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Department of Entomology

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By J. M. ALDRICH.

DEMOCRATIC-TIMES' JOB ROOM,
Moscow, Idaho.

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BULLETINS

The regular Bulletins of the Station are sent free to all who request them. Late Bulletins are:

21. The Codling Moth.
22. Onion Growing.
23. Meteorological Records and Prediction of Frosts.
24. Cattle Feeding and Crop Tests.
25. Composition of Arsenical Insecticides.

Crude Petroleum as an Insecticide.

Preliminary Report.

Since the discovery of the San Jose Scale in many parts of the East in recent years, this substance has been taken up in that part of the country as a remedy. The common western method of spraying with sulphur, lime and salt has not been very satisfactory east of the Rocky Mountains, hence there has been a marked tendency to turn to other measures of relief. This has led to a considerable use of petroleum. The bulletins of the New Jersey Station, by Dr. John B. Smith, embody a good share of the investigations, especially Bulletin 146.

The seeming success of eastern experiments, together with the probability that petroleum might have a considerable range of usefulness in destroying other insects, led to the beginning of the experiments reported in this Bulletin.

The material used was commercial crude petroleum, purchased of the Standard Oil Company, San Francisco. It was a heavy, opaque brown oil, with a specific gravity of 95.4, the density by the Baume scale being 16.8. The entirely different nature of this material from that used by eastern experimenters soon forced itself on our attention. In the first place, it was impossible to spray it pure, as it was of such a tenacious, gummy consistency that the heaviest pressure obtainable with a good machine—75 pounds to the inch, determined by pressure guage—was sufficient only to break it up into large drops, most of the discharge forming a solid stream.

In the second place, the spraying machine commonly used for making an automatic mixture of kerosene and water while spraying was useless, as the petroleum either would not draw in,

or else when it did, would not mix with the water. As perhaps all the reported eastern work was either by spraying pure or by the automatic mixing process, it became evident that we had an essentially different problem before us.

The next effort was in the direction of making an emulsion. This was successful, the combination with soapsuds being effected more readily than with kerosene. We used one-third of petroleum and two-thirds of soapsuds, but the emulsion on standing would rise and leave a little soapsuds below, indicating that the actual proportions in the combination are about half and half.

Comparing our oil with the eastern, the latter is much lighter, running, according to Dr. Smith's bulletin, from .7314 to .8560 in specific gravity. Of this class of oils, the heavier are hangerous to apply pure to foliage. Dr. Smith thinks a spraying oil should be between .8066 and .8156 in gravity. Samples heavier than the latter have been known to kill foliage. Since our sample had a specific gravity of .954, it would doubtless be very unsafe if it were otherwise similar to the eastern oil. It is said, however, that the western oil belongs to a different "series," having an asphaltum base, instead of paraffin. This is probably the explanation of the difference in its action.

These facts show that spraying with western petroleum is entirely different from spraying with the eastern product.

Experiments on the San Jose Scale.

The spraying in these cases was done at Lewiston, from March 1 to 10, by Messrs. S. G. Isamon and Robert Schleicher. They procured petroleum from San Francisco and applied it independently of the Experiment Station. Their material seems to have been precisely like my own, in reference to color, consistency, etc., hence I assume was of about the same specific gravity. As I was not in a position to apply the petroleum to scale insects myself, it is due to the courtesy of the gentlemen above mentioned that I can report this line of work, which is doubtless the most important of those included in the bulletin.

The first five experiments were made at Mr. Schleicher's place,

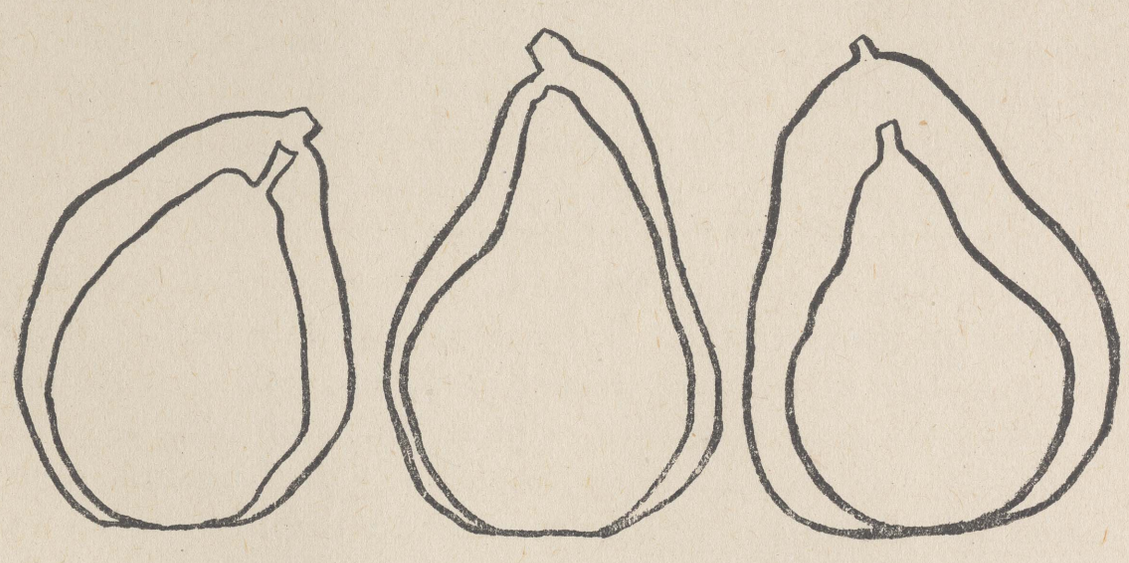
under his direction; the remainder were performed by Mr. Isamon, mostly on his own premises.

The notes on the results were made by me on September 21, after examing the trees mentioned. Previous to this and quite early in the season, I had examined specimen branches which were sent to me for the purpose.

No. 1: Pure Petroleum—One large pear tree was sprayed with pure petroleum. It was not really sprayed, but the application was partly a solid stream and partly a coarse spatter, the best that could be done with such a thick fluid. On September 21, this tree was still covered on trunk and branches with a black coating of dried petroleum. The foliage was fine and the fruit larger than on adjacent trees of the same variety, the latter having no scale. The tree treated had scale on the previous year, but no live ones could be found at this time.

No. 2: Pure Petroleum.—One side of an apple tree was sprayed with pure petroleum. It died after leafing out.

No. 3: Fifty per cent. Emulsion.—The other side of the tree was sprayed with 50 per cent. emulsion. It was in good condition and free from scale when examined in the fall.



(Fig. 1.)—See Page 18.

No. 4: Fifty per cent. Emulsion.—Some partly dead pear trees were cut back severely, almost to stumps, and sprayed with 50 per cent emulsion. Free from scale September 21. The trees

made but a poor growth. The blister mite was rather abundant on the leaves, not having been killed by the spray. This may have been because the emulsion was too thick to penetrate the bud-scales, as we saw no mites where weaker emulsion had been used.

No. 5: Twenty-five per cent. Emulsion.—Several Mt. Vernon pears were sprayed with 25 per cent. emulsion. When examined in the fall, they were apparently free from scale; bark still black; foliage and fruit very much finer than that of unsprayed trees of same variety standing next in the row. The latter had not been affected by scale. Figure 1 will show the relative size of average pears from sprayed and unsprayed trees. The larger outlines represent three pears from sprayed trees; the smaller outlines inside the former, three pears from unsprayed trees *that had not had the scale*. The difference in the foliage was about as marked. The two lots of pears are drawn in exact proportion, and equally reduced in the figure.

No. 6: Twenty per cent. Emulsion.—A number of large prune trees were sprayed with this. In the fall, the scale was still present to some extent. The foliage and the fruit were perceptibly larger on the sprayed trees than on adjacent ones, though the difference was hardly as great as in No. 5. Some silver prunes, fruit and branches, which I photographed, showed a difference that was unmistakable in favor of the spray. The prunes were silver and Italian. The former perhaps showed most benefit from the spray, in the way of larger foliage and fruit.

No. 7: Five per cent. Emulsion.—Several peach trees were sprayed with this. In the fall, some scale still living on these, but much less than on untreated trees, and less than on trees sprayed by the same man with sulphur, lime and salt.

No. 8: Less than 5 per cent. Emulsion.—Mr. Isamon sprayed a mixed orchard adjoining his own with an emulsion which was not carefully calculated, but was supposed to be about $3\frac{1}{2}$ per cent. Considerable scale present in the fall, but beyond a doubt most of it was killed in the spring.

It should be noted that Mr. Isamon sent me some branches after spraying in the spring, from trees sprayed with these weak-

est sprays, and I carefully examined them without finding a single living scale, although the bark was literally covered with dead ones. I am therefore inclined to think that even the weakest spray killed all the scale it came in contact with. Those who have attempted the eradication of scale do not need to be reminded that it is not sufficient to have an effective spray;—it must be placed in actual contact with every scale insect on the tree.

These experiments show enough promise to justify a thorough series along the same lines this spring. In fact, those who have inspected these trees will, many of them, use crude petroleum this spring instead of sulphur, lime, salt and lye. My own opinion is that the prospect for benefit from this spray is most encouraging, but we need to know how weak it may be applied without destroying its efficacy. We also need to know more of the conditions under which injury may be caused by it. Another phase of the subject is the marked stimulation of pear trees observed last year. Will this prove an ultimate benefit, or will reaction set in, detrimental to the tree? These are some of the questions which call for at least one more year's investigation.

Experiments with Plant-Lice.

The Apple Aphis.—On March 24, an emulsion containing one-third (33⅓ per cent.) petroleum was used to spray an apple tree that had a large number of eggs of this aphis upon it. The leaves had not yet started. The eggs did not hatch, showing that they had been killed by the spray.

The Elm Aphis.—Two trees of the common American Elm were sprayed with one-third emulsion, as in the preceding case. The work was done March 24, while the buds had not yet started. Examined April 14, these trees had no lice on except a few on small branches high up in the trees, where the spray evidently had not reached the upper side of a few limbs. In spraying, special attention had been paid to the rough bark of the trunk and large limbs, as the eggs are here.

These two experiments show that we have a valuable insecticide for the plant-lice in crude petroleum. The eggs of lice are generally hard to kill, hence the strength used. It remains to be

determined, among other things, how weak the application may be made.

How to Make Crude Petroleum Emulsion.

Dissolve one-half pound hard soap in a gallon of boiling water, and while still boiling take from stove and add it to a gallon of petroleum in the reservoir of the spraying pump. Then immediately pump the material through the machine back into the reservoir, using considerable force, so as to mix the ingredients thoroughly. In a large pump, it will be better to start with four or five gallons of water, increasing the soap and petroleum in proportion. The emulsion is done as soon as it presents a thoroughly mixed appearance, and the pure oil does not rise to the top when it is allowed to stand a moment. Generally four or five minutes pumping will be enough. It combines more readily than kerosene. Dilute and stir well before use.

Experiments with the emulsion should be made with caution, in the present state of our knowledge, when the leaves are on the tree. There seems to be but little danger in winter with 25 to 33 per cent. emulsion, which is even stronger than necessary for any purpose, as it appears from our experience so far.

The Elm Aphis.

Schizoneura americana Riley.

This insect has been under observation by the Department for several years, during which time most of its life history has been worked out. It had previously been studied by C. V. Riley, who published a report with figures in Bulletin No. 1, Vol. V of the U. S. Geol. and Geog. Surv. of the Territories, 1876. This account is quoted by Thomas, Report of the State Entomologist of Illinois, 1878 (issued 1879), p. 202.

The eggs winter over in crevices of the bark, and the young emerge with the very earliest unfolding of the elm leaves in the spring. They are tiny, blue-backed insects, and their first impulse is to crawl up the trunk and branches. By this means they soon find themselves on the leaves. They attach themselves to the under side of the leaf by the proboscis, and afterward do

not move about much. If not abundant, usually each louse is solitary on its leaf, but sometimes two or three are found together. In a short time, the injury done by the louse causes the crumpling of the leaf, making a concavity on the under side. These deformed leaves are the certain sign of the presence of the louse, and are sufficiently prominent to make the detection of the insect very easy. It has not seemed necessary to use any illustrations in this article, since the species cannot be confused with any other in the state.

These first lice from the egg produce large uumbers of progeny, bringing them forth alive, as is the custom in summer broods of plant-lice; so that the rolled-up leaf soon contains a hundred or more lice of all sizes.

Some of the specimens in the leaves develop wings and fly to new locations during the early part of the summer; and about midsummer all the rest do the same, so the old leaf-nests are deserted. Where they go has not yet been found out. There is a closely-related form in Europe that migrates to grass and it is probable that ours do the same.

In September the return migration takes place. Last year it was a very conspicuous affair in Moscow, as all the trees, of whatever kind, were surrounded by a hovering swarm of delicate, winged lice. These return migrants do not eat anything, and after a few days their dead bodies were very abundant on the trunks of many trees, filling the crevices of the bark. All that they do on their return is to bring forth a new brood of little lice. These young develop into the true egg-laying form, male and female. They are wingless and mouthless, very small when grown, bright orange in color, and seem to have no object in life except the deposition of eggs, since they can not eat or fly. The eggs are placed in the deepest crevices of the bark, especially those that are tangential to the tree, and are not easy to find. The small lice perish after depositing eggs, leaving only the latter to survive the winter.

Last fall the egg-laying brood were abundantly produced on all kinds of trees promiscuously. Their eggs must have been de-

posited on the same trees, but there is no evidence to show that the young can subsist on any trees but the elm, so it is safe to assume that all on other trees perished.

Remedies—Until we know the alternate food-plant, there is but little that can be done in the summer for this insect. It is so well protected by deformation of the leaf that spraying is almost useless.

In the egg, however, it is easily reached. Our experiment, reported in the preceding pages, shows that crude petroleum emulsion containing one-third petroleum was completely successful in killing all the eggs reached. Probably a weaker emulsion would have done as well. This will be tested this season. Kerosene might be the next best thing, applied in a rather strong emulsion, say 20 per cent. If used with care, pure kerosene might also be satisfactory, but it would be somewhat dangerous, as it would be necessary to give a thorough application in order to soak all the small crevices full. At present we are only certain of crude petroleum as a remedy.

In spraying, the main effort should be to cover all the rough bark of trunk and large limbs,—almost the reverse of ordinary spraying.

The migration of this louse seems not to have been noticed by other entomologists. It was strikingly apparent last year with us.

The Pear Tree Blister Mite.

Phytoptus pyri Sor.

The work of the Blister Mite is easily detected in spring or summer by the small blotches or blisters on the leaf. There may be many of these on a single leaf, so that they ultimately run together; but generally they are separate. When first formed, the blisters are whitish, soon turning red, and finally brown or blackish. These symptoms do not resemble any other attack on the pear except the fire blight, and that can be distinguished without trouble by the fact that the leaf does not show small dead spots, but turns brown over most of its surface at once.

About five years ago, the Blister Mite was very common in the state, but it winter-killed, and since then has not been a serious pest until the last year. It is evidently increasing to such an extent that spraying will be required in many orchards this winter, or before the buds start. Hence a few words on its habits and our experience with it are necessary.

It secretes itself for the winter in the little scales which cover the leaf-buds for the following year, especially those buds that are at or near the tips of the shoots. As it is impossible to find the animals without a glass and considerable pains, it is often introduced into orchards on nursery stock. As it is never winged, its powers of locomotion are feeble; yet it does spread slowly in an orchard.

With a good pocket magnifying glass, the animal has the appearance of a light yellow or whitish worm-like object. In a warm room it can be seen to crawl, but outdoors in the winter it is dormant and motionless. After finding a specimen with a glass, it may be detected with the naked eye, but can not be distinguished from a particle of dust.

As soon as the buds open in the spring, ths mites, of which there may be hundreds in a single bud, rouse themselves and crawl to the nearest leaves. They burrow in the tender tissue, immediately producing the blisters so characteristic of them. Here they produce a new brood, which migrates to the newest leaves at the tip of the young shoot, and repeats the process. The new leaves are constantly suffering during the summer. When cool weather comes in the fall, and the leaves are nearly ready to fall, the mites abandon the blisters and secrete themselves under the newly-formed bud-scales, so they will be near their food in the spring.

If unchecked, the mites will ruin a tree in a few years. This does not usually take place, because they are somewhat subject to winter-killing, according to our observations. However, a number of pear trees in the vicinity of the Experiment Station have been destroyed by them.

Since the mites are entirely concealed inside the leaves during almost the whole of their lives in the summer, it is useless to spray

them at that time. They yield readily to winter spraying, however, if properly done. Professor Slingerland, in a Cornell bulletin several years ago, reported complete success in spraying trees in winter with a kerosene emulsion containing from 5 to 7 per cent. of kerosene. Following his suggestion, the first spraying at our Station was with 10 per cent emulsion. This seemed at first quite satisfactory, but a more careful examination of the scales showed that many mites survived. A day or two later more work was done, using this time 12½ per cent. emulsion. This proved superior in penetrating quality, but still fell short of killing all the mites. Next a 16⅔ per cent. emulsion was used, with better but not perfect results. Finally an emulsion of one-fifth, or 20 per cent. kerosene, was applied to two trees, and this time the destruction of the mite was complete. No harm resulted to the trees.

The very marked difference between the results at Cornell and our own does not indicate any mistake, but only affords a new and striking illustration of the fact that kerosene as an insecticide is much more effective in the eastern part of the United States than the western.

As a result of our experiments, we recommend spraying for the Blister Mite before the buds start in the spring, with a 20 per cent. kerosene emulsion. It is very necessary to pay special attention to the tips of the twigs, as most of the mites are there. A mild day should be chosen for the work.

The common formula for kerosene emulsion is as follows:

Heat one gallon of water to boiling and dissolve therein half a pound of soap (not the cheapest), and while still boiling hot remove from the fire and add two gallons of kerosene. Pass the mixture through a spray pump and direct the stream back into the receptacle with as much force as possible. This causes it to rapidly assume the appearance of cream. Continue the pumping five or ten minutus, or until no kerosene separates at the top when it stands undisturbed for a moment. When made, dilute with seven gallons more of water and it is ready for use on the Blister Mite. For use on Green Aphis, etc., it should be diluted with seventeen to twenty gallons of water instead of seven.

The expense of emulsion applied as directed, will amount, for materials, to about 5 cents for a pear tree twelve to fifteen feet high, with a large top, and will run down to the fraction of a cent on young trees only set a year or two.