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Winter Spraying for the Apple Aphis

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By J. M. ALDRICH

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# IDAHO EXPERIMENT STATION

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## Winter Spraying for the Apple Aphis.

By J. M. ALDRICH.

The apple aphis has been much more troublesome than usual for the last two years, especially in the northern counties of the state. Formerly so few trees were affected that it was rarely thought necessary to use any means to hold the insect in check. With its recent increase the necessity has arisen for regular defensive work by the orchardist. The present bulletin, while chiefly devoted to one phase of this subject, includes a brief summary of the habits of the insect, and the usual methods for destroying it.

There are two species of aphis on the foliage of apple in Idaho. One is very rare, and is distinguished by its pink, red or purple color (*Aphis sorbi*); the other is the common green species (*Aphis pomi*). The latter only is here considered, as the former has not so far done any noticeable damage. The two kinds have been distinguished by some writers as the green aphis and the rosy aphis.

The green aphis is familiar to every orchardist as the small, soft, green species which clusters on the young leaves and shoots of apple. It also affects the pear, but not often, and there are some records of it on the quince. As far as known, it does not affect any of the wild shrubs or plants of this section. This is a somewhat important point, and any positive observations to disprove it would be most interesting and valuable. The possibility of its living on wild trees or shrubs has been suggested very strongly by the fact that it is

generally worse in orchards located on clearings, and surrounded more or less by timber and brush. This is a matter of common observation throughout the northern counties of Idaho; but so far no other explanation can be given than that these sheltered locations offer more favorable climatic conditions for the insect. If it could be shown that the insect comes upon the apple from the adjacent brush, it would completely change the nature of the problem. Many farmers believe that the aphid has this habit; and in fact a related species of apple aphid in the east (*Aphis fitchii*) does have two food-plants, living for part of the year on grass or wheat. In that case, however, the insect winters on the apple, and does not leave it till about June, coming back in September. There is no doubt that our apple aphid also winters on the apple tree, as the eggs can be found without much trouble.

The relation of ants to aphids is often greatly misunderstood. While the apple aphid is generally accompanied by ants, it is not in the least degree injured by them. The ants treat the aphid with great care and consideration, because it gives out a sweet excretion greatly relished by them. From this a common saying has arisen that the aphid is the ant's cow, and there is some resemblance in the relation that exists. Many species of aphid are cared for with considerable intelligence by ants. The eastern apple aphid has been known to be carried by ants from the apple-tree to wheat stalks at the proper time for the migration. The theory has been advanced that our own species of apple aphid is wintered by the ants in their nests, and brought out on the tree again in the spring. There is nothing impossible about this, but no observations directly bearing upon it have been made. As

we know that the aphid winters upon the tree in the egg state, it is not necessary to account for its winter existence by any other theory. But it will do no harm to destroy ant's nests in the orchard, and it may be of some assistance in holding the aphid in check.

### HABITS.

The eggs of our species are deposited in October and November on the young shoots of apple-trees, usually near the tips. Occasionally they are found also about the forks of somewhat larger branches. When first laid, they are bright yellow in color, approaching orange, but they soon turn dark, and in a few days are shining black. On small trees, where the branches can be easily inspected, it is easy to recognize the eggs with the naked eye. Only a few of the trees which had aphid on in the earlier part of the season will be found to have any eggs on, and even when they do occur, it will probably be on only one or two twigs. Healthy eggs are smooth, plump and shining black, and can readily be detected without a magnifying glass. It is not uncommon to find shriveled eggs, and sometimes the remains of small lice will be found on the same branch, and these may more or less resemble the normal eggs; but a little experience will readily distinguish the latter.

The eggs hatch about the last of April, while the young apple leaves are still very small, and just beginning to unfold. For some time, owing to the cold weather of that season, the young grow slowly; but before the leaves are fully grown, they may be covered with lice on the under side, and beginning to curl. The lice increase very rapidly, bringing

forth living young at the rate of several a day, which themselves are large enough to repeat the process in a few days. There are no males at this season, all the individuals being viviparous females. Hence the rate of increase is enormous. Among those which are produced in the earlier part of the season, many have wings, which enables them to fly to other trees. May and June appear to be the season of spread; later they do not appear to attack new trees.

There are numerous enemies of the apple aphid, which exercise a marked influence on its abundance. In almost every orchard where the aphid is troublesome, there seems to be a period of relief about midsummer. This is caused by the increase of those predaceous insects which feed upon the aphid. There are so many kinds of these beneficial insects that it would not be practicable to enumerate them in a brief bulletin.

After increasing and spreading in the summer, as described, the aphid produces a generation in the fall of perfect males and females, which are small, yellowish insects, considerably different from the individuals produced during the summer. The females of this generation lay their eggs as described above.

There is a very marked difference in susceptibility to aphid among different trees, even of the same variety. An occasional tree will be affected year after year, while surrounding trees will be exempt. More rarely one variety will be worse attacked than others adjacent; but I have not been able to make any reliable lists of resistant varieties. The difference seems to be mainly a quality of individual trees rather than of varieties.

The damage to the trees is caused by loss of sap, which is sucked from the leaves and tender shoots by the aphid. When they begin work on a new leaf, it speedily becomes rolled up; as the insects are on the under side, they are on the inside of the roll, and well protected from sprays. There is some difference among the different known species of apple aphid in the extent to which they roll the leaves. Our species rolls them as tightly as any, as will be seen by referring to the illustration.

### REMEDIES.

This naturally would divide itself into two branches; remedies to destroy the eggs in winter, and those to destroy the active stages of the insect at other seasons—or practically in early summer.

#### Spraying for the Eggs.

This has been but little tried, and with mostly unsuccessful results, as far as I have learned. It was decided to carry out a series of experiments to see if any satisfactory spray could be found for winter use.

First it was necessary to find an orchard in which there were enough trees with eggs on to give the number of series desired. After some searching, the young orchard of Hon. J. H. Forney, a few miles north of Moscow, was found suitable. Here were a large number of two and three year old trees among which one hundred were found to have eggs on, and were tagged with pieces of cloth, so that they could be readily found. On April 16, 1903, the buds not having swelled perceptibly yet, the spraying was done. Eight series of trees

were provided, of which seven were sprayed with the following materials:

1. Pure kerosene.
2. Kerosene emulsion, one-third kerosene.
3. Kerosene emulsion, one-fifth kerosene.
4. Sulphur and lime, 1-1-2 (one pound sulphur, one pound lime and two gallons of water).
5. Sulphur and lime, 1-1-4.
6. Sulphur and lime, 1-1-8.
7. Crude petroleum emulsion, ten per cent strong.

Nos. 4, 5 and 6 were made by putting equal weights of slacked lime and sulphur in a boiler with a convenient amount of water, and boiling for about two hours and a half. It is not usually boiled so long, according to Professor Piper's directions (Bull. 56, Washington Experiment Station,) but I had some doubts as to whether it was sufficiently dissolved, and continued the process. The lime had been slacked the previous evening. After the boiling, enough additional water was used to make the proportions mentioned, and all was strained into the barrel through a sieve.

No. 7 was made from heavy, black oil obtained from the Standard Oil Co's San Francisco office under the name of crude petroleum. It may have been a distillate. The company would not engage to furnish any particular kind or brand of crude oil. This was very heavy and thick, and separated from the emulsion before more than half a dozen small trees were sprayed, so that on the rest large drops of pure oil were interspersed with soapsuds on the trees, making the attempt to spray quite useless. I had had the same trouble once before with the same kind of oil, and it has been reported to me



from Lewiston and Weiser, Idaho, also. It would seem therefore that this sort of crude oil is valueless for spraying purposes.

Directions for making the sulphur, and lime spray and kerosene emulsion will be found at the end of the bulletin.

### Results.

May 7, 1903. The following notes were made:

#### UNSPRAYED.

Tree No. 1. Eggs hatched and the lice distributed a few in a place on the young leaves for the whole length of last year's growth, on the only affected branch. Lice have grown perceptibly; not all the same size, but none newly hatched. Largest leaves on the tree are an inch long, besides the stem, and affected ones are curling a little. It is considerably too early for apples to bloom yet.

No. 2. Condition like No. 1, but aphids more plentiful. I think all are at least five days old, some considerably more.

No. 24. No eggs hatched; all shriveled; probably not fertilized.

#### SPRAYED WITH NO. 1.

No. 3. No eggs hatched at all. Tree not leaved out very evenly as yet, but probably not killed in any part.

No. 4. Tree almost entirely killed. A few buds pushing out. No eggs hatched.

No. 5. No eggs hatched. Tree checked and belated in starting, but perhaps not much killed.

No. 6. No eggs hatched. A few buds are coming out

normally, but the rest are delayed by the spray.

No. 7. One branch is plastered with eggs, but not one is hatched. Tree obviously delayed in starting, like the preceding ones.

#### SPRAYED WITH NO. 2.

No. 10. Buds not affected. Eggs have hatched quite generally.

No. 11. Buds not affected. Eggs have hatched out quite generally.

No. 18. Buds somewhat retarded by the spray, not seriously. No eggs hatched.

No. 19. Very few eggs hatched. One main shoot perceptibly retarded.

No. 22. No eggs hatched.

No. 23. Several eggs hatched. A perceptible retardation of several shoots, not very serious.

#### SPRAYED WITH NO. 3.

No. 12. Foliage normal. On two twigs with plenty of eggs, found only three aphids; but there were two lady-bugs on one of the twigs. At least 95 per cent of the eggs did not hatch.

No. 13. Foliage normal. Eggs hatched pretty freely.

No. 14. Foliage normal. Eggs hatched as in No. 13.

No. 15. Almost no eggs hatched. Foliage normal.

No. 16. No eggs hatched. Foliage normal.

No. 17. Found only one aphid. Foliage normal.

#### SPRAYED WITH NO. 4.

No. 20. Foliage normal. No eggs hatched.

- No. 25. Same results.  
 No. 26. Same results.  
 No. 30. Same results.  
 No. 31. A single aphid. Foliage normal.  
 No. 35. Affected branch not found (the spray in a few cases concealed the few eggs, which did not hatch.)  
 No. 47. Affected branch not found.  
 No. 49. Affected branch not found.  
 No. 50. Six aphid hatched out of a large number of eggs. Foliage normal.

#### SPRAYED WITH NO. 5.

- No. 27. No eggs hatched. Foliage normal.  
 No. 28. No eggs hatched. Foliage normal.  
 No. 29. No eggs hatched. Foliage normal.  
 No. 32. Affected branch not found.  
 No. 33. Affected branch not found.  
 No. 36. No eggs hatched. Foliage normal.  
 No. 37. No eggs hatched. Foliage normal.  
 No. 38. Three aphid on one bud; no others hatched. Foliage normal.  
 No. 40. One aphid on terminal bud; no others hatched. Foliage normal.  
 No. 41. Six aphid on one branch, evidently missed in spraying; another branch had eggs upon it, none of which hatched. Foliage normal.  
 No. 42. Affected branch not found.

#### SPRAYED WITH NO. 6.

- No. 43. No eggs hatched. Foliage normal.  
 No. 44. A few hatched out of a large number. Foliage normal.

- No. 45. Affected branch not found.
- No. 46. Affected branch not found.
- No. 51. Two or three eggs hatched out of a large number.
- No. 52. Affected branch not found.
- No. 53. No eggs hatched. Foliage normal.
- No. 54. No eggs hatched. Foliage normal.
- No. 55. Four eggs hatched. Foliage normal.
- No. 56. Two eggs hatched. Foliage normal.
- No. 57. Several eggs hatched.

#### SPRAYED WITH NO. 7.

- No. 47. One aphid hatched; only a few eggs. No remains of spray except a little on trunk, dry.
- No. 58. Petroleum remaining in dried drops. Plenty of lice hatched.
- No. 59. Same result as preceding.
- No. 60. Spray more uniformly applied. One branch with many eggs, none hatched.
- No. 61. No lice hatched.
- No. 62. Only a few eggs; some of these have hatched; spray uneven.
- No. 63. Plenty of lice hatched.
- No. 64. No eggs hatched, but eggs too few to signify much.
- No. 65. Eggs numerous; none hatched.

#### SUMMARY OF SPRAYING EXPERIMENTS.

Crude petroleum could not be uniformly applied. The emulsion was very unstable, and the oil is much too thick to apply pure. No damage resulted to the trees, but in many

cases the eggs of lice were not destroyed.

Pure kerosene seriously injured the trees to which it was applied, but killed all the eggs.

Kerosene emulsion of one-third strength injured the foliage to some extent, though not very seriously; it did not kill the eggs with any uniformity. In one-fifth strength it did not injure foliage, but was not at all effective in killing eggs.

Sulphur and lime did not injure foliage in the least, however strong. In the 1-1-2 and 1-1-4 proportions it killed almost all the eggs; it is a question whether the very few that hatched had not been missed by the spray.

Of the seven kinds of spray used, the choice for commercial purposes would undoubtedly be No. 5, sulphur and lime in the 1-1-4 proportion, or what is called the "Piper formula."

### **Practicability of Winter Spraying.**

The experiments above detailed seem to show that winter spraying is a success; still there are limits to its applicability. It should be remembered, that eggs are laid on only a few trees, and usually on only a few branches of these, often on only one twig in the tree. Hence it becomes desirable to ascertain first where the eggs are, in order not to waste time with trees that are free from eggs. With a young orchard, not over four years old, this is not a difficult matter. On older trees, it will, probably be as well to depend on summer spraying. Winter spraying will not generally be thorough enough unless the trees are small, and the places to spray are definitely known, and can be easily reached. All these conditions can be met in young trees, but in orchards five or more years old serious difficulties will be met with. Summer spray-

ing has the advantage that the curled leaves show at a glance, even on quite large trees.

Since the aphid is almost always worse on young trees, and furthermore since our investigations last spring showed that young trees are preferred for the deposit of eggs, where young and old are in the same orchard, it does not appear that the difficulty of treating large trees will interfere to a great extent with the use of winter spray.

### **Other Methods of Destroying the Eggs.**

On small trees the eggs can be destroyed by crushing them with the hand. This is quite practicable when only a few trees are to be taken care of, and is not to be despised on a larger orchard if anything makes it impossible to apply spray. For instance, there are a few orchards known to me that are located on such rough land that it would be difficult to handle an ordinary spraying outfit among the trees. In such a case, while the trees are small, it would certainly pay to examine them in the course of the winter and destroy the eggs of the aphid. There are also some apple-growers who do not have the use of a team all the time; and with such it might pay to use hand work.

Mr. Geo. Heyd, who was employed in the orchard where our spraying was done, inspected and cleaned by hand several acres of trees. He devised a little wooden paddle for reaching between the bud and twig after eggs that could not be reached with the hand.

### **Summer Treatment.**

This is a line of work that has been practiced on a commercial scale in some sections for a number of years. In

Idaho however it has not generally been necessary heretofore, except for the last few years in Kootenai county, and perhaps in occasional orchards elsewhere in the vicinity of timber. Elsewhere in the state the injury by aphid has been comparatively little. As the subject has been pretty thoroughly investigated, it was not included in the experiments of last season. Some observations on practical work have been made, which are here set forth.

The treatment of trees not over four years old is quite different from that of bearing trees, since the former can be dipped instead of sprayed, which is much more thorough. Simply take a pail nearly full of the solution and go round the tree, bending the affected branches down into it so that the curled leaves are thoroughly soaked. This is more rapid than spraying, more effective, and more economical, as only a little material is required. On larger trees spraying is necessary, and must be very thorough, or the lice inside the curled leaves will not be reached. It is a rare thing to be a complete success; it generally has to be repeated at intervals of a week or ten days through the worst part of the season. Even dipping does not always give complete success, but generally lasts better than spraying.

A striking illustration of success in spraying large apple trees was seen near Coeur d'Alene City, last May. It was done by Mr. J. A. Waters and it was hard to find a living aphid; on some trees there were absolutely none, as far as could be found by careful search. Mr. Waters sprayed with quassia and whale oil soap. His method of preparing is given further on.

Prof. L. F. Henderson, on his orchard near Moscow, used part of the time a ten per cent kerosene emulsion, and on



Fig. 1. Young shoot of apple, dipped for aphid early in its growth. [From photos; drawn by Miss Metta Woodworth.]

the rest of the orchard a preparation of quassia and whale oil soap, following the formula of Mr. E. L. Smith, President of the Oregon Board of Horticulture given further on. As his trees were two and three years old, he dipped instead of spraying. Parts of the orchard he had to treat several times, and the task was quite laborious; but he had no loss to speak of from aphid. In examining his trees late in the season, some branches were found which testified in a silent but expressive manner to the success of his work. Photographs were made of one of these, and from them the accompanying illustration was prepared. It shows the whole of this year's growth on one branch, which was 44 inches long. At the base, where the shoot began the season, a few leaves are seen of normal appearance; next the aphid commenced work and a few leaves are badly curled; then the branch was dipped, completely destroying the aphid, which did not happen to come back in the season; so all the remaining parts of the branch has fine, vigorous



foliage. An inspection of the illustration will show these stages, and conclusively prove that the treatment was a success. This particular tree was dipped in ten per cent kerosene emulsion, but equally good results were had with quassia and whale oil soap. In fact, Professor Henderson prefers the latter, as he had some trouble with the emulsion; it would sometimes separate a little, leaving a thin film of oil on the surface of the emulsion, which injured some leaves when they were dipped in it.

### **Quassia and Whale Oil Soap Solution:**

#### **J. A. WATER'S FORMULA.**

Take 18 pounds of quassia chips; put in barrel and pour ten gallons of boiling water over them; let stand over night, or at least half a day; then pour off the water, heat it to boiling, and dissolve in it 18 pounds of whale oil soap. Dilute this to make 180 gallons before applying.

#### **E. L. SMITH'S FORMULA.**

Boil one pound of quassia chips in water for two hours; add enough water to the extract to make four gallons. Dissolve one pound whale oil soap in four gallons of hot water, and combine the two solutions.

### **Kerosene Emulsion.**

Heat one gallon of water to boiling, and dissolve in it one-half pound of hard soap shaved fine (so that it will dissolve more readily). While the solution is still boiling hot, remove it from the fire and pour into two gallons of kerosene. Then immediately pump through a small spraying machine back into the same vessel, dashing the stream from the nozzle against the surface of the mixture with as much force

as possible. This will cause the mixture to blend into an emulsion, which has a milky appearance. It generally takes about five minutes vigorous pumping to completely emulsify the quantity used in the formula. If on stopping a film of free kerosene is seen rising to the surface after a minute or two, pumping should be resumed. When perfectly made, there should be no free oil, and it should stand for weeks without separating. To get such results, good soap and clean, soft water are requisite.

The formula makes in itself three gallons. Adding 17 gallons of water will make a ten per cent emulsion, as two gallons of the twenty are kerosene. This is the strength usually recommended for spraying aphids.

A little free oil on the surface makes but little difference in spraying, until the bottom of the tank has been nearly reached, as the spray is drawn from beneath; but in dipping branches it is otherwise, as the leaves get the full benefit of the free oil on the surface, and may easily be killed by it.

#### **Sulphur and Lime Spray—Piper's Formula.**

Sulphur, 1 pound. Lime, 1 pound. Water, 4 gallons.

First slake the lime in the cooking vat. When slaked add the sulphur and enough water so that the mixture will stir easily. Keep it well stirred until boiling begins. Boil one hour. The mixture should then be completely dissolved (except for impurities in the lime) and of an amber color. Then add the requisite amount of water, and the mixture is ready to spray. Pour into the spraying tank through a strainer. In applying, use a rather coarse nozzle and considerable pressure.