SOIL-APPLIED SYSTEMIC INSECTICIDES IN RELATION TO INSECT AND MITE CONTROL ON VARIOUS VEGETABLE CROPS [1]

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A leaf miner, *Liriomyza munda* Frick, the cabbage aphid, *Brevicoryne brassicae* (L.), the poplar petiole gall aphid, *Pemphigus populitransversus* Riley, a mite, *Tetranychus marianae* (McG.), and the potato aphid, *Macrosiphum euphorbiae* (Thomas), are frequent pests of pepper, cantaloupes, cabbage, lettuce, and tomatoes in the Lower Rio Grande Valley of Texas. Previous information has shown that soil applied systemic insecticides control some of these pests. Systemic insecticides, applied in the soil with the seed, have been of limited use because of phytotoxicity. Experiments were therefore conducted to evaluate the effectiveness of various systemic insecticides against insects and mites when applied to the soils in furrow irrigated areas of south Texas, and show the relationship of granule placement to insect control and phytotoxicity. The data reported herein are the results of field experiments conducted in the Lower Rio Grande Valley during the 1959 and 1961-63 seasons.

No control measure has been found to date which will reduce or eliminate infestations of the poplar petiole gall aphid, locally called the cabbage root aphid. Wene and White (1952) concluded that no control was obtained with evaluated insecticides. Systemic insecticides have shown promise in south Texas for controlling mites on tomatoes and eggplant (Wolfenbarger and Getzin 1964), turnip aphid on turnips, potato aphid on potatoes, and cabbage aphid on cabbage (Harding 1959, 1962, Harding and Wolfenbarger 1964), and leaf miners on various crops (Harding and Wolfenbarger 1963). The use of systemic insecticides has previously shown promise for green peach aphid control on peppers (Shorey 1963).

METHODS AND MATERIALS

The dates of sampling are shown in the tables because not all treatments were applied at the same time in all experiments. For discussion purposes the days after application are used as this figure indicates the period of time the materials remained effective.

All experiments were arranged in a randomized complete block design. All treatments were replicated four times except in the poplar petiole gall aphid control experiment. In this experiment, each of the two randomized complete blocks contained two check plots. The data are presented as percent increase in control over the untreated check in all experiments except

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those presented in Table 4 and Fig. 1. The data in Table 4 are presented as mean aphids per plant and that in Fig. 1 as percent aphid free plants. All plots were furrow irrigated within 24 to 72 hours after the treatments were applied.

The chemical designations of the proprietary insecticides used in these evaluations are these:

American Cyanamid 43064 — 2-(diethoxyphosphinothioylimino)-1,3-dithiolane
American Cyanamid 47031—2-(diethoxyphosphinylimino)-1,3 dithiolane
Bayer 25141 — 0,0-diethyl 0-p-(methylsulfinyl) phenyl phosphorothioate
Di-Syston — 0,0-diethyl S-2-(ethylthio) ethyl phosphorodithioate
Niagara 9205 — N-methyl-5-(diethoxyphosphinothiothiol)-3-thiapentanamide
Union Carbide 8305 — P-chloro-2,3-dioxa-5-methyl P-thiono-3-phosphabicyclo (4.4.0) decane.

The crops used in these evaluations are planted by the following methods. Lettuce, peppers, and cabbage are commonly planted in two rows 18 inches apart on a raised bed. Tomatoes, peppers, cabbage, and curcubits are commonly planted in rows 38 inches apart on a raised bed. The furrow irrigated tomato, cabbage, and pepper transplants are usually planted not on top of the bed itself but on the sloping side away from the sun. Two to four weeks after planting, the bed is widened by throwing soil to the seedling side of it by opening a furrow 19-20 inches from the bed.

Results

Two separate experiments were conducted with phorate, Di-Syston, and dimethoate as soil treatments on Rio Gold cantaloupes. In the first experiment, the seed was planted and the granulated insecticides were applied by hand to the seed furrow and covered. In the second experiment, phorate was compared at two rates in seed furrow and sidedress treatments at planting time on plots 2 rows wide and 50 feet in length. The sidedress treatment was located 3-4 inches from the seed and level with the seed.

All insecticides included in both experiments (Table 1) provided 67-97% control of leaf miners compared to the untreated check 90 days after treatment. In experiment 1, the data show that phorate and Di-Syston reduced seeding emergence when applied in the seed furrow. Phorate, experiment 2 (Table 1), applied in the seed furrow reduced seedling emergence. Dimethoate reduced cantaloupe seedling emergence 3 and 7%. When phorate was applied as a sidedress, phytoxicity was reduced by 56%.

Plots 2 rows wide and 25 feet in length served to evaluate phorate, Di-Syston, and dimethoate as seed furrow treatments on Yolo Wonder pepper. The plots were planted and the insecticides applied by hand in the seed furrow on the same date. Final emergence counts were made 33 days after planting and leaf miner counts were taken 33 and 57 days after planting.

All insecticides provided good leaf miner control on peppers until 50 days after planting (Table 2). Counts taken 64 days after seeding showed that phorate was the most effective insecticide, averaging 94% control for both rates. Di-Syston and dimethoate averaged 77 and 88% control.

TABLE 1.—PLANT EMERGENCE AND INSECT CONTROL ON CANTALOUPES OBTAINED WITH GRANULATED SYSTEMIC INSECTICIDES, WESLACO, 1959.

Treatment	Lb/A actual	Application	Percent * seedling reduction	Percent leaf miner control**	
				2 April	16 April
Experiment 1					
Phorate	3.0	Furrow	58	17	97
Phorate	1.5	Furrow	37	94	91
Di-Syston	3.0	Furrow	70	79	92
Di-Syston	1.5	Furrow	40	86	67
Dimethoate	3.0	Furrow	7	91	93
Dimethoate	1.5	Furrow	3	55	71
Check				52**	52†
Experiment 2					
Phorate	1.5	Furrow	70	96	95
Phorate	3.0	Furrow	69	89	96
Phorate	1.5	Banded	14	99	79
Phorate	3.0	Banded	13	98	93
Check				48**	65†

* Based on total plants in check plot.
** Number of mined cotyledons per 50 plants.
† Number of mined true leaves per 100 ft. of row.

Phorate, dimethoate, and Di-Syston reduced the pepper plant population 24, 11, and 5%, respectively. Thus, there was less phytotoxicity to peppers than to cantaloupes.

Granulated systemic insecticides were applied by hand to Valverde lettuce plots in a 3-4 inch deep furrow in the center of the bed (9 inches from either row) at the time of first thinning. The granules were then covered by hand. Green peach aphid infestations on 10 plants were recorded 118 days after application.

Data in Table 3 show American Cyanamid 43064 and Di-Syston (4.0 lb/A) eliminated green peach aphid populations for 84 days after application on lettuce. The maximum control attained by any rate of material was 60%.

Di-Syston and phorate were applied to plots 4 rows wide and 1980 feet in length for poplar petiole gall aphid control on globe cabbage. The granules were applied by a tractor mounted applicator in a band on each side of the row when the plants were in the 4-5 leaf stage. Rows were 38 inches apart. The band was 5-6 inches from the plant and 4 inches deep. Plots were evaluated by sampling 50 plants per plot. Each plant was examined to determine if the plant was infested with 1 or more aphids and the data are presented as percent infested plants.

Data in Fig. 1 show phorate and Di-Syston effectively controlled poplar petiole gall aphid infestations on cabbage 35 and 51 days after application. Sixty-four days after application, only the Di-Syston treated plots remained free of root aphid infested plants while the phorate plots showed

TABLE 2.—PLANT EMERGENCE AND LEAF MINER CONTROL ON PEPPERS OBTAINED WITH GRANULATED SYSTEMIC INSECTICIDES APPLIED AS FURROW TREATMENTS, WESLACO, 1959.

Treatment	Lb/A actual	Percent seedling* reduction	Percent leaf miner control	
			19 March	2 April
Phorate	3.0	22	100	92
Phorate	1.5	26	100	95
Di-Syston	3.0	10	81	71
Di-Syston	1.5	0	100	86
Dimethoate	3.0	21	96	93
Dimethoate	1.5	0	94	83
Check			53**	266**

* Based on plants in check plot.
** Number of mined leaves per 100 feet of row.

TABLE 3.—SYSTEMIC INSECTICIDES FOR CONTROL OF THE GREEN PEACH APHID ON LETTUCE, PROGRESO, 1963.

Material*	Actual (lb/A)	Percent aphid control 28 February
Phorate	1.0	19
Phorate	2.0	60
Phorate	4.0	19
Di-Syston	1.0	0
Di-Syston	2.0	0
Di-Syston	4.0	100
AC 43064	1.0	100
AC 43064	2.0	100
AC 43064	4.0	100
AC 47031	1.0	19
AC 47031	2.0	60
AC 47031	4.0	60
Bayer 25141	1.0	19
Bayer 25141	2.0	0
Bayer 25141	4.0	19
UC 8305	2.0	0
UC 8305	4.0	60
Dimethoate	1.0	0
Dimethoate	2.0	60
Dimethoate	4.0	0
NIA 9205	1.0	0
NIA 9205	2.0	42
NIA 9205	4.0	0
Check		11.3**

* Applied 4 December.
** Mean aphids per 10 plants examined.

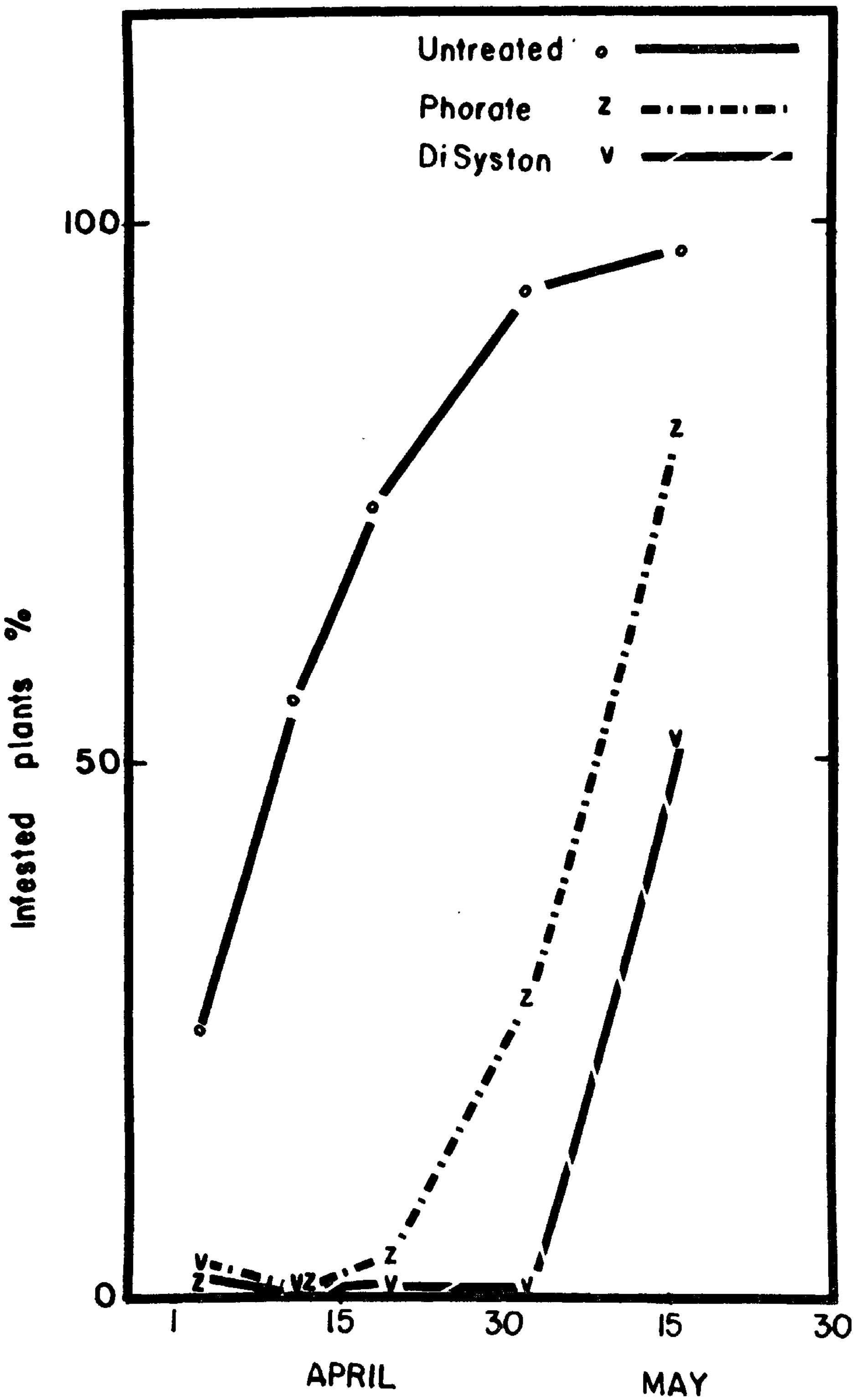

Fig. 1. Percent cabbage root aphid infested cabbage plants after one application of Di-Syston and phorate, Hidalgo, 1963.

28% infested plants and the check 94%. Di-Syston, 77 days after the single application, gave 50% aphid free plants and remained the best treatment.

Several granulated systemic insecticides were applied to the soil for cabbage aphid control as a side dress application when the Marion Market cabbage plants were in the 2 and 3 leaf stage. Plots were single row, 25 feet in length. The granules were placed in a furrow 3-4 inches from the seed and 2-3 inches deep on one side of the row and were covered by hand. Four plants per plot were examined for aphids on the first sampling date and all plants in each plot were examined at the second sampling. Data in Table 4 show that all insecticides significantly reduced mean cabbage aphid populations compared to the untreated check 130 days after application. All treatments except Bayer 25141 were significantly better than the untreated check 144 days after application.

TABLE 4.—GRANULATED SYSTEMIC INSECTICIDES FOR CABBAGE APHID CONTROL ON CABBAGE, PROGRESO, 1963.

Material*	Actual (lb/A)	Mean aphids per 10 plants 26 February	12 March
AC 43064	2.0	44.2 a**	168.6 a**
AC 43064	4.0	5.4 a	190.4 ab
Di-Syston	2.0	5.3 a	249.9 abc
Bayer 25141	2.0	62.0 a	701.1 c–g
Dimethoate	2.0	17.2 a	398.4 a–e
Dimethoate	4.0	9.9 a	483.6 a–e
Phorate	2.0	13.7 a	643.4 a–g
Phorate	4.0	9.6 a	504.1 a–e
Check		175.0 b	1161.6 gh

* Applied 16 October.

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

Data in Table 5 summarize results from Chico tomato plots where several granulated insecticides were used six different ways in a raised bed for mite, leaf miner, and potato aphid control. The seed was planted on February 19 in a single row at the middle on top of the bed on plots 1 row wide and 25 feet in length. All granule treatments were applied by hand and the furrows were made with a hoe.

The materials were most effective initially when applied 1-6 inches deep at seeding and 39 days after application (Table 5). Granules on the soil surface at seeding time provided aphid control but did not give effective mite and leaf miner control.

Di-Syston provided the best mite control although variations were noted between granule placement. Granules placed 1-2 inches below and 3-4 inches to the side of the seed provided the best control 91 days after application and seeding. Di-Syston applied 3-4 or 5-6 inches deep and 3-4 inches to the side of the seed provided the best control 100 days after application and seeding. These data show that the deeper the granules

TABLE 5.—LOCATION OF SYSTEMIC INSECTICIDES AT 2.0 LB. ACTUAL/ACRE IN RELATION TO MITE, LEAF MINER, AND APHID CONTROL ON TOMATOES, WESLACO, SPRING, 1963.

Time of application	Depth (inches)	Placement relative to seed row (inches)	Mean % control compared to untreated check* Phorate		AC 43064	
			28 May	6 June	28 May	6 June
Mite infested leaflets						
At seeding	1-2	2-3 to side	49	0	25	0
At seeding	3-4	2-3 to side	17	23	24	25
At seeding	5-6	2-3 to side	42	0	46	31
At seeding	3-4	1-2 below seed	47	40	23	32
At seeding	Surface	8-12 band	26	0	14	8
Post-Emergence*	3-4	2-3 to side	57	40	19	38
Mean			40	17	25	22
Leaf miner mines			30 April	28 May	30 April	28 May
At seeding	1-2	2-3 to side	1	34	86	53
At seeding	3-4	2-3 to side	53	30	75	22
At seeding	5-6	2-3 to side	47	45	56	49
At seeding	3-4	1-2 below	57	35	36	50
At seeding	Surface	8-12 band	39	15	70	26
Post-emergence*	3-4	2-3 to side	40	7	31	20
Mean			40	28	59	37
Potato aphid			30 April	28 May	30 April	28 May
At seeding	1-2	2-3 to side	0	84	74	64
At seeding	3-4	2-3 to side	43	42	28	82
At seeding	3-6	2-3 to side	0	58	0	100
At seeding	3-4	1-2 below	0	0	0	34
At seeding	Surface	8-12 band	0	82	0	94
Post-emergence*	3-4	2-3 to side	0	76	0	88
Mean			7	57	17	77

(Continued)

TABLE 5. (Continued)
Mean % control compared to untreated check*

AC 47031		Di-Syston		Dimethoate		Mean	
28 May	6 June	28 May	6 June	28 May	6 June	28 May	6 June
44	3	77	25	12	0	41	6
37	0	38	60	28	15	29	25
24	6	35	59	28	0	35	19
32	18	57	52	3	0	32	28
35	0	67	23	18	0	32	6
51	33	37	30	49	0	43	28
37	10	52	42	23	3		
30 April	28 May	30 April	28 May	30 April	28 May	30 April	28 May
74	8	70	24	57	0	56	24
71	18	59	14	58	18	63	20
64	38	73	9	33	0	55	28
42	33	60	34	46	6	48	32
43	27	54	13	38	1	49	16
46	16	74	26	50	42	48	22
57	23	65	20	47	11		
30 April	28 May	30 April	28 May	30 April	28 May	30 April	28 May
0	12	28	30	0	66	20	51
3	0	0	58	0	80	15	52
26	4	40	78	0	36	13	69
0	82	23	64	17	24	8	51
0	48	0	88	0	52	0	73
11	88	0	82	0	60	2	79
7	39	15	67	3	53		

* The untreated check had the following mean counts: Mite infested leaves—28 May, 57.5; 6 June, 43.3. Leafminer mines—30 April, 36.0; 28 May, 84.8. Potato aphids—30 April, 8.8; 28 May, 8.3.

** 39 days after planting.

are placed in the soil, the longer control is obtained. Di-Syston applied 39 days after seeding failed to provide increased mite control compared to the other treatments. These data indicate that perhaps the stage of plant maturity plays a role in uptake and movement of the toxicant to tomato foliage. Di-Syston granules placed at a 5-6 inch depth gave the best mean control on both dates. American Cyanamid 43064, phorate, and American Cyanamid 47031 followed in order of over-all effectiveness for mite control.

American Cyanamid 43064 applied at a depth of 3-4 inches and Di-Syston applied at a depth of 5-6 inches had consistently lower leaf miner populations than the untreated check and other materials and treatments 63 days after application. Fifty-two days after the post-emergence application and 92 days after the seeding time application, all systemics had lower leaf miner populations than dimethoate and untreated check. American Cyanamid 43064 applied 1-2 inches below the soil surface reduced potato aphid populations compared to the other treatments. American Cyanamid 43064 and Di-Syston gave the best control of all treatments. No treatment was injurious to tomato seedlings but phorate and Di-Syston placed beneath the seed caused a whitening of the margins of cotyledon leaves.

Discussion

Baranowski (1962) concluded that granulated systemic insecticides placed with tomato seed at rates over 1 pound actual toxicant per acre caused a reduction in germination. This was also the case on cantaloupes and peppers (Tables 1 and 2). At the rates used in the other experiments, no insecticide caused a reduction in stand when the insecticides were placed to the side of the seed.

Soil types have been shown to influence the movement of phorate in the soil (Getzin and Chapman 1959, 1960). Soils of high clay or high organic matter content reduced or prevented insecticide movement in the soil and insecticide uptake in the plant. The soil applied granulated insecticides were applied to Hidalgo Fine Sandy Loam and Harlingen Clay soil types. The data indicated that insect control was generally similar on the two soil types when applied at equal rates. These soil types predominate in the Lower Rio Grande Valley. Thus, soil type appears not to play a signficant role in the use of these materials in the Lower Rio Grande Valley.

Getzin and Chapman (1959) showed that only a small amount of the insecticide added to an agricultural soil was absorbed by the plant. They also pointed out that longer residual effects can be obtained with phorate if correct application procedures are used because the soil acts as a protective mechanism by reducing hydrolysis and volatilization. This was substantiated when the materials applied 3-6 inches below the soil level offered the best residual control for both soil types.

Time of application also appeared to play a role in insect control on cabbage and tomatoes. The granules were applied at the 4-5 leaf stage (Fig. 1) and effective control was obtained. In the results of an unpublished experiment, Di-Syston and phorate (1.0 lb/A) were applied to mature cabbage plants and compared for poplar petiole gall aphid control. The plots were furrow irrigated 24 hours later and the roots were examined after 10 days. No reduction in aphid control was noted. Thus, again, it appears that plant maturity plays a role in insect and mite control on cabbage and tobatoes.

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