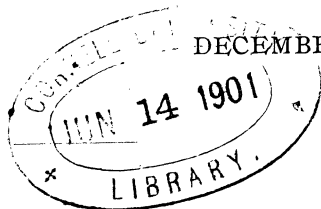


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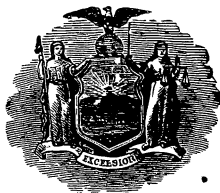
# New York Agricultural Experiment Station.

GENEVA, N. Y.

## SAN JOSÉ SCALE INVESTIGATIONS. II.

- I. SPRAYING EXPERIMENTS WITH KEROSENE OIL.
- II. METHODS OF COMEATING THE SAN JOSÉ SCALE.

V. H. LOWE.



PUBLISHED BY THE STATION.

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## SAN JOSE SCALE INVESTIGATIONS. II.

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V. H. LOWE.

### SUMMARY.

In a series of winter spraying experiments with refined (150° fire test) kerosene oil, peach trees were killed with one application of a 20 per ct. mixture of oil with water; and plums seriously injured with a 40 per ct. mixture. Pears and apples were not injured except by the pure oil and then only slightly. The 20 per ct. mixture of kerosene had no apparent effect on the scales but the 40 per ct. proved effectual in every case.

Summer applications of 100° and 150° fire test oil showed the former to be dangerous, burning the leaves at a percentage too low to kill the scale; while the latter did not injure the foliage except when applied undiluted.

### I. SPRAYING EXPERIMENTS WITH KEROSENE OIL.

The experiments herein recorded were begun two years ago, the original intention being to duplicate them the following year. At that time kerosene oil was used more extensively in combating the San José scale than now. Although crude petroleum is taking its place in many localities it is still used extensively in this State. Where but few trees are to be treated it is often more convenient to use it than crude petroleum as it is more easily obtained and in most localities costs less in small quantities.

The number of trees and bushes treated, 382, is not a large one for a series of experiments of this kind but is sufficient to give

reliable results. The treating of a large number of trees was purposely avoided in order to give an opportunity of making the treatment thorough and accurate.

#### OBJECTS OF THE EXPERIMENTS.

The principal objects of these experiments were: To determine the effects of winter applications of kerosene oil (1) on healthy nursery trees and (2) on healthy bearing trees; (3) to determine the percentage of oil required to kill the scale during the winter; and (4) to determine the effects of summer applications upon healthy bearing trees.

#### CONDITIONS.

Unless otherwise stated only 150° fire test oil was used. In all cases the oil was applied in the form of a spray, the machine being frequently tested to ascertain whether the right proportions of oil and water were being maintained. Much care was also taken to make the applications even, each tree being wet to the same degree.

#### EXPERIMENTS TO DETERMINE THE EFFECTS OF WINTER APPLICATIONS OF KEROSENE OIL ON HEALTHY NURSERY TREES.

These experiments were divided into two series, the first receiving one application and the second two applications<sup>1</sup>.

*Series I.*—Sprayed Nov. 22; temperature 49°, high wind, cloudy. Weather during the week following alternately cloudy and bright, with average temperature of 27°.

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<sup>1</sup> Unless otherwise stated, the trees in Series I and II have received one and two applications of oil, respectively.

TABLE I.—NURSERY TREES SPRAYED WITH KEROSENE DURING WINTER :  
SERIES I.

Trees.			Percent- age oil.	Results.	Checks. <sup>1</sup>
Kind.	No.	Age.			
APPLE : Baldwin	13	Years. 2	20	No injury ; following season's growth normal.	Good growth.
"	15	2	40	Same.	Same.
"	18	2	100	Same.	Same.
PEAR : Bartlett	11	2	20	No injury ; following season's growth normal.	Growth good.
"	15	3 and 4	40	Same.	Same.
"	7	3 and 4	100	Very slight injury to tips of branches.	Same.
PEACH :	12	1	20	Within three days all showed injury, May 31 all dead.	No winter killing. Good growth following season.
"	8	1	40	Same.	Same.
"	18	1	100	Same.	Same.
PLUM : Bradshaw	9	2	20	No injury ; following season's growth normal.	Good growth.
"	6	2	40	Evidence of injury appeared within three days May 31 five dead, one badly injured, lived.	Same.
"	6	2	100	Injury apparent day following application. May 31, five dead ; one slightly injured, fair growth following season.	Same.
QUINCE :	6	3	100	No injury ; following season's growth normal.	Same.

<sup>1</sup> Checks same number as in first test under each variety.

*Series II.*—Sprayed Nov. 22 (see Series I) and March 27. Temperature on latter date 32°. Weather during the week following windy ; average temperature 30°.

TABLE II.—NURSERY TREES SPRAYED WITH KEROSENE DURING WINTER :  
SERIES II.

Trees.			Percent- age oil.	Results.	Checks. <sup>1</sup>
Kind.	No.	Age.			
APPLE :		<i>Years.</i>			
Baldwin	9	2	20	No injury. Growth normal following season.	Growth excellent.
"	12	2	40	Same.	Same.
"	17	2	100	Tips of branches slightly injured after second application. Buds apparently uninjured. Growth following season good.	Same.
PEAR :					
Bartlett	8	3 and 4	20	No injury. Growth during following season excellent.	Growth excellent.
"	10	3 and 4	40	Same.	Same.
"	6	3 and 4	100	Slight injury to buds. Growth following season good.	Same.
PEACH :	19	1	20	May 31, all dead to the ground.	Very slight evidence of winter killing. Growth following season excellent.
"	11	1	40	Same.	Same.
"	8	1	100	Same.	Same.
PLUM :					
Bradshaw	13	2	20	No injury, growth normal.	Growth excellent.
"	8	2	40	May 31. Upper third of trees dead.	Evidence of slight winter injury.
"	6	2	100	May 31. Five dead nearly to the ground; other much injured.	Same.

<sup>1</sup> Checks equal or greater in number than in single test under variety.

*Summary.*—Five different kinds of fruit trees were used in these experiments, including 46 apple, 33 pear, 38 peach, 21 plum and 6 quince trees, making a total of 144. This is a sufficient number to make a fair test. Summing up the results it will be observed that peach and plum trees, especially the former,

were very sensitive, the peaches being killed with a 20 per ct. mixture and the plums in most cases seriously injured with a 40 per ct. mixture. Neither pears nor apples were injured with one application of a 40 per ct. mixture, and the pears only very slightly with two applications while the apples were uninjured. One hundred per ct., one application, did not injure apples, and injured pears only slightly; two applications hurt both apples and pears slightly.

SPRAYING EXPERIMENTS TO DETERMINE THE EFFECTS OF  
WINTER APPLICATIONS OF KEROSENE OIL UPON HEALTHY  
BEARING TREES.

*Series I.*—Nearly all of these trees were in excellent condition and were bearing well. The checks were of the same grade. They were sprayed Nov. 22.

TABLE III.—BEARING TREES SPRAYED WITH KEROSENE DURING  
WINTER: SERIES I.

Trees.			Percent- age oil.	Results.	Checks. <sup>1</sup>
Kind.	No.	Age. <i>Years.</i>			
PEAR : Dwarf Kieffer	2	8	20	No injury. Fruit equal to check trees.	Fruit average yield.
Standard Bartlett	2	8	20	Same.	Same.
Standard Bartlett	2	8	40	Same.	Same.
Dwarf Kieffer	4	12	100	Bark somewhat discolored by oil especially on lower part of larger limbs and upper half of trunk. On May 31 fruit buds were not well set, but foliage good. Growth poor during following season and less than one-fourth crop of fruit.	Same.

<sup>1</sup> Two check trees for each test.

TABLE III.—Continued.

Trees.			Percent- age oil.	Results.	Checks. <sup>1</sup>
Kind.	No.	Age.			
		<i>Years.</i>			
Standard Bartlett	2	8	100	On May 31 the fruit buds were well set, and foliage good. Growth during following season was good, with average yield of fruit.	Same.
PLUM : Gueii	6	8	20	No injury.	Growth good. Fruit above average yield.
"	3	8	40	No injury.	Same.
Japan	1	8	100	May 31. Much of the bark discolored; more than $\frac{3}{4}$ of the fruit buds killed. Tree nearly dead by following fall and was dug out.	Same.
Reine Claude	1	10	100	May 31, seriously injured. Nearly dead by following fall and was dug out. <sup>2</sup> But little injury to upper third.	Same.
European	1	14	100	May 31. Fruit buds well set toward tips of upper limbs. Very little foliage except on upper third. Nearly dead by following fall.	Same.
European	2	8	100	But little injury to upper half. Lower half seriously injured; no foliage and all fruit buds killed. Nearly dead by following fall.	
CURRENT :	2	( <sup>3</sup> )	100	Within a few days showed injury and died during following spring.	

<sup>1</sup> Two check trees for each test.<sup>2</sup> Soon after this tree was sprayed it was found to be seriously affected by disease which probably aided materially in causing its early death.<sup>3</sup> Bushes in full bearing.

*Series II.*—The trees of this series, as those of Series I, were selected as being in good condition. The applications were made November 22 and March 27.

TABLE IV.—BEARING TREES SPRAYED WITH KEROSENE DURING WINTER: SERIES II.

Trees.			Percent- age oil.	Results.	Checks.
Kind.	No.	Age.			
		<i>Years.</i>			
CRAB APPLE: Hyslop.	1	( <sup>1</sup> )	20	No injury. Fruit average crop.	
PEAR: Kieffer.	2	10	20	No injury. Fruit average crop.	Two trees same age and variety. Fruit usual crop.
Dwarf Kieffer	1	10	100	About 80 per ct. of fruit buds killed. Foliage good.	
PLUM: Bradshaw.	1	10	20	No injury. Fruit average crop.	
"	1	8	100	More than 80 per ct. of fruit buds killed. Very little foliage. Tree nearly dead by following fall.	
	1	10	40		

<sup>1</sup> Full bearing.

*Summary.*—Three different kinds of fruit trees and one variety of currants were used in these experiments, including 15 pears, 17 plums, 1 crabapple and 2 currants making a total of 35. In all cases there was no injury to pears except where pure oil was used in both Series I and II. Plums were not injured by one application at 40 per ct.; but seriously injured by two applications, and also by one application of 100 per ct.

SPRAYING EXPERIMENTS TO DETERMINE THE PERCENTAGE OF KEROSENE OIL REQUIRED TO KILL THE SAN JOSÉ SCALE WHILE HIBERNATING.

*Series I.*—The trees were sprayed November 21. Weather cloudy and windy, temperature 42°. During the following week the weather varied from cloudy to clear with an average temperature of 28°.

TABLE V.—PERCENTAGE OF KEROSENE REQUIRED TO KILL HIBERNATING  
SAN JOSÉ SCALE : SERIES I.

Trees.			Percent- tage oil	Degree of infestation.	Results.	Checks.
Kind.	No.	Age.				
PEAR :	3	<i>Years.</i> 14	20	Badly infested ; incrusted on some parts.	Scales appar- ently not af- fected by the oil, May 31 and later.	Scales but little af- fected by winter. Larvæ abundant during following season.
Bartlett.	41	10	20	Majority of trees badly in- fested, others moderately.	No effect upon the scales.	Same
"	4	10	40	All badly infest- ed ; incrusted in places.	May 31. Scales dead ; three trees not in- jured ; one tree slight yellowing of leaves.	Same.
"	1	10	100	Well infested.	May 31. Scales dead. No in- jury to tree except bark on low re- limbs and upper part of trunk slight- ly injured, but not se- riously.	Same.
PEACH.	4	Old.	20	Nearly dead with scale. In- crusted on trunk and near- ly all limbs.	May 31. Trees dead, and as a result, scales dead also.	Same.
PLUM : Lombard.	1	8	40	Badly infested.	Scales dead. No apparent injury to tree.	Same.
SWEET CHERRY.	1	12	40	Incrusted on trunk and low- er limbs.	May 31. Scales dead. Tree uninjured.	Same.

*Series II.*—These trees were sprayed Nov. 21 and March 17. Weather bright on latter date, temperature 20. Weather during following week bright. Average temperature 29.

TABLE VI.—PERCENTAGE OF KEROSENE REQUIRED TO KILL HIBERNATING SAN JOSÉ SCALE: SERIES II.

Trees.			Percentage oil.	Degree of infestation.	Results.	Checks.
Kind.	No.	Age.				
PLUM : Reine Claude	I	Years. 8	40	Badly infested. Incrusted on lower limbs and trunk.	June 29. Scales dead.	Scales not much affected by winter. Larvæ abundant.
	I <sup>1</sup>	8	{ 20 15	Badly infested.	June 29. Scales not affected.	Scales not affected by winter. Larvæ abundant.
SWEET CHERRY :	I	Bearing	100	Moderately infested.	June 29. Scales dead. Tree somewhat injured.	

<sup>1</sup>Sprayed with 20 per ct. in late November; with 15 per ct. in early December.

*Summary.*—These experiments included 58 pear, plum, peach and sweet cherry trees. All of them were sufficiently infested to give definite results. It will be noticed that although 49 out of 58 trees were sprayed with 20 per ct. kerosene the scales were not killed in any instance except one, and that was on four peach trees that were killed by the oil and the scales died with them. In every case where 40 per ct. and higher percentages were used the scales were killed.

SPRAYING EXPERIMENTS TO DETERMINE THE EFFECTS OF  
SUMMER APPLICATIONS OF KEROSENE OIL UPON HEALTHY  
BEARING CANES AND BUSHES.

In these experiments two grades of kerosene oil, 100° and 150° fire test were used as follows :

*Series Ia.*—In this test 100° fire test oil was used on healthy, bearing gooseberry and currant bushes and pear and apple trees. Two applications were made. The first on April 27 and the second on May 5. On the former date the weather was bright with slight wind. Temperature 62°. The average temperature during the week following was 64°. On the latter date the weather was hazy, partially cloudy, slight wind, temperature 56. Average temperature during the week following 61°.

TABLE VII.—BEARING BUSHES SPRAYED WITH 100° FIRE-TEST KEROSENE.

Bushes.		Percent- age oil.	Results.	Checks.
Kind.	No.			
GOOSE- BERRIES : 27 varieties	27	25	Burning of foliage varied from one-fifth to three-fourth, injured leaves dropped early, thus weakening bushes; latter wintered poorly; about half died next spring.	Two to 5 bushes of each variety. Nearly all wintered well.
CURRENTS : 5 varieties.	10 <sup>1</sup>	{ 15 25	Foliage slight burned in all cases; bushes uninjured.	Four bushes of each variety.

<sup>1</sup>Two bushes of each variety sprayed; 15 per ct. oil first application, 25 per ct. second.

The following experiments with pear and apple trees included but one application of oil. The apples were sprayed May 4 and 5. The weather was bright, slight wind, temperatures May 4, 54°, May 5, 56°. Average temperature during the following week 60°. The pears were sprayed May 12. The weather was bright with a strong wind. Temperature 64°. Average temperature during the following week 55°.

TABLE VII.—BEARING APPLE AND PEAR TREES SPRAYED WITH 100° FIRE-TEST KEROSENE.

Trees. <sup>1</sup>			Results.
Kind.	No.	Percentage oil.	
APPLE :			
Greenings and Baldwins.	10	15	May 9 small percentage of leaves killed.
Greenings and Baldwins.	16	25	May 9 a little less than one-third of leaves killed.
Greenings and Baldwins.	17	40	May 9 from one-third to one-half of leaves killed. Bark somewhat discolored near base of larger limbs.
Greenings and Baldwins.	10	60	May 9 about two-thirds of leaves killed. Bark discolored on many of the limbs.
Greenings and Baldwins.	10	100	Nearly all of the leaves killed. Also some of the small branches. The bark on the large limbs and trunk injured in spots but not enough to seriously affect the tree. All of the trees put out new foliage.
DWARF PEAR :			
Principally Bartlett.	40	15	No injury to leaves or bark except in a few cases where the nozzle was held in one place too long. This injury was only very slight.

<sup>1</sup> Full size trees.

*Series I b.*—In these experiments 150° fire-test oil was used on healthy, bearing apple and pear trees. One application was made on one lot of apples on June 4 and 5, and on another lot June 10. (Weather cloudy, wind, mild temperature 66°. Average temperature during week following 73°.)

Trees.			Results.
Kind.	No.	Percent- age oil.	
APPLE :			
Principally Bald- win and Green- ing.	10	20	No injury.
Principally Bald- win and Green- ing.	3	15	No injury.
Principally Bald- win and Green- ing.	2	25	No injury.
Principally Bald- win and Green- ing.	2	40	No injury.
Principally Bald- win and Green- ing.	1	50	No injury.
Principally Bald- win and Green- ing.	1	60	No injury.
Principally Bald- win and Green- ing.	1	100	Slight burning of the foliage.
PEAR :			
Dwarf Bartlett.	4	15	No injury.
“ “	4	25	Very slight burning of foliage on wind- ward side.

<sup>1</sup> Trees in full bearing.

*Summary.*—These experiments show, principally, the difference between the 100° and 150° oils in their effects on apple and pear trees. The former injured the foliage in all cases, even with 15 per ct. and when used at 60 per ct. and above, seriously injured the bark as well. The 150° oil did not injure the trees except when used pure when the foliage was slightly burned.

#### GENERAL SUMMARY AND DISCUSSION OF RESULTS.

The results taken as a whole indicate that peach and plum trees are more susceptible to injury by kerosene oil than apple and pear trees. Peach trees were the most sensitive, being killed by the lowest percentage (20 per ct.) used. The experiments to determine the percentage of high grade oil required to

kill the scales showed very definitely that a 20 per ct. mixture had practically no effect but that a 40 per ct. mixture killed the scales in every case. Kerosene oil of 100° fire test proved dangerous to apple foliage at a percentage as low as 15, while 150° oil did not injure the foliage except when used pure and then only slightly. So far as could be ascertained, temperature and weather conditions had little effect on the results, as the effects of spraying were practically the same under varying conditions of heat and cold, sunshine and cloudy skies.

The results of these experiments are also sufficiently definite to indicate that kerosene oil may be used during the winter on apple and pear trees at a percentage (40 per ct.) strong enough to kill the scale without endangering the tree; but that it is impracticable for use on peach trees and dangerous to plum trees.

## II. METHODS OF COMBATING THE SAN JOSÉ SCALE.

There are two principal methods of combating the San José scale in the orchard: First, fumigating the infested trees with hydrocyanic acid gas; and second, spraying with some caustic substance that will penetrate the scale and kill the insect beneath or seal it over so firmly as to entirely smother it.

### FUMIGATION.

Fumigation is practicable only for comparatively small trees that can be safely cut back to about twelve feet in height and about eight feet in diameter. Either a tent or a canvas box may be used. The former is likely to be unsatisfactory because of the difficulty in accurately estimating its cubic contents and the trouble involved in handling. The box fumigator<sup>1</sup> avoids these difficulties and if not too large is more satisfactory. A modification of the box type has been used by Prof. W. G. Johnson<sup>2</sup> with reported success. It consists of a box which is let down over the top of the tree by means of a mast and pulley. The top of the box consists of a canvas hood which adjusts itself to the height of the tree. The cubic contents of the rigid part of the box can be easily ascertained and the cubic contents of the extended hood estimated.

<sup>1</sup> A form of box fumigator is described in Bulletin 181 of this Station.

<sup>2</sup> U. S. Dept. Agr. Div. Ent., Bul. 20, n. ser., pp. 43-45.

*The amount of cyanide to use.*—The amount of cyanide to use depends upon the strength required and the size of the tent or box. For fumigating orchard trees in winter use 0.3 gram of cyanide per cubic foot of space inside the tent or box. For example, suppose a tree is to be fumigated with the box fumigator described in our Bulletin No. 181. This fumigator measures  $10 \times 6 \times 6$  feet. It cubic contains, therefore, 360 cubic feet. We wish to use the gas at a strength of 0.3 gram of cyanide per cubic foot. The amount of cyanide required would then be  $360 \times 0.3 = 108.0$  grams<sup>3</sup> or 3.51 oz.

After reducing to ounces use one and one-half times as many fluid ounces of sulphuric acid as cyanide and one and one-half time as much water as acid. This would make the formula for fumigating a tree in a  $10 \times 6 \times 6$  ft. fumigator with gas containing 0.3 gram of cyanide per cubic foot as follows :

Cyanide of potassium 98-99 % pure.....	3.51 oz. avoird.
Sulphuric acid.....	5.27 fl. oz.
Water.....	7.90 “

The exact amount of acid is not important. A small fraction of an ounce will make no difference. In this case 5 oz. would answer the purpose or if preferred  $5\frac{1}{2}$  oz. could be used. Likewise eight ounces of water could be used in place of 7.9 ounces. The water should first be placed in the generating dish, which should be a flat-bottomed, open dish, preferably earthenware, the acid being added slowly. When all is ready, drop the cyanide into the dish. A very convenient way to handle the cyanide is to measure it out into small Manila paper bags and when ready to set off the charge drop the bag with the cyanide into the acid.

Cyanide of potassium can usually be had for about 33 cts. a pound and commercial sulphuric acid by the carboy (about 12 gallons) at  $1\frac{1}{2}$  cts. a pound. At these prices the cost of the chemicals to fill the above fumigator with gas containing 0.3 gram of cyanide per cubic foot would be about  $7\frac{1}{2}$  cts.

*Caution.*—Cyanide of potassium is a deadly poison and hence should be properly handled and labeled. When exposed to the air for a few hours it absorbs moisture ; it should therefore be kept in a tight box in a dry place. Hydrocyanic acid gas is also

<sup>3</sup> One gram is equivalent to .03257 oz. avoirdupois.

very poisonous and hence, when fumigating, the operator should be careful that the tent or box has aired for a few minutes before he goes inside.

#### SPRAYING.

A large number of mixtures have been tested with a view to ascertaining a satisfactory wash to destroy the scale. At present three are considered the most satisfactory here in the East, namely, kerosene oil, crude petroleum and whale-oil-soap solution.

A discussion of kerosene oil is given in the first part of this bulletin.

*Crude petroleum.*—Crude petroleum can be obtained from any dealer in kerosene oil. The quality that seems to determine its value as a safe insecticide is its specific gravity which should not be less than  $43^{\circ}$  (Beaumé oil scale) at  $60^{\circ}$  F. Oils of lower specific gravity have been found to be more dangerous to the trees.

*Method of application.*—Crude petroleum may be applied pure or mixed with water by means of a machine especially designed for the purpose. In either case care should be taken not to apply too much. The object of the spraying should be to cover every part of the tree above ground with as thin a film of oil as possible. If it is mixed with water by means of the pump, use at least 40 parts of oil to each 60 parts of water making a mixture containing 40 per ct. oil.

*When to apply.*—Late winter or early spring is probably the best time to apply the oil but more experiments are needed to determine this point. In any case it will be better not to apply it after the buds have begun to swell; for although this has been done in some cases without apparent injury, in others it has ruined the trees. Summer applications should be avoided. Care should be taken not to put too much on the trees and to make the applications uniform. The spray should be applied until the trees begin to drip slightly.

*Caution.*—Peach and Japan plum trees are more liable to injury by crude petroleum than either European plums or pears and apples. It is also to be borne in mind that the full extent of the effect of the oil on the tree is not always apparent the first

season—but many require a second season to show the full extent of the injury if there is any.

*Whale oil-soap.*—Whale oil soap is one of the safest insecticides that can be depended upon to kill the scale. A caustic soda soap is preferable to a caustic potash soap. Although the price fluctuates somewhat it can usually be obtained in 100 pound lots at about  $4\frac{1}{2}$  cts. a pound.

The soap should be dissolved in hot water using two pounds to the gallon, and should be applied to the trees as hot as possible. The treatment should be made during the winter.