

The Florida Entomologist

Official Organ of the Florida Entomological Society

VOL. XVIII

APRIL, 1934

No. 1

EFFECT OF ARSENICAL AND COPPER INSECTICIDES ON THE NATURAL CONTROL OF WHITEFLIES AND SCALE INSECTS BY FUNGI ON ORANGE TREES IN FLORIDA

By

S. B. HILL, JR., W. W. YOTHERS, and RALPH L. MILLER
U. S. Department of Agriculture
Bureau of Entomology

One of the most important considerations in the choice of an insecticide for use on living plants is the effect it may have on the tree or plant on which the application is made. In killing insects on citrus trees one of the important requirements is that the insecticide shall not destroy the great abundance of beneficial entomogenous fungi present on the trees. When new materials were being tried as insecticides against the Mediterranean fruit fly in 1930, it was always important to know just what effect these would have on the entomogenous fungi on the citrus trees. Copper and arsenical insecticides having been found to be the most promising, as reported in a paper by Miller and McBride¹, these materials, with a few others, were used in the toxicity work on entomogenous fungi. The effect of these materials on citrus trees and fruit has been investigated by Miller and Bassett². The present paper is concerned mainly with the effect of arsenical and copper insecticides on scale fungi and whitefly fungi on citrus trees.

Method of Investigation.—Three citrus groves at Orlando, Fla., were used for the experimental spraying in 1930. One was of Valencia orange trees that were only about 7 years old, another was of seedling trees some 30 or more years old, and the third was of mixed seedling and budded trees. The spraying was done with hand sprayers, and only small parts of the trees were sprayed, following the method used during the Mediterranean fruit fly campaign. A record of fungi present was made

¹ Miller, Ralph L., and McBride, O. C. Experiments with Copper Carbonate, Lead Arsenate, and Other Compounds Against the Mediterranean Fruit Fly in Florida. Journ. Econ. Ent., vol. 24, no. 6, pp. 1119-1131. 1931.

² Miller, R. L., Bassett, Ione P., and Yothers, W. W. Effect of Lead Arsenate Insecticides on Orange Trees in Florida. U. S. Dept. Agr. Tech. Bul. 350, 20 pp. 1933.

six to eight months after the first application. An accurate record was kept of meteorological conditions, but only those data that seem necessary or significant are given in this paper.

In both the Valencia and the seedling orange groves seven trees were used in each plot. Three were left as checks and four were sprayed. In some cases only half of a tree was sprayed and this was checked against the unsprayed half.

Rainfall.—The rainfall during the period covered by the experiment, June 1930 to April 1931, was 47.68 inches in the Valencia grove, 43.13 inches in the seedling grove, and 65.36 inches in the mixed grove.

Effect on Whitefly Fungi.—Some 7 or 8 months after the first spray application, 50 leaves on each of the treated and untreated parts of the 78 plots were inspected to determine the abundance of the citrus whitefly (*Dialeurodes citri* (Ashm.)), the cloudy-winged whitefly (*Dialeurodes citrifolii* (Morgan)), and the fungi attacking them. The fungi considered were the red *Aschersonia* (*Aschersonia aleyrodinis* Webber), the yellow *Aschersonia* (*Aschersonia goldiana* Sacc. et Ellis), and the brown whitefly fungus (*Aegerita webberi* Fawcett); these were found to have been destroyed in approximately the same ratio, judging from the numbers of parasitized whiteflies found on leaves that had received different spray treatments. As a matter of convenience, only the percentages of live whitefly pupae are given in table 1.

All the insecticides used in the Valencia and seedling groves allowed an increase in the percentages of live whitefly pupae found 8 months after spraying. On leaves sprayed with lead arsenate, cryolite, and potassium aluminum fluoride there was only a small increase, ranging from 1½ to 5 times as many live pupae as were found on the unsprayed parts of the trees. On foliage sprayed with copper compounds there was a greater increase, with from 5 to 10 times as many live whitefly pupae in the sprayed plots as in the checks. Syrup and sugar did not seem to have any influence on the fungus control of the whitefly. The results secured in the Valencia and seedling groves were fundamentally similar. The percentages in the last two columns of the table show very clearly that the mixed grove had different treatment. On investigation it was found that this grove had been thoroughly sprayed with Bordeaux-oil mixture, and consequently the data cannot be compared with those for the other two groves; however, they may indicate what will happen when Bordeaux-oil mixture is used.

TABLE 1.—PERCENTAGES OF LIVE CITRUS WHITEFLY AND CLOUDY-WINGED WHITEFLY PUPAE ON FIFTY CITRUS LEAVES EIGHT MONTHS AFTER SPRAYING; ORLANDO, FLA., APRIL 1931.

Kind of spray ¹	No. of plots	Valencia		Seedling		No. of plots	Mixed grove ²	
		Sprayed	Check	Sprayed	Check		Sprayed	Check
		%	%	%	%		%	%
Lead arsenate, 8 pounds	7	11.4	7.0	13.2	7.2	4	64.3	80.5
Bordeaux mixture, 4-4-50)	5	56.5	6.8	77.0	4.7	8	85.0	71.0
Copper acetate, 4 pounds						4	64.0	46.5
Copper carbonate, 8 pounds	6	36.4	14.5	14.8	2.6	4	28.1	35.1
Copper cyanide, 8 pounds	2	50.5	3.1	67.0	12.4			
Cryolite, 8 pounds.....	3	19.2	3.4	5.0	2.6			
Potassium aluminum fluoride, 8 pounds	3	9.0	5.4	4.6	2.8			
Syrup and sugar solution	1	.3	7.7	3.2	.7	4	60.5	36.4

¹ For each spray (except Bordeaux mixture, which was of the formula 4-4-50) the given quantity of the chemical was used in 200 gallons of a syrup and sugar solution made of 10 gallons of syrup and 50 pounds of sugar in 190 gallons of water.

² This entire grove had been sprayed with Bordeaux-oil mixture before the counts were made, so the checks had been sprayed also.

From the preceding table it is evident that citrus growers, at least in the vicinity of Orlando, Fla., can expect up to 90 percent control of the whiteflies by fungi. When they spray with any mixture containing a copper compound they may expect an increase of from 5 to 10 times as many live whiteflies on the trees, or only about 40 or 50 percent natural control.

Effect on Purple Scale Fungi.—Ten leaves on each plot were very carefully examined under a binocular microscope some 6 to 8 months after the first spraying, and a record of the live and fungus-killed purple scales was made. The fungi considered in this examination were the pink scale-fungus (*Nectria diploa* B. and C.), the red-headed scale-fungus (*Sphaerostilbe aurantiicola* (B. et Br.) Petch), and the white-headed scale-fungus (*Podonec-tria coccicola* (E. and E.) Petch). The effects of the various materials on the scale populations are shown in table 2.

Lead arsenate, cryolite, potassium aluminum fluoride, and syrup and sugar did not have any appreciable effect on the action of scale fungi. All the copper compounds allowed the scale to increase to nearly twice the normal population. Bordeaux mixture was the most serious in this respect and copper carbonate followed closely.

TABLE 2.—PERCENTAGES OF LIVE PURPLE SCALES ON TEN CITRUS LEAVES EIGHT MONTHS AFTER SPRAYING; ORLANDO, FLA., APRIL 1931.

Kind of spray ¹	No. of plots	Valencia		Seedling		No. of plots	Mixed grove ²	
		Sprayed	Check	Sprayed	Check		Sprayed	Check
		%	%	%	%		%	%
Lead arsenate, 8 pounds	7	66.	67.	36.8	36.0	4	81.5	69.
Bordeaux mixture, (4-4-50)	5	88.	42.7	90.0	43.5	8	83.0	73.
Copper acetate, 4 pounds						4	87.0	85.
Copper carbonate, 8 pounds	6	77.6	40.3	68.5	53.0	4	84.5	83.
Copper cyanide, 8 pounds	2	43.0	59.5	93.0	43.6			
Potassium aluminum fluoride, 8 pounds	3	50.7	59.4	49.0	53.2			
Cryolite, 8 pounds	3	62.6	52.0	60.6	40.4			
Syrup and sugar solution	1	3.4	58.5	49.5	52.7	4	89.5	81.5

Citrus growers in the vicinity of Orlando, Fla., can expect a natural control of about 60 percent on unsprayed trees, but when Bordeaux mixture is used only about 20 percent control can be expected.

The data for the mixed grove, as in the case of the whitefly counts, serve only to show what an application of Bordeaux-oil mixture will do to the live scale population.

Summary.—Lead arsenate, cryolite, and potassium aluminum fluoride allowed whiteflies to increase on orange trees at Orlando, Fla., so that after 8 months the infestation was from 1½ to 5 times as great as on untreated checks, while copper compounds allowed whiteflies to increase to an infestation from 5 to 10 times as great as on the checks. Unsprayed groves at Orlando may have a natural fungus control of the whitefly as high as 90 percent, but when groves are sprayed with any mixture containing a copper compound, such as Bordeaux mixture, only about 40 or 50 percent of natural control can be expected.

Copper compounds used on orange trees at Orlando, Fla., allowed the purple scale to increase to a population nearly twice as great as that on untreated checks. Lead arsenate, cryolite, and potassium aluminum fluoride had no measurable effect on the amount of scale fungus or on the live scale population. Bordeaux mixture was the most serious in allowing scale to increase and copper carbonate followed closely. A natural control of about 60 percent in unsprayed groves can be expected, but when the groves are sprayed with Bordeaux mixture only about 20 percent control can be expected.