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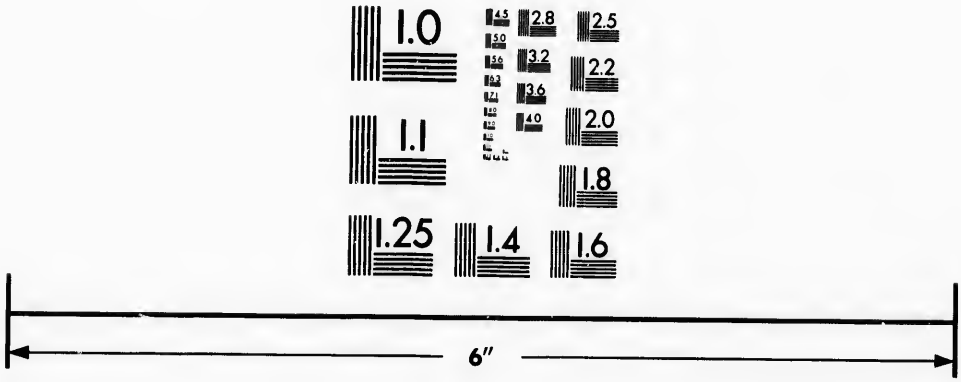


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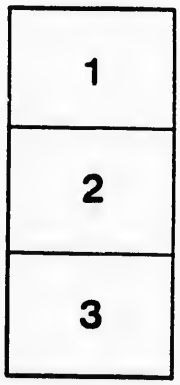


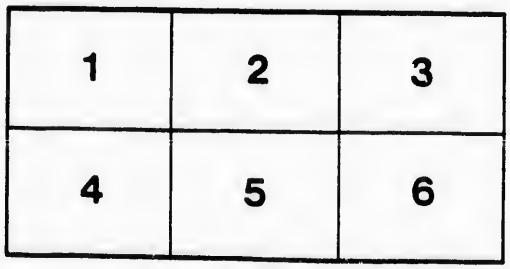

# CENTRAL EXPERIMENTAL FARM.

DEPARTMENT OF AGRICULTURE

OTTAWA, - - - - - - CANADA.

## BULLETIN No. 23.

1. SPRAYING FOR THE PREVENTION OF FUNGOUS DISEASES.
2. INJURIOUS INSECTS.
3. POTATO BLIGHTS.
4. BLACK KNOT OF THE PLUM AND CHERRY.

APRIL, 1895.

PUBLISHED BY DIRECTION OF THE HON. A. R. ANGERS, MINISTER OF AGRICULTURE.

To the Honourable

The Minister of Agriculture.

SIR,—I beg to submit for your approval Bulletin No. 23 of the Experimental Farm series which has been prepared under my direction by Mr. James Fletcher, Botanist and Entomologist, and by Mr. John Craig, Horticulturist.

During 1894 it was deemed advisable in order to meet some pressing demands for information in certain districts, to issue, in limited editions, circulars and "Experimental Farm Notes" containing matter bearing on the subjects treated of in this bulletin. These publications were sent to the press and to persons residing in those districts where the information they contained, was most urgently needed. Further experience has since been obtained on these topics, and as the subjects treated of are of general interest, the additional facts gained, together with those contained in the circulars and "Notes" referred to, have now been brought together and condensed in Bulletin 23 which will be distributed in the usual manner, to all those whose names are on the mailing lists of the Experimental Farm.

In the part written by the Botanist and Entomologist, a few of the most injurious and destructive insects are treated of, such as the fruit grower can best deal with during the spring months by the timely use of the insecticides recommended. The principal diseases to which the potato is subject, are also explained and the best remedies given.

In the part written by the Horticulturist, the question of spraying fruit trees and vines for the prevention and destruction of those fungous diseases which are so detrimental to fruit growing, is discussed and the best methods of treatment explained. The life history of the "Black Knot" of the Plum and Cherry is also given and remedies recommended.

This bulletin is issued with the hope that it will be of service to fruit growers and farmers generally throughout the Dominion.

I have the honour to be
Your obedient servant,

WM. SAUNDERS,
*Director Experimental Farms.*

OTTAWA, April 1st, 1895.

# SPRAYING FOR THE PREVENTION

OF

# FUNGOUS DISEASES.

By John Craig, *Horticulturist.*

This bulletin is issued in response to the growing demand by fruit growers and farmers, for definite and concise information with regard to the practice of spraying, for the prevention of diseases injurious to the fruit-bearing trees and plants of the orchard and garden.

The results of experimental work upon this subject have been given annually by this Division either in the report of the Experimental Farms, or in circular form, since bulletin No. 10 was issued in April, 1891. Each year has marked an increase of interest in spraying, has furnished additional evidence of its value, and has shown conclusively that the fruit grower of to-day must include spraying in the routine of his yearly round of operations, if he would secure the largest returns possible, in addition to having healthy and vigorous trees. In fact, no line of work associated with the successful culture of fruits at the present time is charged with greater interest to the Horticulturist than the subject under consideration. It is also true that there are few, if any, of the operations now included in the annual programme of the fruit grower, whose success is more dependent upon conditions practically outside the control of the operator than is spraying. Meteorological conditions, as rain and wind, heat and cold, have a marked influence on the results, and are often the means of discouraging a beginner, and of preventing him from carrying out good resolutions formed at the beginning of the year. An unfavourable season may, occasionally, so mar the effect of conscientious effort as to place in doubt the beneficial results, and sometimes shake the confidence of the novice, in the efficacy of the remedies recommended.

It must not be taken for granted, on account of the importance of the practice of spraying as set forth in the various publications of this division, that it is offered to the fruit grower as a universal panacea for all phases of ill-health and non-productiveness affecting fruit trees. It should rather be viewed by the orchardist in the light of an additional weapon, assisted by good cultivation and liberal feeding, with which to ward off injurious enemies. Good cultivation,—meaning thorough tillage of orchards,—with an abundance of plant food, undoubtedly does much towards lessening the amount of diseases affecting plants, by making them vigorous and healthy, and thus resistant to parasitic attacks.

Fungous diseases, however, in accordance with natural laws, will in all probability increase in number, in proportion as the food plants upon which they prey, are multiplied, and as climatic conditions are favourable to their development.

In order, in this age of keen competition, to obtain from a given area the largest possible product of the highest quality, the best means of preventing injury from these pests must be adopted. After giving good cultivation, spraying, therefore, must be resorted to in order to secure this result. If we would derive the greatest benefit, it should be generally practised. The value of the efforts of one man who faithfully sprays his orchard, is greatly lessened if his neighbour neglects this preventive measure, and so allows his orchard to serve the purpose of a breeding ground for the spores of fungous diseases, of which we have such well marked examples in the "scab" of the apple and pear.

## NATURE OF FUNGI.

A brief consideration of the principles underlying the practice of spraying, may enable the grower to understand the nature of fungous diseases, and this will be of service in directing an intelligent application of the remedies which are recommended. A glance at the character and habits of parasitic fungi will throw light upon the system of treatment.

The word *fungi* is used to designate an exceedingly numerous class of plants of simple organization ; we must never lose sight of the fact that they belong to the vegetable world and are therefore subject to the ordinary conditions of plant life. Some of them derive their nourishment from living plants or animals, others from dead plants or animals. Those which draw their food from other plants more highly organized than themselves, are termed parasites, and it is with this class that the fruit grower is chiefly concerned. These plants (parasitic fungi) have not the power of assimilating food from the soil or atmosphere, and therefore must obtain it in a prepared condition through the agency of the higher plants upon which they feed. The vegetative part of a fungus—that part corresponding to the root, stem and leaves of the higher plants—is made up of delicate thread-like tubes, usually more or less matted together ; these collectively are termed *mycelium*. The term *hypha* is applied to a single thread-like tube. Parasitic fungi bear no seeds or flowers, but are reproduced by spores which are borne upon specialized branches of the hyphæ. These spores are produced in great numbers and are the principal, though not the only, means of spreading disease. The hyphæ-threads of the parasitic fungi penetrate the tissues of the host plant—a name applied to the plant upon which they feed.

The spores are exceedingly light and easily carried by currents of air. When one falls upon a leaf and is supplied with moisture, it germinates by sending out a slender tube, which effects an entrance into the tissues of the leaf through the breathing pores (stomata), or intercellular spaces. After the parasitic fungus has thus entered the interior

of a leaf, it developes rapidly at the expense of the tissues of the latter. Pushing forward from one cell to another, the contents are appropriated and fresh vigour is thus gained by the parasite. This goes on till the vigour of the host plant is much impaired, or its life destroyed. Some of the principal parasitic diseases attack both foliage and the fruit of the host plant, as in the case of the "mildew" of the grape, "scab" of the apple and pear, and "rot" of the plum and peach. They are thus doubly destructive. If this destruction were confined to a few cells, leaves, or even to a few plants, the loss would be trifling; but the extraordinary rapidity with which fungi multiply, and the ease with which their reproductive bodies (spores) are carried from plant to plant, renders their extirpation a very difficult matter.

This explanation of the methods of reproduction and growth of these diseases emphasizes the truth of the maxim that "prevention is better than cure." When the mycelium of the fungus has become established within the tissues of the host plant, any remedy applied to the exterior of the plant, it is readily seen, can at the best be only partially effective. The copper salts have long been known to possess valuable germicidal properties. One of the commonest and cheapest of them, copper sulphate (blue-stone) has been used for many years to kill the spores of smut infesting seed wheat. *Bordeaux mixture*, which is composed of blue-stone, dissolved in water, combined with lime, has proved to be the most effective and the cheapest preventive agent yet discovered. A very concentrated mixture was used at first, which was difficult to apply and rather expensive. This has now been abandoned for weaker mixtures as hereafter explained.

## EXPERIMENTAL WORK.

In the spring of 1890, the first year of the appointment of the writer as Horticulturist to the Central Experimental Farm, Ottawa, experiments were planned and carried out in orchards at Abbotsford, Quebec. The experiments were designed to show the benefit of spraying with ammoniacal copper carbonate in varying proportions, copper sulphate of varying strength, as well as the value of other fungicides. The variety of apple treated was Fameuse, and the results gained demonstrated the profit of spraying with *ammoniacal copper carbonate*, of the strength since recommended by the Horticultural Division of the Experimental Farm. Experiments have been continued each year up to the present, all marked with more or less success according to the character of the season. In the initial stages of this work, the important questions of economy and ease of application, in addition to the effectiveness of each mixture, had to be studied by the experimenter so that a remedy when discovered might be practicable and thus commend itself generally to the public.

These experiments have covered the trial of over thirty spraying mixtures, and among the fruits included were apple, pear, plum, cherry, peach, and the majority of the small fruits.

Owing to the difficulty of applying and the cost of making the concentrated Bordeaux mixture as first prepared, many other copper salt compounds have been tested, with the result that many were discarded, while a few were recommended for trial. Copper sulphate, or blue-stone, having entered into all mixtures giving favourable results, the number of formulæ recommended has gradually lessened with each year's experience, till at the present time the fruit grower needs not burden his mind with a bewildering array of receipts or formulæ, almost as numerous as the legion of enemies which attack his orchards and vineyards.

As a result of experiments conducted in 1892, the writer recommended a modified formula for the preparation of *Bordeaux mixture*. This was given to the public by means of a bulletin and by circulars issued during 1892 and 1893. Prof. Green of the Ohio Experimental Station also recommends this formula. The formula is as follows:—4 pounds of copper sulphate, 4 pounds of lime and 50 gallons of water. The cost of this need not exceed one-half cent per gallon, and it admits of the addition and application of Paris green at the same time. *Ammoniacal copper carbonate* was also recommended at that time. This will not be used as freely as Bordeaux mixture on account of its greater cost and the increased labour of preparing it. For spraying late in the season, when stains on the fruit are undesirable, copper carbonate is the most useful agent yet discovered. In copper sulphate we have the base or foundation of both the above mixtures, and a very effective fungicide to apply *before the foliage appears*. With this trio, backed up by intelligence and perseverance, the fruit grower may largely increase the revenue derived from his orchard.

As the treatment is entirely preventive, in order to make spraying effective it must be commenced early. All parts of trees or plants, must be reached with the preventive agent. Drenching is not necessary and is expensive. A thin film or coating of the fungicide deposited upon the foliage in the form of a misty spray will prevent the development of the spores better than a complete soaking which will run off like a shower of rain; but it is important that all the leafy surface should be well covered, and on this thoroughness of the work will depend the ultimate success of the undertaking.

## SPRAYING MIXTURES.

The following fungicides are those which experience leads me to recommend:—

Copper sulphate..... 1 lb.
Water.....25 gallons.

This should be used *only before* the foliage appears. It is easily applied and acts as a general germicide and disinfectant. In simple solution Copper Sulphate is very injurious to foliage. When lime is added as in making Bordeaux mixture, its corrosive action is neutralized and injury to the foliage prevented. In this way a larger quantity of blue-stone may be used, and it adheres to the foliage better by the agency of the lime.

## DILUTED BORDEAUX MIXTURE.

The ingredients are copper sulphate, lime and water, in the following proportions :—

| | |
|---|---|
| Copper sulphate..... | 4 lbs. |
| Lime.. ..... ..... | 4 lbs. |
| Water..... .... | 50 gals. or one kerosene barrel. |

To destroy leaf-eating insects, add 4 oz. of Paris green. For peaches use 3 lbs. each copper sulphate and lime and 3 oz. of Paris green, on account of the tenderness of the foliage.

When a single barrelful of Bordeaux mixture is required, dissolve in a coal-oil barrel partly filled with water 4 lbs. of copper sulphate (blue-stone). Hot water facilitates the operation. To dissolve quickly place the copper sulphate in a cotton bag or basket, and suspend this in the vessel containing the water so that it is entirely immersed. Solution rapidly takes place. In another vessel slake 4 lbs. of fresh lime with as many gallons of water. If the lime when slaked is lumpy or granular, it should be strained through a fine sieve or coarse sacking, into the barrel containing the copper sulphate now in solution, then fill the barrel with water and it is ready for use. It should be used soon after being prepared.

When a large amount of spraying is contemplated, it is a good plan to make stock solutions separately, of lime and blue-stone, which can be diluted as needed :—Dissolve 100 lbs. of copper sulphate in 50 gallons of water; two gallons when dissolved will contain 4 lbs. of the salt. In another barrel slake 100 lbs. of lime and make up to a milk by adding 50 gallons of water; when well stirred two gallons should contain 4 lbs. of lime. When as before, it is desired to make a barrel of Bordeaux Mixture, take two gallons of the stock solution of copper sulphate, and add the same quantity of the milk of lime; if the lime is of good quality, it will be sufficient in order to neutralize it completely. If the lime is air-slaked or impure, the right quantity can be ascertained by applying the ferro-cyanide of potassium test. A two-ounce bottle containing a saturated solution of ferro-cyanide of potassium costing five cents is all that is required for a season's work. If the lime is deficient, a drop of the ferro-cyanide of potassium (yellow prussiate of potash) added to the mixture will turn brown. Add the milk of lime till the drop of ferro-cyanide of potassium remains colourless. Then add a little more milk of lime to make sure that the strength is uniform, and fill the barrel with water.

### Ammoniacal Copper Carbonate.

| | |
|---|---|
| Copper Carbonate..... | 5 oz. |
| Ammonia .. ..... | 2 qts. |
| Water..... ..... ..... | 50 gals. |

This is prepared by dissolving the copper carbonate in the ammonia, and diluting with water to 50 gallons. The concentrated solution should be poured into the water. Care should be taken to keep the ammonia in glass or stone jars tightly corked.

This mixture is more expensive than the former, but is more easily applied and may be used as a substitute, especially in the case of grapes, cherries or plums, where late spraying is necessary, and when Bordeaux mixture might, by adhering to the fruit, injure its sale.

## HOME MANUFACTURE OF COPPER CARBONATE.

As the precipitated form of Carbonate of Copper is not always obtainable from druggists, and, unless freshly precipitated, may not be readily soluble, the following directions are given, for the easy preparation of this material at a cost much less than the usual wholesale price.

In a vessel capable of holding two or three gallons, dissolve 1½ pounds of copper sulphate (blue vitriol) in 2 quarts of hot water, using the crystalline form. This will entirely dissolve in fifteen or twenty minutes. In another vessel dissolve 1¾ pounds of sal soda (washing soda), also in 2 quarts of hot water. When completely dissolved, pour the second into the first, stirring briskly. When effervescence has ceased, fill the vessel with water, and stir thoroughly; then allow it to stand five or six hours, when the sediment (called the precipitate) will have settled to the bottom. Pour off the clear liquid without disturbing the precipitate, fill with water again, and stir as before; then allow it to stand until the sediment has settled again, which will take place in a few hours. Pour the clear liquid off carefully as before, and the residue is *carbonate of copper*. Using the above quantities of Copper Sulphate and sal soda, there will be formed 12 ounces of copper carbonate.

Instead of drying this, which is a tedious operation, add four quarts of strong ammonia, stirring in well; then add sufficient water to bring the whole quantity up to 6 quarts. This can be kept in an ordinary two-gallon stone jar, which should be closely corked.

Each quart will contain 2 ounces of the carbonate of copper, which, when added to 20 gallons of water, will furnish a solution for spraying, of the same strength and character as that obtained by the use of the dried carbonate, and one which can be prepared with little labour, and kept ready for use throughout the season.

## EQUIPMENTS FOR SPRAYING.

The necessity of spraying as an annual practice has created a demand for suitable appliances. Many kinds of hand and horse power pumps, specially designed for this purpose, are now to be found upon the market. Up to a comparatively recent period there were no spraying pumps of Canadian manufacture offered to the public. I do not know of any horse power pump being manufactured in Canada at the present time, but there are a number of strong force pumps now available, and lack of suitable machinery can no longer be urged as a reason for not spraying.

There are three principal classes of sprayers besides the small hand pumps suitable to limited garden areas: 1. Knapsack, 2. Force

pump, fitted in a barrel, 3. Force pump, fitted in a tank mounted on wheels and operated by power derived from the motion of the wheel.

1. *Knapsack sprayers*; as may be inferred, are designed to be carried on the back, and are copper tanks holding from four to six gallons of liquid, each supplied with a force pump. The pump handle should be adjustable so as to allow of its being worked by either hand. To prevent clogging, the discharge pipe should enter the tank at the top. The price of these varies from $10 to $15. Tanks made of galvanized iron or tin, while much cheaper and useful for applying Paris green or other insecticides, will soon become corroded if they are used to apply Bordeaux mixture. For small areas, fruit gardens, or when the ground is rough and uneven the knapsack sprayer is exceedingly useful; at the same time, the work of carrying this tank is neither easy nor agreeable.

2. *Force Pumps, fitted in Barrels.*—This style of pump will meet the requirements of the majority of fruit growers. Secure a coal oil barrel and a good strong force pump. The valves, working parts and linings should be of brass, which will resist the corroding action of the copper salts much longer than iron. The metal chambers and all castings should be strong and heavy and the packing of the most durable character. In some respects displacement and rotary pumps have certain advantages over suction pumps in this respect. Nothing is more annoying and nothing acts more as a deterrent to the introduction of the practice of spraying, than the "breakdowns" which sometimes occur with irritating frequency at the beginning of the work each year. More durable pumps than were formerly procurable are now being made in Canada, and a list of Canadian manufacturers, as far as known at present, is subjoined.

The force pump is firmly fitted to the end or side of a barrel, as convenience may suggest. It should be supplied with two lines of hose, the lengths proportionate to the height of the trees, and each fitted with a stop-cock and nozzle. In case of clogging, the stop-cock will always be appreciated. In spraying tall trees, a bamboo pole through which is inserted a $\frac{3}{8}$-inch brass tube, is to be recommended. This is also supplied with a stop-cock and is very useful in elevating the nozzle; the extension may be from 6 to 10 feet long. A gas pipe of the same length may be substituted for the bamboo, or an equal length of hose employed and the nozzle elevated by means of a pole; but the better the appliances one has, the more thoroughly the work will be done, and, therefore, the more decisive the results obtained.

3. *Power Pumps.*—The power which operates the pump in these machines is usually derived by means of chain and sprocket-wheel, from the revolving wheel of the carriage upon which the tank is mounted. For extensive orchards, vineyards and potato fields, some form of power sprayer will be found most economical. The only one with which I have had personal experience, is the "New Victor," manufactured by the Field Force Pump Co., of Lockport, N.Y., U.S. This was used last year

with a fair degree of satisfaction in the orchards of the Central Farm. In purchasing a power machine, the buyer should see that the castings and working parts are strong and perfect. It is also advisable to secure extras or duplicates of those parts which are most likely to give out. Before purchasing a pump or sprayer, the grower should also carefully study his needs and conditions. If his orchard ground is rough and uneven, or apt to be soft in spring, a power pump, may not be as suitable as a barrel pump mounted upon a stoneboat or wagon.

Home-made sprayers are frequently found to be more serviceable and better adapted to existing conditions than any that can be found in the market. Some large orchardists use home-made box-like tanks, the length of a wagon box, holding 200 to 250 gallons, supplied with hand force pumps, and claim for them superior durability. The motion of the wagon assists the agitator in keeping the liquid stirred, but it is somewhat doubtful whether it can be successfully agitated in this way, owing to the form of the tank operating against the work of the agitator.

## AGITATORS.

It is important that all spraying liquids should be kept thoroughly stirred while being applied, in order to maintain a uniform strength and to prevent the clogging of the nozzle. Most force pumps are supplied with a return discharge pipe to stir the liquid. As a general rule, these are unsatisfactory and inadequate. There are few pumps, if any, which possess sufficient power to throw a desirable spray and stir the liquid at the same time by means of a return stream. A mechanical agitator, operated by an attachment to the pump handle, will usually be found more satisfactory than any other stirring device. The agitator in most of the power machines now upon the market is usually a weak point. The liquid should always be well stirred by hand or some other means, before beginning to spray.

## NOZZLES.

The distributing agent is one of the most important parts of the spraying outfit. The nozzle should throw a fine spray and thus be economical of fluid, and also be easily freed from any substance which may clog the passage.

In the experiments of the past year, the nozzles which gave greatest satisfaction were the "Vermorel" and the "McGowen." The former uses a minimum amount of liquid, and may be used with the greatest advantage where the trees are small, or upon the lower branches of large trees. Of course, it may be elevated with a pole, bamboo or gas pipe extension. The McGowen is a valuable instrument for carrying the fluid to the upper branches with a minimum degree of waste. It is a great mistake to use for spraying purposes such instruments as the "Boss" and "Graduating" nozzles. They are useful for watering lawns, but are entirely out of place in an orchard. Trees should be sprayed, not drenched.

Small hand pumps are often very useful for limited garden areas, where they will serve the purpose as well as the more expensive knapsack pumps.

Advertisements of spraying materials and apparatus are now found in the leading agricultural and horticultural journals, and particularly in the *Canadian Horticulturist*, published at Grimsby, Ont.

## PUMP MANUFACTURERS.

The following firms are manufacturers of spraying pumps, samples of which they have kindly forwarded to the Experimental Farm for trial, and which, in the main, have given satisfaction :

Holmes & Holladay, Clarksburg, Ont. ;
Goold, Shapley, Muir Co., Brantford, Ont. ;
Ontario Pump Co., Toronto, Ont.

In addition to the above, pumps are manufactured by J. W. Anderson, Barr' Ont., and The Parker Excelsior Spray Pump Co., London, Ont.

They can also be obtained through the leading seedsmen of the Dominion.

Pumps of various kinds have also been kindly forwarded for trial from the following firms in the United States: Field Force Pump Co., of Lockport, N.Y., M. B. Brooks, Novelty Works, Oak Point, N.Y., and P. C. Lewis, Catskill, N.Y.

## DISEASES PREVENTED AND PROFITS OF SPRAYING.

As already stated, experimental work along this line has been going on for some years at the Experimental Farm, with results each year corroborative of the effectiveness of spraying. By means of the experiments planned and carried out in conjunction with the Fruit Growers' Association of Ontario, during the past season, by authorization of the Minister of Agriculture for the Dominion, the value of the work has received such emphatic confirmation that the resulting impetus will place the utility of the practice of spraying to lessen fungous injury, as well as insect attacks, on a plane well out of the reach of controversy.

These experiments were designed to show (1) the practicability of the remedies recommended for the prevention of fungous diseases and (2) to furnish to fruit growers instructive and convincing object lessons of the benefits of spraying.

The following is a brief statement of the most important results obtained as stated in the Report of the Horticulturist for 1894 :—

The unprecedented and continuous rains which visited southern Ontario during May and June of last year, coupled with the scorching heat and drought of mid-summer, combined to form a season with conditions most unfavourable to obtaining even average results. Never to my knowledge have apple trees—foliage and fruit—suffered so severely from the *apple spot fungus*. The disease coming before the fruit had much more than formed, attacked the foliage so severely as to cause it

to resemble and be easily mistaken for the ordinary "twig blight." Most varieties lost a large proportion of their leaves, which of course resulted in a corresponding loss of the fruit. This visitation had the effect, however, of emphasizing the value of spraying as a factor having an important bearing upon increasing the yield of apples in seasons of severe fungous visitation, as well as improving the quality of the fruit. To sum up briefly, untreated trees lost their foliage, and consequently their crop of fruit. Spraying prevented the growth of the disease upon the foliage, which was thereby retained, and with it a large proportion of the fruit.

Peaches, cherries and plums were treated with the object mainly of preventing loss from fungous diseases, causing the fruit to rot on the tree.

## PEACHES.

The crop of peaches in the Niagara and St. Catherines districts, where the experiments were carried on, was one of the heaviest in many years. Rot was not severe even on early varieties. Sprayed trees of Early River's and Early Richmond showed 3 to 4 per cent less rotten fruit than those unsprayed. The fruit on sprayed trees was better coloured and finer in appearance than that on trees not treated.

Formula for peaches, 3 lbs. each copper sulphate and lime to the same quantity of water. (*See* Calendar).

## PLUMS.

The principal fungous enemies of the plum are the "shot hole fungus" (*Septoria*), causing the leaves to drop prematurely, and *Monilia*, or fruit rot. These were satisfactorily controlled by spraying. The foliage of the treated trees was retained till the close of the season, and the fruit was 20 to 30 per cent larger, than that on trees not sprayed. The sprayed plums would easily sell as good "firsts," while the unsprayed, owing to small size and lack of colour, could hardly be classed as "seconds."

## CHERRIES.

The cherry suffers from the same diseases as the plum. The following are results gained from two series of experiments in preventing "rot" on Yellow Spanish cherries:

(1.) Sprayed tree yielded 90 lbs. of fruit. Unsprayed tree yielded 30 lbs. of fruit.

(2.) One selected sprayed tree yielded 130 lbs. of fruit, which netted $9.25. One selected, equally good, unsprayed tree yielded 17 lbs. of fruit, which netted $1.20.

Spraying cherries not only prevents "rot," but prolongs the ripening season. They should be very carefully sprayed with Bordeaux mixture after the blossoms fall, making two or three applications. The last application, a few days before picking, should be made with ammoniacal copper carbonate.

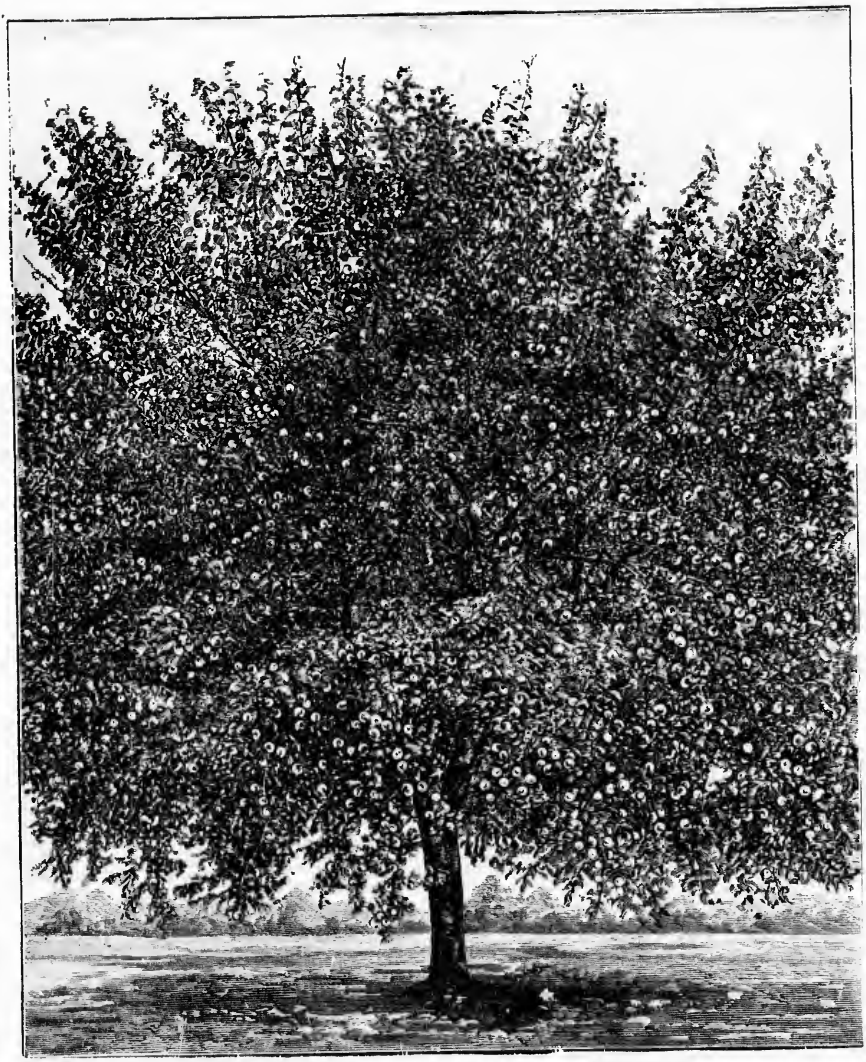

PLATE I.

NORTHERN SPY. SPRAYED.

Photographed in the orchard of Mr. E. J. Woolverton, Grimsby, Ont., Sept., 1891.

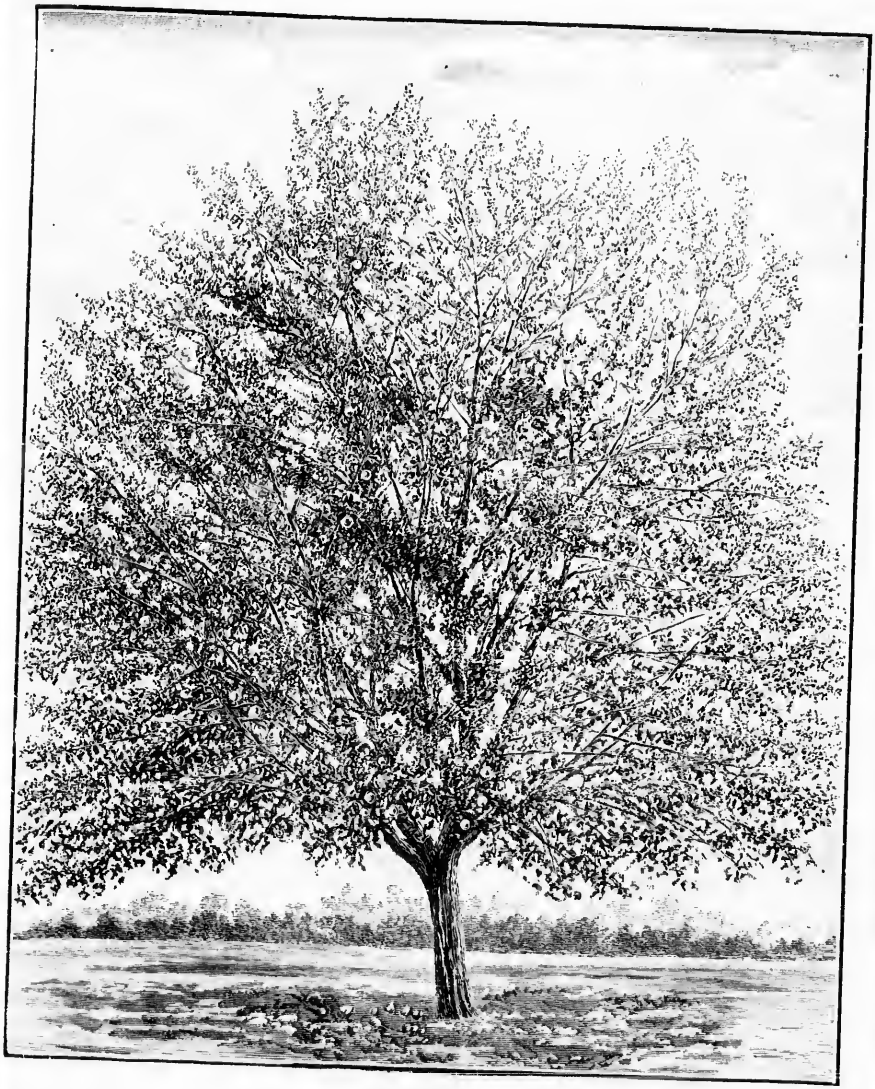

PLATE II.

NORTHERN SPY. NOT SPRAYED.

Photographed in the orchard of Mr. E. J. Woolverton, Grimsby, Ont., Sept., 1894.

Pear tre
ing and spot
Flemish Bea
fruit than th
results. Th
trees unspray
results than
important.

Apples v
from the fung
moth.

| Varieties. | H |
|---|---|
| A. G. Russet.. | Sp |
| A. G. Russet.. | Un |
| Baldwin..... | Spr |
| Baldwin..... | Un |
| Greening..... | Spr |
| Greening..... | Uns |
| Northern Spy. | Spra |
| Northern Spy. | Uns |
| Average of above. | Spra |
| | Unsp |

## PEARS.

Pear trees were sprayed to prevent "leaf blight" and the "cracking and spotting" of the fruit. The best results gained showed that Flemish Beauty pears sprayed, yielded 75 per cent more marketable fruit than those unsprayed. Beurré Giffard gave practically the same results. The foliage of the treated trees was vastly superior to that on trees unsprayed. Two sprayings before the blossoms opened gave better results than three sprayings after that time. Early applications important.

## APPLES.

Apples were sprayed in several orchards, mainly to prevent injury from the fungus causing "apple rot" and the depredations of the codling moth.

## AVERAGED RESULTS.

### Gained in Spraying Four Leading Varieties.

| Varieties. | How Treated. | PERCENTAGE SCALE. Grades of Fruit. 10 20 30 40 50 60 70 80 90 100 |
|---|---|---|
| A. G. Russet.. | Sprayed..... | First Quality. Second Quality. Third Quality. |
| A. G. Russet.. | Unsprayed.... | 1st Quality. Second Quality. Third Quality. |
| Baldwin..... | Sprayed..... | First Quality. 2nd Qual. 3rd Qual. |
| Baldwin..... | Unsprayed.... | First Quality. Second Quality. |
| Groening..... | Sprayed..... | First Quality. Second Quality. 3rd Qual. |
| Greening..... | Unsprayed.... | 1st Qual. Second Quality. Third Quality. |
| Northern Spy. | Sprayed..... | First Quality. Second Quality. 3rd Qual. |
| Northern Spy. | Unsprayed.... | 1st Quality. Second Quality. Third Quality. |
| Average of above. | Sprayed..... | First Quality. Second Quality. 3rd Qual. |
| | Unsprayed.... | 1st Quality. Second Quality. Third Quality. |

## Averaged Results from all Varieties.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Percentage Scale..... | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Sprayed..... | First Quality. | | | | | Second Quality. | | | 3rd Quality | |
| Unsprayed..... | First Quality. | | Second Quality. | | | | | Third Quality. | | |

The results gained show that the sprayed trees yielded 24 per cent *more* of first-class fruit, 6 per cent *less* of second-class and 18 per cent *less* of third-class fruit than the same number of trees unsprayed.

The effect of this improvement *in quality alone* upon the gross receipts from an acre of bearing apple trees may be shown as follows: Supposing the yield to be 50 barrels we find according to results gained that spraying would give at ordinary market rates, $2.50, $1.75 and $0.75, for first, second and third class, respectively, $56.75 worth of No. I. fruit, $31.50 worth of "seconds," and $6.97 of "thirds," or a total of $95.22. The same area unsprayed would give of No. I. fruit $26.75, of No. II. $37, and of a third class, $13.64, or a total return of $77.40, leaving a balance in favour of the sprayed acre of $17.82. This is supposing that all the "seconds" and "thirds," which in the case of the unsprayed is very large, could be sold. The cost of spraying an acre of apple trees will vary according to the size of the trees; using diluted Bordeaux mixture and making five applications, it need not exceed $6 and may be under $5. There would thus be a net profit of $10 to $12 on the basis of equal yields and improved quality. As a result of the experiments referred to, and looking at spraying as *affecting the yield*, we find that the sprayed trees give 74 per cent of the total yield. This return added to the improved quality gives a difference in the net receipts of $51.53 in favour of the sprayed acre.

The general results obtained in treating "apple spot" are shown in a graphic way in the preceding chart. The following illustrations engraved from photographs taken at the close of the season give a relative impression of the appearance of sprayed and unsprayed trees in the autumn. The improvement in the foliage of the sprayed trees over the unsprayed was very marked.

There is also added a spraying calendar, which will serve as a working guide to the orchardist throughout the season, giving the time and method of treating the various injurious pests which affect his crops.

## TO CORRESPONDENTS.

Information embodying the results of actual experience in spraying is solicited and will be gratefully received, and further information at my command on this subject will be cheerfully given on application.

## SPRAYING CALENDAR.

| Plant. | 1st Application. | 2nd Application. | 3rd Application. |
|---|---|---|---|
| *Apple.*<br>Apple spot fungus, codling moth, bud moth. | *Copper Sulphate.*<br>Before buds start.<br>*(Important.)* | *Bordeaux.*<br>Just before blossoms open.<br>*(Important.)* | *Bordeaux.*<br>*Paris Green.*—Soon after blossoms fall.<br>*(Important.)* |
| *Cherry.*<br>Rot, leaf diseases and injurious insects. | *Bordeaux.*<br>Before flower buds open.<br>*Kerosene Emulsion* for aphis. | *Bordeaux.*<br>*Paris Green.*—When fruit has set.<br>*(Important.)* | *Bordeaux.*<br>*Paris Green.*—10-15 days later.<br>*(Important.)* |
| *Grape.*<br>Mildew, rot, leaf eating insects. | *Copper Sulphate.*<br>Before buds start. | *Bordeaux.*<br>*Paris Green.*—When first leaves are half grown. | *Bordeaux.*<br>When fruit has set. |
| *Peach—Apricot.*<br>Rot, leaf-curl, curculio. | *Copper Sulphate.*<br>*Paris Green.*—Before buds start. | *Bordeaux.*<br>3 lbs. copper sulphate.<br>3 lbs. lime.<br>50 gals. water.<br>*Paris Green* (4oz).—Just before blossom. | *Bordeaux.*<br>*Paris Green.*—Soon after fruit has set. |
| *Pear.*<br>Scab, leaf blight, codling moth. | *Copper Sulphate.*<br>Before buds start.<br>*(Important.)* | *Bordeaux.*<br>Just before blossoms open.<br>*(Important.)* | *Bordeaux.*<br>*Paris Green.*—Soon after blossoms fall.<br>*(Important.)* |
| *Plum.*<br>Rot, shot-hole fungus, curculio. | *Copper Sulphate.*<br>*Paris Green.*—Before buds open. | *Bordeaux.*<br>*Paris Green.*—Soon after blossoms have fallen.<br>*(Important.)* | *Bordeaux.*<br>*Paris Green.*—10-12 days later. |
| *Currant.*<br>Fungous diseases, "currant worm." | *Paris Green.*<br>When worms appear. | *Hellebore.*<br>When fruit is fully formed. | *Bordeaux.*<br>After fruit is picked. |
| *Gooseberry.*<br>Mildew, "currant worms" | *Bordeaux.*<br>*Paris Green.*—As soon as leaves expand. | *Hellebore. Bordeaux.*<br>10-15 days later. | *Ammoniacal Copper Carbonate.*<br>10-15 days later. |
| *Raspberry, Blackberry, Dewberry.*<br>Anthracnose, rust. | *Copper Sulphate.*<br>Before buds burst. | *Bordeaux.*<br>10-15 days later. | *Bordeaux.*<br>After old canes are cut out. |
| *Strawberry.*<br>Rust. | *Bordeaux.*<br>After first blossoms have fallen. | *Bordeaux.*<br>After picking season. | *Bordeaux.*<br>10-15 days later. |
| *Bean.*<br>Anthracnose. | *Copper Sulphate.*<br>½ oz. to 1 gal. water.<br>Soak 1 hour. | *Bordeaux.*<br>When rough leaves appear. | *Bordeaux.*<br>8-12 days later. |
| *Potato.*<br>Scab, rot, insects. | *Corrosive Sublimate.*<br>2 oz. to 15 gals. water.<br>Soak 1½ hours. | *Paris Green.*<br>For Col. pot. beetle. *Bordeaux* for flea beetle. | *Bordeaux.*<br>From 1st August till end of season, 2 weeks apart. |
| *Tomato.*<br>Rot, blight. | *Bordeaux.*<br>First appearance of rot. | *Bordeaux.*<br>When necessary. | *Bordeaux.*<br>Same. |

SPRAYING CALENDAR.

| 4th Application. | 5th Application. | 6th Application. |
|---|---|---|
| *Bordeaux.* *Paris Green.*—10-15 days later. | *Bordeaux.* 10-15 days later if spot disease is severe. | |
| *Ammoniacal Copper Carbonate.* 10-15 days later. *(Important.)* | | |
| *Bordeaux.* 10-15 days later. | *Bordeaux.* 10-15 days later. If disease persists. | *Ammoniacal Copper Carbonate.* If disease persists. |
| *Bordeaux.* *Paris Green.*—8-12 days later. | *Bordeaux.* 8-12 days later. If rot is prevalent. | *Ammoniacal Copper Carbonate.* 10-15 days later if rot is prevalent. |
| *Bordeaux.* *Paris Green.*—10-12 days later | *Bordeaux.* 10-15 days later. | |
| *Bordeaux.* *Paris Green.*—10-15 days later. | *Ammoniacal Copper Carbonate.* 10-15 days later if rot is prevalent. | *Ammoniacal Copper Carbonate.* 10-20 days later if rot is prevalent. |
| *Bordeaux.* 10-15 days later. | | |

## FUNGICIDES.

### Copper Sulphate Solution.

| | |
|---|---|
| Copper sulphate | 1 lb |
| Water | 25 galls. |

For use *only before the buds open.* It is ready for use as soon as dissolved in the water.

### Bordeaux Mixture.

| | |
|---|---|
| Copper sulphate | 4 lbs. |
| Quick lime | 4 " |
| Paris Green (for leaf eating insects) | 4 oz. |
| Water (1 barrel) | 40-50 galls. |

See page 7 of bulletin No. 23 for method of preparation. To prevent Potato rot 6 lbs. of copper sulphate is used instead of 4.

### Ammoniacal Copper Carbonate.

| | |
|---|---|
| Copper carbonate | 5 oz. |
| Ammonia | 2 qts. |
| Water (1 barrel) | 40-50 galls. |

For use late in the season when Bordeaux mixture may stain the fruit. It is also best adapted for green-house spraying. Method of preparation given on page 7 of Bulletin 23.

## INSECTICIDES.

### Kerosene Emulsion.

| | |
|---|---|
| Kerosene (coal oil) | 2 galls. |
| Rain water | 1 " |
| Soap | ½ lb. |

To be diluted before use with 9 parts of water. For sucking insects.

### Paris Green and Water.

| | |
|---|---|
| Paris Green | 1 lb. |
| Lime (fresh) | 1 " |
| Water | 200 galls. |

For insects which eat foliage.

# INJURIOUS INSECTS.

By James Fletcher, F.R.S.C., F.L.S., *Entomologist and Botanist.*

Insects may be divided into two classes by the nature of their mouth parts. In the first or larger division, Biting Insects (Fig. 1), they are furnished with mandibles or biting jaws, by means of which they consume the substance of their food, as with caterpillars, beetles, etc. In the second class, Sucking Insects (Fig. 2), they have, instead of mandibles, a beak or tube, by means of which they suck up their food in a liquid form from beneath the surface, as with the true bugs, plant-lice and flies. It is evident that with the insects of the first class all that is necessary, is to place some poisonous substance on the food plant, which they will eat together with their food. With the second class, however, this would be useless, for they would push their beaks through the poisonous covering on the outside of their food-plant and would extract the juices upon which they live, from the interior. For this class, therefore, some substance must be used which will kill by mere contact with their bodies. Now, for both of these classes of insects, we have cheap and available remedies.



Fig. 1.

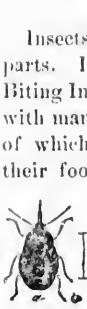

Fig. 2.

## BITING INSECTS.

For biting or mandibulate insects, Paris green is a sure remedy and, on the whole, has been found superior to any of the other materials which are sometimes recommended. It is, of course, very poisonous to man, as well as to all other animals. Care must, therefore, be taken to keep it out of the reach of children, ignorant people and domestic animals. If applied too strong to the foliage of plants, it is also very destructive and must, therefore, be mixed with some diluent both on this account and for the sake of economy, only a very small quantity being necessary to destroy any known leaf-eating insect. The most convenient diluents are water or some dry powder. For a liquid application, mix one pound of Paris green in 200 gallons of water together with one pound of fresh lime. This may be applied to all plants without danger of injuring the foliage, if proper care be taken to break up the liquid into *a fine spray.* Too much emphasis cannot be laid upon the fact that it is of just as much importance to apply these washes properly—in the form of a spray—as it is to make them of the proper ingredients in the right proportions. This shows the necessity of exercising great care in the selection of a

good spraying nozzle, as a poor nozzle has frequently been the cause of much annoyance, loss of time and materials, and, what is worse, discouragement.

From this cause alone, some have actually given up the work altogether and thus have lost the advantage of what is now recognized to be one of the greatest aids to the fruit-grower, farmer, and gardener, which years of scientific investigation have produced.

In mixing Paris green, it should first be made into a paste with a small quantity of warm water, and the paste subsequently mixed with the larger amount of water required.

In spraying foliage, the spray must be forcibly applied, so as to reach every part, but should be shifted from place to place as soon as the liquid begins to drip from the leaves.

For dry applications, suitable diluents will be found in flour, land-plaster, air-slaked lime, and finely sifted ashes or road-dust. It it of the utmost importance that these should be perfectly dry and in a very fine state of division, so as to mix thoroughly with the insecticide used and to allow of their being distributed evenly over the plants as a very fine powder. The proper quantity of the diluents to be used with the different insecticides will vary with the insects to be treated and the plants to which they are applied. In most cases, one pound of Paris green in 50 of the diluent will be found effective.

There are several instruments for distributing dry poisons, such as bellows, insect-guns, dusting-boxes, etc. Any operation requiring the body to be kept for a long time in a stooping posture while walking, soon becomes extremely tiresome; it is therefore necessary, for field application, to devise some means for distributing the poison, so as to waste as little as possible of the material and yet allow the body to be kept in its natural position. This is best done by placing the powder to be distributed in a small bag of very fine muslin (two thicknesses, if necessary), and then tying this to the end of a short stick so that it swings freely. It will be found that by tapping the bag lightly with another stick held in the other hand the operator can walk erect, and do much better work than by stooping along over his crop with an aching back.

Dry mixtures should be applied when plants are wet with dew, or in still weather. It is found by experience, however, that during the spring months, when insecticides are most needed, there are often periods of several days when these conditions do not occur. It, therefore, becomes necessary to apply the poisons in some other way, so that the material may be evenly distributed over the plants to be protected, and not blown away by the wind. For this purpose, mixing with water and spraying is the most convenient plan.

After considerable experience I have come to the conclusion that it will repay anyone who has to apply insecticides, to go to the expense of procuring a pair of proper bellows for dry mixtures and a force pump

for liquid applications. Suitable bellows and pumps can now be obtained from most of our Canadian seedsmen. Such make-shift contrivances as ordinary watering cans, whisks, wisps of hay, or bunches of leaves, which are frequently used, actually cost far more in wasted time and materials than would pay for the best special instruments; added to which, when such work is done, it is neither so satisfactory nor so effective.

## The CODLING MOTH (*Carpocapsa pomonella*, L.)

There is no more striking instance of the good effects of spraying to prevent insect injuries than is shown in the case of the above named insect. The caterpillar, commonly known as the "Apple worm," hatches from an egg laid by a small brown moth in the flower of the apple, pear, and quince. Soon after hatching, it eats its way into the core of the forming apple and destroys it. The annual loss from this insect is enormous: but the satisfactory results which have been obtained whenever systematic spraying has been resorted to, show clearly the great importance of bringing this useful remedy prominently before Canadian fruit-growers at this season of the year. The experience of the past enables us to state positively that Paris green in the proportion of 1 pound to 200 gallons of water, to which 1 pound of lime has been added, sprayed over apple-trees at the time the eggs are laid, is the best, cheapest, and most effective remedy for the Codling Moth. In Eastern Canada, there is only one regular brood of this insect. West of Toronto, there are two broods, the latter of which is by far the more destructive. Where there is only one brood, spraying once or twice early in the spring, immediately after the flowers have fallen, is all that is necessary. In the region where there are two broods, banding the trees in autumn with strips of burlap, wisps of hay, or one of the many contrivances known as "tree protectors," will be found necessary. The caterpillars resort to these shelters when ready to spin their cocoons and may be easily destroyed at any time before the following spring, when the moths emerge.

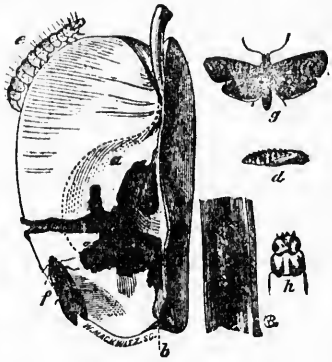

Fig. 3.—The Codling Moth.

Spraying for the Codling Moth should not be done before the petals have fallen from the flowers, as such a practice is very injurious by poisoning bees, and there is no advantage whatever gained by it.

Besides protecting apple trees from the attacks of the Codling Moth, spraying with Paris green immediately after the flowers have fallen will destroy many other enemies which feed on the foliage, such as the Canker-worms, Tent caterpillars, etc.

## THE PLUM CURCULIO (*Conotrachelus nenuphar*, Herbst).

Plums, cherries, peaches, and apples are seriously injured every year by the Plum Curculio. Although the habits are quite different from those of the Codling Moth and it is decidedly more difficult to treat than that insect, experience has shown that spraying with Paris green is, on the whole, the best remedy for this pest also. On emerging in spring, the mature beetles feed on the young twigs, leaves, and buds of the trees. Later on, the leaves and flowers are attacked, and the eggs are laid in the young fruit, in a little flap cut out by the mother beetle. The larva hatches beneath the surface and is at no time within reach of applications. The only chance, therefore, for controlling the Plum Curculio is by poisoning the perfect beetles. Opinions differ as to the extent of immunity of a crop sprayed with Paris green from attack by the Plum Curculio; but there is, no doubt, sufficient benefit to well repay for the trouble and expense, and the experience of many of the leading plum growers has shown that this remedy is still the cheapest and most practical of all that have been tried.

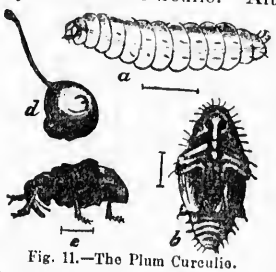

Fig. 11.—The Plum Curculio.

The beetles may be found and eggs are laid during the last week of May and up to the middle of June. The first spraying should take place before the flowers open, and the Paris green may be mixed with Sulphate of copper solution (one pound Sulphate of copper; two ounces Paris green; twenty-five gallons of water), so as to treat both fungous diseases and the Curculio at the same time. The second spraying should be made when the plums are about as large as pease, and two subsequent sprayings, a week or ten days apart, will generally be found sufficient. The applications should be made with the Paris green, lime, and water mixture, of the same strength as advised for the Codling Moth. The foliage of peaches and some varieties of plums is so particularly susceptible to injury from the caustic effect of Paris green that until the neutralizing effect of lime upon this causticity was discovered, spraying these with Paris green was impracticable; now, however, by this simple means Paris green is rendered an available and effective remedy for all leaf-eating insects, even upon delicate plants.

## BORERS.

In addition to the injuries caused by insects which attack the foliage and fruit of orchard trees, much loss is occasioned by the grubs of different kinds of beetles which pierce the bark and wood. These, of course, vary in habits, but for the most part develop from eggs laid by the female beetles or in crevices of the bark. The most effective remedy against these is a deterrent wash applied to the bark at the season of the year when the females resort to the trees for the purpose

of egg-laying. These washes owe their efficacy to some alkaline or malodorous substance which they contain. The best known of these are the following:—

Alkaline Wash.—A wash largely used in Canada is that noted by Prof. Saunders in his "Insects Injurious to Fruits," and consists of "soft soap reduced to the consistence of thick paint by the addition of a strong solution of washing soda in water. If applied during the morning of a warm day, this will dry in a few hours, and form a tenacious coating not easily dissolved by rain."

Carbolic Acid.—Prof. A. J. Cook has experimented extensively with this substance, and claims that no fruit-grower or lover of shade trees can aford to be ignorant of the Carbolic Acid Emulsion. He says: "I make it just as I do the kerosene emulsion, only stronger. One part of carbolic acid—I use the crude material—to from 5 to 7 parts of the soap solution (1 quart soft soap, or 1 lb. hard soap in 2 gallons of water) is of the proper strength. This is the best preparation I know of to protect against the apple tree bark-lice and apple tree borers."

It is applied to the trunks and larger limbs by means of a stiff brush or cloth, about 20 days after the trees blossom.

Carbolic Acid Wash.—Prof. Cook also recommends for radish maggots a preparation made by adding 2 quarts of soft soap to 2 gallons of water, to which, when heated to the boiling point, 1 pint of crude carbolic acid is turned in. For use, one part of this mixture is mixed with 50 of water and sprinkled directly upon the plants once a week from the time they appear above the ground.

## SUCKING INSECTS.

For the large class of insects, such as the true Bugs which have their mouth parts modified into a sucking tube, instead of jaws, Paris green is useless, since these subsist only on the sap of plants or the blood of animals, which they suck up from beneath the surface. For such, some material which will kill by mere contact with their bodies, is necessary. The simplest, best known, and most convenient of these is the "Kerosene Emulsion" which is the standard remedy for all plant-lice, scale-insect, true bugs, animal parasites, red spider, &c., as well as several biting insects which from one cause or another cannot be treated with Paris green.

The best formula, which is known as the Riley-Hubbard formula, is as follows:

Kerosene (coal oil), 2 gallons.
Rain water, 1 gallon.
Soap, ½ lb.

Boil the soap in the water till all is dissolved; then, while boiling hot, turn it into the kerosene, and churn it constantly and forcibly with a syringe or force pump for five minutes, when it will be of a smooth, creamy nature. If the emulsion be perfect, it will adhere to the surface

of glass without oiliness. As it cools, it thickens into a jelly-like mass. This gives the stock emulsion, which must be diluted with nine times its measure of warm water before using on vegetation. The above quantity of 3 gallons of emulsion will make 30 gallons of wash. Insects breathe through small openings along their sides The effect of Kerosene emulsion is to suffocate them, by stopping up these breathing pores.

Soap-suds made from whale-oil soap, 1 lb. to 8 gallons of water, is a useful remedy for the destruction of plant-lice.

# POTATO DISEASES.

By James Fletcher, F.R.S.C., F.L.S.

## POTATO BLIGHTS.

There are few diseases of field crops which are the direct cause of more loss to the farmers of Canada than the two blights which have been aptly termed by Prof. L. R. Jones, of Vermont, the Early Blight and Late Blight of potatoes. These are usually confounded under the various names "Potato rot," "Potato blight" and "Potato rust"; but, as a matter of fact, although somewhat similar in general appearance, they are very distinct, and are due to the attacks of two different vegetable parasites.

FIG. 5—THE EARLY BLIGHT.
(*Kindly lent by Prof. L. R. Jones.*)

1. The Early Blight.—This disease is caused by the fungus *Macrosporium solani*, E. & M., and shows itself during the months of June and July, when greyish-brown spots appear upon the older leaves. These soon become dry and crisp, and in bad cases the whole leaf is affected, so that nothing is left but the stems, and the tubers stop growing.

The appearance of this disease is well shown in fig. 5.

FIG. 6—THE LATE BLIGHT.
(*Kindly lent by Prof. L. R. Jones.*)

2. THE LATE BLIGHT OR POTATO ROT.—This disease of the potato is due to the attack of a parasitic fungus, known by the name of *Phytophthora infestans*, D. By. The life history of this enemy is briefly as follows: The fungus passes the winter inside the potato tuber and is planted with it in the spring. As soon as the potato throws out its shoots, the parasite grows with it, running up through the tissues of the stems, and from about the end of July produces beneath the leaves an abundance of spores, or seed-like bodies. These are exceedingly minute, but are produced in such numbers that they frequently give a frost-like appearance to the under sides of the leaves. When these spores are produced on the leaves, the appearance known as "rust" shows itself in the shape of dark brown spots, as represented in fig. 6, which are caused by the drying up of the tissues, owing to the parasite having used up their contents. From the rust stage all future infection takes place. Some of the spores are carried by the wind, and, falling upon the leaves of other adjacent plants, produce more rust spots, while others falling to the ground are washed beneath the surface, and reaching the forming tubers, produce the rot stage. The wet-rot, as seen in autumn in the tubers, is the form of this disease which is best known; but potato rot is really a dry-rot which kills the tubers, and in autumn the wet-rot follows as a result of decay. In winter the disease occurs in the tubers, as patches of hard, whitish, diseased tissue.

In the Ottawa district the rust stage does not generally appear until about the 1st of August, and is the first evidence that blight is present in the field. As a rule, the dark spots appear only on a few leaves at first; but, if the weather be favourable, the disease spreads rapidly from spores carried by the wind from these centres of infection, so that a large field may become diseased in a few days, and as a result the crop of potatoes be ruined.

*Remedy.*

Careful experiments have shown that if the BORDEAUX MIXTURE is sprayed over the growing potato plants, it will in a large measure hold in check both of the injurious diseases mentioned. For Early Blight the first application should be made early in July, and a second one a fortnight later. For the Potato rot, the first spraying need not be applied before the 1st of August; and two subsequent applications at intervals of two weeks, will generally carry the crop past all danger.

The formula for making the Bordeaux mixture, which has given the best results in our experiments at Ottawa, is the following:—

Copper sulphate, 6 pounds.
Lime (fresh), 4 pounds.
Water, 45 gallons.

The method of preparing the mixture is described in detail on page 7.

*To apply this mixture* to the foliage, undoubtedly the best and cheapest way is to use a proper spraying pump and nozzle; but, if these are not on hand, good results which will well repay the trouble, may be obtained by applying the mixture with watering cans supplied with fine roses. There are several different kinds of spraying pumps in the market; perhaps the most convenient for this work is a force pump attached to a barrel on wheels, to be drawn through the field by a horse. Smaller machines, known as Knapsack Sprayers, consist of a reservoir containing a small force pump, which can be carried upon a man's back. Both of these kinds of pumps can be purchased for about $10 to $20, and are now for sale by most of our seedsmen. It will be necessary to spray the field two or three times to protect the crop thoroughly. There is no danger of injuring the foliage with the above mixture.

A great advantage of this mixture is that Paris green, the only practical remedy for the Colorado Potato-beetle, can be applied at the same time. To do this, mix from a quarter to half a pound of Paris green with a little water, so as to make a thick paste, and then add it to the 45 gallons of Bordeaux mixture; that is, it is used in exactly the same strength as with plain water.

These mixtures must be kept constantly stirred while being used, as both the lime in the Bordeaux mixture and the Paris green sink quickly to the bottom of any mixture if left undisturbed.

*The time to apply.*—The Bordeaux mixture is a preventive remedy, and the time to apply it in any locality is just before the blights treated of usually appear there, the object being to keep the plants, during the whole of the time they are liable to injury, covered with the fungicidal preparation.

The Early Blight in this part of Canada generally appears at the end of June or early in July. The Late Blight or Potato rot seldom shows itself until August. Therefore, spraying should be begun early in July, and repeated every two weeks at least until the end of August.

## POTATO SCAB.

Another disease of the potato which may be largely controlled by special treatment, is known by the name of "POTATO SCAB." Several causes have been assigned for this disease, such as injuries due to the attacks of insects, the chemical action of some of the ingredients of the soil, excessive moisture, &c.; but the common and most prevalent form of "scab" is due to the presence of a minute parasitic fungus known as *Oospora scabies*, Thaxter, which is easily detected on freshly dug scabby potatoes and which produces the well known corky patches on the tubers. Many experiments have been made during the last five years to discover a practical remedy for this disease, and the best results have been secured by treating the seed potatoes before planting with a solution of CORROSIVE SUBLIMATE. Prof. Bolley, of North Dakota, who was the first to suggest this treatment, recommends as follows :—

"Procure an ordinary barrel, and fit into the base a common wooden faucet. Purchase of a druggist two ounces of finely pulverised corrosive sublimate. Empty this all into 2 gallons of hot water in a wooden or earthenware vessel, and allow it to stand till all is dissolved. Place in the barrel 14 gallons of water; then pour in the two gallons of solution, and mix thoroughly.

"Select as fair seed potatoes as possible; wash off all the dirt, and immerse as many as you wish to treat, in the solution, for one hour and thirty minutes. At the end of this time, turn off the solution into another vessel. The same solution may be used a number of times if necessary."

*Caution:* Corrosive sublimate is a very strong poison, and too great care cannot be exercised in its use. The strength of the solution as here recommended is the same as that used in surgery, and will do no harm externally on the hands, but is a deadly poison if taken internally. When finished with, the solution should be poured out into a hole, dug for the purpose, away from wells or streams or where chicken or farm stock could obtain any of it. No more of the chemical should be purchased than is to be used at the time, and the vessels must not be accidently used for any other purpose by which any risk of poisoning could occur. All potatoes treated must be planted or destroyed.

It should be remembered that the best results will only be obtained by planting clean seed in soil which has not previously produced a scabby crop. Smooth, clean-looking potatoes may still bear the germs of the disease, if they have been mixed with scabby tubers, or have been kept in bags or bins where such had been previously placed. The germs of the scab fungus are known to have remained in the soil for three or four years after an infested crop had been removed, and if these germs be present in the soil, the crop produced may be scabby, although apparently clean seed was used. It is claimed that the scab on beets, swedes, carrots and cabbages is due to the same fungus, and that, therefore, when possible, potatoes should not follow these crops.

# BLACK KNOT OF THE PLUM AND CHERRY.

## PLOWRIGHTIA MORBOSA (Schw.) Sacc.

By John Craig, *Horticulturist.*

The object of publishing this bulletin is not to give to the public the results of new experiments in treating a destructive enemy to fruit-growers, but to stir up and create a wholesome feeling of the danger of allowing this disease to multiply and spread the contagion, and of the necessity of united action in stamping it out. Why should we not exercise the same precautions in preventing the spread of contagious diseases affecting plants, as are employed in checking the spread of diseases of a similar nature affecting animals. Every inducement which incites a desire among orchardists to study this enemy in all its bearings, is a source of congratulation, as a study of its habits cannot fail to reveal its dangerous character, nor fail to point out the only remedy known thus far, by the thorough application of which it may be successfully prevented. It is for this reason then, viz., that of directing attention to the necessity of combined and coöperative action in fighting this enemy, that it is deemed advisable to review briefly the life history of this disease, stating at the same time as concisely as possible the facts upon which the belief in the fungous nature of this malady is based.

The disease known as Black Knot was carefully studied by Dr. Farlow, of Cambridge University, about twenty years ago, then and now the leading mycologist of America. We are indebted to this eminent scientist for much valuable data regarding its habit of growth and multiplication. Not the least important part of his investigations was that which at once proved its fungous nature, and the possibility of transmitting the disease

by inoculation from wild forms of cherries to cultivated garden and orchard varieties. Dr. Farlow states in a bulletin of the Bussey Institute, issued March, 1876, that "we have made direct experiments to show that the spores of the knot on the *choke cherry* will germinate and produce the knot in healthy plum-trees." These experiments disprove the theory which held the necessity of insect agency or assistance in developing the knotty growth.

Black Knot is an exceedingly troublesome disease, found attacking the branches and stems of sweet and sour cherries, *bird cherries. choke cherries*, and all varieties of plums, including the wild plum of the hedgerow and thicket, which frequently is a prolific source of infection, and a menace to neighbouring orchards.

Writing of this fifty years ago the most prominent horticulturist of the time, Mr. A. J. Downing, said that "in some parts of the country this is a most troublesome disease, and has even destroyed the whole race of plum-trees i· neighbourhoods where it has been suffered to take its course." Prof. S. A. Beach, Horticulturist of the New York Experiment Station, commenting on this in bulletin No. 40, says: "Could he have looked into the future and seen the plum industry literally wiped out of existence by Black Knot, not only 'in whole neighbourhoods,' but in whole counties along the famous Hudson River Valley, doubtless the strong words quoted above would have seemed to him a faint statement of the destructive character of this disease. Although Downing did not know the real cause of the trouble, yet he urged upon his readers the proper remedy, namely, the destruction of all affected parts by fire; but he advocated burning as early as possible in spring, while, as will be shown hereafter, it is advisable to burn again just after the leaves fall. He also gave the following sound advice: "It will be necessary to prevail on your neighbours, if they are near ones, to enter into this plan, or your labours will be of little value." Had his advice been followed and the work of burning all Black Knots wherever found, been systematically undertaken at that time and enforced by wise laws, supported by strong public sentiment in their favour, there is little reason to doubt that in the favoured localities along the Hudson River commercial plum orchards might have been paying good profits for the last twenty years, instead of presenting as they do discouraging pictures of loss and decay.

It was believed by early writers on this subject that the characteristic knotty excrescences were caused by insects, but this erroneous belief has been clearly disproved by many investigators. Where the disease is abundant the knots are as a rule much infested by insects. It has also been found that they are inhabited by various insects belonging to dif-

ferent orders. Prof. Webster in *Entomological News* for October, 1893, records having bred nine distinct species from one lot of knots collected in a single garden, and this collection did not include the plum curculio well known to breed in the knots as well as in the fruit.

*Fig. 1.*

In an excellent bulletin on this subject Prof. B. D. Halsted (New Jersey Ag. Ex. Sta. Bul., No. 78), the life history of this parasite is given at length and an appeal is made to fruit-growers to induce them to make greater efforts to eradicate so pernicious a foe.

Prof. Halsted says:—In the first place let the reader get a clear understanding of the nature of the enemy that it is proposed to conquer. There is no question whatever about the black knot being caused by a low form of vegetable growth classed with fungi, which sends its minute threads through the substance of the twigs and branches. It is therefore, necessary to gain a knowledge of this fungus, and for this purpose the accompanying engravings have been prepared. (These engravings have been kindly furnished by Dr. Halsted.) While it is generally assumed that the appearance of the disease is familiar to most of our readers, it has been thought well to give some illustrations.

The beginnings of a young knot are first seen in a manifest swelling of the young twig, which is soon followed by a cracking of the bark, and in the rifts thus formed the threads of the fungus come to the surface and clothe it with a covering of olive filaments bearing multitudes of spores. A young branch is shown in figure 1, which exhibits the characteristic swelling of the initial knot and the crack in the back in which the spores are borne. A highly manifested portion of a rift in the bark is shown in figure 2, in which the superficial stalks and their spores are seen. These spores are carried in all directions by the wind, and falling upon the surface of young shoots, germinate, send their filaments through the bars into the growing ring of soft tissue beneath and institute another knot.

As the season advances the young knots and the fresh growth of older ones lose their olive, velvety appearance turn a dark colour, and develop a hard incrustation upon the surface. Within the substance of this black and brittle layer many supherical pits are formed, as shown in fig. 3, and as winter advances, minute sacs are produced on the wall of the cavity, that toward spring bear each eight oval bodies that are known as ascospores. These escape from their long sacs and pass out through a pore at the top of the cavity, and are then ready to be carried by the wind to the surface of a young cherry or plum twig, and thus begin another knot, which, in the course of time, produces a new crop of summer and another

of winter spores, and thus the disease is preserved and propagated. In fig. 4 is shown two of the sacs with the eight spores in each. A free

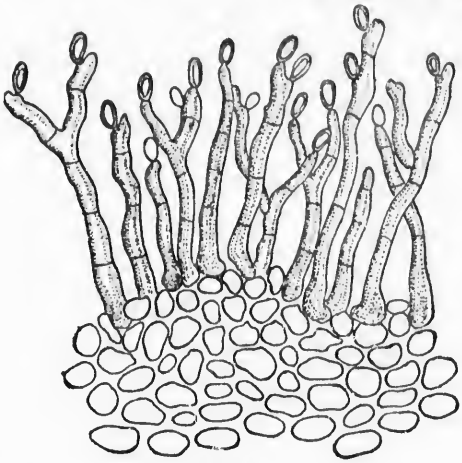

*Fig. 2.*

spore is also shown in the process of germination. It is a fact that cannot be too emphatically stated here that the ascospores above mentioned are matured during the winter months, and that they will continue to ripen when the knots have been removed from the trees, and therefore may be omitted from special mention. The fact of their existence only strengtens

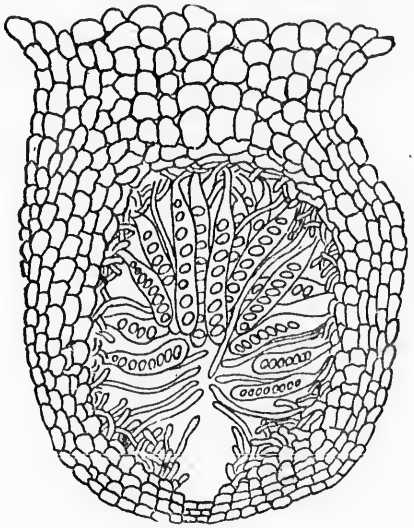

*Fig. 3.*

the previous conviction that the black knot we have a fungus perennial in its character, and wonderfully provided with methods of spore formation for the rapid spreading of the malady at all seasons of the year."

This pest is known to attack at least eight species of the genus *prunus* —plum and cherry family. The appearence of the knot varies somewhat among the various species, but, as Dr. Halsted points out, "it has been demonstrated by direct inoculation that spores from the knot of the choke cherry will produce the quite dissimilar excrescences common to the garden plum," a fact that in this connection it is important to know.

*Fig.* 4.

REMEDIES.

Many of the fungous diseases which attack our field and garden crops may now be controlled by the application of Bordeaux mixture. This is made of equal parts of copper sulphate and lime dissolve and diluted with water. Ammoniacal copper carbonate is also quite effective in preventing the same diseases. The peculiar method by which this disease propagate itself, together with its perennial nature, militates against the usefulness of the copper salt remedies, as the above mixtures are called, although there is no doubt that a thorough application of Bordeaux mixture to affected trees at the time of the dissipation of the summer spores would in a measure prevent the spread of the disease. Results of experiments conducted by Prof. Lodeman, of Connell University, N.Y., recently published, indicate that Bordeaux mixture may be used in preventing the spread of Black Knot with considerable success. The best remedy however is to *cut off and burn promptly every knot which makes its appearance* on plum or cherry-tree. This remedy is effectual only in proportion as it is generally applied. A public sentiment is needed which will

call for concerted and united action. Cherry and plum-trees should be carefully examined for knots two or three weeks after growth begins in the spring and again after the leaves fall in the autumn.

When trees are badly attacked it is best to cut them down and destroy them by fire, root and branch. When the smaller branches only are affected the knots should be cut off, taking care to cut 5 or 6 inches below the knotty portion. The cut surface should then be painted with linseed oil or turpentine.

It should be remembered that an affected branch cut off, and thrown on the ground will be just as useful in spreading the disease as if left on the tree. The spores will ripen in knots on separated branches with equal facility. Single knots which sometimes appear on the trunks or main limbs of trees should be carefully pared off and the wound treated with a mixture of linseed oil and red oxide of iron. Saturating the knots with kerosene will kill them, but it will also injure the healthy wood, and if applied freely will cause the branch to die.

In many cherry and plum growing districts neglected fence corners and thickets of choke cherry, native plum and cherry, breed millions of spores of black knot which are a constant source of danger to surrounding orchards. In village and city gardens too often do we find trees covered with knots, and producing nothing from year to year but a crop of spores by which the disease is propagated and spread. These infested trees which act as breeding grounds should be rigorously destroyed.

It has been already pointed out, and it is repeated again for the sake of emphasis, that a single hedge-row or thicket of knotty wild plum or cherry will furnish sufficient spores, or seeds, to spread the disease over and infect an entire neighbourhood. The remedy is simple and effective, and if united action could be incited and aided, by the passing and enforcing of suitable laws, such a course would be certain to produce good results.

The disease is dangerously prevalent in the provinces of Quebec and Ontario. It also exists to some extent in the maritime provinces and in Manitoba. Its presence in British Columbia has not yet been reported. The provinces of Ontario and British Columbia have very wisely passed laws which, if strictly enforced, will leave the fruit growers little to fear from this disease.

The following is a summary of the Act relating to the suppression of this disease now in force in Ontario. Most of the fruit growing States of the Union have laws of a similar nature in operation.

### BLACK KNOT LAW.

In Ontario an Act was passed in 1893, intitled the "Yellows and Black Knot Act." This Act provided that—

3. "It shall be the duty of every occupant of land, or if the land be unoccupied it shall be the duty of the owner:—

"(1) To cut out and burn all black knots found on plum or cherry-trees on his land so often each year as it shall appear on such tree;"

and in relation to the yellows, a fungous disease of contagious character, attacking peach-trees, owners and occupants are ordered—

"(2) To cut down and burn any peach, nectarine or other trees on his land affected with the disease known as the "yellows" and to destroy all the fruit of these trees so infected."

Municipal councils have the power to appoint district inspectors whose duty it is to enforce the law. A fine of "not less than $5.00 and not more than $20.00" may be imposed for every offence or case of non-compliance with the requirements of the Act.

The Act also provides for an appeal from the decision of the inspector, as well as outlining the duty of municipal councils.

RECAPITULATION.

A few of the salient points in connection with the nature of this disease, and the measures which should be adopted for its prevention, may be briefly enumerated as follows:—

1. Black Knot is due to a fungous disease and spreads rapidly by means of spores.

2. Several species of insects have been observed inhabiting the knots, but none of them belong to the gall-producing kinds, and most of these insects are also found upon other trees which never produce knots.

3. The same fungus attacks the wild species of plum and cherry and may be communicated by them to cultivated forms.

4. The only sure remedy is to examine carefully for knots all plum and cherry-trees twice each year. The first time two or three weeks after growth begins in spring, and again after the leaves fall in autumn. Bordeaux mixture is worthy of trial to prevent dissemination of summer spores.

5. Cut off all knots five or six inches below the affected portion, and paint the wounds with turpentine or linseed oil.

6. Burn all prunings and affected branches which are removed.

7. United action on the part of all fruit-growers is necessary in order to secure the best results from the enforcement of these recommendations.