

THE
Connecticut Agricultural Experiment Station.
 NEW HAVEN, CONN.

BULLETIN No. 111.

MARCH, 1892.

CONTENTS.

	PAGE
Notice as to Bulletins	2
Notice as to Annual Reports	2
Common Fungus Diseases and Methods of Treatment	3
Apple, { Scab	3
{ Ripe-rot or Bitter-rot	5
Pear, { Leaf-blight or Leaf-rot	5
{ Scab	6
Quince, { Leaf-blight or Leaf-spot	6
Peach, { Yellows	7
Plum and } { Black-knot	8
Cherry, } { Brown-rot	9
Grape, { Black-rot	10
{ Brown-rot or Downy-Mildew	11
{ Anthracnose	12
Raspberry and Blackberry, } Anthracnose	12
Strawberry, { Leaf-blight	13
Onion, { Smut	14
Potato, { Blight or Rot	15
Tomato, { Leaf-blight	15
{ Potato-rot	16
Fungicides, and their Preparation	16
Bordeaux Mixture	16
Ammoniacal Carbonate of Copper	16
Ammonia-Copper Solution	17
Cost of Crude Chemicals	17
Spraying Apparatus	18
Pumps	18
Nozzles	19
Hose	19
Cost of Pumps and Accessories	20
Explanation of Plates	20

NOTICE AS TO BULLETINS.

The Bulletins of this Station, issued quarterly or oftener, are mailed free to citizens of Connecticut who apply for them, and to others, as far as the limited editions permit.

Applications should be renewed annually before January 1st.

Citizens of other States desiring to secure the Bulletins regularly are referred to notice below.

The matter of all the Bulletins of this Station in so far as it is new and of permanent value will be made part of the Annual Report of the Director.

Bulletins earlier than No. 71 and Nos. 83, 93, 100, 101 and 102 are exhausted and cannot be supplied.

NOTICE AS TO SUPPLY OF STATION REPORTS.

The Annual Report of this Station for 1891, printed at State expense, is limited to an edition of 7,000 copies, of which 5,000 copies are bound and distributed by the Secretary of the Board of Agriculture, T. S. Gold, West Cornwall, Conn.

After satisfying necessary exchanges, the copies remaining at the disposal of the Station have been sent to citizens of Connecticut, who made application for them, until our supply is exhausted.

Those on our list who have not received copies of the Report for 1891 will be supplied by Mr. Gold through the town agents.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1883, and 1887, and will pay a liberal price for a number of clean copies of Reports for any of these years.

Extra copies of the next Annual Report can be secured if called for before the printing-forms are broken up. Such copies will be struck off and supplied early next year to citizens of other States who apply to this Station before February 1st, and who remit 25 cents per copy to defray costs. This remittance will also secure to the sender the Bulletins issued by this Station during the year.

Coin may be forwarded by Post at sender's risk with small chance of loss, as follows: Cut an inch hole in a card or scrap of paper-box that will just fit inside an envelope, fasten a twenty-five cent piece in the cavity by pasting paper over it on both sides of the card, write thereon name and Post office address, inclose within an envelope, and send as a letter prepaid in full. P. O. stamps cannot be accepted.

COMMON FUNGUS DISEASES AND THEIR TREATMENT.

By WILLIAM C. STURGIS, PH.D., MYCOLOGIST.

With the approach of spring numerous inquiries are addressed to us from all parts of the State regarding fungus diseases of plants, the substances used in combating them, the proper season for beginning spraying, the required frequency of application, the means and methods of application, and other matters of a like nature. Although the subject is by no means a new one, and has been treated many times in purely scientific books and periodicals as well as in the publications of the Department of Agriculture at Washington and of the various State Experiment Stations, it is a matter of no slight difficulty to find in this mass of literature just what is needed under definite and often urgent circumstances. The purpose of the present Bulletin is to answer as briefly as is compatible with clearness, and with as few technical terms as possible, some of the questions referred to above. The only diseases here noticed are those familiar to the farmers and fruit growers of this State, and readily recognized by their common names. No extended description of the different fungi will therefore be given, but only sufficient to enable one who has seen the diseases, to recognize them.

DISEASES OF THE APPLE.

“SCAB.” [*Fusicladium dendriticum* (Wallr.) Fekl.]

This disease attacks the leaves and fruit of the apple, producing roundish or irregular blotches on the upper surface of the leaves, and on the fruit. These blotches are of a dark greenish-brown color, and of a more or less velvety texture. The growth of the fungus causing these blotches does not tend to produce any rapid or widespread decay in the fruit, but it does stunt and distort the fruit, rendering it to a greater or less degree unsightly and unmarketable. The “scab” should not be confounded with the diseases known as “bitter-rot” and “black-rot,” both of which tend to produce rotten areas in the fruit.

Treatment.

Inasmuch as the "spores" or fruit of the "scab" fungus pass the winter in the fallen leaves beneath the trees or in the cracks and crevices of the bark, collecting and burning the leaves in winter is of great assistance in controlling the disease, and a winter treatment in the form of a strong wash or spray applied to the trees is most desirable. The material used is a strong solution of either sulphate of copper, 1 lb. to 10 galls. of water, or sulphate of iron, 1 lb. to 5 galls. of water. This application is best made by means of some form of spraying apparatus, and should be used in early spring before the buds have begun to swell.

This should be followed up by a summer treatment, consisting in the application of either the Bordeaux mixture or ammoniacal carbonate of copper. Formulas and directions for the preparation of these and other fungicides are given on pp. 16 and 17. The Bordeaux mixture presents one very decided advantage over the ammoniacal copper carbonate in that it contains no ammonia, hence does not dissolve the arsenic compounds, and can therefore be used in conjunction with Paris green or London purple to prevent the attacks of the codling moth as well as of the "scab" fungus. The mixture should be made in the proportion of one pound of the arsenic compound (Paris green or London purple) to 100 gallons of the fungicide, the former being stirred to a smooth paste with a little water and added to the latter.

Time of application.

In applying fungicides for apple "scab" it should be remembered that early treatment, especially one treatment previous to the opening of the flowers, is extremely important, and that spraying after midsummer is of doubtful value. One application just before the flowers open, a second as soon as the fruit is set, and a third when the fruit is half grown, will be found as efficient as a number of applications later in the season. This recommendation may be modified by conditions of weather. In case of frequent and heavy rains in early summer the applications must be made oftener, perhaps every ten days, and even then it will be found impossible to prevent entirely the attack of the fungus.

“RIPE-ROT” OR “BITTER-ROT.” (*Gleosporium fructigenum*
Berk.)

The presence of this fungus upon the fruit is characterized by roundish brown spots, slightly sunken, and having the appearance of ordinary decay. Later a few minute black pimples appear in the center of each brown area, the substance of the fruit below these areas becomes brown, spongy, and more or less decayed, and is extremely bitter to the taste. The fungus also attacks the grape, and does serious damage.

Treatment.

Inasmuch as this disease attacks the fruit when it is nearly or quite ripe, the early application of fungicides is not necessary. Sulphide of potassium (liver of sulphur) mixed with water in the proportion of one-half ounce to a gallon of water, and ammoniacal carbonate of copper, have both proved effective remedies. The first spraying should be made about the middle of July, and the treatment repeated twice at intervals of about two weeks, or oftener if the rains are frequent.

DISEASES OF THE PEAR.

“LEAF-BLIGHT” OR “LEAF-SPOT.” (*Entomosporium maculatum* Lév.)

This disease attacks the leaves and fruit of both the pear and the quince, producing on the leaf yellowish or reddish spots marked in the center by minute black pimples. The affected leaves fall prematurely, generally by the first part of July, the tree suffers in consequence, and may eventually die from the effects of repeated premature defoliation. Upon the fruit the spots produced by the fungus are not usually as prominent as upon the leaf, but the fruit cracks badly, and becomes stunted and quite unmarketable.

Treatment.

The Bordeaux mixture has been successfully used in the treatment of this disease, but its greater cost renders it inferior to the almost equally effective ammoniated compounds, except in very severe cases.

The ammoniated compound which has produced the best results is an ammonia-copper solution, the formula of which is given

on p. 17. Collecting and burning the fallen leaves, and a winter treatment of the trees with a strong solution of sulphate of copper as recommended for apple "scab," would also check the spread of the disease.

Time of application.

The first spraying with the Bordeaux mixture or the ammonia-copper solution should be made just before the blossoms open; a second, as soon as the blossoms have fallen; and either two or three more at intervals of two or three weeks according to the rainfall.

"SCAB." [*Fusicladium pyrinum* (Lib.) Fckl.]

The fungus causing this disease is very closely related to that causing the apple "scab," and the effects of the two are very similar. Upon the pear, as upon the apple, the fungus produces dark brownish patches of a velvety texture on the leaves and fruit. Cool, damp weather is in both cases favorable to the spread of the disease.

Treatment.

A spray of sulphide of potassium, used in the proportion of one ounce to two gallons of water, has been recommended, but is probably not as effective as the Bordeaux mixture or the ammoniacal carbonate of copper. The first application should be made when the flowers are beginning to open, a second when the fruit is about the size of peas, and additional applications every two weeks until five or six in all have been made.

DISEASES OF THE QUINCE.

"LEAF-BLIGHT" OR "LEAF-SPOT." (*Entomosporium maculatum* Lév.)

See Plates I, II, and III.

This is the same fungus which causes the blight or spot of the leaves of the pear, and the cracking of the fruit. In the case of the quince the most marked effect of the fungus is upon the leaves, hence the first effect of remedial measures is seen in a vigorous, healthy leafage, and in severe cases a good set of fruit is only secured after spraying for two seasons.

Treatment.

In treating the disease as it occurs on quince trees, experience seems to show that in the end, and taking into consideration the much greater success attending its use, the Bordeaux mixture is preferable to the ammoniacal solution. The use of the Bordeaux mixture is also to be recommended because it permits of admixture with Paris green as a remedy against the quince "maggot." The Paris green should be mixed to a smooth paste with a little water, and then stirred into the Bordeaux mixture in the proportion of one pound of Paris green to 100 gallons of mixture.

This treatment should be supplemented by the gathering and burning of the fallen leaves, and by the winter treatment with sulphate of copper or sulphate of iron as recommended in other cases, p. 4.

The proper times for making the applications are the same as in the case of the "leaf-spot" of the pear, p. 6.

DISEASES OF THE PEACH.

Practically the only disease of peach trees which at present seriously threatens the fruit interest of Connecticut is that known as "yellows." It is impossible to give within the limits of the present Bulletin even a brief outline of the investigations which have been made on the cause or causes of this malady. It is sufficient to say that as yet no definite cause has been ascertained with any certainty, and no means have proved effective in checking the spread of the disease except rooting out and destroying by fire every tree which shows the first symptoms of the disease. Constant study has however, given us certain general facts relative to the disease.

(1) The first manifestation of "yellows" is the premature ripening of the fruit. The moment this symptom is seen, though the tree is to all appearance sound and healthy otherwise, it must go, if the spread of the disease is to be checked. There are no authentic instances of trees recovering after the appearance of this symptom.

(2) The second evidence of a diseased condition is the premature development of winter buds, producing spindly growths and sickly green leaves. All the other symptoms of "yellows" are due primarily to these two.

(3) The period of incubation, i. e. the time elapsing between artificial inoculation and evident symptoms of disease, is considerable; after the appearance of symptoms the tree may live from one to five years, and even produce fruit during the early stages of the disease.

(4) The whole tree is affected when symptoms appear in any part of it, hence

(5) Pruning has little or no effect on the spread of the disease. If a single diseased tree is allowed to remain in the hope that it will bear fruit for at least one more year, not only are the adjoining trees endangered but the whole orchard and even adjoining orchards may become infected.

(6) There is no question that the disease can be communicated from one tree to another, though how it is communicated, that is, the nature of the contagion, is as yet unknown. It may be communicated by even apparently healthy buds when these are taken from diseased trees, but it is also conveyed in some other way than by bud inoculation, certainly in the case of old trees. Finally the trees are not infected through the blossoms.

(7) The use of special fertilizers has never cured a tree, though heavy fertilizing may, by increasing the vigor of the tree, enable it to withstand longer the effects of the disease.

(8) It is possible to grow healthy trees in the identical spot from which a diseased tree has been taken. This has been the practice of growers in Michigan and the disease has been almost completely eradicated. In other States however, notably in Delaware, the practice has not proved so advisable, and on the whole it seems to be at least unsafe to set out a new tree in the spot where a diseased tree has recently been rooted out.

For further details on this subject the reader is referred to Dr. Erwin F. Smith's exhaustive treatises, Bulletin No. 1, U. S. Dep't of Agric., Division of Veg. Path., and Bulletin No. 9, U. S. Dep't of Agric., Div. of Bot., to which publications we owe most of our knowledge concerning peach "yellows."

DISEASES OF THE PLUM AND CHERRY.

"BLACK KNOT." [*Plowrightia morbosa* (Schw.) Sacc.]

This disease attacks the smaller limbs and twigs of wild cherries and plums as well as of the cultivated varieties, producing on them jet-black wart-like growths. At first these growths are small and do but little damage, but they increase rapidly in size;

by inducing a morbidly active growth of the tissue of the branch on the side upon which they are growing, they produce a distortion of the branch; and finally, surrounding the branch completely, they produce death. It is not rare for a whole tree to be killed by this disease in the course of two seasons. The black "knots" are largely composed of the fruiting part of a fungus, the vegetative part of which is buried in the tissues of the branch, and occupies a distance of three to five inches above and below the "knot" itself.

Treatment.

After the disease has once obtained a good hold upon the larger branches of a tree it is well nigh impossible to eradicate it. Its spread can be stopped however, if it is taken in hand early, or when the "knots" are still small and few in number.

With a sharp knife the "knots" should be cut out, the portion removed extending three or four inches above and below the "knot" itself. The wound should then be washed, or the whole tree sprayed with a strong solution of sulphate of copper, and painted over with some oil paint. The spores of this fungus mature and are distributed from the latter part of December to February; the best season therefore, for cutting out the "knots" is November or early in December. The young "knots" appearing in the spring, bursting through the bark in greenish swellings, may be cut out at that season. If the whole tree is badly diseased it should be cut down at once and burned; and the same applies to the individual "knots." If allowed to remain on the ground they will infect healthy trees as readily as though they were still on a living tree. Wild cherries which are diseased should be subjected to the same treatment, or destroyed altogether.

"BROWN-ROT." (*Monilia fructigena* Pers.)

This disease attacks the stone-fruits, such as the peach, plum, and cherry, and sometimes the apple and pear. Its first effect is to induce a browning of the fruit accompanied by a copious production of ash-colored dusty tufts on the surface of the fruit, composed of the fruiting threads of the fungus. Later the fruit becomes shrunken and dry, and in this "mummified" condition may remain for a long time without decay. Not infrequently the whole fruit becomes encased in a layer of brownish dust consisting almost entirely of the spores of the fungus.

Treatment.

The most practical method of checking the spread of the disease is by burning all diseased or "mummified" fruit. It is in this dried fruit that the fungus threads pass the winter. With the advent of warm weather the threads produce spores in immense quantities upon the remains of the fruit, and the fresh crop of fruit becomes readily infected. Hand-picking and burning all diseased fruit, both on the tree and on the ground, is therefore the surest method of combating the disease. It occasionally attacks both the leaves and twigs as well as the fruit, and in such a case again the best remedy is picking and burning the diseased parts.

DISEASES OF THE GRAPE.

"BLACK-ROT." [*Physalospora Bidwellii* (Ellis.) Sacc.]

This well known disease usually appears first upon the leaves and young shoots, producing reddish-brown or blackish spots. About two weeks later the berries are attacked, the first evidence of this being a black or brownish spot at one or more points on the surface. Soon the whole berry turns brown, then black, and finally becomes hard and leathery, while still remaining on the stalk. A magnifying glass reveals on the surface of the diseased berries minute black pimples, within which the several forms of spores produced by the fungus are born.

Treatment.

Warm, damp weather is especially conducive to the spread of the disease, so that during such weather the vines will require constant care. The first precaution to be taken in the spring consists in ploughing or cultivating between the rows so as to turn under or cover any diseased grapes which may have fallen the previous year.

Treatment of the vines immediately after pruning, with the strong solution of sulphate of copper is advisable (p. 4); but more important is the summer spraying with either the Bordeaux mixture or the ammoniacal carbonate of copper. The latter is more profitable on account of its almost equal efficacy and much smaller cost.

Time of application.

Early treatment is indispensable to success. The appearance of the first leaves should be the signal to begin spraying. Make the first application then, repeat it just before the vines begin to bloom, follow it up with a third as soon as the vines have finished blooming, and repeat at intervals of twelve or fifteen days according to the weather, until the berries begin to change color and ripen. The most critical period in this climate is about the last of June; the spraying at this time should therefore be especially thorough and careful. If the Bordeaux mixture is used throughout the season there is danger of some of the dried copper compound remaining on the berries when harvested, and this damages the appearance of the fruit, though the quantity of copper is too small to produce any injurious effects from eating the grapes. This staining of the fruit may be remedied by using the ammoniacal carbonate of copper for the last two sprayings instead of the Bordeaux mixture.

“BROWN-ROT” OR “DOWNY MILDEW.” [*Plasmopara viticola*
(B. and C.) Berl. and De Ton.]

The fungus producing this disease is more disastrous to the vines themselves than the fungus of “black-rot,” inasmuch as it attacks the leaves causing them to turn brown and fall prematurely. Later it attacks the berries. The latter do not dry and shrivel as in the case of “black-rot” but they assume a grayish tint, the surface becomes discolored in places, especially near the stem end, and finally, decay accompanied by a uniform brown color, destroys the fruit. On the leaves the disease is readily recognized by the grayish, downy or furred appearance produced on the under surface of the leaves by the fruiting threads of the fungus. This downy form of the disease may also attack the berries, and under such circumstances is unmistakable.

Treatment.

The ammoniacal carbonate of copper and the Bordeaux mixture have both been used with success for this “mildew.” The former is to be preferred because, while equally effective, it is cheaper than the Bordeaux mixture.

Time of application.

The treatment should begin soon after the first leaves are fully formed, or from the middle to the last part of June in this climate, and should be repeated every twelve or fifteen days until the berries begin to color. In order to insure perfect ripening of the wood it is often well to make one or two sprayings after the fruit is harvested. Of course if the vines are being treated for "black-rot," no additional treatment is needed for the "mildew."

"ANTHRACNOSE" (*Sphaceloma ampelinum* De Bary).

This disease attacks the canes, leaves, and berries. On the leaves it produces small brownish spots with a slightly raised border. Later these spots become gray in the center and often separate from the surrounding healthy portions of the leaf, leaving the latter full of round or ragged holes. On the canes the effect is similar except that the spots often become confluent, producing large elongated diseased areas of a grayish color and slightly flattened or depressed. On the berries the spots are more nearly circular, and their appearance, gray in the center with a reddish surrounding circle and a dark border, gives to the disease the common name of "bird's-eye rot."

Treatment.

The best remedy for "anthracnose" is to wash or spray the vines after pruning, and before the buds begin to swell in the spring, with a strong solution of sulphate of copper, using one pound to ten gallons of water. "Anthracnose" is not liable to do much damage in vineyards that are well treated for "mildew" or "black rot," especially if the vines are severely trimmed.

DISEASES OF THE RASPBERRY AND BLACKBERRY.

"ANTHRACNOSE." (*Gloeosporium Venetum* Speg.)

This "anthracnose" produces on the canes, small round or elongated whitish patches, slightly flattened and bordered with a ring of dark purple. These patches gradually increase in size and number, and finally destroy the new growth or stunt it badly. Upon the leaves it is often visible as very small yellowish spots surrounded by a dark border, resembling those on the

canes but much smaller. The fungus producing the disease passes the winter in the diseased canes and leaves, a fresh crop of spores is produced from the old spots in the spring, and the new canes and foliage are readily infected.

Treatment.

As in the case of the grape "anthracnose," cutting out all diseased wood and burning it will gradually eradicate the disease. It should be cut out in winter or very early spring, below the lowest diseased spot. If the canes are then sprayed with a solution of sulphate of copper, using one pound to ten gallons of water, and if necessary sprayed two or three times during the summer with sulphide of potassium (liver of sulphur), one ounce to one gallon of water, or with Bordeaux mixture, very little damage is to be feared from the "anthracnose."

DISEASES OF THE STRAWBERRY.

"LEAF-BLIGHT." (*Sphaerella Fragariae* Sacc.)

This disease is characterized by the appearance of reddish areas on the upper surface of the leaves. Later there appear in the center of these discolored areas gray or whitish spots, upon which in autumn and winter are developed several forms of the reproductive bodies or spores of the fungus which causes the discoloration of the leaf.

Treatment.

By annually renewing the settings, and planting only in deep and thoroughly drained soil, the loss from blight will be very largely diminished. Removing and destroying all the old leaves after harvesting, followed by cultivating, and the application of a quick fertilizer, is a process which has produced good results. A simpler line of treatment which in some cases has proved efficacious, is spraying with the ammoniacal carbonate of copper.

Time of application.

The first application should be made the latter part of April, and this should be repeated at intervals of about two weeks, until four applications in all have been made.

DISEASES OF THE ONION.

"SMUT." (*Urocystis Cepulae* Frost.)

This disease attacks the onion seedling, appearing as dark spots or lines in the leaves. Later, and as other leaves develop and become attacked, these spots begin to crack open longitudinally, exposing the fungus with its spores as a black, powdery mass. If the disease is not checked by the natural withering of the leaf first attacked, it spreads throughout the plant, affecting even the bulb, on which it produces black, linear elevations, running down to the base of the bulb and extending up into the leaves.

Treatment.

The only treatment, except rotation and transplanting, which has ever been recommended for onion "smut," is that suggested in the Reports of this Station for 1889 and 1890. It consists in sowing in the drills, with the seed, either a mixture of equal parts of sulphur and lime, or of sulphide of potassium and lime. The experiments which led to this suggestion were made on very smutty land, and increased the yield in a ratio of about 5 to 1. They were merely preliminary and therefore not decisive, but the result certainly seems to warrant a repetition of the experiment. The details will be found in the Reports referred to. It seems probable now that the measure of success attending this treatment will hardly warrant its very extended adoption, and that onion growers in this state, as elsewhere, will have to adopt the method of starting the plants from seed in cold frames, and transplanting to the field. This method is laborious, but the additional labor is compensated for by an earlier harvest, and very superior bulbs.

To lessen the danger of spreading the disease it should be noted that all implements used in smutty ground should be thoroughly washed before being used in clean ground; that all refuse left on the field from a crop infected with smut, should be collected and burned; that when it is possible, onion land should be burned over in the fall; and that at the second and subsequent hand-weedings, all onions which show the smut should be pulled and burned at once.

DISEASES OF THE POTATO.

"BLIGHT" or "ROT." [*Phytophthora infestans* (Mont.) DeBary.]

This disease first appears as a premature wilting of the tops of the vines. The color rapidly changes to yellow and then to a dirty brown. On the under side of the leaf in these diseased portions, is seen a delicate whitish mould, the fruiting threads of the fungus. The disease spreads quickly, inducing a very rapid and characteristic decay in the plants, and if not checked, the fungus causing the decay makes its way to the tubers and affects them producing the well-known "rot."

Treatment.

If applied in time, the Bordeaux mixture is an effective preventive of potato "rot." It should be applied whether the disease appears or not, since it is a preventive rather than a cure.

Time of application.

The first application should be made when the plants are from four to five inches high, and it should be repeated every ten or twelve days until the tops begin to wither. If it is desired at the same time to treat the vines for the "potato-bug," Paris green may be used with the Bordeaux mixture by stirring the former to a smooth paste in water and adding it to the latter in the proportion of one pound of Paris green to 100 gallons of the mixture.

DISEASES OF THE TOMATO.

"LEAF-BLIGHT." (*Cladosporium fulvum* Cke.)

This fungus forms rusty-brown patches on the under side of the leaves, inducing a yellowing and wilting, usually followed by the death of the leaf attacked.

Treatment.

Inasmuch as warmth, moisture, and insufficient circulation of air are all factors in the spread of this disease, training the plants on sticks or trellises to keep them off the ground, and pruning away all the lower branches and leaves so as to allow of the free access of sun and air, will to a great degree prevent the disease. Should it still prove harmful however, either the Bordeaux mixture or the ammoniacal carbonate of copper will be found effective.

"POTATO-ROT." (*Phytophthora infestans* De Bary.)

This fungus which does so much damage to potatoes, frequently attacks tomatoes also. Its general effect is the same in both cases, and it may be controlled by the same means.

THE PREPARATION OF FUNGICIDES.

BORDEAUX MIXTURE.

Formula 1.

Sulphate of copper ("blue vitriol," "blue-stone")	2½ lbs.
Quick lime.....	2 lbs.
Water.....	22 galls.

Or 2.

Sulphate of copper.....	1 lb.
Quick lime.....	1 lb.
Water.....	22 galls.

Pulverize the sulphate of copper and dissolve in 2 galls. of water heated to hasten the solution. Dilute this solution with 14 galls. of water. Slake the lime (which should be fresh, i. e. not partly air-slaked) with 6 galls. of water, adding the latter slowly and stirring to a smooth paste. Allow this mixture to stand a short time, then stir it and pour it slowly into the copper sulphate solution, stirring rapidly during the operation. Never pour in any of the coarser sediment which settles readily to the bottom.

This mixture should be made fresh for each application in order to secure the best results.

Formula 2 is, of course, cheaper than Formula 1, and is quite as effective against "black-rot," and "mildew" of the grape, "leaf-blight" of the tomato, and probably against "potato-rot" as well.

AMMONIACAL CARBONATE OF COPPER.

Carbonate of copper.....	3 oz.
Carbonate of ammonia.....	1 lb.
Water.....	50 galls.

Pulverize and mix together the carbonate of copper and the carbonate of ammonia. Add two quarts of hot water, obtaining a clear solution. Dilute with water to fifty gallons.

The carbonate of copper can be made more cheaply than it can be bought by dissolving in one barrel $2\frac{1}{2}$ lbs. of carbonate of soda (sal soda) in hot water, and in another barrel 2 lbs. of sulphate of copper in hot water. When the solutions are complete, and *cool*, pour the sal soda solution slowly into the copper solution, stirring continuously. A heavy green precipitate will result, consisting of 1 lb. of carbonate of copper. Now fill the barrel up with water, let the carbonate settle at the bottom, and then siphon off the clear water. Repeat the operation once. Finally, strain out and dry the carbonate of copper.

A much simpler ammonia-copper solution is made as follows:

AMMONIA-COPPER SOLUTION.

Sulphate of copper	$\frac{1}{2}$ lb.
Carbonate of ammonia	1 lb.
Water	62 galls.

The carbonate of ammonia should be hard and transparent. If it has become soft and opaque, $1\frac{1}{4}$ lbs. will be required. Pulverize the carbonate of ammonia and dissolve it in hot water in a wooden pail, stirring until foaming ceases. Then add the sulphate of copper and stir again as long as the mixture effervesces. Dilute with water to 62 gallons (2 barrels).

This solution may be used in any case where ammoniacal carbonate of copper is recommended, though having been used but little as yet, practical trials are requisite to determine what dilutions are most proper. The formula given above corresponds very nearly to the formula given for ammoniacal carbonate of copper.

COST OF MATERIALS.

The following are the approximate wholesale prices of the chemicals most commonly used as fungicides.

Lime	per bbl. (300 lbs.)	\$ 1.65
Sulphate of copper (granulated)*	" (450 lbs.)	15.75
Sulphate of iron	per lb.	.01
Carbonate of copper	"	.42
Carbonate of ammonia	"	.12
Carbonate of soda	"	.02
Sulphur (flowers of sulphur)	"	.02
Sulphide of potassium (liver of sulphur) . . .	"	about .12

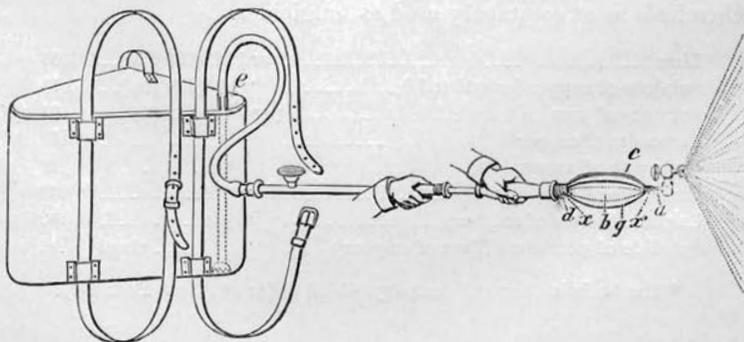
* The Nichols Chemical Company, 45-49 Cedar St., New York City.

SPRAYING APPARATUS.

PUMPS.

For spraying on a large scale where a large portable receptacle is needed, a strong force-pump which can be mounted on a barrel and drawn from place to place, is a great saving of time and labor. A pump well adapted to this purpose is "Gould's double-acting spraying pump" fitted with couplings on both sides which allow of the simultaneous use of two sets of hose, and the spraying of two orchard rows at the same time. (See Plate IV.) This pump, which is powerful, simple, and compact, is made by the Goulds M'fg. Co., of Seneca Falls, N. Y. An equally good pump for use under the same conditions is manufactured by W. & B. Douglas, of Middletown, Conn. The mixture may be kept stirred by means of a disk of wood screwed to the end of a broom-handle and inserted through a hole in the top of the barrel.

For spraying on a smaller scale, or where a mounted barrel cannot be driven, some form of "knapsack" sprayer is convenient if not essential. Many forms are advertised, all made on the principle of combining with a small force-pump, a tank or receptacle to be carried on the back. A very perfect machine of the kind is known as the "Galloway Knapsack Sprayer." The Messrs. Douglas, of Middletown, are prepared to furnish this sprayer, or one very similar to it. A knapsack sprayer consisting of a copper tank to which is adjusted an ordinary "Aquanette" or "Hydronette" hand force-pump, was devised by Dr. Thaxter of this Station, and described in detail in the Station Report for 1890. This machine, as seen in the subjoined cut, is simple, easily made and adjusted, costs but little over \$8.00 complete, and when not in use leaves the force-pump free for any of the numerous uses to which such a pump may be put.



If the area to be sprayed requires but six or eight gallons of the liquid, as e. g. in greenhouse work, or when only a few plants or vines are to be treated, a most serviceable pump for attaching to a pail is the Johnson pump, sold for \$4.50 by Cordley & Hayes, 173-175 Duane St., New York City. If the nozzle sent with this pump is removed and replaced by a piece of $\frac{3}{8}$ -in. hose, 6 or 8 ft. long, provided with a Vermorel nozzle, a most effective and convenient means of spraying on a small scale is procured.

NOZZLES.

It is hardly necessary to say, after so much has been written and said on the subject, that for the proper application of fungicides a rose nozzle or an ordinary sprinkler is not sufficient. Several spraying nozzles have been devised of which only two need be mentioned here, the Nixon and the Vermorel.

In the Nixon nozzle the liquid is driven through a fine gauze cap and issues in a copious, smoky spray. For use with clear liquids it is unsurpassed. With mixtures however, like the Bordeaux mixture which contains lime in suspension, this nozzle is liable to clog and is not readily cleaned.*

The Vermorel nozzle works equally well with clear solutions and with liquids having substances in suspension, it delivers a fine and abundant spray, and is on the whole the most serviceable nozzle for general work with which we are acquainted.

HOSE.

It is often necessary in directing a spray at some distance from the ground, to use a greater length of hose than would ordinarily suffice. The best kind for the purpose, as for any light discharge pipe, is what is known as $\frac{1}{4}$ in. "linen insertion tubing." The hose should be attached to a light pole of sufficient length to reach above the foliage to be sprayed, so that the spray may be directed downwards upon it.

* This nozzle may be procured of the Nixon Nozzle and Machine Co. of Dayton, Ohio, at \$1.00 each.

The following quotations for spraying pumps and accessories are furnished by Messrs. W. & B. Douglas of Middletown, Conn. The quotations are on goods ordered directly from their factories at Middletown, and the prices are *net*:

Double Acting Spraying Pump (similar to Gould's) with all brass piston and brass outer cylinder*.....	\$9.50
——Double Acting Spraying Pump (similar to Gould's) with all brass piston and iron outer cylinder, fitted with leather valves.....	5.00
——The same, fitted with metallic valves.....	6.50
Three feet suction hose for same with couplings and brass strainer.....	2.25
Single couplings for $\frac{1}{4}$ -inch hose.....	.25
Y-couplings " ".....	1.00
"Aquanette" force pump.....	4.00
Vermorel Nozzle (2 caps with coupling for $\frac{1}{4}$ -inch hose or with large standard coupling as desired).....	1.25
The Messrs. Douglas will also be prepared to furnish Prof. Galloway's Knapsack Spraying Pump with planished copper tank and copper cover, for about.....	11.00
Tanks arranged for use with Hydronette or Aquanette as shown in cut on page 18, can be made of unplanished copper with tin cover by any tinman for less than.....	3.00

Quotations for tubing given by the Goodyear Rubber Store, F. C. Tuttle, prop., 866 Chapel St., New Haven.

$\frac{1}{4}$ -inch linen insertion tubing (lots of 100 feet or more) per foot.....	.08
" " " " (lots of 50 feet or more) per foot.....	.10
" " " " (lots of less than 50 feet) per foot.....	.12
$\frac{3}{8}$ -inch heavy rubber tubing, per foot.....	.20

EXPLANATION OF PLATES.

PLATES I and II. Quince Orchard at Milford, Conn., showing comparative result on leafage of one season's treatment with Bordeaux mixture. Season of 1890.

PLATE III. Same Orchard, showing comparative result on fruit crop of two seasons' treatment with Bordeaux mixture. Season of 1891.

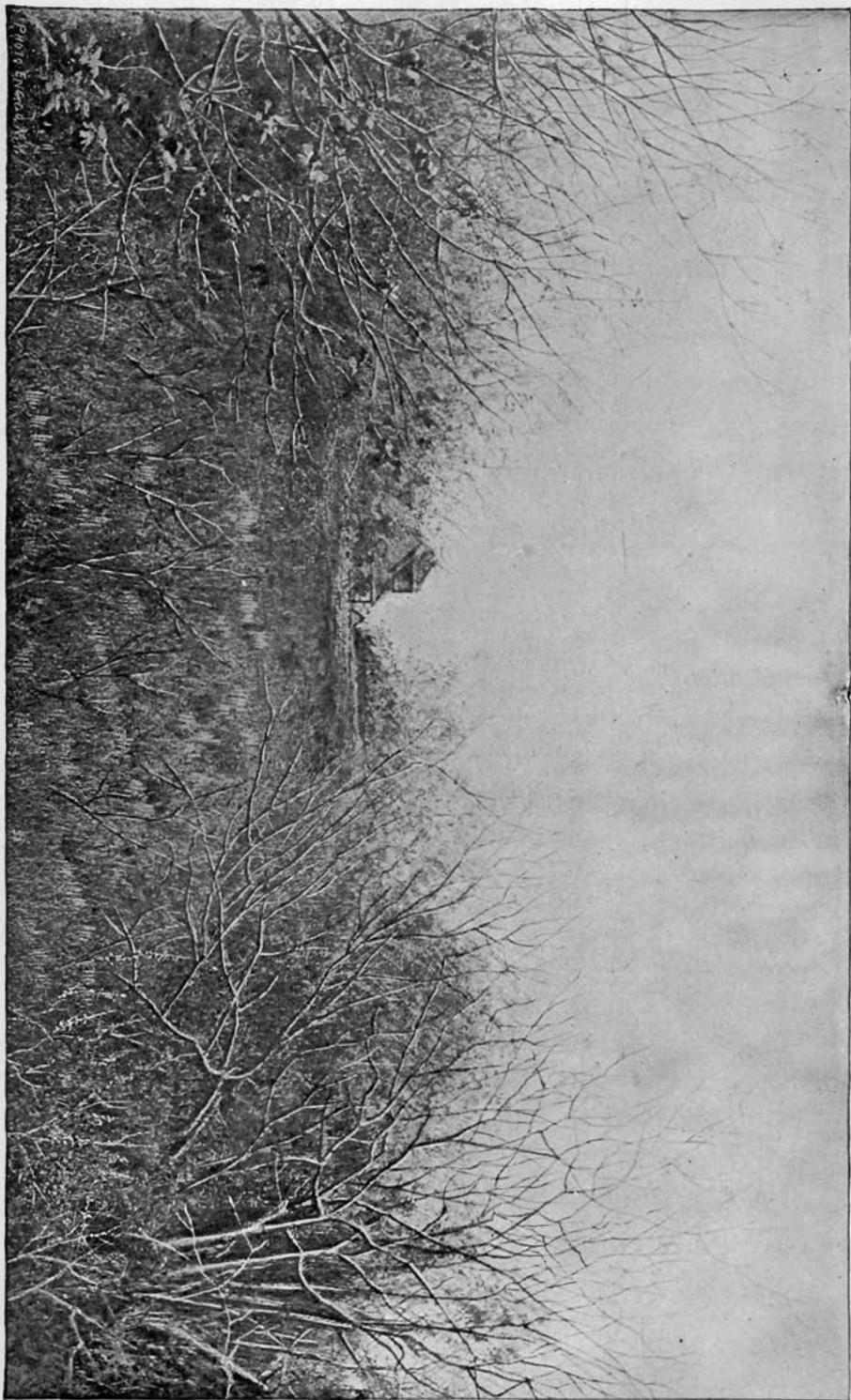
PLATE IV. Double-acting spraying pump in operation.

* For use with the copper compounds it is advisable to have all the parts of the pump, including the outer cylinder, made of brass, as these compounds corrode iron.



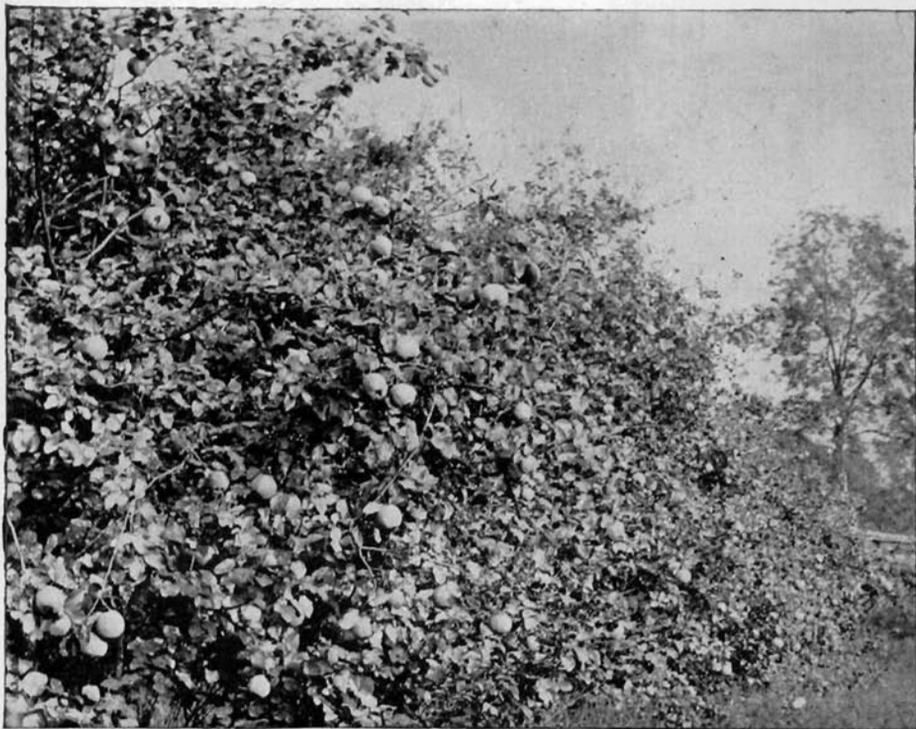
Photo EN 66 X 2

Quince Orchard, showing results of treatment with Bordeaux Mixture for the "leaf spot" (Photo Oct. 31.)

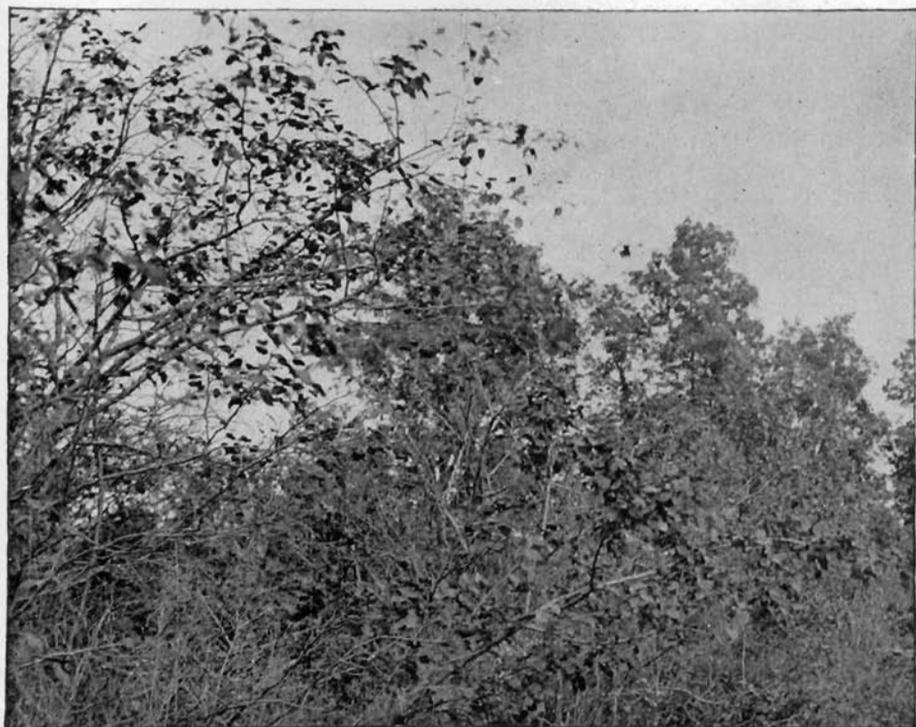


Adjacent rows in same orchard, showing results of no treatment. (Photo Oct. 31.)

Photo Engell



Quince Orchard showing result of Spraying with Bordeaux Mixture, 1891.



Adjacent row showing result of no treatment.

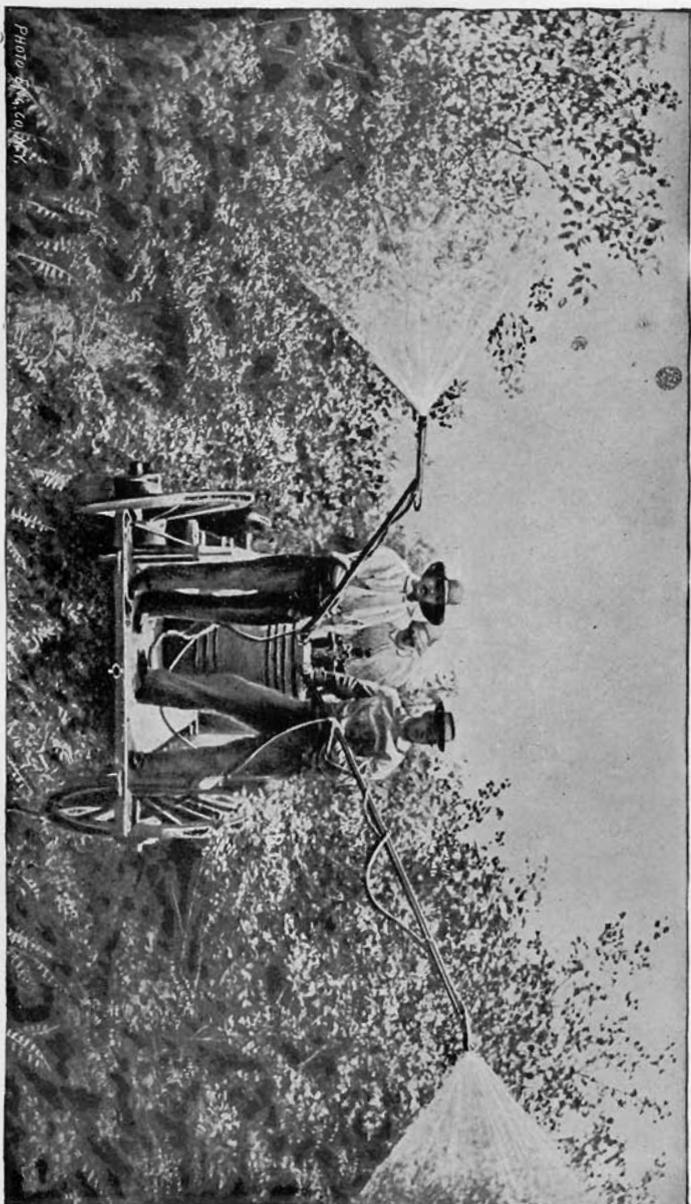


Photo by G. A. Smith

Method of Spraying Orchards with Double Acting Pump and Vermorel Nozzles.