Fertilizer,	Listers Agricultural Chemical Works, Newark, N. J.	Lincoln.
48	Celebrated Onion Fertilizer,	Listers Agricultural Chemical Works, Newark, N. J.,	Amherst.
22	Swift's Lowell Potato Phosphate,	Lowell Fertilizer Co., Boston, Mass.,	Sunderland.
149	Swift's Lowell Potato Phosphate,	Lowell Fertilizer Co., Boston, Mass.,	Lowell.
250	Swift's Lowell Potato Phosphate.	Lowell Fertilizer Co., Boston, Mass.,	Springfield.
289	Swift's Lowell Potato Phosphate,	Lowell Fertilizer Co., Boston, Mass.,	Hinsdale.
33	Swift's Lowell Fruit and Vine for Strawberries,	Lowell Fertilizer Co., Boston, Mass.,	Hatfield.
131	Swift's Lowell Fruit and Vine,	Lowell Fertilizer Co., Boston, Mass.,	Lowell.
150	Swift's Lowell Lawn Dressing,	Lowell Fertilizer Co., Boston, Mass.,	Lowell.
236	Swift's Lowell Bone Fertilizer for Corn,	Lowell Fertilizer Co., Boston, Mass.,	Springfield.
349	Swifts Lowell Market Garden Manure,	Lowell Fertilizer Co., Boston, Mass.,	Spencer.
299	Tobacco Manure, "Wrapper Brand,"	Mapes Formula and Peruvian Guano Co., New York City,	Greenfield.
324	Mapes Economical Potato Manure,	Mapes Formula and Peruvian Guano Co., New York City,	Gt. Barrington
331	Mapes Corn Manure,	Mapes Formula and Peruvian Guano Co., New York City,	Gt. Barrington
353	Fruit and Vine Manure,	Mapes Formula and Peruvian Guano Co., New York City,	Worcester.
334	Nobsquè Guano,	Pacific Guano Co., Boston, Mass.,	S. Williamst'n.
314	Gardeners' Complete Manure,	Packers' Union Fertilizer Co., New York City,	Greenfield.
315	Animal Corn Fertilizer,	Packers' Union Fertilizer Co., New York City,	S. Williamst'n.
320	Wheat, Oats and Clover,	Packers' Union Fertilizer Co., New York City,	Van Deusen.
333	Wheat, Oats and Clover,	Packers' Union Fertilizer Co., New York City,	S. Williamst'n.
53	Special for Strawberries and Small Fruits,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
369	Star Brand Superphosphate,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs. Found.	Nitrogen in 100 lbs. Guaranteed.	Phosphoric Acid in 100 lbs. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in 100 lbs. Found.	Guaranteed.
	Compound Fertilizers.												
47-140-274	Special Potato Fertilizer, ...	12.22	1.75	1.65-2.47	5.38	2.70	3.08	11.16	9	8.08	8-10	2.84	3-4*
48	Celebrated Onion Fertilizer,...............	11.52	3.68	3.71-4.12	5.04	2.30	2.44	9.78	7.5-9	7.34	—	6.80	7-8
22-149-250-289	Swift's Lowell Potato Phosphate, ...	8.75	2.81	2.47-3.30	6.66	1.92	1.86	10 44	9-12	8.58	8-11	6.20	6-7
33	Swift's Lowell Fruit & Vine for Strawberries	9.22	3.58	3.29-4.12	5.62	1.40	1.80	8.82	9-10	7.02	8-10	5.96	6-7
131	Swift's Lowell Fruit and Vine,............	10.82	3.04	2.47-3.30	6.14	2.38	1.40	9.92	9-10	8.52	8-10	5.17	6-7
150	Swift's Lowell Lawn Dressing,...........	11.37	4.41	4.11-4.94	6.66	1.58	.72	8.96	8-10	8.24	7-9	5.20	5-6
236	Swift's Lowell Bone Fertilizer for Corn, ..	10.09	1.82	1.65-2.5	4.35	4.34	1.41	10.10	9-12	8.69	8-10	3.02	3-4
349	Swift's Lowell Market Garden Manure,....	10 38	3 99	4.10-4.92	6.02	1.46	1.28	8.76	8-11	7.48	7-9	4.13	6-7
299	Tobacco Manure "Wrapper Brand,"	7.72	6.51	6.18	.38	3.58	2.30	6.26	—	3.96	4-5	10.32	10.5*
324	Mapes Economical Potato Manure, ...	9.82	3.26	3.29-4.12	1.46	2.33	2.35	6.14	6-8	3.79	4-5	9.18	8-10*
331	Mapes Corn Manure, ...	12.15	2.42	2.47-2.88	3.36	4.06	3.46	10.88	10-12	7.42	8-10	6.24	6-7
353	Fruit and Vine Manure,..................	7.93	2.63	1.65-2.47	3.78	2.28	2.10	8.16	7-9	6.06	5-7	11.40	10-12
334	Nobsque Guano,....	13.01	1.27	1.15-1.65	5.56	2.34	2.46	10.36	9-11	7.90	8 12	2.05	2-3
314	Gardeners' Complete Manure,............	9.59	2.77	2.47-3.29	7.04	1.90	.52	9.46	11-15	8 94	9-12	9.71	10-12
315	Animal Corn Fertilizer,..................	13.77	2.81	2.47-3.29	6.26	1.52	2.38	10.16	9-15	7.78	8-12	2.28	2-4
320-333	Wheat, Oats and Clover,.................	13.51	—	—	3.25	7.85	1.05	12.15	—	11.10	11-13	1.82	2-3
53	Special for Strawberries and Small Fruits,.	12.69	3.07	2.47-3.29	3.81	5.22	—	9.03	10-13	9.03	9-11	7.10	6-7
369	Star Brand Superphosphate,.............	8.51	2.17	1.64-2.46	2.82	3.50	2.56	8.88	8-11	6.32	7-9	2.74	2.5-3.5

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
25	Onion Manure,	The Quinnipiac Co., Boston, Mass.,	Hatfield.
28	Havana Tobacco Fertilizer,	The Quinnipiac Co., Boston, Mass.,	Hatfield.
30	Dry Ground Fish,	The Quinnipiac Co., Boston, Mass.,	Hatfield.
176	Quinnipiac Grass Fertilizer,	The Quinnipiac Co., Boston, Mass.,	So. Seekonk.
205	Pequot Fish and Potash,	The Quinnipiac Co., Boston, Mass ,	Springfield.
228	Quinnipiac Corn Manure,	The Quinnipiac Co., Boston, Mass.,	Springfield.
305	Quinnipiac Climax Phosphate,	The Quinnipiac Co., Boston, Mass.,	Orange.
58	Essex for Potatoes, Roots and Vegetables,	Russia Cement Co., Gloucester, Mass.,	Taunton.
74	Essex Odorless Lawn Dressing,	Russia Cement Co., Gloucester, Mass.,	Taunton.
99	Essex Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Taunton.
288	Essex Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Pittsfield.
238	Essex Dry Ground Fish,	Russia Cement Co., Gloucester, Mass.,	Dighton.
262	Essex for Corn, Grain and Grass,	Russia Cement Co., Gloucester, Mass.,	Dighton.
322	Essex Corn Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Williamstown.
218	Hubbard's Fertilizer for all Soils and all Crops,	The Rogers & Hubbard Co., Middletown, Conn.,	Holyoke.
332	Hubbard's Fertilizer for all Soils and all Crops,	The Rogers & Hubbard Co., Middletown, Conn.,	Hinsdale.
227	Hubbard's Fertilizer for Oats and Top Dressing,	The Rogers & Hubbard Co., Middletown, Conn.,	Holyoke.
294	Hubbard's Soluble Tobacco Manure,	The Rogers & Hubbard Co., Middletown, Conn.,	Hinsdale.
370	Hubbard's Grass and Grain Fertilizer,	The Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
72	Clark's Garden Special,	Read Fertilizer Co., New York City	So. Seekonk.
75	Clark's Garden Special,	Read Fertilizer Co., New York City,	So. Seekonk,
116	Farmers' Friend Superphosphate,	Read Fertilizer Co,, New York City,	Amesbury.
123	Truck Fertilizer "Special Formula,"	Read Fertilizer Co., New York City,	Amesbury.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.
								Found.	Guaranteed.	Found.	Guaranteed.		
	Compound Fertilizers.												
25	Onion Manure,	11.76	3.58	3.30-4.12	4.76	8.58	2.74	11.08	9-13	8.34	8-11	6.70	7-8
28	Havana Tobacco Fertilizer,	5.94	5.48	5.78-6.61	6.14	1.70	.98	8.82	6-9	7.84	5-7	10.80	10-12*
30	Dry Ground Fish,	8.88	7.95	7.43-9.00	—	3.20	5.16	8.36	7-9	3.20	—	—	—
176	Quinnipiac Grass Fertilizer,	9.24	4.62	3.91-4.73	1.22	3.90	2.30	7.42	6-8	5.12	5-7	2.40	2-3
205	Pequot Fish and Potash,	17.55	2.63	2.06-2.80	3.30	4.25	2.53	10.08	7-10	7.55	6-8	2.84	2-3
228	Corn Manure,	14.78	2.20	2.06-2.89	6.45	3.52	2.64	12.61	10-14	9.97	9-11	2.60	1.5-2.5
305	Quinnipiac Climax Phosphate,	16.23	1.24	1.03-1.64	5.42	2.42	2.48	10.32	9-13	7.84	8-11	2.14	2-3
58	Essex for Potatoes, Roots and Vegetables,	6.47	4.03	3.7-4.5	4.53	2.84	3.86	11.23	9-11	7.37	7-7.24	8.55	8.5-10*
74	Essex Odorless Lawn Dressing,	2.76	3.99	3.7-4.5	.64	2.37	6.02	9.03	8-10	3.01	6-7	7.10	7-8
99-288	Essex Fish and Potash,	9.36	2.68	2.1-3.00	4.86	4.60	5.38	14.84	12-14	9.46	10-11	2.60	2.25-3.25
238	Essex Dry Ground Fish,	9.82	8.40	8-10	—	5.06	7.22	12.28	11-13	5.06	—	—	—
262	Essex for Corn, Grain and Grass,	8.37	3.85	3.7-4.5	3.92	4.04	4.32	12.28	9.5-11	7.96	7-8	9.72	9.5-11.
322	Essex Corn Fertilizer,	8.83	2.52	2-2.5	2.14	5.77	5.73	13.64	11-13	7.91	9-10	3.38	3-3.5
218-332	Hubbard's Fert. for all Soils and all Crops,	12.90	2.20	2.30-3.	8.55	3.15	2.17	13.87	12-14	11.70	10-12	2.74	3-4
227	Hubbard's Fert. for Oats and Top Dressing,	5.16	9.95	8.80-9.70	—	3.66	7.80	11.46	7.85-8.75	3.66	—	10.46	8.35-9.25
294	Hubbard's Soluble Tobacco Manure,	9.33	5.00	5-6	1.48	4.66	4.48	10.62	10-12	6.14	7-8.5	10.72	10-11*
370	Hubbard's Grass and Grain Fertilizer,	4.86	2.96	2.5-3.	—	5.16	14.66	19.82	16.5-18.	5.16	—	10.84	12.5-13.5
72-75	Clark's Garden Special,	10.02	4.15	.37-4.5	4.12	5.34	3.00	12.46	11-12	9.46	10-12	5.85	6-7
116	Farmers' Friend Superphosphate,	13.69	2.14	2.-2.25	7.06	2.56	1.69	11.31	10-18	9.62	9-11	2.20	2-4
123	Truck Fertilizer "Special Formula,"	11.92	3.29	3.3-4.	4.30	2.59	2.17	9.06	8-12	6.89	7-10	6.06	7-8

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
159	High Grade Farmers' Friend,	Read Fertilizer Co., New York City,	Amesbury.
177	Bone, Fish and Potash,	Read Fertilizer Co., New York City,	Amesbury.
4	South Sea Guano,	The South Sea Guano Co., Boston, Mass.,	Boston.
119	Tobacco and Sulphur Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Lowell.
280	Sanderson's Old Reliable,	Lucien Sanderson, New Haven, Conn.,	Hinsdale.
384	Sanderson's Formula "A,"	Lucien Sanderson, New Haven, Conn.,	Amherst.
329	Swift Sure Superphosphate for General Use,	M. L. Shoemaker & Co., Limited, Philadelphia, Pa.,	Greenfield.
117	Tucker's Bay State Special,	Henry F. Tucker Co., Boston, Mass.,	Newburyport.
164	Tucker's Imperial Bone Superphosphate,	Henry F. Tucker Co., Boston, Mass.,	Newburyport.
277	Tucker's Imperial Bone Superphosphate,	Henry F. Tucker Co., Boston, Mass.,	Dalton.
267	Ferti Flora,	E. A. Tompkins, Jamaica Plain, Mass.,	Amherst.
42	Champion Animal Fertilizer,	Darius Whithed, Lowell, Mass.,	Amherst.
168	Dry Ground Fish Guano,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
193	Fish and Potash,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
101	High Grade Special for Potatoes, etc.,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fall River.
215	Dry Ground Fish,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton.
221	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass,	Northampton.
297	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
229	Fish and Potash "A No. 1,"	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton.
304	Grass Manure,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
311	Potato Manure.	M. E. Wheeler & Co., Rutland, Vt.,	Williamstown.
330	Grass and Oats,	M. E. Wheeler & Co., Rutland, Vt.,	Williamstown.
363	Havana Tobacco Grower,	M. E. Wheeler & Co., Rutland, Vt.,	Sunderland.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
159	High Grade Farmers' Friend,	11.28	3.48	2.25-4.25	4.30	1.32	1.28	6.90	6-8	5.62	5-6	9.92	10-11
177	Bone, Fish and Potash,	15.79	2.67	2.5-3.	2.68	1.76	2.60	7.04	5-6	4.44	4-5	4.48	4-5
4	South Sea Guano,	7.11	7.10	7.	2.74	14.94	1.18	18.86	—	17.68	17.5	—	—
119	Tobacco and Sulphur Fertilizer,	17.45	2.06	1.96	—	—	—	1.00	.75	—	—	8.10	7.66
280	Sanderson's Old Reliable,	10.27	2.84	2.47-3.3	3.32	4.34	5.38	13.04	10-13	7.66	7-8	2.62	2-3
384	Sanderson's Formula "A,"	9.93	3.78	3.30-4.	4.22	4.18	2.90	11.30	10-12	8.40	6-8	6.50	6-8
329	Swift Sure Superphosphate,	9.70	2.96	2.46-4.12	8.76	2.39	3.12	14.27	—	11.15	9-11	4.80	4-6
117	Tucker's Bay State Special,	11.83	3.15	3.3-4.12	5.30	3.40	2.17	10.87	9-13	8.70	8-11	7.00	7-8
164-277	Tucker's Imperial Bone Superphosphate,	13.71	1.92	1.35-2.00	5.17	3.28	3.22	11.67	11-15	8.45	9-12	2.60	1.85-2.5
267	Ferti Flora,	82.58	4.02	3.30	3.68	—	—	3.68	3.66	3.68	3.66	3.20	3.25
42	Champion Animal Fertilizer,	3.10	4.09	3.74	—	1.79	11.13	12.92	12.74	1.79	—	8.13	12.34
168	Dry Ground Fish Guano,	6.56	8.60	8.5-10	.84	1.31	4.09	6.24	6-9	2.15	4-6	—	—
193	Fish and Potash,	22.05	2.98	2.5-3.5	1.20	3.61	2.23	7.04	6-8	4.81	5-7	3.48	3-4
101	High Grade Special for Potatoes,	11.35	3.38	3.30-4-12	4.45	4.05	2.07	10.57	9-13	8.50	8-11	7.02	7-8
215	Dry Ground Fish,	8.17	8.14	7.43-9.09	—	2.12	3.58	5.70	7-9	2.12	—	—	—
221-297	Ammoniated Bone Superphosphate,	12.95	2.48	2.47-3.30	4.99	4.17	3.79	12.95	10-13	9.16	9-11	2.	2-3
229	Fish and Potash A No. 1,	13.33	3.40	3.30-4.15	2.22	1.92	3.66	7.80	5-8	4.14	3-5	3.78	3-5
304	Grass Manure,	8.91	4.42	3.91-4.73	1.41	3.99	2.53	7.93	6-9	5.40	5-7	2.52	2-3
311	Potato Manure,	13.42	2.32	2.05-2.88	7.39	.82	1.79	10.00	9-15	8.21	8-12	3.40	3.25-4.00
330	Grass and Oats,	14.70	—	—	3.74	5.75	2.23	11.72	—	9.49	11-13	1.74	2-4
363	Havana Tobacco Grower,	9.53	3.28	2.88-3.75	5.32	2.10	1.40	8.82	7-11	7.42	6-9	7.14	7-9*

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Chemicals.		
358	Castor Pomace,	E. India Chem. W'k's, H. J. Baker & Bro., P'r's, N. Y. City	So. Deerfield.
59	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
60	Nitrate of Soda	Bowker Fertilizer Co., Boston, Mass.,	Attleboro.
113	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Fall River.
70	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
160	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Fall River.
61	Kainit,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
261	Nitrate of Soda,	Bradley Fertilizer Co., Boston, Mass.,	New Bedford.
302	Dissolved Bone Black,	Bradley Fertilizer Co., Boston, Mass.,	Fitchburg.
327	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Williamstown.
338	High Grade Sulphate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
230	High Grade Sulphate of Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
247	Muriate of Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
118	Cotton Seed Meal,	Chas. M. Cox & Co., Boston, Mass.,	Danvers.
361	Sulphate of Ammonia,	Mapes Formula and Peruvian Guano Co., New York City,	So. Deerfield.
362	Nitrate of Soda,	Mapes Formula and Peruvian Guano Co , New York City,	So. Deerfield.
372	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
374	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
378	High Grade Sulphate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
270	Nitrate of Soda,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
275	Muriate of Potash,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
310	Muriate of Potash,	The Quinnipiac Co., Boston, Mass.,	Orange.
231	Nitrate of Soda,	The Quinnipiac Co., Boston, Mass.,	Springfield.
383	Sulphate of Potash High Grade,	Lucien Sanderson, New Haven, Conn.,	Amherst.
77	Nitrate of Soda,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fall River.
167	Muriate of Potash,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fall River.
226	Double Manure Salts,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.												
358	Castor Pomace,	9.62	5.85	5.56	—	—	—	—	—	—	—	—	—
59-60-113	Nitrate of Soda,	2.07	15.80	15.65-16.14	—	—	—	—	—	—	—	—	—
70-160	Muriate of Potash,	1.38	—	—	—	—	—	—	—	—	—	50.00	50-52
61	Kainit,	1 81	—	—	—	—	—	—	—	—	—	12.65	12-13
261	Nitrate of Soda,	2.25	15.70	14.83-16.48	—	—	—	—	—	—	—	—	—
302	Dissolved Bone Black,	15.61	—	—	13.68	3.20	—	16.88	16-18	16.88	15-18	—	—
327	Muriate of Potash,	1 67	—	—	—	—	—	—	—	—	—	49.80	50-55
338	High Grade Sulphate of Potash,	.29	—	—	—	—	—	—	—	—	—	48.50	48.64-51.34
230	High Grade Sulphate of Potash,	1.55	—	—	—	—	—	—	—	—	—	47.80	48.64-51.34
247	Muriate of Potash,	.74	—	—	—	—	—	—	—	—	—	50.60	50-55
118	Cotton Seed Meal,	8.46	7.14	6.89	—	—	—	—	—	—	—	—	—
361	Sulphate of Ammonia,	1.94	21.00	20.60	—	—	—	—	—	—	—	—	—
362	Nitrate of Soda,	2.05	16.24	—	—	—	—	—	—	—	—	—	—
372	Nitrate of Soda,	1.33	15.15	—	—	—	—	—	—	—	—	—	—
374	Muriate of Potash,	.22	—	—	—	—	—	—	—	—	—	49.40	—
378	High Grade Sulphate of Potash,	1.10	—	—	—	—	—	—	—	—	—	48.90	50.55-54.33
270	Nitrate of Soda,	1.50	15.71	14.41-14.83	—	—	—	—	—	—	—	—	—
275	Muriate of Potash,	1.82	—	—	—	—	—	—	—	—	—	50.80	50.54-53.70
310	Muriate of Potash,	1.64	—		—	—	—	—	—	—	—	49.20	50.54-53.70
231	Nitrate of Soda,	1.87	15.60	15.80	—	—	—	—	—	—	—	—	—
383	Sulphate of Potash High Grade,	1.76	—	—	—	—	—	—	—	—	—	48.50	48-50
77	Nitrate of Soda,	1.62	15.83	15.8	—	—	—	—	—	—	—	—	—
167	Muriate of Potash.	3.61	—	—	—	—	—	—	—	—	—	48.40	50-55
226	Double Manure Salts,	3.93	—	—	—	—	—	—	—	—	—	26.70	25-28

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Ground Bones.		
10	Bone Meal,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
143	Bone Meal,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
246	Bone Meal,	Armour Fertilizer Works, Chicago, Ill.,	Springfield.
197	Animal Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Holyoke.
219	Animal Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Holyoke.
375	Fine Ground Bone,	E. India Chem. W'r'ks H.J.Baker & Bro., Props, N.Y. City,	Springfield.
83	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
92	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
300	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Fitchburg.
110	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
308	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Williamstown.
352	Abattoir Bone Dust,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
373	Pure Ground Bone,	Bartlett & Holmes, Springfield, Mass.,	Springfield.
255	Pure Ground Bone,	E. Frank Coe Co., New York City,	Westfield.
67	Dow's Pure Ground Bone,	John C. Dow & Co., Boston, Mass.,	Boston.
120	Swift's Lowell Ground Bone,	Lowell Fertilizer Co., Boston, Mass.,	Lowell.
211	Swift's Lowell Ground Bone,	Lowell Fertilizer Co., Boston, Mass.,	Springfield.
368	Pure Ground Bone,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
371	Raw Knuckle Bone Flour,	The Rogers & Hubbard Co., Middletown, Conn.	Amherst.
41	Flour of Bone,	Darius Whithed, Lowell, Mass.,	Lowell.
57	Flour of Bone,	Darius Whithed, Lowell, Mass.,	Boston.
111	Pure Ground Bone,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Mechanical Analysis.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Fine Bone.	Fine Medium.	Medium.	Coarse Medium.
	Bones.														
10-143-246	Bone Meal,	5.75	3.85	2.47-3.28	–	6.42	17.68	24.10	24-28	6.42	10-14	48.75	25.01	17.35	8.89
197-219	Animal Fertilizer,	7.73	3.61	3.5-4.5	–	5.78	16.10	21.88	20-22	5.78	5-8	53.17	27.82	15.15	3.86
375	Fine Ground Bone,	4.37	3.01	2.88-3.71	–	11.70	14.76	26.46	23-24	11.70	—	62.39	30.92	6.69	—
83-92-300	Fresh Ground Bone,	5.14	2.31	2.25-3.25	–	6.18	19.16	25.34	24-26	6.18	5-6	56.06	23.98	17.46	2.50
110-308	Fine Ground Bone,	4.58	2.93	2.5-3.2	–	5 50	18.32	23.82	21-23	5.50	—	42.00	25.67	22.53	9.80
352	Abattoir Bone Dust,	9.14	2.29	1.65-2.25	–	3.56	13.26	16.82	14-18	3.56	—	45.98	26.05	22.98	4.99
373	Pure Ground Bone,	3.87	2.17	2-3	–	4.76	23.48	28.24	27-29	4.76	—	67.08	32.47	.45	—
255	Pure Ground Bone,	7.68	3.88	3.25-4.	–	4.34	18.44	22.78	22.90-25.19	4.34	—	21.77	25.08	51.94	1.21
67	Dow's Pure Ground Bone,	2.75	2.22	1.65-2.47	–	5.00	19.44	24.44	22-25	5.00	—	60.47	39.53	—	—
120-211	Swift's Lowell Ground Bone,	2.93	2.54	2.47-3.29	–	7.72	20.46	28.18	23-28	7.72	—	66.46	24.88	8.66	—
368	Pure Ground Bone,	7.20	1.61	1.65-2.47	–	5.12	17 02	22.14	16-20	5.12	—	79.27	15.10	5.63	—
371	Raw Knuckle Bone Flour,	7.99	3.70	3.5-4.	–	5.88	18.94	24.82	24.5-26	5.88	—	65 03	34.97	—	—
41-57	Flour of Bone,	2.80	1.71	1.83	-	2.94	25.97	28.91	28-40	2.94	—	72.46	18.43	9.11	—
111	Pure Ground Bone,	8.99	3.50	3-4	–	6.86	17.52	24.38	20-25	6.86	—	35.83	35.60	26.47	2.10

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1899. Cents per pound.
Nitrogen in ammonia salts,	15.0
" nitrates,	12.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.0
" " " fine bone and tankage,	14.0
" " " medium bone and tankage,	10 0
Phosphoric acid soluble in water,	4.5
" " soluble in ammonium citrate,	4.0
" " in fine ground fish, bone and tankage,	4.0
" " in cottonseed meal, castor pomace and wood ashes,	4.0
" " in coarse fish, bone and tankage,	2.0
" " insoluble (in water and in am. cit.) in mixed fertilizers,	2.0
Potash as Sulphate, free from Chlorides,	5.0
" " Muriate,	4.25

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy action, exert as a rule, a decided influence on their selling price.

The market value of fertilizing ingredients like other merchandise is liable to changes during the season. The above stated values are based on the condition of the fertilizer market in centers of distribution in New England, during the six months preceding March 1899.

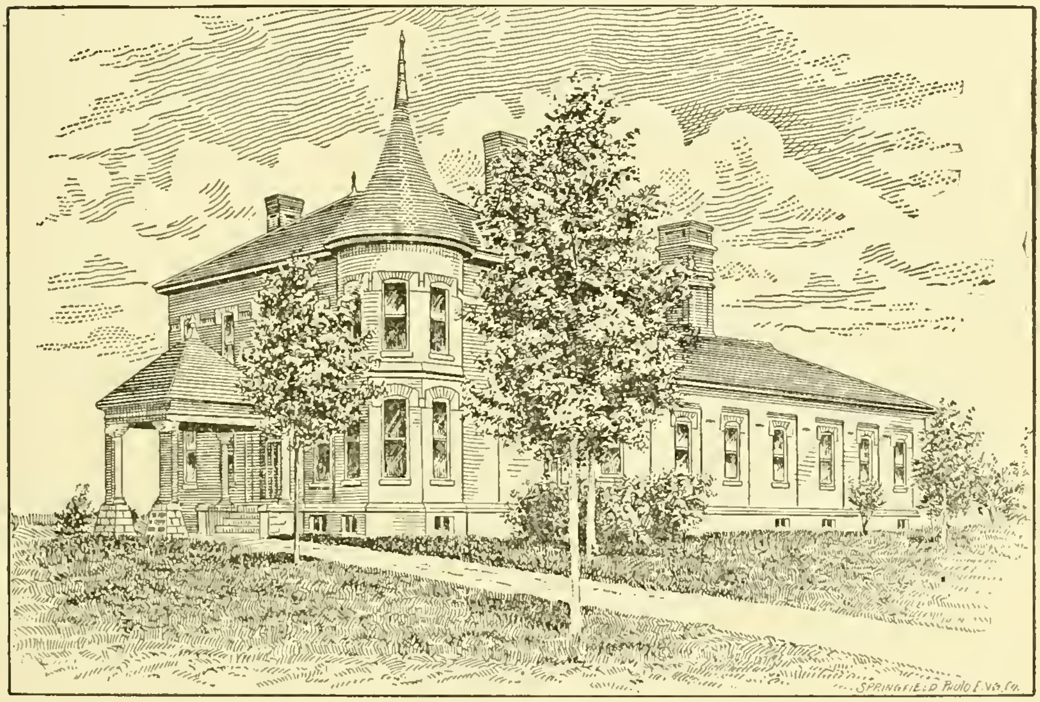
HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 64.

CONCENTRATED FEED STUFFS.



CHEMICAL LABORATORY.

FEBRUARY, 1900.

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,
1900.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann B. Sc.,	*Assistant Chemist* (Fertilizers).
Samuel W. Wiley, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, M. Sc.,	*First Chemist* (Foods and Feeding).
Frederick W. Mossman, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Philip H. Smith, B. Sc.,	*Assistant in Foods and Feeding.*
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Herbert D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
Henry T. Fernald,	*Associate Entomologist.*
Arthur C. Monahan,	*Observer.*

The co-operation 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 FOODS AND FEEDING.

Joseph B. Lindsey.*

RESULTS AND SUGGESTIONS.

1. The cottonseed meals shipped into Massachusetts the past year were practically free from adulteration, yet the guaranteed meals averaged one per cent higher in protein showing the advisability of buying only branded goods. The guaranty in all cases should be supported by the name of the manufacturer or wholesaler.

Last spring several samples of dark colored meal were taken by our inspectors and a number of others were sent in for examination which upon analysis gave a high percentage of protein proving that color alone is not a safe guide.

2. Cleveland flax meal, old process and new process linseed meals, gluten meals, and gluten feeds are of fair average composition with the exception of the old process linseed meals which are low in many cases.

3. Of the wheat feeds, the middlings show quite a wide variation in percentage of protein as a result of different methods of manufacture; the mixed feeds with few exceptions are of fair quality; and the brans are of a high and very uniform grade.

4. The oat feeds show the most serious adulteration of any feeds on the market. Many of them fall below seven per cent in protein with an average of 45 per cent of coarse material.

5. Protein Standards† of unadulterated Feed Stuffs are as follows:

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*Assisted by E. B. Holland, B. K. Jones, and F. W. Mossman.

†By "protein standard" is meant the per cent of protein an unadulterated feed should contain.

	FEED STUFF.	PROTEIN STANDARD.
	Cottonseed meal,	43 per cent.
	Cleveland flax meal,	38 "
	O. P. linseed meal,	36 "
	Gluten meal,†	34 "
	Gluten feed,	25 "
Protein Feeds.	*Wheat middlings,*	18-20 "
	Mixed feed,	17 "
	Wheat bran,	16 "
	Malt sprouts,	25 "
	Dried brewers' grains,	22 "
	H. O. dairy feed,	18 "
	Corn meal,	9 "
	Hominy meal,	10-11 "
	Oat feed,	9-10 "
Starchy (carbohydrate) *Feeds.*	*Quaker dairy feed,*	13 "
	Corn and oat feed,	9 "
	Corn, oat, and barley feed,	11-12 "
	H. O. horse feed,	12 "
	American poultry feed,	13 "
Poultry Feeds.	*H. O. poultry feed,*	17 "
	Meat and bone meal,	40 "

†King gluten meal from the Demoines factory generally contains 33 per cent of protein and 15 per cent of fat, but that marked Buffalo, N. Y., shows much less fat.

CONCENTRATED FEED STUFFS.

A. Classification.
B. Guaranteed Feed Stuffs.
C. Results of Inspection.
D. Cheapest Feeds at Fall Prices.
E. Grain Mixtures.
F. Key to Comparative Commercial Values.

This Bulletin is issued in accordance with Chapter 117 of the Acts and Resolves of Massachusetts for 1897. The law will be found in Bulletin 53 issued by the Station in April, 1898.

A. CLASSIFICATION OF CONCENTRATED FEEDS.

The term "concentrated feed," taken in its broadest sense, is meant to include the grains and other seeds of agricultural plants, as well as their manifold by-products left behind in the process of oil extraction and in the preparation of human foods. As here used it is applied more particularly to the various by-products.

The following classification is made on the basis of the amount of *protein* contained in the several feed stuffs, those in class I. showing the largest amount, and those in Class IV. the smallest quantity.

Division I. Protein Feeds.			Division II. Starchy (Carbohydrate) Feeds.
Class I. 30 *to* 45% *protein.* 50 to 60% carbohyd's.* 75 to 90% digestible.	Class II. 20 *to* 30% *protein.* 60 to 70% carbohyd's.* 80 to 85% digestible.	Class III. 14 *to* 20% *protein.* 70 to 75% carbohyd's.* 60 to 75% digestible.	Class IV. 8 *to* 14% *protein.* 75 to 85% carbohyd's.* 75 to 90% digestible.
Cottonseed meal. Cleveland flax meal. N. P. and O. P. linseed meals. Chicago, Cream, and King gluten meals.	Buffalo, Davenport, Golden, Marshalltown, Rockford Diamond, and other standard gluten feeds. Atlas meal, dried brewers' grains, and malt sprouts.	Wheat middlings, mixed feed, and wheat bran. H. O. dairy feed.	Wheat, rye, barley, oat, corn, and hominy meals. Oat, corn and oat, and corn, oat, and barley feeds. Quaker dairy and H. O. horse feeds.

*Including fat reduced to carbohydrates.

B. GUARANTEED FEED STUFFS.

Although the law does not require that concentrated feed-stuffs be accompanied with a guaranteed analysis, it would most assuredly be a source of satisfaction to the consumer, and greatly to the interest of all reliable manufacturers, if the package containing the article be marked with the name under which the feed stuff is known in the trade, the net weight of the package, the name and address of the manufacturer, and the percentage of protein and fat it contains. *Feed stuffs thus marked and guaranteed, ought to be given the preference by all intelligent purchasers.*

The following firms now guarantee their products:

American Cotton Oil Co.,	Cottonseed meal.
Burditt Bros.,	" "
Butler, Breed & Co.,	" "
Chapin & Co.,	" "
W. H. Haley & Co.,	" "
Hollister, Crane & Co.,	" "
Humphreys, Goodwin & Co.,	" "
Hunter Bros.,	" "
J. E. Soper & Co.,	" "
Southern Cotton Oil Co.,	" "
E. B. Williams & Co.,	" "
American Linseed Co.,	Cleveland flax meal.
Glucose Sugar Refining Co.,	Chicago gluten meal.
" " " "	Buffalo gluten feed.
" " " "	Davenport gluten feed.
" " " "	Golden gluten feed.
" " " "	Marshalltown gluten feed.
" " " "	Rockford Diamond gluten feed.
Charles Pope Glucose Co.,	Cream gluten meal.
H. O. Co.,	H. O. dairy feed.
H. O. Co.,	H. O. horse feed.
H. O. Co.,	H. O. poultry feed.
Smith & Romaines,	Boiled beef and bone.

C. RESULTS OF INSPECTION.

I. Protein Feeds.

Cottonseed Meal.

Manufactured by:	Sampled at:	*Guaranteed.* Protein. %	Fat. %	Moisture. %	*Found.* Protein. %	Fat. %
American Cotton Oil Co.,	Amherst.	—	—			
" " " "	Greenfield,	43.	9	5.66	44.56	9.75
" " " "	Springfield,	43.	9			
" " " "	Baldwinsville,	41.50	9			
" " " "	Fall River,	41.50	9			
" " " "	Greenfield,	41.50	9	7.39	44.00	9.20
" " " "	Haverhill,	41.50	9			
" " " "	Methuen,	41.50	9			
" " " "	Worcester,	41.50	9			
Burditt Bros.,	Gardner,	42-48	10-14	6.64	44.69	10.13
Butler, Breed & Co.,	Concord,	—	—			
" " " "	Haverhill,	—	—	6.70	43.28	10.55
" " " "	Lawrence,	43.	9			
Frank E. Chandler,	Lynn,	—	—	6.17	45.81	10.18
Chapin & Co.,	Concord,	—	—			
" " "	N. Adams,	43.	9	6.77	44.10	9.98
" " "	N. Adams,	—	—			
" " "	Springfield,	43.	9			
" " "	Ware,	43.	9	6.69	45.00	9.00
J. Cushing & Co.,	Southboro,	—	—	7.10	42.13	11.15
W. H. Haley & Co.,	N. Adams,	43.	9-10	7.18	43.82	10.84
Hollister, Crane & Co.,	N. Amherst,	43.	9-10	8.33	42.41	9.38
Humphreys, Goodwin & Co.,	Huntington,	43-48	10-14	6.94	44.97	12.11
" " " "*	Worcester,	43-48	10-14			
" " " "	Amherst,	43-48	9-11			
" " " "*	Huntington,	43-48	10-14			
" " " "*	Leominster,	43-48	9-11	7.25	45.03	11.11
" " " "*	Northampt'n,	43-48	9-11			
" " " "*	Waltham,	43-48	9-11			
" " " "	Westfield,	43-48	9-11			
Hunter Bros.,	Attleboro,	43.	7			
" "	Hudson,	—	—	7.58**	28.88**	8.67**
" "	Millbury,	43.	7			
" "	New Bedford,	—	—			
J. E. Soper & Co.,	Ayer,	43.	9			
" " " "	Fall River,	43.	9			
" " " "	Holyoke,	43.	9			
" " " "	Holyoke,	43.	9	6.28	45.28	11.26
" " " "	Holyoke,	43.	9			
" " " "	Pittsfield,	43.	9			
" " " "	Springfield,	43.	9			
" " " "	Springfield,	43.	9			

*Dixie brand.

**Not included in the average.

Cottonseed Meal (continued).

Manufactured by:	Sampled at:	Guaranteed. Protein. %	Fat. %	Found. Moisture. %	Protein. %	Fat. %
J. E. Soper & Co.,	Middleboro,	43.	9	6.91	44.38	14.00
" " " "	Springfield,	43.	9			
Southern Cotton Oil Co.,	N. Amherst,	43.	9	7.06	44.71	9.98
" " " "	Shelbur'e Falls,	43.	9	5.78	45.85	9.79
" " " "	Southbridge,	43.	9	7.88	44.56	10.34
E. B. Williams & Co.,†	Springfield,	43-48	9-14	5.81	44.59	11.75
" " " "	N. Wilbraham,	—	—	6.89	44.41	11.34
" " " "†	S. Deerfield,	43-48	9-14			
F. L. Worthy & Co.,	Westfield,	—	—	7.06	45.38	9.96
Owl brand,	Northampton,	43.	9	6.09	45.34	10.35
" "	N. Wilbraham,	43.	9			
Unknown,	Rockland,	42-48	8-14	6.74	43.10	11.64
"	Wakefield,	42-48	10-14	6.00	40.82	11.58
Highest,				**8.33**	**45.85**	**14.00**
Lowest,				**5.66**	**28.88**	**8.67**
Average,				**6.75**	**44.46**	**10.67**

All the cottonseed meals from known sources, with one exception, are free from adulteration.

Without name or guaranty.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Unknown,	Amherst,	—	44.23	—
"	Ayer,	7.80	44.34	9.87
"	Fitchburg,	6.65	41.42	13.54
"	Gt. Barrington,	7.07	43.00	10.84
"	N. Adams,	6.72	43.11	10.67
"	Waltham,	6.28	47.63	10.98
"	Weir,	7.35	39.84	10.37
"	Beverly,	6.37	41.31	8.61
"	Brockton,	6.46	44.19	12.42
"	Danvers,	8.02*	30.19*	9.55*
"	Fitchburg,	5.88	45.19	11.08
"	Salem,	6.69	44.13	13.48
"	S. Framingham,	6.16	44.94	11.39
"	Taunton,	5.98	39.63	10.74
"	Weymouth,	7.55	45.03	10.55
Highest,		**8.02**	**47.63**	**13.54**
Lowest,		**5.88**	**30.19**	**8.61**
Average,		**6.69**	**43.43**	**11.12**

Of the above meals several are inferior and one shows adulteration.

†Daisy brand.

*Not included in the average.

Cleveland Flax Meal.

Guaranty: **Protein 38 to 40 per cent.**

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
American Linseed Co.,	Salem,	9.21	39.06	2.52
" " "	Athol, New Bedford, Salem, Springfield,	9.52	39.31	2.58

Cleveland flax meal shows a high uniform composition and is the only guaranteed linseed product.

Old Process Linseed Meal.

Guaranty: None.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Douglas & Co., " " " " " "	Fitchburg, N. Adams, Springfield,	7.43	30.28	7.67
Hauenstein & Co.,	Salem,	7.45	34.88	8.24
Hunter Bros.,	Northampton,	7.74	35.31	8.48
Kellogg & Miller,	Greenfield,	7.71	35.44	8.76
" " "	Pittsfield,	8.19	34.81	8.36
National Linseed Oil Co., " " " "	Amherst, Worcester,	8.40	30.94	8.38
Average,		**7.80**	**32.57**	**8.18**

Without name or guaranty.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Unknown,	Lexington,	8.53	32.38	7.43
"	Salem,	9.17	36.00	6.13
"	Amherst,	8.90	32.13	6.87
"	Concord,	8.40	32.38	5.93
"	E. Brookfield,	8.51	35.19	8.64
"	Lexington,	7.70	32.66	5.98
"	Methuen,	8.36	29.85	7.67
"	Webster,	9.42	39.31	4.65
"	Worcester,	7.46	32.00	6.73
"	Springfield,	8.34	38.19	3.01*
"	Huntington,	8.13	39.78	1.96*
"	Middleboro,	8.66	39.56	2.09*
"	New Bedford,	7.89	36.53	2.86*
Average,		**8.42**	**35.07**	**5.38**

Many of the old process meals are decidedly inferior.

*New process meal.

Other Linseed Products.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Flaxseed meal,	Kellogg & Miller,	Pittsfield,	7.77	30.75	21.80
Sucrene oil meal,	Internat'l Milling Co.,	Northampton,	9.57	27.07	2.95
" " "	" " "	N. Wilbraham,			
" " "	" " "	Marlboro,	9.47	25.47	3.03
" " "	" " "	Natick,			

Chicago Gluten Meal.

Guaranty: Protein 36.00 per cent. Fat 3.37 per cent.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Glucose Sugar Ref. Co.,	Athol,	9.52	36.50	1.84
" " " "	Fall River,			
" " " "	Greenfield,*			
" " " "	Lawrence,			
" " " "	New Bedford,†			
" " " "	Pittsfield,			
" " " "	Southboro,			
" " " "	Weir,			
" " " "	Westfield,			
" " " "	Worcester,			
" " " "	Athol,	9.70	33.72	2.90
" " " "	Brockton,			
" " " "	Holyoke,			
" " " "	Ipswich,			
" " " "	Lowell,			
" " " "	Palmer,			
" " " "	Pittsfield.			
" " " "	Shelburne Falls,			
" " " "	Southboro,			
" " " "	Taunton,			
" " " "	Worcester.			

*Guaranty: Protein 37.50 per cent. Fat 9.00 per cent.
†Guaranty: None.

Cream Gluten Meal.

Guaranty: Protein 37.12 per cent. Fat 3.20 per cent.

Manufactured by	Sampled at:	Moisture. %	Protein. %	Fat. %
Chas. Pope Glucose Co.,	Athol,			
" " " "	Attleboro,			
" " " "	N. Adams,	8.51	34.38	2.27
" " " "	Pittsfield,			
" " " "	Worcester.			
" " " "	Athol,			
" " " "	Baldwinsville,			
" " " "	Chicopee,			
" " " "	Clinton,			
" " " "	Dalton,*			
" " " "	Danvers,*			
" " " "	Dedham,			
" " " "	Fall River,*			
" " " "	Holyoke,			
" " " "	Ipswich,	9.04	33.10	1.74
" " " "	Methuen,*			
" " " "	Millbury,*			
" " " "	Millbury,*			
" " " "	Natick,*			
" " " "	N. Adams,*			
" " " "	Northbridge,*			
" " " "	N. Wilbraham,*			
" " " "	Worcester,*			

King Gluten Meal.

Guaranty: None.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Nat'l Starch M'f'g Co.,	Lawrence,			
" " " "	N. Adams,	6.42	32.85	7.44
" " " "	N. Wilbraham,			
" " " "	Brockton,			
" " " "	Clinton,			
" " " "	Franklin,			
" " " "	Hudson,	6.51	33.38	6.66
" " " "	Natick,			
" " " "	N. Adams,			

The fall samples, i. e. *the latter composites, of the three brands of gluten meal, show a similar percentage of protein.*

*The manufacturers finding it impractical to maintain the original guaranty in protein have of late dropped it to 34.12 per cent and the various lots sampled in the places starred were so marked.

Buffalo Gluten Feed.

Guaranty: **Protein 25.50 per cent. Fat 4.00 per cent.**

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Glucose Sugar Ref. Co.,	Concord,*			
" " " "	Greenfield,*			
" " " "	Haverhill,			
" " " "	Northampton,			
" " " "	Salem,	8.03	26.10	2.54
" " " "	S. Framingham,*			
" " " "	Springfield,*			
" " " "	Walpole,			
" " " "	Westfield,*			
" " " "	Andover,*			
" " " "	Chicopee Falls,			
" " " "	Concord,*			
" " " "	Danvers,			
" " " "	Haverhill,			
" " " "	Haverhill,			
" " " "	Holyoke,			
" " " "	Huntington,			
" " " "	Lawrence,*	8.38	26.19	3.42
" " " "	Marlboro,*			
" " " "	Natick,			
" " " "	Salem,			
" " " "	S. Framingham,*			
" " " "	Springfield,			
" " " "	Stoughton,			
" " " "	Ware,*			
" " " "	Westfield,			

Davenport Gluten Feed.

Guaranty: **Protein 25.50 per cent. Fat 4.00 per cent.**

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Glucose Sugar Ref. Co.,	Gt. Barrington,*	6.33	23.56	4.02
" " " "	Lawrence,†			
" " " "	Sunderland,	9.02	22.38	2.96
" " " "	Amherst,	7.23	23.28	3.87

*Guaranty: None.
†Guaranty: Protein 25.10 per cent. Fat 3.62 per cent.

Golden Gluten Feed.

Guaranty: Protein 25.50 per cent. Fat 4.00 per cent.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Glucose Sugar Ref. Co.,	Newburyport,			
" " " "	N. Wilbraham,*	8.54	25.06	3.58
" " " "	S. Deerfield,			

Marshalltown Gluten Feed.

Guaranty: Protein 27.00 per cent. Fat 4.00 per cent.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Glucose Sugar Ref. Co.,	Dedham,			
" " " "	Fall River,	8.20	27.19	3.17
" " " "	Newburyport.			

Rockford Diamond Gluten Feed.

Guaranty: Protein 27.00 per cent. Fat 4.00 per cent.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Glucose Sugar Ref. Co.,	Gt. Barrington,			
" " " "	Holyoke,			
" " " "	Holyoke,*			
" " " "	Lawrence,†	7.79	24.44	2.66
" " " "	Pittsfield,			
" " " "	Shelburne Falls,			
" " " "	Amherst,*			
" " " "	Montague,*	8.41	23.97	2.83
" " " "	Pittsfield,			
" " " "	Weymouth,†			

All the foregoing gluten feeds are controlled by the Glucose Sugar Refining Company** which aims to produce like feeds from its various factories.

*Guaranty: none.

†Guaranty: Protein 24.20 per cent. Fat 3.76 per cent.

**A recent letter contains the following: "We are endeavoring to manufacture all brands of Gluten Feed so they will analyze practically the same and in this way overcome the prejudice in the minds of a great many feeders that one brand is superior to the other."

Other Gluten Feeds.

Guaranty: None.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Joliet,	Chapin & Co.,	Gt. Barrington,	8.42	23.72	1.97
	Glen Cove Starch Co.,	Holyoke,	7.71	28.50	3.55
	Hollister, Crane & Co.,	Amherst,	7.76	24.69	2.74
	" " " "	Southboro,			
Illinois,	M. G. Rankin Co.,	N. Wilbraham,	7.46	22.88	3.50
Milwaukee,	Simpson Hendee & Co.,	Shelburne Falls,	9.60	24.60	2.23
	Unknown,	Greenfield,	7.81	22.38	2.75

Wheat Middlings.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Dexter,	Chapin & Co.,	Lexington,	9.42	18.28	5.31
"	" " "	Athol,	9.71	18.53	5.08
	Cleveland Milling Co.,	Gardner,	10.00	17.00	5.22
	C. H. Cressey & Co.,	New Bedford,	9.93	18.88	5.51
Daisy,	Daisy Roller Mill Co.,	Athol,	9.39	18.19	5.00
"	" " " "	N. Adams,			
Daisy flour,	" " " "	B'ldwinsville,	9.31	18.53	5.30
" "	" " " "	Dalton,			
" "	" " " "	Gt. Barringt'n,			
" "	" " " "	N. Wilbrah'm,			
Superior flour,	" " " "*	Fitchburg,	7.09	17.07	4.67
" "	" " " "*	S. Framing'm,			
Daisy,	A. M. Fish,	Pittsfield,	8.19	17.19	5.47
White,	Freeman Milling Co.,	Amherst,	9.57	17.07	5.09
Pig,	" " "	S. Deerfield,			
	Harris Milling Co.,	Chicopee,	9.27	15.94	3.73
	Hollister, Crane & Co.,	Gt. Barrington,	9.08	17.60	4.44
	Hunter Bros.,	Amherst,	9.57	18.50	3.87
	" "	Worcester,			
	" "	Worcester,	11.13†	13.47†	0.97†
	Kehlor Bros.,	Fitchburg,	9.02	18.47	3.56
Comet XXX,	N.W. Cons. Mil'g Co.,	Fall River,	9.12	20.06	5.27
Comet,	" " " "	Fitchburg,			
"	" " " "	Newburyport,			
"	" " " "	Worcester,			
Flour,	" " " "	N. Adams,	9.83	18.88	5.27
Comet XXX,	" " " "	Worcester,	10.00	20.69	5.88

*Lake Superior Mills, Superior, Wis.

†Not included in the average.

Wheat Middlings (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
	N.W.Cons.Mil'g Co.,	Gardner,			
	" " " "	N. Adams,			
A,	" " " "	Weir,	9.01	17.22	5.45
D,	" " " "	Weir,			
	" " " "	Andover,			
	" " " "	Beverly,			
	" " " "	Holyoke,			
	" " " "	Millbury,			
	" " " "	New Bedford,	9.55	16.78	5.29
	" " " "	N. Adams,			
	" " " "	Palmer,			
	" " " "	Winchendon,			
Red dog flour,	C. A. Pillsbury,	Fitchburg,	10.01	17.19	4.25
A,	" "	Athol,	9.30	18.25	5.04
"	" "	Holyoke,			
	" "	New Bedford,			
B,	" "	Pittsfield,	9.28	17.16	5.23
"	" "	Springfield,			
	" "	Weir,			
Daisy XX,	" "	Franklin,	11.57	18.88	5.25
	" "	Athol,	10.05	18.31	5.59
	" "	Franklin,	9.42	15.91	5.28
B,	" "	Brockton,			
"	" "	E.Braintree,			
"	" "	Fitchburg,	10.18	16.88	5.59
"	" "	N. Adams,			
"	" "	Pittsfield,			
"	" "	Southbridge,			
Standard,	Sheffield Milling Co.,	Holyoke,	8.82	18.56	4.90
	" " "	Lawrence,			
Flour,	" " "	Greenfield,	9.77	18.69	6.31
Northland,	Simpson,Hendee&Co.,	Springfield,	8.89	18.72	5.01
"	" " "	Springfield,			
	Stratton & Co.,	Newburyport,	10.28	15.81	4.80
Climax,	D. Stotts Flour'g Mills,	Rockland,	10.53	17.38	4.97
Fine,	" " " "	Woburn,	10.89	14.16	2.97
White,	Valley City MillingCo.,	Newburyport,	8.91	16.50	5.03
Choice winter,	" " " "	Westfield,			
" "	" " " "	Gt.Barrington,	9.25	16.72	4.71
Standard,	Washburn & Crosby,	Lawrence,	9.03	18.47	5.07
"	" " "	Palmer,			
	" " "	N. Adams,	9.23	18.53	4.33
Standard,	" " "	E. Brookfield,	10.58	18.03	4.85
"	" " "	Weymouth,			
Flour,	" " "	Dalton,	11.04	18.06	4.73
"	" " "	Montague,			
Winter,	Williams Bros.,	Rockland,	9.71	17.25	4.74

Wheat Middlings (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Snow's Cream,	E.S.Woodworth Co.,	Huntington,	9.50	18.94	5.79
	F. L. Worthy,	Dalton,	9.33	18.88	5.06
	Unknown,	Fall River,	8.76	16.25	4.18
	"	Fitchburg,	9.27	16.78	5.47
Coarse,	"	Gardner,	8.93	16.78	5.46
	"	Gt.Barrington,	9.22	17.88	4.95
Flour,	"	Greenfield,	10.34	19.38	4.91
	"	Hudson,	9.10	18.10	5.27
Fancy,	"	Lawrence,	9.41	18.44	4.94
White spring,	"	Lawrence,	9.22	17.41	5.92
Globe,	"	Lowell,	8.94	17.88	5.63
	"	Southboro,	8.99	17.07	5.56
	"	Walpole,	10.07	16.78	5.14
Red dog,	"	Westfield,	10.43	18.82	4.89
Spring,	"	Amherst,	10.60	19.35	5.60
Winter,	"	Amherst,	10.61	18.62	5.59
"	"	E. Braintree,	10.27	18.28	6.10
	"	Fall River,	10.84	17.81	4.90
	"	Huntington,	10.16	17.00	3.38
Red dog,	"	Lawrence,	10.51	19.38	4.86
Flour,	"	Lexington,	10.35	16.35	3.76
	"	Lowell,	9.64	19.16	5.96
F. M. Co.,	"	Middleboro,	9.82	18.44	5.48
Spring,	"	Needham,	10.27	17.07	5.27
Red dog flour,	"	New Bedford,	10.00	18.94	5.36
	"	N. Adams,	10.35	17.22	3.36
M,	"	Salem,	9.77	17.22	5.32
	"	Whitman,	11.01	18.31	4.37
	Highest,		**11.57**	**20.69**	**6.10**
	Lowest,		**7.09**	**13.47**	**0.97**
	Average,		**9.60**	**17.77**	**4.98**

There are many grades of middlings some being decidedly superior to others.

Mixed Feed.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Acme,	Acme Milling Co.,	Brockton,	8.44	16.88	4.55
"	" " "	Sh'lb'ne Falls,			
"	" " "	Westfield,			

Mixed Feed (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Acme,	Acme Milling Co.,	Amesbury,	8.62	17.38	4.29
"	" " "	E. Brookfield,			
"	" " "	Gt. Barrington			
"	" " "	Huntington,			
Buckeye wheat,	Am. Cereal Co.,	Fall River,	8.45	16.19	4.66
" "	" " "	Haverhill,			
" "	" " "	Sh'lb'ne Falls,			
" "	" " "	Worcester,			
" "	" " "	Andover,	9.27	16.13	4.99
" "	" " "	Brockton,			
" "	" " "	Methuen,			
" "	" " "	Montague,			
" "	" " "	Ware,			
" "	" " "	Webster,			
" "	" " "	Westfield,			
" "	" " "	Worcester,			
Anchor,	Anchor Mills Co.,	Concord,	8.48	16.94	5.50
"	" " "	Fitchburg,			
"	" " "	Lowell,			
"	" " "	Weir,			
"	" " "	Danvers,	9.81	16.13	5.45
"	" " "	Haverhill,			
"	" " "	Millbury,			
"	" " "	Palmer,			
"	" " "	Southboro,			
"	" " "	Ware,			
Fancy winter,	E. W. Bally & Co.,	Amherst,	8.61	15.81	4.66
Bay State,	BayStateMill'gCo.,	Greenfield,	9.14	17.07	5.60
	Blish Milling Co.,	Lowell,	9.03	16.78	4.70
	" " "	Newburyport,			
	" " "	Pittsfield,			
	" " "	S. Deerfield,			
Blish,	" " "	Athol,	8.53	17.07	4.67
	" " "	Haverhill,			
Blish,	" " "	Lexington,			
Jersey,	BrooksGriffith&Co.	Amesbury,	8.93	16.44	5.19
"	" " " "	Athol,			
"	" " " "	Hudson,			
"	" " " "	Needham,			
"	" " " "	Palmer,			
"	" " " "	Walpole,			
Sterling,	Chapin & Co.,	Fall River,	8.94	17.81	4.38
"	" " "	Gt. Barringt'n,			
"	" " "	Weir,			
	" " "	Franklin,	9.41	16.69	4.43
Sterling,	" " "	Worcester,	7.81	17.00	4.61
	C. M. Cox & Co.,	Lawrence,	9.39	14.88	4.97
	Cummings & Chute.	Woburn,	9.19	15.63	4.56

Mixed Feed (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Superior,	Dai'y R'l'r Mill Co.,*	Fitchburg,			
“	“ “ “ “*	Huntington,			
“	“ “ “ “*	Lexington,			
“	“ “ “ “*	N. Wilbrah'm,	8.37	16.73	4.94
“	“ “ “ “*	Southboro,			
“	“ “ “ “*	Worcester,			
“	“ “ “ “*	Clinton,			
“	“ “ “ “*	Dedham,			
“	“ “ “ “*	E. Brookfield,			
“	“ “ “ “*	Easthampton,			
“	“ “ “ “*	Lowell,			
“	“ “ “ “*	Marlboro,	8.05	16.35	5.07
“	“ “ “ “*	Montague,			
“	“ “ “ “*	N. Wilbrah'm,			
“	“ “ “ “*	Southboro,			
“	“ “ “ “*	S. Framing'm,			
Boston,	Duluth Imper'l Mill,	Ayer,			
“	“ “ “	Gt. Barringt'n,	10.10	16.38	4.31
“	“ “ “	Millbury,			
“	“ “ “	Amesbury,			
“	“ “ “	Dedham,			
“	“ “ “	Leominster,			
“	“ “ “	Lynn,	8.87	16.35	4.91
“	“ “ “	Millbury,			
“	“ “ “	Northampton,			
“	“ “ “	Whitman,			
Hosier,	Geo. T. Evans,	Westfield,	8.46	16.69	4.27
New England,	Freeman Mill'g Co.,	Millbury,	9.45	15.88	5.39
Harter's,	Isaac Harter Co.,	Concord,	8.73	16.28	4.64
“	“ “ “	Worcester,			
Superior,	Abner Hendy & Co.,	Westfield,	8.46	16.81	4.48
Holly,	Holly Milling Co.,	Fitchburg,	7.34	15.88	4.11
	Hunter Bros.,	Walpole,	9.49	17.25	4.23
Sunshine,	“ “	Fall River,	8.62	17.41	4.21
“	“ “	Ware,			
Kehlor Bros.,	Kehlor Bros.,	Lowell,	8.59	18.06	4.57
Snowflake,	Lawrenceburg Roller Mill Co.,	Attleboro,			
“	“ “ “	Fall River,	7.70	16.69	4.46
“	“ “ “	Lowell,			
“	“ “ “	Weir,			
“	“ “ “	Andover,			
“	“ “ “	Chicopee,			
“	“ “ “	E. Braintree,			
“	“ “ “	Fall River,	8.24	17.13	4.50
“	“ “ “	Lexington,			
“	“ “ “	Millbury,			
“	“ “ “	Taunton,			

*Lake Superior Mills, Superior, Wis.

Mixed Feed (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Lexington,	Lex'n Roll'r Mills,	Worcester,	8.73	14 96	4.55
"	" " "	Lowell.			
"	" " "	Shelb'neFalls,	8.15	15.81	4.90
Hiawatha,	W.List'nMill'g Co.,	Athol,			
"	" " "	Ayer,			
"	" " "	Concord,			
"	" " "	Holyoke,	8.38	16.56	5.13
"	" " "	N Adams,			
"	" " "	S.Fram'gham,			
"	" " "	Holyoke,			
"	" " "	Millbury,			
"	" " "	N.Wilbrah'm,	8.49	16.56	5.44
"	" " "	Orange,			
"	" " "	S. Deerfield,			
	MillstadtMill'gCo.,	Fitchburg,	8.25	15.88	4.38
Minkota,	Minkota Mill'gCo.,	Athol,	8.07	15.75	4.93
"	" " "	Lynn,	8.39	15.88	5.50
	R.P.Moore Mill'g,	Amesbury,	8.64	17.07	4.33
Apex winter,	Noyes & Crosby,	Rockland,	9.01	16.63	4.31
	C. A. Pillsbury,	Southbridge,	9.33	16.97	4.32
Rex,	Rex Mills Co.,	Fitchburg,			
	" " "	Lawrence,	8.19	17.44	4.68
	" " "	Newburyport,			
Sunshine,	S. B. & Co.,	Fitchburg,	8.84	15.50	4.29
	Si'psonHendeeCo.,	Gt.Barrington,	7.91†	11.13†	3.05†
Angola,	" " "	Palmer,	8.67	16.63	4.99
"	" " "	S. Deerfield,	8.58	16.97	5.21
Quincy,	Taylor Bros.,	Amherst,			
"	" "	Brockton,	8.59	17.25	4.05
"	" "	Fitchburg,			
Farmer's Favorite winter wheat cow,	Valley City Milling Co.,	Pittsfield,	8.62	16.81	4.56
" " "	" "	Gt.Barrington,			
" " "	" "	Leominster,			
" " "	" "	Natick,	9.30	16.06	4.33
" " "	" "	Newburyport,			
Winter,	VictoriaFlo'rMills.	Fall River,	8.42	17.44	4.60
	" " "	Waltham,			
Superior,	Wash'n-CrosbyCo.,	Millbury.	8.26	17.60	4.26
K,	Unknown,	Lowell,	8.38	17.41	5.12
K. Y.,	"	N. Adams,	7.31†	11.13†	2.78†
Kentucky Cow,	"	Fall River,	8.17	15.50	5.71
Kentucky,	"	Lawrence,	7.92	16.69	4.92
"	"	Lowell,			
Michigan,	"	Lawrence,	8.95	16.25	4.56

†Not included in the average.

Mixed Feed (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Russell's,	Unknown,	Greenfield,	8.24	16.63	5.31
"	"	N. Adams,			
Superior,	"	Westfield,	8.21	17.60	4.68
	"	Athol,	9.02	18.00	4.29
	"	Athol,	10.08†	11.97†	3.06†
	"	Fitchburg,	9.09	17.60	4.23
	"	Gt. Barrington,	9.02	17.19	4.47
	"	Gt. Barrington,	8.90	17.44	4.46
	"	N. Adams,	8.99	17.19	4.63
	"	Adams,	8.32	16.35	5.03
	"	Athol,	6.88	13.10	3.62
	"	Huntington,	8.11	17.13	4.89
	"	Stoughton,	8.21	16.81	4.51
	Highest,		10.10	18.00	5.60
	Lowest,		7.31	11.13	2.78
	Average,		8.67	16.62	4.77

Adulterated and poor quality mixed feeds are now and then noticeable.

Wheat Bran, Shorts.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Winter shorts,	Aurora Milling Co.,	New Bedford,	7.41	15.63	4.27
	Bay State Mill'g Co.,	Athol,	8.69	16.69	5.19
Choice,	" " " "	Huntington,			
	" " " "	Montague,			
	" " " "	Southboro,			
	Clevela'd Mill'g Co.,	Gardner,	7.96	15.06	5.10
	H. C. Cole Mil'g Co.,	Needham,	9.15	17.13	4.86
	" " " "	S. Framing'm,			
Clean,	J. C. Davis & Co.,	Pittsfield,	10.01	15.50	5.49
	Duluth Impe'l Mill,	Gt. Barrington,	9.55	16.69	4.43
Duluth Imp,	" " "	Natick,	8.55	15.32	5.18
Cow,	Freeman Mill'g Co.,	Needham,	9.64	15.25	5.52
	Harris Milling Co.,	Chicopee,	9.24	16.06	4.45
Shorts,	Hart Milling Co.,	Salem,	8.86	16.06	4.39
Winter,	Harv't Queen Mill'g.	Lowell,	8.41	15.88	4.28
	Isaac Harter Co.,	Wakefield,	8.61	15.06	3.98
	" " "	Woburn,			
Winter,	Hunter Bros.,	N. Adams,	9.02	17.81	4.59

†Not included in the average.

Wheat Bran, Shorts (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Winter,	Kehlor Bros.,	Attleboro,			
	" "	Fall River,			
Winter,	" "	N. Adams,	9.06	16.81	4.98
	" "	N. Adams,			
	" "	Worcester,			
Spring,	" "	Northampton,			
	" "	Webster,	8.22	16.94	4.49
	" "	Worcester,			
	J. H. Knowles,	Weir,	9.22	15.06	4.91
	Listman Mill Co.,	Hudson,	9.02	15.47	4.95
	Minn'ap'sFl'rM'f'g,	Lowell,	9.05	14.25	5.14
Shorts,	" " "	Lowell,	8.73	15.81	5.45
Coarse spring,	New UlmRoll'rMill,	Lynn,	8.11	15.50	5.06
Coarse,	" " " "	Taunton,			
	N.W.Cons.M'gCo.,	Gardner,	9.38	15.44	4.82
	" " " "	Andover,	6.41	15.38	5.02
A,	" " " "	Taunton,			
	C. A. Pillsbury,	Fall River,	9.67	15.32	4.81
	" "	N. Adams,			
	" "	Athol,			
	" "	Brockton,			
	" "	Greenfield,	7.70	15.06	4.90
Pillsbury's spring,	" "	Methuen,			
Spring,	" "	Southboro,			
"	S. C. M. Co.,	Athol,	7.81	16.69	5.18
Stotts,	D.StottsFl'gMills,	E.Brookfield,	10.04	14.56	3.83
Mich. winter,	Valley City Mill'g,	Gt. Barrington,	8.11	16.28	4.45
Winter,	VictoriaFlo'rMills,	Montague,	9.23	16.53	4.45
Choice,	Voigt Milling Co.,	Southbridge,	10.34	15.22	4.21
Coarse,	Washburn-Crosby,	Athol,	9.28	15.81	4.61
	" "	New Bedford,			
Coarse,	" "	Amherst,			
"	" "	E.Brookfield,			
"	" "	Leominster,	9.63	15.19	4.55
"	" "	Northampton,			
"	" "	Westfield,			
Winter,	F. L. Worthy,	Palmer,	9.18	15.81	4.61
Spring,	" "	Dalton,	9.56	14.50	5.07
Globe,	Unknown,	Lowell,	8.83	16.31	6.09
Spring,	"	N. Adams,	9.04	13.91	4.80
"	"	Easthampton,	7.99	15.41	5.25
"	"	Montague,	7.38	15.13	5.01
"	"	Needham,	8.33	15.63	5.03
"	"	New Bedford,	7.47	17.13	4.51
"	"	Taunton,	9.57	14.97	5.17

Wheat Bran, Shorts (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
A. Spring,	Unknown,	Salem,	7.43	15.81	5.40
Winter,	"	Danvers,	8.93	17.16	4.39
"	"	E. Braintree,	9.64	17.44	4.81
"	"	Fall River,	7.94	19.75	4.22
"	"	Ipswich,	7.05	17.66	4.57
"	"	Northampton,	9.13	17.25	4.33
"	"	Salem,	9.03	17.00	4.55
"	"	Stoughton,	8.46	15.00	5.11
"	"	Taunton,	8.45	16.78	4.42
J,	"	Fitchburg,	8.60	18.10	4.23
Coarse winter shorts,	"	Methuen,	8.41	13.91	4.39
	"	Salem,	8.66	15.44	4.80
	Highest,		**10.34**	**18.10**	**5.52**
	Lowest,		**6.41**	**13.91**	**3.98**
	Average,		**8.70**	**16.00**	**4.72**

The brans show a fairly even composition and good quality.

H. O. Dairy Feed.

Guaranty: **Protein 18.00 per cent. Fat 4.50 per cent.**

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
H. O. Company,	Brockton,	7.95	16.81	3.64
" "	Brockton, Springfield, Taunton, Wakefield.	6.39	17.63	3.85

Miscellaneous Feeds.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Brewers' grains,	Unknown,	Taunton,	7.24	22.56	6.12
Malt sprouts,	"	Concord,	4.76	28.28	1.24
" "	"	Concord,	9.89	26.53	1.16
Sucre'e Dai'y feed,	Brooke & Pennock,	Southboro,	7.79	18.69	2.97
Blatchf'scalf meal,	J. W. Barwell.	Leominster,	6.61	23.97	4.50

The malt sprouts and brewers' grains are of average quality.

II. Starchy (Carbohydrate) Feeds.

Corn Meal.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
J. B. Bridges & Co.,	S. Deerfield,	11.05	9.78	3.75
Cutler Co.,	N. Wilbraham,	10.81	9.31	3.61
J. W. Doon & Son,	Natick,	9.86	9.35	4.07
J. H. Nye,	Brockton,	9.83	9.50	4.53
E. C. Packard,	Brockton.	11.18	9.25	4.16
W. H. Smith,	Northampton,	9.20	9.78	4.05
F. L. Worthy,	Pittsfield,	13.88*	9.16*	1.61*
Average,		**10.32**	**9.50**	**4.03**

Average meals with one exception.

Hominy Meal.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
C. M. Cox & Co.,	Danvers,	8.53	9.63	5.93
Illinois Cereal Co.,	Walpole,	7.89	10.91	6.93
Unknown,	Concord,	8.02	10.50	9.06
"	Holyoke,	5.27	11.78	8.74
"	Shelburne Falls,†	6.03	11.50	9.33
"	Fall River,	6.63	11.13	8.21
"	Lawrence,	7.71	10.75	6.67
"	Lynn,	7.67	10.57	6.68
"	Needham,	7.27	11.10	8.09
Average,		**7.22**	**10.87**	**7.74**

Oat Feed.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
	Akron Cereal Co.,	Taunton,	5.58	4.81	1.63
Quaker,	Americ'n Cereal Co.,	Gt. Barringt'n,	6.35	10.81	3.71
"	" " "	Holyoke,			
"	" " "	Lawrence,			
"	" " "	New Bedford,			
"	" " "	Pittsfield,			
"	" " "	Springfield,			
"	" " "	Weir,			
"	" " "	Worcester,			

*Not included in the average.
†Shelbarker's brand.

Oat Feed (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Quaker,	Americ'nCerealCo.,	Chicopee Falls,	6.21	12.07	3.08
"	" " "	Gt. Barringt'n,			
"	" " "	Marlboro,			
"	" " "	Westfield,			
Vim,	" " "	Concord,	5.63	5.25	2.16
"	" " "	Haverhill,			
"	" " "	Lawrence,			
"	" " "	Worcester,			
"	" " "	Athol,	5.96	4.78	1.91
"	" " "	Concord,			
	C. M. Cox & Co.,	Woburn,	7.01	7.00	3.05
Standard grade,	M. L. Crittendon,	Gardner,	6.32	7.75	2.36
	Cutler Co.,	Webster,	5.96	6.44	2.10
Brextel,	R.H.Hardy &Sons,	Fitchburg,	6.29	9.50	3.41
	Hollis'rCrane&Co.,	Holyoke,	6.00	2.88	1.49
Oatena,	Illinois Cereal Co.,	Holyoke,	6.88	6.78	2.38
"	" " "	Fitchburg,	7.92	5.91	1.97
"	Unknown,	Waltham,	5.53	6.25	2.30
Friendsdairyfood	Muscat'e Oatmeal,	Wakefield,	4.92	7.56	2.75
" " "	" " "	Woburn,			
Puritan,	Rivers'eRol'dOats,	Newburyport,	6.27	13.72	5.99
Lincolnshire,	Unknown,	Southboro,	6.29	6.50	2.66
Lincolnsh'e fancy,	"	Rockland,	6.66	6.53	2.35
Pure,	"	Lexington,	6.08	5.91	2.58
X,	"	Haverhill,	5.85	4.59	1.77
	"	Ayer,	7.04	6.87	2.48
	"	Concord,	4.87	2.65	1.19
	"	Greenfield,	6.15	6.94	3.28
	"	Hudson,	7.39	9.50	4.10
	"	Lowell,	6.23	7.50	2.62
	"	Lexington,	6.03	7.60	3.44
	"	Woburn,	5.81	13.31	6.53
Middlings,	"	Wakefield,	6.15	13.28	6.19
	Highest,		**7.92**	**13.72**	**6.53**
	Lowest,		**4.92**	**2.75**	**1.19**
	Average,		**6.15**	**8.16**	**3.00**

The oat feeds show a wide variation in protein and a large proportion of them are of inferior character. The range in coarse material, principally hulls, is from 29 to 56 per cent.

Quaker Dairy Feed.

Manufactured by :	Sampled at :	Moisture. %	Protein. %	Fat. %
American Cereal Co.,	Baldwinsville,			
" " "	Easthampton,			
" " "	Haverhill,			
" " "	Ipswich,			
" " "	Lowell,			
" " "	Montague,			
" " "	Natick,			
" " "	N. Amherst,	6.14	13.00	3.39
" " "	Taunton,			
" " "	Walpole,			
" " "	Waltham,			
" " "	Webster,			
" " "	Whitman,			
" " "	Worcester,			

Quaker dairy feed, composed chiefly of oats, has succeeded the Quaker oat feed.

Corn and Oat Feed. Provender.

Brand.	Manufactured by:	Sampled at :	Moisture. %	Protein. %	Fat. %
	Akron Cereal Co.,	Taunton,	7.67	9.06	4.59
Victor,	Amer. Cereal Co.,	Gardner,			
"	" " "	Gt. Barringt'n,			
"	" " "	Gt. Barringt'n,	8.43	8.72	3.54
"	" " "	Springfield,			
"	" " "	Weir,			
"	" " "	Baldwinsville,			
"	" " "	Holyoke,			
"	" " "	N. Amherst,			
"	" " "	Orange,			
"	" " "	Pittsfield,	7.20	8.82	3.81
"	" " "	Springfield,			
"	" " "	Springfield,			
"	" " "	Taunton,			
"	" " "	Ware,			
Provender,	City Mills Co.,	Holyoke,	12.85	9.44	3.15
Sterling prov'er,	M. L. Crittendon,	N. Adams,	8.59	9.56	4.35
" "	" "	S.Framingh'm,			
Empire state,	" "	Salem,	7.59	9.16	4.01
999 oat feed,*	" "	Concord,	8.46	12.13	3.27
Provender,	Cutler Co.,	Pittsfield,	9.01	10.63	3.69
Defiance,	H. O. Co.,	Gardner,	7.75	8.82	2.94
"	" "	Huntington,	7.97	7.91	2.48
"	" "	Adams,			
"	" "	Athol,	7.53	8.53	2.76
"	" "	Concord,			

*Corn present.

Corn and Oat Feed. Provender (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Cham'n mill f'd,	Hollister,CraneCo.,	Adams,	6.98	8.63	4.31
Provender,	E. W. Pierce,	Lawrence,	8.29	10.41	4.01
"	Smith Bros.,	Westfield,	10.97	10.06	2.99
"	F. L. Worthy,	Pittsfield,	13.04	8.44	2.36
"	" "	Pittsfield,	12.68	9.16	3.56
Lenox,	Unknown,	Lexington,	8.78	7.66	2.49
"	"	Franklin,	8.92	8.53	2.85
Russell's,	"	S. Deerfield,	9.17	9.53	3.35
S.A.&S.O.prov.,	"	Methuen,	6.30	6.28	2.08
Winds'r grou'doats,*	"	Lowell,	6.92	8.44	2.84
Windsor feed,	"	Lowell,	6.22	8.53	2.37
Oat feed,*	"	N. Adams,	8.36	7.44	2.69
	Highest,		**13.04**	**12.13**	**4.59**
	Lowest,		**6.22**	**6.28**	**2.08**
	Average,		**8.28**	**8.89**	**3.39**

Several corn and oat feeds can be considered low grade but one is of marked inferiority.

Corn, Oat and Barley Feed.

Brand.	Manufactured at:	Sampled at:	Moisture. %	Protein. %	Fat. %
Schumacher's,	AmericanCerealCo.,	Pittsfield,			
"	" " "	Springfield,	8.28	11.25	4.08
"	" " "	Worcester,			
"	" " "	Montague,			
"	" " "	Westfield,	6.24	11.35	4.04
"	" " "	Worcester,			
	" " "	Pittsfield,	8.81	11.78	4.28
Sterling,	M. L. Crittendon,	Beverly,			
"	" "	Lexington,	7.74	9.97	3.24
	" "	N. Adams,			
	F. L. Worthy,	Huntington,	12.79	8.50	1.88
	Average,		**8.03**	**10.73**	**3.66**

One sample is of poor quality.

*Corn present.

H. O. Horse Feed.

Guaranty: Protein 12.00 per cent. Fat 4.50 per cent.

Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
H. O. Co.,	Brockton,*	9.04	11.56	3.47
" "	Athol,			
" "	Brockton,			
" "	Greenfield,			
" "	Lawrence,	7.40	12.41	3.51
" "	Lynn,			
" "	Springfield,			
" "	Taunton,			

Miscellaneous Feeds.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Kaffir corn,	Unknown,	Lawrence,	10.54	11.61	3.00
Corn screenings,	Shovan & Battles,	Orange,	8.67	9.38	2.44
Monarch chopf'd,	Hus'd Mill'g & Elev.,	Hudson,	8.12	7.07	1.74
West'n chop feed,	Unknown,	N. Adams,	7.67	10.32	5.59
Shredded wheat,	Cereal Machine Co.,	Salem,			
" "	" "	" Shelb'ne F'lls,	8.60	12.00	1.23
" "	" "	" Wakefield,			
Ground oats,	J. O. Ellison,	Haverhill,	8.40	11.75	4.53
Barley meal,	H. K. Webster,	Lawrence,	9.15	13.37	2.58
Rye feed,	Boutwell Mill'g Co.,	Fitchburg,	9.65	14.63	3.45
Rye meal,	J. Cushing Co.,	S. Framingham,	10.56	9.69	1.82
" "	E. C. Packard,	Brockton,	9.22	6.28	1.90
Marsden's new food product,†	Marsdens Co.,	Lawrence,	7.45	3.75	0.85
" "	" "	Needham,			
Concentra'd food,	Concen Food Co.,	Millbury,	8.35	12.24	2.86

*Not guaranteed.
†Corn stalk.

III. Poultry Feeds.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
American,	Amer. Cereal Co.,	Lawrence,			
“	“ “ “	Salem,	7.63	13.28	5.70
“	“ “ “	Walpole,			
“	“ “ “	Beverly,			
“	“ “ “	Lowell,			
“	“ “ “	Natick,			
“	“ “ “	Newburyport,	7.22	12.94	6.02
“	“ “ “	Taunton,			
“	“ “ “	Walpole,			
H. O.,	H. O. Co.,	Brockton,	8.23	17.13	5.31
“	“ “	Lawrence,			
“	“ “	Brockton,*			
“	“ “	Haverhill,*			
“	“ “	Leominster,*	6.66	16.72	5.24
“	“ “	Lynn,*			
“	“ “	Wakefield,*			
H.O. scratching food,	“ “	Brockton,	9.73	11.50	3.33
“ “	“ “ “	Orange,			
Scratching grain,	Unknown,	Salem,	9.30	11.96	3.61
Clover meal,	Bennett & Mill'tt,	Salem,	8.56	9.50	1.78
Cut clover,†	W. R. Curtis & Co.,	Sa em,	6.97	10.85	1.93
Clover meal,	Jordan Milling,	Newburyport,	7.77	11.19	1.87

Both American and H. O. Poultry feeds show an even composition.

Meat and Bone Meal.

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Meat and bonemeal,	Beach Soap Co.,	Danvers,			
“ “ “	“ “ “	Lawrence,	4.10	30.19	5.89
“ “ “	“ “ “	Lawrence,			
B'ker's animal meal,	Bowk'r Fert. Co.,	Millbury,	5.82	48.53	9.97
“ “ “	“ “ “	Danvers,			
“ “ “	“ “ “	Easthampton,			
“ “ “	“ “ “	Haverhill,	5.57	43.53	9.58
“ “ “	“ “ “	Lowell,			
“ “ “	“ “ “	Ware.			
Poultry food,†	“ “ “	Lowell,	6.34	49.22	8.56
Bowker's fish meal,	“ “ “	Haverhill,	7.14	42.00	7.00
Darling's beef scrap,	L. B. Da'g Fert.,	Fall River,	6.12	49.81	20.46
“ “ “	“ “ “	Webster,			

*Guaranty: Protein 17.00 per cent. Fat 5.00 per cent.
*Niagara brand.
†B. M. brand.

Meat and Bone Meal (continued).

Brand.	Manufactured by:	Sampled at:	Moisture. %	Protein. %	Fat. %
Dow's animal meal,	John C. Dow,	Newburyport,	8.38	28.13	9 90
Dow's beef scrap,	" "	Middleboro,	12.59	47.13	17.49
Dow'spoul'y meal,	" "	Middleboro,	10.06	31.78	9.58
Meat scrap,	J. Lederer & Co.,	Fall River,	8.74	51.25	17.60
Beef meal,	Parment'r&Polsey	Wakefield,	6.44	36.13	9.43
Boiled b'f bone,**	Smith&Romaines,	Pittsfield,	8.16	48.09	11.44
" " "	" " "	Orange,†	4.10	45.38	16.51
	Highest,		**12.59**	**51.25**	**20.46**
	Lowest,		**4.10**	**28.13**	**5.89**
	Average,		**6.50**	**41.77**	**11.20**

Meat and bone meals are valuable chiefly for their protein and several of the above test noticeable low. Attention is called to the guaranteed meal.

D. CHEAPEST FEEDS AT FALL PRICES.

At market prices as here given, those feeds are cheapest that stand first in the list, and those the most costly that stand last. These results have been obtained by using the Key under F.

	Feed Stuff.	Retail Price.
Protein Feeds.	Dried brewers' grains and cottonseed meal,	$16 and $25 per ton.
	Gluten feed and gluten meal,	$20.50 and $24 " "
	Wheat middlings,	$20 " "
	Malt sprouts,	$16 " "
	Cleveland flax meal and mixed feed,	$27 and $19 " "
	O. P. linseed meal,	$29 " "
	Wheat bran,	$19 " "
	H. O. dairy feed,	$24 " "
Starchy (carbohydrate) Feeds.	Hominy meal,	$18 " "
	Corn meal,	$18 " "
	Corn and oat, and corn,oat,and barley feeds,	$18 and $19 " "
	Quaker dairy feed,	$18 " "
	Oat feed,	$18 " "

Because dried brewers' grains or cottonseed meal is the cheapest of the protein feeds and hominy meal the cheapest of the starchy feeds it does not follow that cottonseed meal or hominy meal should be fed exclusively. A judicious combination of the starchy and protein feeds is desirable, and various grain mixtures are recommended below. Prices fluctuate and the above relative values may be changed at the present time.

**B. B. B. brand.

†Guaranty: Protein 45.00 per cent. Fat 15.00 per cent.

E. GRAIN MIXTURES TO BE FED DAILY WITH COARSE FEED.

I.

100 lbs. corn or hominy meal.
100 lbs. bran, mixed, or chop feed.
75 lbs. cotton, gluten or linseed meal.
Mix and feed 8 to 9 quarts daily.

II.

200 lbs. chop feed.
100 lbs. cotton, gluten or linseed meal.
Mix and feed 7 to 8 quarts daily.

III.

100 lbs. oat feed.
100 lbs. Buffalo or Golden glu'n feed.
Mix and feed 8 quarts daily.

IV.

H. O. dairy feed.
Feed 6 to 8 quarts daily.

V.

Gluten feeds.
Feed 5 to 6 quarts daily.

VI.

100 lbs. fine middlings.
100 lbs. brewers' grains or malt sprouts.
Mix and feed 7 to 8 quarts daily.

VII.

50 lbs. linseed meal.
50 lbs. cottonseed meal.
100 lbs. oat feed or chop feed.
Mix and feed 7 to 8 quarts daily.

VIII.

100 lbs. corn meal.
50 lbs. bran.
50 lbs. cottonseed meal.
Mix and feed 7 quarts daily.

F. KEY TO COMPARATIVE VALUES OF CONCENTRATED FEEDS.

Protein feeds.	Cottonseed meal,	152
	Cleveland flax meal,	134
	O. P. linseed meal,	138
	Gluten meal,	140
	Gluten feed,	121
	Wheat middlings,	107-114†
	Mixed feed.	90-95*
	Wheat bran,	86
	Malt sprouts,	95
	Dried brewers' grains,	100
	H. O. dairy feed,	96
Starchy (carbohydrate) feeds.	Corn meal,	100
	Hominy meal,	105
	Oat feed (very excessive hulls),	49
	Quaker dairy feed,	84
	Corn and oat feed,	89
	Corn, oat, and barley feed,	92*
	H. O. horse feed,	91

*Estimated but not actually determined.

†The 114 value refers to the fine light colored middlings with 19 per cent protein.

The above feed stuffs are divided into protein and starchy feeds. The former are purchased primarily to increase the protein, while the latter are bought to increase the digestible matter in the ration fed to the animal.

How to use the Key.

It is not possible in this connection to show the relative effects of the various feed stuffs on the flow of milk or the production of beef. The figures are offered rather as a key to the comparative commercial values of the different feeds based on the nutriments contained in them. Thus if corn meal is worth 100, Quaker dairy feed would be worth 84; or if wheat bran is worth 86, cottonseed meal would be worth 152. These figures can be easily converted into dollars. Thus if corn meal is worth $18 per ton or 100, Quaker dairy feed would be worth 84 per cent of $18 or $15.12, the amount the farmer can afford to pay for the feed. Again with cottonseed meal worth $25, what can the farmer afford to pay for old process linseed meal? Cottonseed meal equals 152, or $25, and linseed meal 138. We have a case in simple proportion. 152 : 138 : : $25 : x = $22.70, the value of a ton of linseed meal. It must not be forgotten that these figures do not take into consideration the mechanical condition, or the particularly favorable effect which some feeds are supposed to exert upon the general health of the animal.

SPECIAL NOTICE.

Bulletins containing information concerning Concentrated Feed Stuffs, and analyses of the same, are sent only to those especially desiring them. If you wish for these and do not receive them, send your name AT ONCE to the Director, Hatch Experiment Station, Amherst, Mass.

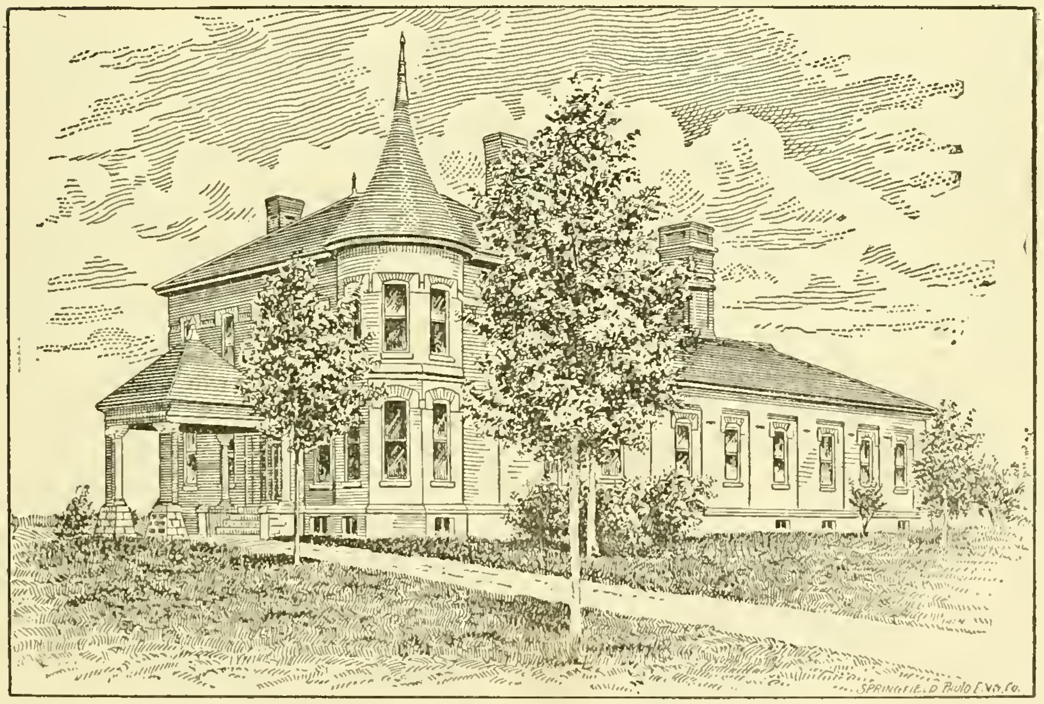
HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 65.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1899.
III. INSTRUCTIONS REGARDING THE SAMPLING OF MATERIALS TO BE FORWARDED FOR INVESTIGATION.
IV. DISCUSSION OF TRADE VALUES OF FERTILIZING INGREDIENTS.
V. INSTRUCTIONS TO MANUFACTURERS, IMPORTERS, AGENTS, AND SELLERS OF COMMERCIAL FERTILIZERS.



CHEMICAL LABORATORY.

MARCH, 1900.

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.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann B. Sc.,	*Assistant Chemist* (Fertilizers).
Samuel W. Wiley, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, M. Sc.,	*First Chemist*(Foods and Feeding).
Frederick W. Mossman, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Philip H. Smith, B. Sc.,	*Assistant in Foods and Feeding.*
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Herbert D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
Henry T. Fernald, Ph. D.,	*Associate Entomologist.*
Arthur C. Monahan,	*Observer.*

The co-operation 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 CHEMISTRY.

C. A. Goessmann.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

816-820. I. Received from Malden, Mass.
II., III., IV. and V. Received from Danvers, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	.20	4.89	2.70	3.93	2.87
Potassium oxide,	5.44	6.25	6.01	8.19	6.04
Phosphoric acid,	1.38	1.71	1.54	2.25	1.30
Calcium oxide,	37.20	37.77	39.92	39.01	33.28
Insoluble matter,	29.79	14.55	8.71	7.91	23.97

821-825. I. Received from Boston, Mass.
II. Received from Waltham, Mass.
III. Received from Beverly, Mass.
IV. Received from North Hadley, Mass.
V. Received from North Hadley, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	16.60	11.40	16.82	10.27	2.05
Potassium oxide,	5.81	6.30	5.37	5.88	5.44
Phosphoric acid,	1.33	1.30	1.25	1.54	1.28
Calcium oxide,	29.33	29.99	31.39	32.55	33.93
Insoluble matter,	14.65	17.32	11.78	17.34	29.70

826-829. I. Received from Sunderland, Mass.
II. Received from Clinton, Mass.
III. Received from Sunderland, Mass.
IV. Received from North Hatfield, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	3.72	1.08	8.15	1.96
Potassium oxide,	5.20	6.06	4.77	5.62
Phosphoric acid,	1.54	1.64	1.87	1.92
Calcium oxide,	34.24	33.03	32.25	39.61
Insoluble matter,	26.24	24.38	17.39	11.83

830-833. I. Received from Sunderland, Mass.
II. Received from Amherst, Mass.
III. Received from Concord, Mass.
IV. Brick yard ashes, received from Bernardston, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	6.25	17.21	8.50	.40
Potassium oxide,	5.20	5.44	7.08	3.59
Phosphoric acid,	1.28	1.54	1.46	1.61
Calcium oxide,	41.19	31.80	36.00	23.44
Insoluble matter,	11.89	13.42	11.84	53.32

COTTON SEED HULL ASHES.

834-838. I. Received from Southwick, Mass.
II. Received from Boston, Mass.
III. Received from Springfield, Mass.
IV. Received from North Hadley, Mass.
V. Received from North Hatfield, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.47	6.00	10.85	12.10	3.48
Potassium oxide,	22.05	15.61	22.04	24.96	15.20
Phosphoric acid,	8.98	8.09	8.38	11.00	6.26
Calcium oxide,	*	*	*	8.24	6.67
Magnesium oxide,	*	*	*	12.54	12.75
Insoluble matter,	16.38	36.36	14.30	9.82	39.21

*Not determined.

Cotton Seed Hull Ashes are eagerly sought after by the tobacco raisers in the Connecticut Valley. The ashes furnish a most valuable source of potash for tobacco culture; in the majority of cases proving superior to high grade sulphate of potash. The analyses of different samples of this material show a wide variation in the percentage of potassium oxide present. This fact should be taken into consideration by the farmer when purchasing these goods. Cotton seed hull ashes, like wood ashes and all other by-products and refuse materials used for fertilizing purposes, should be bought on a guarantee of composition of their essential elements of plant food. Several inquiries have been made from different sections of the State, as to where cotton seed hull ashes may be procured.

The American Cotton Oil Co., 27 Beaver street, New York City, has secured a license for the sale of this material in Massachusetts.

COTTON SEED MEAL.

839-841. I., II. and III. Received from North Hatfield, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	6.93	6.29	6.87
Nitrogen,	7.53	7.76	7.45

The percentage of phosphoric acid and potassium oxide in the various samples of cotton seed meal received for analysis, is not, as a general rule, determined unless upon special request of the party sending the sample. The amount of these two elements varies but little, the average of fifty analyses showing a content of phosphoric acid of 1.76 per cent and of potassium oxide of 1.79 per cent.

ANALYSES OF MISCELLANEOUS MATERIAL.

842-844. I. Tankage received from Northampton, Mass.
II. Tankage received from South Westport, Mass.
III. Complete fertilizer received from Merrimac, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	6.15	5.22	2.31
Total Phosphoric acid,	22.37	17.40	9.90

Soluble Phosphoric acid,	*	*	2.44
Reverted Phosphoric acid,	*	8.18	6.44
Insoluble Phosphoric acid,	*	9.22	1.02
Potassium oxide,	*	*	20.76
Nitrogen,	3.22	5.13	2.32

845-846. I. Sludge Cake, received from Worcester, Mass.
II. Cork Dust, received from South Framingham, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	65.61	.74
Phosphoric acid,	.47	.10
Potassium oxide,	.07	.33
Nitrogen,	.58	.59
Calcium oxide,	*	.74
Magnesium oxide,	*	.08
Insoluble matter,	5.63	.24

847. Kiln dust from brewery.

	Per Cent.
Moisture at 100° C.,	9.72
Phosphoric acid,	.96
Potassium oxide,	2.16
Nitrogen,	4.32
Calcium oxide,	.78
Insoluble matter,	7.11

MANURES.

848-852. I., II., III., IV. and V. Received from Amherst, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	76.44	77.12	67.67	83.35	78.77
Phosphoric acid,	.34	.39	.47	.13	.37
Potassium oxide,	.51	.46	.88	.29	.41
Nitrogen,	.37	.42	.60	.30	.39

*Not determined.

COTTON WASTE.

853-854. I. and II. Received from Bedford, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	4.82	5.00
Phosphoric acid,	.49	.32
Potassium oxide,	1.30	1.20
Nitrogen,	1.60	1.10
Calcium oxide,	1.19	.16
Insoluble matter,	28.15	15.83

TOBACCO REFUSE MATERIAL.

855-856. I. Tobacco stems and sulphur, received from Worcester, Mass.
II. Tobacco dust, received from Worcester, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	7.32	6.15
Phosphoric acid,	.77	.36
Potassium oxide,	8.18	2.74
Nitrogen,	2.50	2.25
Calcium oxide,	6.75	3.09
Insoluble matter,	1.65	26.72

MUCK.

857-858. I. and II. Received from Marlboro, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	72.44	71.40
Organic and volatile matter,	80.05	90.29
Nitrogen,	.72	.67
Phosphoric acid,	trace.	trace.

SOILS.

859-861. I. Received from Lynn, Mass.
II. Received from Boston, Mass.
III. Received from Springfield, Mass.

	Per Cent. I.	II.	III
Moisture at 100° C.,	17.58	76.06	22.83
Phosphoric acid,	.33	.09	.11
Potassium oxide,	.26	.17	.37
Nitrogen,	.32	.37	.30
Calcium oxide,	1.24	.16	1.02
Chlorine,	*	.99	*

*Not determined.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1899, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
381	Bowker's Green House Chemicals,	Bowker Fertilizer Co., Boston, Mass.,	Natick.
14	Chittenden's Complete Tobacco,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
16	Tankage,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
86	Market Garden Manure,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
142	Market Garden Manure,	National Fertilizer Co., Bridgeport, Conn.,	New Bedford.
89	Ammoniated Bone Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
122	Ammoniated Bone Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	New Bedford.
385	Northern Corn Special,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
386	General Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
387	Vegetable, Vine and Tobacco,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
388	Grass and Oats Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
389	Garden Special,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
	Chemicals.		
11	Muriate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
18	Low Grade Sulphate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
20	Dissolved Bone Black,	National Fertilizer Co., Bridgeport, Conn ,	Sunderland.
23	Nitrate of Soda,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
381	Bowker's Green House Chemicals, ...	11.46	4.14	4.12-4.94	1.37	4.06	5.41	10.84	—	5.43	5-6	5.70	5-6
14	Chittenden's Complete Tobacco, ...	11.07	4.03	3.3-4.1	5.48	2.56	3.86	11.90	10-12	8.04	8-11	4.81	5.40-6.48
16	Tankage, ...	5.95	7.26	6.59	—	4.78	2.44	7.22	9.	4.78	—	—	—
86-142	Market Garden Manure, ...	13.80	2.68	2.5-3.	3.60	5.34	2.18	11.12	9-11	8.94	7-9	5.86	6-8
89-122	Ammoniated Bone Phosphate, ...	9.50	2.40	1.85-2.0	2.92	6.98	1.86	11.76	9-11	9.90	7-9	2.22	2-3
385	Northern Corn Special, ...	10.06	3.36	2.88-3.7	6.54	2 25	1.83	10 62	9-15	8.79	8-12	3.83	2-4
386	General Fertilizer, ...	13.64	1.44	.82-1.50	6.03	2.40	1.00	9.43	9-15	8.43	8-12	4.68	4-6
387	Vegetable, Vine and Tobacco, ...	10.00	2.57	2.06-2.88	6.78	2.20	1.66	10.64	9-15	8.98	8-12	6.67	6-8
388	Grass and Oats Fertilizer, ...	14.07	—	—	6.29	4.27	1.79	12.35	12-17	10.56	11-15	2.59	2-4
389	Garden Special, ...	8.64	3.42	3.29-4.25	3.76	2.54	1.54	7.84	7-11	6.30	6-9	12.94	8-10
	Chemicals.												
11	Muriate of Potash, ...	.02	—	—	—	—	—	—	—	—	—	50.05	50.54-54.70
18	Low Grade Sulphate of Potash, ...	2.25	—	—	—	—	—	—	—	—	—	24.04	25.93
20	Dissolved Bone Black, ...	9.44	—	—	15.14	3.98	.70	19.82	—	19.12	16.	—	—
23	Nitrate of Soda, ...	.10	16.36	15.64	—	—	—	—	—	—	—	—	—

DETAILED INSTRUCTIONS REGARDING THE SAMPLING OF MATERIALS AND METHOD OF SHIPPING SAME TO LABORATORIES.

It is of the utmost importance that parties forwarding fertilizing substances for examination should take particular pains in sampling, packing and forwarding such materials in order that the analysis obtained may represent the average composition of the goods sampled, that no addition or loss of moisture in transportation may be effected and that the package be addressed to the proper department.

All samples are received and entered in the order of their arrival at this office. Each sample is assigned a number and is taken up for investigation in the order in which it has been received.

All samples should be addressed to Dr. C. A. Goessmann, Chemical Department of the Hatch Experiment Station, Amherst, Mass., to prevent confusion and possible delay. Express charges must always be prepaid. The name of the sender should be enclosed in an envelope and placed inside the receptacle together with a statement of the nature of the material forwarded for analysis; whether it is an agricultural chemical, mixed fertilizer, a wood ash or the by-product of some manufacturing industry.

The receipt of all samples will be acknowledged by return mail and the results of analysis will be forwarded free of charge to all farmers as soon as completed.

The results of all analyses of samples made at the Station, free of charge, are left at the disposal of the managers for publication if deemed advisable.

SAMPLING OF MATERIAL IN BULK.

In sampling such materials as wood ashes, cotton hull ashes and in fact any material in bulk, portions should be taken from various parts of the heap and placed on a thick smooth piece of paper and thoroughly mixed; from this mixture should be drawn a sample of about one pound which should be placed in a clean bottle, jar or tin can which should be tightly stoppered and sealed in order to retain the moisture conditions of the original material.

SAMPLING OF MATERIAL IN BAGS.

In sampling material which is shipped in bags, portions should be drawn from at least ten per cent of the number of bags present. A fair sample may be obtained by emptying about ten per cent of the bags present on a clean floor or other smooth surface and thoroughly mixing; small amounts are then taken from different parts of the heap and an average sample drawn as has been previously described.

SAMPLING OF SOILS.

The correct taking of representative soil samples, when such are desired for chemical investigation, is of the first importance, as without a properly taken sample, the results which a careful chemical analysis will show become of little value. The sample should be taken from different portions of the field and to a depth not exceeding the downward limit of the surface soil. After selecting a place where a sample is to be taken, pull up all growing vegetation and remove all surface matter which is not a part of the soil. Dig a hole in the soil about two feet square, making the sides smooth and clean by means of a sharp pointed shovel or other instrument; now place a sharp bladed shovel at the point of separation of the surface soil from the subsoil and by means of another flat bladed instrument shave off a portion (about two inches) from all four sides of the aperture letting the soil fall into a shovel which is held in a proper position to receive the same. Place the soil in a suitable receptacle and proceed to take other samples in a like manner from several different parts of the field. The large bulk of soil which has thus been taken is now placed on a clean floor or on a large piece of thick paper and thoroughly broken up and mixed, after which an average sample is drawn and placed in a glass jar or bottle. The bottle is then securely stoppered and sealed, properly labelled and forwarded for the subsequent chemical examination.

A description of the soil should accompany the sample or be sent in a sealed letter, setting forth the locality, depth at which the sample was taken, nature of subsoil and depth, the method of fertilization and crop rotation which has been in practice, general fitness of land for cultivation and all other information that would be of interest or assistance to the chemist in formulating his report.

Care should be exercised in sampling when the weather conditions are normal and no time should be lost between the drawing of the sample and the forwarding of same to the laboratory. This point applies with equal force to all materials forwarded for investigation.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1900. Cents per pound.
Nitrogen in ammonia salts,	17.0
" nitrates,	13.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	15.5
" " " fine bone and tankage,	15.5
" " " medium bone and tankage,	11 0
Phosphoric acid soluble in water,	4.5
" " soluble in ammonium citrate,	4.0
" " in fine ground fish, bone and tankage,	4.0
" " in cottonseed meal, castor pomace and wood ashes,	4.0
" " in coarse fish, bone and tankage,	3.0
" " insoluble (in water and in am. cit.) in mixed fertilizers,	2.0
Potash as Sulphate, free from Chlorides,	5.0
" " Muriate,	4.25

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy action, exert as a rule, a decided influence on their selling price.

The market cost of the different essential elements of plant food, with the exception of the nitrogen compounds, compares favorably with the prices of the same ingredients for the year 1899. Nitrogen compounds show a material increase in cost as compared with the previous year.

The above schedule of trade values is based upon the condition of the fertilizer market in centers of distribution in New England during the six months preceding March 1900 and refers to the current market prices of the leading standard raw materials which enter largely into the manufacture of our commercial fertilizers.

The following is a list of such materials :

Sulphate of Ammonia,	Dissolved bone,
Nitrate of Soda,	Ground phosphate rock,
Azotine,	Acid phosphate,
Dried blood,	Refuse bone black,
Cotton seed meal,	High grade sulphate of potash,
Castor pomace,	Muriate of potash,
Linseed meal,	Sulphate of potash-magnesia,
Dry ground fish,	Kainit,
Bone and tankage,	Sylvinite,
Dry ground meat,	Crude saltpetre.

Valuation. The approximate value of a compound fertilizer or any material used for fertilizing purposes is obtained by calculating the value of each of the three essential elements of plant food (nitrogen, phosphoric acid and potassium oxide, including the different forms of each wherever different forms are recognized in the table), in one hundred pounds of the fertilizer and multiply each product by twenty to change it to a ton basis. The sum of these values will give the total value of the fertilizer per ton at the principal places of distribution,

INSTRUCTIONS TO MANUFACTURERS, IMPORTERS, AGENTS AND SELLERS OF COMMERCIAL FERTILIZERS AND MATERIALS USED FOR MANURIAL PURPOSES IN MASSACHUSETTS.

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1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this state must be accompanied :

   First, with a distinct statement of the name of each brand offered for sale, the name of the manufacturer and place of factory.

   Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

   Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles : nitrogen, phosphoric acid and potassium oxide guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes offered for sale in this State.

3. The certificate of compliance with our State laws must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

All inquiries regarding the sales of commercial fertilizers, etc., may be addressed to C. A. Goessmann, Amherst, Mass., Chemist in charge of the official inspection of these articles.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 66.

VARIETY TESTS OF FRUITS.
FERTILIZERS FOR FRUITS.
THINNING FRUITS.
PRUNING.

MARCH, 1900.

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,
1900.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

HENRY H. GOODELL, LL. D.,	*Director.*
WILLIAM P. BROOKS, PH. D.,	*Agriculturist.*
GEORGE E. STONE, PH. D.,	*Botanist.*
CHARLES A. GOESSMANN, PH. D., LL. D.,	*Chemist* (Fertilizers).
JOSEPH B. LINDSEY, PH. D.,	*Chemist* (Foods and Feeding).
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
J. E. OSTRANDER, C. E.,	*Meteorologist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
RALPH E. SMITH, B. SC.,	*Assistant Botanist.*
HENRI D. HASKINS, B. SC.,	*Assistant Chemist* (Fertilizers).
CHARLES I. GOESSMANN, B. SC.,	*Assistant Chemist* (Fertilizers).
SAMUEL W. WILEY, B. SC.,	*Assistant Chemist* (Fertilizers).
EDWARD B. HOLLAND, M. SC.,	*First Chemist* (Foods and Feeding).
FREDERICK W. MOSSMAN, B. SC.,	*Ass't Chemist* (Foods and Feeding).
BENJAMIN K. JONES, B. SC.,	*Ass't Chemist* (Foods and Feeding).
PHILIP H. SMITH, B. SC.,	*Assistant in Foods and Feeding.*
GEORGE A. DREW, B. SC.,	*Assistant Horticulturist.*
HERBERT D. HEMENWAY, B. SC.,	*Assistant Horticulturist.*
HENRY T. FERNALD, PH. D.,	*Associate Entomologist.*
ARTHUR C. MONAHAN,	*Observer.*

The co-operation 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.

HORTICULTURAL DIVISION.

S. T. MAYNARD.

SUMMARY OF THE WORK OF THE HORTICULTURAL DIVISION FOR THE YEAR 1899.

VARIETY TESTS OF FRUITS.

Of the numerous questions that come to this department, a large majority relate to fruits,—the best varieties, the best methods of cultivation and pruning, the best and cheapest fertilizers and the control of insect and fungous pests. Answers to these questions will be found in this summary for the year's work.

APPLES.

184 varieties growing, 48 fruited.

THE PLUM CURCULIO.

The injury done by the plum curculio which causes a large portion of the gnarly fruit and is considered by some fruit growers as the most injurious pest attacking the apple has been shown to have largely decreased by spraying with the Bordeaux mixture and Paris green. (See Spraying Calendar.) This is in line with the results obtained by the same treatment of the plum practiced for many years to prevent this fruit from being destroyed by the above mentioned pest. The varieties showing the most injury from the pest were Early Harvest, Spy, Willowtwig, Roxbury Russett and R. I. Greening, while almost all varieties were more or less injured especially when there was little fruit on the trees.

THE BROWN DRY-ROT.

For three or four years past many winter varieties have been seriously injured by small brown dry-rot spots under the skin. In many cases it has been so abundant as to render the fruit almost unmarketable. The conclusion arrived at from numerous experiments made here and in other localities with fertilizers and with different methods of cultivation is that it is largely due to a premature and imperfect ripening, on light land especially exposed to the south, or on trees where there is an excess of nitrogen in the soil available during July and August. (See Fertilizers for fruits, page 9.) While on rather cool, moist soils with a northern exposure and where there is an abundance of potash in the soil and the nitrogenous elements are pretty well exhausted when the fruit begins to mature, there are few or no spots found. A warm, rather dry August and September, seems to increase the amount of injury especially if the trees are not in clean, cultivated land. Under cultivation the frequent stirring of the soil tends to a later growth that is not so much subject to this disease. This injury is more abundant in fruit grown on old weak trees, but it sometimes attacks that from young trees as well.

NEW VARIETIES.

The old standard varieties possess qualities that render them especially valuable for home use and for market, but there have been many tests made of new varieties grown here as well as in other localities that are competing with the old varieties grown for our local markets. If new varieties are showy, bear transportation well and are good keepers, old varieties are likely to become unpopular unless of especially fine quality and good size and color. The question then is, whether the growers of Massachusetts shall raise Baldwins, Rhode Island Greenings, Roxbury Russetts, varieties of unquestionable hardiness, vigor and productiveness, yet with many defects, or the more showy Macintosh, Wealthy, Washington Royal (Palmer Greening), Sutton Beauty, etc. which possess the merits of being beautiful and of fine quality, but which are rather delicate for shipping, or the Ben Davis, which is beautiful, productive and a good shipping variety, but of very poor quality. Viewed in the light of past experience it is safe to say that varieties of poor quality, no matter how showy, will not, in the long run, increase the demand for them, while beautiful form and color *with good quality*, which should go together, will increase the demand and generally raise the price. The varieties most profitable for Massachusetts as determined by the tests in the Station orchards and in various localities of the state are as follows:

Summer, Astrachan and Early Williams.

Autumn, Gravenstein, Wealthy and Macintosh.

Winter, Hubbardston, Baldwin, Sutton Beauty, Washington Royal (Palmer Greening) and Rhode Island Greening.

PEARS.

33 varieties growing, 14 fruited in 1899.

The Bartlett, Seckel, Bosc and Hovey are to be recommended for general cultivation for market and home use. The leaf blight can be wholly prevented and the fire blight largely controlled by spraying according to Spraying Calendar.

PEACHES.

41 varieties growing; none fruited.

The fruit buds of all varieties were destroyed by cold about Jan. 1st, 1899, so that variety tests could not be made last season. The trees have made a vigorous growth and matured their buds in such a way that all are uninjured at the present time and about 30 varieties are in condition to bear a large crop.

The peach cannot be sprayed with Paris green without injury, and the arsenate of lead must be used when the plum curculio is abundant. For the brown-rot or monilia a very weak solution of copper sulfate, 2 to 3 ounces to 50 gallons of water can be used without danger. It is better to spray with this solution and with kerosene, for the aphis, only on bright dry days. Under these conditions less injury will be experienced than if the work is done on a moist or cloudy day.

PLUMS.

85 varieties growing; 33 fruited in 1899.

Domestica. (46 varieties growing, 20 fruited in 1899.) For several years past there has been little or no profit in growing this class of plums in this state, largely from the injury to the tree by the black knot, and the rotting of the fruit as it approaches ripening. In the Station orchards where the trees have been regularly and thoroughly sprayed there have been few black knots and most of the fruit has been saved. The varieties producing the best crops the past season were Quackenbos, Kingston, German Prune (Fellemburg), Prune d'Agen and Czar.

Japanese. (21 varieties growing, 4 fruiting.) Of the large number of varieties growing in the Station orchard, very few produced any fruit, the buds having been killed by the cold at the same time the peach buds were destroyed. In many cases the branches were killed and in a few, the entire tree. Those showing the most fruit were the Red June and the Chabot; the Burbank and Yosebe showing a few large, fine specimens.

American. (18 varieties growing, 9 fruited.) The collection of this class of plums has been largely increased by the best kinds from various parts of the country. The results of the trial of these varieties show, (1) that they are curculio proof, (sometimes the fruit is disfigured by this pest, but not destroyed); (2) that many of them are immensely productive; (3) that the fruit buds are never winter killed; (4) that the fruit is not injured by the brown rot; (5) that the varieties fruited are inferior to the best of the Domestica and some of the Japanese varieties, but some are of good quality and especially valuable for canning purposes; (6) that the trees are not subject to the attack of the black knot but that the leaf curl and plum pocket fungus sometimes attack them. The most desirable of those fruiting the past season are the Wild Goose, Hawkeye, Hammar and Wolf.

A collection of the largest and best new varieties obtainable have been grafted on large trees which will fruit the coming season. Among them it is hoped to find some that will prove more valuable than any now fruited.

CHERRY.

35 varieties growing; 20 fruited in 1899.

Within the past two or three years cherry trees in Massachusetts have greatly improved in vigor and healthfulness and during the past season more home grown fruit appeared in our markets than for many years. The trees that have produced the largest amount and best fruit are growing somewhat slowly, either in rather poor soil or in turf land on the lawn or by the roadside where there is food supply sufficient to make a moderate growth, but not enough to create that coarse, soft growth produced in rich garden or orchard land under cultivation, which results in the trees being cracked by the frost on the south side and their consequent rapid decay and short life. The orchard on the Station grounds is located on the east side and close up to a chestnut grove when the surplus plant food is rapidly taken up by the roots of the latter and the trees make but a moderately vigorous growth. These trees planted from 5 to 20 years have borne good crops for several years. The wormy fruit has grown less in amount each year since regular spraying has been practiced and the crop has been one of considerable profit. Careful experiments show that the monilia which sometimes causes the fruit to rot on the trees or very soon after picking can be largely prevented by spraying *after every rain* with the copper sulfate solution 3 ounces to 50 gallons of water. Of the sweet varieties the past season the Napoleon and Gov. Wood were the most satisfactory, and the Early Richmond and large Montmorency of the sour kinds.

GRAPE.

164 varieties growing; 110 fruited in 1899.

One hundred and ten varieties of grapes fruited the past season and the crop as a whole ripened better than for many years. Little or no rot or mildew appeared where the vines were sprayed. It may be said in this connection that of all the fungous pests attacking fruits, those injurying the grape can be the most certainly controlled by spraying. The varieties giving the most satisfaction were the Concord, Worden, Winchell and Delaware of the older sorts, while of the newer well tested kinds, Campbells Early is the only one that can be strongly recommended for general cultivation in Massachusetts. The especial merits of this variety are that it ripens from a week to ten days earlier than the Concord (as early as Moore's Early), the vine is vigorous and productive, the fruit is large and showy, the skin tough, pulp rather firm and sweet but the seeds separate readily, and it hangs long on the vine without dropping. Unless it develops some weakness not yet noticed, it should be grown extensively in Massachusetts in place of Concords, Wordens, or any other black grape now grown.

BLACKBERRIES.

25 varieties growing; 18 fruited in 1899.

Of the new varieties fruiting, none can be recommended above the old standard sorts, Agawam, Snyder and Taylor. The Eldorado is, perhaps, quite as hardy as any of the above and the fruit is of fine quality but not quite equal in size to the above in their best condition. Its great hardiness, however, good habits of growth and good quality make it a valuable variety for market or home use and it may become more valuable than any now grown. The Rathburn in habit of growth is much like the Wilson but with many more spines, the fruit is of medium to large size and of good quality. On older plants it may prove more productive and the fruit of larger size. This, however, will require one or more seasons to prove.

ORANGE RUST.

In treating for the orange rust, it was found that the removal of the diseased canes and leaves before the orange spores were mature, in addition to the spraying, remedied the evil much more quickly than where they were only sprayed. The cost of this work need be very little unless the plantation is badly affected.

RED RASPBERRY.

28 varieties growing; 19 fruited.

Of the varieties giving the best results the King, Loudon and Cuthbert were the most productive, the latter variety winter killing more than the others.

BLACKCAP RASPBERRIES.

26 varieties growing; 12 fruited in 1899.

The most productive of this group were the Souhegan, Hilborn and Ohio. Where the canes and foliage of the blackberry and both kinds of raspberries were sprayed, the growth was much better and the canes matured so as to be less injured by cold than when not sprayed.

CURRANTS.

27 varieties growing; 23 fruited in 1899.

Of the twenty-three varieties of currants fruited the past season, those yielding the most marketable and the best fruit were the Cherry, Versailles and Fays. The Wilder, Red Cross, Ruby King and Pomona, on three year old plants, compared favorably with those first mentioned. Of the latter the Pomona yielded the largest amount and was of the best quality, though perhaps a little smaller in size than some of them.

STRAWBERRY.

170 varieties growing; 151 fruited in 1899.

Of the one hundred and fifty varieties fruited twenty-six produced fruit for the first time in the Station plots. Each kind is grown on both heavy and light land and several varieties were found to produce more fruit upon one kind of soil than upon the other. Those yielding the greatest amount of fruit on heavy soil were Methuen, Sample, Brandywine, Bismarck, Glen Mary, Maximus, Premium and Seaford. Those producing the largest yield on light land were Clyde, Howards No. 4, Haverland, Moore, Patrick, Paris King, Plymouth Rock, Seedling No. 104, Sample and Shusters. The varieties to be recommended, based on the results of the past three years, for general cultivation, for size, quality and productiveness are the Clyde, Glen Mary, Sample and Brandywine. When extremely large berries are desired, the Marshall, Bubach and Glen Mary will generally be satisfactory.

FERTILIZERS FOR THE APPLE.

A large majority of the apple trees in Massachusetts do not make the growth of tree necessary to produce fruit of large size and fine quality. Probably nine-tenths of these trees are growing in land from which a crop of grass or hay is expected and little or no fertilizing material is applied. In many cases the land is so covered with rocks as to make it very expensive to plow or cultivate. It is beyond question that fruit such as is demanded by our markets, especially for shipping purposes, cannot be grown upon such trees unless they are made to produce a more vigorous growth of foliage and wood. In some cases where the land is naturally rich or where there is a washing of plant food from higher soil about the roots, trees will grow and produce good fruit under these conditions of neglect, but such locations are few. If the land is light in texture, thorough and continued cultivation would be necessary to produce profitable crops, but in strong, deep soil no such necessity exists if a liberal supply of plant food is applied annually. The question then before us is how to make these trees, growing in pastures, by the roadside or in mowing lots, produce paying crops of fruits. Numerous experiments made with fertilizers applied to both old and young trees growing in grass, lead us to the conclusion that such trees can be made to grow with sufficient vigor to produce large and profitable crops of fine fruit. To determine what fertilizers would give the best results upon apple, pear and peach trees, three orchards of apples, two of pears and two of peaches were used for experiment. The apple trees, 4 to 8 inches in diameter, were treated as follows:

1st row,	14 trees,	2 lbs.	Muriate of Potash.
2d "	"	2 "	Sulfate " "
3d "	"	4 "	Kainite.
4th "	"	1 "	Nitrate of Soda.
5th "	"	4 "	S. C. fine rock.
6th "	"	2 "	Muriate Potash, 1 lb. Nitrate Soda.
7th "	"	2 "	S. Potash, 1 lb. N. Soda.
8th "	"	4 "	Kainite, 1 lb. N. Soda.
9th "	"	2 "	M. Potash, 1 lb. N. S., 4 lbs. S. C. Rock.
10th "	"	2 "	S. Potash, 1 lb. N. Soda, 4 lbs. S. C. Rock.
11th "	"	4 "	Kainite, 1 lb. N. Soda, 4 lbs S. C. Rock.
12th "	"	Check.	

RESULTS.

The result of this test and those in other orchards was that marked improvement was shown in the growth of the trees, *only where nitrate of soda* was applied and about as much growth was made where nitrate of soda was applied alone as where all the elements were used. This result may not be obtained every year from the same application, as a more complete plant food is needed for permanent growth, but it is conclusive that the nitrate of soda is well suited to produce the result desired in the quickest possible time. Numerous other experiments have been made with bone and potash, fish and potash and with bone and fish combined with Canada and crematory ashes, but in no case was as much growth made as when the nitrate of soda was used. The explanation for this may be that the nitrate being quickly soluble washes down below the roots of the grasses and is absorbed by the roots of the trees, while the nitrogen from fish and bone or manure being slowly dissolved is largely taken up by the roots of the grasses and the tree roots get little benefit from it. It is probable that if these materials (bone, fish and manure) were applied during the fall and winter the nitrogen would be more available for the trees than when applied at the usual time, in April or May. Basing our judgment on the numerous experiments made at the Station and other places, and the practice of some of the best orchardists, we would advise for apple trees in grass the following:

Nitrate of Soda, 1 to 5 lbs.
Sulfate of Potash, 1 to 5 lbs.
S. C. Rock (Floats), 4 to 10 lbs.

varying the quantity according to the size of the trees, condition of growth and crop of fruit.

In place of the potash and S. C. Rock one-half ton to two tons of good Canada ashes may sometimes be used with equally good results. To determine the amount of fertilizers to use, the trees should be carefully examined and enough fertilizer be put on each year to produce, on fruiting trees, a growth of from *6 inches to 1 foot* of firm well matured wood at the ends of most of the branches. Young trees and fruiting trees *under constant cultivation* will need much less than those in grass.

FERTILIZERS FOR THE PEACH.

The practice of some of the best peach growers of the country is to use fertilizers or manure sparingly until the trees set a crop and then a liberal application is made to enable the trees to produce the most perfect crop possible and preserve the vigor of the trees. The best results are generally obtained with quickly soluble fertilizers applied at the beginning of the growing season. The following formula is suggested:

Nitrate of Soda, 1 to 5 lbs. per tree according to size and crop of fruit.

Sulfate of Potash, 1 to 5 lbs. per tree according to size and crop of fruit.

S. C. Fine Rock, 2 to 10 lbs. per tree according to size and crop of fruit.

Wood ashes may be used, in place of the potash and S. C. rock phosfate, at the rate of one-half to two tons per acre or 5 to 20 lbs. per tree. Nitrate of soda should not be applied until just as the trees are beginning to grow. If *stable manure* is most available, a dressing of two or three cords per acre may be used in the fall or early winter, but should *never* be put on in the spring unless the land is very poor and the trees are heavily loaded with fruit or are making a very weak growth.

Young trees on fairly good soil should receive no fertilizers or manure, if the land is kept under constant cultivation, until they have set a crop of fruit. A cover crop of peas and barley sown in August to keep the land from washing and to supply some plant food has been found of great value in all orchards under cultivation. The advantage of this crop is that it can be sown late in the season after the growth of the trees has been completed. It grows late in the season, produces a large crop of organic matter which prevents loss of ammonia while the peas in addition absorb it from the atmosphere. This cover crop can be easily turned under in the spring when cultivation begins and will largely supply the plant food needed for the growth of the trees.

FERTILIZERS FOR OTHER FRUITS.

Fertilizers of a similar composition to those mentioned above are to be recommended for all other fruits, but there are so many varying conditions of soil and previous fertilization and cultivation that it is impossible to make an exact formula that will apply equally well to all fruit plantations. In a general way we may say that for all perennial fruits (trees, shrubs or plants,) the fertilizers that are largely available in the early part of the season (i. e. quickly soluble) will produce a more mature and firmer growth, that will withstand the cold better than a growth produced by fertilizers that are available all through the season. The amount and kind of fertilizers that will give the best result must be determined by the condition of the crop. previous to applications. If the trees or plants are growing slowly, the fruit being small and of poor quality a larger amount must be used than if the growth be vigorous and the fruit of fine quality. For those trees or plants that are liable to injury from cold the nitrate of soda will be found especially valuable with of course sufficient potash and phosforic acid to make a complete growth.

A formula that will prove generally satisfactory for fruits is one containing about 3% of nitrogen, 7% of phosforic acid, and 8 or 9% of potash applied at the rate of from one-half ton to one ton per acre according to the growth of the crop and previous fertilization. This would be best made up of about,

Nitrate of Soda, 150 to 300 lbs.

S. C. Rock Phosfate or Acid Phosfate, 500 to 1000 lbs.

Sulfate of Potash, 150 to 300 lbs.

In place of the potash 1 to 2 tons of good wood ashes might be used with good results for a single application or once in four to six years and especially on rather light land, but it is doubtful if equally good results would be obtained if the ashes were used every year on the same land. If less quickly soluble materials, like fine bone, fish, tankage or stable manure are used for the supply of nitrogen, they should be applied in the fall or winter that they may be abundantly available in the early part of the growing season, as was suggested for the peach.

THINNING FRUITS.

The past season has demonstrated more clearly than ever the necessity of producing a better grade of fruit than can be grown by the *let alone* method so long practiced by most of our growers. The results of thinning out a liberal amount of fruit from an overloaded tree or plant are (1) that the foliage becomes more vigorous and more resistant to insect and fungous pests; (2) the remaining fruit grows larger and more perfect in size, color and quality; (3) the larvae of the codling moth, the insect producing wormy fruit in the apple, pear and quince and the larvae of the plum curculio that produces the wormy plums and cherries, are destroyed in the immature fruit when it dries up or decays on the ground, and much less labor is required to sort and pack the remaining fruit when it is harvested. The price obtained for fruit from carefully thinned trees or plants is certain to be much higher than if all the fruit were allowed to remain unthinned, while the cost of thinning is not much greater than would be the extra cost of the final picking and sorting of so much inferior fruit.

TIME FOR THINNING.

The best time for thinning fruits is as soon as it can be determined what specimens are injured by insects or by any other cause. This time for the apple, pear, peach and plum is early in July. The grape should be thinned as soon as the size of the bunches can be determined, which may be the last of June or the first of July. The amount of fruit to be removed will depend largely upon how much has set. In some cases three-fourths should be removed. In the case of peaches and plums the fruit should not mature on the branches nearer than six inches apart if the whole tree is fruiting. With apples and pears the amount of thinning to be done must depend upon the size and vigor of the trees, but all wormy and deformed fruit should be removed even to the extent of taking the entire crop, for in the majority of cases such fruit only serves to increase the number of insects the next year and *will not pay* the cost of harvesting if allowed to mature. In thinning the grape all small bunches should be removed if the fruit is intended for market, as only large, full bunches will sell for good prices, and only a limited amount, depending upon the strength of vine, should be allowed to remain on each cane. In vineyards at full growth from 10 to 20 lbs. of fruit will be all that each vine can mature and retain its vigor.

PRUNING FRUIT TREES AND PLANTS.

Most of our fruit trees are pruned too much. They are often cut and slashed and the lower branches removed so that in a few years we have trees with only branches and foliage at the tops, the fruit requiring a 20 to 30 foot ladder to secure it, when by a little foresight and light annual pruning the trees might have been kept in good form with an abundance of vigorous, healthy foliage to protect the branches from the hot sun and drying winds and would mature choice fruit. Every orchardist, and person having the care of ornamental shrubbery, should carefully examine every tree under his charge at least once annually, and oftener if possible, and do whatever pruning is needed, from time to time, to keep it in proper shape and prevent a too close growth. A fruit tree will not bear a large crop of choice fruit unless it has an abundance of leaves and branches and these spread over space enough to allow considerable light in and about them.

WHEN TO PRUNE.

All things considered March is the best month in which to prune deciduous trees and shrubs, as the sap has then become more active and the wound will dry out less and heal over more quickly than if pruned in the fall or early winter.

TOOLS FOR PRUNING.

For removing small branches near the ground the pocket knife and hand shears are all that are needed. For heading in the growing ends of trees from 8 to 20 ft. above the ground, the pole pruning hook (the Waters or other forms) is most useful, and for removing small suckers on the main branches a chisel on the end of a long pole is very serviceable. When large branches are to be removed the saw should always be used,—the axe never—for with every blow of this tool the wood is cracked inward and toward the center and decay will more quickly follow than if the saw is used. A saw with about *five teeth to the inch*, set like a splitting saw, the teeth pointing toward the end, is better than a cutting-off saw. The curved "Paragon" is the best saw in the market, the teeth on the inner curve pointing toward the handle while those on the outside are directed toward the point. In sharpening this saw the file should not be carried quite as nearly at right angles with the blade as in the common splitting saw but more nearly to that angle than with the common cutting-off saw.

RULES FOR PRUNING.

1. The knife or saw should never be used on a fruit or ornamental tree unless there is positively good reason for so doing.

2. Train all trees while young with a central leader or main shoot, and never allow two main branches to grow in such a way as to have the weight of the tree come upon a fork of the main trunk.

3. When two branches cross so as to be injured by rubbing together the weaker of the two should be cut out.

4. When one branch rests on another under it the weaker of the two should be cut out.

5. Suckers or water-sprouts should be *thinned out* before they have made much growth, but if the main branches are bare or if the head is open in places, suckers should be allowed to grow where they will cover this condition. If parts of the tree are weak in growth, this weak wood may be cut out and some of the suckers be allowed to grow in its place. The cause of these sprouts is that the sap becomes impeded by the bending down of the branches with weight of fruit, by the hot sun striking the branches or perhaps by some injury to the bark in pruning or gathering the fruit, and nature makes this effort to repair the injury. The removal of all of these suckers will soon result in the death of the tree while allowing some of them to grow where needed will renew the vigor of the tree.

6. If large branches are to be removed make the cut in the middle of the enlarged part where it joins the main branch or trunk, and not quite in line with the face of the main branch or trunk.

7. Paint all wounds above one-half inch in diameter with linseed oil paint, gas tar or grafting wax.

8. Never cut away the main branches of a tree if it can be avoided, but thin out the head, when it becomes crowded, from the outside. This can be quickly done with the pruning hook on a long pole, and little or no injury will result, while if the large branches are cut from the trunk the tree is weakened and soon dies or is broken down.

9. Cut off dead branches as soon as discovered and cover the wound with paint to prevent further decay.

10. In training young trees, start the branches low, the trees will grow better, the thinning and gathering of the fruit will be more easily done and the cultivation can be as well and cheaply done with the modern acme, or spring-tooth harrow and weeder as if the head was higher, while the trunk of the tree and the ground under it will be so protected that growth will be better than if more exposed.

SPECIAL PRUNING.

The Peach. This tree requires special pruning to keep it in a compact stocky form as it tends to grow largely at the ends of the branches and to produce few laterals on the main branches. While the trees are young, at least one-half of the last season's growth should be cut off during the latter part of the winter, varying the amount cut from different parts of the trees so as to produce a regularly formed head. As the trees grow older this pruning reduces the number of fruit buds, and thus lessens the cost of thinning and improves their growth. It also often becomes necessary to cut back some of the main branches well into the center of the tree to force a lateral growth of new wood, without which the long branches would soon break down when heavily loaded with fruit, or with foliage wet with rain in a high wind.

The Plum and Cherry. The special pruning required by these two fruits is the heading in of strong leading shoots while young to cause a stocky, compact growth that can be easily cared for. Pinching the shoots while young will often accomplish the same end.

The Grape. The grape vine will stand more pruning without injury than any other fruit crop we grow, and by the modern method of training, the whole vine is practically renewed every two years. The fruit is grown on the vigorous young wood of the last season's growth and the more vigorous and well ripened this wood the better will be the product. Pruning may be done at any time after the leaves fall, up to March 1st. Summer pruning or pinching is practised to force the growth where desired, i. e., into the fruiting canes and into the new canes that are being grown for the next season's fruit, and no surplus canes should be grown that must be cut and thrown away at the end of the season.

Raspberry and Blackberry. The fruiting canes of these fruits should be cut out as soon as the crop has been harvested, that all growth may go into the new canes that are to produce fruit the next season. Such new canes as are to be preserved for next season's fruiting should have the end taken off when they reach three feet in height and all weak canes and those not needed to make a well stocked field should be treated as weeds and be hoed or pulled up.

Currants and Gooseberries. An annual pruning is generally given these fruits, cutting out all wood over three years old, keeping the bushes in a compact, stocky condition that will hold the fruit up from the ground where it will not be spattered by the soil during heavy rains, and leaving a limited amount of strong wood two and three years old which produces larger fruit than will grow on old canes. All canes looking sickly, which generally indicates a borer in them, should be cut out and burned as soon as discovered.

SPRAYING CALENDAR FOR 1900.

In Bulletins Nos. 52 and 60 a full discussion was given of the various insecticides and fungicides most useful for the protection of fruits and garden crops from insect and fungous pests, and their preparation and most economical application, therefore in this number only the spraying calendar, slightly modified in view of the results of the past seasons, is presented.

SPRAYING CALENDAR.

PLANT.	FIRST APPLICATION.	SECOND APPLICATION.
APPLE, ... *(Scab, codling moth, bud moth, tent caterpillar, canker worm, plum curculio.)*	When buds are swelling, Bordeaux.	If canker-worm and plum curculio are abundant just before blossoms open, Bordeaux and Paris green.
BEAN, ... *(Anthracnose, leaf blight.)*	When third leaf expands, Bordeaux.	10 days later, Bordeaux.
CABBAGE . . . . *(Worms.)*	Insect powder 1 lb. to 25 lbs. of plaster or cheap flour dusted into the head.	7-10 days later, repeat.
CELERY, for rust and blight.	Spray in seed bed with Bordeaux every two weeks.	Dip plants in Bordeaux before planting.
CHERRY* . . . . *(Rot, aphis, slug, plum curculio, black knot.)*	As buds are breaking, Bordeaux; when aphis appear, kerosene and water.	When fruit has set, Bordeaux. If slugs appear, dust leaves with air slacked lime or hellebore. Try arsenate of lead for plum curculio.
CURRANT } GOOSEBERRY } . . . . . . *(Worms, leaf blight.)*	At first appearance of worms, hellebore. Thorough application in water.	10 days later, hellebore. Bordeaux.
GRAPE . . . . *(Fungous diseases, rose bug, etc.)*	In spring when buds swell, Bordeaux.	Just before flowers unfold, Bordeaux and Paris green.
NURSERY STOCK . . . . . *(Fungous diseases.)*	When first leaves appear, Bordeaux.	10-14 days, repeat first.
PEACH, NECTARINE* . . *(Rot, mildew.)*	As the buds swell, Bordeaux. Arsenate of lead for plum curculio.	When fruit has set, Bordeaux. Arsenate of lead for curculio.
PEAR . . . . *(Leaf blight, scab, psylla, codling moth, blister mite.)*	As buds are swelling, Bordeaux.	Just before blossoms open, Bordeaux. Kerosene and water when leaves open for psylla.
PLUM*† . . . . *(Curculio, black knot, leaf blight, brown rot.)*	When buds are swelling, Bordeaux.	When blossoms have fallen, Bordeaux and Paris green. Begin to jar trees for curculio.
QUINCE . . . . *(Leaf and fruit spot.)*	When blossom buds appear, Bordeaux.	When fruit has set, Bordeaux.
RASPBERRY } BLACKBERRY } . . . . . . DEWBERRY } *(Rust, anthracnose, leaf blight)*	Before buds break, Bordeaux.	Bordeaux, just before the blossoms open.
STRAWBERRY . . . . . . *(Rust, black para, etc.)*	As soon as growth begins, with Bordeaux and Paris green. Dip plants in Bordeaux before setting.	When first blossoms open spray both young and old plantation. Bordeaux and Paris green.
TOMATO . . . . *(Rot, blight, flea beetle.)*	Soon after planting use Bordeaux.	Repeat as soon as fruit is formed. Fruit can be wiped if disfigured by Bordeaux.
POTATO . . . . *(Flea beetle, Colorado beetle blight and rot.)*	Spray with Paris green and Bordeaux when about one-half grown.	Repeat before insects become too numerous.

*Paris green cannot be used on foliage of cherry, peach or Japanese plum without injury.

†Black knots on plums or cherries should be cut and burned as soon as discovered.

THIRD APPLICATION.	FOURTH APPLICATION.	FIFTH APPLICATION.
When blossoms have fallen, Bordeaux and Paris green.	8-12 days later, Bordeaux and Paris green.	10-14 days later, Bordeaux. Use dilute copper sulfate solution in Sept. if season is wet for scab.
14 days later, Bordeaux.	14 days later, Bordeaux.	Spraying with Bordeaux after the pods are one-half grown will injure them for market.
7-10 days later, repeat.	Repeat in 10-14 days if necessary.	
Use Bordeaux until banking begins.	Freedom from disease depends largely upon good cultivation and an abundance of plant food in the soil.	
10-14 days if rot appears, Bordeaux. Arsenate of lead for plum curculio.	10-14 days later, weak solution of copper sulfate.	Repeat after every rain when fruit begins to color.
If worms persist, hellebore.	2 to 4 weeks later, if any disease appears, weak solution of copper sulfate.†	After fruit is gathered, Bordeaux.
When fruit has set, Bordeaux and Paris green.	2 to 4 weeks later, Bordeaux.	Weak solution of copper sulfate.
10-14 days, repeat first.	10-14 days repeat first.	5-7 days later, repeat.
When fruit is one-half grown, Bordeaux.	†5-7 days later, weak solution of copper sulfate.	10-14 days later, weak solution of copper sulfate.
After blossoms have fallen, Bordeaux and Paris green. If necessary, kerosene and water.	8-12 days later, repeat third.	10-20 days later, weak solution of copper sulfate.
10-14 days later, Bordeaux. Paris green cannot be safely used on Japanese varieties.	10-20 days later, Bordeaux	10-20 days later, copper sulfate solution as fruit is ripening.
10-20 days later, Bordeaux.	10-20 days later, Bordeaux.	
(Orange or red rust is treated best by destroying the plants attacked in its early stages.)	Spray after fruit is gathered with Bordeaux.	10-20 days later, repeat.
Spray new plantation Bordeaux.	Repeat third if weather is moist.	
Repeat first when necessary.	†Try weak solution of copper sulfate.	
Repeat for blight, rot and insects as potatoes approach maturity.		

*For aphides or plant lice, kerosene and water applied in fine mist only in bright drying weather.

†If a pailful of lime wash, well strained, be added to each barrel full of copper solution—4 ounces to 50 gallons—delicate foliage like that of the peach, etc., will not be injured.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 67.

THE GRASS THRIPS.

TREATMENT FOR THRIPS IN GREENHOUSES.

MAY, 1900.

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,
1900.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry T. Fernald, Ph. D.,	*Associate Entomologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann, B. Sc.,	*Assistant Chemist* (Fertilizers).
Samuel W. Wiley, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, M. Sc.,	*First Chemist* (Foods and Feeding).
Frederick W. Mossman, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Philip H. Smith, B. Sc.,	*Assistant in Foods and Feeding.*
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Herbert D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
Arthur C. Monahan,	*Observer.*

The co-operation 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.

THE GRASS THRIPS.

Anaphothrips striata (Osb.).

H. T. FERNALD, PH. D. AND W. E. HINDS, B. S.

The grass thrips is so small an insect that it is generally overlooked by the farmer. Nevertheless it does much damage to the grass crop in Massachusetts, sucking the juices from the stalks and causing the trouble commonly known as "silver top."

Studies upon this insect, the damage it causes, and the best methods for controlling it, have been carried on for some time at the Massachusetts Agricultural College by Mr. W. E. Hinds, B. S., the scientific and practical results of which have already been published. To present that portion of these results which is of practical value to the agricultural interests of the State, in a form available for direct use is the object of this Bulletin.

HISTORY.

"In 1875, Prof. J. H. Comstock, in his 'Syllabus of a Course of Lectures,' mentioned a species of thrips which was doing very great damage to timothy and June grass by working in the upper joints. To this insect, of which he had seen only the larvæ at that time, he gave the name *Limothrips poaphagus*; but he published no description of it previous to the appearance of his 'Introduction to Entomology,' in 1888.

"Five years before this latter date, Prof. Herbert Osborn published, in the 'Canadian Entomologist', Vol. XV., page 155, the description of a species of thrips, under the name of *Thrips striata*. The description was made from a single specimen, and the food plant was unknown to Prof. Osborn; but the published description agreed so closely with the 'grass thrips' that the two were suspected to be identical. Not knowing whether *Limothrips poaphagus* Comst. and *Thrips striata* Osb. were positively synonymous, I sent some of my specimens to the Division of Entomology at Washington for determination, where they were referred to Mr. Theo. Pergande, one of the highest authorities on this group of insects, who expressed the opinion that the specimens were identical with *Thrips striata* Osb., and placed them in the genus *Anaphothrips* Uzel.

"For the purpose of making a comparative study of the material before me with the types of Professors Comstock and Osborn, Professor Fernald obtained the loan of these types, and I find upon making the comparison that *Limothrips poaphagus* Comst., *Thrips striata* Osb., and the species which I have found in such abundance here in Amherst and upon which I have made the studies given in this paper, are identical; and, as the species was first described by Osborn, his name should hold, and this insect be known by the scientific name of *Anaphothrips striata* (Osb.).

"Since Professor Comstock's first mention of the injury done by this species of thrips to June grass and timothy, several economic entomologists have referred to the most conspicuous effects of its work, the dead tops of these grasses, as 'silver-top' or 'white-top.' Many have questioned the agency of thrips in producing this injury, and have ascribed it to some other suctorial insect; but the majority of writers were inclined to credit thrips with a part, if not all, of this damage. As they had no means of identifying the little pest, they have usually referred to it as the 'grass thrips.' This name has been very generally used for this species, but not for any other so far as I can learn, and I have therefore adopted it as the common name."

LIFE HISTORY.

The adults (Figs. 3 and 4) pass the winter at the bases of the grass stems just above the ground. In the spring as soon as the weather is sufficiently warm to start the grass, they become active and begin to deposit eggs, continuing to do this for from four to six weeks. The eggs are deposited in the tissues of the fresh and tender parts of the leaf, and one female may lay quite a number, individuals kept in confinement averaging from fifty to sixty, each. The process of egg-laying is as follows: The female arches her body so as to bring its weight to bear upon the slender ovipositor which is attached to the underside of the body close to its hinder end. The ovipositor is then slowly worked down through the surface of the leaf into its substance, the body being gradually lowered during this process, though otherwise the insect appears to be perfectly quiet. Then, by successive contractions, the egg is pushed back under the surface of the leaf. The complete operation requires about a minute and a half, after which the female usually moves off a short distance and begins feeding. Occasionally the ovipositor becomes so firmly wedged in the leaf as to hold its possessor prisoner for some time, frequently until death results. The length of time between egg-laying and hatching appears to vary somewhat according to the weather. Eggs laid in early spring hatch in from ten to fifteen days, but during the summer much less time is required.

When the egg hatches, the young thrips which somewhat resembles Figure 1, works its way up out of the leaf till it is nearly free, where it remains until its body has sufficiently dried, when it pulls itself entirely out and soon begins feeding. When full grown it is about four times as long as when it left the egg, and has now the appearance shown in Figure 1.

The full grown larvæ or young, now seek for some protected place in which to pass through the next stage of life—the pupa. Sometimes the place selected is between the stem of the grass and an upper leaf sheath, but usually it is in similar places at the base of the stem near the ground. Here they move about but little, doing no feeding, and assume the form represented in Figure 2. In this condition they remain for a few days, at the end of which time, the outer covering is thrown off and the adult insect appears (Figs. 3 and 4.)

The adult insects are of two kinds viz. those with wings (Fig 4), and those without (Fig. 3). Over 90% of those of this first spring generation are winged, and are thus able to fly and infest new fields. They appear early in May and at once begin laying eggs for another generation, which passes through the same stages from egg to adult as the first brood, the history of which has just been outlined, except that less time to produce a generation is required as the weather grows warmer. During the season therefore, there is time for eight or nine generations to complete their life histories, each year. As fall approaches, however, fewer winged adults appear, more wingless ones being produced, until in October only about 2%

are winged. Egg-laying by the last generation of adults may continue until snow comes, but only the adults appear to be able to survive the winter.

INJURIES.

The amount of injury done by these minute insects is little appreciated on account of their small size, but what they lack in this regard is made up by their numbers. Calculating the number of eggs laid by each adult at 50 and allowing each of these on becoming adult to lay 50 more (no males having thus far been discovered, and the probability being that they are rare, if they exist at all) and continuing this rate of increase for the eight generations usual in an ordinary season, we have the astonishing number 781,250,000,000, as the number of descendents in the eighth generation from one insect, while during the single summer which it requires to produce eight generations, not only these, but also all the members of the intervening generations (797,193,877,550 in all) have during a portion of their lives been sucking the juices from the grasses of our fields. It should not be forgotten, however, that many individuals fail to reach maturity, thus reducing this estimate. It has also been noted that while the increase appears to be extremely rapid during the early summer months, the heavy showers of midsummer appear to destroy many of the insects.

FEEDING HABITS.

"The adults of this species feed entirely upon the leaves and external parts of the grass. They are very seldom found within the sheath of a leaf, but frequently congregate in numbers within the terminal leaf before it has fully unrolled. They select the fresh tender parts of the grass, and consequently their work is most apparent upon the upper leaves. The mouth parts are used to pierce the surface of the leaf and the wall of a cell below. As soon as the juices contained in this cell have been extracted, the piercing mouth parts are withdrawn and another cell is punctured, the empty cells presenting a shrunken, whitish appearance. The insects usually feed lengthwise of the leaves, their path being marked by whitish streaks in the tissue of the leaf and by dots of dark excrementitious matter.

"The young seek a more protected place in which to feed, and may be found in large numbers within nearly every sheath of June grass during the latter part of May and through June. A favorite haunt is in the head, just as it is making its appearance. The minute young work their way down inside the sheath, and some of them, reaching a node where they must stop, continue to feed upon the juices from the very tender stem within until shortly before they enter the pupal stage. The young may be found within any sheath; but it is almost always those that enter the top sheath which cause the 'silver-top,' as these directly cut off the supply of sap to the head. Examination of affected stems shows that at a point just above the upper node the stem has been sucked dry for about half an inch of its length (Fig. 6)."

FOOD PLANTS.

"This minute pest attacks a number of species of grass, but by far the greatest damage is done to June grass (Figs. 5 and 6), few fields of this escaping more or less serious injury. After the first of July, by which time June grass has usually matured, the insect changes to some later species, as timothy when this is present. They may be found in abundance upon barn-yard grass from midsummer till late in the fall. About the middle of July, 1898, I found them quite common upon a field of young corn which was nearly surrounded by grass land, but later in the season they could not be found upon the corn. Many other grasses show unmistakable traces of the work of thrips by their whitened heads, and a list of these, with the percentage of 'silver-top,' estimated on June 29, 1898, is given below; but I cannot positively connect this species with all the injury.

"The percentages given were obtained by counting the injured and uninjured heads upon a small area on which the damage appeared to be of average severity. Slight traces of 'silver-top' are indicated by a dash in the column of percentage."

Fowl-meadow grass,	*Poa serotina*,	30
	Poa nemoralis,	80
Wire-grass,	*Poa compressa*,	40
	Poa arachnifera,	20
	Poa Fletcheri,	10
	Poa aquatica.	35

Blue grass, June grass,	*Poa pratensis,*	75
Roughish meadow-grass,	*Poa trivialis,*	10
	Poa cœsia,	10
White bent-grass,	*Agrostis alba,*	30
Brown bent-grass,	*Agrostis canina,*	20
	Agrostis stolonifera,	25
Red Top,	*Agrostis vulgaris,*	25
	Festuca Olcoll,	20
	Festuca heterophylla,	35
Field Fescue,	*Festuca pratensis,*	—
Meadow Fescue,	*Festuca elatior,*	—
Sheep's Fescue,	*Festuca ovina,*	95
	Festuca duriuscola,	95
	Festuca tenuifolia,	40
	Festuca rubra,	20
Barnyard grass,	*Panicum crus-galli,*	—
Common Crab or Finger-grass,	*Panicum sanguinale,*	—
Timothy,	*Phleum pratense,*	—
	Elymus striatus,	—
	Elymus virginicus,	—
Chess,	*Bromus erectus,*	—
	Bromus inermis,	—
	Avena flavescens-vera,	—
	Agropyrum caninum,	—
Oat grass,	*Arrhenatherum avenaceum,*	—
Rye-grass,	*Lolium perenne,*	—

REMEDIES.

"A knowledge of the life history of this insect suggests to us a few ways in which it may be most easily combatted and its damage lessened. As the females hibernate above ground, burning in early spring must destroy large numbers of them. To be effective, the burning must be close and thorough, and the burned space either quite large or isolated from other infested fields. This must be done before the grass starts, which is usually about the first of April, because the females hibernate very close to the base of the stems, and a close burn after the green blades appear cannot be obtained.

"The damage appears to be most severe on worn-out meadows, fields and lawns. This suggests stimulating the plants, to give them additional vigor, and harvesting as early as possible. The June grass should either be cut as soon as the heads begin to turn white, or be fed green.

"So far as I can learn, the seed of this grass is sold only in lawn mixtures, and is not used for field seeding. The June grass comes in gradually, as the stouter-growing species usually sown run out. Attacks are most severe on fields that have been seeded for several years and have become partially exhausted. This suggests ploughing deeply, and planting for at least one year with some cultivated crop before reseeding."

TREATMENT FOR THRIPS IN GREEN-HOUSES.

During the past few years attention has been called several times to the severe injury caused by thrips to hothouse cucumbers.

This is a different species from that described on grass though the two are quite similar in color and general appearance. Reports of the injury to cucumbers show that this insect is widely distributed over the state and is becoming of considerable economic importance. While the main points of its life history are quite similar to those of the grass thrips already described in this bulletin, the methods to be used in its control must, of course, be very different. In order to find some substance which may be used for the successful treatment of this pest, experiments have been carried on with it, with the kind permission and assistance of Dr. G. E. Stone, in the greenhouses of the Hatch Experiment Station. A record of these experiments with the results obtained is given herewith.

DETAILS OF EXPERIMENTS ON GREENHOUSE THRIPS.

No.	Substance Used.	Treatment.	Space Treated.	Time.	Result to Plant.	Result to Thrips.	Remarks.
1	Tobacco leaves	12 oz. burned	1000 cu. ft.	Night	None	None	Killed plant lice.
2	Fir-tree oil	10cc.+120cc. water. Spray	—	Day	None	Part killed	All wetted by the spray were killed.
3	Lemon oil	1 part to 48 parts of water at 120°	Plant dipped in.	Day	None	Killed	Potted tomato plants, 6-8 inches high. Most insects washed off; rest soon died.
4	Lemon oil	1 part to 48 parts of water at 120°	Plant dipped in.	Day	None	Killed	Potted tomato plants, 6-8 inches high. Most insects washed off; rest soon died.
5	Lemon oil	1 part to 48 parts water. Spray	—	Day	Injured	?	Cucumbers, terminal leaves killed. Growth checked.
6	"Rose leaf" tobacco extract	1 part to 48 parts water. Spray	2 plants	Day	None	None	Many insects escaped the spray by hiding in grooves of the stem, under the leaf veins, etc.
7	"Rose leaf" tobacco extract	1 part to 32 parts water. Spray	2 plants	Day	None	Part killed	
8	"Rose leaf" tobacco extract	300cc. vaporized	5000 cu. ft.	Night	None	None	House sprinkled first. Treatment entirely too weak.
9	"Rose leaf" tobacco extract	600cc. vaporized	5000 cu. ft.	Night	None	None	House sprinkled first.
10	"Rose leaf" tobacco extract	5cc. vaporized	3.5 cu. ft.	Day	None	Part killed	Plant not wet down. Many insects dropped to ground but recovered later.
11	"Rose leaf" tobacco extract	5cc. vaporized	3.5 cu. ft.	Day	Killed	Killed	Plant wet down before the experiment.
12	"Rose leaf" tobacco extract	5cc. vaporized	3.5 cu. ft.	Night	Injured	Killed	Plant wet down before the experiment. This indicates that plants are more resistant at night.
13	"Rose leaf" tobacco extract.	3.5cc. vaporized	3.5 cu. ft.	Night	None	Killed	Plant wet down. One larva left alive.

No.	Substance Used.	Treatment.	Space Treated.	Time.	Result to Plant.	Result to Thrips.	Remarks.
14	"Rose leaf" tobacco extract	3cc.+3cc. water vaporized	3.5 cu. ft.	Day	None	Killed	Plant not wet down. Addition of water increased density of the vapor.
15	"Rose leaf" tobacco extract	3cc.+3cc. water vaporized	3.5 cu. ft.	Night	None	Killed	
16	Carbon disulphide	2cc. evaporated	.4 cu. ft.	9 hours	None	Killed	One plant enclosed by small cylinder.
17	Carbon disulphide	3.5cc. evaporated	3.5 cu. ft.	Day	None	Few killed	Fumes very heavy and settled to bottom. Insects on upper leaves escaped.
18	Nikoteen Aphis Punk	Three rolls burned	5000 cu. ft.	Night	None	None	Killed plant lice.
19	Nikoteen Aphis Punk	Four rolls burned	5000 cu. ft.	Night	None	None	
20	Nikoteen	10cc.+750cc. water vaporized	5000 cu. ft.	Night	None	Few killed	Vaporization not satisfactory.
21	Nikoteen	20cc.+750cc. water vaporized	5000 cu. ft.	Night	None	Nearly all killed	
22	Nikoteen	20cc.+750cc. water vaporized	5000 cu. ft.	Night	None	Nearly all killed	
23	Nikoteen	20cc.+750cc. water vaporized	5000 cu. ft.	Night	None	Many killed	Poorer results; reason not known.
24	Hydrocyanic acid gas	.155 gm. potassic cyanide; .227 gm. sulph. acid; .31 gm. water	30 cu. ft.	Night	None	All killed	Lettuce and cucumbers not injured; tomatoes killed. Plant lice killed. Red spiders unaffected.
25	Hydrocyanic acid gas	.2 gm. potassic cyanide, .3 gm. sulph. acid, .4 gm. water	30 cu. ft. 4 hrs.	Cloudy afternoon	None	All killed	Plant lice killed; red spiders unaffected.
26	Hydrocyanic acid gas	.31 gm. potassic cyanide, .46 gm. sulph. acid, .62 gm. water	30 cu. ft.	Night	None	All killed	Tomato plants killed, however. Red spiders killed.

SUMMARY.

As thrips take their food by suction, stomach poisons are not available, and contact poisons and fumigation are the only methods of value.

Spraying with contact poisons, however, is only a partial success at best, as many of the insects escape, being protected by the leaf veins, spines, and grooves of the stem of the plant. Dipping the whole plant into the poison, as was the case with experiments 3 and 4, would avoid this difficulty, but as this is only possible in the case of potted plants, fumigation appears to be the most successful method of dealing with these insects in greenhouses.

Of the materials tried in fumigation—Rose-leaf Tobacco Extract, Carbon disulphide, Nikoteen Aphis Punk, Nikoteen and Hydrocyanic acid gas—the carbon disulphide fumes were so heavy that they settled to the bottom of the case, leaving the insects on the upper parts of the plant uninjured, while if a sufficient quantity of fumes should be produced to fill the greenhouse, it is probable that in the lower parts they would necessarily be so dense as to kill the plants.

Nikoteen Aphis Punk proved ineffective for thrips though strong enough to destroy plant lice.

Rose-leaf Tobacco Extract, though a success in killing the thrips, as shown by experiments 14 and 15, is more expensive for the work than Nikoteen, which when vaporized in the proportions given in experiments 21, 22 and 23 gave about the best results of anything tried, though the results from Hydrocyanic acid gas were also successful. If the extremely dangerous character of this gas and also the fact that in some cases the plants were injured by it, be taken into account, however, the Nikotèen appears to have been the most successful substance for fumigation, used in these experiments. The Nikoteen used was manufactured by the Scabcura Dip Co. of Chicago.

Plate and Explanation.

Explanation of Plate.

Fig. 1. Full-grown larva. $\frac{62}{1}$

Fig. 2. Pupa. $\frac{62}{1}$

Fig. 3. Wingless adult female. $\frac{62}{1}$

Fig. 4. Winged adult female. $\frac{62}{1}$

Fig. 5. Head of Kentucky blue-grass normally developed $\frac{1}{2}$.

Fig. 6. Head of Kentucky blue-grass arrested in its growth by the attack of the grass thrips, also showing the shrivelled condition of the stem just above the upper node. $\frac{1}{2}$

Explanation of the Lettering of Figures in the Plate.

Ant. Antenna.

Bl. Bladder terminating the tarsus.

Bs. Base of stem of Kentucky blue-grass, taken from just above the upper node, injured by thrips.

CE. Compound eye.

FL. Fore leg.

FWp. Fore wing pad.

H. Head.

HL. Hind leg.

HWp. Hind wing pad.

L. Ligule.

ML. Middle leg.

Ms. Mesonotum.

Mt. Metanotum.

O. Ocelli.

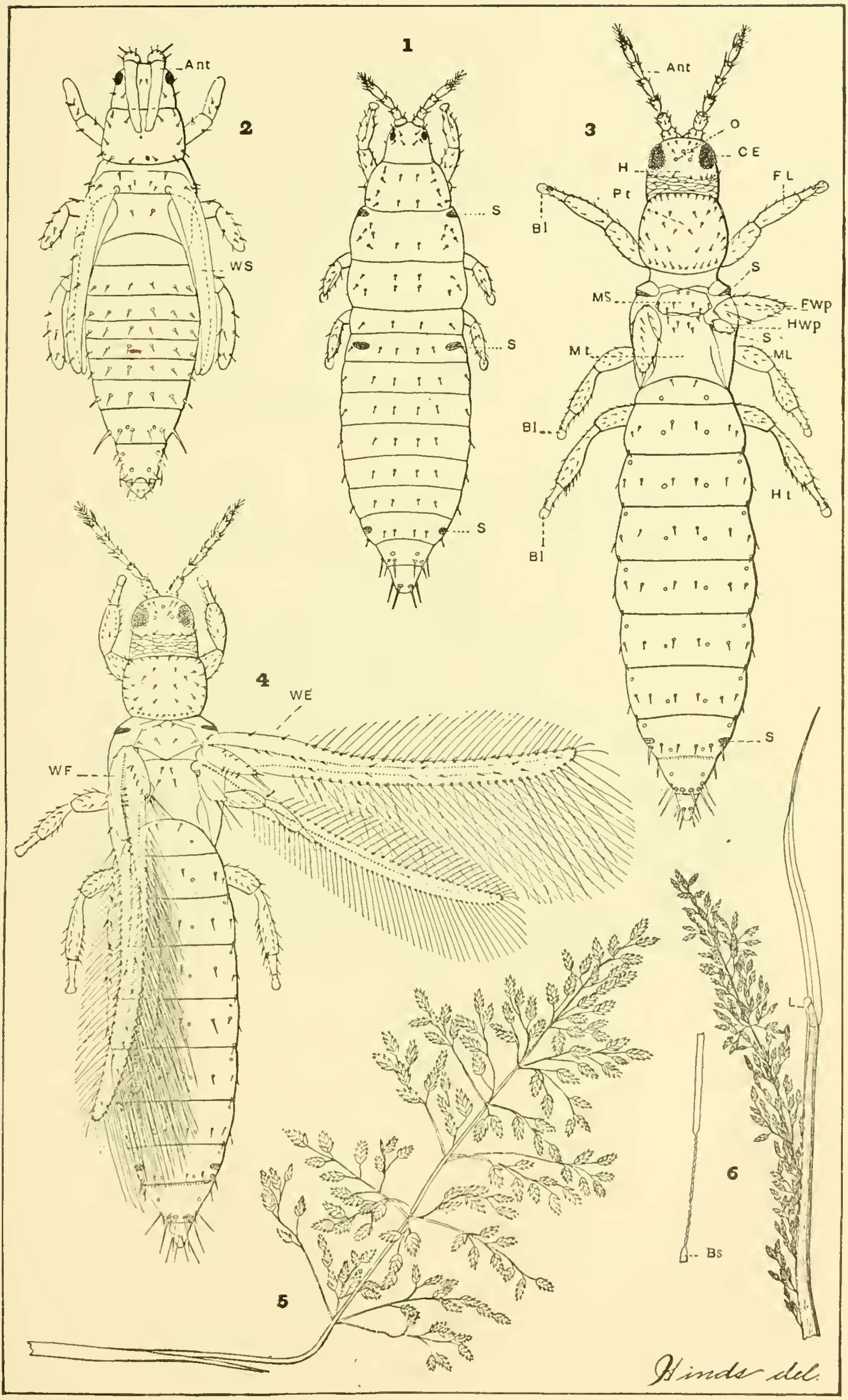
Pt. Prothorax.

S. Stigma.

WE. Wings extended in position for flight.

WF. Wings folded at rest.

WS. Wing sheath.



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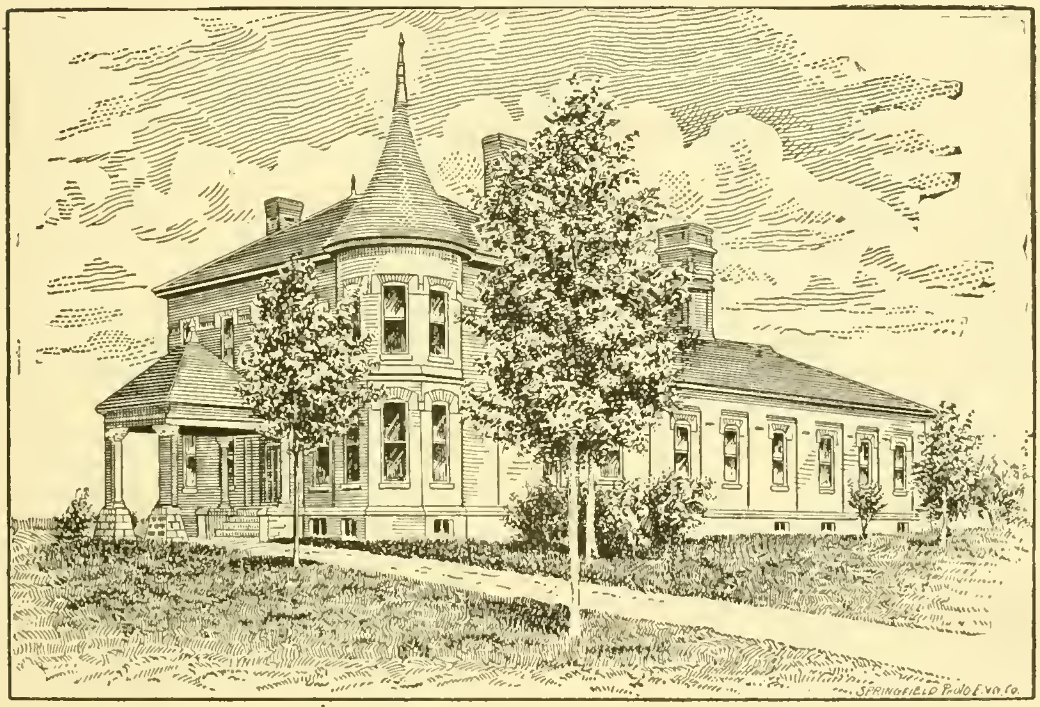
HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 68.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1900.



CHEMICAL LABORATORY.

JULY, 1900.

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,
1900.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

HENRY H. GOODELL, LL. D.,	*Director.*
WILLIAM P. BROOKS, PH. D.,	*Agriculturist.*
GEORGE E. STONE, PH. D.,	*Botanist.*
CHARLES A. GOESSMANN, PH. D., LL. D.,	*Chemist* (Fertilizers).
JOSEPH B. LINDSEY, PH. D.,	*Chemist* (Foods and Feeding).
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
J. E. OSTRANDER, C. E.,	*Meteorologist.*
HENRY T. FERNALD, PH. D.,	*Associate Entomologist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
RALPH E. SMITH, B. SC.,	*Assistant Botanist.*
HENRI D. HASKINS, B. SC.,	*Assistant Chemist* (Fertilizers).
SAMUEL W. WILEY, B. SC.,	*Assistant Chemist* (Fertilizers).
LOUIS E. GOESSMANN,	*Assistant Chemist* (Fertilizers).
EDWARD B. HOLLAND, M. SC.,	*First Chemist* (Foods and Feeding).
FREDERICK W. MOSSMAN, B. SC.,	*Ass't Chemist* (Foods and Feeding).
BENJAMIN K. JONES, B. SC.,	*Ass't Chemist* (Foods and Feeding).
PHILIP H. SMITH, B. SC.,	*Assistant in Foods and Feeding.*
GEORGE A. DREW, B. SC.,	*Assistant Horticulturist.*
	Assistant Horticulturist.
ARTHUR C. MONAHAN,	*Observer.*

The co-operation 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 CHEMISTRY.

C. A. Goessmann.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

678-682. I. Received from Sunderland, Mass.
II., III., IV. and V. Received from Concord, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.11	12.17	11.26	7.45	4.33
Potassium oxide,	5.05	6.76	6.96	7.12	7.28
Phosphoric acid,	1.68	1.54	1.54	1.80	1.58
Calcium oxide,	40.52	27.39	34.44	29.41	32.56
Insoluble matter,	11.72	26.09	16.68	11.92	14.63

683-687. I. Received from Sunderland, Mass.
II. Received from East Amherst, Mass.
III. and IV. Received from Sunderland, Mass.
V. Received from South Deerfield, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	2.15	11.57	16.45	16.01	13.60
Potassium oxide,	7.92	5.40	5.32	5.20	5.48
Phosphoric acid,	1.66	1.30	1.40	1.20	1.34
Calcium oxide,	35.67	31.91	31.11	30.66	31.07
Insoluble matter,	15.44	12.86	11.88	11.83	12.14

688-692. I. Received from North Amherst, Mass.
II. Received from Boston, Mass.
III. Received from Sunderland, Mass.
IV. Received from Concord, Mass.
V. Received from Northfield, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.90	1.47	20.80	10.77	8.11
Potassium oxide,	5.28	5.20	4.96	6.96	7.12
Phosphoric acid,	1.28	1.66	1.34	1.72	2.04
Calcium oxide,	28.67	21.50	24.55	27.23	32.95
Insoluble matter,	14.87	25.28	11.39	15.75	12.65

693-697. I. Received from North Hadley, Mass.
II. Received from Millis, Mass.
III. Received from Concord, Mass.
IV. Received from Littleton, Mass.
V. Received from Fitchburg, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.78	7.78	14.24	16.25	10.75
Potassium oxide,	6.28	.44	6.10	6.26	4.40
Phosphoric acid,	1.86	.20	1.59	1.36	1.18
Calcium oxide,	31.14	.86	30.12	33.50	38.38
Insoluble matter,	9.22	83.84	13.77	6.82	12.80

698-702. I. Lime Kiln Ashes, received from Springfield, Mass.
II. Lime Kiln Ashes, received from Hadley, Mass.
III. Leather Scrap Ashes, received from Spencer, Mass.
IV. Cotton Hull Ashes, received from Amherst, Mass.
V. Cotton Hull Ashes, received from Springfield, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	.82	1.52	.70	4.90	8.05
Potassium Oxide,	.43	3.86	3.36	20.34	24.48
Phosphoric acid,	.28	1.47	3.96	8.64	10.38
Calcium oxide,	36.30	46.14	2.56	7.20	—
Insoluble matter,	1.33	2.56	40.00	32.05	13.90

POTASH COMPOUNDS.

703-708.

I. Silicate of Potash, received from Amherst, Mass.
II. Muriate of Potash, received from Amherst, Mass.
III. Muriate of Potash, received from Hudson, Mass.
IV. Kainit, received from Amherst, Mass.
V. High Grade Sulphate of Potash, received from Amherst, Mass.
VI. Low Grade Sulphate of Potash, received from Amherst, Mass.

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	2.17	.63	1.02	1.83	1.10	3.73
Potassium oxide,	27.62	51.80	49.44	13.65	50.00	31.45

NITROGEN COMPOUNDS.

709-712. I. Nitrate of Soda, received from Amherst, Mass.
II. Nitrate of Soda, received from Hudson, Mass.
III. Sulphate of Ammonia, received from Amherst, Mass.
IV. Cotton Seed Meal, received from N. Amherst, Mass.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	.44	.42	.47	5.40
Nitrogen,	14.88	14.14	21.15	7.09

GROUND BONES AND TANKAGE.

713-716. I. Raw Bone Flour, received from Amherst, Mass.
II. Ground Bone, received from South Lincoln, Mass.
III. Tankage, received from South Lincoln, Mass.
IV. Tankage, received from South Hadley Falls, Mass.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	6.91	3.85	6.11	9.60
Total Phosphoric acid,	24.98	26.86	14.38	23.48
Available Phosphoric Acid,	8.60	11.46	8.50	12.66
Insoluble Phosphoric Acid,	16.38	15.40	5.88	10.82
Nitrogen,	4.25	1.49	6.78	3.11

717-721. I. Steamed Bone Meal, received from Amherst, Mass.
II. Tankage, received from Peabody, Mass.
III. Ground Bone, received from Brockton, Mass.
IV. Ground Bone, received from Furnace, Mass.
V. Dissolved Bone, received from Amherst, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.07	20.90	4.12	3.92	4.77
Total Phosphoric Acid,	24.74	14.40	21.82	26.28	15.04
Available Phosphoric Acid,	7.42	7.62	9.54	6.86	11.66
Insoluble Phosphoric Acid,	17.22	6.78	12.28	19.42	3.38
Nitrogen,	2.72	4.76	3.59	2.78	2.05

PHOSPHORIC ACID COMPOUNDS.

722-727.
I. Apatite, received from Amherst, Mass.
II. South Carolina Rock Phosphate, received from Amherst, Mass.
III. Odorless Phosphate, received from Mansfield, Mass.
IV. Dissolved Bone Black, received from Amherst, Mass.
V. Acid Phosphate, received from Amherst, Mass.
VI. Acid Phosphate, received from Hudson, Mass.

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	none	.95	.23	14.52	16.22	13.20
Total Phosphoric Acid,	32.62	26.50	19.80	18.30	16.00	16.38
Soluble Phosphoric Acid,	none	none	none	15.78	13.82	9.78
Reverted Phosphoric Acid,	2.00	3.60	6.04	2.08	2.06	4.84
Insoluble Phosphoric Acid,	30.62	22.90	13.76	.44	.12	1.76

MISCELLANEOUS MATERIAL.

728-732.
I. Complete Fertilizer, received from Fitchburg, Mass.
II. Complete Fertilizer, received from Fitchburg, Mass.
III. Stable Refuse Material, received from Amherst, Mass.
IV. Castor Pomace, received from Sunderland, Mass.
V. Cotton Waste, received from Walpole, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.67	6.17	57.64	6.32	7.31
Total Phosphoric Acid,	2.48	3.20	.54	2.12	.66
Soluble Phosphoric Acid,	1.40	1.98	—	—	—
Reverted Phosphoric Acid,	1.08	.98	—	—	—
Insoluble Phosphoric Acid,	none	.24	—	—	—
Potassium Oxide,	12.08	12.06	1.01	1.20	1.12
Nitrogen,	8.30	8.22	.56	5.60	1.31

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
13	Blood, Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
284	Blood, Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Salem.
11	Ammoniated Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
289	Ammoniated Bone and Potash,	Armour Fertilizer Works, Chicago, Ill.,	Salem.
10	High Grade Potato Fertilizer,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
277	High Grade Potato Fertilizer,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
45	Cape Cod Asparagus Mixture,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
206	Cape Cod Asparagus Mixture,	Armour Fertilizer Works, Chicago, Ill.,	Orleans.
243	Eagle Brand for Grass and Grain,	W. H. Abbott, Holyoke, Mass.	Amherst.
244	Tobacco Fertilizer,	W. H. Abbott, Holyoke, Mass.	Amherst.
408	Cotton Hull Ashes,	American Cotton Oil Co., New York City,	Springfield.
130	Farquhar's Lawn and Garden Dressing,	Bartlett & Holmes, Springfield, Mass.,	Boston.
141	Farquhar's Complete Animal Fertilizer,	Bartlett & Holmes, Springfield, Mass.,	Boston.
102	A. A. Ammoniated Superphosphate,	East India Chemical Works, New York City,	New Bedford.
140	A. A. Ammoniated Superphosphate,	East India Chemical Works, New York City,	Boston.
378	A. A. Ammoniated Superphosphate,	East India Chemical Works, New York City,	Worcester.
110	Complete Potato Manure,	East India Chemical Works, New York City,	New Bedford.
380	Complete Potato Manure,	East India Chemical Works, New York City,	Worcester.
95	Complete Manure for General Use,	East India Chemical Works, New York City,	Fall River.
101	A. A. Ammoniated Superphosphate,	East India Chemical Works, New York City,	New Bedford.
193	Ammoniated Bone Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	North Amherst
361	Ammoniated Bone Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	Pittsfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
13-284	Blood, Bone and Potash,	6.05	4.72	4.11-4.94	5.24	4.53	2.20	11.97	10-12	9.77	8-10	6.56	7-8
11-289	Ammoniated Bone and Potash,	5.42	3.23	2.47-3.29	3.28	4.90	4.66	12.84	8-10	8.18	6-8	2.44	2-3*
10-277	High Grade Potato Fertilizer,	4.51	1.95	1.64-2.47	7.61	.78	1.82	10.21	10-12	8.39	8-10	10.58	10-12
45-206	Cape Cod Asparagus Mixture,	6.44	3.48	3.30-4.12	2.82	3.78	2.97	9.57	7-9	6.60	5-7	10.32	10-12
243	Eagle Brand for Grass and Grain,	4.70	3.23	3-4	—	6.14	8.88	15.02	14-18	6.14	5-8	11.68	10-11*
244	Tobacco Fertilizer,	4.97	4.57	4.5-5.5	—	4.81	7.11	11.92	14-16	4.81	5-8	12.10	10-11*
408	Cotton Hull Ashes,	8.05	—	—	—	—	—	10.38	10-12	—	—	24.48	20-30
130-141	Farquhar's Lawn and Garden Dressing,	7.17	3.51	3.30-4.12	—	9.70	7.11	16.81	14-17	9.70	4-5	7.52	7-8
102-140-378	A. A. Ammoniated Superphosphate,	12.80	2.51	2.5-3.25	6.52	2.95	1.69	11.16	10-14	9.47	9-12	2.20	2-3
110-380	Complete Potato Manure,	10.12	3.37	3.30-4.12	3.35	2.94	2.51	8.80	7-10	6.29	6-9	9.54	10-12
95	Complete Manure for General Use,	13.05	2.41	2.5-3.25	4.26	3.95	1.46	9.67	10-13	8.21	8-10	8.62	6-7
101	A. A. Ammoniated Superphosphate,	7.83	3.03	2.47-3.29	4.10	4.31	3.10	11.51	11-13	8.41	10-12	2.88	2-3
193-361	Ammoniated Bone Phosphate,	5.10	1.72	.82-1.65	2.17	5.35	5.99	13.51	10-12	7.52	8-10	2.18	2-3

* Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
199	Berkshire Potato Phosphate,	Berkshire Mills Co., Bridgeport, Conn.,	North Amherst
261	Fish, Bone and Potash,	Hiram Blanchard, Eastport, Me.,	Danvers.
33	Stockbridge's Potato and Vegetable,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
173	Stockbridge's Potato and Vegetable,	Bowker Fertilizer Co., Boston, Mass.,	Dighton.
61	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Hudson.
269	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Haverhill.
356	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Leominster.
26	Farm and Garden Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
70	Farm and Garden Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Hudson.
23	Market Garden,	Bowker Fertilizer Co., Boston, Mass..	Springfield.
346	Market Garden,	Bowker Fertilizer Co., Boston, Mass.,	Concord.
366	Market Garden,	Bowker Fertilizer Co., Boston, Mass.,	Williamstown.
21	Bone and Wood Ash Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
171	Bone and Wood Ash Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Dighton.
22	Peruvian Guano,	Bowker Fertilizer Co , Boston, Mass.,	Springfield.
345	Peruvian Guano,	Bowker Fertilizer Co., Boston, Mass..	Concord.
59	Ten Per Cent Manure,	Bowker Fertilizer Co., Boston, Mass.,	Hudson.
414	Dissolved Bone,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
104	Brightman's Fish and Potash,	W. J. Brightman, Tiverton, R. I.,	Fair Haven.
60	X. L. Superphosphate of Lime,	Bradley Fertilizer Co., Boston, Mass.,	Hudson.
78	X. L. Superphosphate of Lime,	Bradley Fertilizer Co., Boston, Mass.,	Weir.
229	X. L. Superphosphate of Lime,	Bradley Fertilizer Co., Boston, Mass.,	Orleans.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
199	Berkshire Potato Phosphate, ...	6.11	1.79	1.65-2.47	2.79	3.22	4.86	10.87	8-10	6.01	6-8	4.58	4-6
261	Fish, Bone and Potash, ...	21.50	3.47	4.47	—	2.68	1.82	4.50	5.15	2.68	—	4.80	6.00
33-173	Stockbridge's Potato and Vegetable,	10.49	3.53	3.20-4.20	5.25	3.02	1.07	9.34	8-10	8.27	6-8	10.36	10-12
61-269-356	Hill and Drill Phosphate, ...	12.22	2.57	2.25-3.25	6.40	5.04	1.94	13.38	10-13	11.44	9-11	2.20	2-3
26-70	Farm and Garden Phosphate, ...	10.96	2.22	1.5-2.5	4.86	4.61	1.79	11.26	11-14	9.47	8-11	2.10	2-3
23-346-366	Market Garden, ...	7.91	2.76	2.25-3.25	3.85	4.65	2.07	10.57	7-10	8.50	6-8	10.71	10-12
21-171	Bone and Wood Ash Fertilizer, ...	13.09	2.12	1.5-2.5	—	8.32	2.66	10.98	8-10	8.32	6-8	2.67	2-3
22-345	Peruvian Guano, ...	13.59	2.72	2.58	2.30	5.46	25.02	32.78	31-32	7.76	5.84	1.35	1.19
59	Ten Per Cent. Manure, ...	8.45	1.12	.75-1.50	2.24	4.05	2.28	8.57	8-10	6.29	6-8	9.42	10-12
414	Dissolved Bone, ...	4.77	2.05	—	5.50	6.16	3.38	15.04	—	11.66	—	—	—
104	Brightman's Fish and Potash, ...	14.15	2.21	2.07-2.90	2.17	4.13	3.12	9.42	7.5-10.5	6.30	6-8	2.92	2-3
60-78-229	X. L. Superphosphate of Lime, ...	13.75	2.58	2.5-3.25	8.21	1.74	.46	10.41	11-14	9.95	9-11	2.09	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
55	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Hudson.
77	Potato Manure,	Bradley Fertilizer Co,, Boston, Mass.,	Weir.
218	Potato Manure,	Bradley Fertilizer Co.. Boston, Mass.,	Orleans.
339	Potato Manure,	Bradley Fertilizer Co , Boston, Mass.,	Leominster.
395	Potato Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Gt. Barrington
399	Potato Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Spencer.
150	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
203	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Brockton.
273	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Haverhill.
398	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston. Mass.,	Dalton.
53	Corn Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Hudson.
315	Corn Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Lowell.
331	Corn Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Leominster.
149	Breck's Lawn and Garden Dressing,	Bradley Fertilizer Co., Bost n, Mass.,	Boston.
288	Eclipse Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Amesbury.
335	Eclipse Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Leominster.
225	Fish and Potash "B,"	Bradley Fertilizer Co., Boston, Mass.,	Foxboro.
139	English Lawn Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
265	English Lawn Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Haverhill.
365	English Lawn Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Fitchburg,
151	Breck's Market Garden Manure,	Joseph Breck & Sons, Boston, Mass.,	Boston.
76	Church's Fish and Potash "D,"	Joseph Church & Co., Tiverton, R. I.,	Weir.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
55-77-218-339	Potato Manure,	10.10	2.50	2.5-3.25	3.20	2.69	2.17	8.06	8-11	5.89	6-8	5.01	5-6
395 399	Potato Fertilizer,	11.72	2.13	2.06-2.88	6.33	2.44	1.82	10.59	10-13	8.77	7.5-9.5	3.38	3-4
150-203-273-398	Complete Manure for Potatoes and Veg'bles	10.70	3.33	3.30-4.12	5.88	2.59	1.59	10.06	9-13	8.47	8-11	7.46	7-8
53-315-331	Corn Phosphate,	13.60	2.17	2.06-2.88	6.08	3.03	1.79	10.90	10-13	9.11	8-10	1.56	1.5-2.5
149	Breck's Lawn and Garden Dressing,	7.74	5.26	4.12 4.94	.84	4.60	1.48	6.92	—	5.44	5-6	5.40	5-6
288-335	Eclipse Phosphate,	13.00	1.32	1.03-1.64	4.06	5.55	2.17	11.78	9-13	9.61	8-11	2.02	2-3
225	Fish and Potash "B,"	17.72	2.24	2.07-2.90	—	4.91	5.07	9.98	7.5-10.5	4.91	6-8	2.74	2-3
139-265-365	English Lawn Fertilizer,	7.67	5.13	4.95-5.78	1.28	5.18	1.23	7.69	6-8	6.46	5-7	2.92	2.5-3 5
151	Breck's Market Garden Manure,	12.77	2.64	2.5-3.25	6.72	3.88	.56	11.16	11-14	10.60	9-11	2.46	2-3
76	Church's Fish and Potash "D,"	14.95	2.49	2.07-2.50	3.01	2.74	3.97	9.72	7.5-10.5	5.75	6-8	2.22	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
51	Bay State Fertilizer G. G.,	Clark's Cove Fertilizer Co., Boston, Mass.,	Hudson.
386	Bay State Fertilizer, G. G.,	Clark's Cove Fertilizer Co., Boston, Mass.,	Spencer.
58	Potato Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Hudson.
18	Great Planet Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
66	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co., Boston, Mass.,	Hudson.
158	High Grade Complete Manure,	Cleveland Dryer Co., Boston, Mass.,	Dighton.
43	High Grade Ammoniated Bone Superphosphate,	E. Frank Coe Co., New York City,	Holyoke.
56	High Grade Ammoniated Bone Superphosphate,	E. Frank Coe Co., New York City,	Sterling.
38	Special Potato Fertilizer,	E. Frank Coe Co., New York City,	Holyoke.
330	Special Potato Fertilizer,	E. Frank Coe Co., New York City,	Ashburnham.
52	Gold Brand Excelsior Guano,	E. Frank Coe Co., New York City,	Sterling.
19	Excelsior Potato,	E. Frank Coe Co., New York City,	Springfield.
57	Excelsior Potato,	E. Frank Coe Co., New York City,	Sterling.
40	Columbian Potato Fertilizer,	E. Frank Coe Co., New York City,	Westfield.
325	Columbian Potato Fertilizer,	E. Frank Coe Co., New York City,	Ashburnham.
128	Potato, Hop and Tobacco,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fair Haven.
296	Potato, Hop and Tobacco,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Amesbury.
80	General Crop Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Taunton.
285	General Crop Phosphate	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Topsfield.
400	New England Potato and Tobacco Grower,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Worcester.
226	Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Orleans.
271	Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Georgetown.
364	Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Lanesboro.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
51-386	Bay State Fertilizer G. G.,	12.95	2.16	2.06-2.88	6.40	2.94	1.30	10.64	10-13	9.34	8-10	1.90	1.5-2.5
58	Potato Fertilizer,	12.15	2.16	2.06-2.50	6.70	1.54	1 97	10.21	9-13	8.24	8-11	3.02	3-4
18	Great Planet Manure,	11.35	3.34	3.30-4.12	5.76	3.32	1.92	11.00	9-12	9.08	8-11.5	8.23	7-8*
66	King Philip Alkaline Guano,	13.70	1.25	1.03-1.65	6.20	2.17	2.02	10.39	9 12	8.37	8-10	2 50	2-3
158	High Grade Complete Manure,	12.55	3.88	3.30-4.12	5.92	3.45	1.38	10.75	9-13	9.37	8-11	7.38	7-8
43-56	High Grade Ammoniated Bone Superphos',	13.05	1.79	1.85-2.00	7.93	1.40	1.54	10.87	11-13	9.33	9-12	2.57	2.25-3.00
38-330	Special Potato Fertilizer,	11.90	1.68	1.60-2.	6.01	3.07	2.69	11.77	10-11	9.08	8-10	4.09	4-5
52	Gold Brand Excelsior Guano,	8.32	2.74	2.40-3.00	4.48	2.43	2.56	9.47	8.25	6.91	7.25-9.25	6.54	6 5-7.5
19-57	Excelsior Potato,	7.33	3.42	2 5-3.00	4.99	2.30	2.43	9.72	9-11	7.29	7-10	8.08	8-10
40-325	Columbian Potato Fertilizer,	10.98	1.33	1 20-2.00	6.81	1.86	3.71	12.38	9-10	8.67	8.5-10.5	2.50	2.5-3.00
128-296	Potato, Hop and Tobacco,	12.42	2.36	2.05-3.00	4.60	6.35	1.23	12.18	10-12	10.95	8-10	3.30	3.5
80-285	General Crop Phosphate,	10.42	1.20	.82-1.64	3.10	3 65	2 38	9 13	8-12	6.75	7-10	1.24	1.09-2.5
400	New England Potato and Tobacco Grower,	18.77	3.62	3.29-5.00	5.59	2.03	.64	8.26	7-10	7.62	6-8	5.30	5.4-6.5
226-271-364	Superphosphate,	14.03	2.16	2.06-2.88	5.19	3.46	2.17	10.82	10-13	8.65	8-10	1.76	1.5-2.5

* Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
275	Cumberland Potato Fertilizer,	Cumberland Bone Phosphate Co., Boston, Mass.,	Georgetown.
292	Cumberland Potato Fertilizer,	Cumberland Bone Phosphate Co., Boston, Mass.,	Amesbury.
211	Potato Manure "Special,"	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Bridgewater.
377	Farm Favorite,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord.
343	Bone, Blood and Potash,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord.
401	Bone, Blood and Potash,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
376	Complete 10% Manure,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord.
402	Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
418	Wood Ashes,	Wm. E. Fyfe & Co., Clinton, Mass ,	Clinton.
176	Market Garden Special,	Farmers' Union Fertilizer Co., Peabody, Mass.,	Dighton
159	Complete Potato Fertilizer,	Farmers' Union Fertilizer Co., Peabody, Mass.,	Dighton.
370	Northern Corn Special,	Great Eastern Fertilizer Co., Rutland, Vt.,	Lanesboro.
327	Vegetable, Vine and Tobacco,	Great Eastern Fertilizer Co., Rutland, Vt.,	S. Ashburnham
321	General Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	S. Ashburnham
412	Unleached Canada Hardwood Ashes,	F. E. Hancock, Walkerton, Ontario, Canada,	Northfield.
105	Bone Fertilizer for Corn and Grain,	Lowell Fertilizer Co., Boston, Mass.,	Fall River.
117	Bone Fertilizer for Corn and Grain,	Lowell Fertilizer Co., Boston, Mass.,	New Bedford.
8	Animal Brand for all Crops,	Lowell Fertilizer Co., Boston, Mass.,	Sunderland.
118	Animal Brand for all Crops,	Lowell Fertilizer Co., Boston, Mass.,	New Bedford.
239	Animal Brand for all Crops,	Lowell Fertilizer Co., Boston, Mass.,	Mansfield.
3	Potato Phosphate,	Lowell Fertilizer Co., Boston, Mass.,	Sunderland.
121	Potato Phosphate,	Lowell Fertilizer Co., Boston, Mass.,	No. Westport.
200	Potato Phosphate,	Lowell Fertilizer Co., Boston, Mass.,	No. Amherst.
237	Potato Phosphate.	Lowell Fertilizer Co., Boston, Mass.,	Mansfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
275-292	Cumberland Potato Fertilizer,	12.55	2.32	2.06-2.88	4.34	4.53	2.30	11.17	10-13	8.87	8-10	3.00	3-4
211	Potato Manure "Special,"	8.97	2.68	2.48	7.27	2.79	.51	10.57	7	10.06	6	5.52	5
377	Farm Favorite,	7.84	2.62	2.06	4.45	5.02	.61	10.08	9	9.47	8	3.86	3
343-401	Bone, Blood and Potash,	8.18	4.30	4.12	4.95	3.06	.56	8.57	8	8.01	7	7.18	7
376	Complete 10% Manure,	8.80	3.72	3.30	3.84	4.48	.51	8.83	7	8.32	6	9.78	10
402	Animal Fertilizer,	8.27	4.24	3.30	6.40	3.32	.38	10.10	10	9.72	8	4.18	4
418	Wood Ashes,	1.08	—	—	—	—	—	1.64	1-3	—	—	6.06	4.5-8
176	Market Garden Special,	10.00	3.44	3.29-4.12	3.39	6.26	1.33	10.98	9-13	9.65	8-11	7.30	7-9
159	Complete Potato Fertilizer,	10.42	2.02	1.64-2.47	3.20	4.19	1.59	8.98	7-10	7.39	6-8	6.76	6-6.5
370	Northern Corn Special,	13.13	2.53	2.47-3.50	6.55	3.81	1.66	12.02	9-15	10.36	8-12	2.90	2-4
327	Vegetable, Vine and Tobacco,	13.21	2.11	2.06-2.88	5.62	4.36	2.04	12.02	9-15	9.98	8-12	5.72	6-8
321	General Fertilizer,	11.80	1.19	.82-1.50	4.67	3.37	3.45	11.49	9-15	8.04	8-12	3.70	4-6
412	Unleached Canada Hardwood Ashes,	8.11	—	—	—	—	—	2.04	1-2	—	—	7.12	5-7
105-117	Bone Fertilizer for Corn and Grain,	8.23	1.83	1.65-2.5	5.25	3.26	2.75	11.26	9-12	8.51	8-10	3.22	3-4
8-118-239	Animal Brand for All Crops,	7.84	3.56	2.46-3.25	4.96	2.92	3.20	11.08	10-12	7.88	9-11	4.07	4-5
3-121-200-237	Potato Phosphate,	5.55	2.52	2.48-3.30	2.56	6.75	.95	10.26	9-12	9.31	8-10	6.30	6-7

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
382	Fruit and Vine for Strawberries,	Lowell Fertilizer Co., Boston, Mass.,	Marlboro.
250	Success Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Amherst.
249	Special Potato Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Amherst.
246	Special Tobacco Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Amherst.
68	Economical Potato Manure,	Mape's Formula and Peruvian Guano Co., New York City	Taunton.
192	Economical Potato Manure,	Mape's Formula and Peruvian Guano Co., New York City	So. Deerfield.
340	Economical Potato Manure,	Mape's Formula and Peruvian Guano Co., New York City	Fitchburg.
54	Mape's Potato Manure,	Mape's Formula and Peruvian Guano Co., New York City	Ware.
74	Mape's Potato Manure,	Mape's Formula and Peruvian Guano Co., New York City	Taunton.
341	Mape's Potato Manure,	Mape's Formula and Peruvian Guano Co., New York City	Fitchburg.
190	Tobacco Manure "Wrapper Brand,"	Mape's Formula and Peruvian Guano Co., New York City	So. Deerfield.
125	Complete Fertilizer for Roots,	National Fertilizer Co., Bridgeport, Conn.,	New Bedford.
169	Complete Fertilizer for Roots,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
337	Complete Fertilizer for Roots,	National Fertilizer Co., Bridgeport, Conn.,	Leominster.
347	Complete Fertilizer for Roots,	National Fertilizer Co., Bridgeport, Conn.,	Concord.
108	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	New Bedford.
163	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
5	Special Mixture,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
136	Complete Tobacco Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	So. Deerfield.
258	Soluble Pacific Guano,	Pacific Guano Co., Boston, Mass.,	Haverhill.
280	Soluble Pacific Guano,	Pacific Guano Co., Boston, Mass.,	Newburyport.
96	Nobsque Guano,	Pacific Guano Co., Boston, Mass.,	N. Westport.
306	Nobsque Guano,	Pacific Guano Co., Boston, Mass.,	Lowell.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
382	Fruit and Vine for Strawberries, ...	5.32	3.29	3.29-4.12	3.84	1.69	2.15	7.68	9-10	5.53	7-8	6.00	6-7
250	Success Fertilizer, ...	10.40	.84	1.24-1.65	5.63	2.40	1.77	9.80	9 5-11	8.03	—	4.22	2-3
249	Special Potato Fertilizer, ...	11.49	1.87	1.65-2.47	6.97	1.39	3.56	11.92	—	8.36	8-10	3.02	3-4
246	Special Tobacco Fertilizer, ...	10.63	1.93	1.65-2.47	5.42	3.62	3.04	12.08	8.5-10	9.04	—	2.46	4-5
68-192-340	Economical Potato Manure, ...	5.86	3.50	3.29-4.12	2.33	2.36	1.66	6.35	6-8	4.69	4-5	8.84	8-10
54-74-341	Mape's Potato Manure, ...	4.35	3.85	3.71-4.12	2.88	4.66	2.69	10.23	8-10	7.54	8	6.45	6-8
190	Tobacco Manure "Wrapper Brand," ..	3.77	6.24	6.18	.26	3.44	2.84	6.54	4.50	3.70	—	10.90	10.50*
125-169-337-347	Complete Fertilizer for Roots, ...	9.50	3.44	3.7-4.5	3.96	4.16	2.71	10.83	10-12	8.12	8-10	6.38	6-7
108-163	Fish and Potash, ...	6.70	2.68	2.47-3.30	2.21	2.32	4.78	9.31	8-9	4.53	—	3.52	3 4
5	Special Mixture, ...	7.60	3.81	3.30	4.09	2.25	.54	6.88	7	6.34	—	5.52	5
136	Complete Tobacco Fertilizer, ...	9.65	3.46	3.30-4.10	5.88	2.56	2.94	11.38	10-12	8.44	8-11	5.28	5.4-6.48*
258-280	Soluble Pacific Guano, ...	13.97	2.20	2.06-2.88	4.53	3.91	2.61	11.05	10-13	8.44	8-10	1.64	1.5-2.5
96-306	Nobsque Guano, ...	14.95	1.51	1.03-2.47	5.44	2.06	2.99	10.49	9-14	7.50	8-12	2.22	2-3

* Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
233	Animal Corn Fertilizer,	Packers' Union Fertilizer Co., New York City,	Foxboro.
227	Potato Manure,	Packers' Union Fertilizer Co., New York City,	Foxboro.
167	Special Fertilizer for Strawberries,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
278	P. & P. Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
36	Quinnipiac Phosphate,	The Quinnipiac Co., Boston, Mass.,	Springfield.
371	Quinnipiac Phosphate,	The Quinnipiac Co., Boston, Mass.,	Pittsfield.
37	Corn Manure,	The Quinnipiac Co., Boston, Mass.,	Springfield.
34	Market Garden,	The Quinnipiac Co., Boston, Mass.,	Springfield.
93	Market Garden,	The Quinnipiac Co., Boston, Mass.,	Fall River.
35	Grass Fertilizer,	The Quinnipiac Co., Boston, Mass.,	Springfield.
208	Grass Fertilizer,	The Quinnipiac Co., Boston, Mass.,	Bridgewater.
100	Potato Phosphate,	The Quinnipiac Co., Boston, Mass.,	Fall River.
216	Potato Phosphate,	The Quinnipiac Co., Boston, Mass.,	W. Br'gewater
46	Grass and Grain Fertilizer,	Rogers & Hubbard Co., Middletown, Conn.,	Easthampton.
112	Grass and Grain Fertilizer,	Rogers & Hubbard Co., Middletown, Conn.,	Acushnet.
49	Soluble Tobacco Manure,	Rogers & Hubbard Co., Middletown, Conn.,	Easthampton.
48	All Soils and All Crops,	Rogers & Hubbard Co., Middletown, Conn.,	Easthampton.
127	All Soils and All Crops,	Rogers & Hubbard Co., Middletown, Conn.,	Acushnet.
44	Complete Corn Fertilizer,	Rogers Manufacturing Co., Rockfall, Conn.,	Westfield.
39	Fish and Potash,	Rogers Manufacturing Co., Rockfall, Conn.,	Westfield.
81	Essex Fish and Potash XXX,	Russia Cement Co., Gloucester, Mass.,	Taunton.
160	Essex Fish and Potash XXX,	Russia Cement Co., Gloucester, Mass.,	Dighton.
392	Essex Fish and Potash XXX,	Russia Cement Co., Gloucester, Mass.,	Williamstown.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
233	Animal Corn Fertilizer,	12.00	2.64	2.47-3.30	4.50	2.92	2.99	10.41	10-16	7.42	9-13	2.50	2-4
227	Potato Manure,	13.62	2.08	2.06-2.47	4.94	4.20	1.07	10.21	10-14	9.14	9-12	6.12	6-8
167	Special Fertilizer for Strawberries,	10.25	2.67	2.47-3.29	3.51	5.93	2.02	11.46	10-13	9.44	9-11	6.08	6-7
278	P. & P. Potato Fertilizer,	7.65	1.90	1.64-2.47	1.48	4.77	3.34	9.59	7-10	6.25	6-8	6.57	6-6.50
36-371	Quinnipiac Phosphate,	14.24	2.52	2.47-3.30	6.91	3.07	1.79	11.77	10-14	9.98	9-12	2.38	2-3
37	Corn Manure,	15.28	2.04	2.06-2.88	6.65	2.69	1.92	11.26	10-13	9.34	8-10	1.90	1.5-2.5
34-93	Market Garden,	12.89	3.42	3.30-4.12	7.06	1.74	1.05	9.85	9-13	8.80	8-11	7.03	7-8
35-208	Grass Fertilizer,	7.10	4.25	3.91-4.74	2.17	3.84	1.79	7.80	6-9	6.01	5-8	3.08	2-3
100-216	Potato Phosphate,	13.05	2.17	2.05-2.88	6.40	1.58	2.89	10.87	9-14	7.98	8-12	3.18	3-4
46-112	Grass and Grain Fertilizer,	5.83	2.91	2.5-3.00	.51	5.86	9.72	16.09	16.5-18	6.37	6.60	12.28	12.5-13.5
49	Soluble Tobacco Manure,	6.30	5.64	5-6	3.80	4.51	2.56	10.87	10-12	8.31	7-8.5	10.54	10-11*
48-127	All Soils and All Crops,	9.25	2.35	2.30-3.00	7.93	.44	2.43	10.80	11-14	8.37	9.80-12	3.71	3-4
44	Complete Corn Fertilizer,	6.30	3.95	3.60-4.00	2.69	3.68	4.20	10.57	8-9	6.37	6-7	11.60	7-8
39	Fish and Potash,	7.07	3.31	3.25-3.50	2.00	3.22	4.17	9.39	6-8	5.22	4-5	4.20	3.75-4.50
81-160-392	Essex Fish and Potash XXX,	7.38	2.55	2.1-3.00	3.45	7.47	3.66	14.58	12-14	10.92	9-10	2.80	2.25-3.25

* Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
9	Potato Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Sunderland.
79	Potato Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Taunton.
183	Potato Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Dighton.
6	Complete Manure for Potatoes, Roots and Vegetables,	Russia Cement Co., Gloucester, Mass.,	Sunderland.
82	Complete Manure for Potatoes, Roots and Vegetables,	Russia Cement Co., Gloucester, Mass.,	Taunton.
165	Complete Manure for Potatoes, Roots and Vegetables,	Russia Cement Co., Gloucester, Mass.,	Dighton.
86	Complete for Corn, Grain and Grass,	Russia Cement Co., Gloucester, Mass.	Taunton.
379	Complete for Corn, Grain and Grass,	Russia Cement Co., Gloucester, Mass.,	Spencer.
2	Special Tobacco Manure,	Russia Cement Co., Gloucester, Mass.,	Sunderland.
4	Tobacco Starter,	Russia Cement Co., Gloucester, Mass.,	Sunderland.
235	Standard Fertilizer,	Standard Fertilizer Co., Boston, Mass.,	Foxboro.
234	Standard Special for Potatoes,	Standard Fertilizer Co., Boston, Mass.,	Foxboro.
290	Tobacco Stems,	F. C. Sturtevant, Hartford, Conn.,	Amesbury.
417	Tobacco Stems,	F. C. Sturtevant, Hartford, Conn.,	Worcester.
270	Original Bay State Bone Superphosphate,	Henry F. Tucker Co., Boston, Mass.,	Haverhill.
89	Champion Animal Fertilizer,	Darius Whithed, Lowell, Mass.,	Amherst.
115	Potato, Onion and Tobacco Manure,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
124	Wilcox Potato Manure,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
97	Fish and Potash,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
374	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
241	Potato Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Foxboro.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs. Found.	Nitrogen in 100 lbs. Guaranteed.	Phosphoric Acid in 100 lbs. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in 100 lbs. Found.	Guaranteed.
	Compound Fertilizers.												
9-79-183	Potato Fertilizer, ...	6.78	2.68	2-2.5	3.33	7.57	3.79	14.69	11-13	10.90	9-10	5.64	5-6
6-82-165	Complete Manure for Pot., Roots and Veg.,	6.87	4.10	3.1-4.5	4.22	5.25	2.30	11.77	9-11	9.47	7-8	9.21	8.5-10*
86-379	Complete for Corn, Grain and Grass, ..	6.30	4.54	3.7-4.50	4.48	3.84	3.71	12.03	9.5-11	8.32	7-8	9.80	9.5-11
2	Special Tobacco Manure, ...	3.96	4.78	4.5-5.3	4.86	4.27	1.54	10.67	8·5-9.5	9.13	7-8	12.07	12-13*
4	Tobacco Starter, ...	6.65	2.84	2.5-3.00	3.97	6.90	3.84	14.71	12-14	10.87	9-11	3.29	2.3-3
235	Standard Fertilizer, ...	13.26	2.22	2.06-2.88	6.33	3.11	1.28	10.72	10-13	9.44	8-10	2.02	2-2.5
234	Standard Special for Potatoes, ...	10.32	2.07	2.05-2.88	6.20	2.58	2.15	10.93	9-14	8.78	8-12	3.56	3-4
290-417	Tobacco Stems, ...	7.32	2.50	1.96	—	—	—	.77	.75	—	—	8.18	7.66
270	Original Bay State Bone Superphosphate,	12.60	2.30	2.06-2.47	6.27	3.55	2.41	12.23	11-15	9.82	9-12	2.24	2-3
89	Champion Animal Fertilizer, ...	3.87	4.38	4.75	—	6.93	6.55	13.48	13.56	6.93	—	9.16	7.46
115	Potato, Onion and Tobacco Manure, ..	12.07	3.46	3.30-4.30	4.73	2.74	2.84	10.31	8-10	7.47	7-9	7.04	6-7
124	Wilcox Potato Manure, ...	10.99	2.91	2-3.09	1.73	3.36	6.60	11.69	7-8	5.09	5-8	4.92	4.5-5.5
97	Fish and Potash, ...	20.85	2.94	2.5-3.5	3.52	1.08	2.15	6.75	6-8	4.60	5-7	4.40	3-4
374	Ammoniated Bone Superphosphate, ..	12.50	2.53	2.47-3.30	4.03	4.62	4.45	13.10	10-13	8.65	9-11	2.16	2-3
241	Potato Phosphate, ...	10.61	2.58	2.47-3.30	4.09	1.95	2.20	8.24	7-10	6.04	6-9	5.00	5-6

* Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
253	Potato Manure,	Williams & Clark Fertilizer Co., Boston, Mass.,	Danvers.
236	Royal Bone Phosphate for all Crops,	Williams & Clark Fertilizer Co., Boston, Mass.,	Foxboro.
197	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.	N. Amherst.
257	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Danvers Cent'r
291	Superior Truck Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amesbury.
262	Bermuda Onion Grower,	M. E. Wheeler & Co., Rutland, Vt.,	Danvers Cent'r
	Ground Bone and Tankage.		
299	Armour's Bone Meal,	Armour Fertilizer Works, Chicago, Ill.,	Salem.
351	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Leominster.
410	Ground Bone,	Berkshire Mills Co., Bridgeport, Conn.,	Furnace.
29	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
135	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
177	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Dighton.
31	Tankage,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
90	Dow's Pure Ground Bone,	John C. Dow Co., Boston, Mass.,	Amherst.
238	Dow's Pure Ground Bone,	John C. Dow Co., Boston, Mass.,	Mansfield.
116	Meat and Bone,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
416	Tankage,	Thomas Kirley, South Hadley Falls, Mass.,	S. Hadley Falls
352	Tankage,	Lowe Bros. & Co., Fitchburg, Mass.,	Fitchburg.
300	Pure Ground Bone,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Beverly.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs. Found.	Nitrogen in 100 lbs. Guaranteed.	Phosphoric Acid in 100 lbs. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in 100 lbs. Found.	Potassium Oxide in 100 lbs. Guaranteed.		
	Compound Fertilizers.														
253	Potato Manure,	11.95	2.08	2.06-2.88	1.66	6.22	1.84	9.72	9-13	7.88	8-11	3.44	3-4		
236	Royal Bone Phosphate for All Crops,	14.07	1.22	1.03-1.64	6.14	1.68	2.57	10.39	10-13	7.82	8-10	2.26	2-3		
197-257	Corn Fertilizer,	14·02	1.95	1.64-2.47	6.56	3.50	1.97	12.03	9-14	10.06	8-12	2.62	2-3		
291	Superior Truck Fertilizer,	7.17	3.72	3.29-4.10	3.55	4.33	2.92	10.80	8-11	7.88	7-9	8.00	8-10		
262	Bermuda Onion Grower,	13.46	1.15	.82-1.64	5.82	3.18	1.18	10.18	10-15	9.00	8-12	4.04	4-6		
												Mechanical Analyses. Fine Bone.	Fine Med.	Med.	Course Med.
	Ground Bone and Tankage.														
299	Armour's Bone Meal,	10.72	3.01	2.47-3.29	—	8.44	16.61	25.15	24-28	8.44	10-14	36.81	27.10	27.64	8.45
351	Pure Ground Bone,	3.77	3.37	2-3	.18	6.10	20.72	27 00	27-29	6.28	—	67.86	30.72	1.42	—
410	Ground Bone,	3.92	2.78	—	—	6.86	19.42	26.28	—	6.86	—	66 78	25.35	7.87	—
29-135-177	Fresh Ground Bone,	5.35	2.69	2.25-3.25	.41	10.27	14.90	25.58	24-26	10 68	5-7	69.84	17.06	11.80	1.30
31	Tankage,	8.35	5.21	4.94-5.77	—	8.04	7.34	15.48	14-16	8.04	—	68.04	23.00	8.96	—
90-238	Dow's Pure Ground Bone,	2.99	2.06	2.06-2.47	—	7.29	18.22	25.51	26-28	7.29	—	58.50	41.50	—	—
116	Meat and Bone,	3.60	4.66	2-4.24	—	8.11	10.72	18.83	19.52	8.11	6.73	64.50	24.00	11.50	—
416	Tankage,	9.60	3.11	—	—	12.66	10.82	23.48	—	12.66	—	53.63	18.26	17.03	11.08
352	Tankage,	4.77	3.89	3-4	—	7.75	14.43	22.18	22-24	7.75	—	13.15	12.14	14.90	59.81
300	Pure Ground Bone,	4.50	2.00	2-3	—	6.01	16.53	22.54	16-20	6.01	6-8	61.51	23.64	14.05	.80

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Bone and Tankage.		
47	Raw Knuckle Bone Flour,	Rogers & Hubbard Co., Middletown, Conn.,	Easthampton.
111	Raw Knuckle Bone Flour,	Rogers & Hubbard Co., Middletown, Conn.,	Acushnet.
7	Blood, Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
91	Pure Ground Bone,	Thomas L. Stetson, Randolph, Mass.,	Randolph.
207	Pure Ground Bone,	Thomas L. Stetson, Randolph, Mass.,	Brockton.
87	Pure Ground Bone,	A. L. Warren, Northboro, Mass.,	Northboro.
383	Pure Ground Bone,	A. L. Warren, Northboro, Mass.,	Worcester.
219	Pure Ground Bone,	Sanford Winter, Brockton, Mass.	W. Br'gewater
411	Pure Ground Bone,	Sanford Winter, Brockton, Mass.,	Brockton.
354	Tankage,	J. M. Woodard & Bro., Greenfield, Mass.,	Greenfield.
	Chemicals.		
15	Cotton Seed Meal,	American Cotton Oil Co., New York City,	N. Hadley.
16	Cotton Seed Meal,	American Cotton Oil Co., New York City,	N. Hadley.
17	Dissolved Bone Black,	Bowker Fertilizer Co., Boston Mass.,	Springfield.
349	Dissolved Bone Black,	Bowker Fertilizer Co., Boston, Mass..	Concord.
144	Sulphate of Ammonia,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
413	Sulphate of Ammonia,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
282	Acid Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Amesbury.
415	Acid Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
148	Dissolved Bone Black,	Bradley Fertilizer Co., Boston, Mass,,	Boston.
32	Dissolved Bone Black,	E. Frank Coe Co., New York City,	Springfield.
1	Dissolved Bone Black,	Lucien Sanderson, New Haven, Conn.,	Sunderland.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Mechanical Analyses.			
								Total.		Available.					
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Fine Bone.	Fine Medium.	Medium.	Coarse Medium.
	Ground Bones.														
47-111	Raw Knuckle Bone Flour,	8.40	3.58	3.5-4.00	.38	7.37	17.58	25.33	24.5-26.	7.75	—	52.05	42.88	5.07	—
7	Blood, Bone and Meat,	8.00	7.16	5 77-7.41	1.28	6.27	2.94	10.49	10-12	7.55	—	71.61	12.23	8.83	7.33
91-207	Pure Gronnd Bone,	6.35	4.16	4.20	—	6.75	14.28	21.03	20.66	6.75	—	32.86	31.93	27.09	8.12
87-383	Pure Ground Bone,	8.70	2.67	3 92	—	6.22	19.85	26.07	22.72	6.22	—	64.27	23.06	8.92	3.75
219-411	Pure Ground Bone,	4.12	3.59	4.04	—	9.54	12.28	21.82	20.64	9.54	4.58	47.25	45.93	5.26	1.56
354	Tankage,	5 75	4.33	—	—	8.44	14.43	22.87	—	8.44	—	38.41	18.65	16.18	26.76
	Chemicals.														
15-16	Cotton Seed Meal,	5.70	7.64	7	—	—	—	—	—	—	—	—	—	—	—
17-349	Dissolved Bone Black,	12.35	—	—	16.12	2.15	.28	18.55	16-20	18.27	15.18	—	—	—	—
144-413	Sulphate of Ammonia,	.47	21.15	19-20	—	—	—	—	—	—	—	—	—	—	—
282-415	Acid Phosphate,	16.22	—	—	13.82	2.06	.12	16.00	15-17	15.88	13.15	—	—	—	—
148	Dissolved Bone Black,	10.67	—	—	13.56	2.56	.43	16.55	16-19	15.12	15-18	—	—	—	—
32	Dissolved Bone Black,	11.80	—	—	14.20	3.82	.92	18.94	—	18.02	—	—	—	—	—
1	Dissolved Bone Black,	12.38	—	—	14.71	2.38	.31	17.40	16-18	17.09	16-18	—	—	—	—

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1900. Cents per pound.
Nitrogen in ammonia salts,	17.0
" nitrates,	13.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	15.5
" " " fine bone and tankage,	15.5
" " " medium bone and tankage,	11.0
Phosphoric acid soluble in water,	4.5
" " soluble in ammonium citrate,	4.0
" " in fine ground fish, bone and tankage,	4.0
" " in cottonseed meal, castor pomace and wood ashes,	4.0
" " in coarse fish, bone and tankage,	3.0
" " insoluble (in water and in am. cit.) in mixed fertilizers,	2.0
Potash as Sulphate, free from Chlorides,	5.0
" " Muriate,	4.25

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy action, exert as a rule, a decided influence on their selling price.

The market cost of the different essential elements of plant food, with the exception of the nitrogen compounds, compares favorably with the prices of the same ingredients for the year 1899. Nitrogen compounds show a material increase in cost as compared with the previous year.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 69.

THE ROTTING OF GREENHOUSE LETTUCE.

SEPTEMBER, 1900.

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.
1900.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry T. Fernald, Ph. D.,	*Associate Entomologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Samuel W. Wiley, B. Sc.,	*Assistant Chemist* (Fertilizers).
Louis E. Goessmann,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, M. Sc.,	*First Chemist* (Foods and Feeding).
Frederick W. Mossman, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Philip H. Smith, B. Sc.,	*Assistant in Foods and Feeding.*
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Henry L. Crane, B. Sc.,	*Assistant Horticulturist.*
Charles L. Rice,	*Observer.*

The co-operation 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 BOTANY.

G. E. Stone and R. E. Smith.

The Rotting of Greenhouse Lettuce.

For the past five years this Division has been carrying on continuous investigations upon the growth of greenhouse lettuce, with particular reference to the troubles or diseases with which the growers of this crop have to contend. Frequent reference has been made to this work in our annual reports, but no systematic account and no definite results or conclusions have yet been given. The problem has proved to be of so complicated a nature as the investigation proceeded that it has been impossible to arrive at fixed conclusions except by observation and experiment on a large number of crops, together with a considerable amount of laboratory work. For this purpose seven crops of lettuce have been grown in our own house, each comprising experiments which have suggested themselves from time to time. Besides this we have been in communication with several of the largest lettuce growers in the State, visiting their establishments and exchanging suggestions with them, and by this means much valuable information has been obtained. The experiments of the past winter have brought the work to such a point of completeness that we now feel able to publish our observations and conclusions in definite form.

It is not the intention of the present bulletin to present the technical side of these investigations, although much of the work has been of that nature. One of the writers has already published (Botanical Gazette 29: 369. June, 1900.) an extended article on this subject, to which reference may be made by those wishing a more detailed account of that portion of the work which deals with the life-history and relations of the fungi under consideration. The results of this study have shed much new light upon the subject, showing especially the existence and common occurrence of a very destructive disease which we designate here as the "Drop," hitherto entirely unrecognized in lettuce. This disease has previously been confused with another much less important one which is similar to it in many ways, but differs radically in several very important respects. This is the trouble caused by the attacks of Botrytis. We have shown that the more destructive disease is caused by a fungus entirely distinct from that to which the disease has been generally ascribed and the life-history of which in the greenhouse we have been able to trace out very completely. Another disease of lettuce has also been found which has not previously been described. This is caused by a species of Rhizoctonia, the development of which has been found to be similar to that of the Drop in many respects. Peculiarities have been found in the development and growth of these fungi which make their control possible and methods have been developed by which this result can be practically and economically attained.

Lettuce Growing in Massachusetts.

It is probable that very few people outside of the district have any idea of the extent to which lettuce is grown in greenhouses in the vicinity of Boston. Located particularly in the towns of Arlington and Belmont, this industry has seen in the past few years an almost phenomenal development. Individual growers estimate the space in their establishments covered by modern forcing houses in acres, and single houses with a length of five and even six hundred feet or more are to be seen. Greenhouse lettuce is also grown in other parts of the Commonwealth and the industry is increasing near all the larger cities and towns, but no other portion of the State and very few in the entire country can compare with the Boston district, where a large part of the lettuce for the markets of New England, as well as New York city and beyond, is grown. No better example can be found of a highly specialized agricultural industry. From the time when the first crop is matured in early winter until (according to the general practice) cucumbers or tomatoes are put into the houses in the spring, lettuce is turned out very nearly as regularly and methodically as are the products of the mill or factory and handled by equally business-like methods.

Lettuce as a Crop.

Lettuce is not an easy crop to grow under glass successfully and profitably. This is true for two reasons, one from the nature of the marketable product, the other on account of the peculiarities of the plant itself. Cucumbers and tomatoes may be gathered, to some extent at least, from plants poorly grown, more or less diseased, or in other ways not well developed. This will of course cause a loss, but not a total loss, in the product. But with lettuce the case is different. Here the whole plant is marketed and forms the edible portion. Consequently it must be well grown, sound, perfect, and of good size and texture, or, in competition with the large amount of lettuce of the best quality which is almost always on the market, the small margin of profit which even the best goods bring will fail to be realized. This, therefore, is one reason why it is not easy to grow lettuce on a large scale with profit. Furthermore, there is no crop grown under glass so easily influenced by unfavorable conditions or improper handling. This applies particularly to temperature and moisture, conditions toward which this plant is vitally sensitive. With this combination of circumstances, a most sensitive plant to handle and a perfect product demanded, it is to be expected that much failure would occur. Even the best growers have trouble with their crops, sometimes experiencing severe loss, and the fact that they reach the success they usually do shows their great practical knowledge of the plant and its growth. In fact it may be said that the lettuce growers of the Boston district, with a few others in various parts of the state, cultivate this crop with a degree of skill and success unequalled by any other class of vegetable growers, and represent to-day the most successful, the most skillful, and above all the most business-like, up-to-date, and thoroughly wide awake agriculturists of the State.

THE TROUBLES OR DISEASES WHICH AFFECT GREENHOUSE LETTUCE.

BIBLIOGRAPHY.

1. HUMPHREY, J. E. The rotting of lettuce. Rept. Mass. State Exp. Sta. 9: 219. 1892.

2. JONES, L. R. (*a*) Lettuce mildew and lettuce rot. Rept. Vt. Exp. Sta. **5**: 141. 1892. (*b*) Lettuce rots. Rept. Vt. Exp. Sta. **6**: 84. 1893.

3. TAFT, L. R. Lettuce mildew. Am. Gard. **15**: 375. 1894.

4. GALLOWAY, B. T. The growth of lettuce as affected by the physical properties of the soil. Agrl. Science **8**: 302. 1894.

5. PAMMEL, L. H. Diseases of lettuce and radishes. Am. Gard. **16**: 150. 1895.

6. BAILEY, L. H. Lettuce. Bull. Cornell Univ. Exp. Sta. 96: 387. 1895.

7. HALSTED, B. D. Some of the more injurious fungi upon market-garden crops: Lettuce. Rept. N. J. Agrl. Coll. Exp. Sta. **7**: 349. 1895.

8. SELBY, A. D. Lettuce rot. Bull. Ohio Exp. Sta. 73: 221. 1896.

9. STONE, G. E., and SMITH, R. E. (*a*) "Drop" of lettuce. Rept. Hatch Exp. Sta. Mass. Agrl. Coll., **9**: 79. 1897. (*b*) The "drop" of lettuce. Rept. Hatch Exp. Sta. Mass. Agrl. Coll. **10**: 55. 1898. (*c*) Further considerations in regard to the "drop" in lettuce. Rept. Hatch Exp. Sta. Mass. Agrl. Coll. **11**: 149. 1899.

10. KINNEY, L. F. Garden lettuce and its cultivation. Rept. R. I. Exp. Sta. **10**: 270. 1898.

11. GARMAN, H. A method of avoiding lettuce rot. Bull. Ky. Exp. Sta. 81: 3. 1899.

12. WHITE, F. H. Notes on Heart-Rot of Lettuce. Am. Gard. **21**: 486. 1900.

It has just been said that lettuce is a plant very sensitive to improper conditions and treatment. The effects of such circumstances may be simply a poor development, but often more serious results occur and the plant falls a prey to disease which brings about its destruction. The diseases of lettuce have not been well understood. A number have been described and practical growers distinguish several different forms, but very little definite knowledge of the subject exists. The worst troubles with which Massachusetts growers have to contend may be classed in general as *rotting* of the crop, in various forms and at various stages of the growth of the plant. That is, the plant is spoiled by a part or all of it decaying before it reaches maturity. This may or may not kill the plant, but in any event it is almost always spoiled for market. The nature of the trouble of this sort varies a good deal in different cases and many growers distinguish several forms of rotting by distinctive names. It is generally believed and undoubtedly demonstrated in a practical way that much of this rotting can be controlled by the handling of the crop, but in general it is a fact that the whole subject of the cause and prevention of the rotting of greenhouse lettuce is not at all understood, either by practical growers or vegetable pathologists. Various diseases of lettuce other than rotting are known, but they are seldom or never troublesome to experienced growers in this section. The most trouble is caused by certain forms of rotting, which may now be described.

"Damping Off" or Rotting of Seedlings.

All lettuce growers and gardeners generally are familiar with the dying of seedlings, prickers, and cuttings by what is known as "Damping Off." This is not often destructive to lettuce, owing to the low temperature at which the plants are grown, although in almost any lot of seedlings some affected plants may be found. Damping is favored by excessive moisture, high temperature, and stagnant air ; i. e. poor ventilation, and affects especially plants which are very close together. All good lettuce growers understand this and guard against the trouble by avoiding these conditions. Affected seedlings rot off in the stem and soon wither away. The cause of this disease is not very definite, as the same effect is produced by several different fungi, which get a start in the stem of the plant, and, growing there, cause it to rot. One fungus which often causes it is the common dusty gray mould which is seen in any greenhouse upon dead flowers, leaves, etc., and this is of particular importance, not from the injury which it causes by Damping but from its further relation to the lettuce plant. This mould, which is called Botrytis, may usually be seen on some of the plants in a lot of lettuce seedlings, covering the decaying, withered remains with a gray, dusty growth, or not rarely it appears only on leaves, either dead or living, while the plant is still alive. (See Fig. 1.) The death of the plant is brought about by the fine, thread-like branches of the fungus which grow all through the stem and completely demoralize its tissues. When it gets on to the leaves they are killed in the same way, but it may not spread to

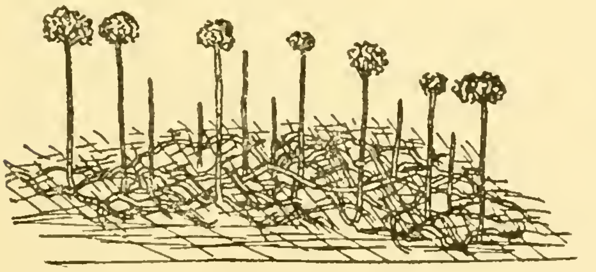


FIG. 1. Growth of Botrytis, considerably enlarged, showing the upright branches bearing the spores.

the stem or not until later. The gray, dusty growth appearing on the surface is composed of the minute spores of the fungus, which, when the growth is disturbed, may be seen flying off in a fine cloud of dust. These are carried about in currents of air and serve to reproduce and spread the fungus. The spores fall upon the young plants and mostly do no damage. Here and there, however, finding a dead leaf to grow on or favorable atmospheric conditions, they get a start and produce damping off.

Rotting of Plants Soon After Setting Out.

When the plants are put out into the bed there are pretty sure to be some among them which have lost a leaf or two by the Botrytis, and often a small black spot may be seen on the stem, just at the crown, where the leaf rotted off. In this scar more or less of the fungus is usually present in a dormant condition. It may or may not become active again according to circumstances.

The relations of Botrytis to the lettuce crop after it is put out in the bed depend almost entirely upon the handling of the house. If the crop is carried through in good shape, properly heated and ventilated, loss from this cause is not often extensive. A few plants almost always die from this cause immediately after being set out. These are mostly weak plants which fail to get a start, wilt down and dry away. The stem is almost always consumed by a dry rot, the interior turning a yellowish-brown color, and the gray dusty Botrytis mould appearing on the surface. This, as just said, occurs mostly immediately after the plants are set out in the bed. It is caused either by Botrytis, which came on the plants from the flats, getting a fresh start by the check to the plant in transplanting, or it may come directly from spores in the air which are not able to attack vigorous plants but pick out the weakest ones. This is simply a case of belated Damping Off. Its abundance depends entirely upon the condition of the plants set out and the management of the house, but a few plants go off in this way in almost every crop. These may be, and usually are, replaced by other plants which, if vigorous, are not affected by the fate of their predecessors.

Dying of the Lower Leaves and "Black Root."

Beyond this, as the plants go on toward maturity, some plants are found in almost every large house which are affected and injured, but not always killed outright by the gray mould. In these cases the direct effect is found in the lower, older leaves. Some of these, often only one or two on the same side of the plant, slowly rot off at the base. The stem and fleshy mid-rib of the leaf rots out, the green blade withers away, and along on the rotten part the gray, dusty mould appears, which, if the leaves mat down close together, may spread all over the leaf. By this rotting off of the leaf a black spot is left on the side of the stem, and where several go off close together the whole side of the stem, just at the surface of the soil, looks black and rotten. It does not, however, in typical cases of this sort, rot deep into the stem, but simply at the surface. This loss of the lower leaves and slight decay of one side of the stem is not without its effect upon the head and inner leaves of the plant. No fungus or rotting appears in these, but the head does not fill up properly and the inner leaves remain slender and straight, standing out separate from one another in something of a rosette. This trouble is well known to the growers and is called by them "Black Root." In some houses it is quite abundant. Plants are affected in all degrees and many are marketed which show the trouble to some extent, but they are of poor quality, being imperfectly headed and rendered unattractive in appearance by the black, decayed look of the stem. The loss of the lower leaves is directly responsible for this trouble and there can be no remedy save a handling of the crop which will keep the outer leaves growing and prevent their rotting off. This is accomplished by the best growers, in whose houses the loss from this source is reduced to a minimum. Black Root is especially abundant in crops where the outer leaves died off in transplanting, thus checking the plants and giving the fungus a foot-hold. The ability to carry the plants through this stage without a setback is the chief requisite for preventing this disease.

Rotting of the Stem of Mature Plants.

In the report of the Massachusetts Experiment Station for 1891 Dr. Humphrey described a disease of greenhouse lettuce in part as follows: "The trouble ordinarily appears first upon the stem of the plant about at the surface of the soil. Here may be seen at first a soft, dark, decayed spot, which rapidly spreads, penetrating the stem and involving next the bases of the lower leaves. The latter, being thus cut off from the plant by the decay of their bases usually dry up. With the further progress of the decay the centre of the head, with the tender inner leaves, becomes attacked, and soon collapses into a fetid, slimy mass. In the decaying tissue one can often recognize fungous threads; and, if they are left undisturbed, there appear on the decayed remains the fruiting threads and spores of a fungus, always the same.—The fungus in question is one of the imperfect forms known as Botrytis or Polyactis.—In its development, so far as observed, and in the details of its structure, this fungus appears to agree with the form known as *Botrytis* (*Polyactis*) *vulgaris* Fr., and is with little doubt the conidial stage of some sclerotium producing Peziza (Sclerotinia)."

Humphrey seems to have been the first to describe a disease of this sort on lettuce. The above quotation describes in a general way the most destructive and troublesome form of rotting of lettuce which confronts the growers at the present time. It is the disease known by them as the "Drop" or "Rot" and is common enough everywhere. In its typical form it is characterized by a rotting of the stem at the surface of the ground and consequent collapse of the plant, but it is quite evident that some writers have ascribed to Botrytis on the authority of Humphrey, forms of rotting quite different from that which he describes. Probably in most cases the gray mould was found upon the affected plants, but the exact nature of most of this trouble has not been closely investigated. Whether Botrytis is always the cause of the rotting or to what extent it causes it and what other organisms are concerned is one of the problems which the present work attempts to solve. The attention of the writers was first called especially to this subject in the winter of 1895, when a lettuce grower from the Boston district brought diseased plants to the Station to find if possible a remedy for what was causing great loss to himself and others. These plants agreed well with Humphrey's description. The stem and leaf bases were rotten, thus causing the plant to collapse. The gray mould appeared profusely upon the affected parts and examination showed that the rotten part of the tissue was full of this fungus. Soon after another lot of diseased plants was received from the same locality. These seemed to have the same disease, but with this difference, that the gray mould did not appear upon the surface as before. The affected tissue was full of a fungus, which grew on the surface as a white, cottony growth, with no sign of the gray, dusty appearance of Botrytis. Many more lettuce plants from different places and showing a similar disease were then examined and it was found that the same, difference continually appeared. In some the gray Botrytis manifested itself at once, seeming to leave no doubt that it was the cause of the disease, in others where the trouble appeared to be the same the white mould and no Botrytis appeared. This disease is known by the Boston growers as the "Drop". It is also called the "Rot" by some. It has been mentioned in several bulletins as caused by Botrytis and all recommendations for its treatment have been based on this idea. Our study of the subject, however, has shown that this is not the case at all in the most destructive form of the disease, but that the terms Drop, Rot, and Botrytis Disease, have in reality included several distinct troubles. These may now be described in detail.

The Botrytis Rot of Mature Plants.

The disease described by Humphrey was without doubt a more destructive development of the Black Root, which often occurs. In this case the trouble starts as before with a rotting of the outer leaves at the base by the Botrytis mould, which works down into the stem and causes a black spot at the surface of the ground. In the regular Black Root it stops here so far as the stem is concerned. But under certain circumstances of management, of which the most active are high temperature with lack of ventilation, high night temperature, (which is the worst), and excessive moisture, the fungus does not stop on reaching the stem, but is able to keep on down into it, sending its branches all through it, and producing a general rotting and death throughout. When this occurs, the plant, of course, is cut off from the roots and collapses and dies. This does not usually occur with great rapidity, but commonly the outer leaves go first, drooping down upon the ground with their bases covered with a gray, dusty growth of Botrytis. In this way all the larger, loose leaves go down flat on the ground while the solid head at the centre remains erect, perhaps for some time, or even after the plant is completely dead, thus giving a very characteristic appearance. (See fig. 2.) Meantime the mould spreads all over the plant if it is moist, and the interior tissue is found to be completely riddled with it. This trouble passes in most cases for the Drop, though it is not that disease in its most characteristic and destructive form, but, as regards cause, something quite distinct and of an entirely different nature, though the effect is very similar. It can be distinguished in many cases by the peculiar form of affected plants, and almost always by the gray, dusty growth of *Botrytis* which appears on them. It has no relation whatever to the soil and can be handled only by running the house skillfully in respect to temperature, moisture, and ventilation. This is probably the disease which is referred to by Jones, Galloway, Bailey, Selby, Kinney, and Garman, though it has doubtless been confused more or less with the true Drop which we shall presently describe. In its true form it does not often trouble experienced growers to any great extent as they keep it down by skillful management; still, taking green-house lettuce everywhere, it is very common, and affords by its occurrence or absence a pretty good indication as to the way the crop is being handled, although this test is not infallible as the disease occasionally gets in, even with the best growers.

Botrytis on the Leaves of Mature Plants.

Besides the somewhat characteristic cases which have been described, the Botrytis mould often occurs on lettuce, in the head or in the leaves, more or less spoiling it. (See Fig 3.) This often follows the diseases described, or occurs on poor, weak, or old plants. Sometimes it gets down into the head, rotting it out completely. In such cases it is usually called "Mildew." This should not and does not occur in well handled crops, except in connection with other more destructive diseases. It can usually be readily distinguished by the characteristic appearance of the fungus.

The Drop.

We are not aware that any rot disease of lettuce has ever been described except that caused by Botrytis and a bacterial disease to which we shall allude further on. As has already been mentioned, it became evident very early in our investigation that *Botrytis vulgaris* in its ordinary form was not the cause of a large part of the trouble known to the growers as Drop. Yet we still regarded the disease as being caused by a peculiar form of this fungus and have so alluded to it in our annual reports from year to year. The most prominent difference was that in many cases of the disease the gray, dusty growth of Botrytis spores did not appear. A mould was abundant in and upon affected plants, but it was white in color and bore no spores whatever, being simply a delicate, cottony mass of fungous filaments. To the practical lettuce grower there is no great importance in the simple fact itself whether one fungus or another causes the rotting which carries off his crop. But in this case, when remedies come to be considered, the question is of fundamental importance. Botrytis spreads in the house and lives from season to season and crop to crop by means of its spores which float in the air. Further it is known that this fungus can usually be kept down by skillful handling of the crop. If, therefore, anything else is concerned in the trouble which may propagate differently and perhaps differ entirely in its relation to the lettuce plant, it is of the greatest practical importance to know just what we are dealing with; its habits, life history, course of development, and relation to the crop. Without this knowledge we must work largely by chance and in a very uncertain manner. We have therefore devoted much attention to the clearing up of this point and feel that we can speak with certainty in regard to it. It will not be necessary, however, to discuss here the technical side of the subject further than is necessary to explain matters.*

There is a fungus which attacks many different kinds of plants, called *Sclerotinia Libertiana*. It lives mostly in the soil, usually attacking plants just at the surface of the ground, where the stem rots off. It has long been a question whether or not *Botrytis vulgaris* has any connection with this fungus, many believing it to be a form of it. They are similar in their effect on plants as well as in other ways and are often found together. Humphrey described the disease of green-house cucumbers called "Timber Rot" as caused by Sclerotinia, and finding Botrytis in the same house argued a connection between the two. This point we have carefully studied and found that the two forms, though closely related to each other, which accounts for their similarities, are nevertheless entirely distinct species, one never producing the other. With regard to

*The above mentioned article by one of the writers deals especially with this point.

lettuce we find that Botrytis has no connection whatever with the real Drop, but that it is caused by the Sclerotinia. In such cases the disease does not usually appear until just before the crop matures. Its effect is very similar to that of the Botrytis in similar plants. There is this difference, however, that the plant goes off more suddenly and collapses more completely, showing that the fungus is more active. Usually but a single night elapses from the time when slight wilting is noticed until the whole plant, head and all, lies flat on the ground. (See Fig. 4.) The stem and bases of the leaves are found to be full of the fungous growth, (see Fig. 5.) which appears on the surface as a delicate, white mould. The plant usually rots more completely than when attacked by Botrytis and soon the mould spreads to the soil, making a luxuriant growth upon the surface and reaching out to attack neighboring plants. If it reaches a leaf, stem, or any part of a plant, it soon spreads over and penetrates it, works down into the stem and produces the disease. This fungus produces no spores as found in Botrytis. On plants in the early stages of decay it consists simply of a mass of fungous threads which reproduce only by direct growth on the plant or soil, being able to live and grow on either. Later, however, when the affected plant becomes dead and dried up, there may be found on the under side of the old remains next the soil, very small black granules looking something like the excrements of mice. These are called *sclerotia*. (See Fig. 6.) They are simply solid masses of the substance of the fungus, which are not so delicate as the mould-like growth, and hence are better able to withstand heat, drying, etc. Sclerotia of larger size are sometimes produced and from these a kind of spore is developed, (See Fig. 7.) but it is very doubtful if this ever occurs in the

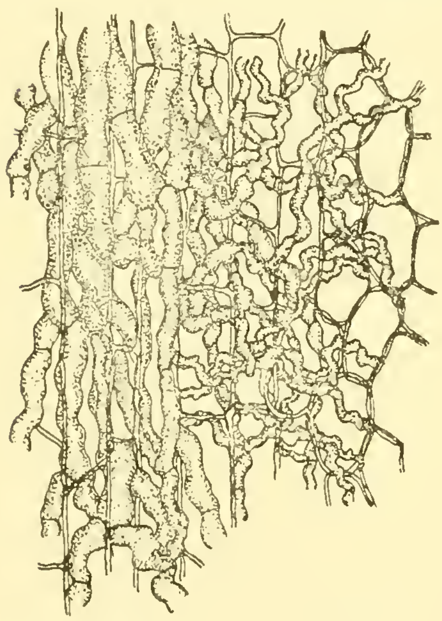


FIG. 5. Filaments of Sclerotinia in lettuce stem.

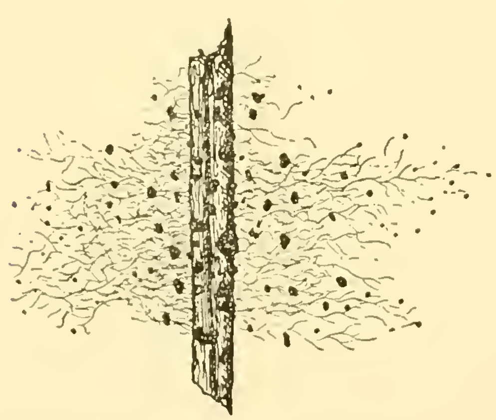


FIG. 6. Mycelium and sclerotia of the Drop fungus.

lettuce house. The sclerotia are mostly of very small size and act simply to carry the fungus over from crop to crop and from season to season. When first formed they make no growth, but after a period of rest and dryness they send out the mould-like growth which soon finds and attacks the plants. This destructive organism is not limited to lettuce, as we have seen pig-weed and buckwheat in a lettuce bed killed by it, and it is known to attack many other plants. Among green-house vegetables it causes the Timber Rot of cucumbers, sometimes attacks tomatoes, (though we have grown tomatoes in an infested lettuce bed without any trouble), and is quite often seen on water cress and parsley as a dense, white mould.

FIG. 7. Form of sclerotium producing spores.

This disease appears to have been thus far entirely overlooked by all who have studied lettuce troubles, yet there is no doubt that it is causing to-day far more destruction of green-house lettuce in Massachusetts than any other. It is an active, vigorous parasite, attacking and always killing every plant with which it comes in contact, destroying strong and weak alike. The ordinary details of green-house management have very little effect upon it and recommendations of this nature have no practical value. It is found in the houses of the most skillful lettuce growers unless some special treatment has been applied. On the other hand we have proved beyond doubt that in its method of reproduction and spreading, this fungus is strictly limited to growth in the soil, which fact being known, its extermination in the house becomes a simple matter, the comparative economy and practicability of methods being the only uncertain question. When once recognized, this disease can almost always be distinguished from the attacks of Botrytis by ordinary observation. By more technical methods the distinction is absolute. The presence of the dusty growth of spores almost always characterizes the Botrytis. In the other case the white mould is seen at the base of the plant, rotting the leaf bases and stem and spreading in a luxuriant growth to the soil, which does not occur with Botrytis. Further than this, Botrytis-affected plants usually go down more slowly, the head remaining upright, while in the real Drop the plant collapses completely in a day or two.

A Rhizoctonia Disease of Lettuce.

We are somewhat at a loss for a popular name to characterize this hitherto undescribed lettuce disease. Those few growers who recognize it use the name "Mildew," which covers other things as well and is not at all distinctive. This is not a common disease, and we have never seen it doing any great damage except in our own house, where crop after crop of lettuce has been grown in the same soil and diseases of all kinds encouraged to develop as much as possible. We have often seen a little of this disease, however, on a plant here and there in various houses, and our own experience shows that it can most effectually ruin a crop when well started. The trouble appears first on the lower leaves where they lie on the ground. A moist, brown rot sets in here which spreads through the leaf in a very characteristic manner. The green blade rapidly rots away and disappears, so that the stalk and mid-rib remain clean and sound as though the blade had been carefully cut away or eaten by insects. (See Fig. 8.) This distinguishes the trouble at once from the Drop and Botrytis, in each of which the leaf stalk and mid-rib rot first, leaving the blade to dry up. One leaf infects another at points where they touch, so that the rotting often reaches the centre of the head while the outer leaves are only affected in small spots, one corresponding to another on the next leaf, by which the track of the fungus can be traced. Delicate threads of the fungus can be seen on and amongst the leaves and to some extent on the soil. It does not, however, make the profuse growth of Botrytis or Sclerotinia. In the centre of the head the rotting becomes general and the tender, inner leaves resolve into a slimy, black mass. In many cases the rotting does not reach this point, but the outer leaves keep drying off one after the other. This has an effect similar to that of the Black Root; but even more marked. No head is formed, but the inner leaves remain straight and slender, forming a loose rosette. (See Fig. 10.) This is quite

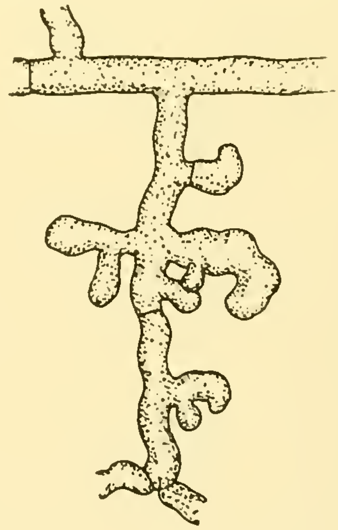


Fig. 9. Filaments of Rhizoctonia.

FIG. 2. Nearly mature lettuce plant affected by Botrytis rot in the stem.

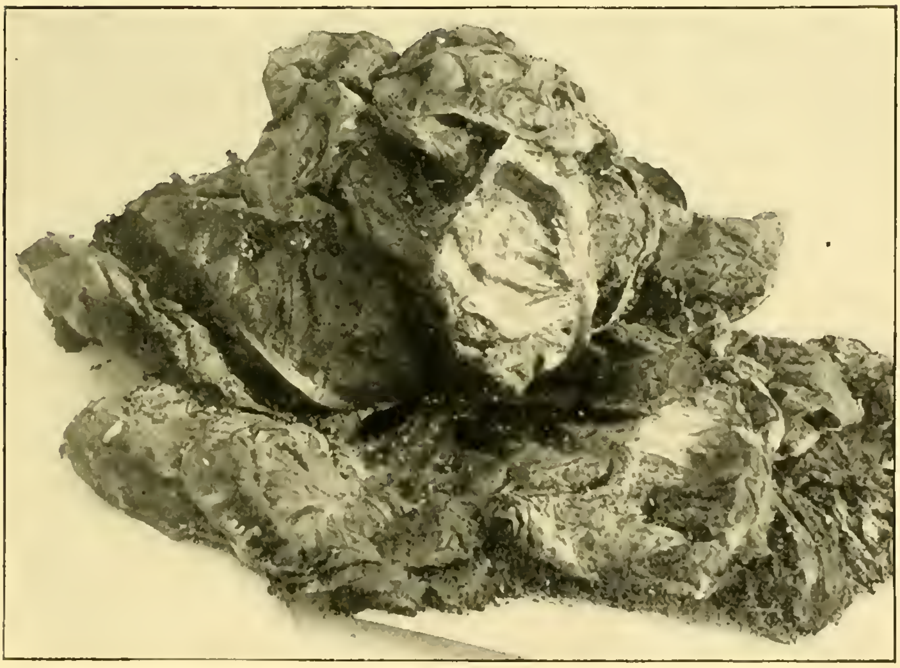


FIG. 3. Mature lettuce plant with Botrytis on lower leaves.

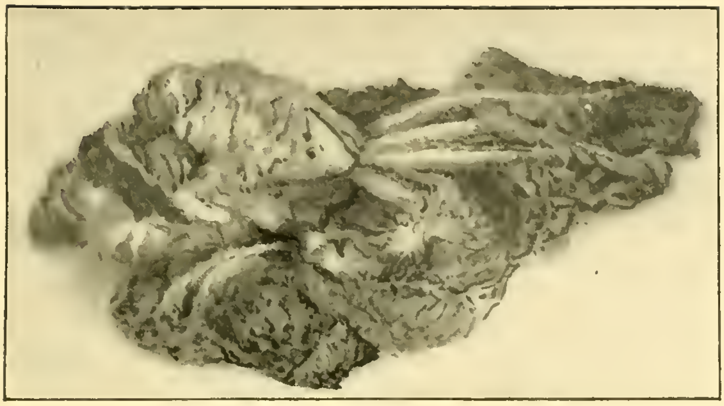


Fig. 4. Lettuce plant attacked by Drop.

Fig. 8. Lettuce leaves affected by Rhizoctonia.

Fig. 10. Lettuce plant showing characteristic rosette form caused by Rhizoctonia.

characteristic to one familiar with the disease, but much more so is the peculiar, clean cut rotting away of the blades of the outer leaves, leaving a sound, bare stalk. The cause of this is a fungus whose full development is not well understood. It is a species of Rhizoctonia. We have found that in the lettuce house it lives entirely in the soil, producing no spores, and is entirely similar to the real Drop (Sclerotinia) in regard to its susceptibility to treatment.

Bacterial Diseases of Lettuce.

References are not uncommon to diseases of lettuce caused by bacteria, but in this section no clearly defined trouble of this sort is at all prevalent. We have found occasionally on weak, poorly grown plants a dying of the leaves which seemed to be caused by bacteria. In these cases the disease was located on the margins of the inner leaves which died or withered along the edge, the affected portion being full of bacteria. This effect was entirely similar to that produced by the physiological trouble known as "Top Burn," with which it is very likely more or less connected. Still there are cases where the rotting continues down into the head leaving only the stump intact, and no organisms but bacteria can be found, so that the principal destruction is apparently caused by them. In well grown plants we have found no such trouble. This appears to be the same disease as that described by Jones, and also by White. The bacterial stem rot mentioned by Jones and the "Bacteriosis" which Halsted speaks of seem to be quite similar to the Drop in effect. We have never met with such a disease.

METHODS OF CONTROLLING AND ERADICATING THE DROP.

In the treatment of a disease the first essential is to understand its cause, and when this is a parasitic organism it is of the greatest importance to gain a knowledge of its life-history and its relation to its environment. We have previously pointed out what is known concerning the life-history of the fungus which is the specific cause of this disease, and our methods of treatment must take into consideration this knowledge. Since the Drop fungus does not produce myriads of light spores (conidia) similar to those produced by Mildew, etc., but propagates itself by means of mycelium and sclerotia confined entirely to the soil, the problem of treating it is therefore one of treatment of the soil. Were we dealing with a disease caused by a fungus capable of producing thousands of spores in the course of a few hours, which need only a slight current of air to waft them about in every direction, then the question of treatment would be quite different from that of the disease under consideration.

From numerous cultures of the Drop fungus during the last three years and from many observations in our greenhouse and others, we have never observed that the fungus is propagated in any other manner than by the growth of mycelium through the soil. It is undoubtedly disseminated from bed to bed and from one house to another by means of tools, etc. and by transplanting plants derived from infected propagating houses. At the beginning of our investigations of the Drop in lettuce, our greenhouse which had been recently remodeled and newly filled with fresh soil, was entirely free from infection. Another house in this vicinity did not contain any of the Drop until some young lettuce plants were introduced into it from Arlington. Since then, however, it has been common enough, as no means have been taken to check it. In order to obtain a considerable amount of the Drop in our lettuce house, we obtained about one peck of badly infested soil from Arlington and in our first experiment we inoculated three rows of plants, the infected soil being put two or three inches deep around each plant. The results of this inoculation can be seen in Diagram I, where the various plots which received different treatment are represented. Each plot contained 55 plants set 8 inches apart in a ground bed made up of one foot of typical Amherst loam, containing from 8 to 10% organic matter. The various plots were separated from each other by means of boards, and except for surface treatment the soil was identical. The conditions for all of the experiments which we shall presently describe were nearly alike and practically the only condition offering any variations was that of the temperature of the house and soil, which always gave rise to differences in the maturity of the plants. The plot n. 3. (Diagram 1), for example, would usually register from four to six degrees higher than plot a, and uniform gradations of temperature existed in the intermediate plots.

The variety of lettuce used in all the experiments was a headed form, and the seedlings were transplanted in the usual manner, except that seed was sown in sterilized soil, and they were subse

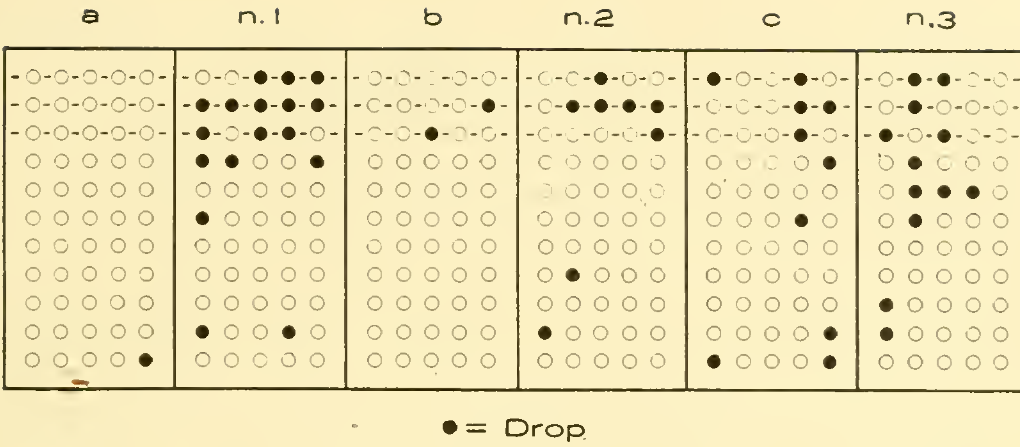


DIAGRAM I. Showing the effects of different kinds of treatment on soil inoculated with the Drop. n. 1, n. 2, and n. 3, normal or untreated plots. a, covered with 3 in. of sterilized soil. b, ¾ in. of sterilized sand. c, ¾ in. of sand. The dotted lines indicate the three inoculated rows of lettuce.

quently pricked out when about one inch in height into larger boxes of sterilized soil. When the plants had obtained half a dozen leaves from 4 to 6 inches long, which is the usual size for the second transplanting, they were put into the plots. By this precaution we were tolerably certain that the plants were entirely free from Drop when set out in the experimental plots and any infection which occurred would of course be traced to the soil in the plots. By this means we were able to observe the spread of the disease. Each infected plant, when presenting its specific symptoms, was carefully recorded together with data concerning its occurrence. The first experiment relating to the Drop, which is graphically shown and sufficiently explained for most purposes in Diagram 1, gives us an idea of the relative value of certain methods of controlling this disease and also some idea of its rapidity of spreading. The three upper rows in this experiment represented by the dotted lines were inoculated with Drop infected soil as previously described, and the largest number of infected plants are shown in the three back rows in which the infection was placed. The encroachment of the Drop upon the uninfected areas is well shown, although it is possible that some of the other plants were infected in this experiment before being transplanted, as the soil was not in this instance sterilized, and we subsequently ascertained that the soil in which the young plants were grown was not wholly free from Drop. Only one plant showed the Drop when 3 in. of sterilized soil was placed upon the surface against 30% in the normal or untreated plot. This experiment shows also in favor of $\frac{3}{4}$ in. of sterilized sand.*

Both the sand plots show cleaner lower leaves which are much more free from decay (Botrytis Rot) than any of the untreated ones. A similar experiment to that just described is shown in Diagram II;

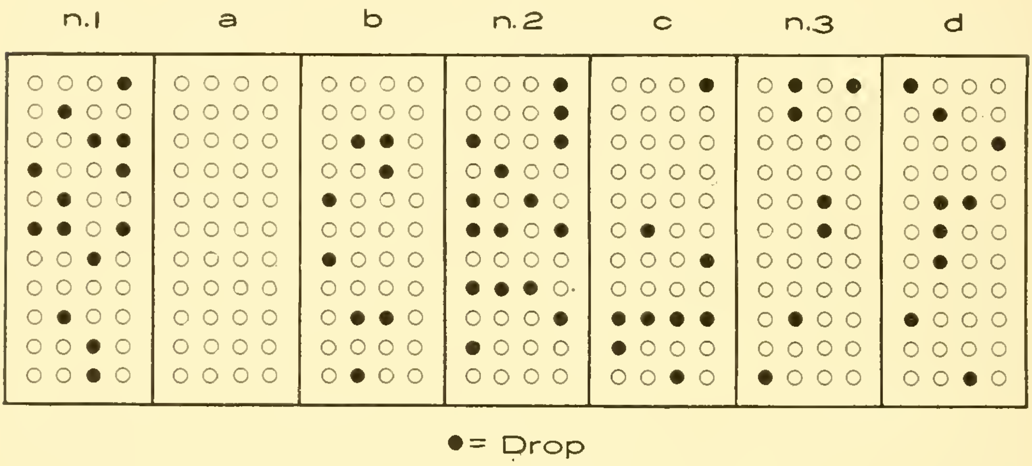


DIAGRAM II. Similar to I. n. 1, n. 2, and n. 3, normal or untreated plots. a, 4 in. of sterilized soil. b, $\frac{5}{8}$ in. of sterilized sand. c, $\frac{5}{8}$ in. of sand. d, $\frac{3}{4}$ in. of coal ashes.

which followed that given in Diagram I. In this case the soil was purposely contaminated throughout by forking it over after the preceding experiment had been completed; in addition to this, another bed containing 264 plants was inoculated, and the plots treated with heat, sulphur, and lime. The infection in this experiment is about the same as in experiment 1. The $\frac{5}{8}$ in. of sterilized sand is however scarcely better than the same amount of unsterilized sand, which gives practically the same result as $\frac{5}{8}$ in. coal ashes, while 4 in. sterilized soil was entirely free from Drop.

The covering of one plot with a thin layer of powdered charcoal and two others with similarly covered layers of sulphur and lime did not produce favorable results, and they will therefore not be considered here. In experiment 3, (Diagram III) we have a slight modification of the two preceding ones with an additional amount of infectious material in the soil. A period of some five months elapsed between this experiment and the preceding one; in the meantime a crop of tomatoes was grown in the soil. The $\frac{5}{8}$ in. cov-

*The term sterilized is employed throughout this work in a relative sense and has reference only to the Drop fungus. A large number of microörganisms still survived after heating, consequently absolute sterilization was not accomplished in any instance. The heating was done by steam, as described in Bull. 55 from this station.

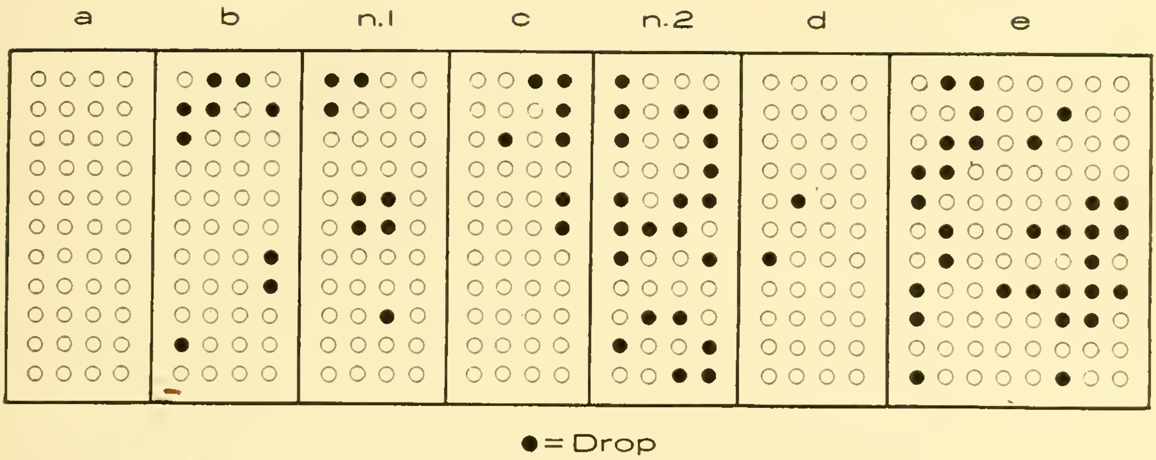


DIAGRAM III. Similar to preceding diagram. n. 1, and n. 2, untreated plots. a, 2 in. of sterilized soil. b, $\frac{5}{8}$ in. of sterilized sand. c, $\frac{5}{8}$ in. sand. d, 1 in. of sterilized sand. e, Dried out soil.

ering of sterilized sand in this experiment is not so good as the same amount of unsterilized sand, there being nine cases of Drop in the former (b) and seven in the latter (c) with eight in the intermediate one n. 1.

The 1 in. of sterilized sand (d) gave far better results than the $\frac{5}{8}$ in. sand plot, there being an average of seventeen in our two adjacent beds (n. 2 and c) against two in d. or a gain of 89% as a result of 1 in. sterilized soil. The 2 in. of sterilized soil covering showed no Drop whatsoever. The double plot (e) was partially desiccated previous to planting and there is a slight increase in the relative amount of Drop. It appears that drying the sclerotia of the fungus accelerates their development, a feature we will illustrate later on. Two of the plots were also treated with lime in this exper-

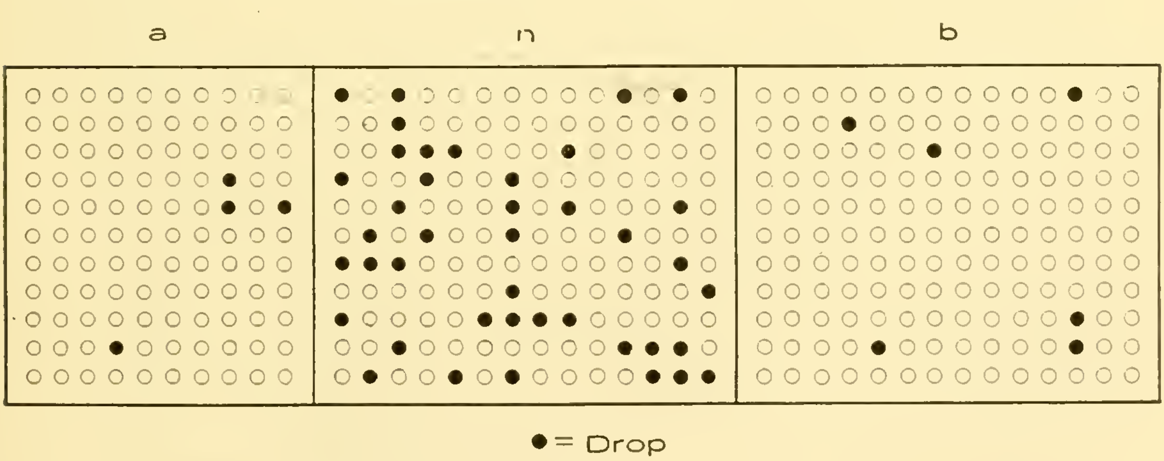


DIAGRAM IV. Similar to preceding diagram. n, untreated plot. a, $1\frac{1}{2}$ in. sterilized soil. b, 1 in. sterilized soil.

iment with practically the same negative result as shown in the preceding one. The results of the three foregoing experiments shown in Diagrams I, II, and III, are conclusive enough to indicate what might be expected from this method of treatment, and we therefore turn our attention to the testing of larger plots in connection with sterilization.

Experiment 4 (Diagram IV) shows the results of covering the top of the plots with 1 in. and $1\frac{1}{2}$ in. of sterilized soil, the number of plants in the three plots being 418. The percentage of Drop plants in the untreated soil was 26% ; that in the $1\frac{1}{2}$ in. sterilized (a) 3.6%; while that in 1 in. sterilized is 3.8%, or in other words, there is shown in this experiment a saving of about 85% of Drop by the use of 1 in. and $1\frac{1}{2}$ in. of sterilized soil.

We have previously alluded to the effects of desiccation upon the germination of sclerotia, but at the time experiment 5 was made the remarkable acceleration which is produced by this means in the development of the sclerotia was not fully comprehended by us. We endeavored to see what effect a long period of thorough drying would have upon the Drop and consequently closed up the house during the greater part of August, September and October, at which time it was subjected to the intense rays of the sun which heated the soil up to a temperature of 123° F. and the air thermometer registered 140° F. As the top layer of the soil became dry, a lower layer to the depth of a foot was forked over two or three times, so that

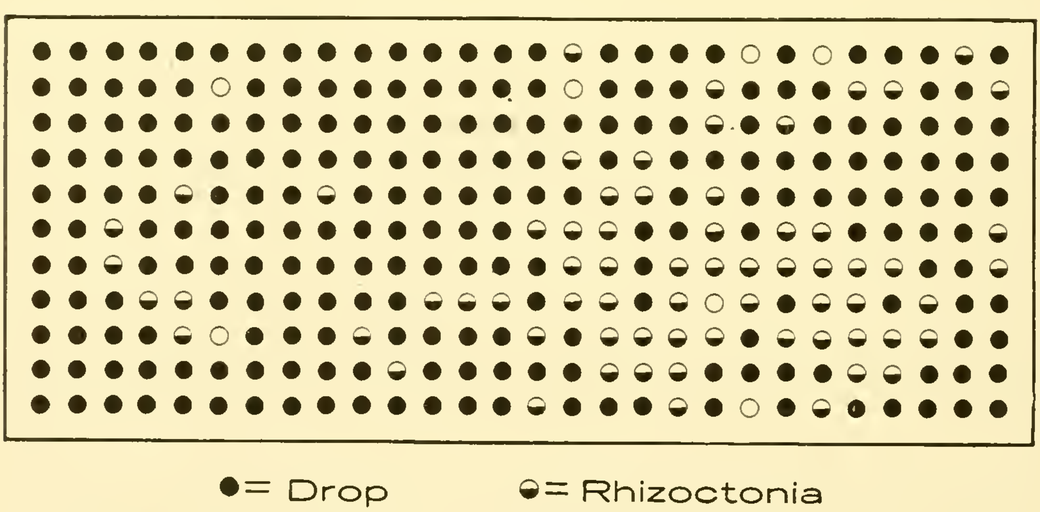


DIAGRAM V. Showing the effects of soil desiccation upon the Drop. The soil was dried from August to October.

practically the whole amount of soil became desiccated. The result of drying out the soil in one bed containing 308 plants can be seen in Diagram V, which shows the same bed and soil used in the preceding experiment, literally covered with diseased lettuce plants, representing in this case the Drop and Rhizoctonia. The number of plants which succumbed to the two diseases is 301 out of a total of 308, or 97%. The number subject to Drop was 235 or 76% and the Rhizoctonia gave 66 or 21%.

The other half of the house with the bed containing 264 plants was treated similarly, with about the same results. The increase in the Drop due to drying was 64% over that of the same soil in the preceding experiment (Diagram IV), which shows that this method of treatment cannot be recommended. It is undoubtedly the influence of desiccation upon the sclerotia that accounts for the remarkable loss from Drop which some growers have experienced.

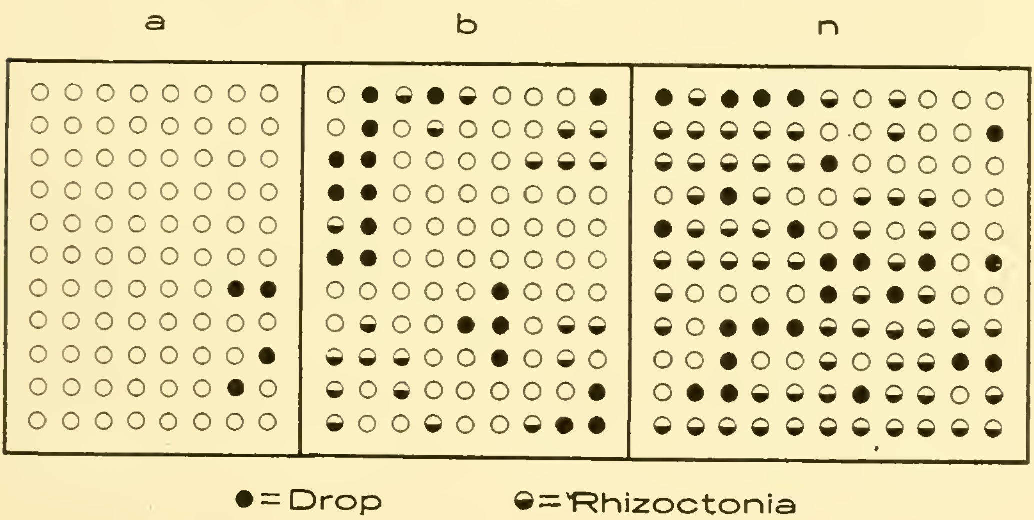


DIAGRAM VI. n, untreated plot. a, treated with hot water from the boiler; temperature of water 210° F. b, treated with steam cultivator.

The experiment shown in Diagram VI followed the preceding one and some other methods of control were tried, such for example as covering the surface of the soil with one inch of sawdust, packing two inches of excelsior around the plants and over the soil,* allowing the plants to grow through 2 in. meshes of wire netting raised 2 or 3 inches above the bed in order to keep the lower leaves from touching the soil, heating the top layers of soil with hot water, and an application of steam to the surface of the soil by means of an improvised steam rake or cultivator. The steam culti-

*As recommended by Garman.

vator consisted of an iron rake 6 in. wide and 18 in. long, constructed of $\frac{3}{4}$ and $\frac{5}{8}$ in. iron tubing which was attached to a two wheeled hand cultivator frame. The rake was provided with 7 teeth of $\frac{5}{8}$ inch tubing 8 in. long, the lower ends of which were nearly closed by flattening them out. Numerous small holes drilled through the lower portion of each tube permitted the exit of steam. Steam was connected with this apparatus through the top by means of a hose attached to a small high pressure boiler and it passed down through the perforated tubes into the soil with considerable force. As the steam cultivator was passed slowly through the soil it heated up the upper layers to the depth to which the teeth penetrated, which was about 4 to 6 inches. We found that by passing this through the soil three or four times the temperature was raised in some places as high as 194° F., and averaged about 168° F. throughout the bed. This temperature did not hold very long, however, and the corners and edges of the bed were difficult to reach. The percentage of Drop with this treatment was 18% while the normal bed gave 19%, which equals a gain of 5%. The amount of Rhizoctonia in the treated bed was 21% against 49% for the normal or untreated bed, or in other words, a gain of 57%. It appears from this experiment that the Rhizoctonia does not require as high a temperature for its extermination as the Drop. This method has been given only one trial and while it is capable of reducing the amount of Drop infection to a much greater extent than in this experiment, we do not recommend its trial, or that of any other partial control method, inasmuch as it would have to be used previous to the setting out of every crop.

Larger and deeper steam cultivators could be employed which would do the work more effectually, but in every case the corners and edges of the bed would be difficult to reach, and hence, without care, these places would constitute a source of contamination.

The hot water method showed better results than the preceding one, it heated the soil to a depth of 4 in. at a temperature from 176° F. to 186° F. (See a, Diagram VI.) The water was taken through a hose from an adjacent pipe connected with the house system of heating and was 210° F. as it left the hose. The top layer of the soil was quite freely saturated with water. The percentage of Drop was only 4.5% and there was present no Rhizoctonia or Bacterial Rot, although the Botrytis Rot was present. Sterilization cannot be expected to exert any influence whatever upon the presence of the latter disease as the spores of this fungus appear to be everywhere. The Botrytis Rot, as already pointed out, is not caused by a genuine parasite, and its appearance in lettuce is always associated with plants weakened from other causes. The cause of this weakness in our plants was due to placing them too soon in a soil which contained too much water. In regard to results obtained by the use of sawdust over the surface of the soil and the application of excelsior and wire netting, it may be briefly stated that they show nothing of a positive nature. The amount of rot due to any organism was as much in one bed as in another.

The deductions which can be drawn from these various experiments are, that there are certain methods of treatment which are capable of reducing Drop to a very large extent and others which will exterminate it, while some methods of treatment are of little practical importance. To the latter class belongs the use of excelsior, sawdust, coal-ashes, sand, charcoal, sulphur, lime, etc. The use of a layer of sand succeeds in giving a clean culture, there being less Botrytis Rot on the lower leaves: but little more can be said of this method. The slightly beneficial result obtained from its use was probably due as much as anything to its modifying the moisture conditions, besides covering up to a certain extent some of the infectious material. We have found moistened sand, on the other hand, an excellent medium for cultivating the Drop fungus in the laboratory. The object in using sawdust, excelsior and wire netting is similar to that of sand, namely, to separate the infected soil from the plants as much as possible and to keep them in a dry condition. Sawdust and excelsior are less satisfactory than sand on account of their moisture retaining properties.

Undoubtedly one of the chief factors in the development of Drop is the stagnant air and moist conditions surrounding the base of the plants. Could lettuce be raised up some distance from the soil, and air and sunlight allowed to penetrate to the base of the stem, the presence of Drop would be much reduced and this disease would probably cause as little trouble as the Timber Rot in cucumbers, which is caused by the same organism. The influence of close culture can be seen frequently upon such crops as parsley, water-cress, etc., when grown in the greenhouse. When these plants are crowded, the Drop fungus attacks their tender etiolated, or light secluded stems, whereas when these plants are not crowded the sunlight has an opportunity to penetrate to the stems and they are not attacked by this fungus. This indicates that the Drop is, in some instances at least, associated with abnormal conditions in plant development. The close growth of lettuce to the soil is quite normal to it, although it is probable that the more delicate stems which result from the modern forcing method render lettuce slightly more susceptible to the Drop than when grown under conditions where less forcing is resorted to. The method of surface sterilization and total sterilization are the only methods at the present time found worthy of consideration, unless we resort to the method of completely changing the soil in the houses, which would be expensive when one has a large range of houses to care for. There is a material reduction in the amount of disease by using one or two inches of sterilized soil upon the surface of the bed. This method has been tried for two years by one of the largest and most successful growers in this state with practically the same results which we have obtained here.

The hot water method just described has been employed by Hittinger Bros. of Belmont, Mass., whose area of lettuce soil under glass may be reckoned by acres. This treatment is quite efficient, and would probably work better on coarse soils such as Arlington than on fine soil, on account of differences in their water retaining capacity, especially if transplanting takes place immediately after treatment, inasmuch as we found that our plants were stimulated too much by the saturated soil. Another grower who had experienced a loss of about 25% from Drop treated his house with hot water heated by means of steam in a barrel and poured on the soil with a pail. It took a man 3 days to treat a house 256x50 feet, decidedly beneficial results being obtained. While the results obtained from this surface sterilization method are encouraging, in our opinion the troublesome details connected with their constant repetition make such a method in the end much more expensive than complete sterilization of the soil. This has already been accomplished on a large scale by some growers. In one instance two houses 225 ft. by 30, and 125 ft. by 20 ft. respectively, have been tiled and subjected to steam heat with the result that the two crops following this process were stated to be the best ever obtained. The tile, however, were not placed to the best advantage in this trial; the two inch tile were laid 8 in. deep and 18 in. apart, but far better results could be obtained in having the tile 9 or 10 inches apart. The expense of treating the house once for all is far less in the end than continual treatment of the surface layer, and while the sterilization method is more or less of a bother, the only alternative at the present time is a complete change of the soil, which would be more troublesome and expensive to most lettuce growers than sterilization. Where a bed is properly tiled and where a large steam boiler is at hand, the heating of the soil can be more readily done than most people imagine. We are of the opinion that when a house is once free from Drop it can be kept in this condition for some time providing that care be taken not to use tools which have been in infected houses, and also when applying manure to see to it that it does not contain the germs of Drop. In all probability, horse manure taken from localities where the refuse from lettuce and cucumber houses has not been thrown would be free from Drop germs.

Irrigation.

In connection with the preceding experiments that have been described there were carried on some investigations relating to the effects of sub-irrigation upon the suppression of the Drop. The results of these experiments were not sufficiently marked for drawing any definite conclusions, though in almost every case the sub-irrigated plots showed less of the disease.

Rotation.

The rotation of crops in soil containing the Drop does not appear to reduce the amount of infectious material. On the other hand, during rotation the mycelium of the fungus increases and becomes more generally distributed.

Results of Treating the Drop with Chemicals.

In the treatment of pathogenic(disease producing)organisms located in the soil by chemical substances we have a problem to deal with quite different from treating foliage. Such a problem is much more difficult than when we have to deal with foliage, inasmuch as it is not impossible in most instances to cover the latter with an adhesive mixture that will act to a greater or less extent as a prevention to the development of fungi. The depth of the soil which would have to be treated, the considerably large volume of air-space* which would have to be subjected to fungicides, and the difficulty of reaching this space, together with the extremely delicate relationship existing between the soil and plant-growth, make the problem of the application of a fungicide to the soil a difficult one. Certain delicate organisms such as that which gives rise to Club-foot appear to be affected by the application of lime to the soil, and sulphur is used in the same way as a remedy for Potato-scab, but unfortunately all fungous and insect pests are not so susceptible to treatment. From the beginning of our experiments upon the treatment of soil fungi we had little faith in the treatment of the soil by means of chemicals, but the reported beneficial results obtained by some gardeners by the use of certain substances, induced us to give them a trial. There are always certain substances recommended for every disease, which constitute panaceas as it were for all troubles. The number of diseases for example which lime and sulphur are believed to cure would fill a volume, but the number that they actually exert an influence upon would require only a small space for enumeration. One writer in a gardener's journal stated a few years ago in the most positive language that the Rot Disease of lettuce can be entirely controlled by simply sprinkling a little lime upon the surface of the soil. It may be very gratifying to gardeners to learn from one of their brethren that a troublesome disease can be disposed of so readily; nevertheless should they give the remedy a trial and find it to their sorrow a failure, they are likely to feel quite differently. The practice of advocating remedies which have never been thoroughly tried, and which nine times out of ten fail, constitutes a menace to the introduction of efficient ones. We have already briefly alluded to experiments in which lime, sulphur and charcoal were tried separately on different beds (see experiment 2) and the negative results obtained from their use. These substances were sprinkled on the surface of the soil quite liberally, in fact, so as to entirely cover the surface with a thin coating. In every instance the mycelium of the Drop fungus was observed growing over the surface of the soil coated with this substance without apparently the slightest ill effect to the fungus. Another experiment was also tried

* The volume of space in the average lettuce soil is about 40% or 50%.

in the laboratory in which three slant tubes of prune agar were completely covered with powdered sulphur, lime and charcoal respectively, and then inoculated with portions of the Drop mycelium. In each experiment the mycelium grew over the coating of the substance as profusely as in normal cultures wherein no such substances were employed. The experiments show conclusively that lime, charcoal and sulphur utterly fail as a remedy for the Drop, even when put on the soil thick enough to form a considerable covering.

The success with which the fumes or gases given off from certain substances are being used as insecticides has suggested the trial of similar methods for treating destructive fungi in the greenhouse and this has been tested especially with regard to lettuce diseases. The value of such a method, if it could be applied with success, is very easily seen, as in treating a house between crops no limit need be placed upon the strength of the gas employed. It is quite essential however that in treating houses for the Drop or Rhizoctonia, which thrive in the soil, that not only must the gas be fungicidal in its effects, but that it possesses sufficient power of penetration to permeate the soil to a considerable depth and exercise its destructive action. Could such a gas be produced in an economical and practical way it would be of inestimable value to all growers of greenhouse plants. It is not difficult to find a considerable number of gaseous substances which have strong fungicidal properties and which may also be readily and cheaply produced. To choose among these it is essential to find out especially their relative effects upon fungi and plants, (the most desirable combination being, of course, a maximum of the former with a minimum of the latter) and their ability to penetrate the soil. Upon these features depend their value as greenhouse fungicides.

HYDROCYANIC GAS.

This gas was first chosen for trial on account of its extensive use as an insecticide. For such purposes it is often used with living plants in the greenhouse, though occasionally with serious damage. It is also used very extensively in fumigating nursery stock and in various other ways for fumigating against insects. It is a deadly poison to all animal life, causing almost instantaneous death when inhaled in any quantity. This gas is produced by treating cyanid of potash with sulphuric acid ; the gas being given off when these two substances are combined. In these experiments it was first tested in its effects upon the spores of various fungi in open air. A tight case containing about 8 cu. ft. was used into which was put a glass slide bearing a drop of water with the spores to be tested. The production of the gas was then started and the case closed for the desired length of time, after which the slide was placed in a moist chamber and the spores observed at intervals as to their germination. In all cases the results were checked by means of untreated slides. A well marked fungicidal effect of the gas was evident, and where 20 grams of potassium cyanid were combined with 40 grams of sulphuric acid diluted with 20 cubic-centimetres of water the spores of *Botrytis vulgaris* were killed when exposed to the gas for so short a period as fifteen minutes. In the experiment where 10 grams of potassium cyanid were used, the Botrytis spores failed to be killed after forty minutes exposure, although germination was almost entirely prevented. When 20 grams of cyanid were used, tube cultures of the "Drop" fungus (Sclerotinia) were exposed to the gas and were found to be readily killed with about the average exposure required for the spores. This shows, therefore, that the lettuce-attacking-fungi, or their spores, can be killed with cyanid gas when freely exposed to it. There remains to be considered its effect upon plants and its power of penetrating the soil. The first point was readily determined by placing plants in the case during the treatment and in this connection it may be stated that they were invariably killed. Furthermore a test was made of spores of the carnation rust from plants which had been nearly killed by an overdose of the gas used as an insecticide, and it was found that they germinated freely.

In regard to penetration of the soil the following tests were made: Spores of Botrytis were placed in a drop of water within a glass cell on a slide and a strip of coarse cheese cloth fastened over the top to keep out the dirt. The slides thus prepared were then buried rather loosely in a box of fine loamy soil and the whole exposed to the gas in the closed chamber. Depths of ½, 1, 1½, and 2 in. were tried, both in dry and wet soil. With an exposure of from one to several hours, using 20 grams of cyanid, no effect whatever could be detected. It was plainly evident that the gas did not penetrate the soil to any appreciable extent. Tests were also made with the Drop fungus. Remains of lettuce plants infected with the disease were buried just beneath the surface in pots of soil and thoroughly exposed to the gas. After several hours they were taken out and placed in the greenhouse, where the fungus immediately started into growth and developed luxuriantly upon the soil, showing not the slightest effect from the gas. One of our greenhouses was treated with this gas at the following rate: 1 oz. of potassium cyanid, 1 oz. of sulphuric acid and 3 oz. of water to 150 cu. ft. of space, with the result that no kind of fungi either in the soil or upon the plants was affected. From these results it may be concluded that hydrocyanic gas has considerable value for fumigating a house between crops and killing insects and fungi where exposed to its action, but as a fungicide to be used with living plants or for the control of the Drop fungus, it has no value whatever.

FORMALDEHYDE GAS.

This gas was chosen for experiment on account of its rapidly increasing use as a germicide and disinfectant. It results from the imperfect combustion of wood alcohol, and is produced by burning the latter substance in a lamp made especially for the purpose. Several different makes of these lamps are in the market. In these experiments a single burner "Moffatt" lamp, presented by E. Lilly & Co., Indianapolis, Ind., was used. Larger sizes and various styles are made by the same company. Spores of Botrytis were not entirely prevented from germination when exposed sixty minutes to formaldehyde gas in the case used in the last experiment. Tube cultures of the Drop fungus when exposed for several hours under the same conditions were killed. A test was also made by burning the lamp for twelve hours in a portion of a greenhouse in which there was a bench of carnations considerably affected by rust, the space area being within the capacity of the lamp. Subsequent tests showed that the rust spores germinated freely and apparently were not at all injured. Beneath the surface of the soil the same results appeared as with cyanid gas; namely no effect. With exposure of twelve hours in the small tight case it could not be seen that the gas had the slightest effect beneath the surface. Plainly therefore this gas has no practical value as a fungicide for these organisms.

SULPHUR.

The fumes of burning sulphur are well known as one of the strongest disinfectants. In experimenting with this substance 5 grams were burned in the 8 cu. ft. case. This killed effectually all kinds of spores and cultures of the Drop fungus in fifteen minutes; the shortest time tried. It was hoped that it might also prove effectual in the soil, but a trial showed that as in the other cases no effect whatever was produced beneath the surface. Burning sulphur very freely in the greenhouse for half a day at a time failed to kill the Rhizoctonia or Drop fungus in the superficial tissues of infected lettuce plants, and various weeds and grasses growing in the soil were only affected above the surface of the ground, moreover various seeds contained in the soil showed abundant signs of life two or three days later. This substance can therefore be highly recommended for disinfecting the air, woodwork, etc., but for controlling the Drop it is entirely useless.

CARBON BISULPHID.

The evaporation of ten cubic centimeters of this substance in the case appeared to be entirely without effect upon spores in the air. It was also tried in the soil by pouring small quantities into holes in Drop infested earth, also with no effect.

BROMIN.

It was found that liquid Bromin evaporated in the case had considerable fungicidal effect. Tube cultures of the Drop fungus were killed by it. It showed no more power of penetrating the soil, however, than the other gases.

CHLORIN.

The same results were obtained with chlorin gas, produced by combining Chlorid of Lime and Sulphuric Acid. The powerful gas thus produced readily kills spores in the air and appears to be among the best gaseous disinfectants, but it shows no effect beneath the surface of the soil.

From these results it appears that of these substances cyanid gas, sulphur, (burning). and chlorin are very efficacious for general disinfection between crops, though all are dangerous or fatal to living plants. For the absolute control of lettuce diseases, none of the substances experimented upon have any value, and there appears to be very little probability that any similar treatment will be successful. However powerful the toxic effect of the gas may be, the indispensable penetration of the soil from the surface seems to be entirely lacking.

Effects of Temperature Upon the Drop.

The following shows the rate of development of the Drop mycelium at different temperatures. Pure cultures were used in prune agar slant tubes and the development of the mycelium with which eachtube was inoculated was noted.

TABLE SHOWING DEVELOPMENT OF THE DROP FUNGUS AT DIFFERENT TEMPERATURES.

Average Temperature,	48° F.	54° F.	60° F.	76° F.	101° F.
Degree of Development,	Mere trace	Slight growth	Considerable growth	Luxuriant growth	Slight growth

These experiments lasted ten days, the readings being made three times each day, and the temperatures given represent only the average temperature for the whole period. From these experiments it is clear that the optimum or best temperature for the development of the mycelium of the Drop is not far from 76° F., and that an average temperature of 101° F. is too high for much growth.

The temperature at times went higher than 101° F., otherwise greater growth would have taken place. On the other hand the mycelium will develop at 48° F. and probably at a temperature somewhat lower than this, but this point retards growth and would require a longer time than ten days for the culture to show well developed mycelium growth.

A greenhouse kept at a low temperature is held by some to be less subject on this account to disease. This appears to be true in the case of the Botrytis disease, which is not of a strictly parasitic nature, but with the real Drop the evidence at our disposal shows no decided lessening of the disease on account of low temperatures. Experienced growers, who run their houses at what are considered proper temperatures, often suffer serious loss from this disease, which would not occur if low temperatures would control the trouble. In our house, also, no such effect has been evident except with the Botrytis disease. With low temperatures lettuce will develop much more slowly, as will the Drop, and in the end little would be gained. Practical men prefer not to wait twelve weeks for the development of lettuce when a better article at greater profit can be produced in one-half this time.

The maximum temperature which the mycelium will stand appears to be not far from 130° F., while the sclerotia are not killed until the temperature reaches a much higher point. Numerous experiments were made with sclerotia buried in the soil, the temperatures to which they were subjected being brief in duration. The temperature of 160° F. in most cases killed the sclerotia, though in some experiments made with sclerotia of a larger type it was found that it took considerable more heat to kill them. Somewhat lower temperature for a longer time would doubtless be equally effective. Sclerotia subjected for a brief period of time to a considerably high temperature not sufficient to kill them, were greatly accelerated in their germination.

The minimum temperature which the Drop will stand has not been ascertained either for sclerotia or mycelium, but it may be stated that we have never observed any detriment from exposing it to a temperature below zero. Some of the large sclerotia and also bread cultures of the usual Drop fungus were left out of doors for about a month in midwinter. The temperature went down to at least —12° F. on two occasions and was below freezing almost all the time. When brought into the laboratory all the material at once showed strong stimulation by the cold, producing a much more abundant mycelium growth than in similar lots not frozen. From what we know in regard to the behavior of other reproductive bodies, there is reason to believe that the sclerotia are capable of standing exceedingly low temperatures without interfering in the least with their vitality.

Period of Greatest Loss to Lettuce Crops by Disease.

From carefully dated records made of the Drop and other diseases, we are able to ascertain at what period in the life-history of the lettuce plants they succumb to disease. The curve shown in Diagram VII, represents the average amount of Drop recorded each

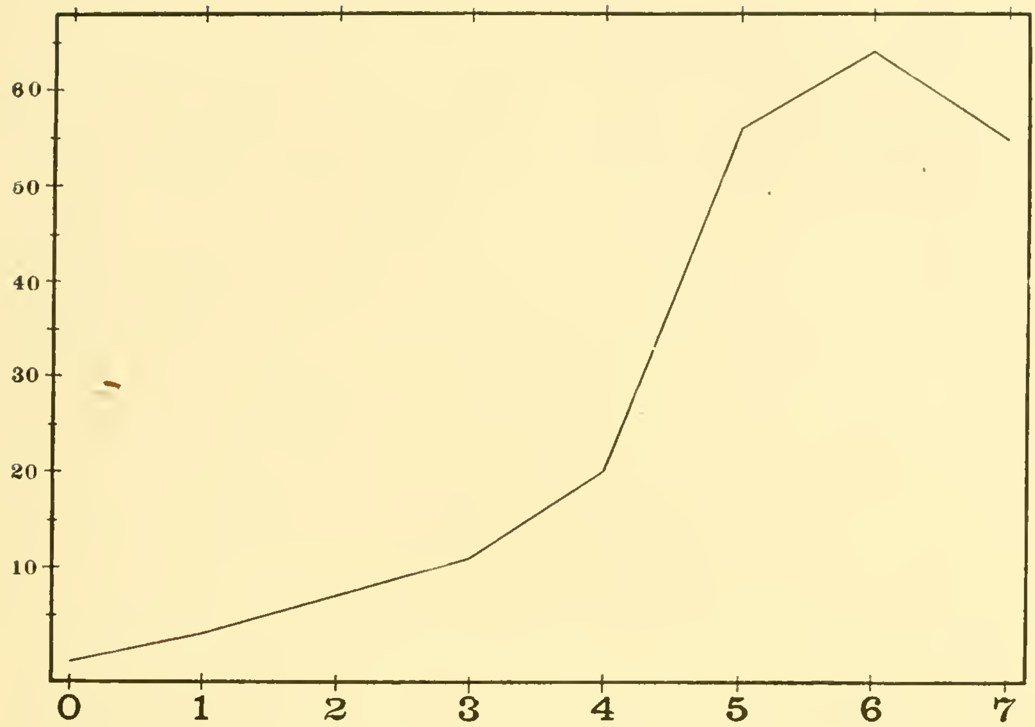


DIAGRAM VII. Showing the relative amount of the weekly loss from Drop in a lettuce crop. The figures at the bottom of the diagram represent the number of weeks. Those in the vertical column at the left the number of infected plants. Average of three experiments.

week in three experiments. The crops in these experiments occupied nearly the same amount of time for their maturity, and they represented about the same amount of development when set out, that is they were about seven weeks along from seed, and when transplanted in the house it took them about seven weeks to reach maturity. These observations were made during the time the plants remained in the infected soil in the house, since previous to this time they had been growing in sterilized soil and were free from disease. Plants started in infected soil might show symptoms of Drop somewhat earlier than those planted in sterilized soil. From the data represented by the curve it appears that the Drop increased rather slowly at first until the fourth week was reached, when it increased very rapidly, reaching its maximum at the sixth week, just previous to the time the crop reached maturity.

A curve based upon data from one experiment in which the amount of Rhizoctonia was recorded was quite similar, the maximum amount of disease due to Rhizoctonia coinciding with that given in Diagram VII for the Drop. This also seems to be true in a general way in the case of the Botrytis Rot.

Amount of Damage Caused by Fungous Diseases of Lettuce.

No attempt has been made to ascertain, in dollars and cents, the exact amount of loss due to fungous diseases. The proportion of lettuce plants, however, which succumb to disease is anywhere from 15 to 85 or 90%. The latter percentages are very exceptional, as growers are not content to experience this loss more than once without making radical changes in their methods. Practically entire crops have been destroyed by Drop alone to our knowledge, and the majority of growers in Massachusetts have experienced at one time or another a loss of from 15% to 40%. The loss of 25% from Drop is no uncommon experience in a large number of lettuce houses and when we consider that these houses each may contain from 6000 to 12000 plants, worth from 40 cts. to $1.00 per dozen, some idea of the loss may be obtained. In addition to the loss from Drop, there are others arising from such diseases as Rhizoctonia, Botrytis Rot, Mildew, and Top-burn, but the last three diseases need not enter very seriously into an experienced lettuce grower's calculations.

Lettuce Diseases in General.

In addition to the various rots which have already been considered, we have at times in this state two other diseases, namely, Mildew, (*Bremia Lactucae* Regel.) and the physiological trouble known as Top-burn. Two other diseases of lettuce known as Anthracnose* and Leaf-spot** have been described by the Ohio Experiment Station, but they have never been called to our attention in Massachusetts. In considering lettuce diseases as a whole, we can arrange them into three groups based upon the specific causes which give rise to them. These three groups of diseases may be characterized as follows:

First: Those which occur in apparently healthy plants and which are directly due to pathogenic (disease producing) organisms.

Second: Those which occur in plants that are abnormal, originating from irrational treatment or from inherent weakness, and which are aggravated by the presence of either pathogenic or non-pathogenic organisms.

Third: Those which are brought about entirely by abnormal treatment, result in physiological disorders, and as a rule neither pathogenic nor non-pathogenic organisms are present.

*Ohio Agr. Exp. Sta. Bull. 73. **Ohio Agr. Exp. Sta. Bull. 44.

In the first group can be placed the purely parasitic organisms, such as those which cause Drop and Rhizoctonia Rot. One of the characteristic features distinguishing the disease known as the Drop is that seemingly healthy† lettuce plants fall a prey to it with the same apparent ease as plants presenting slightly abnormal characteristics. We have here therefore a veritable parasite to deal with, and any mode of treatment of this disease must take these facts into consideration. It is quite evident that for the control of diseases in this group we must pay attention to other matters than the greenhouse conditions, although this class of diseases can be subdued somewhat by changing the conditions under which they are growing.

The second group of lettuce diseases with which fungi are associated are brought about primarily by some physiologically abnormal condition, and the fungi in such instances are merely secondary intrusions. To this latter group belong the Botrytis Rot, Mildew, and Bacterial Rot. The first requisite in their treatment or, more properly speaking, their exclusion, consists in understanding lettuce requirements, and paying the strictest attention to the details of heat, light, ventilation, moisture, soil, etc., or in other words to proper cultural conditions of the crop. There are to be sure instances where plants may receive normal treatment from the most skillful gardeners and become diseased, as for example from the use of poor seed or constitutional weaknesses inherent in the stock. The lettuce Mildew, however, which seldom causes much harm in this State appears from our observations to occur on plants which have received a set-back from transplanting, as it is found largely upon the outer leaves of newly transplanted plants and also upon the older leaves of nearly matured heads. The Mildew was introduced into two houses at the Station a few years ago where it existed for only one season. This fungus propagates by conidia (summer spores) and by oögonia (winter spores). The latter reproductive organs were never observed by us on our plants, and as our lettuce crop was followed by tomatoes, which do not constitute a

†Plants which have been under cultivation for a number of generations cannot be considered in a strict sense as in a normal condition, notwithstanding their capability of responding to skillful treatment in a manner which apparently is normal, or at least not presenting pathological conditions. The modifications wrought in their anatomical and physiological characteristics by long cultivation, influence to a large extent their environmental adaptations and render them susceptible to diseases not occurring in their uncultivated state.

host for this fungus, and as the soil underwent desiccation, the conidia apparently died out and hence no further infection has been noticed.

Under the third group of diseases peculiar to lettuce we can include the Top-burn, the cause of which has no special reference to a specific organism, it being brought about by the failure or perversion of the normal physiological activities of the plant. Micro-organisms, however, may not infrequently accompany the diseased tissues. If a sharp knife is plunged into the soil to some depth and passed around in proximity to the lettuce plant so as to cut off the apices of the roots we can produce artificially the characteristic symptoms of Top-burn. This simple experiment teaches us that Top-burn is associated incidentally at least with root absorption, but there are other elements which come into play in practical greenhouse management which bear upon the prevalence of this disease. Indeed it is possible to fill a house with Top-burn and ruin a crop within the short space of twenty-four hours by disregarding temperature and light conditions. Top-burn is most commonly brought about in the following manner. If the night and day temperatures are run high during a period of cloudy weather and this period is followed by bright sunshine, Top-burn is quite sure to follow. The reason of this is that a high temperature accompanied by cloudy weather causes active growth, which results in producing tissues of an extremely delicate character. When exposed to intense sunlight and rapid transpiration, the edges of the young leaves wilt, collapse and turn black. The remedy for this group of diseases consists therefore in paying strict attention to the details governing healthy plants and, in case of Top-burn in regulating the day and night temperatures in accordance with the conditions of the crop and weather. Skillful lettuce growers understand quite well the cause of the Top-burn and are able to control it successfully. Inasmuch as lettuce plants make the most growth at night, the danger from high temperature at this time is the greatest, especially when the crop is approaching maturity. High temperature at night on immature plants is allowable and during clear days the temperature can go frequently as high as 80° or 90° F. either on mature or immature plants without causing any injury.

Summary.

In the lettuce forcing industry, which is of great importance in Massachusetts, much loss is experienced by various diseases of the crop, of which rotting is the worst. The amount of loss due to this cause is very commonly 25% and occasionally a whole crop is destroyed.

This trouble has been prevalent for some time, but its real nature has been very little known. It has been found to be caused by several different fungi entirely distinct from each other, and differing very much in their mode of development and relations to the crop.

Botrytis vulgaris, the fungus to which the trouble has generally been ascribed, occurs very rarely upon well grown lettuce as a real parasite and is of minor importance. It is commonly associated with the troubles known indefinitely as " Damping Off," " Mildew," " Black Root," and " Rot."

By far the worst trouble is that characterized by a rotting of the stem and sudden and complete collapse of the whole plant, which is known as the " Drop."

This disease has been found to be caused by a fungus called *Sclerotinia Libertiana*, which has not previously been described on lettuce, but is well known as the cause of many similar diseases of other plants.

The spread of this fungus in the greenhouse is almost entirely by growth in the soil, where by means of special organs called *sclerotia* it is able to exist indefinitely between crops and resist all the ordinary influences of Nature.

Another undescribed disease of lettuce has been found which is caused by a species of Rhizoctonia. This is much less prevalent than the Drop and is characterized by a rotting of the leaf blades.

No serious bacterial rot of lettuce is prevalent in this State.

By sterilizing the soil either wholly or in part, the Drop and Rhizoctonia can be completely eradicated or suppressed.

Experiments show that $\frac{5}{8}$ in. or $\frac{3}{4}$ in. surface coverings of sterilized sand or earth gave a reduction of 47% in the amount of Drop. One inch of sterilized sand or earth gave an average reduction of 87%; $1\frac{1}{2}$ in. of sterilized soil an average of 93%, and 2, 3, and 4 in. gave 100% reduction or no Drop whatsoever, when not contaminated by infected material.

The treatment of the soil by hot water, which raised the temperature of the surface from 176° F. to 186° F. to a depth of 4 in., reduced the amount of Drop 76% and completely killed the Rhizoctonia.

Treating the surface with a steam rake raised the temperature of the soil to 168° F. to a depth of 4 or 5 in. This treatment succeeded in reducing the Drop only 5%; the Rhizoctonia being reduced 57%.

The amount of heat necessary to kill the Drop is about 160° F.; that for the Rhizoctonia appears to be somewhat less.

This method of treatment possesses no value for such diseases as the Botrytis, Mildews, Bacterial-Rot, etc., which can be controlled by proper management of the crop.

Other than the methods of heating the only alternative is changing the soil.

The application of such substances as lime, sulphur, and charcoal to the surface of the soil exerts no repressive influence on the Drop or other lettuce diseases.

Coatings of sawdust, coal ashes and sand applied to the surface of the soil exert only a slight controlling influence upon the Drop. The last substance, however, showed generally less Botrytis-Rot.

Sub-irrigation, by reducing the surface moisture, has a tendency to lessen the amount of rot.

Experiments with various gases showed that while some are capable of killing rot fungi when freely exposed to their influence, they are all powerless when the organisms are superficially embedded in plant tissues or in the soil.

Freezing the soil has no detrimental effect upon the Drop; on the other hand the development of the sclerotia is accelerated by freezing.

Desiccation exerts a remarkable accelerating influence upon the development of the sclerotia; in one experiment the amount of Drop was increased 64%.

The period in the development of the crop at which the greatest loss occurs is at about the time of maturity.

The optimum conditions for the development of the Drop fungus are practically the same as those for lettuce.

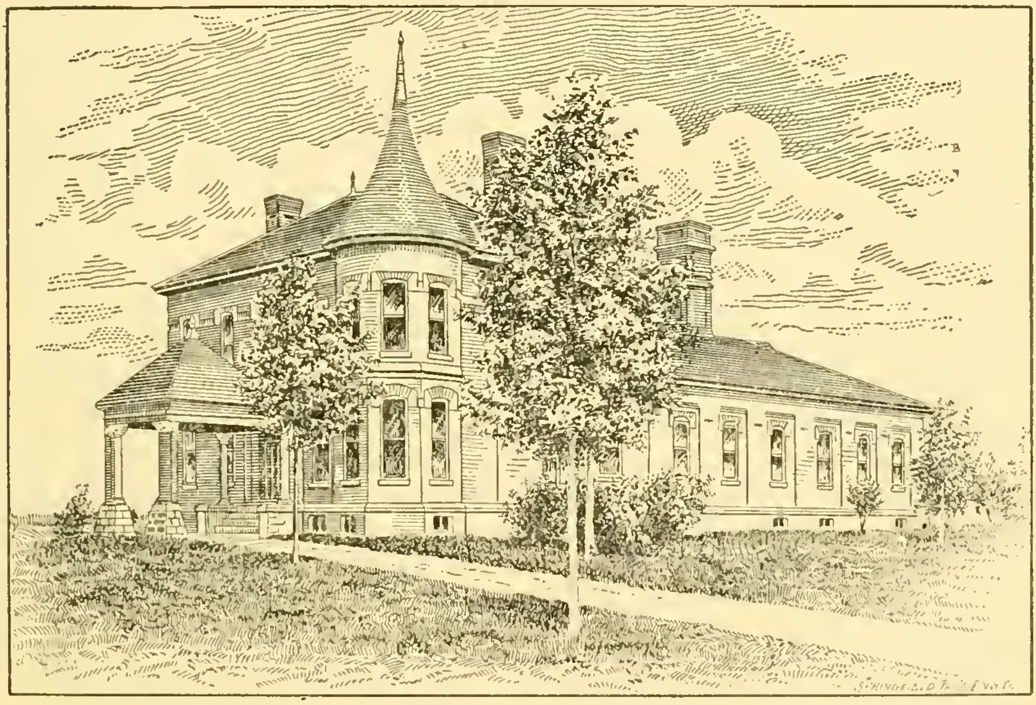
HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 70.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1900.



CHEMICAL LABORATORY.

NOVEMBER, 1900.

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,
1900.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry T. Fernald, Ph. D.,	*Associate Entomologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Samuel W. Wiley, B. Sc.,	*Assistant Chemist* (Fertilizers).
James E. Halligan, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, M. Sc.,	*First Chemist*(Foods and Feeding).
Philip H. Smith, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
James W. Kellogg, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
George A. Drew, B. Sc.,	*Assistant Horticulturist.*
Henry L. Crane, B. Sc.,	*Assistant Horticulturist.*
Charles L. Rice,	*Observer.*

The co-operation 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 CHEMISTRY.

C. A. Goessmann.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

733-737. I and II. Received from Sunderland, Mass.
III. Received from Fitchburg, Mass.
IV. Received from Amesbury, Mass.
V. Received from Grafton, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	14.63	13.00	18.89	18.13	7.88
Potassium oxide,	5.53	5.72	4.66	.59	4.68
Phosphoric acid,	2.07	1.23	1.46	1.15	1.92
Calcium oxide,	30.52	32.36	32.47	3.38	32.21
Insoluble matter,	13.73	13.93	10.80	68.72	19.13

738-742. I. Received from Danvers, Mass.
II. Received from Concord, Mass.
III. Received from Sherborn, Mass.
IV. Received from Concord, Mass.
V. Received from Concord, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.50	22.34	22.32	22.64	18.62
Potassium oxide,	5.57	4.47	4.01	4.69	5.32
Phosphoric acid,	1.87	.56	1.48	1.23	1.48
Calcium oxide,	36.89	29.35	30.76	29.05	30.76
Insoluble matter,	7.00	11.24	11.02	11.45	11.20

743-747. I. Received from Concord, Mass.
II. Received from Amherst, Mass.
III. Received from North Hadley, Mass.
IV and V. Received from Sunderland, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	18.95	22.82	26.58	14.50	24.05
Potassium oxide,	5.64	3.35	4.32	4.64	3.24
Phosphoric acid,	1.56	1.07	1.36	.64	.12
Calcium oxide,	30.37	36.66	23.35	40.20	31.26
Insoluble matter,	10.28	6.82	18.91	8.51	11.98

748-752. I and II. Received from Sunderland, Mass.
III. Received from Danvers, Mass.
IV. Received from North Hadley, Mass.
V. Received from Northfield Farms, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	32.77	13.52	3.65	21.70	8.10
Potassium oxide,	2.72	3.84	7.20	4.32	1.86
Phosphoric acid,	.64	1.28	1.66	1.28	1.00
Calcium oxide,	37.89	38.03	37.20	37.47	38.03
Insoluble matter,	4.17	9.63	12.48	6.84	16.95

753-757. I. Received from Lexington, Mass.
II. Received from North Amherst, Mass.
III. Received from Mt. Hermon, Mass.
VI. Received from Marblehead, Mass.
V. Received from Bernardston, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	29.03	21.30	3.59	21.51	3.15
Potassium oxide,	3.29	5.09	3.88	6.04	4.22
Phosphoric acid,	1.41	1.48	2.58	1.54	2.00
Calcium oxide,	28.26	31.32	38.87	30.42	38.41
Insoluble matter,	8.69	9.56	15.42	9.49	12.84

758-762. I. Received from South Amherst, Mass.
II and III. Received from So. Easton, Mass.
IV. Received from South Amherst, Mass.
V. Received from Danvers Centre, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.33	22.03	21.80	9.43	11.52
Potassium oxide,	4.36	2.32	2.68	5.98	5.28
Phosphoric acid,	1.28	1.22	1.48	1.43	1.28
Calcium oxide,	40.36	35.64	33.96	34.47	32.08
Insoluble matter,	10.98	6.21	7.01	13.14	17.09

763-767. I. Received from Worcester, Mass.
II. Received from East Charlemont, Mass.
III. Received from Westfield, Mass.
IV. Received from Lakeville, Mass.
V. Cotton Hull Ashes, received from Hatfield, Mass.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C ,	1.22	7.83	13.59	12.57	11.52
Potassium oxide,	1.64	4.92	1.79	3.88	21.96
Phosphoric acid,	1.12	1.16	4.40	1.54	9.59
Calcium oxide,	33.76	32.71	9.95	35.59	.74
Insoluble matter,	28.51	14.99	55.69	10.26	19.28

POTASH COMPOUNDS.

768-771.
I. Potash-Magnesia Sulphate, received from North Amherst, Mass.
II. Potash-Magnesia Sulphate, received from Lunenburg, Mass.
III. Muriate of Potash, received from Boston, Mass.
IV. Sulphate of Potash, received from Middleboro, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	6.70	1.84	1.04	1.58
Potassium oxide,	21.90	23.90	49.45	45.70

NITROGEN COMPOUNDS.

772. I. Nitrate of Soda, received from Boston, Mass.

	Per Cent. I.
Moisture at 100° C.,	1.03
Nitrogen,	14.86

GROUND BONE.

773-775. I. Bone from Fish, received from Northampton, Mass.
II. Bone meal, received from Concord, Mass.
III. Ground bone, received from Whitingsville, Mass.

	Per Cent.		
	I.	II.	III
Moisture at 100° C.,	8.78	2.32	4.05
Total Phosphoric acid,	23.54	25.79	20.78
Available Phosphoric acid,	8.04	8.06	*
Insoluble Phosphoric acid,	15.50	17.73	*
Nitrogen,	4.82	1.84	4.04

GROUND FISH.

776-778. I. Ground Fish, received from Hatfield, Mass.
II. Dry Fish meat, received from Northampton, Mass.
III. Fish waste, received from Hatfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	5.72	11.40	10.75
Total Phosphoric acid,	11.64	7.01	9.42
Available Phosphoric acid,	5.52	3.22	*
Insoluble Phosphoric acid,	6.12	3.79	*
Nitrogen,	10.48	8.06	8.99

PHOSPHORIC ACID COMPOUNDS.

779-780.

I. Dissolved Bone Black, received from Boston, Mass.
II. Florida Rock Phosphate, received from North Amherst, Mass.

	Per Cent.	
	I.	II.
Moisture at 100° C.,	5.93	.41
Total Phosphoric acid,	20.93	40.34
Soluble Phosphoric acid,	12.58	*
Reverted Phosphoric acid,	4.18	*
Insoluble Phosphoric acid,	4.17	*

COMPLETE FERTILIZERS.

781-786. I. Received from Grafton, Mass.
II. Received from Amherst, Mass.
III. Received from Manomet, Mass.
IV and V. Received from Sunderland, Mass.
VI. Received from Pittsfield, Mass.

*Not determined.

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	14.80	3.79	6.12	5.02	8.35	7.90
Total Phosphoric acid,	4.12	10.98	8.06	11.76	5.76	7.42
Soluble Phosphoric acid,	.36	.28	3.42	—	—	—
Reverted Phosphoric acid,	2.63	3.87	3.36	5.88	3.08	4.10
Insoluble Phosphoric "	1.13	6.83	1.28	5.88	2.68	3.32
Potassium oxide,	16.78	9.71	8.14	17.04	16.34	11.40
Nitrogen,	.29	1.85	2.80	—	—	2.56

787-791. I. Received from Sunderland, Mass.
II. Received from Agawam, Mass.
III. Received from Hatfield, Mass.
IV. Received from Methuen, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.02	4.05	5.56	7.46	4.36
Total Phosphoric acid,	8.18	13.18	10.87	10.75	11.26
Soluble Phosphoric acid,	4.75	2.04	2.17	1.06	2.38
Reverted Phosphoric acid,	2.16	5.90	5.96	6.24	4.48
Insoluble Phosphoric acid,	1.28	5.24	2.74	3.45	4.40
Potassium oxide,	8.70	9.40	10.22	12.34	8.32
Nitrogen,	3.50	3.98	4.99	4.00	4.45

COTTON WASTE.

792-794. I. and II. Received from Lowell, Mass.
III. Received from Springfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	5.96	32.40	19.65
Total Phosphoric acid,	.28	trace	.69
Potassium oxide,	1.26	.61	.43
Nitrogen,	.97	1.21	1.20
Insoluble matter,	23.61	31.96	51.84
Calcium oxide,	*	*	2.12

*Not determined.

PRODUCT FROM GARBAGE PLANT.

795. I. Received from New Bedford, Mass.

	Per Cent. I.
Moisture at 100° C.,	4.14
Total Phosphoric acid,	6.92
Potassium oxide,	.50
Nitrogen,	2.56
Insoluble matter,	16.48

TOBACCO STALKS.

796-797.

I. Exposed to the action of the weather, received from No. Hadley.
II. Unexposed, received from No. Hadley, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	7.58	6.88
Total Phosphoric acid,	.38	.54
Potassium oxide,	.52	3.88
Nitrogen,	1.18	2.44
Insoluble matter,	1.86	.95

MANURES.

798-800. I. Bat Guano, received from Havana, Cuba.
II and III. Sheep manure, received from Boston, Mass.

	I.	Per Cent. II.	III.
Moisture at 100° C.,	6.95	7.85	5.11
Total Phosphoric acid,	5.04	1.66	2.24
Potassium oxide,	.53	2.14	3.16
Nitrogen,	6.96	2.27	2.38
Calcium oxide,	10.89	*	*
Magnesium oxide,	trace	*	*
Ferric and aluminum oxide,	5.76	*	*
Sodium oxide,	6.17	*	*
Ash,	*	16.95	17.34
Insoluble matter,	.40	*	*

BARNYARD MANURES.

801-806.

I, II, III, IV, V, and VI. Received from Amherst, Mass.

*Not determined.

	Per Cent. I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	73.57	70.74	63.52	75.76	76.96	73.07
Total Phosphoric acid,	.33	.39	.52	.30	.29	.28
Potassium oxide,	.47	.62	.68	.41	.55	.66
Nitrogen,	.43	.53	.69	.30	.33	.35

DEPOSITS.

807-809.

I. Deposit from Charles River, received from Newton Upper Falls.
II. Dredgings from Cape Cod, received from Boston, Mass.
III. Deposit from pond, received from Ware, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	21.46	18.99	4.01
Total Phosphoric acid,	.74	.07	.32
Potassium oxide,	.59	.13	.26
Nitrogen,	.95	.99	.41
Calcium oxide,	1.81	trace	.62
Magnesium oxide,	*	trace	*
Ferric and aluminum oxide,	*	2.06	*
Chlorine,	*	.54	*
Insoluble matter,	44.27	*	*

GREEN COW PEA AND SOJA BEAN (matured state).

810-812. I. Cow Pea (Early).
II. Cow Pea (Late).
III. Soja Bean.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	83.08	81.52	72.59
Nitrogen,	.31	.41	.85

SOILS.

813-816. I and II. Received from Clinton, Mass.
III and IV. Received from South Carver, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.,	.72	1.47	22.94	8.26
Total Phosphoric acid,	.13	.24	.06	.27
Potassium oxide,	.15	.80	.15	.54
Calcium oxide,	1.52	.65	.18	.45
Nitrogen,	.22	.22	.05	.09

*Not determined.

817-819. I. Received from South Carver, Mass.
II. Received from Truro, Mass.
III. Received from Fitchburg, Mass.

	Per Cent. I.	II.	III.
Moisture at 100° C.,	12.58	.64	69.62
Total Phosphoric acid,	.29	.24	.07
Potassium oxide,	.34	.27	.05
Calcium oxide,	.25	.81	trace
Nitrogen,	.10	.19	.44

820-821. I. Peat, received from Concord, Mass.
II. Soot, received from North Grafton, Mass.

	Per Cent. I.	II.
Moisture at 100° C.,	59.70	.23
Total Phosphoric acid,	.13	.72
Potassium oxide,	.10	1.57
Calcium oxide,	1.29	2.92
Nitrogen,	.75	—
Insoluble matter,	*	87.60

SLUDGE.

822-826.

I. Unpressed sludge, bottom of basin, received from Worcester.
II. Unpressed sludge, top of basin, received from Worcester.
III. Pressed sludge, yellowish color, received from Worcester.
IV. Pressed sludge, black color, received from Worcester.
V. Pressed sludge, reddish color, received from Worcester.

	Per Cent. I.	II.	III.	IV.	V.
Moisture at 100° C.,	65.99	63.59	54.98	68.15	53.11
Nitrogen,	.44	.38	.49	.36	.62

827-828.

I. Complete average analysis of the above five samples of sludge.
II. Sludge, from Brockton filter beds, received from South Easton.

*Not determined.

	Per Cent. I.	II.
Moisture at 100° C.,	61.16	2.77
Total Phosphoric acid,	.39	.72
Potassium oxide,	.13	.66
Calcium oxide,	5.08	trace
Nitrogen,	.46	1.27
Insoluble matter,	10.57	69.91
Magnesium oxide.	2.19	*
Ferric oxide,	6.50	*
Aluminum oxide,	2.05	*
Sulphuric acid,	.44	*
Chlorine,	trace	*
Carbonic acid,	4.86	*

The character of this material depends, in a controlling degree upon the process of precipitation.

*Not determined.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
12	All Soluble,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
295	All Soluble,	Armour Fertilizer Works, Chicago, Ill.,	Salem.
50	Grain Grower,	Armour Fertilizer Works, Chicago, Ill.,	Amherst.
256	Grain Grower,	Armour Fertilizer Works, Chicago, Ill.,	Danvers.
195	Complete Root Fertilizer,	Berkshire Mills Co., Bridgeport, Conn.,	No. Amherst.
201	Complete Fertilizer for Tobacco,	Berkshire Mills Co., Bridgeport, Conn.,	No. Amherst.
134	Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
302	Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
318	Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Lawrence.
385	Potato and Vegetable Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
404	Potato and Vegetable Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Gt. Barrington
312	Sure Crop Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Georgetown.
334	Sure Crop Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Fitchburg.
181	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Dighton.
220	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	W. Bridg'wat'r
298	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
314	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Lowell.
355	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Concord.
157	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Dighton.
64	Bay State Grass Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Hudson.
436	Potato Phosphate,	Cleveland Dryer Co., Boston, Mass.,	Amherst.
435	Superphosphate,	Cleveland Dryer Co., Boston, Mass.,	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
12-295	All Soluble,	9.05	3.21	2.88-3.70	1.92	8.72	4 17	14.81	10-12	10.64	8-10	5.51	4-5
50 256	Grain Grower,	6.13	2.74	1.65-2.47	5.38	3.50	4.22	13.10	10-12	8.88	8-10	2.20	2-3
195	Complete Root Fertilizer,	9.83	2.79	2.47-3.30	5.09	3.48	2.15	10.72	10-12	8.57	8-10	7.76	6-8
201	Complete Fertilizer for Tobacco,	7.97	2.79	2.47-3.30	5.48	3.35	2.25	11.08	10 12	8.83	8-10	5.82	6-8
134-302-318	Lawn and Garden Dressing,	9.03	4.57	3-4	2.30	4.97	2.05	9.32	8-10	7.27	6-8	5.18	5-6
385-404	Potato and Vegetable Phosphate,	10.25	1.89	1.5-2.5	5.27	3.53	2.32	11.12	10-12	8.80	8-10	2.36	2-4
312-334	Sure Crop Phosphate,	10.02	.93	.75-1.50	3.20	6.46	2.28	11.94	11-12	9.66	9-11	2.31	2-4
181-220-298-314-355	High Grade Fertilizer,	12.38	2.73	2.25-3.25	6.40	2.58	1.26	10.24	10-13	8.98	8-10	4.40	4-6
157	Bay State Fertilizer,	12.82	2.61	2.47-3.30	6.08	3.55	1.89	11.52	10-14	9.63	9-12	2.09	2-3
64	Bay State Grass Fertilizer,	5.82	4.88	3.91-4.00	1.51	3.84	1.66	7.01	6-9	5.35	5-7	3.34	2-3
436	Potato Phosphate,	11.52	2.49	2.05-2.85	5 95	4.36	2.28	12.59	10-13	10.31	8-10	2.95	3-4
435	Superphosphate,	12.15	2.60	2.06-2.88	7.46	3.39	1.48	12.33	10-13	10.85	8-10	1.68	1.5-2.5

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Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
444	Tobacco and Onion Fertilizer,	E. Frank Coe Co., New York City,	Sunderland.
62	Red Brand Excelsior Guano,	E. Frank Coe Co., New York City,	Sterling.
268	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Haverhill.
293	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Amesbury.
441	Potato and Root Crop Manure,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.
407	Imperial Liquid Plant Food,	Eastern Chemical Co., Boston, Mass.,	Boston.
419	Imperial Liquid Grass Fertilizer,	Eastern Chemical Co., Boston, Mass.,	Amherst.
320	Grass and Oats Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.	S. Ashburnham
427	Garden Special,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
437	Ferti Flora	C. W. Hastings, Jamaica Plains, Mass.,	Amherst.
428	Pride of the Valley,	Thomas Kirley, So. Hadley Falls, Mass.,	Amherst.
120	Potato Manure,	Lowell Fertilizer Co., Boston, Mass.,	Fall River.
384	Potato Manure,	Lowell Fertilizer Co., Boston, Mass.,	Worcester.
248	Celebrated Onion Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Amherst.
223	High Grade Special for Spring Crops,	Lister's Agricultural Chemical Works, Newark, N. J.,	W. Bridgew'er
247	High Grade Special for Spring Crops,	Lister's Agricultural Chemical Works. Newark, N. J.,	Amherst.
187	Tobacco Ash Constituents,	Mape's Formula and Peruvian Guano Co., New York City	So. Deerfield.
67	Mape's Corn Manure,	Mape's Formula and Peruvian Guano Co., New York City	Taunton.
164	Market Garden Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
444	Tobacco and Onion Fertilizer,	8.02	3.50	3.2-4	4.74	2.16	1.28	8.18	8-10	6.90	6-8	8.70	8-9*
62	Red Brand Excelsior Guano,	8.47	3.42	3.4-4	6.65	2.77	1.38	10.80	11-13	9.42	9-10	6.34	6-7*
268-293	New Rival Ammoniated Superphosphate,	14.15	1.31	1.23-2	6.45	2.10	1.89	10.44	11-15	8.55	10-12	2.28	1.6-2
441	Potato and Root Crop Manure	6.11	3.76	3.30	5.67	3.67	1.20	10.54	9	9.34	8	7.38	7
407	Imperial Liquid Plant Food,	89.12	1.82	1	1.33	—	—	1.33	1	1.33	1	1.86	1
419	Imperial Liquid Grass Fertilizer,	87.68	2.20	1	2.01	—	—	2.01	1	2.01	1	1.82	1
320	Grass and Oats Fertilizer,	11.87	—	—	7.35	3.07	1.30	11.72	12 17	10.42	11-15	2.16	2-4
427	Garden Special,	9.40	3.65	3.29.4.25	5.09	3.30	1.84	10.23	9-15	8.39	8-12	6.40	7-9
437	Ferti Flora,	82.10	3.52	3.25	3.81	—	—	3.81	3 66	3.81	—	3.48	3.30
428	Pride of the Valley,	11.59	4.23	3.5-4.5	1.47	4.18	3.89	9.54	7-9	5.65	—	1.68	4.32-5.40
120-384	Potato Manure,	4.42	1.92	1.64-2.46	3.17	2.92	3.43	9.52	8-11	6.09	7-9	4.32	4-5
248	Celebrated Onion Fertilizer,	12.12	3.71	4.5-5.00	6.40	1.66	2.30	10.36	7.5-9	8.06	—	6.98	7-8
223-247	High Grade Special for Spring Crops,	12.22	2.41	1.85 2.47	4.73	3 59	1.56	9.88	10.5-13	8.32	8-10	9.06	10-12
187	Tobacco Ash Constituents,	9.35	.81	.50	—	3.22	2.51	5.73	5.70	3.22	—	16.54	15.
67	Mapes' Corn Manure,	8.27	2.70	2.47-2.88	2.34	5.08	4.09	11.51	10-12	7.42	8-10	6.70	6-7
164	Market Garden Fertilizer,	8.64	3.09	2.47-3.30	4.22	2.48	2.69	9.39	9-10	6.70	7-10	6.46	6-8

NOTE.—We wish to give credit for potash in form of Sulphate on the samples of E. Frank Coe Co.'s fertilizers, the analysis of which were published in our July bulletin No 68, as follows: "High Grade Ammoniated Bone Superphosphate," "Special Potato Fertilizer," "Gold Brand Excelsior Guano," "Excelsior Potato," and "Columbian Potato Fertilizer."

*Sulphate of potash the source of potash.

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Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
162	Ammoniated Bone Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
332	Ammoniated Bone Phosphate,	National Fertilizer Co,, Bridgeport, Conn.,	Leominster.
434	High Grade General Fertilizer,	Pacific Guano Co., Boston, Mass.,	Amherst.
113	Potato Special,	Pacific Guano Co., Boston, Mass.,	No. Westport.
307	Potato Special,	Pacific Guano Co., Boston, Mass.,	Lowell.
228	Gardener's Complete Manure,	Packer's Union Fertilizer Co., New York City,	Foxboro.
232	Universal Fertilizer,	Packer's Union Fertilizer Co., New York City,	Foxboro.
426	Wheat, Oats and Clover Fertilizer,	Packer's Union Fertilizer Co., New York City,	Amherst.
145	Plymouth Rock Brand,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
168	Special Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
189	A. A. Brand,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	So. Deerfield.
210	Potato Manure,	Quinnipiac Co., Boston, Mass.,	Bridgewater.
369	Potato Manure,	Quinnipiac Co., Boston, Mass.	Pittsfield.
222	Special Manure with 10 per cent Potash,	Quinnipiac Co., Boston, Mass.,	Bridgewater.
319	Hubbard's Oats and Top Dressing,	Rogers & Hubbard Co., Middletown Conn.,	Ashbur'm C't'r.
323	Hubbard's Fairchild's Formula forCorn and General Crop	Rogers & Hubbard Co., Middletown, Conn.,	Ashbur'm C't'r.
360	Hubbard's Soluble Potato Manure,	Rogers & Hubbard Co., Middletown, Conn.,	Williamstown.
119	Hubbard's Potato Phosphate,	Rogers & Hubbard Co., Middletown, Conn.,	Acushnet.
126	Hubbard's Corn Phosphate,	Rogers & Hubbard Co., Middletown, Conn.,	Acushnet.
328	Hubbard's Corn Phosphate,	Rogers & Hubbard Co., Middletown, Conn.,	Ashbur'm C't'r.
420	All Around Fertilizer,	Rogers Manufacturing Co., Rockfall, Conn.,	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
162-332	Ammoniated Bone Phosphate,	11.03	1.91	1.82-2.64	6.18	3.00	2.79	11.97	10-12	9.18	8-10	2.68	2-3
434	High Grade General Fertilizer,	7.49	3.88	3.25-4.25	5.76	2.76	1.71	10.23	9-13	8.52	8-11	7.48	7-8
113-307	Potato Special,	12.75	2.44	2.06-2.89	5.80	3.77	.84	10.41	9-13	9.57	7-11	3 26	3-4
228	Gardener's Complete Manure,	11.40	2.91	2.47-3.29	2.69	2.92	2.17	7.78	8-13	5.61	6-10	10.68	10-12
232	Universal Fertilizer,	15.50	1.28	.82-1.50	6.01	1.18	2.69	9.88	9-15	7.19	8-12	4.02	4-6
426	Wheat, Oats and Clover Fertilizer,	7.54	—	—	8.83	3.17	1.25	13.25	12-17	12.00	11-15	2.82	2-4
145	Plymouth Rock Brand,	9.17	3.25	2.47-3.29	4.32	4.05	1.89	10.26	9-13	8.37	8-11	4.30	4-4.25
168	Special Potato Fertilizer,	9.87	3.69	3.29-4.12	3.43	6.02	1.48	10.93	9-13	9.45	8 12	7.42	7-9
189	A. A. Brand,	10.35	4.57	4.53-5.76	3.56	4.37	1.56	9.49	8-11	7.93	7-9	9.16	8-9
210-369	Potato Manure,	11.80	2.80	2.47-3.30	4.45	2.66	1.64	8.75	7-11	7.11	6-9	5.48	5-6
222	Special Manure with 10 per cent Potash,	7.05	4.13	2.47-3.29	.68	6.02	1.18	7.88	7-11	6.70	6-8	3.32	10-11
319	Hubbard's Oats and Top Dressing,	7.42	8.83	8.80-9.70	—	4.20	4.17	8.37	7.85-8.75	4.20	—	8.34	8.35-9.25
323	Hub'd's Fairchild'sForm.Corn & Gen'l Crops	5.52	6.11	5.5-6.5	—	3.20	7.85	11.05	12-13	3.20	4.80	12.51	12.50-14
360	Hubbard's Soluble Potato Manure,	7.82	5.10	5-6	.93	6.57	3.43	10.93	10-12	7.50	7-8.5	5.86	5-6
119	Hubbard's Potato Phosphate,	9.85	2.56	2.-2.50	5.16	3.67	3.20	12.03	10-12	8.83	9-10	5.52	5-6
126-328	Hubbard's Corn Phosphate,	10.90	1.54	1-1.50	4.10	5.62	2.18	11.90	10-12	9.72	8-10	3.86	3.5-4
420	All Around Fertilizer,	4.91	2.04	1.65-2.65	6.69	3.32	7.34	17.35	10-12	10.01	8-10	2.68	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
41	Potato and Vegetable,	Rogers Manufacturing Co., Rockfall, Conn.,	Westfield.
421	Tobacco and Potato Manure,	Rogers Manufacturing Co., Rockfall, Conn.,	Amherst.
422	Oats and Top Dressing,	Rogers Manufacturing Co., Rockfall, Conn.,	Amherst.
423	Grass and Grain Fertilizer,	Rogers Manufacturing Co., Rockfall, Conn.,	Amherst.
42	High Grade Soluble Tobacco Manure,	Rogers Manufacturing Co., Rockfall, Conn.,	Westfield.
146	Essex Dry Ground Fish,	Russia Cement Co., Gloucester, Mass.,	Dighton.
367	Essex Dry Ground Fish,	Russia Cement Co., Gloucester, Mass.,	Pittsfield.
240	Corn Fertilizer,	Russia Cement Co., Gloucester Mass.,	Mansfield.
373	Corn Fertilizer,	Russia Cement Co., Gloucester, Mass.,	Williamstown.
75	Odorless Lawn Dressing,	Russia Cement Co., Gloucester, Mass,,	Taunton.
175	Odorless Lawn Dressing,	Russia Cement Co., Gloucester, Mass.,	Dighton.
329	Standard Superphosphate,	Read Fertilizer Co., New York City,	S. Ashburnh'm
391	Standard Superphosphate,	Read Fertilizer Co., New York City,	Greenfield.
390	High Grade Farmer's Friend,	Read Fertilizer Co., New York City,	Greenfield.
322	Practical Potato Special,	Read Fertilizer Co., New York City,	S. Ashburnh'm
388	Fish, Bone and Potash,	Read Fertilizer Co., New York City,	Greenfield.
324	Samson Fertilizer,	Read Fertilizer Co., New York City,	S. Ashburn'hm
344	Old Reliable Superphosphate,	Lucien Sanderson, New Haven, Conn.,	Lanesboro.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
41	Potato and Vegetable,	11.22	2.66	2.25-3.25	7.27	2.32	4.58	14.17	10-12	9.59	8-10	3.96	5-6
421	Tobacco and Potato Manure,	10.22	3.48	3.5-4	1.64	6.11	2.46	10.21	9-11	7.75	7-9	11.54	8.75-10*
422	Oats and Top Dressing,	7.05	5.89	6.3-6.8	2.11	4.55	3.68	10.34	9-10.5	6.66	7-9	7.08	7.5-8.5
423	Grass and Grain Fertilizer,	6.95	3.23	3-4	—	4.94	15.35	20.29	16-17	4.94	—	10.68	12.5-14
42	High Grade Soluble Tobacco Manure,	5.15	5.18	5-6	1.54	4.86	2.99	9.39	8-10	6.40	6-8	13.32	11-12*
146-367	Essex Dry Ground Fish,	7.70	7.44	8-10	—	7.60	8.47	16.07	11-13	7.60	—	—	—
240-373	Corn Fertilizer,	8.75	2.01	2-2.5	3.20	4.38	6.24	13.82	11-13	7.58	9-10	3.48	3-3.5
75-175	Odorless Lawn Dressing,	2.60	4.79	4.5-5.5	.68	4.90	5.35	10.93	7-8	5.58	5.5 6.5	7.40	7-8
329-391	Standard Superphosphate,	14.75	1.38	.82-1.65	4.29	3.63	3.08	11.00	9-10	7.92	8-10	4.06	4-5
390	High Grade Farmers' Friend,	9.35	3.43	3.30-4.12	3.80	2.74	2.44	8.98	7-8	6.54	6-8	9.82	10-11
322	Practical Potato Special,	8.50	.95	.82-1.65	2.50	3.08	.48	6.06	5-6	5.58	4-6	8.50	8-9
388	Fish, Bone and Potash,	15.40	2.17	2-3	1.54	2.68	2.68	6.90	6-8	4.22	4-6	4.06	4-6
324	Samson Fertilizer,	12.65	2.12	2.10-2.4	6.75	3.83	1.82	12.40	9-10	10.58	8-10	3.07	3-4
344	Old Reliable Superphosphate,	7.19	3.31	2.47-3.30	2.41	4.86	4.38	11.65	10-12	7.27	7-8	4.56	2-3

* Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
363	Formula "A,"	Lucien Sanderson, New Haven, Conn.,	Lanesboro.
429	Standard Guano,	Standard Fertilizer Co., Boston, Mass.,	Amherst.
430	Standard Complete Manure,	Standard Fertilizer Co., Boston, Mass.,	Amherst.
431	Standard A Brand,	Standard Fertilizer Co., Boston, Mass.,	Amherst.
433	Special Potato Fertilizer,	Henry F. Tucker Co., Boston, Mass.,	Amherst.
114	Dry Ground Fish Guano,	Wilcox Fertilizer Works, Mystic, Conn.,	Fall River.
214	High Grade Special for Potatoes,	Williams & Clark Fertilizer Co., Boston, Mass.,	W. Bridgewa'r
217	High Grade Special for Potatoes,	Williams & Clark Fertilizer Co., Boston, Mass.,	Eastham.
381	High Grade Special for Potatoes,	Williams & Clark Fertilizer Co., Boston, Mass.,	Marlboro.
279	Corn Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Danvers.
394	Corn Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
205	Americus with 10 per cent. Potash,	Williams & Clark Fertilizer Co., Boston, Mass.,	W. Bridgewa'r
317	Prolific Crop Producer,	Williams & Clark Fertilizer Co., Boston, Mass.,	Lowell.
432	Fine Wrapper Tobacco Grower,	Williams & Clark Fertilizer Co., Boston, Mass.,	Amherst.
198	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	No. Amherst.
264	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	DanversC'ntre
313	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Georgetown.
267	Grass and Oats Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Danvers C'ntre

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
363	Formula "A,"	9.88	2.45	3.8-4	4.61	4.50	3.79	12.90	10-12	9.11	6-8	5.62	6-8
429	Standard Guano,	7.93	1.41	1.03-2.50	4.64	3.47	2.84	10.95	10-15	8.11	8-12	2.56	2-3
430	Standard Complete Manure,	7.89	3.97	3 30-4.12	6.18	2.29	1.66	10.13	9-13	8.47	8-11	7.50	7-8
431	Standard "A" Brand,	8.95	1.56	.82-1.64	4.61	3.20	3.04	10.85	9-12	7.81	7-9	1.44	1-2
433	Special Potato Fertilizer,	10.58	2.52	2 06-2.88	6.37	3.12	2.38	11.87	10-13	9.49	8-10	3.04	3-4
114	Dry Ground Fish Guano	8.80	8.63	8.5-10	—	4.71	3.48	8.19	6-9	4.71	4-6	—	—
214-217-381	High Grade Special for Potatoes, etc.,	11.78	3.33	3.3-4.12	6.08	3.04	1.50	10.62	9-13	9.12	8-11	7.02	7-8
279-394	Corn Phosphate,	16.30	2.17	2.06 2.88	6.55	2.29	1.66	10.50	10-13	8.84	8-10	1.93	1 5-2.5
205	Americus with 10 per cent. Potash,	11.83	2.51	2.47-3.30	2.87	5.85	1.90	10.62	7-11	8.72	6-9	8.88	10-11
317	Prolific Crop Producer,	17.15	1.17	.82-1.65	4.63	3.09	2.26	9.98	8-11	7.72	7 9	1.40	1-2
432	Fine Wrapper Tobacco Grower,	3.68	6.33	5 78-6.61	4.71	4.76	1.30	9.77	6-9	9.47	5-7	12.18	10-12
198-264-313	Potato Manure,	13.80	2.15	2.05-2.88	6.50	3.04	2.44	11.98	8-12	9.54	8-12	3.15	3.25-4
267	Grass and Oats Fertilizer,	13.03	—	—	6.78	3.26	1.80	11.84	12-18	10.04	11-16	2.06	2-4

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Ground Bones.		
297	White Bone Flour,	Armour Fertilizer Works, Chicago, Ill.,	Salem.
242	Animal Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Amherst.
424	Pure Ground Bone,	Bartlett & Holmes, Springfield, Mass.,	Amherst.
425	Tankage,	Bartlett & Holmes, Springfield, Mass.,	Amherst.
333	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Leominster.
129	Fine Ground Bone,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Boston.
123	Pure Bone Meal,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
132	Ground Bone,	Lowell Fertilizer Co., Boston, Mass.,	Boston.
438	Ground Bone,	McQuade Bros., West Auburn, Mass.,	Amherst.
368	Pure Bone Meal,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
387	Hubbard's Strictly Pure Fine Bone,	Rogers & Hubbard Co., Middletown, Mass.,	Williamstown.
88	Bone Meal,	Darius Whithed, Lowell, Mass.,	Amherst.
131	Bone Meal,	Darius Whithed, Lowell Mass.,	Boston.
396	Pure Bone Meal,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Mechanical Analyses.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Fine Bone.	Fine Med.	Medium.	Coarse Med.
	Ground Bones.														
297	White Bone Flour,	7.22	3.88		—	9.57	16.61	26.18		9.57	—	41.13	54.74	4.13	—
242	Animal Fertilizer,	8.22	4.17	3.5-4.5	—	7.28	13.08	20.36	20-22	7.28	5-8	38.45	30.21	18.58	12.76
424	Pure Ground Bone,	2.12	1.54	2-3	—	10.42	19.24	29.66	27-29	10.42	—	95.27	4.56	.17	—
425	Tankage,	4.38	4.38	4.12-4.94	—	11.51	6.27	17.78	17-18	11.51	—	74.53	17.03	6.33	2.11
333	Fine Ground Bone,	3.83	2.85	2.5-3.25	—	7.34	13.84	21.18	21-23	7.34	—	46.73	29.14	19.40	4.73
129	Fine Ground Bone,	3.65	2.98	2.5-4	—	9.10	17.94	27.04	20-23	9.10	—	56.72	31.12	11.36	.80
123	Pure Bone Meal,	3.55	2.22	1.46	—	10.46	16 58	27.04	28-25	10.46	6.78	64.88	15.51	14.89	4.72
132	Ground Bone,	2.08	2.23	2.47-3.29	—	9.49	20.03	29.52	23-28	9.49	—	65.97	29.04	4.99	—
438	Ground Bone,	2.80	2.35	2.78	—	9.50	16.86	26.36	24-52	9.50	—	52.56	27.94	15.57	3.93
368	Pure Bone Meal,	3.89	3.54	2.47-4.12	—	9.04	14.17	23.21	20-25	9.04	—	60.23	21.74	16.23	1.80
387	Hubbard's Strictly Pure Fine Bone,	9.72	4.04	3.5-4	—	9.03	12.92	21.95	22-23	9.03	—	27.36	33.12	35.43	4.09
88-131	Bone Meal,	3.05	2.11	2.41	—	10.10	19.27	29.37	28-28	10.10	—	79.94	15.50	4.48	.08
396	Pure Bone Meal,	5.00	3.61	2.47-4.12	—	8.26	13.00	21.26	20-25	8.26	—	28.56	30.48	34.73	6.23

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1900, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Chemicals.		
107	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Fall River.
109	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	New Bedford.
154	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Dighton.
221	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	No. Eastham.
303	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Amesbury.
25	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
316	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Amesbury.
305	High Grade Sulphate of Potash,	Bowker Fertilizer Co., Boston, Mass.	Lawrence.
342	High Grade Sulphate of Potash,	Bowker Fertilizer Co , Boston, Mass.,	Fitchburg.
103	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	New Bedford.
231	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Orleans.
245	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
147	Nitrate of Soda,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
24	High Grade Sulphate of Potash,	E. Frank Coe Co., New York City,	Springfield.
27	Muriate of Potash,	E. Frank Coe Co., New York City,	Springfield.
440	Nitrate of Soda,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.
439	Muriate of Potash,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst,
353	Nitrate of Soda,	Lowell Fertilizer Co., Boston, Mass.,	Leominster.
276	Muriate of Potash,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
254	Nitrate of Soda,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Peabody.
209	Muriate of Potash,	Quinnipiac Co., Boston, Mass.,	W. Bridgew'r.
14	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
212	Nitrate of Soda,	Williams & Clark Fertilizer Co., Boston, Mass.,	Eastham.
213	Kainit,	Williams & Clark Fertilizer Co., Boston, Mass.	Eastham.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.												
07-109-154-221-303	Nitrate of Soda,	1.25	16.42	15-16	–	–	–	–	–	–	–	-	–
25-316	Muriate of Potash,	2.38	–	–	–	–	–	–	–	–	–	49.15	50-52
305-342	High Grade Sulphate of Potash,	.76	–	–	-	–	–	–	–	–	–	48.40	48-52
103-231-245	Muriate of Potash,	2.72	–	–	–	–	–	–	–	–	–	46.85	50-55
147	Nitrate of Soda,	1.82	15.56	15.00	–	–	-	–	–	–	–	–	–
24	High Grade Sulphate of Potash,	.12	–	–	–	–	–	–	–	–	–	53.15	–
27	Muriate of Potash,	1.09	–	–	–	–	–	–	–	–	–	54.80	–
440	Nitrate of Soda,	1.03	16.20	15.5-16.00	–	–	–	–	–	-	–	–	–
439	Muriate of Potash,	1.04	–	–	–	–	–	–	–	–	–	48.80	50.54
353	Nitrate of Soda,	1.67	15.20	–	–	–	–	–	–	–	–	–	–
276	Muriate of Potash,	2.55	–	–	–	–	–	–	–	–	–	51.80	50.54-53.7
254	Nitrate of Soda,	1.85	14.19	14-14.83	–	–	–	–	–	–	–	–	-
209	Muriate of Potash,	3.32	–	–	–	–	–	–	–	–	–	45.40	50-55
14	Nitrate of Soda,	.32	16 40	15.64-16.48	–	–	–	–	–	–	–	–	–
212	Nitrate of Soda,	1.27	15.70	15.8	–	–	–	–	–	–	–	–	–
213	Kainit,	1.35	–	–	–	–	–	–	–	–	–	12.90	12-13

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1900. Cents per pound.
Nitrogen in ammonia salts,	17.0
" nitrates,	13.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	15.5
" " " fine bone and tankage,	15.5
" " " medium bone and tankage,	11.0
Phosphoric acid soluble in water,	4.5
" " soluble in ammonium citrate,	4.0
" " in fine ground fish, bone and tankage,	4.0
" " in cottonseed meal, castor pomace and wood ashes,	4.0
" " in coarse fish, bone and tankage,	3.0
" " insoluble (in water and in am. cit.) in mixed fertilizers,	2.0
Potash as Sulphate, free from Chlorides,	5.0
" " Muriate,	4.25

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy acticn, exert as a rule, a decided influence on their selling price.

The market cost of the different essential elements of plant food, with the exception of the nitrogen compounds, compares favorably with the prices of the same ingredients for the year 1899. Nitrogen compounds show a material increase in cost as compared with the previous year.

Wm. P. Barker