EFFECTIVENESS OF VARIOUS METHODS OF APPLYING SYSTEMIC INSECTICIDES TO TOMATOES

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Among the several papers published on the use of systemic insecticides during the past few years, two deal directly with tomatoes. Baranowski (3) and Hayslip (5) have shown that soil applications of granular phorate and Di-Syston provided effective control of a serpentine leaf miner, *Liriomzya archboldi* Frost (formerly referred to as *L. pusilla* (Meig.) by authors in Florida), for several weeks.

Work has been expanded on systemic insecticides at the Sub-Tropical Experiment Station for two primary reasons: to determine the most efficient and economical method of using systemic insecticides and to investigate whether systemic insecticides, applied in ways other than as sprays on the foliage, present less of a threat to the parasites and predators of insect pests. Some of the effects of foliar applications of insecticides to leaf miner parasites have been shown by Baranowski (2), Wene (8) and Hills and Taylor (6).

To date 4 methods of applying systemic insecticides are being considered: (1) the application of granular formulations to the soil at seeding and transplanting, (2) sprays applied to the foliage, (3) drenches over the row after emergence and (4) the addition of the insecticide to starter solutions used at transplanting. All experiments were conducted during the 1960-61 and 1961-62 seasons on Rockdale soils.

Tests to determine the effectiveness of soil application of granular formulations of systemic insecticide were conducted during both seasons. In both years the insecticides were applied in the fertilizer bands at a depth of two inches on either side of the row at transplanting time. Plots consisted of single rows 40 feet long, replicated four times. Plants were set 18-24 inches apart and rows six feet apart. Tables 1 and 2 summarize leaf miner control resulting from the soil applications.

Three materials were effective in controlling serpentine leaf miners when applied as granular formulations at transplanting. In terms of per cent control on January 6, phorate at 3 and 5 pounds toxicant per acre provided 66 and 68 per cent control respectively. Di-Syston at 3 and 5 pounds provided 61 and 62 per cent control. Dimethoate at three pounds provided 100 per cent control. Since it takes about 10-14 days for the roots to grow into the area of insecticide application, the foliage on the plants is unprotected for a period of time unless a material is sufficiently water soluble to be able to diffuse to the root zone by means of soil moisture. By January 26, phorate at 3 and 5 pounds provided 92 and 97 per cent control respectively, and Di-Syston at the same rates, 69 and 86 per cent control, indicating that a greater quantity of toxicant had been absorbed and translocated by this time. Essentially the same type of results were shown by Baranowski (1) on pole beans. In this experiment dimethoate provided nearly complete protection of the primary leaves, but phorate and Di-Syston did not provide any protection, which again indicates that dimethoate is carried to the plant by soil moisture. Reynolds and Metcalf (7) in a recent paper reported the water solubility of Di-Syston to be 0.0066 per cent, phorate 0.0085 per cent and dimethoate 2 per cent. Judging from aphid mortalities on cabbage resulting from soil application of systemic insecticides, they concluded water-soluble systemic materials were carried into the root zone and absorbed and translocated in insecticidal quantities faster than less water-soluble materials.

A comparison of the results in Table 1 and 2 indicate that phorate and Di-Syston did not provide control for as long a period in 1961 as in 1960. The reason for this is not known, but it is suspected that the extreme drought of the 1961 season may at least partially account for it. It seems plausible that under drought conditions and the low water solubility of phorate and Di-Syston, not as much material was actually absorbed by the plants.

On October 17, 1960 a test was put in to determine what effect placement and dosage of 10 per cent granular formulations of phorate and Di-Syston would have on germination. The insecticides were applied with a Gandy applicator in three ways: (1) a scatter pan was used to spread the materials over a seven inch band at the seed level, (2) the materials were applied

Florida Agricultural Experiment Stations Journal Series No. 1540.

Table 1. Leaf miner control through soil application of systemic insecticides at transplanting on December 1, 1960.

Treatments	Pounds tox./A.	Average number of mines per leaf			
		Jan. 6	Jan. 26	Feb. 7	Mar. 2
		*	*	*	*
Phorate	1.0	16.2 c	27.0 d	33.7 d	45.3 a
Phorate	3.0	9.4 b	5.0 ab	8.7 ab	41.0 a
Phorate	5.0	8.8 b	1.8 a	3.3 a	37.7 a
Di-Syston	1.0	19.0 c	44.0 e	39.7 cde	42.5 a
Di-Syston	3.0	10.9 b	18.3 c	16.4 b	35.7 a
Di-Syston	5.0	10.5 b	8.4 b	9.9 ab	46.7 a
Dimethoate	3.0	0.0 a	0.8 a	18.4 c	42.2 a
Bayer 39007	3.0	29.4 d	56.0 f	42.1 e	42.8 a
Am. Cy. 18133	3.0	27.8 d	59.5 f	41.5 de	46.5 a
Check	--	27.6 d	58.2 f	43.5 e	49.2 a

* Duncan's Multiple Range Test. Means in the same column followed by a like letter are not significantly different at the 5% level.

directly in the drill with the seed and (3) the materials were placed in a narrow band about two inches to the side and slightly below the seed. The results presented in Table 3 indicate that rates of over one pound toxicant per acre caused a reduction in germination if the insecticide was in contact with the seed. None of the rates used caused a reduction in stand when the insecticide was placed to the side of the row.

Four systemic insecticides, at two rates and applied at three intervals were included in a test to determine the effectiveness of these materials against serpentine leaf miners through foliar applications. Each material was used at 0.25 and 0.50 pounds per 100 gallons. The lower rate was applied every seven days while the higher rate was applied at 7, 10 and 14 day intervals. A summary of the results is given in Table 4. Dimethoate was the most effective material used. It does not appear that the use of systemic insecticides as foliar sprays will enable a longer interval to be used between applications and still maintain effective control. It is also of interest to note that all of the treatments caused a considerable decrease in the amount of parasitization and that dimethoate caused the greatest decrease.

Table 2. Leaf miner control through soil application of systemic insecticides at transplanting on October 30, 1961.

Treatments	Pounds tox./A.	Avg. No. mines/leaf	
		Dec. 11	Dec. 28
		*	
Check	--	25.3 a	59.0
Nia. 9205	3.0	21.2 ab	54.2
Nia. 9205	6.0	19.5 b	50.3
Phorate	3.0	10.5 c	44.4
Phorate	6.0	5.3 c	35.5
Di-Syston	3.0	10.8 c	60.5
Di-Syston	6.0	8.4 c	54.8

* Duncan's Multiple Range Test. Means followed by the same letter are not significantly different at the 5% level.

Table 3. Effects of placement and dosage on *germination.*

Treatments	Pounds tox./A.	Average number of plants per plot		
		7" band	in drill	2" to side
Phorate	1.0	128.0	113.3	147.3
Phorate	2.0	93.3	93.3	144.7
Phorate	3.0	69.7	80.0	138.3
Check	--	119.3	119.3	129.3
Di-Syston	1.0	132.7	116.7	129.7
Di-Syston	2.0	100.0	105.7	98.0
Di-Syston	3.0	94.3	98.3	112.7

The use of systemic insecticide drenches also offered promise for leaf miner control on tomatoes. Plots for the drench tests consisted of single rows 14.5 feet long, replicated four times. The plot size was selected so that one gallon per plot would be the equivalent of applying 500 gallons per acre based on band treatment of rows six feet apart. The materials were applied with a sprinkler can in bands six inches wide. Treatments were applied on February 28, nine days after seeding when the first true leaves were just beginning to unfold. A summary of the results of one test is given in Table 5. Dimethoate and CL 43,064 provided control of leaf miners for 3-4 weeks after application. It is of considerable interest to note that the effectiveness of dimethoate increased as the amount of water used in application was decreased, whereas the effectiveness of CL 43,064 increased as the amount of water was increased. Results of similar treatments in another test showed the same relationship. Plots treated with dimethoate at 0.25 pounds per acre in 500, 250 and 125 gallons of water had 93, 83 and 63 per cent mined plants

Table 4. Leaf miner control through foliar application of systemic insecticides.

Treatments	Interval Days	Pounds tox./100 gals.	Avg. No. mines/leaf	Avg. No. Pupae/sample	Percent Parasitization
Check	--	--	92.50 h*	266.00	66
Dimethoate	7	0.25	19.75 ab	14.50	0
"	7	0.50	10.00 a	1.50	0
"	10	0.50	24.75 b	19.50	5
"	14	0.50	31.00 bc	45.50	8
Nia. 9205	7	0.25	54.25 d	53.00	60
"	7	0.50	38.75 c	24.00	19
"	10	0.50	77.50 fg	84.00	52
"	14	0.50	70.75 efg	89.50	39
S.D. 3562	7	0.25	52.50 d	35.00	9
"	7	0.50	33.50 bc	23.50	6
"	10	0.50	66.75 def	20.00	23
"	14	0.50	53.25 d	95.50	25
CL 43,064	7	0.25	56.00 d	26.50	25
"	7	0.50	31.25 bc	36.50	0
"	10	0.50	80.75 gh	27.00	35
"	14	0.50	60.00 de	133.00	17

* Duncan's Multiple Range Test. Means followed by the same letter are not significantly different at the 5% level.

respectively, while plots treated with CL 43,064 at 0.25 pounds in 500 and 250 gallons had 70 and 83 per cent mined plants. Why amounts of water had different effects on the two materials is not known. In a third drench test Isolan, Dimetilan and Pyramat were tried at 0.25, 0.50 and 1.00 pounds per acre in 500 and 250 gallons of water. None of these treatments provided any appreciable control at two weeks after application.

Another method of application that appears to be effective is the addition of the insecticide to the starter solution used at transplanting. For these tests a modified Oliver transplanter was used to put out the treatments. The transplanter was operated at a speed necessary to release five ounces of starter solution per plant. Dosages were calculated on the basis of 3,680 plants per acre. In a preliminary, non-replicated trial dimethoate and S.D. 3562 were applied at 3.75 and 7.50 pounds toxicant per acre. All treat-

Table 5. Leaf miner control with drenches applied on Feb. 28.

Treatments	Pounds tox./A.	Gallons water/A.	Percent mined plants Mar. 12	Mar. 19	Mar. 23
Check	--	500	95	95	98
Dimethoate	0.25	500	0	15	90
"	0.50	500	0	8	53
"	1.00	500	0	0	0
"	2.00	500	0	0	5
"	0.50	250	0	0	28
"	0.25	125	0	35	43
"	0.50	125	0	8	13
"	0.25	250	0	15	75
CL 43,064	0.25	500	40	68	100
"	0.50	500	0	0	43
"	1.00	500	0	0	0
"	2.00	500	0	0	3
"	0.50	250	0	18	78

ments caused severe wilting two days after treatment application, and within a week all plants were dead. A second non-replicated trial was put in, using 0.25, 0.50 and 1.0 pound rates of the same materials. No injury was apparent on any of the plots. It was also evident that S.D. 3562 was ineffective when used in this manner. A replicated trial was put in on November 20, using dimethoate and CL 43,064 at 0.25, and 0.50 and 1.00 pounds per acre. The stand in this test block was exceedingly poor; many of the plants dying shortly after transplanting from causes not related to treatment. A summary of the results is given in Table 6. Both materials were effective when used in this manner, with CL 43,064 perhaps being effective for a longer period. A second replicated test was put in using the same procedures. No plants were lost in this test, though it was evident within a few days that the 2.0 pound rate of both materials was phytotoxic, and within three weeks the plants in these treatments were smaller than the check plants. It was also evident that plant growth

Table 6. Leaf miner control with insecticide-starter solution.

Treatments	Pounds tox./A.	Avg. No. plants/plot	Average no. of mined plants Dec. 11	Dec. 18	Dec. 22
Dimethoate	0.25	12	0	7	11
"	0.50	8	0	3	7
"	1.00	8	0	1	3
CL 43,064	0.25	13	0	0	2
"	0.50	15	0	0	2
"	1.00	8	0	0	0
Check	--	11	11	11	11

Table 7. Effects of insecticide-starter solution on plant growth.

Treatments	Pounds tox./A.	Rating Conover	Strobel	Average	DMRT 5%
Dimethoate	0.25	1.0	1.0	1.0	a
"	0.50	1.3	2.2	1.8	b
"	1.00	2.7	3.2	2.9	d
"	2.00	5.0	5.0	5.0	f
CL 43,064	0.25	1.7	2.0	1.8	b
"	0.50	1.7	2.0	1.8	b
"	1.00	2.7	3.3	3.0	d
"	2.00	4.0	4.0	4.0	e
Check	--	1.7	2.5	2.1	c

Ratings: 1 = best to 5 = poorest.

DMRT: Means followed by the same letter are not significantly different at the 5% level.

and over-all appearance in some of the plots was superior to the check plots. On February 6 and 7 Drs. R. A. Conover and J. W. Strobel rated the plots as to plant size and appearance (Table 7). The plots treated with 0.25 and 0.50 pounds of dimethoate and CL 43,064 were superior to the untreated plots, whereas plots treated with the higher dosages were definitely inferior to the untreated plots. The leaf miner population was too low during this period to obtain any control data.

The results of these tests show that systemic insecticides can be used effectively in various ways, but no one method is equally efficacious for all materials. The results also suggest that when applied as sprays to the foliage systemic insecticides are no more effective than non-systemic insecticides. This is possibly the least effective way of utilizing the unique properties and advantages of systemic insecticides. Although dimethoate was very effective when used as a foliar spray, it was more effective when applied as a granular formulation at planting. CL 43,064 was only moderately effective as a spray but was highly effective when used as a drench or when added to the starter solution. Furthermore, systemic insecticides present less of a hazard to parasites and predators when applied to the soil than when applied as a foliar spray. The results from drench tests also show that systemic insecticides may require different amounts of water to be most efficacious. Considered together, these results make it clear that we cannot make any broad or general statements about the most effective method of applying systemic insecticides per se. Recently Cordon and Young (4) in a study on the effectiveness of eradicant soil fungicides found that several factors influence the effectiveness of the chemicals used and that assay methods designed to evaluate soil fungicides rarely have been integrated to give a complete understanding of individual chemicals. This statement certainly applies to systemic insecticides as well. Each material must be evaluated individually, and only through studying the use of several methods of application can we hope to determine the most effective way to apply a given systemic insecticide.

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TOMATO VARIETY EVALUATION ON SANDY SOILS FOR PINK HARVEST

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INTRODUCTION

The successful production of field-grown, pink harvested tomatoes for shipment to northern markets began in South Florida about 1952. After experimenting with a small plot of Grothen's Red Globe tomatoes near Indiantown, Mr. Louis Rauth established a farm in Palm Beach County for the development of a commercial "vine ripe" tomato operation. Although several growers had previously tried "vine ripe" tomato production, Rauth Farm, now called Flavor-Pict Cooperative, pioneered this revolutionary method of growing, packaging and marketing tomatoes in South Florida. In the past 10 years "vine ripe" tomatoes have become a firmly established and economically important part of Florida's tomato industry. In 1961-62, 3,380 acres of tomatoes, representing about 8 per cent of the state's total tomato acreage, were harvested as "vine ripes." Because of the system of pruning, and trellising or staking, and harvesting over a long period of time the yield from this acreage would be perhaps 15 to 20 per cent of the total tomato production. The market value of tomatoes harvested in the pink or turning stage is usually higher than that of mature green fruits; therefore, in dollar value these stake and trellis grown tomatoes would represent an even larger percentage of the total Florida tomato industry.

Three major factors contributing to the acceptance of Florida's "vine ripe" fruit in northern markets are: (1) the tomatoes are near mature when harvested in the pink or turning stage, (2) the fruits are handled in a manner to keep bruising at a minimum, and (3) the variety Manalucie, used by most pink-harvest growers, is of excellent quality. Constant efforts to improve these factors should increase the demand for "vine ripe" tomatoes. Florida's 50 million dollar tomato industry could be greatly increased if the fine flavor and appearance of an unbruised vine ripe fruit could be consistently delivered to the northern consumer at a nominal price. Likewise, laxness in what is sold as "vine ripe" tomatoes, in the way the fruits are handled, or in switching to a variety of inferior quality will have an adverse effect on consumer acceptance.

Manalucie, released in 1953, has been used almost exclusively by producers of "vine ripe" tomatoes. However, in recent years some growers have planted Indian River and Manapal with success and have expressed a desire to know more about the varieties. This report is given to make available comparative information on four Flor-

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[1]The authors are indebted to D. G. A. Kelbert, J. M. Walter and R. E. Stall for their helpful suggestions in the preparation of this report.

Florida Agricultural Experiment Station Journal Series No. 1512.