Bulletin No. 61. February 1908

UNIVERSITY OF IDAHO

Agricultural Experiment Station.

Department of Economic Entomology and Plant Pathology.

Spraying Experiments 1907

By L. F. HENDERSON

Idaho Experiment Station

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Spraying Experiments for 1907

By L. F. Henderson.

A few points had not been settled during our former experiments, and it was our purpose to try to settle these in 1907. These several points may be summarized as follows:

1. Are commercial lime-sulphur mixtures as good as home made.
2. What is the value of Scalecide as a spray for San Jose scale.
3. Does the addition of salt aid the lime-sulphur mixtures when spraying for Peach-leaf Curl.
4. Does Bordeaux, well made, injure the apple when applied at flowering time and why.
5. Can Arsenate of Lead, made at home, give us as good results as a well made commercial article.
6. Can the amount of arsenicals be greatly reduced over the advertised proportions and give as good results.
7. What is the relative value of the Dust Spray, compared with liquid sprays, in the treatment of both apple-scab and codling moth.

Three different parts of the state were selected in an attempt to demonstrate these several points. The scale experiments were carried on in Southern Idaho, near Meridian, while the other two were in Northern Idaho.

San Jose Scale

Though I had demonstrated several of these points in respect to scale in and about Lewiston, during the previous season, there were some which I had not carried out at all, while several which I had proved to my own satisfaction in North Idaho, were either doubted, seemed to work differently, or *did* work differently in Southern Idaho. I therefore resolved to put in my final work on scale in the territory tributary to Boise, and selected two very fitting orchards near Meridian. These two belonged, the one to Messrs. Flack & Sons, the other to Mr. J. A. Watt, leased and run by Mr. Barbee. I may add that it rained so much during

the time of these experiments, March 15-23, that I feared greatly for their success. In fact, in referring to my notes, I find that there was not a day nor a night, while actually engaged in the spraying, that it did not snow or rain, the showers being generally very severe. Friday and Saturday, March 15th and 16th, were spent in platting the orchards on the two places, in preparing material and getting together suitable spraying equipment. Rain prevented any spraying Monday or Tuesday morning, and the trees were barely dried of rain in the afternoon when I began the first application.

Scope of Experiments in Watt's Orchard

The trees in this orchard being smaller and less scaly than in the other, I determined to try *every* mixture here, and duplicate but a few of them in the Flack orchard for reasons which will be given later. The sprays used here were as follows:

1. Scalecide, 1-15, and 1-20.
2. California Spray applied luke warm.
3. California Spray applied boiling hot.
4. Piper, or 1-1-4, formula.
5. Niagara Spray, made in Portland, Oregon.
6. Rex Spray, made in 1907.
7. Rex Spray, made in 1906.

The part of the orchard selected for spraying consists nearly entirely of apple trees. One peach tree was sprayed, which was obviously scaly, and one or two very scaly pear trees. The balance of the orchard, consisting of pears, prunes, peaches and plums, was later sprayed by Mr. Barbee himself, and was not considered in this experiment. The apple trees were practically in a square, 12 trees each way, or 144 in the orchard. As a fact there were less trees than that, for Mr. Barbee was engaged in pulling out one full row as I reached the place, while at that time or afterwards he pulled out many individual trees which were nearly dead, or of poor varieties. The 128 trees left were of eight main varieties and a few scattering ones, but as no difference in infestation was apparent due to varieties, no further account was taken than to see that some of every variety were sprayed by every

spray. A more important thing, however, was to note the *degree of infestation* of every tree sprayed in *both* orchards. So, to be sure of things when I returned to check up the orchard May 31st, I platted every tree in its proper place, noted the variety of the fruit, and used ordinary minute marks (') to note the degree of infestation. Each tree was represented by a cross, and the minute marks used would express infestation as thus.

X = tree with no visible scale.
X' = tree with slight scale.
X'' = tree with some scale, but not much.
X''' = tree with much scale.
X'''' = very scaly tree.

Where trees were in broken rows, I showed it on the plat, and where the trees were entirely out of rows or in very irregular rows, I attempted to give these also their relative positions on the plats. The importance of all these details cannot be too much emphasized where one is using several sprays, each spray covering but a few trees. Another thing, which I thought would materially interfere with my results, unless the utmost care was used to prevent it, was the violence of the wind which prevailed during one whole day in this spraying. This accounts for the amount of spray apparently wasted in spraying these few trees The only way I could *know* that I was covering the tree on the leeward side was to bring the nozzle as near the tree as possible and spray *against* the wind, stopping whenever I could see that much of the spray was being carried to any near tree on which any other spray had been used. In the face of so many difficulties I think the results were rather remarkable.

Method Used in this Experiment to Determine Killing Efficiency

It has often occured to me that it is a very serious problem to determine just how great a proportion of the scales is killed by each spray. You cannot simply take *all* the scales containing no live insects into your calculations, for many of these, in well infested trees, are already dead, and simply hanging in place.

Neither, on the other hand, can you say that every live scale you find later in the season withstood the spray, as the spray may not have touched it. Poor spraying accounts for much of this supposed immunity. Then, many of the old scales are completely overlapped by others, while many are placed under projecting bark and in small crevices, into which the spray cannot penetrate. No spray with which I am acquainted will kill *all* of the live scales in a much-infested orchard, simply for the reason that no spray will reach *every* scale. These being some of the difficulties that confront any one who proposes to count the number of scales killed in any area, I determined to adopt a different method. I devoted my enumerations entirely to the little, black, new scales, which by many observations with a good compound dissecting glass I had found in these two orchards, and as far as I had observed elsewhere, *invariably alive*, as well as to such older scales as might be with them in open, exposed places and free from other overlapping scales. In this way, and in this way alone, it seems to me, one can absolutely know the proportion of scales he kills with his spray. No old scale was counted as killed by the spray unless her body showed recent death.

Reasons for Using the Several Sprays, and Results

Scalecide. This material had been sent me with high endorsements by the makers, while the bulletins of many stations had given it a good name. Some writers had said that it would "kill all scale" at the proportion of 1 of scalecide to 19 of water, while the makers and several station men recommended rather 1 to 15. I tried both.

Rex and Niagara Sprays. Both of these are commercial mixtures of lime-sulphur, the first made (then) in Omaha, Nebraska, the second in Portland, Oregon. Both of these sprays had received severe criticism in some quarters, especially in Southern Idaho, so I wished to pit them against the other sprays in this locality. My reason for trying the Rex twice was to see whether it lost in killing power when over one year old, as many, myself included, had feared.

California and Piper Sprays. Though I had tested these

two sprays in Northern Idaho and had been entirely satisfied with the Piper or more dilute spray, I was desirous of testing it in the South, and have its work observed by others there, since in this part of the state it had received most severe criticism. This latter spray is composed of one pound lime and one sulphur to each four gallons of water. Further discussion of this spray can be found in a bulletin published by our station last year.

Experiments at Flack Orchard

The orchard on this place is mainly of very large trees of several kinds of fruits, including apples, pears, cherries, apricots, peaches, plums, and prunes. The apricots showed no San Jose scale, nor did the sour cherries, both trees being nearly always in our country immune. Many of the other trees were enormous, their upper branches could only be thoroughly reached by spraying from the wagon and from ladders. Hardly a tree was free from scale, while some were so infested as to appear grey at considerable distances. The scales were, on almost all of the trees, so numerous as to overlap one another, thus making their killing very difficult. Let me say in justice to Messrs. Flack that these trees were in this condition when they recently bought the place, and that they are showing most praiseworthy zeal in trying to get rid of them. As before remarked it was mainly for these two reasons, size of trees and crowded condition of scales, that I determined to duplicate our experiment, at least as far as the California, Piper, and Rex sprays were concerned. About 95 trees were sprayed by us in this experiment, and these were of six different fruits, but mainly apples. A few, supposedly from the inroads of the scale, were nearly dead. A few were so infested that no part of the bark could be seen for scale.

Results and Conclusions

On May 31st I returned to check up results, bringing with me a fine dissecting glass. A table and chair in both cases were carried out into the orchard, and thus, using both hands with the needles, I could be sure of every scale examined, no matter

how small. Each tree was examined and finished before another was touched. In doing this, many small strips were cut from the trees in various places, some where the limb or trunk would be fully exposed to the spray, while others were cut from the under sides of limbs or from places where two limbs or a limb and the trunk came together. This would give two extremes, the places reached most easily by the spray, as well as those reached with most difficulty. I shall now give the results of these examinations on each tree, giving variety of tree, and spray used. I shall give the Flack orchard first, as I began my observations in this orchard. It must be borne in mind, as before explained, that in these countings I considered only the small, black scales, which had been seen to be all alive in March, together with whatever old exposed scales could be found alive or *recently dead*. No scales, where the insects would break readily under the needles, were counted, as it was most likely these had died prior to the spraying. Of course no empty scales were considered at all.

Flack Orchard

A. Rex Spray. 1 gallon Rex to 9 of water.

Tree 1. Specimens of bark from infested apple-tree. Turned over hundreds of scales of all ages and sizes. One live scale.

Tree 2. Prune much infested. Turned over 100 scales. Three live ones on under sides.

Tree 3. Plum limbs. Whole tree covered with scales. 100 scales examined. None alive.

Tree 4. Peach. Scales scattered. 57 counted, 2 lives ones in bud crevice.

B. California Spray. 30 lbs. lime, 15 sulphur, 7½ salt, boiled one hour.

Tree 1. Apple. Limb slightly infested, scales scattered. 19 counted, all dead.

Tree 2. Apple tree nearly killed by scale. Scales very abundant. 100 examined, four alive.

Tree 3. Apple tree very badly infected. 103 scales counted, seven alive.

Tree 4. Pear tree, very scaly. 38 counted, two alive.

C. Piper Formula. 1 lb. sulphur, 1 lime, 4 gallons water. Boiled one hour.

Tree 1. Apple. Whole tree badly covered, scales overlapping. 100 counted, eight alive.

Tree 2. Apple. Somewhat affected. Twigs near center of tree. 113 counted, all dead.

Tree 3. Slices from trunk of badly affected apple tree. 175 scales counted, all dead.

Tree 4. Limb from badly affected apple tree, scales much overlapping, so whole tree gray with them. 100 scales counted, 10 alive.

D. Rex Spray. Second test. 1 to 10.

Very scaly apple tree, but scales mainly single or separate. 40 counted, all dead.

Watt's Orchard

Mr. Yost, with whom I was staying, now became so interested in my experiments, that he went with me to this orchard, and for the whole of the afternoon assisted me in counting. We took off two or four slips of bark from each tree, and while he counted one lot with a microscope I counted the other. The most seriously infested trees were selected but these seldom equalled the average in Flack's orchard.

A. Scalecide.

Tree 1. Formula 1-15, or one gallon scalecide in 14 gallons water. 100 scales counted. two alive. 100 counted, all dead.

Tree 2. Formula 1-20. 100 counted, none alive. 100 counted, nine alive. 100 counted, 20 alive. 100 counted, all dead.

B Niagara Spray. 1 Niagara to 9 of water.

Tree 1. Tree somewhat infested. 40 counted, one alive. 53 counted, 2 alive. 85 counted, 1 alive.

C. Rex Spray. Over one year old, nearer 1½ years. 1 gallon Rex to 9 of water.

Tree 1. 67 scales counted on rather scaly tree, one alive in a small crack in the bark.

Tree 2. Tree slightly scaly. 19 counted, all dead. 36 counted,

all dead.

D. Piper Formula. 1 lb. lime, 1 lb. sulphur, 4 gallons water, boiled one hour.

Tree 1. Pear tree, badly infested. Counted 100 scales twice, all dead. Scraped off with knife blade several hundred scales, all conditions, counted, and found three alive.

Tree 2. Apple with many scales. 100 counted, all dead. 50 counted, five alive.

Tree 3. Apple, slightly infested. 100 counted, three alive. 104 counted, none alive.

Tree 4. Apple, with scales very numerous and overlapping. 106 counted, three alive. 100 counted, one alive. 200 counted, none alive.

Tree 5. Shown by notes to have been sprayed soon after a very hard rain and *not dry*. On one specimen, counted 100 scales, all dead. On another specimen, counted several hundred scales and fully 25 per cent were alive.

E. California Spray, 30-15-7½ boiled one hour. Applied part boiling hot, other part warm.

Tree 1. Counted 200 scales, none alive. Counted 150, 1 alive.

Tree 2. Scales more numerous than on last. Counted 100, with two alive. 100 counted, six alive. Small limb counted, all dead.

Tree 3. Counted several hundred scales, and found 20 per cent alive. From notes found that this tree had been sprayed just *before* the very hard shower mentioned above, and had not dried at all.

Reducing the counting for both orchards to per cents with each spray, and then averaging we find:

1.	Scalecide, 1-15	96 per cent of scales counted killed.
2.	Niagara, 1-10	98 per cent of scales counted killed.
3.	Rex, 1-10	98½ per cent of scales counted killed.
4.	Piper, 1-1-4	96.3 per cent of scales counted killed.
5.	California, 30-15-7½-50	97 per cent of scales counted killed.

Conclusions

1. All of these sprays, at least in my experiments, show about equal and very high killing efficiency.

2. Scalecide 1-20 does not kill enough scale. At 1-15 it kills scale as well as any spray, is pleasant to handle, covers the tree quickly with its oily coating and mixes easily and readily. Were its cost not far in excess of home made lime sulphur sprays, and even twice that of the commercial articles, it would be the most desirable agent I am acquainted with in getting rid of this pest. In spraying a few trees or bushes for scale, I should buy it in preference to any other spray, owing to its non-corrosive character and ready mixing.

3. Salt added to lime sulphur sprays is useless.

4. Sprays containing less sulphur and lime are just as efficient as the California spray.

5. Where trees are small and scales separate from one another, any of these sprays will kill practically all the scales.

6. Where trees are enormous, and hard to cover and offering many rough places, and consequent hiding places for the scale, no spray is likely to kill all the scales.

7. Where scales are massed so as to cover one another, the undermost scales will not all be touched by the spray, and consequently will not be killed.

8. For trees in either of these two last classes it will be found most beneficial to give two sprayings, one in the late fall, and one in the early spring.

Mixed Sprays for Codling Moth and Apple Scab

In the two previous seasons I had proved that three sprayings with Bordeaux are sufficient for the worst attacks of scab we have ever had in this country. I had also shown that it is early enough to commence these sprayings just as the first color is showing in the apple buds, that is as the flower buds are beginning to separate from one another in the clusters. My previous two years' experience with the arsenicals, in combatting codling moth, had told me that some good make of arsenate of

lead, like Swift's, had killed most worms, followed closely by home-made arsenate of lead, Paris Green, Kedzie's Soda Arsenite of Lime, and Taft's Arsenite of Lime There were many problems connected with the subject which I had not solved to my satisfaction, and these I hoped to clear up this season. These problems I have mentioned at the beginning of my article, and I shall not repeat them save as I come to them.

I may right here say that we had almost no scab this year in any well kept orchards, whether sprayed or unsprayed, so that we were forced to take consideration only of the codling moth. Then, in the month of July we had several tremendous and unprecedented storms, which must of necessity largely have affected the amount of codling moth. For the first time in my 15 year's experience in this country a perfect deluge of rain fell accompanied by hail of great size and of unusually long duration. The surface soil in many places was carried from the orchards, baring the roots of the trees, while the hail stones were so large that hardly a tree or an apple escaped some injury. I considered this so large a factor in the destruction of moth, eggs, and larvae then on the ground that I am unwilling to say what portion of the brood was killed by the sprays.

Does Bordeaux Applied at Flowering Time Hurt the Young Apple and Why

For several years I had noticed that Bordeaux injures the apple when young, but what it was due to I did not know. First I had laid it to the door of excess of blue stone over lime or too great a strength of the former in reference to water. Last year, when the admirable bulletin on "Bordeaux Injury" was about to appear from the Geneva Station, I was inclined to think *weather* had most to do with this, and so informed Professors Hedrick and Hall. This year, luckily, I had beautiful warm, sunny weather at time of the calyx spraying, so this year at least neither rain nor wind could have had anything to do with the injury. Instead of spraying the whole orchard, as I had the year before, with Bordeaux plus the arsenical at this time, I selected about 6 or 8 trees of each of the four varieties of apple, Rome, Jonathan, Ben Davis

and Gano, and these I sprayed with Bordeaux plus arsenate of lead, while the rest of the trees in several acres I sprayed with the arsenical alone. I furthermore used the Bordeaux in the strengths.

2 lbs. copper sulphate—2 lbs. lime—100 gallons water.
4 lbs. copper sulphate—4 lbs. lime—100 gallons water.
8 lbs. copper sulphate—8 lbs. lime—100 gallons water.

Not two weeks had elapsed before the injury was apparent and it became more and more noticeable throughout the growth of the apple, till at picking time scarcely a fruit was to be seen on any of the trees which was not russetted or even much distorted. Moreover the injury seemed the same with the weakest as with the strongest mixture. *No injury was to be found where the arsenate of lead alone was used.* Twenty days after the first spraying with the arsenical we went over the whole plat again and this time we used *on every tree* the Bordeaux plus the arsenate of lead. No injury resulted from this spraying, though in every 100 gallon tank I used 8 pounds of copper sulphate and 8 pounds of lime. When using the first spray for moth I employ a Bordeaux nozzle, on account of the force obtained by it and the coarseness of the spray. I endeavor to spray *into* every young apple with violence and with abundant spray. While I was spraying in this orchard, a neighbor across the way was using the same spray, Bordeaux plus arsenate of lead, but he used much less spray than do I, while he also employed a Vermoel nozzle, which throws a conical, thin spray of little force. *Very few of his apples showed any Bordeaux injury.* I am, in the light of another season's experience, inclined therefore to think that the sprayer must do one of two things at the time of first spraying for moth. He must either give a very light and inefficient spraying at this time with Bordeaux and the arsenicals; or if he believes as do I that this is the most important spraying for moth, and therefore should be heavy and forcible, he must *leave out* the Bordeaux and use it in the ensuing spraying two or three weeks later.

The three other points we had outlined for our experiment,

1. Home made versus Commercial Arsenates of Lead,
2. Reduction of amount of Arsenate of Lead,

3. Dust Sprays versus Liquid Sprays, were inconclusive owing mainly to absence of fungi in this orchard this year, as well as to the violent storms. Partial results we did however get.

1. The Dust spray gave as good results for codling moth *this year* as did the liquid spray.

2. The per cent of wormy apples in this, as well as in all sprayed orchards, was very low, not one per cent.

3. Unsprayed and uncultivated orchards had a high per cent of loss from codling moth, frequently under my own observations running as high as 75 per cent.

4. While some of our rows of trees did not average a half dozen wormy apples to the loaded tree, those rows that were next to an orchard which has never been sprayed, cultivated, nor pruned, to my knowledge, gave as high as 50 per cent of wormy apples, decreasing rapidly to less than one per cent as we left the infested orchard, though all of the trees in our orchard had been sprayed three times. It is therefore vain to look for good, clean apples in your orchard, no matter how often you spray, if an indifferent, careless neighbor just over the fence will not spray at all. Such a man should be compelled to spray or have his orchard destroyed by law.

5. The weaker sprays, with arsenate of lead, gave us this year about as good results as did the stronger. Whether this would be the case in a normal year I cannot say.

Peach Leaf Curl

But one point remains. Does salt add to the efficiency of Rex or Niagara Sprays when used to prevent curl of Peach? This may be answered briefly. Several years ago I had used the California wash, with salt, to combat curl in an orchard near Lewiston with good results. Last year I used in my orchard the Niagara and Rex Sprays of course without salt, and the sprayed trees were as much covered by curl as were the controls. I was much surprised, and this year determined to use salt in some Niagara Spray which was sent me from Portland. I put in about seven pounds common salt, first dissolved in hot water, and this

year these same trees showed almost no curl at all. Though this experiment is not conclusive, I am inclined to think that salt is essential to the efficiency of this spray, of the Rex, and of the Piper Spray, when used for curl.