THE CONTROL OF SAN JOSE SCALE
AND THE
PROFITABLE REJUVENATION OF NEGLECTED ORCHARDS
BY SPRAYING

by

Thomas Jesse Talbert, B. S. in Agr.

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*Approved
R. H. Henshaw*

The San Jose Scale.

(*Aspidiotus perniciosus*, Comst.)

The San Jose scale is the most serious insect pest of the Missouri orchards.

It is capable of killing young fruit trees in two or three years and old trees become unprofitable and succumb to the attack in a few years if unsprayed.

It has been widely spread over almost every county in the State.

The scale is a dangerous pest on account of its rapid multiplication and inconspicuous spread which enables it to entirely cover the bark, leaves and fruit of the tree within a few years.

It seriously infests nearly all kinds of fruit trees and many ornamental plants. No other insect pest has received more attention or has had more written or said about it than the San Jose scale.

History and Occurence of San Jose Scale.

The native home of the pest has been located in Northern China, and for this reason it has been called the Chinese scale. It is thought that Mr. Lick of San Jose, California, first imported the scale in the early seventies from China on the flowering Chinese peach. The pest soon became very generally distributed over the fruit growing section of the San Jose valley and

in a few years. it was established in practically all of the states west of the Rocky Mountains.

The scale derived its common name from the San Jose Valley, California, because it was in this valley that it first became injurious to fruit trees in the United States. About 1886 or 1887 it was introduced into New Jersey nurseries upon Japanese plum stock shipped from the San Jose valley. In 1893 it was found in Virginia and was supposed to have been brought in on stock from New Jersey. Before the danger and habits of the insect became known it had been shipped on dormant nursery stock to all parts of the United States. As early as 1894 it had become established in thirteen of the eastern states from New York to Florida, and it was also found at this time in many of the central states.

Occurrences of the San Jose Scale in Missouri.

The San Jose scale was introduced into Missouri from eastern nurseries between 1890 and 1895. It was first found in the following counties: St. Louis, Cape Girardeau, Jackson, Cole, Webster, Carroll and Randolph. From these original infestations it spread rapidly to adjoining orchards. Some Missouri nurseries became infested and the scale was spread on infested nursery stock from these nurseries and from the infested nurseries of other states to the orchards of almost every county in Missouri.

No Compulsory Inspection Of Nurseries until 1913.

With the original infestations confined to a few private orchards and with the nurseries of the state apparently free from scale, its control and the prevention of its further spread would have been a comparatively simple matter, had the states taken immediate action. Many of the states whose horticultural interests were much smaller than those of Missouri passed strict nursery and orchard inspection laws and gave their fruit growers the best protection that could be obtained. Missouri, whose horticultural interests ranked third, left her fruit growers to the ravages of the scale, and the nurserymen of other states turned to Missouri as the dumping ground for their scale infested stock.

Fortunately for the fruit growers and horticultural interests of the State, the Legislature passed an act in 1913 for the protection of the agricultural and horticultural interest of the State of Missouri. This nursery and orchard inspection law provided fully for the prevention of the further introduction of San Jose scale and other dangerous and injurious insects and plant diseases. The new law having been framed and drafted from the best parts of all the nursery and orchard inspection laws of other states is considered the wisest and most efficient law of any of the states of the Union. It has demonstrated its efficiency since its passage and with adequate appropriations from the State Legislature and the support of the fruit growers and nurserymen, it is

all the State could ask for in the protection of its horticultural and agricultural interests, important as they are.

Appearance of San Jose Scale.

The bark of the tree badly infested looks as if it had been dusted with ashes. This ashy looking substance can be scraped off with the blade of a knife or ones' thumb nail. On doing so there is left a yellowish smear on the bark caused by the crushing of the bodies of the insects beneath the scales. Growers sometimes mistake the normal roughness of the bark for the scale. As a matter of fact the scale occurs just as often on smooth bark which is young and growing rapidly as on rough places where the bark is dead or in a dying condition. Various fungi may produce spots on the bark that resemble those produced by the scales. Sometimes farmers mistake the lenticels or breathing pores of plants for scales. The lenticels, which are entirely natural to the tree, are especially conspicuous on pear branches. In this case they are occasionally regarded as scales by purchasers of nursery stock and the nurseryman thus gets a criticism that he does not deserve. By careful examination with a lens the difference can be easily told.

Each San Jose scale on living bark causes a reddish discoloration immediately surrounding it. This reddish or purplish area is several times the diameter of the scale, which thus

Fig. 1 - San Jose Scale. Infested apple branches on left and right. In the center, a non-infested apple branch.

appears as a tiny black or grayish speck about the size of the head of a small pin. By carefully inspecting these reddish spots with their accompanying scales it is not difficult to find scattered infestations on smooth, healthy bark of most kinds of fruit trees. This is especially true where the pest is just getting a start on the tree. This discoloration is more noticeable on the apple and pear than it is on the peach and plum. The fruit shows infestation even more clearly than the trees, the spots appearing as bright reddish blotches. The scales are very noticeable on the leaves and tender twigs on account of the red spots or discolorations. The prominent nipple or crater-like formation found about the center of the scale in both the males and females must not be overlooked as a means of identification.

Other Scale Insects Resemble San Jose Scale.

Other scale insects may cause the characteristic red spots or blotches to appear on the tender twigs, fruit and leaves. The discolorations may be much like those produced by the San Jose scale. This is especially true of Forbes' scale, Putnam's scale and scurfy scale. Forbes' scale is present in almost all of the old orchards of the state. These scale insects are occasionally numerous enough to cause a few apples to be blotched at harvest time but generally they are not severe enough to warrant special treatment.

Fig. 2 - San Jose Scale on an Ingram apple which
was purchased in a Columbia grocery store, on
March 30, 1917.

Forbes' scale and Putnam's scale are easily mistaken for San Jose scale. These species differ markedly from San Jose scale, however, in that the nipple is usually to one side of the center and orange or yellow in color, and the scales are not so black and the depressed ring and nipple are not well developed. Scurfy scale is lighter in color, larger and more oblong in shape, and should be easily distinguished from the other scales.

Habits and Life History of San Jose Scale.

The insect passes the winter in a dormant condition under its scale attached to the bark of the trees. The fully mature and very young scales die during the late fall or early winter, leaving only the half to three-fourths grown insects to pass the winter. The scales that pass the winter alive are less in size than the head of a small pin. They are blackish in color and have a distinct crater-like top. In early spring when the sap of the trees begins to flow, the growth of the insect is resumed. The males emerge from the old scales in a few weeks as small, active, two winged gnat-like insects, while the females continue to suck sap from the trees and remain beneath the armor or scale. After mating with the females, the males die. The females continue to grow and begin to produce young alive at the rate of eight or ten a day. They may continue to produce young at this rate for a period of from four to six weeks. This causes an overlapping of the gener-

ations or broods because the young begin to produce at least a week or ten days before their mothers die. The adult females may produce from 100 to 400 young during their life. The overlapping of the generations makes it difficult to trace the broods. In Missouri, however, it has been definitely proven that there are at least four full generations. The small yellow larvae which have just been born may be seen on badly infested plants any time during last spring, summer, fall and in some seasons until after the middle of December. In 1913, the tiny crawling young were observed in St. Louis County on December 21. From this it can be seen that the insect multiplies very rapidly and it has been estimated that the progeny of a single female, if none were destroyed, would amount to millions in a single season. It is this remarkable power of reproduction to which the great injury of this pest is due.

After crawling about for a few hours, the young settle down and begin to suck sap through their long whiplash-like sucking beaks which they thrust into the bark. In a few hours, they begin to secrete an armor or covering for their bodies. At first the covering is white in color but as the white cottony and waxy fibers, which they secrete from their bodies, begin to mat down, the scale-like covering becomes darker in color.

In two or three weeks the covering turns black and later it takes on an ash-gray appearance. At the first molt, the

males and females lose their legs and antennae and the females lose their eyes. After two more molts the males develop into delicate, two-winged orange colored insects. The females after the second molt, mate with the males and remain under the old scales as flat, circular yellow louse-like insects.

How San Jose Scale Spreads.

Since the young crawling lice are sometimes active for a day before settling down on the bark, they may during this crawling period crawl from one tree to another where the branches touch or interlace. Strong winds may blow the crawling young to other trees near by. The young may crawl upon the feet and bodies of birds and other insects and be carried to neighboring trees. The chance for the scale to be spread by horses or cattle in the orchard or by persons walking through the orchard is very slight. There is a possible spread of the scale from infested fruit but this is so small that it may be almost entirely ignored. The greatest local spread is no doubt accomplished by the wind, birds and insects.

The spread of the scale from county to county and from one state to another has been accomplished mainly by the sale of scaly nursery stock. Before rigid nursery and orchard inspection laws were passed, scale infested nursery stock was spread broadcast over the states and most of the severe infestations in every neighborhood may be traced to such a source. Practically all of

the nurseries are inspected annually now and there is very little danger of getting infested nursery stock from any of them.

Nature and Extent of Injury.

The San Jose scale may be found on all parts of the fruit tree, including the fruit, leaves, branches and trunk. The tree is injured by depriving the growing tissues of sap or plant food. The scale insect also secretes a toxic or poisonous substance which it injects into the growing tissues. This poisonous substance causes the reddish discoloration under the bark and the red spots or blotches on the tender twigs and fruit. Where the trees are badly infested the scales may crowd together in such a way as to present a roughened scurfy deposit on the bark. If the bark is scraped, it appears greasy and slick upon crushing the soft bodied insects beneath the scales. The scales may also cluster around the blossom and stem ends of the fruit.

If the conditions are favorable for the development of the scales, the injury is fatal to most fruit trees. Young orchards are generally killed in two or three seasons. Old orchards may live longer but they usually become unprofitable or worthless in from four to five years.

Food Plants

San Jose scale may be found feeding upon a great number of plants but the greatest injury, which it does, is confined to

our common fruit trees. The following trees are injured most in the order named: Peach, pear, Japanese plum, apple and quince.

Nearly all of the varieties of apples may be badly infested by the scale but there is a great difference in the susceptibility of the different varieties. The Ben Davis, Grimes Golden, Yellow Transparent and Huntsman being very susceptible to injury, while such varieties as Winesap, Jonathan, Delicious and Staymen in the same orchard will usually show much less injury.

The Kieffer pear is almost immune but the Duchess and Bartlett are badly infested. The blue Damson plum is more liable to severe infestation than any of the other varieties of plums. The varieties of sweet cherries are susceptible to severe infestations but the sour cherries are practically immune. Currant bushes usually become heavily infested if scale is present. The scale may also infest many varieties of rose bushes, the Japan quince, and the mountain ash. The Japan quince or burning bush, however, is one of the most common plants liable to severe infestation. The Osage orange hedges near orchards may become badly infested and act as breeding ground for the scale. Grape vines are not usually attacked by San Jose scale but when grown under or near badly infested trees they may become infested.

There are many common shade trees and ornamental plants that are so seldom infested that they have been called accidental

host plants. To this class belong the maple, elm, honey locust, cottonwood, poplar, lilac, flowering almond, willow and snowball.

The following list of host plants was prepared by Dean for the State of Kansas and includes those trees and scrubs most commonly grown in Missouri:

(1) Trees and shrubs that are badly infested: Peach, pear, currant, plum (Wild Goose excepted), mountain ash, osage orange, apple, crabapple, rose (some species), quince, japonica (Japanese quince), sweet cherry, spirea, and Juneberry (Amelanchier).

(2) Trees and shrubs that may be badly infested but are very seldom so infested: Elm (young trees), maple (young trees), hawthorne (Crataegus), willow, cottonwood, poplar, lilac, flowering almond, grape, and snowball (Viburnum).

(3) Trees and shrubs that are occasionally infested but not injured: Ash (white, green, and black), bittersweet, blackberry, box elder, catalpa, elderberry, elm, gooseberry, raspberry, maple, rose, walnut, and honeysuckle (Lonicera fragrantissima).

(4) Fruit trees that are practically immune, but upon which a few scales have been found upon a few occasions: Kieffer pear, sour cherry, and wild goose plum.

(5) Trees and shrubs that have never been infested in the United States: Tree of heaven (Ailanthus), arbor vitae, bald cypress (Taxodium), Boston ivy (Ampelopsis), butternut, white walnut, sycamore, cedar, hazelnut (Corylus), fir (Abies), hickory,

honeysuckle (most species), ironwood (*Ostrya*), hydrangea (all species), redbud (*Cercis*), juniper, Kentucky coffee tree, (*Gymnocladus*), maidenhair tree (*Ginkgo*), syringa (mock orange), (*Philadelphus* sp.), oak (all species), pawpaw, pine (all species), prickly ash (*Xanthoxylum*), California privet (*Ligustrum*), spruce (*Picea*), trumpet creeper (*Tecoma radicans*), trumpet vine (*Bignonia*), and tulip tree.

(6) Plants accidentally infested when growing under badly infested trees: Horse ragweed, smartweed, blades of corn, and rhubarb.

Natural Enemies.

The San Jose scale is attacked by numerous insect enemies but on account of its remarkable power of reproduction it is usually able to develop in injurious numbers in spite of them. It is therefore clear that the control of the scale must be accomplished by artificial means, such as the use of the correct, thorough and timely sprays.

Almost a dozen ladybird beetles have been found feeding upon San Jose scale. The so-called pitiful ladybird beetle is perhaps the most useful in destroying the scale. These beetles and their grubs eat the scale insects.

There are very small wasp-like insects that do much good by killing San Jose scale. These tiny four winged flies

place their eggs beneath the scales. The grubs which hatch from eggs kill the scales by eating their bodies. After becoming fully developed they escape through small holes made through the scales.

Numerous attempts have been made in the Gulf State to control the scale by the use of fungous diseases. Since the effectiveness of the fungous disease depends upon certain weather conditions, the results vary greatly. The work was fairly successful in Florida and Georgia but when the disease was introduced into the central states and the areas of less moisture it lost its destructive powers on account of a lack of moisture.

Prevention of San Jose Scale.

In purchasing trees or shrubs for the orchard or home grounds, one should be sure that he is buying from a reliable nursery, and above all, that the nursery stock has been inspected by an authorized inspector. That the nursery has been inspected and is apparently free from San Jose scale and other dangerous insect pests and plant diseases is usually indicated by the inspection tag or certificate which should accompany each shipment. Of course, it often happens that even inspected stock may not be entirely free from the scale and other pests but in nearly all cases it is free from dangerous insects and plant disease. The inspection certificate is therefore one of the safest guides of the farmer or fruit grower who is not acquainted with injurious insects and plant diseases.

How to Control the Scale in an Infested Orchard.

San Jose scale, the most serious insect trouble, and peach-leaf curl, an important fungous disease of the peach, must both be controlled by dormant spraying. A spray strong enough to kill the old scale during the summer or growing season may also kill the leaves, destroy the fruit and perhaps do great damage to the trees. It has been found by experience that the only way to control the peach-leaf curl is to spray a few weeks before the blooming time to prevent the germination of the spores of the fungus which cause the peach leaves to thicken, turn reddish in color, wrinkle up and drop in a few weeks.

The lime-sulphur spray will not only control the above trouble but it is also effective against the oyster shell scale, Forbes' scale, and the scurfy scales which are distributed widely over the state on various kinds of fruit trees. The pear psylla, the branch of the wooly aphid, the bud moth, the pear leaf blister mite, eggs of the aphides, the apple scab, and possibly other insects and diseases may be at least partially controlled by dormant or semi-dormant sprays, which should be made if possible just as the trees start growth.

Direction for Use of Spray.

The spray for San Jose scale may be applied at any time after the dropping of the leaves in the fall and before the

cluster buds open in the spring. The later the application can be made in the spring, the better the results, as a rule. The best time for the scale spray is just as the buds begin to swell and show green leaves in March or April. To control the scale it may be necessary to make this application every year. This is true, because we can hardly spray thoroughly enough to hit every scale. The scales which are missed multiply so very rapidly the following season, that spraying is necessary almost every spring. If this scale spray is applied often enough, just as good fruit may be had and just as healthy trees produced as if the scale were not present. Once the scale is under control, however, the spray may be skipped occasionally, but a watchful eye should be kept to see how rapidly it is developing. Sprays should be applied often enough to prevent the spotting of the fruit.

Prune Before Spraying.

The orchard should be intelligently pruned before spraying. This will reduce the surface to be covered by the wash and will rid the trees of perhaps their worst affected limbs. The limbs and brush removed in pruning should be burned. To obtain the best results in spraying, it is usually advisable to begin at the top branches and spray down, doing one side of the tree at a time. It is always wise to take advantage of the wind and

Fig. 3 - An orchard demonstration in Madison County, showing an apple tree before pruning. Pruning facilitates spraying.

Fig. 4 - An orchard demonstration in Madison County,
showing a neglected apple tree being pruned for the
first time.

December 12, 1916.

when it is too strong to do good work, the operations should stop. Spraying should not be attempted when it is raining, or when the temperature is down to freezing.

The Best Spray to Use.

It has been fully demonstrated that lime-sulphur is generally the best wash or spray to use in the control of San Jose scale. The lime-sulphur spray, in addition to killing the scale, is a powerful fungicide. A concentrated solution testing 33° Baume should be used at no greater dilution than one gallon of the strong mixture to seven or eight gallons of water. If good results are to be obtained the work must be thoroughly done. The trunk, large limbs, branches and twigs of the trees must be covered with the strong spray. Every scale must be hit if it is to be destroyed. Great care should be taken in order to cover the ends of the branches and the fruit spurs with the insecticide. If this is not well done there may be some spotting of the fruit, although nearly all of the scales were killed on the trunk and larger branches of the trees.

Number of Sprays Necessary.

Where orchards have been neglected and have become badly infested by the scale, it is usually advisable to spray the infested trees thoroughly soon after the leaves drop in the fall.

Fig. 5 - Demonstrating the best method of pruning and shaping a young apple tree. If young trees are pruned properly for the first few years after planting, they will be much more profitable when they come into bearing.

This will relieve the trees of the severity of the infestation and prevent the pest from feeding and devitalizing the orchard until the middle of December or even later. A second spray is usually made in the spring just as growth starts. This is always necessary where the work was not done thoroughly in the fall. Once the scale is under control, one dormant application is sufficient.

Sprayed and Unsprayed Orchards.

Some fruit growers try to excuse themselves for not spraying against San Jose scale because their neighbors do not spray. They maintain that it would be a useless expense and loss of time to spray an orchard to control scale unless all of the other orchards in that immediate neighborhood were sprayed, because the scale would be carried by the winds, birds and other insects from the unsprayed orchards to the sprayed orchards.

While it is true that the scale and other injurious insects and plant diseases may be brought in from adjoining orchards, yet the fruit grower who sprays his own orchard thoroughly and timely and makes use of the proper mixture will be able to control San Jose scale and other injurious pests and produce good marketable fruit at a splendid profit. If all of the farmers sprayed and made a cooperative effort to control the pest, the fight would not be so difficult and many advantages in fruit

growing might be obtained. Individual farmers can control it, therefore, in any community no matter how great the infestation of the scale may be in other orchards.

Omit the Dormant Spray Unless San Jose Scale Is Present

Many fruit growers in Missouri have been applying a dormant spray every winter or fall in orchards which are not infested with San Jose scale. The dormant spray is not profitable in orchards free from San Jose scale. This spray, if properly made, does the orchard no injury but the benefits to be derived from it do not justify the expense of labor and material unless the trees are infested with the San Jose scale.

Every fruit grower should inspect his trees carefully during the fall and winter to see if the San Jose scale is present. If the scale is found and the trees are badly infested, they should be sprayed thoroughly during the early winter and again the next spring just as growth starts, if the spraying in the fall was not well done. Where the trees are not badly infested, one spraying is usually all that is necessary and the best time for the application is in the spring.

Trees Stay Dormant Longer by Lime Sulphur Spray.

In the course of the work in the experimental and demonstration orchards with commercial lime-sulphur, it was ob-

Fig. 6 - The effect of the San Jose scale spray when applied in the fall or winter. It keeps the fruit buds dormant longer. The apple twigs on the left were unsprayed, while those on the right were sprayed in February, 1917, with commercial lime-sulphur 1 to 7. The photograph was taken on April 7, 1917.

served in 1914 and again in 1916 that the apple trees which received the scale spray in the winter or early spring remained dormant longer than unsprayed trees. The treated trees came into full bloom from two to four days later than unsprayed trees. Where the apple trees remained white by the application of the dormant spray in the fall or early winter, they too came into bloom a few days later.

Soluble Oils Versus Lime Sulphur.

The soluble or miscible oils, which have been treated in such a way as to cause them to mix freely with water, have the following advantages as a spray against San Jose scale: (1) They are easier and more pleasant to apply, doing no injury to the hands or spraying machinery; (2) They have greater spreading and penetrating powers and are particularly adapted to old scaly-barked apple trees; (3) The scales on the ends of the pubescent or "Fuzzy" twigs are easier reached with the oil, especially when the work is not thorough; and (4) Gallon per gallon, the oil will cover more surface than the lime sulphur.

The advantages of the commercial or home-made lime sulphur are as follows: (1) It has been definitely proven that the lime sulphur will control the scale equally as well as the soluble oil if the work is done thoroughly; (2) In addition to killing the scale it is a powerful fungicide, especially if used

late in the spring just after growth has started; (3) The cost of the spray material is less although it does take a little more of the liquid to cover a tree thoroughly; and (4) The lime sulphur is much less apt to do damage to the trees, particularly on the stone fruits such as peaches, cherries and plums. Since the peach leaf curl disease must be controlled by a dormant spray, it is certainly always advisable to use the lime sulphur on peaches when scale is to be combatted. The oil also does greater damage to the rubber hose than the lime sulphur.

How to Make the Lime Sulphur.

There are about as many different formulae for preparing the lime sulphur as there are Experiment Stations, but the important point to remember is to use enough lime and sulphur to thoroughly combine with each other and produce a sufficiently concentrated wash to destroy the scale. The old formula 15-15-50 has apparently given just as good results as where the lime and sulphur were increased to 30 or 40 pounds for 50 gallons of wash. If extra lime is added all of the sulphur combines with it and when the wash dries it shows up much plainer on the trees. As a result, skipped patches on the limbs and twigs will be much more noticeable. The following formula has been successfully used with good results:

Lime (burnt or stone lime)		25 lbs.
Sulphur (flowers or flour)		15 lbs.
Water		50 gal.

Slake the lime in about five gallons of hot water; add the sulphur that has passed through a screen, boil, stirring frequently, for forty minutes to one hour; strain mixture into spray barrel or tank and dilute all to make 50 gallons. While boiling add water from time to time to keep the solution thin enough to boil readily. This mixture should be used at once, preferably while still warm. Some growers find it difficult to prepare the mixture and use it immediately and for this reason object to it.

The above solution may be boiled by fire or steam, depending on the amount to be made. The average farmer will find that kettles, holding from 20 to 25 gallons are very effective. An ordinary 75 to 100-gallon food cooker composed of a kettle with jacket and fire box is perhaps the most convenient and economical outfit for small and medium sized orchards.

There are various brands of commercial lime sulphur which vary as to the amount of lime and sulphur which they contain. By the use of an orchard hydrometer the density of any particular brand can be determined. Most of the commercial brands should test from 30° to 35° on the Baume scale. A concentrated solution can be made from the following formula, testing from 26° to 30° Baume, which is almost exactly like the commercial brands so far as composition and effectiveness when used is concerned:

Lime (burnt or stone lime) . . . 40 lbs.
Sulphur (flowers or flour) . . . 80 lbs.
Water 50 gal.

Slake the lime in a small quantity of water, make a paste of the sulphur and add it to the slaking lime in the barrel, kettle or vat. Boil for about one hour. After the boiling is completed the lime sulphur can be diluted and used at once or stored in tight barrels for future use. The concentrated lime-sulphur wash should be used to control the scale at the strength given in the following table of dilutions:

Lime sulphur tests 35° Baume, dilute each gallon with 8 gal. water

"	"	"	34°	"	"	"	"	7½	"	"
"	"	"	33°	"	"	"	"	7	"	"
"	"	"	32°	"	"	"	"	6½	"	"
"	"	"	31°	"	"	"	"	6	"	"
"	"	"	30°	"	"	"	"	5½	"	"
"	"	"	29°	"	"	"	"	5¼	"	"
"	"	"	28°	"	"	"	"	4	"	"
"	"	"	27°	"	"	"	"	3¾	"	"
"	"	"	26°	"	"	"	"	3½	"	"
"	"	"	25°	"	"	"	"	3¼	"	"

An orchard hydrometer, an instrument for measuring the strength or density of liquids, may be obtained from almost any dealer who handles spray chemicals. It may also be procured from druggists or lens companies. Where the grower makes his

lime sulphur he should not be without the hydrometer. It is not safe to guess at the strength of spray chemicals.

Making and Buying Commercial Lime Sulphur.

Where the fruit grower or orchardist is not prepared to make the lime sulphur and has only a comparatively small amount to use, he will usually get much better results in his orchard and find the work a great deal more agreeable by buying the commercial product. Some of the larger orchardists claim that they can buy the commercial lime-sulphur at prices so low that they cannot afford to make it at home. There is close competition in the sale of this product and the profits made are small. The fruit grower will, therefore, usually find it to his advantage to buy the chemical rather than make it, particularly if he has other work to do. It is also a fact that the commercial product is more uniform in density and generally gives better results in the hands of the fruit growers than does the home-made product.

Summer Sprayings Necessary

The dormant spray should be followed by the usual summer sprays, if the trees are to be protected from the ravages of other injurious insects and plant diseases. It is absolutely impossible to obtain good marketable fruit without the later

summer sprayings. The following Spray Calendar gives in brief the schedule to follow for Apples and Pears and for Peaches, Cherries and Plums:

Spray Calendar for Apples and Pears.

What to spray for	When to spray	What to use
1. San Jose scale Aphids	Any time after leaves drop in the fall and before growth starts in the spring. Most effective just before buds swell.	Commercial lime-sulphur (1 to 7) or miscible oil (1 to 12). Unnecessary to spray at this time unless scale is present.
2. Apple Scab Curculio Apple Rust Spring Canker Worm	When cluster buds are separated but before the blossoms open.	Lime-sulphur ($1\frac{1}{2}$ to 50) plus 2 to 4 lbs. of arsenate of lead paste.
3. Codling Moth Apple Scab Curculio Spring Canker Worm Lesser Apple Worm	Start when bloom is two-thirds off and finish before the blossom ends close.	Lime-sulphur ($1\frac{1}{2}$ to 50) plus 2 lbs. of arsenate of lead paste or 1 lb. of the dry form.
4. Apple Blotch Curculio Codling Moth Lesser Apple Worm Leaf Eating Insects	Apply within three weeks after bloom falls. If curculio injury is severe, apply within six to ten days.	Lime-sulphur ($1\frac{1}{2}$ to 50) plus 2 lbs. of arsenate of lead paste. If apple blotch is severe use Bordeaux mixture (3-4-50) instead of lime sulphur.

5. Apple Blotch Curculio Codling Moth Lesser Apple Worm Leaf Eating Insects	Apply 5 or 6 weeks after the bloom falls, or if No. 4 is made within 6 to 10 days, make No. 5 from 2 - 3 weeks later.	Lime-sulphur ($1\frac{1}{2}$ to 50) plus 2 lbs. of arsenate of lead paste. If apple blotch is severe, use Bor- deaux mixture (3-4-50) instead of lime-sulphur.
6. Codling Moth Lesser Apple Worm Apple Blotch Bitter Rot Sooty Blotch Curculio Leaf Eating Insects	Apply about 3 - 4 weeks after No. 5 or 8 - 10 weeks after bloom falls.	Lime-sulphur ($1\frac{1}{2}$ to 50) plus 2 lbs. of arsenate of lead paste. If apple blotch or bitter rot is serious, use Bor- deaux mixture (4-4-50) instead of lime-sulphur.

Not all of the above sprayings are likely to be needed. A study of the insects and diseases common in the orchard will help the grower arrange a schedule adapted to his particular needs. The sprayings ordinarily needed are 2, 3, 4, and 6. In localities where bitter rot needs attention later sprayings at intervals of 2 or 3 weeks may be necessary. The early sprayings recommended for apples also apply to pears.

General Spray Calendar for Peaches, Cherries and Plums.

What to spray for	When to spray	What to use
1. Leaf Curl San Jose Scale	Apply shortly before growth begins.	Commercial lime- sulphur (1-7). If scale is not pres- ent, use Bordeaux mixture (4-4-50), or lime-sulphur (2-50).
2. Curculio Leaf Eating- Insects Peach Scab Cherry Leaf- Spot	Apply after bloom- ing and when most of the shucks are off the fruit.	Arsenate of lead paste $1\frac{1}{2}$ lbs. or dry form $\frac{3}{4}$ lb. in self-boiled lime- sulphur (8-8-50) or in 50 gal. of water to which is added milk of lime from 2 or 3 lbs. of stone lime.
3. Curculio Leaf Eating- Insects Brown Rot on Plums Peach Scab Cherry Leaf- Spot	Apply 6 - 10 days after shucks are off the fruit.	Self-boiled lime- sulphur (8-8-50) plus $1\frac{1}{4}$ lbs. of arsenate of lead paste or $\frac{3}{4}$ lb. of the dry form.
4. Curculio Leaf Eating- Insects Brown Rot Peach Scab Cherry Leaf- Spot	Apply 2 - 3 weeks after No. 3 or at least 3 weeks before fruit ripens.	Self-boiled lime- sulphur (8-8-50) plus $1\frac{1}{2}$ lbs. of arsenate of lead paste or $\frac{3}{4}$ lb. of the dry form.

Under ordinary seasonal conditions, sprayings No. 2
and 3 will afford sufficient protection.

During wet seasons, Elberta and later varieties of peaches may need later applications of self-boiled lime-sulphur (8-8-50), but in no instance should any variety of stone fruit be sprayed with this mixture later than three weeks before picking.

Good stone lime (not air-slaked)	. . 8 lbs.
Flowers of sulphur	 8 lbs.
Water	 50 gal.

Place lime in a barrel or vat. Add a bucket of water to start slaking. When slaking is well started, add another bucket or so of water, then add the sulphur. Keep sulphur and lime well stirred to prevent caking. Add water as needed to keep the mixture from drying or burning. When slaking ceases, add water to make up to 50 gallons. Strain into spray barrel.

Cost of Spraying.

The cost of spraying will depend upon the size of the trees and the thoroughness of the work. In using the commercial lime-sulphur for the past four years in orchard demonstration work, the cost for trees averaging from 12 to 15 years of age, was from 5 to 7 cents per tree for the San Jose scale spray. This did not include the cost of labor. When the lives of the fruit trees are at stake as they are when infested with San Jose scale, the orchardist should not hesitate to spray when the cost is so small.

The spraying mixture for the summer application will generally cost about one cent per gallon. The expense of materials for spraying a single tree one time would, therefore, depend upon the number of gallons used. Average sized apple trees, from 12 to 15 years old, will require from 5 to 7 gallons of the spraying liquid to cover them thoroughly. At this rate, the expense would be from 5 to 7 cents per tree for materials for one application. The cost of labor, in most cases, will amount to a little more than the cost of materials. Figuring the cost of labor the same as the cost of the chemicals, would bring the expense of spraying one tree, one time, up to 10 to 14 cents. Four such summer sprayings would amount to 40 to 56 cents per tree. Where the dormant spraying is necessary for the control of San Jose scale, the expense would be increased to about 45 or 65 cents per tree. Where the spraying materials can be purchased in large quantities this cost can be reduced one-third or more.

Spraying Equipment

A bucket pump sprayer or a knapsack sprayer may be used successfully for spraying small trees or shrubs. The barrel pump sprayer is usually as small an outfit as the farmer should purchase. By placing the barrel in the wagon and spray-

Fig. 7 - A spraying demonstration to control San Jose scale
in the Sandfort Orchard, St. Charles County, April 15, 1916.
A barrel-pump sprayer is being used.

ing from the wagon, the tallest tree can usually be well covered by the use of an 8 or 10-foot extension rod. Just as good work can be done with the barrel pump sprayer as can be done with the gasoline power outfit. With the barrel sprayer, however, the work is harder, more time is required, and an extra effort should be made to spray thoroughly.

For orchards of ten acres or more, the hand-tank pump or gasoline outfits should be used. In the larger orchards, tank fillers and supply tanks are often used effectively to save time in spraying.

Discharge hose of a good grade should always be purchased. The hose should be long enough to allow the operator to work entirely around trees of average size without moving the pump. At least 25 or 30 feet of hose should be procured and in some cases longer leads will be needed. The extension rod should be from 8 to 10 feet long. The bamboo rod lined with brass or aluminum is light and very convenient to handle, but a quarter-inch gas pipe from 8 to 10 feet long makes a serviceable extension rod and is much less expensive. The bamboo rods retail at a price ranging from \$2.00 to \$3.00, while the gas pipe costs about 50 cents.

Several types of nozzles may be used with good results, but, in general, the large-chambered angle disc type gives the best results. Almost all of the spray machine com-

These manufacturers the large angle like type of nozzle. The angle of nozzle is very important and the fruit grower should not hesitate to buy the best type in order to make his work the most effective. After each spraying, the pump, hose, tank and nozzle should be cleaned by running clear water through them.

Fig. 8 - Filling the spray tanks of two power sprayers from a pond and mixing the spraying chemicals. The Chas. Winfrey Orchard at De Witt.

panies manufacture the large angle disc type of nozzle. A good nozzle is very important and the fruit grower should not hesitate to buy the best type in order to make his work the most effective. After each spraying, the pump, tank, hose and nozzle should be cleaned by running clear water through them.

Summer Sprays as a Factor in San Jose Control.

In the course of orchard demonstration work for the control of San Jose scale the writer has often had his attention called to the possible effect of summer spraying on the control of San Jose scale. A splendid opportunity has been afforded to observe the effect of summer applications because orchards of all degrees of infestations have been under experiment and observation. In many cases the owners of orchards neglected to apply the dormant spray thoroughly for the control of the scale, but the summer applications were made. The number of these summer sprayings in orchards infested by San Jose scale ranged from 1 to 4.

Some Previous References on the Control of San Jose Scale by Summer Spraying

The fact that the summer sprays do have a killing effect upon the scale and help to control the pest has long been recognized, especially when an extra effort is made to heavily coat the trunk, large limbs, branches and twigs.

Fulton, Wright, Gregg, (1912, p 17) says, "Experiments at this Station (Pennsylvania) during the summer of 1910, show that it is possible to control this pest by spraying with diluted lime-sulphur applied frequently. Three applications, at a density of 1.01, applied immediately after the young began to emerge and at intervals of 10 days thereafter, completely controlled a bad infestation on the apple."

Quaintance (1915, p 21) writes, "The use of lime sulphur wash as a fungicide will constitute sufficient spraying for the scale, provided attention is given in spraying to coat, in addition to the leaves and fruit necessary in fungicidal work, also the limbs, branches and twigs."

These data were obtained in experimental work in 1911 at Fennville, Michigan.

Orchard Observations on the Control of San Jose

Scale by Summer Spraying.

1914 and 1916

Orchard	Treatments	Severity of Infestation	No. of Trees	Results
E. Greenwade Willard	L.S. $1\frac{1}{2}$ to 50 Sprayed April 4: May 5, May 25, July 2.	Slight Infestation	100	:Many apples :blotched :badly by :scale. :About 50 : per cent
P. Jaeger Boonville	L.S. $1\frac{1}{2}$ to 50 Sprayed April 4: May 8, June 2.	Severe Infestation	50	:Many apples :blotched :badly by :scale. :About 60 :per cent
J. Sanfort St. Charles	L.S. $1\frac{1}{2}$ to 50 Sprayed May 4, May 18.	Severe to slight Infestations	108	:Many apples :blotched :badly by :scale. :About 40- :50 percent
A. Thoma Allenville	L.S. $1\frac{1}{2}$ to 50 Sprayed April 14, May 1, May 16.	Severe to slight Infestations	175	:Many ap- :ples :blotched :badly by :scale. :About 40 :per cent.

All treatments had two pounds of arsenate of lead to each 50 gallons of spray.

In all the orchards listed above the spraying was done with poor equipment and this no doubt accounts for much of the fruit being blotched by the scale. The dormant or San Jose scale spray was applied in each orchard a short time before growth started.

In the above orchards the scale was not well controlled with the dormant spray, and in addition to this, two to four summer sprayings failed to check it enough to prevent the spotting of the fruit. The owners of the orchards also made an effort to coat the limbs, branches and twigs with the spray, as well as the fruit and leaves.

The orchard demonstration work has shown conclusively that many of the crawling young are killed by the summer sprays where the work is well done and where a special effort is made to cover the limbs, branches and twigs with the spray. It is wise and advisable to urge the fruit grower, in orchards where scale is present, to take special pains to wet the bark of the trunk, large limbs and branches of the trees during each summer application, especially if the dormant spray has not been thoroughly made or in orchards where it was left out entirely. In cases of severe infestations, however, the summer sprays cannot in any way take the place of the scale spray for controlling San Jose scale. Where the pest is badly infesting an orchard the scale spray is absolutely necessary to keep the insect pest

under control. Then, by the addition of the summer sprayings, good marketable fruit may be obtained the first year. After the scale is well under control the spray against the pest may possibly be omitted for one or two years. When the scale spray is omitted, however, an extra effort should be made to control the pest by the summer applications.

Spraying Experiments and Demonstrations for Rejuvenating Neglected Orchards and Controlling San Jose Scale.

During the years 1913 and 1914, the Departments of Horticulture and Entomology cooperated in carrying out extensive spraying experiments and demonstrations for rejuvenating old neglected orchards and for the control of San Jose scale, and other insect pests and diseases of fruit. The work was stopped on September 1, 1914, on account of the author accepting a position with the Kansas State Agricultural College, but it was continued again in the fall of 1915, when he accepted the position of Extension Entomologist in the Missouri Agricultural Extension Service.

The object of the work was not planned for making a comparative study of the value of the different sprays, but rather to show the proper methods of spraying to control San Jose scale; to compare the results of fall, winter and spring

spraying; to determine the possibility of controlling the scale and other pests in badly infested orchards; to determine the feasibility of combining the scale spray and the cluster-bud spray; and to determine the value of following the scale spray with timely and thorough summer sprays to rejuvenate the fruit trees, and put the orchard on a profitable basis.

In 1913 and 1914 the spraying work was done in six different orchards - two at Willard, one at Sikeston, one at Jackson, one at Boonville and one at Hannibal. Three Geniton and two Ben Davis apple trees, on the Station grounds, were also included in the experiment.

Spraying Results for San Jose Scale Control During the
Seasons of 1913 and 1914.

Orchard	No. of tree	Age of tree	Spray and Strength	Time Sprayed	No. of Sprays	Cost of: Labor and Ma- terial per tree	Re- sults
J. L. Tanner,	6	18	L.S.(1-8)	In fall	1	18½¢	Good
Sikeston	6	18	Scalecide: (1-12)	In fall	1	38¢	Good
E. Green- wade, Willard	70	25	L.S.(1-8)	In Spg. leaves out	1	18¢	Good
Dr. Hen- derson, Jackson	75	18	L.S.(1-8)	In fall	1	12¢	Good
P. R. Jaeger,	25	19	L.S.(1-8)	Fall & Spg.	2	35¢	Good
Boonville:	6	19	Scalecide: (1-12)	Fall & Spg.	2	50¢	Good
J. Dam- eron Hannibal	6	15	L.S.(1-7)	In spg. leaves out	1	8¢	Excel- lent
G. K. Murray Willard	50	15	L. S. (1-10)	In spg. leaves out	1	13¢	Excel- lent
Station Plot, Columbia	3	18	L.S.(1-7)	In spg. leaves out	1	10¢	Excel- lent

Under the column "results", the word good indicates the scale was controlled but there was a slight spotting of the fruit. The word "excellent" indicates an almost entire absence of live scales and practically no spotting of the fruit. L.S. under "spray used" means commercial lime sulphur.

Practically all of the common varieties of apples, such as Ben Davis, Gano, Grimes, Winesap, Jonathan, etc., were sprayed in each of the above orchards. No perceptible difference was noticed in the effect of the spray on the different varieties.

Brief Description of Orchards Treated, Effect
of Sprays, and Results of San Jose Scale
Sprays and Summer Sprays.

From Missouri Agricultural Experiment Station Bulletin No. 124, entitled, "Profits from Spraying Twenty-five Missouri Orchards", page 190:-

"Mr. T. J. Talbert, Assistant in Entomology and Deputy Nursery Inspector had full charge of the dormant spraying against San Jose scale (which will be reported in full by the Department of Entomology) and also conducted many of the demonstrations in connection with the spring and summer spraying which was under the direction of the Department of Horticulture".

The notes and data submitted in regard to the summer sprays and harvesting results are taken from Bulletin No. 124.

The tables under column labeled "Value of Fruit per Acre", in most cases does not include the cost of making the dormant spray for San Jose scale control.

The author had charge of practically all of the summer spraying work and the collecting of data on the orchards from which data was taken.

Dameron Orchard - The trees were about fifteen years old but had never been sprayed. All of the trees were infested with San Jose scale but some much worse than others, and a few trees had been killed by the pest. In the experiment 36 trees were used, 30 of which were sprayed in March with commercial lime sulphur diluted 1 to 7. The remaining six trees were sprayed at the time for the cluster bud spray, with the lime-sulphur, diluted 1 to 8.

Results - Excellent results were obtained in the control of the scale. It was only on the poorly sprayed trees that the fruit could be found blotched by the pest.

The strong lime-sulphur spray (1 to 7) did not injure the buds or the leaves permanently. The tips and margins of the leaves were slightly burned and the leaves and the buds appeared to be scorched a little for a few days. After 10 days or two weeks, no injury could be observed. Apple scab was controlled equally as well where the strong spray was applied as

where the summer spray was used. The orchard consisted of Jonathan and Ben Davis. The trees were sprayed as follows:

April 22 with lime-sulphur, 3-100
May 11 with lime-sulphur, 3-100 plus 6 lbs.
arsenate of lead.

All trees except six received an application of lime-sulphur of a strength of 1 to 7 on March 28 for the purpose of controlling the San Jose scale which was present. The first notes were taken July 2. The results of the summer sprayings are given below. No notes are available showing results on the Jonathan variety. It should be remembered that this orchard was sprayed only twice and that two applications rarely afford adequate protection against insects and diseases which are likely to be prevalent the latter part of May and June.

The fruit was harvested in October and the fruit on representative trees counted. The results are given in Table 7.

This data shows that this orchard should have been sprayed a third time. The failure to make the third application accounts for the large percentage of insect injury shown on the sprayed trees.

The cost of spraying for the two applications per tree was as follows: Materials, 11 cents; labor, 14 cents; total, 25 cents, or \$15.00 per acre. This represents a profit due to spraying amounting to \$60.10 per acre. It should be added that had a third application been made there would have

been a much higher percentage of No. 1 fruit. While much of the No. 2 fruit was salable, it was of a low grade and hence not nearly so valuable as the better grade."

Table 6 - Results of Spraying in Dameron Orchard

Up To July 2, 1914.

Variety	Treatment	Percentage insect, disease and spray injury						
		Worms	Cur-	Scab	Rust	Rots	Spray In-	Percentage
		lio	cu-				jury	of sound,
							(Russet-	unblemished
							ing)	fruit
Ben	Sprayed	2.5	2.5	0	0	0	0	94.8
Davis	Check							
	Un-	17.5	72.1	1.7	0	0		10.0
	sprayed							

Table 7 - Harvesting Data in Dameron Orchard, Near Hannibal

Variety	Treatment	Percentage insect, disease and spray injury						
		Worms	Cur-	Scab	Rots	Cedar	Spray	Marketable
		lio	cu-			Rust	In-	fruit per
							jury	tree
								fruit
								per
								acre
Ben	Sprayed	18.5	34.4	0	3.7	0	0	1 $\frac{3}{4}$ bu. No. 1:
								3 $\frac{1}{2}$ bu. No. 2:
								1 $\frac{3}{4}$ bu. culls:
Davis	Check							
	Un-	39.1	21.7	0	20.0	0	...	1 $\frac{1}{4}$ bu. No. 2:
	sprayed							4 $\frac{3}{4}$ bu. culls:

Greenwade Orchard - This orchard was not badly infested by the scale but all of the trees showed a scattered infestation. The twigs and fruit spurs were rather badly infested. The trees were sprayed with lime-sulphur (1-8) during the spring of 1914. The application was applied after the leaves were out and as large as squirrel ears, but before the cluster buds had separated. The spraying was done with a power outfit. The cluster-bud spray was omitted on the experimental plot.

Results - No material injury was done to buds or leaves as a result of the application of the strong spray. The later summer sprayings were applied at the usual strength and very good fruit was harvested. Many of the apples were slightly blotched by the scale but this was due to inefficient work at spraying time, and to the use of an old and very much worn spraying outfit, which furnished very poor pressure. The following summer applications were given:

April 4, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.
May 5, with lime sulphur 5-100, plus 6 lbs arsenate of lead.
May 25, with lime sulphur 2-100, plus 5 lbs. arsenate of lead.
July 2, one-half with Bordeaux mixture 8-8-100, plus 5 lbs. arsenate of lead, one-half with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

The owner sprayed the orchard the first time, this being the important application for controlling the scab. The fourth application with both the Bordeaux and the lime-sulphur were also given by the owner of the orchard. No summer notes were taken. The apples from several representative trees that were sprayed and unsprayed were harvested in October and counted. The results are given in Table 10.

The striking feature of the results is the high percentage of scab on the sprayed fruit. Evidently the first application, the one that chiefly protects against scab, was not thoroughly made. Insects were controlled within reasonable limits. Just why the insect injury should be greater on the sprayed than on the unsprayed trees, is not clear. The fourth spraying seems to have afforded nearly complete protection against the blossom end rot. The cost of spraying per tree was as follows: Materials, 20.5 cents; labor, 10.9 cents; total, 31 cents, or \$18.84 per acre. Profits due to spraying were \$104.66 per acre.

Table 10 - Harvesting Data in Greenwade Orchard at Willard

		: Percentage insect, disease and spray injury							
Variety	Treatment	Worms	Curculio	Scab	Rot	Cedar Rust	Spray injury	Market-able fruit per tree	Value of fruit per acre

Ben	Sprayed	4.0	3.1	45.7	1.4	0	0	1 1/2 bu. No. 1	\$130.40
								3 1/2 " " 2	

Davis	Check								
	Un-sprayed	1.1	1.9	77.0	15.8	0	..	1 bu. No. 2	\$6.90
								1/2 " culls	

Jaeger Orchard - The orchard had been badly neglected. The bark of the trees was infested with the scales and a few trees had been killed by the pest. Very little pruning had been done and the orchard had never been sprayed.

Twelve trees were sprayed with commercial lime-sulphur (1-8) in December, 1913. The same trees were sprayed again the following spring, just before the blooming time. The cluster buds had separated and many of the buds showed pink. The commercial lime-sulphur was used again at the strength of 1 to 8.

Results - The young tender leaves were slightly burned on the tips and the opening buds took on a brownish color for

a few days after spraying. No material injury was done to the developing buds and the treated trees yielded as much fruit at harvest time as the trees that were subjected to the usual treatment. The control of the scale was very good, although there was some spotting of the fruit.

Six trees in the same orchard were sprayed with miscible oil (1 to 12). The applications were made at the same time the sulphur applications were made.

Results - The scale was controlled equally as well as where the lime sulphur was used. There was but very little spotting of the fruit by the scale and it was difficult to find a live scale on the sprayed trees during the early summer.

The buds and leaves showed some severe injury as the result of the strong spring application. Much more injury was done by the oil than by the lime-sulphur. Many of the small tender leaves were killed and a few buds in many of the clusters were destroyed. At harvest time, however, the trees fruited as heavily on the average as the other trees and there was no sign of injury made by the oil.

The trees were sprayed three times during the summer with a very poor hand pump and outfit. It was impossible to do thorough work with the outfit used and no doubt the lack of thorough work accounts for some of the apples at harvest time showing quite a few scale blotches. The summer sprayings were made as follows:

April 4, with lime-sulphur 1 to 8.

May 8, with lime-sulphur 3-100, plus 3 lbs. arsenate of lead.

June 2, with lime-sulphur, 3-100 plus 5 lbs. arsenate of lead.

On July 2 notes were taken showing the results of the spraying up to that date. Some scale was observed on the unsprayed trees, while the sprayed trees were practically free from signs of this insect. The remaining results are tabulated in Table 13.

The figures show that scab, as well as the codling moth and curculio, was very prevalent. In addition to the 29.6 per cent of scab on the unsprayed trees, a high percentage of the leaves on the check trees were affected with this disease. When the leaves of the apple are attacked by scab early in the season, they nearly always drop off before mid-summer, and badly infested trees will be injured by loss of foliage due to this cause.

September 27, Mr. Jaeger reported as follows: "The block of trees under your control is doing fine and is making a nice show. Many of the trees are heavily laden with nicely colored fruit. The apples are going to be of a fine quality with the exception of many scale specks. The result of the heavy spraying speaks for itself, as many other trees in the neighborhood that were not sprayed have already lost their

fruit. With several dormant sprayings perhaps the scale can be destroyed."

The fruit was harvested about the middle of October, when final notes were taken. These are summarized in Table 14.

Table 13 - Results of Spraying the Jaeger Orchard up to July 2, 1914.

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Ben	Sprayed	0.5	6.0	1.7	0	0	1.0	89.3
Davis	Check un-sprayed	37.1	16.0	29.6	0	0		17.3

Table 14 - Harvesting Data, Jaeger Orchard, Boonville

		Percentage insect, disease and spray injury							

Variety	Treatment	Worms	Curculio	Scab	Rots	Cedar Rust	Spray Injury	Marketable fruit per tree	Value of fruit per acre of 60 trees

Ben	Sprayed	12	30.68	0	1.16	0	1.2	4 bu. No.1	
								4 bu. No.2	\$121.80
								3 bu. culls	

	Davis:								
	Check, unsprayed:	No fruit on trees. All dropped off from attacks of diseases and insects.							

In addition to the data given in the table, it may be mentioned that there was a small percentage of scale on the fruit of the sprayed trees, but no signs of the insects could be detected on the twigs. The unsprayed trees were encrusted so severely with scale that the trees were injured severely and apparently almost ready to die.

The summer notes that are given in Table 13 show that the combined spray almost completely controlled the scab up until July 2. From Table 14 it is learned that there was no scale to be found on the trees at harvest time. This was because the few apples that were affected in early summer dropped

off. From Table 14 it is further noticed that all the fruit on the unsprayed trees dropped off before harvesting time, due to attacks of the insects and diseases. It might be added that all of the apple trees in this vicinity that were not sprayed dropped their fruit by September or earlier.

The cost of spraying per tree was as follows: Materials, 31 cents; labor, 25 cents; total, 56 cents, or \$33.90 per acre. Since the check trees produced no fruit whatever, the net profits due to spraying in this case amounted to \$97.90 per acre.

Henderson Orchard - The trees in this orchard were as badly infested by scale as fruit trees could possibly be and some trees had already been killed by the pest. The bark was encrusted and many limbs all through the tops of the living trees had been killed.

The spray against the scale was applied in December, 1913. Commercial lime-sulphur was used at a strength of 1 to 8. The spraying outfit consisted of a very poor barrel pump, a short leaky lead of hose and a small vermorell nozzle.

Results - The scale was fairly well controlled. Much of the fruit was slightly blotched by the scale but this was due to a lack of thorough work in applying the scale spray. The trees were greatly invigorated on account of the scale

being killed. The pest had been brought under control by one spray, although poorly applied. Summer notes and harvesting data were not obtained.

Murray Orchard - In this orchard 50 healthy, thrifty 15-year-old trees were selected for the experiment. A power sprayer was used and the lime sulphur spray was applied at a strength of 1 to 10 just as the cluster buds were opening. The trees were only slightly infested with San Jose scale. This spray was used to control the scale and at the same time take the place of the regular cluster bud spray.

Results - As was true in other orchards, the leaves took on a brownish or burned appearance for a few days after spraying. This color and the effect of the spray soon disappeared and the trees in the sprayed plot fruited equally as well as the check trees. The scale was controlled perfectly and the scab was controlled equally as well as where the regular cluster-bud spray was applied. The varieties consisted of Ben Davis, Grimes, York and others. The following sprays were applied during the summer:

April 1, with lime-sulphur 3-100.

May 4, with lime-sulphur 3-100, plus 6 lbs. arsenate of lead.

May 25, with lime-sulphur 2-100, plus 5 lbs. arsenate of lead.

July 2, with lime-sulphur 3-100, plus 4 lbs. arsenate of lead.

For purposes of comparison, notes were taken on a neighboring orchard July 2. This orchard had not been sprayed. The variety was Ben Davis. This showed 1.9 per cent of worms, 12.3 per cent of curculio, and 64 per cent of scab. It is to be regretted that no harvesting data from this orchard is available, although it is very probable that only a small percentage, if any, of the fruit was of commercial grade.

The apples in the Murray orchard were harvested in October and the results are tabulated in Table 26.

It should have been explained before, that inexperienced men did the spraying in this orchard for the most part. This probably accounts for the high percentage of scab on the sprayed trees. The cost of spraying four times, per tree, was as follows: Materials, 28.2 cents; labor, 10.8 cents; total, 39 cents, or \$23.40 per acre. The profits due to spraying amounted to \$181.80 per acre.

Table 26 - Harvesting Data, Murray Orchard, Willard.

		:Percentage insect,disease and spray injury							

Vari-	Treat-	Worms:	Cur-	Rots:	Scab:	Cedar:	Spray:	Marketable:	Value
ety	ment	:	cu-	:	:	Rust:	In-	fruit	of
:	:	:	lio	:	:	:	jury	per	fruit
:	:	:	:	:	:	:	:	tree	per
:	:	:	:	:	:	:	:	:	acre
:	:	:	:	:	:	:	:	:	of 60
:	:	:	:	:	:	:	:	:	trees

:	Sprayed:	7.4	4.0	2.0	33.0	0	3.8	7.2 bu.No.1:	\$237.
:	:	:	:	:	:	:	:	3.1 " " 2:	:
Ben	:	:	:	:	:	:	:	1 1/2 bu.culls:	:

Davis:	Un-	:	:	:	:	:	:	1 bu.No.2:	:
:	sprayed:	15.7	10.5	2.3	87.4	0	...	2 1/2 " culls:	\$31.80

Tanner Orchard - A barrel and pump sprayer was used in this orchard. The trees were encrusted with scale and they were very large and tall. Six trees were sprayed in November, 1913 with commercial lime-sulphur and six other trees were sprayed at the same time with scalicide. The work of spraying was well done on the trunks and lower limbs of the trees but most of the trees were so tall that it was difficult to spray the tops thoroughly. No pruning had been done and many badly cankered limbs were present.

Results - In September, 1914, the trees were inspected and the scale was found to be under control. The scale

had spotted the fruit a little in the tops of the tree where the spraying had not been thorough, on account of being unable to reach the tops effectively with the spraying outfit. The trees had made a very good growth and the encrusted scales of the previous year had nearly all worn off leaving the bark smooth and healthy. The lime-sulphur and scalicide were about equal in effectiveness in killing San Jose scale. Careful observations with hand lense showed practically no difference in the effect of the two sprays in controlling the scale. Summer notes and harvesting data were not obtained.

Station Plot - A plot of three trees were used in the experiment to test the advisability of combining the dormant spray for San Jose scale and the cluster bud spray. One of the trees was an Ingram and the other two were Ben Davis. The trees were not infested with scale but they were sprayed as thoroughly as if they had been.

All of the trees were sprayed with commercial lime-sulphur, testing 34° Baume. Tree No. 1, Ben Davis, was sprayed with commercial lime-sulphur 1 to 8 on April 15, 1914. The leaves were out and as large as squirrel ears. Some of the cluster buds had separated. Tree No. 2, Ben Davis, was sprayed at the same time with commercial lime-sulphur at a strength of 1 to 12. The spraying was done on a bright, sunny, quiet day, about 5:00 p. m. Rain did not come until April 27.

Fig. 9 - Ben Davis apple tree, No. 1, Station Grounds, Columbia. As it appeared on April 25, 1914, ten days after being sprayed with commercial lime-sulphur 1 to 8.

Notes on Results, Ben Davis Trees - April 17, No. 1 showed more brown or scorched leaves and presented in general a lighter appearance, due to the stronger spray showing more of the lime on the bark of the trunk and the branches. April 20, both trees looked much better and a careful examination showed that only the tip ends and margins of the smallest leaves had been burned or scorched. A great many of the smaller leaves on both No. 1 and No. 2 were wrinkled and twisted on account of the burning of the lime-sulphur. No. 1 appeared somewhat worse than No. 2. No leaves were destroyed; in fact, almost all of the damage was confined to the tips and edges of the small leaves. Now and then, a large leaf could be found which showed a little burning on the tip or edge. April 24, both trees were in full bloom. Nearly all of the petals and leaves were free from burns and brown spots, but the effect of the strong spray could still be seen. A careful examination with hand lense all around the tree showed only 2 or 3 blooms that were damaged by the strong spray. April 25, the trees were photographed. The foliage at this time, only ten days after the strong spray, looked very good. Very few of the leaves, at this time presented the wrinkled and scorched appearance. The plant lice were almost perfectly controlled on both trees. After the strong sprays

Fig. 10 - Ben Davis apple tree, No. 2, Station Grounds, Columbia. As it appeared on April 25, 1914, ten days after being sprayed with commercial lime-sulphur 1 to 12.

were applied, it was difficult to find an aphid, although they were very numerous at the time the application was made.

No. 3, the Ingram apple tree, about 8 years old, was photographed at about 5:00 p. m. on April 25 and sprayed with commercial lime-sulphur (1-8). The lime-sulphur tested 33⁰ Baume. Five and one-half gallons of the dilute spray was used on the one tree.

The leaves were out and the cluster buds had separated. Nearly all of the buds showed pink and within the tree two or three of the buds had opened up and the petals showed plainly. By actual measurement many of the leaves were found to be one-half inch wide and one and one-half inches long. A barrel pump sprayer was used at a pressure of from 60 to 90 pounds.

Notes on Effect of Strong Spray on Ingram Tree No. 3:

The weather was bright and clear at the time the spraying was done. An examination at 10:00 a. m. on April 26 showed that many of the flower buds had opened during the night. The stamens and pistils showed no signs of injury. The whole surface of most of the leaves showed the lime-sulphur spray very plainly. Some of the leaves were slightly crumpled and drawn due to the caustic action of the strong spray.

On April 27, the examination showed more wrinkling, browning and crumpling of the leaves. The smallest leaves

which were young and tender were burned the worst, especially on the tips and edges. A casual observer, in passing the tree, would not have noticed the burning on the tips and edges of some of the leaves. The most conspicuous thing about the tree was the white or light color due to the lime-sulphur on the trunk, limbs, branches and leaves. The entire tree appeared much as if it had received a coating of white-wash. A heavy rain fell on the night of April 27.

April 28, the lime-sulphur showed very plainly all over the tree after the heavy rain. None of the leaves were burned off. The edges and tips of some were scorched, colored brown and killed. The trees did not look severely injured and the passer-by would not have suspected that anything was wrong. A careful examination showed that not a single fruit bud had been damaged. About one-third of the tree was in bloom on April 28.

On May 13, nearly all of the effects of the burning on the tree had disappeared. On close examination, however, the edges and tips of some leaves still showed the browning and others had a wrinkled and twisted appearance. Not a single fruit bud could be found that showed any injury due to the use of the strong spray.

Later observations found no injury to the fruit or its setting. In fact, the tree set more fruit than the two

Fig. 11 - Ingram apple tree, No. 3, Station Grounds, Columbia. As it appeared on April 25, 1914, when it was sprayed with commercial lime-sulphur 1 to 7.

check trees nearby in the same plot. The calyx spray was applied May 13 and the tree appeared to be in splendid condition for fruiting.

Spraying Experiments and Demonstrations for The Control of San Jose Scale, 1915 - 1916.

In the fall of 1915 the spraying experiments and demonstrations were continued under the direction of the Agricultural Extension Service. On account of other work only a few demonstrations were held until January 1, 1916. Work was started, however, during the winter in Knox, Carroll and St. Louis Counties. Eight spraying and pruning demonstrations were held for the control of San Jose scale, one in St. Louis County, two in Carroll and five in Knox.

Knox County San Jose Scale Control Work

Or- chard	No. of trees	Age of trees	Sprays for Scale	Mater- ial used	When Sprayed	Cost, Labor Mater- ial	Out- fit used	Re- sults
T. L. Kriegs- hauser Edina	30	12	1 & 2	L. S. (1-7)	Fall and Spring	6¢	Barrel Pump	Excel- lent
C. S. Huling Novelty	200	20	1 & 2	L. S. (1-7)	Fall and Spring	10¢	Barrel E Pump	Excel- lent

The Kriegshauser orchard was badly infested with scale. The commercial lime-sulphur tested 33° Baume and it was used at a strength of 1 to 7. Two trees were left untreated in the fall to be treated in the spring. These trees were left for the purpose of testing the advisability of applying two sprays during the dormant season in order to bring the scale under control.

Results - The San Jose scale was almost perfectly controlled. The trees sprayed in the spring one time were as free from scale during the summer as the trees that had been sprayed twice during the dormant season. There was almost no spotting of the fruit or injury by the pest on tender twigs. Notes on summer spraying and harvesting data were not obtained.

The Huling orchard consisted of about 200 apple trees which were badly infested with San Jose scale. The varieties were mixed but were mainly Ben Davis, Jonathan and Grimes Golden. The trees were sprayed in the fall and again the following spring with commercial lime-sulphur at a strength of 1-7. Two trees were left untreated in the fall to be sprayed the following spring to determine the difference in controlling scale by one or two dormant sprays.

Results - Where the spraying was thoroughly done, the scale was very well controlled. This was proven by the fact that the small trees which were easy to spray showed very

few live scales during the summer, while the large old trees that were difficult to spray showed the worst infestations during the summer. Harvesting data and summer notes were not taken.

The spraying demonstrations brought out large numbers of attentive and interested farmers and fruit growers. Much more interest in spraying and the care of orchards has been shown since the work started. This has been proven by the increased purchase of spraying equipment and spraying chemicals.

St. Louis County San Jose Scale Control - The spraying demonstration for the control of San Jose scale was held December 20, 1915, near Jefferson Barracks, upon the request of the secretary of the Oakville Farmers' Club. Two spraying machines of different makes were used. Commercial lime-sulphur and miscible oil were both applied on different plots of trees.

Up until this time many fruit growers believed that San Jose scale could not be controlled and the only remedy for the infested trees was the axe. Many of the fruit growers had used both the standard washes recommended for the control of scale, (lime-sulphur and miscible oil) but they had failed to check or control the pest.

Results - The condition of the sprayed orchards July 1, 1916, was very good indeed, and where the work of

Fig. 12 - Two views of a pile of Jonathan apple tree wood, March 25, 1917. This Jonathan apple orchard about 18 years of age was located near Warrensburg and consisted of about 35 acres of healthy, thrifty trees. The orchard was not profitable because it had never been properly sprayed and the owner decided the ground was more valuable for corn and wheat.

spraying was well done no red spots or specks on the fruit, showing injury by San Jose scale, could be found. Every co-operator secured results of which he was very proud and these same orchardists are saying, "San Jose scale is easy to control; in fact, much easier than the codling moth and curculio. This is especially true since we have learned what strength of lime-sulphur to use and how to cover the trees effectively with the strong spray."

The lime sulphur and miscible oil were about equally effective in killing and controlling San Jose scale. Careful observations, made at four different times during the summer, showed practically no difference in controlling the scale.

Twenty-five members of Oakville Farmers' Club, all living near Jefferson Barracks, were secured as cooperators and they followed the directions and recommendations for not only the scale spray but also for the application of the summer sprays.

The names and addresses of a few of the cooperators, who controlled San Jose scale and placed their heretofore unprofitable orchards on a paying and profitable basis within less than a year after the orchard demonstration work started, are as follows:

Samuel Mason,	Jefferson Barracks,	Mo.
William Dorst,	"	"
George Weinreich,	"	"
William Neimer,	"	"
E. H. H. Bernard,	"	"
Oscar Tanzenberger,	"	"
Fred Tanzenberger,	"	"
L. Beyer,	"	"
Amiel Winheim,	"	"

Carroll County San Jose Scale Control - Spraying demonstrations were held at DeWitt and between Carrollton and DeWitt on November 20, 1915, for the control of San Jose scale. The beliefs and opinions of the farmers and fruit growers in this county were similar to those of the farmers in St. Louis County with reference to the control of San Jose scale.

In the orchard in which the demonstration was held at DeWitt the owner had been spraying for five years to control San Jose scale but instead of controlling it the scale gradually grew worse every year and about two-thirds of the orchard had been killed by the pest at the time the demonstration was held.

As a result of this spraying demonstration, many new spraying outfits were purchased and 138 barrels of lime-sulphur

were sold during the spraying season of 1916, while only 35 barrels were sold during the spraying season of 1915. More than 30 cooperators followed the work during the entire season.

Six farmers with a total of 340 acres of orchard were ready on April 1 to apply the dormant spray for the control of San Jose scale, as most of them had been doing for several years. These orchards and many others were inspected from April 3 - 5, 1916, and where San Jose scale was not present, the farmers were advised to omit the scale spray. On the average, it costs the farmer about \$5.00 per acre for spraying materials to apply this dormant spray. At this rate, the Carroll County farmers made a saving of about \$1700.00. If we consider the cost of teams and labor the saving will amount to more than \$3500.00. The dormant spray does not damage the orchard, but it is not necessary or practical to apply it unless San Jose scale is present. Some growers were applying the dormant or scale spray where San Jose scale was not present and they were leaving out one or two of the regular summer sprayings. The scale spray costs about as much as two summer sprayings, and in the production of fruit it is not nearly so important unless scale is present. These difficulties and problems were met and solved in all of the counties where demonstration work was held.

Results of San Jose Scale Spraying Demonstra-
tions on June 1, 1916.

That San Jose scale can be controlled in the worst infested orchards by thorough work and the use of the proper mixtures at the right time is perhaps the greatest result secured. In all of the eight counties where demonstration work was started, San Jose scale was not being controlled and in a majority of the orchards the infestations were gradually growing worse, and the orchards were being cut down.

During the last of June, 1916, all the demonstration orchards were visited and but few live scales were found. Where the work had been well done not a single case of fruit spotting could be found, while in the neighboring orchards, that were not sprayed according to the directions of the Agricultural Extension Service, the fruit, foliage and twigs were badly spotted by the scales and the fruit was almost worthless.

Twenty spraying demonstrations for the control of San Jose scale were held during March and April, 1916, in the following counties: Butler, Cape Girardeau, Bollinger, Ste. Genevieve, Jefferson, St. Charles, Knox and Carroll.

Spraying Demonstrations During Spring and Summer, 1916,
for the Control of Injurious Orchard Insects
and Diseases.

The spraying demonstrations were continued through the summer and spring of 1916 for the purpose of controlling the insect pests and diseases injurious to the fruit and foliage of the apple trees. All of the above counties were visited regularly except Bollinger and Knox. Sullivan, Pike and Nodaway were added to the list. Demonstrations reached the following counties: Butler, Cape Girardeau, Bollinger, Ste. Genevieve, Jefferson, St. Charles, St. Louis, Pike, Carroll, Nodaway, Sullivan and Knox.

The ^{21 days} ~~spraying~~s were applied under the direction of the spraying specialist. From two to four summer sprayings were made in each demonstration orchard. The work in Bollinger and Knox Counties was placed under the advisory plan, that is, one or two visits were made to the orchards during the spring and summer, and the rest of the spraying was directed by correspondence.

Plan of Work.

The plan of the spraying demonstrations was cooperative in every case. The owner or manager of the orchard furnished the spraying chemicals, the labor, spraying outfit, and

equipment, while the Agricultural Extension Service furnished the spraying specialist. In each demonstration orchard a block of fruit trees was selected, ranging in number from 50 to 500 or more. At each of the summer spraying demonstrations this block of trees was sprayed under the personal direction and help of the spraying specialist, and in most cases the rest of the orchard was sprayed by the owner in a similar manner.

The summer sprays were regularly applied in the demonstration orchards of Cape Girardeau, St. Louis, St. Charles, Jefferson, Ste. Genevieve, Pike, Butler, Carroll, Sullivan and Nodaway. From two to four summer sprays were applied in all of the demonstration orchards, most of them receiving the four regular summer sprayings. Ten counties were reached four times during the spraying season.

Results of Summer Spraying Demonstrations in Ten Missouri Counties.

The results obtained by the summer sprays in all of the demonstration orchards of the ten counties were outstanding successes, demonstrating clearly and forcibly the value of thorough and timely sprayings with the proper spraying chemicals.

At harvesting time, round-up meetings were held in nearly all of the demonstration orchards to show the farmers and

fruit growers of each community the value of thorough and timely sprayings for the production of marketable fruit.

Generally over the State there was a thin set of fruit in the apple orchards in the spring of 1916, due, perhaps, to the prolonged wet, cool weather at blooming time. For this reason many of the orchards did not yield more than a third to a half as many bushels of apples at harvest time as they should have. Where the apples did set, however, they were kept on the trees and remained almost free from insect injuries and diseases by careful and timely sprayings, although the insects and diseases were more difficult than usual to control. The check or unsprayed trees which were left in each demonstration orchard yielded practically nothing and the leaves and fruit dropped from the trees by harvesting time. At the same time the leaves continued to be fresh and green on the sprayed trees and the apples did not drop.

An effort was made during 1916 to reach and interest the general farmer in the better care of his home orchard. For this reason nearly all of the demonstration work was done in home orchards. The work was a great success as the reports indicate. Many farmers, in every community where a demonstration was held, who did not spray in 1916 are preparing to spray in 1917. All the cooperators who sprayed are enthusiastic about the results and will continue the work.

On July 1, in some orchards the fruit averaged from 90 to 98 per cent clean, while the fruit on the unsprayed or check trees averaged from 85 to 100 per cent bad or unclean.

The owners of the demonstration orchards are in almost every community considered authorities on orcharding, on account of the work being done on their farms, and all of the neighbors go to them for advice when the care of the orchard is considered.

But very little pruning was done in any of the demonstration orchards and the soil was not cultivated or fertilized in any of them. The results obtained were due almost entirely to spraying.

Reports from all the demonstration orchards have not been received, but the following summary gives the results in brief from the majority of them:

Fig. 13 - An unsprayed apple tree in the Craig Orchard near Carrollton, October 2, 1916. Nearly all the leaves and fruit had fallen. The fruit that remained was so badly affected with scab and insect injury that it was absolutely worthless.

Summary of Results from Spraying Demonstration

Orchards, Carroll County, 1916.

Orchard	Treat- ment	No. of trees	Sprayed for scale	No. of summer sprays	Cost of Mater- ial and Labor	Value Fruit Prev- ious Year	Value of fruit this Year	Prof- it from spray ing
J. J. Bar- gold	Sprayed	400	200	4	\$159.80	\$350	\$1720	1560.20
Wakenda	No.sum. : spray	200	100	none	10.00	7	none	none
R. W. Craig	Sprayed	140	none	3 & 4	34.75	75	344.90	310.15
Carroll- ton	No.sum. : spray	5	none	none	none	none	none	none
Mrs.C.H. Heins	Sprayed	800	none	3 & 4	365.50	600	700	334.50
Carroll- ton	No.sum. : spray	6	none	none	none	0.00	5.00	none
Chas. Winfrey	Sprayed	3300	3300	3	1299.45	4000	4500	3200
DeWitt	No.sum. : spray	400	400	none	80.00	none	none	none

Reports from the Wilson and Beams orchards have not been received, but the results should be equally as good as those given above.

Bargold Orchard - The Bargold Orchard was sprayed with a power outfit for the first time and the whole orchard of 600

Fig. 14 - A sprayed apple tree in the Craig Orchard near Carrollton, October 2, 1916. The leaves were healthy, green and fresh and the branches were bending with clean, market-able fruit.

trees had never yielded more than \$350.00 worth of fruit until this year. The profits this year came from about a one-third set of fruit. The trees are 25 years old and nearly all Ben Davis and Gano varieties. San Jose scale was not present but the dormant spray was applied on 200 trees before the orchard was inspected.

Craig Orchard - A power spray was used in the Craig orchard which had in previous years yielded only about \$75.00 worth of fruit per year by spraying. This orchard also had a very thin set of fruit. The trees are 18 years old.

Heins Orchard - The Heins orchard has been sprayed for several years with a power outfit and it has yielded an average of from \$600.00 to \$800.00 worth of fruit. This year with a third of a set of fruit the value was \$700.00. The trees are from 18 to 25 years of age.

Winfrey Orchard - A young orchard about 15 years of age, healthy and thrifty, and had been well cared for except for the work of pruning. Only a few trees were pruned, however, and no cultivation was given. The trees were slightly infested with San Jose scale. The average price received for the fruit in the same orchard of about 60 acres has been about \$4,000.00 per year. The set of fruit was very poor this year on many blocks of trees. The spraying work was so well done that on

Fig. 15 - Results from sprayed and unsprayed apple trees in the Craig Orchard near Carrollton, October 2, 1916. The large pile of apples, $12\frac{1}{2}$ bushels of good, marketable apples, were picked from one sprayed tree. The pile of apples on the left, $2\frac{1}{2}$ bushels of culls, were picked from one unsprayed tree. The small pile in the center consisted of a few apples from the sprayed trees that were classed as blemished or inferior fruit.

July 1, it was very difficult to find an apple in the entire orchard that showed the least sign of insect injury or disease.

Summary of Results from Spraying Demonstration Orchards,
St. Charles County - 1916.

Orchard	Treat- ment	No. of trees	Sprayed for Scale	No. of summer sprays	Cost of: Mater- ial and labor	Value of fruit	Profits from spray- ing
Wm. Sehrt	Sprayed	65	65	3 & 4	\$23.78	75.25	\$52.47
Augusta	No. sum. : spray	3	3	none	.50	1.50	none
Mrs. Burns	Sprayed	47	47	4	25.65	116.00	90.35
St. Charles	No. sum. : spray	6	6	none	1.00	none	none
F. Burge- schulte	Sprayed	174 apple 49 plum	223	3	139.45	108.95	None poor set of fruit
Portage des Sioux	No. sum. : spray	20	20	none	3.00	none	none
Jno. A. Sandfort	Sprayed	102	102	2	56.62	95.00	38.48
St. Charles	No. sum. : spray	6	6	none	1.00	none	none

Sehrt Orchard - The Sehrt orchard was badly infested with San Jose scale. Many of the trees had been killed by the scale and nearly all of the trees had dead limbs scattered through

Fig. 16 - An unsprayed apple tree in the Sehrt Orchard, Augusta, October 10, 1916. Nearly all the leaves and fruit had dropped. The fruit that remained was sold for 50¢.

Fig. 17 - A sprayed apple tree in the Sehrt Orchard, Augusta, October 10, 1916. The fruit from this tree was sold for \$10.00.

Fig. 18 - Sprayed and unsprayed apple trees, Sehrt Orchard, Augusta, October 10, 1916.

the center and top which had been killed by the pest. The sprays were applied with a barrel and pump outfit. The orchard was never sprayed before and the value of the fruit in previous years was practically nothing. The owner was almost ready to cut the orchard down and make it into fire wood.

Bruns Orchard - This orchard had been almost ruined by San Jose scale. Perhaps one-third of the trees had been killed, and all the others had been greatly weakened. The dormant spray for scale was applied with a barrel and pump outfit in the spring of 1916, just before growth started. For the past five years the fruit from this orchard had been practically worthless.

In regard to the condition of the trees after spraying, Mrs. Bruns' report reads as follows: "About 20 of the trees were in very bad condition, damaged by scale, by storm, and with a considerable percentage of dead limbs. The condition of the orchard at present is fine, but the damaged trees need pruning and it will be necessary to spray again this winter for scale."

Burgeschulte Orchard - This orchard of about 5 or 6 acres was badly infested with San Jose scale and about a third of it had been cut down and made into fire wood. The owner was also making plans to cut down and work up into stove wood the remainder of the infested trees during the winter.

Fig. 19 - The Burgeschulte Orchard near Portage de Sioux, April 12, 1916. This orchard was badly infested by San Jose scale and the owner had cut down several acres after deciding that it was impossible to control San Jose scale. The remaining trees were saved from the ravages of the scale and a very good crop of fruit was harvested in October 1916. See Fig. 20.

San Jose scale was thoroughly controlled with a barrel-pump sprayer on trees that were almost killed by the pest. None of the trees or fruit was damaged badly by injurious insects during the spring or summer and had the trees set even a third of a crop of fruit the results would have been much better. The orchard was saved from the attack of San Jose scale and it is in splendid condition for a crop of fruit in 1917. As this as the set of fruit was, its value at harvest time almost equalled the cost of labor and the materials used for spraying.

Sandfort Orchard - The orchard had been badly neglected. Some of the trees were severely infested with San Jose scale, while many others 25 or more years of age, were too tall for effective spraying with the barrel-pump outfit which was used. The trees had never been pruned in the center and top. The dormant spray and only the second and third summer sprays were applied. The condition of the trees at harvest time was very good, and the fruit was all that could be expected as a result of only two summer sprays. Many of the apples were badly specked by scale.

Fig. 20 - The Burgeschulte Orchard, Portage de Sioux, as it appeared at the time for the calyx spray, May 15, 1916.

Summary of Results from Spraying Demonstration Orchards

Cape Girardeau County - 1916.

Orchard	Treat- ment	No. of trees	Sprayed for Scale	No. of Summer Sprays	Cost of Mater- ial and Labor	Value of Fruit	Profits from Spray- ing
R. Tuschhoff	Sprayed	22	22	3	\$12.25	\$28.42	\$16.17
Oak Ridge	No. Sum: Spray	4	4	none	.50	none	none
H. Burhl	Sprayed	25	25	3	8.55	40.00	31.45
Oak Ridge	No. Sum: Spray	12	none	none	none	none	none
Joseph Jobb	Sprayed	45	45	3	14.95	16.00	1.05
Cape Girardeau	No. sum: Spray	3	3	none	.50	none	none
Adam Thoma	Sprayed	175 apple	300	3	35.00	55.00	20.00
Allen- ville		125 peach					
	No. Sum: Spray	6	6	none	.50	none	none
M. Henderson	Sprayed	300 apple 165 peach	465	3	14.40	20.00	5.60
Jackson	No. Sum: Spray	3	3	none	.50	none	none

Tuschhoff Orchard - The trees had been badly neglected and were heavily infested with San Jose scale. No fruit of any consequence had been produced for several years. Most of the orchard had been cut down and made into fire wood. The trees after treatment were comparatively healthy and thrifty and in fine shape for a good crop of fruit next year. The orchard had never been sprayed before. The trees were about 25 years old. San Jose scale was almost perfectly controlled as there was no blotching of the fruit and no signs whatever of live scale.

Burhl Orchard - This old orchard had been unprofitable for many years and trees had been dying out every year until only about one-tenth of them remained. On many of the trees from one-third to one-half the limbs were encrusted with scale or cankered and dead. The spraying was the only work done in the orchard and the trees were never sprayed before. San Jose scale was controlled on all the trees treated.

Jobb Orchard - This orchard was about 12 years of age and it had been well cultivated and fertilized. The fire blight attacked the trees severely during the spring and summer. This was caused by too much fertilizing and severe pruning. Only a very thin set of fruit was secured, but it was of a splendid quality. Under proper management from now on the orchard should

be very profitable. There was no spotting of the fruit by San Jose scale and it was difficult to find a live scale in the orchard.

Thoma Orchard - The trees in this orchard ranged in age from 7 to 25 years, and most of them were badly infested with San Jose scale. The orchard had been poorly sprayed one year before the demonstration work was started. No pruning or cultivating was practiced. For the past three years practically no clean fruit had been harvested. All the unsprayed orchards in this community failed to produce fruit. The scale was fairly well controlled but better results could have been obtained by spraying with a more efficient outfit.

Henderson Orchard - This is a fine young orchard, perhaps the best young orchard in Southeast Missouri. The trees are from 2 to 7 years old. A hail storm during the summer destroyed most of the fruit. The orchard is being started properly and it should be a great success in a few years. The trees are infested with scale but the pest is under control by proper spraying.

Summary of Results from Spraying Demonstration Or-
chards, Sullivan County, 1916.

Orchard	Treat- ment	No. of trees	Sprayed for Scale	No. of Summer Sprays	Cost of Mater- ial and Labor	Value of Fruit	Profits from Spray- ing
T. H. De- Witt	Sprayed	50	none	4	\$8.52	\$110.00	\$101.48
Green City	No. Sum. Spray	4	none	none	none	none	none
Porter Bros	Sprayed	12	none	2	1.55	20.00	18.45
Green City	No. Sum. Spray	3	none	none	none	none	none
A. L. Miller	Sprayed	35	none	3	3.43	60.00	56.57
Green City	No. Sum. Spray	6	none	none	none	none	none
Mrs. R. C. Clelland	Sprayed	45	none	2	2.50	30.00	27.50
Green City	No. Sum. Spray	3	none	none	none	none	none
Sam Yos	Sprayed	30	none	4	8.52	40.00	31.48
Green City	No. Sum. Spray	3	none	none	none	none	none

The demonstration work in Sullivan County was all done in home orchards that had been neglected and were unprofitable. In many cases a crop of fruit had not been received for several years. It was the general notion of many farmers in this county that good fruit like their grandfathers used to raise could not be produced any more. Some maintained that the soil was not adapted to fruit growing and that the climate had changed and the conditions made fruit production impossible. The check or unsprayed trees left in each demonstration orchard produced no fruit and all the unsprayed orchards of the county failed to produce fruit of a marketable quality.

The success of the work was due almost entirely to spraying as but very little pruning, cultivating, or fertilizing was practiced in any of the orchards listed above.

Summary of Results from Spraying Demonstration Orchards
St. Louis, Nodaway, Butler, and Jefferson Counties, 1916.

Orchard	Treat- ment	No. of trees	Sprayed for Scale	No. of Summer Sprays	Cost of: Mater- ial and Labor	Value of Fruit	Profits from Spray- ing
Geo. Wein- reich	Sprayed	33	33	4	\$21.35	\$287.05	\$265.70
Jefferson Barracks	No. Sum. Spray	3	3	none	.50	none	none
Bert McKee	Sprayed	15	none	3	9.00	25.00	16.00
Ravenwood	No. Sum. Spray	4	none	none	none	none	none
P.G. Haag	Sprayed	100	100	2	97.50	168.75	71.25
Poplar Bluff	No. Sum. Spray	6	6	none	none	none	none
L. B. Hentcher	Sprayed	20	none	3	16.25	80.00	63.75
De Soto	No. Sum. Spray	2	none	none	none	.50	none
H. G. Mc- Donald	Sprayed	500	none	2	186.50	2000.00	1813.50
Clarks- ville	No. Sum. Spray	35	none	none	none	18.00	none

Weinreich Orchard - This orchard had been regularly sprayed for three years but San Jose scale was not being controlled and the fruit harvested was a poor grade and of low quality. The owner of the orchard proved to be one of the best cooperators of the season as is shown by the results. The outfit used was a power sprayer. Many orchards in the same neighborhood consisting of better trees did not yield more than one-third as much fruit as this orchard and the fruit was not as clean.

As to the grade of fruit produced in the orchard in 1916, we wish to quote a letter from the Krueger-Thompson Fruit and Produce Commission Merchants of St. Louis:

Krueger-Thompson
Fruit and Produce Commission Merchants
1107 North Third Street

St. Louis, October 5, 1916.

Mr. Thos. J. Talbert,

Dear Sir:-

In regard to Mr. Geo. Weinrich's apples this year, they were the cleanest and healthiest, free from sting, worms and cripples of any of the Missouri apples we handled. In cleanness they compare with the apples from Calhoun County, Illinois, where some of the cleanest fruit in the country comes from.

Yours truly,
(Signed) Krueger-Thompson.

McKee Orchard - This was a small home orchard consisting of several varieties of trees about 20 years of age that were never sprayed before. The barrel-pump outfit used was old and worn and it was with the greatest difficulty that effective work was done. The fruit in this orchard for the past three years had been practically worthless.

Haag Orchard - The trees were badly infested with San Jose scale. The spraying outfit consisted of a barrel pump. The orchard had never been well sprayed before, and pruning and cultivating had been neglected. No marketable fruit had ever been harvested.

Hentcher Orchard - This consisted of a small home orchard about 20 years old which had never been sprayed, pruned, or cultivated properly. The fruit had been very poor for the past two or three years.

McDonald Orchard - This orchard of about 535 trees, 18 years old, had been badly neglected. It had never been properly pruned and the attempts at spraying were almost equal to no spraying. A new power sprayer was purchased a short time before the summer spraying began. Only two sprays were applied. These were the first and second summer applications. For the best results, at least four sprayings should have been made during the season of 1916. Considering the fact that only two sprays

were applied and that the men who had charge of the work were inexperienced, the results after harvesting the crop were certainly all that we could expect.

Combining Cluster Bud and San Jose Scale Sprays Spring
of 1916.

Orchard	No. of Trees	Age of Trees	Sprays for Scale	Mater- ial Used	When Sprayed	Cost of Mater- ial and Labor	Outfit Used	Re- sults
S. Mason Jefferson Barracks	50	18 Yrs	1	L-S (1-7)	Apr 10	10¢	Power Spray- er	Excel- lent
W. Neimer Jefferson Barracks	10	20 Yrs	1	L-S (1-7)	Apr. 8	9¢	Barrel Pump	Good
Station Orchard, Columbia	6	16Yrs	1	L-S (1-8) (1-10) (1-12)	Apr 15	8¢	Barrel Pump	Excel- lent
C. Winfrey DeWitt	3300	15 Yrs	1	L-S (1-7)	Apr 16	9¢	Power Spray- er	Excel- lent

Mason Orchard - This orchard consisted of about 100 trees, 15 years old. The varieties were mixed, but the most of the trees were Winesap, Ben Davis, Jonathan, and Grimes. The

orchard was badly infested with San Jose scale which had never been controlled. Dormant sprays had, however, been applied every year for the past four or five years but they were not effective in controlling the pest, because the spray had not been used at the proper strength and the work had not been thoroughly done.

On April 16, the apple trees were sprayed with commercial lime-sulphur at a strength of 1 to 7. The lime-sulphur tested 33 degrees Baume. At this time the leaves on the apple trees were larger than squirrel ears and the cluster buds had separated. Many of the buds showed the pink petals. The stage of development was just right for the first summer spray which is just before the trees bloom. The trees were sprayed very heavily. In fact, they were drenched with the strong lime-sulphur spray. From 4 to 6 gallons of the spray was used on each tree. The weather was clear and fine when the work was done.

Results - There was a little scorching and burning on the edges and tips of the leaves. For a week or ten days after the application the foliage on the trees appeared to be browned and scorched a little. No material injury was done. A careful inspection ten days later showed that the strong spray had done practically no damage to the leaves or developing buds. Not a single bud could be found that had been killed.

San Jose scale was never controlled better on apple trees. A hail storm about the first of July destroyed almost

the entire fruit crop in this orchard. What fruit remained on the trees was so badly injured that the harvesting data was not taken.

Neimer Orchard - Ten trees in this orchard were sprayed with lime-sulphur scale strength (1-7) on April 14. The leaves were out and the cluster buds had separated. A power sprayer was used and the pressure was run from 250 to 300 pounds. The trees were drenched with the strong liquid. The weather was clear and fair at the time the work was done.

Results - In this orchard some severe injury was done to the buds and leaves. Decidedly more injury was done to the foliage than in any of the orchards treated in 1914 or any of the orchards treated in 1916. This injury was due no doubt to the high pressure used in spraying, because other orchards were treated at practically the same time with the same strength of spray and no material injury done. In other orchards when power outfits were used the pressure was kept at about 200 pounds. Where barrel-pump sprayers were used, the maximum pressure was usually employed which ranged from about 70 to 90 pounds.

Some of the small leaves were entirely destroyed by burning and many of the buds were killed. Most of the trees set a fairly good crop of fruit in spite of the injury. The damage and injury could be seen much longer in this orchard

than in any other orchard treated with the scale spray after the cluster buds had separated. The fruit in this orchard was also destroyed by the same hail storm that struck the Mason orchard, and no harvesting data was obtained.

Station Orchard - Six trees were treated in this plot as follows:

2	were	sprayed	with	lime-sulphur	1 to 8
2	"	"	"	"	1 to 10
2	"	"	"	"	1 to 12

The lime-sulphur tested 33° Baume. The trees were sprayed after the leaves were out and after the cluster buds had separated. A barrel-pump sprayer was used and an effort was made to spray the trees just as thoroughly as if they had been infested with San Jose scale. The work was done during clear weather.

Results - No material injury was done to leaves or buds as a result of applying the strong spray. As usual, there was a slight burning of the edges and tips of the leaves. The surface of many of the leaves were slightly wrinkled. As much fruit set on the treated trees as on neighboring trees that were sprayed with the lime-sulphur and arsenate of lead at summer strength.

There was a little more injury done where the solution was used 1 to 8 than where used 1 to 10 or 1 to 12. A careful examination also showed that there was slightly more

injury where the solution was used 1 to 10 than where used 1 to 12. The casual observer would not notice any difference as to injury where the solution was used at different strengths. The main difference as to the appearance of the trees as compared with check trees was not the burning or scorching of the leaves. It was the light color on the trunk, limbs and branches due to the lime in the spray.

The control of the plant lice was much better on the treated trees than on check trees. Harvesting data was not obtained.

Winfrey Orchard - This entire orchard was sprayed on April 17 to 24 inclusive, with commercial lime-sulphur 1 to 7. The strong solution tested 33° Baume. The cluster bud and San Jose scale sprays were combined. The work was begun just before the cluster buds separated and was continued until the trees began to bloom. The owner of the orchard had neglected to spray for scale until it was apparently too late on account of the injury that might be done by spraying with lime-sulphur at San Jose scale strength after the cluster buds had separated. An adjoining orchard of 15 acres was sprayed with lime-sulphur at the same strength and at the same time. At least 75 acres of orchard was sprayed thoroughly during the cluster bud period with this strong spray in order to control the scale.

Judging from former recommendations, it was a dangerous experiment, but the owners of the orchards were willing to spray to kill San Jose scale even if the fruit was sacrificed in the spraying.

Results - In the whole orchard of 75 acres, no material injury was done to leaves or buds. It is true that the edges and tips of the leaves in many cases showed burning, but no injurious results were noted at any time during the growing season. On the 60 acres of the Winfrey orchard, the fruit at harvest time was sold on the trees for \$4,500.00. From this it can be seen that the fruit and foliage were not materially injured.

The weather at the time of spraying was bright and clear and the clear weather continued several days after the work was finished.

The varieties in this orchard were mixed, but they consisted mainly of Winesap, Jonathan, Ben Davis, Gano and York.

A Poorly Sprayed Orchard Served as Check - An orchard of 15 acres, just across the road, of the same varieties and the same age belonging to Pete Winfrey served as a check on our work. It was sprayed but the work was not thoroughly done. The chemicals were not properly mixed and the sprayings were not all applied.

The scale was fairly well controlled by a dormant spray made during the winter.

The cluster bud spray was omitted just because the owner of the orchard had never applied this spray. For the calyx spray, the lime-sulphur was left out of the mixture in order to cut down expenses. At the time for the third spray, the lime-sulphur and arsenate of lead were used at the proper strength. This was the only summer spray that was made correctly so far as the strength of chemicals and mixture were concerned.

Results - On July 1, it was impossible to find a perfect apple in the orchard. Almost every apple had been attacked by apple scab, many worms were present, curculio injury was common, and San Jose scale blotching was plentiful on some trees. The fruit at harvest time was practically worthless.

It was a striking demonstration of the right and wrong way to spray for profitable results. Just across the road on the same kind of trees, same age, same conditions, and same number of sprayings, the profit above cost of labor and material was \$53.66 per acre. It is wise to practice economy but the kind of economy the one grower practiced was false economy. It costs so little to spray that the fruit grower cannot afford to not spray at the right time, spray thoroughly, and spray with the proper spraying materials.

Sprayed Trees Develop Most Fruit Buds.

Two weeks orchard demonstration work from April 7 to 21, 1917, showed conclusively that the most fruit buds for the 1917 apple crop are to be found on the trees that were thoroughly sprayed during the season of 1916. The inspections and observations in the orchards were made in the following Counties: Barry, Henry, Johnson, Carroll, Chariton and Cooper.

In the R. W. Craig Orchard near Carrollton, the sprayed trees were bearing a fairly heavy set of fruit buds, while the six unsprayed or check trees in the same orchard were almost entirely without fruit buds.

This is true of the sprayed and unsprayed trees in the Bargold Orchard, Wakenda; W. D. Davis Orchard, Windsor; C. D. Manley Orchard, Cassville; and of many orchards in all the counties visited.

Thoroughly and timely spraying counted for more than usual during the season of 1916, because insect pests and diseases were unusually difficult to control. The fruit in nearly all of the unsprayed orchards of the State was practically worthless at harvest time. The leaves of the trees were badly injured by insect pests and diseases and they dropped early, leaving the trees almost bare of foliage. The drought of July, August and September tended to weaken and devitalize the trees,

especially where they were devoid of foliage. Unsprayed trees were, therefore, unable to develop fruit buds, because it was a great strain to even live through the summer.

San Jose Scale Control Work, Fall and Winter of 1916
and Spring of 1917.

Orchard	No. of trees	Age of trees	Sprays for Scale	Material Used	When Sprayed	Cost of Labor and Material	Results
Phil Hennrick, Doe Run	40	12	1	L.S.	Mar. 28	8¢	
Joe Gisi Ste. Genevieve	75	10 to 20	1	L.S.	Mar. 29	10¢	
C.J. Wilder Ste. Genevieve	25	25	1	L.S.	Mar. 29	10¢	
S. J. Crecelius Jefferson Barracks	200	18	1	L.S.	Mar. 26	8¢	
Louis Aff Jefferson Barracks	60	20	1	L.S.	Mar. 27	9¢	
Chas. Tanzenberger Jefferson Barracks	400	20	1	L.S.	Mar. 26	8¢	
Station Orchard	6	20	1	L.S.	Apr. 30	8¢	

Notes on the results of the sprays for the control of San Jose scale in the above orchards have not been taken.

The effect of the San Jose scale spray applied on the six Ingram apple trees located on the Station Grounds has been observed. The six trees on April 30, when the strong lime-sulphur spray was applied, were coming into bloom. They were sprayed thoroughly with commercial lime-sulphur testing 33° Baume' at a strength of 1 to 7.

Results - No material injury was done to the leaves or developing buds. As usual, the edges and margins of many of the leaves were burned and colored brown as a result of the application of the strong spray. The smallest leaves appeared to be injured most. The surface of some of the larger leaves was wrinkled and scorched a little, but no severe injury was done. No fruit buds were killed and the leaves were not severely injured.

Fig. 21- Apple buds ready for Cluster bud spray, April 30, 1917, Station Grounds, Columbia. Commercial Lime Sulphur(1 to 7) was applied as a spray.

SUMMARY

1. The San Jose scale is a small gray speck, having a crater-like protuberance at its center.

2. The winter is spent in a half to three-fourths grown state.

3. Maturity is reached in the spring, and the males emerge as tiny gnat-like insects while the females remain beneath their armor attached to the bark.

4. The young are born. The females do not lay eggs.

5. There are about four broods or generations a year in Missouri.

6. It produces reddish blotches or discolorations on fruit, leaves and twigs.

7. It is very common in Missouri and may be found in all of the 114 counties.

8. The scale has several natural insect enemies, the most important being the ladybird beetles.

9. San Jose scale is the most important insect trouble and peach leaf-curl is perhaps the most serious fungous disease that requires dormant or semi-dormant spraying for their control. These two troubles cannot be successfully controlled by any other means.

10. The cause of unsatisfactory results appears to be poor equipment, improper materials used, poor distribution of insecticide, and the improper manipulation of the spray nozzle.

11. Thorough work is essential. Since most of the scales are no larger than a fly speck, many may escape being killed if a spot the size of a dime is left uncovered. When it is known that the progeny of a single female may amount to millions during one season, we can readily see the importance of covering every portion of the bark with the spray.

12. An ordinary laborer can spray well enough to preserve the life of the trees, but to prevent the fruit from being spotted thorough work must be done.

13. The scale is killed by smothering, by the corroding and burning action of the spray, and by the young being unable to find a suitable place to settle and begin sucking sap.

14. Where the infestation is severe two applications are advisable - one in the fall and one in the spring. If the weather is warm in the fall the scale continued to feed and if an application is made soon after the leaves are off, the trees are given immediate relief. Another application should be made in the spring if the first was not thorough.

15. The scale may be distributed locally by the wind, rain, birds, other insects, animals and man. The wind, birds, and other insects are the most important factors in local distribution.

16. The food plants of the scale are numerous. It is dangerously injurious to more than a hundred varieties of fruit trees, shrubs, and shade trees.

17. The parasites and predaceous enemies of San Jose scale are fairly numerous, but we cannot depend upon them for protection. The greatest efficiency of parasites which has been observed, was about 90 per cent. The small black ladybird beetle is perhaps the greatest enemy of San Jose scale.

18. Complaint is often made that it is useless for one farmer to spray unless all the neighbors spray. No doubt the scale spreads from orchard to orchard, especially when they are located near each other, but thorough annual spraying will prevent injury, irrespective of the neglect in adjacent orchards.

19. In cases of bad infestations the dead and dying branches should be pruned out in order to simplify the spraying and hasten the formation of new wood.

20. Strong washes must be used against the scale. The object is to use washes about as strong as the trees will endure without injury, in order to secure the maximum killing effect of the spray upon the insects. Stone fruits are more susceptible to injury than apple and pear. The most important sprays in use against scale are as follows:

1. Lime-sulphur wash,
2. Petroleum-oil, or miscible oils.

21. On the average, the farmer cannot afford to make lime-sulphur. He can usually buy the commercial product cheaper than he can afford to make it.

22. Lime-sulphur is generally the best spray to use against San Jose scale; first, because it is the cheapest material in use; second, because it is also a powerful fungicide; third, because it will do no injury to the trees, and fourth, if the work is thoroughly done it is equally as effective in controlling scale as the miscible oil sprays.

23. It costs so little to control San Jose scale by spraying that the farmer should not hesitate to spray. The dormant or scale spray and four summer sprays, including labor, will cost from 35 to 65 cents per tree.

24. If the spraying work is to be properly done, it is important that the spraying outfit be sufficient to do good work. The outfit may consist of a barrel pump, tank pump, or gasoline power sprayer. As small an outfit as the bucket pump and knapsack sprayers might be used effectively on small fruit trees but they would be ineffective and unsuited for bearing fruit trees. For small orchards of 5 or 6 acres, the barrel pump or tank pump is effective, but for larger orchards a power outfit is needed.

25. Where there is a very light infestation of San Jose scale in an orchard, or where the owner has neglected to

apply the spray thoroughly against San Jose scale, it is advisable to take special pains in making the summer applications to coat the trunk, limbs, and branches of the infested trees. The lime-sulphur and arsenate of lead at summer strength will kill the young crawling scales if they are thoroughly wet with the solution. The summer sprays will, therefore, if properly made, help materially to control San Jose scale and prevent much spotting of the fruit.

26. The dormant spray is not profitable in orchards free from San Jose scale. This spray if properly made, does the orchard no injury, but the benefits to be derived from it do not justify the expense of making the spray unless the trees are infested with the pest.

27. Orchards of almost any age that are fairly healthy and vigorous can be rejuvenated and made profitable by spraying. While pruning, cultivating, and fertilizing, are important practices in rejuvenating the orchard and making it profitable, the operation of highest value is thorough and timely spraying with the proper mixture. Unprofitable and neglected orchards of long standing, if fairly healthy, can in most cases be made profitable in one year by spraying alone.

28. The dormant or San Jose scale spray, consisting of commercial lime-sulphur testing 33 degrees Baume, may be

applied on apple trees with safety at the strength of 1 to 7 or 8 up until the time the trees begin to bloom without material injury to leaves or buds. When the spray is applied at this time it takes the place of the so-called cluster bud spray. While the dormant spray is not to be recommended generally, to take the place of the cluster bud or first summer spray, yet it may be said that where orchards are heavily infested with San Jose scale, and where for any reason the dormant spray has not been applied, the commercial lime-sulphur testing 33 degrees Baume at a dilution of 1 to 7, may be applied after growth starts and even up until the blooming time without serious injury to buds or leaves. This statement is based upon the results obtained in four experimental orchards in 1914 and four demonstration orchards in 1916.

29. The dormant spray must be followed by the proper summer sprays if profitable results are to be obtained. At least three summer sprayings should be made in Missouri, and during most seasons four sprayings will produce the most profitable results. During some seasons in South Missouri, five or six sprayings may be necessary in order to control apple blotch and bitter rot.

30. No perceptible difference as to injury was noticed on the different varieties of apple trees, when the lime-sulphur

spray was used at dormant strength after the leaves and buds were out.

31. Commercial lime-sulphur and miscible oil are equally effective in controlling San Jose scale where thorough work is done.

32. Commercial lime-sulphur, when used at a strength of 1 to 7, produces more burning than when used at a strength of 1 to 8, 1 to 10, or 1 to 12. As a rule, the weaker the solution the less the burning. The difference in the effect, however, was very slight, especially between 1 to 7 and 1 to 8.

33. A spraying pressure of from 250 to 300 pounds is much more apt to do injury by burning when the dormant spray is used after the growth is out, than a spraying pressure of 60 to 90 pounds for a hand pump sprayer or about 200 pounds for a power sprayer.

34. The application of the scale spray on apple trees in the fall, winter, or spring, before the growth starts, may cause the trees to bloom from 2 to 4 days later than unsprayed trees.

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