

Oklahoma Agricultural Experiment Station,

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DESTROYING INSECTS AND FUNGUS DISEASES.

INTRODUCTION.

This bulletin is not a report of a single experiment in spraying, but a report on several experiments and a study of the spraying problems as they affect fruit growing in Oklahoma.

When the first orchards came into bearing in Oklahoma there were no diseases or insects on the fruit, but in the last few years all of the most common fruit pests have made their appearance and are now well distributed over the Territory. Among the fungus diseases especially injurious to fruit that are now distributed over Oklahoma may be mentioned apple scab, bitter rot, apple rust, brown rot of the peach and plum, blackberry rust, black rot, and anthracnose of grapes. The most common insect pests that can be held in check by methods of spraying are codlin moth, tent caterpillars, plum curculio, grape leaf hopper, and grape worm. These pests have come so gradually that before the farmers and fruit growers realized their presence they were well established and destroying a large part of the crop each year.

The fungus diseases are now more local in their distribution than

the insects. In many orchards and vineyards these diseases have not appeared in sufficient quantity to do any damage, while in other localities they have destroyed a large proportion of the crops of fruit. The insects first appear in certain localities and then rapidly spread over the entire country. Some insects, like the grape leaf hopper, seem to be especially bad in some localities for a year or two and then nearly disappear. This is probably due to some peculiar influence of the kind of weather. Any or all of these pests are liable to be much worse some years than others, but most of them will be present in sufficient quantity each year to destroy more than one-half of the fruit crop. In the apple orchard on the experiment station farm, about three-fourths of the unsprayed apples have been wormy and a still greater percent of the unsprayed plums and peaches have been wormy. The apple orchard has received good care and has been kept free from weeds and grass, thus reducing to a minimum the hiding places for these insects.

SPRAYING APPLES.

The most destructive pest of the apple crop in Oklahoma is the apple worm or codlin-moth. The apple worm is the larval form of the codlin-moth. The moth lays the eggs on the young fruit as soon as the blossoms have fallen. On the young fruit, a favorite place for the depositing of the eggs is inside the calyx or eye of the apple. Later on the eggs are laid on the side of the apple without any apparent choice of top or bottom end or the shaded or sunny side of the apple as it hangs on the tree.

There seems to be little, if any choice of varieties with this insect but all are attacked alike. The location in the orchard with reference to windbreak, hedge row, or grass plats seems to have no effect so far as liability or immunity from attack is concerned.

A few trees set at some distance from the main orchard usually gain no advantage by being so located but their fruit is usually as wormy as the trees in the main orchard.

There are perhaps three or more broods of this insect in Oklahoma each year. The time between broods, however, is not a distinct period, the appearance of one brood lopping over into that of the one following to such an extent that there are no distinct intervals between. There

are eggs laid and others hatched nearly every week from the middle of April to the first of September. Any method of combating this insect to be successful must continue in operation during the entire breeding season. If the first sprayings are correctly and thoroughly done they will reduce to a very large extent the necessity for continuing the work during the summer. The proximity to other orchards and the care of the other orchards may have some influence, but it is best to assume that the insects will be present during the entire season.

WIND-FALL APPLES.

The wind-fall apples have been a great element in the loss of fruit in Oklahoma. The apples begin to fall soon after the fruit has set and continue throughout the entire season. The falling of the fruit immediately after the flowers are dropped is no doubt due largely to imperfect pollination. All of the apples that fall by reason of this condition are on the ground within about three weeks after the fruit is set. There are many flowers that set fruits which are so located that they cannot mature. These apples fall during the middle of the growing season. A hard wind or storm will cause many of these to fall early in the season, although there is no definite time when the apples begin to fall on this account, or when they stop.

Lack of food supply to the plant and especially to the twigs laden with fruit, causes many apples to fall during the growing period. This may be due to lack of moisture in the soil on account of drouth or weeds and grass on the land, or this lack of food may be due to lack of plant food in the soil. These two causes often combine and cause the apples to fall and are more frequently found working together than separately. However, they are two distinct things but may be partially remedied by the same kind of treatment. The remedy for lack of plant food is to be found in methods of cultivation, manuring the soil and planting wind-breaks. The codlin-moth lays eggs in the blossom end of the fruit soon after flowers have fallen. The worms burrow into the fruits and in many cases so affect their vitality as to cause them to fall. The presence of the worm causes many apples to fall during the first three weeks after their blossoming period, and may frequently be the cause of apples falling that are supposed to be incompletely fertilized. The worms and incomplete pollenization do not usually work together in

the same individual fruits and cause them to fall. The strong and well-formed fruits, although not uniformly the largest, are usually selected by the moth as places on which to deposit the eggs.

The worms in apples that are on weak limbs, or so situated that they are poorly supplied with nourishment, causes the apples to fall early. The worm burrowing in the apples checks the growth of the fruit and causes it to ripen before it has attained normal size. These effects are most noticeable during dry weather, and in trees on poor soil.

The presence of the worms in apples that fall early in the season is of little consequence, because the apples have very little, if any, value. The apples that fall after they are large enough for use and are free from worms can frequently be turned to good account, but the wormy windfall apples are of little commercial value on the market or in the farmer's kitchen. Many such apples are used there, but it is because there is nothing better at hand. The apples that are wormy when matured and gathered as ripe apples are worth but a small part of what the perfect apples will bring on the market. In the average orchard in Oklahoma the larger part of the wormy apples fall before they mature, and in orchards on poor soil, poorly cultivated, or high land, this means the loss of more than half of the apple crop. In the last two years, about three-fourths of the apples on unsprayed trees were wormy. The record of some Missouri Pippin trees shows that approximately two-thirds of the apples on the trees on June 20th were picked up as windfalls before September 4th. Three-fourths of these windfall apples were wormy. Less than one-half of the apples that matured were wormy. This seems to indicate that about one-half of the windfall apples are due to the apple worm. The early apples suffer the least loss of any and the summer apples less than the winter varieties.

SPRAYING TO PREVENT CODLIN MOTH.

Several spraying materials and mixtures have been tested in experiments to control the codlin-moth. The best of these have been found to be the old mixtures that have been in use several years. Bordeaux mixture and Paris green, Paris green and lime, London purple and lime, and arsenate of lead, are effective to the degree of care exercised in preparing the solution and the thoroughness with which they are applied. The Bordeaux mixture and Paris green was prepared in the

following manner: Dissolve 4 pounds of copper sulphate in 2 or 3 gallons of water by placing it in a sack and suspending in the top of a jar or tub of water. Slack four pounds of *fresh* lime by adding slowly just sufficient water to slack it well. Dilute each of these two materials to 20 gallons each, and stir well and strain before mixing. Pour these two solutions together into a tank or barrel and stir vigorously while mixing. Place one-fourth pound of Paris green in a vessel and add a little water and stir it into a dough and then mix it with the Bordeaux mixture. Bordeaux mixture prepared in this way may be diluted to 50 gallons and do good work but this strength is better. The lime used in Bordeaux mixture or any of the other mixtures must be fresh and not air-slacked.

The Bordeaux mixture and Paris green gave as good results as any of the other mixtures used in combating the codlin-moth and it has the advantage of being the best spraying mixture known to prevent fungus diseases. It is cheap, easily applied, and entirely harmless to the tree or to man.

Paris green and lime were used in the proportion of one-fourth pound of Paris green and one pound of lime to a barrel of water. This solution is very good for killing any kind of chewing insects that attack plants. When used against the codlin-moth, it gave very satisfactory results, but was of no practical value in preventing apple scab or bitter rot. The Paris green will burn tender foliage if used without lime, and the lime serves to hold the Paris green on the foliage for a greater length of time.

London purple and lime were used in the proportion of one-fourth pound of London purple and one pound of lime to one barrel of water. This solution gave poor results in spraying to prevent the attacks of the codlin-moth, and it is not as satisfactory as Paris green and lime.

Lead arsenate was prepared by using eleven ounces of lead acetate, dissolved in water, four ounces of arsenate of soda dissolved in water. These materials are dissolved in water in separate vessels and then mixed and diluted with 100 gallons of water. This material has given good results in all cases where it has been used. It is of value only in destroying insects. It is not convenient to prepare or keep and has no special value aside from that possessed by Paris green and lime.

Arsenite of soda was prepared by dissolving one pound of white arsenic and four pounds of salsoda in a gallon of water and boiling for fifteen minutes. One pint of this mixture is used for a barrel of water. This mixture is effective in preventing the codlin-moth, but it burns the foliage and fruit badly. It cannot be recommended for general use.

There are several special insecticide preparations on the market and most of them are good but they do not, as a rule, give any better results than Paris green and lime.

Testing pumps and nozzles have not been taken up, although several different kinds have been used and all the standard kinds have given satisfaction when properly handled. The pump that is nearest the ideal is short and compact in form, strong and capable of throwing a good stream with great force. It should have an air chamber and all working parts should be made of brass. The Bordeaux nozzle is the best for general use. There are several forms of this, but they are all good and will do good work when properly handled.

NUMBER OF SPRAYINGS.

The number of sprayings that should be made varies in different orchards and according to the other care and attention received by the orchard. Spraying every two weeks from the middle of April to the first of August has given the highest percent of perfect fruit, but the most profitable returns for the work done have been produced by spraying four times in the spring. Two sprayings in the early spring have not improved the value of the fruit enough to pay for the work. Spray the trees as soon as the blossoms fall and then repeat the application every two weeks until four sprayings have been made, is the method that has afforded the best protection against the codlin-moth.

The apple diseases are not thick enough in the orchards in Oklahoma to notice any beneficial results from spraying before the blossoms open, but if such diseases spread and increase as fast in the next three years as they have in the last three, it will be necessary to spray before the flowers open to protect the fruit and foliage from these diseases.

DUST SPRAYING.

Dust spraying has been tested but one year and the results are not

decisive although they seem to show little promise for the use of dust spraying mixtures in this climate. The dry air and great amount of wind are the factors which operate against success with dust spraying. The materials used were commercially prepared dry Bordeaux mixture and Paris green and home prepared Bordeaux mixture and Paris green. There was no manifest difference in the preparations. The home made mixture was made as follows: Prepare the solution of copper sulphate and lime the same as for Bordeaux mixture, but do not dilute them before mixing them. After the two solutions have been well mixed, strain through a muslin sack and dry the solid material retained in the sack. After the material is thoroughly dry, which will take about ten days, add one-fourth pound of Paris green and rub through a fine sieve. Mix this with enough finely pulverized air-slacked lime to make a total weight of twenty pounds. This is supposed to equal one barrel of liquid preparation. It will be spread over a much greater area of foliage in the hands of an experienced person. In the spring the dews dry off the trees so early in the morning that but little dust spray can be applied before the foliage is dry. The dust that was sprayed on the trees while the foliage was dry was practically all blown off in twenty-four hours. It is more easily washed off by rain than the dried liquid spray.

EFFECTIVENESS OF SPRAYING.

Paris green and lime has given the best results of any materials used to combat the codlin-moth. Eighty percent of the fruit on trees sprayed with this mixture was free from worms. Seventy-nine percent of the fruit on trees sprayed with Bordeaux mixture and Paris green was free from worms. These results are practically the same as those obtained by spraying with Paris green and lime. Fifty-four percent of the fruit on trees sprayed with London purple was free from worms. Sixty-two percent of the apples on trees sprayed with lead arsenate was free from worms. London purple proved practically worthless as used in the spraying tests. It has, however, in some cases, given very good satisfaction.

The test of arsenite of soda was discontinued on account of the injury done to the foliage.

Dust spraying with dry Bordeaux mixture and Paris green gave forty-four percent perfect fruit.

The percents given above were obtained by gathering all the wind-fall fruit from June 23d to the time the fruit was ripe and also all the ripe fruit gathered from the tree and counting the total number of apples and the number wormy.

The tent caterpillar, bag worm and cigar-case-bearer have at different times appeared on a few trees in the orchard. In such cases the trees were sprayed with Paris green and lime and in every case the spraying has been effectual. Hand picking of the bag worm is sometimes resorted to and is the only sure way of destroying all the insects. but the same can be said of all other insects, and careful spraying is just as effective in destroying the bag worm as any of the other common leaf-eating insects.

APPLE SCAB.

Apple scab is generally considered the worst fungus disease that fruit growers have to combat. The Early Harvest, High Top Sweet, Fameuse and Fall Pippin are especially subject to the disease, and the Ben Davis and a few other varieties seem to be especially exempt from it. But under favorable conditions this disease will destroy the value of a crop of any variety. Apple scab attacks the fruit and foliage of both the apple and pear. Upon the fruit it forms dark brown or dark gray circular spots with a light gray border. These spots are from one-eighth to one-half inch in diameter and frequently entirely cover one side of the fruit with a solid scab. The fruit frequently cracks through the center of the large scabs and shows the dark brown tissue beneath. The disease shows about the same characteristics on the leaves as on the fruit. The badly infected leaves fall and in many cases the trees are stripped of their foliage in midsummer. This disease is fitful in its attacks. It may be very bad one year and then not appear to a noticeable extent for three or four years. This disease can be prevented by spraying the trees with Bordeaux.

BITTER ROT.

Bitter rot attacks the fruit and branches of the trees, but no one has ever reported finding it on the foliage. It first appears in the form

of little brown circular spots on the fruit. These spots appear at all times during the growing season and may enlarge until the entire fruit is covered. They retain a circular form and a definite outline until merged into each other. The affected areas soon become sunken or depressed but not soft. The skin assumes a leathery appearance and all but the central portion of the affected areas looks as if it had been polished. The central portion is rough and broken by small black pimples which are the fruiting portion of the disease. These pimples are situated in irregular concentric circles. The diseased fruits turn brown and shrivel to a hard mummy-like mass of pulp. Many of these "mummies" hang on the trees all winter and are in an ideal position to spread the disease the next spring. This disease appears on the limbs in a form commonly called canker. The limbs one-half to one inch in diameter are most commonly affected but the twigs and large limbs are frequently attacked. The bark of the diseased portion is dead, thick and scab-like in appearance. The limb in its efforts to heal over the injured part becomes enlarged at that point. These infected limbs can be recognized in the winter and unless removed, will be a source of infection to the fruit.

This disease can be controlled by spraying with Bordeaux mixture. It has spread very rapidly in Oklahoma during the last two years.

APPLE RUST.

This disease is peculiar in that it requires two host plants, the apple and red cedar, to complete its round of growth each year. It grows upon the leaves and fruit of the apple in the summer. Its presence is first indicated by a bright-yellow spot on the leaves which spreads until about one-half inch in diameter. The spores are produced on the under side of the leaf. The disease on the fruit is shown by characteristic spots as on the leaves, only darker in color. The diseased portion of the apple enlarges very rapidly and soon ruins the fruit. The spores that are produced on the apples and apple tree leaves find lodgment on cedar trees and during the fall and winter produce hard, round, woody knots on the branches from one-half to three inches in diameter, called cedar apples. In the spring these cedar apples produce long, yellow, horn-shaped tubes which bear the spores of the disease. These spores find lodgment on the apple trees and

again produce the apple rust. The best way to combat the disease is to destroy the cedar apples in the spring before they produce their spores. This requires the destruction of all the cedar apples in the neighborhood of the orchard. Spraying with Bordeaux mixture will do much toward preventing the disease, but it does not remove the source of infection.

PLUM CURCULIO.

Spraying to prevent the damage done by plum curculio has not been successful. "Plum Sting" is the work of an insect commonly known as plum curculio. The small round holes cut in the skin of the plum are the feeding holes of this insect. The hole in the skin is cut and the flesh of the plum is eaten out in all directions as far as the insect can reach. The female cuts a hole in the skin and eats a small hole in the flesh and then deposits the egg in this hole and then cuts and eats a small crescent-shaped line around this hole containing the egg. These insects work on cherries, peaches, apricots and apples also, but do most damage on the plums and peaches. The egg hatches in a few days and produces the worm commonly called the plum or peach worm. These insects do not seem to be easily killed by eating poisons and their habit of feeding makes them doubly hard to combat. Spraying may reduce the amount of injury done fifteen or twenty percent, but methods of disposing of the fallen wormy fruit, and cultivating the land can be used to a greater advantage.

The curculios can be caught by spreading a sheet or canvas under the trees and then striking the tree with a padded club. The sudden jar of the blows causes the beetles to let go of the tree and drop to the ground where they will lie for several minutes before moving. They can then be gathered from the sheet and burned or destroyed in some convenient way. This work was carried out quite successfully on a few trees but is too slow to be practical for a large orchard. This work must be done early in the morning while it is cool and be continued every morning for two or three weeks to be successful.

BROWN ROT OR FRUIT ROT OF PLUMS AND PEACHES.

This disease attacks the plum, peach and cherry. The first appearance of the disease on the fruit is about the time of ripening. The affected fruit turns brown and becomes soft. It is then soon covered

with an ash-colored dust, which is the spores of the disease. The fruit falls to the ground, a soft rotten mass, or dries and hangs on the twigs all the following winter. The disease spreads very rapidly in warm, damp weather. The best method of combating this disease is to carefully gather and destroy all diseased fruits. Spraying with Bordeaux mixture is also effective. There is little reason to anticipate much loss to the peach and plum crop from this disease on account of the dry summer weather.

SHOT HOLE FUNGUS; LEAF BLIGHT OF THE PLUM.

This disease appears on the plum and cherry in early summer. Small purple spots about one-eighth of an inch in diameter appear on the leaves. These spots soon change to a brown color and then the tissue dries and the colored spot falls out. This gives the leaf the appearance of having been pierced with small shot. If the disease is very bad the leaves turn yellow and fall.

LEAF RUST OF THE PLUM.

This disease works only on the Wildgoose and other varieties of that class. It appears in July and August. The underside of the leaves is covered with what appears to be a rust and what is simply the spores and fruiting portion of the fungus. The leaves fall before the summer's growth is complete and mature and the tree is weakened by this process.

PEACH LEAF CURL.

This disease affects the leaf of the peach and often causes all the foliage to fall. When attacked by this disease the leaves show very bright colors of red, yellow and light green. Parts of the leaf look as if blistered and are enlarged and swollen. The diseased leaves all fall and the trees are often left bare. The fruit is retarded in growth and often falls.

APRICOT SCAB.

This disease may appear at any time during the growing season, on the fruit when the fruit is about half grown. The spot spreads but the fruit ceases to grow immediately under the affected spots. These

spots spread and several unite and often cover the entire fruit. The affected fruit is worthless and often hangs on the trees all summer.

PEAR BLIGHT.

This disease works on the tree and kills the wood. The bark on the affected part turns black, withers and dies. The disease usually starts near the end of a twig on the young growth and spreads very fast, running down the limb and then to all parts of the tree. Spraying has no effect on the disease and the only way to check its work is to cut off the affected parts and burn them.

ANTHRACNOSE OR BIRD'S EYE ROT OF THE GRAPE.

This disease is scattered over a large portion of the territory and is doing a great deal of damage. It is one of the worst of plant diseases, as it attacks the fruit and all green portions of the plant and is very difficult to handle. Most of the methods of treatment prove unsatisfactory. The first appearance of this trouble should be vigorously met and all possible care taken to prevent its spread.

This disease may appear at any time during the growing season. It commonly appears on the shoots soon after growth starts in the spring. Its presence on the shoots is first indicated by the darkening and sinking of the bark in small oval or oblong spots extending lengthwise of the shoots. If the disease is abundant the shoots soon have a speckled appearance. These spots usually enlarge, the greater portion remaining black with a more or less distinct line of purple around the edge. After a time the center turns gray and forms a scab; this is the fruiting portion of the disease. Limbs badly affected are severely checked in growth or killed. The leaves are attacked and on the stem and vines show the same marks as on the shoots but on the blade of the leaf the spots turn brown. The stems of the clusters are also attacked, and where the spots girdle a stem the fruit below the girdle does not ripen but remains **green and withers**.

The disease usually appears on the berries when they are about half grown. The diseased portion is brown with the characteristic red or purple margin and round in outline. The discolored part is sunken and later turns to a lighter or gray color, which is caused by the fruiting

portion of the fungus rupturing the skin and forming a scab. Some varieties are more susceptible to the disease than others. Among those most susceptible to its attacks are Goethe, Agawam, Vergennes and Diamond.

Treatment should begin early, before the buds open in the spring. The following solution is very good to apply as a wash before the growth starts in the spring:

Iron Sulfate (Copperas) 70 pounds.

Sulfuric Acid, 1 pint.

Warm water, 16 gallons.

The acid should be poured over the crystals of iron sulfate and then the water added. This if well applied will kill all of the spores that have lodged in the vines over winter. When this solution is used the vines turn black and any part of the vine that has not turned black, within a day or two after the first application should be washed again. Bordeaux mixture is of value in holding the disease in check on the growing vines.

BLACK ROT; OR CHARBON.

The fruit when affected with this disease turns to a deep black, color, hence the name. The fungus causing the disease attacks all parts of the plant. On the stem it causes black, oval, sunken spots which soon show a few dark pimples in the center. These pimples are the fruiting portion of the disease and make this disease easy to distinguish from others. The affected portions of the leaves turn to a dark reddish brown color and are usually near the large veins but are not centered upon them as in the Anthracnose.

This disease seldom attacks the fruit till it is full grown. If the fruit is green the affected portion turns to a purplish brown, and this color soon spreads over the entire berry. Minute black pimples appear scattered over the surface and finally the berry withers, turns black and ultimately dries up, but, as a rule, remains firmly attached to the stem.

These little pimples soon break through the skin and throw off the

spores of the disease. It requires from two to three weeks after infection for the disease to complete its growth. The rapidity of growth and spread of the rot depends much upon the condition of the weather. A warm moist atmosphere is very favorable to the development of the disease.

Much can be done to prevent the disease by training the vines on a good trellis to admit as much air and light to the fruit as possible. Although the disease does not appear till late in the season the preventive measures should be in operation before there are any signs of the attack. Spraying the vines with Bordeaux mixture or ammoniacal solution of copper carbonate is perhaps the best remedy known.

BROWN ROT; GRAY ROT; DOWNY MILDEW.

This fungus attacks the leaves, young wood, flowers and fruit. It is first distinguished on the leaves by greenish-yellow spots on the upper surface while the corresponding under surface is covered with a white frost-like growth. As the growth progresses the mildew disappears, leaving the leaf dead and brown. The young wood and flowers present much the same appearance when attacked. This disease seems to develop in two forms on the fruit. One form is called brown rot, the other gray rot. The brown rot does not make its appearance till the fruit is nearly grown. At this time small brown spots appear and soon cover the entire berry. The berry becomes very soft and falls from the stem at the slightest touch or jar. The skin remains unbroken till the berry falls. In the gray rot the berries are covered with the same kind of growth that appears on the leaves and stems.

This disease is most abundant on wet land and on vines that are on the ground or a very low trellis. If the vines are on a good trellis and so trained as to give the air a chance to pass freely through or under the vines but little trouble need be had. The Bordeaux mixture is a sure preventive for this disease.

RATTLES OR DROPPING.

What is known as rattle, or dropping of the grape has caused considerable loss in some vineyards. The trouble is not due to any definite disease or insect but to the combined effect of drouth, disease and insects,

in which drouth is the most prominent factor. Preventive measures should be directed toward improving the health and vigor of the vines. It will usually be beneficial to fertilize the land and improve the method of cultivation.

THE GRAPE LEAF HOPPER.

This insect has done a great deal of damage to some vineyards in Oklahoma, and it has proven to be one of the most difficult insect pests to handle that has yet appeared in fruit plantations in this country. It lives by sucking the juice from the plants and usually works on the underside of the leaves. Spraying with poison is of no use, as the insects can be killed only by materials that kill by contact. When they first appear in the spring many can be caught on sticky shields. The young "hoppers" can be killed by spraying with whale oil soap (one pound to ten gallons of water), a tobacco decoction or kerosene emulsion. The work must be thorough, as only the insects hit by the spray will be killed. The spray should reach the underside of all the leaves and must be thrown with considerable force to do the most good.

BLACKBERRY LEAF RUST.

This disease works on the leaves and shoots of the blackberry. The disease can be recognized when it appears on the under sides of the leaves. The leaf looks as if it had been blistered by the hot sun. The skin on the under side of the leaf breaks and soon the entire lower surface of the leaf is covered with an orange colored dust which is the mass of spores of the fungus which causes the disease. The mycelium or root of the disease passes down inside of the canes and lives in the roots of the plant all winter and begins growth the next year. Spraying will do much toward preventing the spread of the disease. But the diseased plants must be destroyed before the patch can be entirely rid of the disease.

SPRAYING MIXTURES.

The following fungicides and insecticides are the ones in most common use and are giving the most general satisfaction.

BORDEAUX MIXTURE.

Copper sulfate (blue vitriol)	4 lbs.
Fresh lime	4 lbs.
Water	50 gals.

Dissolve 4 pounds of copper sulfate in 2 or 3 gallons of water by placing the sulfate in a sack and suspending in the top of a jar or tub of water. Do not put this in tin or iron vessels as it will rapidly dissolve them. Before mixing dilute this to about 20 gallons. Slack 4 pounds of fresh lime by adding a small amount of water and after slacking is finished add about 20 gallons of water. Stir the lime and water thoroughly and strain before mixing. Pour these two solutions into the barrel or tank at the same time and stir vigorously while mixing. This may be diluted to 50 gallons.

AMMONIACAL SOLUTION OF COPPER CARBONATE.

Copper Carbonate	6 ounces.
Ammonia	about 3 pints.
Water	50 gallons.

Dissolve the copper carbonate in the ammonia and add the water.

Use no more ammonia than is required to dissolve the copper carbonate. Ammonia is variable in strength, and the amount required must be tested in practice.

To make the copper carbonate: Dissolve 10 pounds of copper sulfate (blue vitriol) in 10 gallons of water, also 12 pounds of carbonate of soda in same quantity of water. When cool, mix the two solutions slowly, stirring well. Allow the mixture to stand 12 hours and settle, after which pour off the liquid. Add the same quantity of water as before, stir and allow to stand for the same length of time. Repeat the operation again, after which drain and dry the blue powder, which is copper carbonate.

POTASSIUM SULFID.

Potassium Sulfid (liver of sulfur)	3 ounces.
Water	10 gallons.

This solution is good for the gooseberry and other powdery mildews, for which it seems even more effectual than the Bordeaux mixture, although its effects are less lasting. It does not discolor the fruit and is quite harmless.

The ammoniacal solution of copper carbonate and potassium sulphid are better to use on ornamental plants and vines as they do not color the foliage and do almost as well in other respects as the Bordeaux mixture.

PARIS GREEN.

Paris green1 pound.
Water100-200 gallons.

For the destruction of insects that eat the foliage or fruit, Paris green is a valuable remedy. It can be used in water in the above proportions, the stronger mixture being used for potatoes, while for fruits it is seldom advisable to use more than one pound in 200 gallons of water, unless in connection with lime water or Bordeaux mixture. It is always advisable to first form a paste with a small amount of water before preparing it for spraying. For low plants Paris green may be used in a powder form, either alone or with one hundred times its weight of plaster. London purple is sometimes used in place of Paris green but is more apt to injure the foliage.

KEROSENE EMULSION.

Dissolve one-half pound hard soap in one gallon of water (preferably soft water) and while still hot, remove from the fire and add two gallons of kerosene. When soft soap is used, take equal quantities of soap and oil and omit the water before mixing. Stir the mixture violently by driving it through a force pump back into the vessel, until it becomes a creamy mass that will not separate. This requires usually from five to ten minutes. The emulsion is then ready to be diluted with water and applied. For the common scale insects and hard bodied insects, like the chinch bug, use 1 part emulsion to 8 or 10 parts water. For soft bodied insects (plant lice, etc.) use one part emulsion to 15 or 20 parts water.

Kerosene emulsion kills by contact and therefore the application should be very thorough. It may be used against a great many dif-

ferent pests, but is especially valuable for destroying those with sucking mouth-parts, for they cannot be killed with arsenical poisons.

HELLEBORE.

Fresh White Hellebore 1 ounce.
Water5 gallons.

Hellebore is often employed in cases where arsenical poisons would be objectionable. For insects that chew, and especially for the currant and cabbage worms.

PYRETHRUM OR BÜHACH.

Pure fresh Pyrethrum1 ounce.
Water5 gallons.

Valuable against both chewing and sucking insects, especially upon maturing fruits or vegetables, and upon flowering plants. It can also be applied in a powder form with a bellows.

These fungicides and insecticides, if properly prepared and applied, have no effect upon the plants. If the mixtures are not correctly prepared and applied they do not form the desired protection to the plants and may damage the foliage and fruit. There is never enough poison on the well sprayed fruits and plants to alter their value for food. Most fruits are pared before eating and all sediment of the spraying material removed. In the case of fruits that are not pared before eating, as grapes, a person would have to eat from 350 to 500 pounds to get a small dose of poison. It will always injure the sale of such fruits, however, if there are any signs of a spraying material on them when placed on the market.

The spraying must be well done if it is to be of any value. Slipshod work will never pay. It is just so much time and material used and still the plants are not protected. The liquid must be applied in the form of a very fine mist or spray. If the liquid is thrown on the plants in large drops it collects and runs off, but if thrown on in a fine mist the foliage and fruit can be wet on all sides and but little liquid reach the ground. The liquid must be applied from every direction so that all parts of the foliage and young shoots will be wet. If the top of the tree is very dense the nozzle should be held in the center and

the spray thrown in every direction. The work can not be done in a hard wind. The side of the plant next to the wind will be washed and the opposite side will show little signs of the spray. The greater the power applied to the pump the better the form of spray thrown by the nozzle.

Spraying is a preventive and not a remedy. There are a few fungus diseases that can be destroyed by spraying but they can also be prevented by the same operation. The damage done by a disease or insect can be repaired only by the plant itself, and such work as can be done to protect it from further damage is about all that can be done for it. The spraying should be done early and the protection made complete before the diseases and insects appear. The first spraying should be done in the orchard, vineyard, and berry patches just before the growth starts in the spring. The second application should be made ten days or two weeks after the first and the third about two weeks after the second. If the orchard or vines are badly infested a fourth application should be made about two weeks after the third. If an application is followed immediately by a hard rain the application should be repeated as soon as possible. If this plan is followed and the work well done with properly prepared mixtures there will seldom be any need of further attention in this direction during the season. The solutions used in these sprayings should be a combined fungicide and insecticide, preferably Bordeaux mixture and Paris green. If the above directions are followed they will meet the requirements for preventing about ninety percent of the common fungus diseases and insect pests. There have been a great many spraying calendars published giving long lists of diseases and insects with specific directions for preventing each one. A careful examination of these calendars shows that a large majority of the treatments recommended are covered by the directions given above.

SPRAYING PAYS.

Spraying improves the growth and vigor of the trees and plants by protecting them from the attacks of insects and fungus diseases.

Spraying improves the quality of the fruit by preventing the attack of fungus diseases and insects.

Spraying increases the yield of mature fruit by preventing wind-falls.

O. M. MORRIS,
Horticulturist.

