contacting a poison we have left on the plant. We must, therefore, have the plant completely covered with fungicide if these spores are to be killed. We must direct the fungicide at the plant with sufficient pressure to blow the material to the center. We recommend a minimum of 400 pounds at the pump for spray machines. A sufficient number of nozzles must be provided, and the ground speed of the machine should not be too fast. Exact recommendations on these factors cannot be made because of the many variables which enter into the picture, such as the efficiency of the machine and the size of the plants. The grower should check individual plants in the field to make certain that there is visible spray or dust residue on the whole plant including the upper and lower leaf surfaces. He should check this several times during the operation.

You well know the three methods for applying fungicides: Ground spraying, ground dusting, and airplane dusting. We strongly recommend ground spraying, because experience has showed that it is by far the most effective method. Airplane dusting is the least effective of the three. However, at times when the soil is too wet for ground equipment, an airplane should be used for protection until ground applications can be resumed or initiated.

Until varieties of tomatoes which are resistant to the more serious fungus diseases are available, the application of the proper fungicides is as important in the farming operation as land preparation, cultivation, and fertilization. The grower should plan his crop before it is planted so that he has adequate machinery and labor to carry out a proper disease control program.

CONTROL STUDIES ON THE SERPENTINE LEAF MINER ON POTATO AND TOMATO

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Serpentine leaf miner, *Liriomyza pusilla* (Meig.), infestations, numerous in the 1945-46 season, were destructive in both the 1946-47, and 1947-48 seasons in the southern part of Florida. This fly was destructive to the vegetable crop plants such as potatoes, tomatoes, beans, okra, squash, and cabbage. The degree of destruction varied among fields and crops. Individual potato and tomato plants, for example, were killed by leaf miner attacks. Fields of infested plants assumed a brownish color in cases, so great was the damage. Cabbage, squash, and beans suffered less injury as a rule than potatoes and tomatoes. These severe infestations have occurred in the cooler months of the year, January, February, and March. Most vegetable production, unfortunately, is coincident with the leaf miner attacks in the cooler months.

Coincidentally or otherwise, the leaf miner was not a serious pest before DDT was used so extensively for control of other insects. It was suggested by Kelsheimer (1948) from observations in Florida and by Jefferson (personal correspondence) in California, that DDT

might be responsible for the leaf miner outbreaks. It is possible that the infestation may be attributed to other, and currently unknown causes.

Effective leaf miner control was reported by Wolfenbarger (1947) in which chlordan, one of the newer insecticides gave good control. The season following these tests (1947-1948) two other new insecticides, chlorinated camphene and parathion, were available and were tested. Tests made with these and other insecticides on potatoes and tomatoes are reported herein.

Test Plots and Procedures

Field plots, each 12 feet wide, 50 feet long for potatoes, and 36 feet long for tomatoes were used for the experiments. The potato plots were four rows, and the tomatoes were two rows wide. The treatments were each replicated four times, arranged in randomized block designs.

All test materials were applied by power sprayer field equipment. The fungicide, dithane, D-14 at 2 quarts, and 1 pound of zinc sulphate per 100 gallons of water was used for control of late blight disease. Lime was omitted from these potato and tomato tests since it is believed to reduce the effectiveness of most of the newer insecticides. The fungicide was mixed according to the usual procedure, then the insecticide was added.

A total of eleven fungicidal applications was made nine of which included insecticides. A total of approximately 1,000 gallons per acre of the insecticide-fungicide combinations was applied during the season.

Large numbers of the serpentine leaf miner adults began invading the potato plots in mid-January. Adults were present on the plants at this time and leaf punctures symptomatic of the miner were soon observed in large numbers. They were abundant for fully 2 months afterward. In a few days many larval mines were in evidence on the leaves. Between January 20 and 24 swarms of the winged green peach aphid, *Myzus persicae* (Sulz.), settled on the plants. Aphids remained on the untreated plants throughout the remainder of the season. They were not serious on potatoes but became injurious to tomatoes. Other insects infesting the plants were the banded cucumber beetle, *Diabrotica balteata* Lec.; the southern armyworm, *Prodenia eridania* (Cram.); and a few tomato hornworms, *Protoparce quinquemaculata* (Haw.). The serpentine leaf miner, however, was the most injurious insect in all plots.

Potatoes. Bliss Triumph potato seed pieces were planted November 26, 1947. Wet soil at planting time and continued rains caused considerable seed piece decay, resulting in poor stands in some plots. This caused unequal yields which in turn caused a larger error value from the statistical analysis and lessened the values of the average yields.

The plants were first sprayed with the fungicide alone on December 30. A week later the insecticides were combined with the fungicide. The next week only the fungicide was used, then applications of the insecticide-fungicide combinations followed at weekly intervals until February 9, after which the interval was reduced to 5 days.

Counts of the leaf mines were made on January 30 and February 16. Four plants or leaves in each plot were used for making each count. These data and the final yield were summarized and are presented in Table 1.

Parathion gave the best control of the

TABLE 1

AVERAGE NUMBERS OF SERPENTINE LEAF MINES FOR EACH OF TWO COUNT DAYS, PERCENTAGES OF CONTROL, AND TUBER YIELDS FROM TREATMENTS

Insecticides included with fungicides	per 100 gals.	Leaf mines, counted on January 30		Leaf mines, counted on February 16		Yield, bu. per acre
		Avg. No. per plant	Percent control	Avg. No. per leaf	Percent control	
DDT, 50% wett. [1]	2 lbs.	20.0	22	55.3	30	221
DDT, 25% emul.[2]	1 qt.	25.5	0	77.5	2	278
Chlordan, 50% wett.[3]	2 lbs.	2.8	89	37.0	53	261
Chlordan, 40% emul.[3]	2½ pts.	3.1	88	51.8	34	204
Benzene hexachloride (Isotox), 25% gamma-isomer, wett.[1]	1 lb.	11.4	55	54.5	31	292
Benzene hexachloride (Isotox), 25% gamma-isomer, emul.[1]	1 pt.	3.9	85	42.3	46	284
Chlorinated camphene, 25% wett.[1]	4 lbs.	3.7	85	40.5	55	240
Chlorinated camphene, 60% emul.[4]	¾ qt.	1.8	93	29.0	63	277
Parathion, 25% wett.[5]	2 lbs.	2.2	91	3.3	96	303
Tetraethyl pyrophosphate, 9% (Vapotone)[1]	1 pt.	12.4	51	71.8	8	293
Tetraethyl pyrophosphate, 95%[6]	½ pt.	9.5	63	50.3	36	305
Lead arsenate + Nicotine sulfate, 40%	4 lbs. + 1 pt.	17.8	30	51.3	35	280
DDT, 50% wett. + Nicotine sulfate, 40%	2 lbs. + 1 pt.	6.8	75	47.0	40	286
Check (fungicide only)	—	25.5	—	78.8	—	246
Difference required for least statistical significance, at 5% level		8.4	—	17.3	—	Not. sig.

[1]Secured from California Spray-Chemical Corporation

[2]Secured from Rohm and Haas Company

[3]Secured from Dow Chemical Company

[4]Secured from Chipman Chemical Company

[5]Secured from American Cyanamid Company

[6]Secured from Victor Chemical Company (Subtropical Experiment Station, Homestead.)

serpentine leaf mines; chlorinated camphene was second best in control. The wettable chlorinated camphene gave some chlorosis of the plants in the first application. The yellowing disappeared, however, with the growth of the plants.

Tomatoes. Tomatoes of the Grothen's Globe variety were set in the field on January 24, 1948. Each plot contained 36 plants placed 2 feet apart in the rows. They were sprayed with the fungicide alone on this date and on January 27,

after which they were sprayed with insecticide-fungicide combinations at 5-day intervals. Late blight was generally severe at the time the plants were placed in the field, but was controlled so that it was never an important factor in the experimental plants. Mosaic disease, however, was serious and greatly decreased yields. The serpentine leaf miner was the most serious insect pest. Many plants in certain treatments were nearly killed by it. The green peach aphid, *Myzus persicae* (Sulz.), increased rapidly to infest the plants, in large numbers. Dry weather and salt intrusion, however, were two uncontrolled factors which combined with mosaic nearly destroyed the experiment as far as yields were concerned. A few tomato hornworms were observed on the check and

TABLE 2

AVERAGE NUMBER OF LEAF MINES PER TOMATO LEAF, PERCENTAGE CONTROL AND YIELD OF MARKETABLE FRUIT FROM THE FIRST TWO PICKINGS

Treatment material	Amt. per 100 gals.	Leaf mines counted on February 25 No. of mines	Feb. 25 Percent control	March 24 No. of mines	March 24 Percent control	Fruit, lbs. per plot
DDT, 25% emul.	1 qt.	52.3	2	44.5	−38	12.8
Benzene hexachloride (Isotox), 25% gamma-isomer wett.	1 lb.	27.3	49	43.0	−33	17.5
Chlordan, 40% emul.	2½ pts.	23.3	56	22.5	30	15.0
Parathion, 25% wett.	2 lbs.	0	100	6.0	81	23.7
Tetraethyl pyrophosphate, 9% *(Vapotone)*	1 pt.	20.5	62	36.5	−13	10.8
Tetraethyl pyrophosphate, 95%	¼ pt.[4]	23.8	55	39.3	−22	1.4
DDD *(Rhothane)*, 50% wett.[1]	2 lbs.	62.3	−17	58.8	−82	11.4
Methoxy DDT *(Marlate)*, 50% wett.[2]	2 lbs.	56.8	−7	48.0	−49	2.4
DDD *(Rhothane)*, 25% emul.[1]	1 qt.	52.8	1	42.5	−32	8.3
Methoxy DDT *(Marlate)*, 25% emul.[2]	1 qt.	56.0	−5	40.8	−26	2.1
Calcium arsenate	4 lbs.	56.3	−6	60.0	−86	7.4
Nicotine sulfate, 40%	1 pt.					
Chlorinated camphene, 40% wett.[3]	2½ lbs.	14.8	72	22.8	29	12.9
Wettable sulfur	2 lbs.					
Chlorinated camphene, 60% emul.	¾ qt.	9.5	82	16.3	50	11.2
Wettable sulfur	2 lbs.					
Check (fungicide only)		53.3		32.3		5.4
Difference required for least statistical significance, at the 5% level		19.3		23.4		12.0

[1]Secured from Rohm and Haas Company.

[2]Secured from E. I. du Pont de Nemours Company.

[3]Secured from Chipman Chemical Company.

[4]The first application was at ½ pint per 100 gallons but burned the plants so severely they never fully recovered.

(Sub-tropical Experiment Station, Homestead.)

the tetraethyl pyrophosphate treated plots; none on any other plot. Data on leaf mines were taken on two different dates to determine treatment effects. Four leaves in each plot of each treatment were examined on each date. These results and also the yields obtained from the first two pickings are summarized in Table 2.

Parathion gave the most outstanding leaf mines control. Chlorinated camphene was considered to have ranked second in reduction of leaf mines. Chlordan gave some control of leaf mines and yielded more fruit per plot than some treatments, including the check.

Average percentages of leaf mines control for certain insecticides, calculated from data in Tables 1 and 2, are given in summary form as follows:

Chlordan	Chlorinated camphene	
Emulsion	Emulsion	Wettable
52	72	60

Parathion	Benzene hexachloride	DDT
		Emulsion
92	23	−9

These percentages illustrate the relative amounts of leaf mines control obtained for these materials on potatoes and tomatoes. Aphid control was most effective on plants sprayed with parathion. Chlorinated camphene also gave satisfactory aphid control. Benzene hexachloride (essentially pure gamma-isomer base) gave good control. Aphid control with DDT emulsion was satisfactory.

Yield data from the parathion plant spray treatments were highest with tomatoes and second highest with potatoes. Evidence has been obtained which shows that regular applications of the phosphatic insecticides, hexaethyl tetraphosphate, tetraethyl pyrophosphate, and parathion, and also of phosphoric acid added to dithane and zinc sulphate, have increased potato yields. A manuscript which was prepared to present this evidence has been accepted for publication in the *Journal of Economic Entomology*, (Wolfenbarger, 1948).

Taste tests and consumption of tomato fruits and potato tubers by members of at least 25 different families from plants treated with chlordan, parathion and chlorinated camphene showed that none detected any off-flavor. Although some tasters detected off-flavor in potatoes from the benzene hexachloride sprays, no off-flavor was detected in tomatoes, even in fruit tasted within a week after spray applications. It is recommended, until more is known about the newer insecticides, that at least 2 weeks elapse between insecticide application and harvest of the tomatoes. This recommendation is given mainly in consideration of the insecticide residues.

Both the older and newer insecticides tested were accepted as poisonous. All were handled alike, without any protective measures, using the same precautionary measures ordinarily exercised in handling spray materials. No injury nor deleterious effect was encountered in testing any of these materials. The 2 pounds dosage of 25 percent wettable parathion used in the experiments is higher than will be generally recommended. In consideration of work done elsewhere it appears that 1 pound of 15 percent wettable powder per 100 gallons of spray and 1 percent of parathion dust will be sufficient. One to one and one-quarter pounds of active ingredient per 100 gallons of spray and a 10 percent dust of chlorinated camphene seems to

be the approximate amount for general recommendation for serpentine leaf miner and aphis control in southern Florida. Late blight disease control was equal in all plots indicating that no insecticide in the combination reduced the efficiency of the fungicide.

SUMMARY

The serpentine leaf miner has been present and serious for the last two seasons on winter vegetable crops in southern Florida. The most outstanding control of leaf mines on potatoes and tomatoes was accomplished by parathion sprays, followed in order by other sprays as listed. Chlorinated camphene ranked second in leaf mines control. Chlordan was considered to have ranked third in reduction of leaf mines. Yields from parathion tested plants ranked second and first on potatoes and tomatoes, respectively.

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SOME CAUSES OF LOSSES IN HANDLING POTATOES

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INTRODUCTION

Spoilage occurring during the process of marketing early Irish potatoes in the Southeastern States is the cause of considerable loss each year to potato shippers, transportation agencies and receivers in terminal markets. Such loss results in a lower price being paid to producers and a greater cost to consumers for potatoes. Because of the regional scope of this problem, and the impossibility of a successful study of the factors responsible for spoilage by any one State, the five Southeastern States of Florida, Alabama, South Carolina, North Carolina, and Virginia are engaging in a cooperative research study of this factor under the Research and Marketing Act. The objectives of the study are:

(1) To determine factors causing spoilage in Marketing early Irish potatoes;

(2) To determine extent of damage caused by various factors;

(3) To determine economic losses resulting from the various types and severity of spoilage; and

(4) To experiment with ways and means to reduce spoilage.

The States are being assisted in the work by the Bureau of Plant Industry, the Bureau of Agricultural Economics, the Railroad Perishable Inspection Agency, the Western Weighing and Inspection Bureau and cooperating shippers, receivers, and farmers in various potato-producing areas.

This study is unique in that the marketing of potatoes is followed from the time they begin to move in volume from Florida until the deal is over in Virginia. The same research crew follows the movement from State to State and col-