

methods will involve an accurate knowledge of the life history of the flies and of their ecology, and experiments to determine the effect of the oil on fish as applied at different times and by different methods. We hope to be able to carry on such investigations in the future, but as such work involves considerable expense, for which we have no funds definitely appropriated, the completion of the work may not be possible in the near future, so that it would seem well to call the attention of others to the work, since they may have a chance to give it the requisite study.

PRESIDENT BRITTON: We will now listen to a paper by Prof. C. P. Gillette, Fort Collins, Col., on "A New Arsenical Poison for the Codling Moth."

NEW SPRAYS FOR THE CODLING MOTH

By C. P. GILLETTE, *Fort Collins, Col.*

When Doctor Headden announced¹ his conviction that the arsenical sprays used for the control of the codling moth are, in many instances, killing the apple trees, he was asked to suggest some poison that would be less injurious to the trees and still give promise of killing the worms. He suggested trying sulfid of arsenic (As_2S_3), and expressed the fear that it would not be sufficiently soluble in the digestive fluids of the larvæ to kill them. Knowing something of the great digestive powers of insects, I expressed to the doctor a very strong desire to try arsenious sulfid in comparison with arsenate of lead in some codling moth spraying experiments already planned for 1909. Doctor Headden first prepared a small quantity in liquid form which was tested upon different kinds of foliage in the insectary to determine the strengths that might be safely used upon the leaves.

It was nearly time to begin the work of spraying for the codling moth, and as we could not obtain a sufficient quantity of this poison near at hand for the experiment, Doctor Headden converted his experimental laboratory into a laboratory for the manufacture of arsenious sulfid.² Enough was made to use upon a few trees and was sent to

¹ Bulletin 131, Colo. Agr'l Exp. Sta.

² Doctor Headden describes his preparation of the poison as follows: The arsenious sulfid was prepared by the usual method, *i. e.*, precipitation by hydrogen sulfid. The washed precipitate was dissolved in lime-sulfur solution, usual strength. The lime-sulfur solution was used because it dissolves, or is assumed to dissolve, the arsenious sulfid to a sulf. arsenite without the formation of an oxygen salt, the arsenite which I wished to avoid, as

Mr. George P. Weldon, field entomologist of the Experiment Station, located at Delta, with instructions to use it in comparison with arsenate of lead. The arsenate of lead was being tested at 2, 3 and 4 pounds to each 100 gallons of water in one application only when the petals were about nine-tenths off.

The arsenious sulfid was used in two strengths to correspond with the two stronger preparations of arsenate of lead in amount of metallic arsenic contained.

The applications were made by Mr. Weldon with a hand pump with moderate force, but the treatment was thorough and in every way was made as nearly like the lead arsenate sprays as possible.

The results of the experiment as tabulated by Mr. Weldon are here given:

The trees sprayed with 2 pounds of arsenate of lead to 100 gallons of water averaged 94.7 per cent of their fruit free from all worm injuries. The trees that were sprayed with 3 pounds to 100 gallons bore fruit that was 95.5 per cent free from worm marks. Trees sprayed with 4 pounds to 100 gallons bore fruit that gave exactly the same percentage of worm marks as when 3 pounds were used.

The trees sprayed with sulfid of arsenic had 93.6 per cent perfect fruit upon trees sprayed with the weaker preparation, and 92.7 perfect from the trees where the stronger solution was used.

The check trees average 58.9 per cent sound, or perfect, fruit, so far as worm injuries were concerned.

All of the experimental blocks, both sprayed and checks, were in a large orchard, all of which was sprayed. Check trees in such a case benefit greatly by the spraying of surrounding trees and do not show the contrast that they should with the results upon sprayed trees. Two orchards in the same vicinity, one very poorly sprayed and one not sprayed at all, bore apples that were 70 to 85 per cent wormy.

So this test of sulfide of arsenic as a spray for the control of the codling moth indicates that this poison may be as efficient for this

I am convinced that a pure preparation of lime arsenite is not good to use.

The solution probably contains the whole of the arsenic in combination with sulfur. The lime-sulfur compound is easily decomposed by the carbonic acid of the air, while the arsenious sulfid withstands the action of water, air and carbonic acid very effectively. The sulfid of arsenics As_2S_3 contains essentially 61 per cent of its weight of metallic arsenic, while lead arsenate contains less than 10 per cent (9.87).

The chief thing, however, is not that it may be placed on the market at a lower price, but that it will remain longer in the soil in an insoluble form than the compounds heretofore used. It is only a mitigation of the evil, however, not a complete avoidance of it.—W. P. Headden.

purpose as the arsenate of lead, which has, in the past few years, almost completely taken the place of other poisons for the control of the codling moth and other leaf-eating insects.

Three other sprays, viz., lime, Black Leaf Extract, and Sulfate of Nicotine, were also tested in hopes that they might prove beneficial. As with the arsenical sprays, each was used but once, as the petals were nearly all off.

Good lump lime, 50 pounds to 100 gallons of water, seemed to give no protection at all, as the percentage of perfect fruit on these trees averaged 58.9, exactly as in case of the check trees.

Black Leaf Extract was used in the proportion of 1 gallon diluted to 50 gallons with water. The trees sprayed with this mixture gave fruit that was 77 per cent free from worm injuries, or about 18 per cent more perfect fruit than in the check block.

Sulfate of Nicotine was used in the proportion of 1 part in 750 parts of water and seemed to give slight protection, as the trees sprayed with this mixture bore fruit that was 73 per cent free from all worm injuries, an improvement of practically 14 per cent over the fruit of unsprayed trees. Even this application indicates a protection of almost exactly 33 per cent of the fruit that would have been wormy if untreated, for the check trees had but 41.1 per cent of their fruit injured by worms.

While I would not feel warranted from this year's experiments in holding out very strong hopes that the codling moth can be sufficiently controlled by the use of nicotine sprays, I am encouraged to continue the experiment through another year and shall probably extend the number of applications to three or four. One or two summer sprays with either of these tobacco preparations will usually pay for themselves in their destruction of plant lice, red spiders and brown mites. And then, if these nicotine sprays will enable us to get fairly good protection from the injuries of the codling moth, it will be a boon to those whose orchards are already sick and dying from the excessive use of arsenical mixtures.

My chief hope, however, for relief from the overaccumulation of arsenic in our soils in a form that is detrimental to the growth of vegetation, lies in the use of the very insoluble sulfide of arsenic. This compound also has the important advantage of being very much cheaper than arsenate of lead, and if we can use it in solution it will do away with the use of stirrers in the spray tanks, which will be another decided advantage.

I have also used this poison successfully, as an arsenic-bran mash, for the destruction of grasshoppers, and as a spray for the destruction

of cherry slugs, and the larvæ of the white ermine moth, *Diacrisia virginica* Fab., but I did not compare the results in these cases with the effects of other arsenical poisons in parallel tests.

MR. J. B. SMITH: Will Professor Gillette please tell us how this poison is prepared and where it can be secured?

MR. GILLETTE: The poison was prepared for me by Doctor Head-den and the method of making it is explained in the footnote given in the paper. I do not think it can be secured at present, unless it is made up specially for the purpose.

MR. FORBES: I realize that it is getting late, yet I think if the subject of arsenical poisoning on fruit trees is not taken up we will lose a great deal of information which should be of great value to the members of this Association.

Doctor Headden has been working on this matter in Colorado, and while some of his results may refer directly to Colorado conditions, I think the whole matter should be of great interest to our members, especially as some of us have conditions to deal with which are in a way similar to those in his state. I trust we shall have time to hear from Doctor Headden concerning this matter.

PRESIDENT BRITTON: We will be glad to hear from Doctor Head-den.

ARSENICAL POISONING OF FRUIT TREES

By W. P. HEADDEN, *Fort Collins, Col.*

[Summary of remarks]

There are some facts in regard to which all agree, namely, that we have many sick fruit trees; particularly apple and pear trees. I do not for a moment wish to assert that all of these sick trees are suffering from arsenical poisoning, nor that all of the dead ones have been killed by arsenic. But I do believe that many of them have died from this cause. Other causes which might have produced death are winter killing, accumulation of nitrates in the soil, fungi of different kinds, possibly blight and still other causes.

The trees referred to have not been killed by freezing. We have very little of this in the state, and these cases present no similarity to those attributed to arsenical poisoning. The former in this latitude produces its injury above the surface of the ground, and the injury is really effected beneath the bark. Arsenic begins its attack below the surface of the ground and on the outside of the bark, converting