SELECTIVE TOXICANTS AND TOXICANT-SURFACTANT COMBINATIONS FOR LEAFMINER, *LIRIOMYZA MUNDA* FRICK, CONTROL AND PARASITE SURVIVAL [1]

DAN A. WOLFENBARGER [2] AND L. W. GETZIN [3]
Texas Agricultural Experiment Station, Weslaco

The leafminer, *Liriomyza munda* Frick, is an important pest of various vegetable crops. Several insecticides, applied for the control of the leafminer, did not reduce populations of the hymenopterous parasite, *Derostenus variipes* (Cwfd.),[4] according to Getzin (1959). Subsequent to the publication of these data it was thought other phosphate compounds would offer selective action relative to the leafminer-parasite relationship.

It has been reported that control of certain foliage-feeding insects can be increased by surfactants or surface active agents to insecticides. Surfactants, both alone and in combination with various toxicants, were evaluated for initial and residual effectiveness to show where the addition of a surfactant would aid in reducing toxicant concentrations for leafminer control. Additional experiments were designed to (1) gain information on losses in pepper yields due to leafminer infestations, (2) investigate reports of leafminer tolerance to methyl parathion, and (3) evaluate new chemicals for leafminer control and parasite survival. Wolfenbarger (1956) evaluated the effects of leafminer infestations on potatoes but not on peppers.

MATERIALS, METHODS, AND RESULTS

Experimental plots of peppers (Yolo Wonder), cantaloupes (Wescan), and Southernpeas (California Blackeye No. 5) were planted at Progreso, Mission or Weslaco. Plots were one or two rows wide and 25 to 40 feet in length and arranged in a randomized complete block design. Most materials were applied with a carbon-dioxide small plot sprayer with approximately 34 p.s.i. and 27 gallons per acre. Plots two rows wide 25 feet in length were sprayed with a tractor mounted small plot sprayer at a rate of 64 gallons of the finished spray per acre at 60 p.s.i. in experiments 6, 7 and 9. The dust applications were applied at the rate of 25 pounds per acre with a rotary hand duster. Five leaves per plot were sampled except as indicated.

All insecticidal effects were evaluated as described by Wolfenbarger (1962). Leaf samples, in pint ice cream carton cages, were held at 27° C for five days for leafminer pupal development and adult parasite emergence.

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[1] Contribution of Texas Agricultural Experiment Station, Substation No. 15, Weslaco.

[2] Associate Entomologist.

[3] Present address Western Washington Experiment Station, Puyallup, Washington.

[4] *Ganaspidium pusillae* adults were determined by L. H. Weld, and *Derostenus variipes* were identified by B. D. Burks, of the Parasite Introduction and Insect Identification Branch, Entomology Research Division, U. S. Department of Agriculture, Beltsville, Maryland.

Pupae were counted and held with the adult hymenopterous parasites which had emerged from the leaves in glass vials until adult leafminer and parasite emergence was complete. These were then sorted by species and counted.

EXPERIMENT 1.—Chemical distributors and growers alike often consider methyl parathion and ethyl parathion as insecticides that will react similarly with leafminers. During the spring and summer of 1960 numerous reports indicated that methyl parathion was not controlling leafminer populations. Therefore, methyl parathion and related compounds were compared for toxicity to the leafminer during the 1960-61 seasons. Excellent control of the leafminer was obtained with ethyl parathion, Delnav, and dimethoate (Table 1).

TABLE 1.—CONTROL OF THE LEAFMINER, *Liriomyza munda,* IN PEPPERS WITH INSECTICIDES TWO DAYS AFTER TREATMENT. MISSION, TEXAS, 1960.

Treatment*	Actual toxicant per acre	Percent control
Parathion	0.5	98
Methyl parathion	0.05	21
Ethion	0.5	66
Ethion	0.25	66
Delnav	0.5	93
Diazinon	0.5	99
Dimethoate	0.25	99
Check (Pupae/leaf)		(10.5)

* Applied 5/25.

The methyl parathion gave little control of leafminers. It is possible that a degree of tolerance to methyl parathion exists although the data are limited. This tolerance may have occurred from repeated applications of methyl parathion.

EXPERIMENT 2.—Pepper seedlings and mature plants have been killed and defoliated respectively by leafminer ovipositional punctures and damage by the mining larvae within the leaf tissue. Experiment 2 was therefore designed to evaluate yield losses where dimethoate was used to control the leafminer infestations. The data of the leafminer infestations, plant stands, plant growth and yields are summarized in Table 2. The leafminer infestation was severe only during the month of July in this field and the difference between treatments are the result of the initial damage only. Since dimethoate was a very effective chemical for leafminer control (Getzin, 1959), the treated plots were virtually free of mining damage. Seedling mortality, as measured by recording the percentage of living and dead plants three weeks after planting, was severe in all treatments. The 30% mortality that occurred in the plots receiving weekly applications of dimethoate was apparently caused by high temperatures and a severe accumulation of salts from the irrigation water. The additional seedling mortality above 30% in the remaining two treatments was considered to have resulted from leafminer damage. The plant stands were recorded after the field was thinned and the plant heights were severely affected by the above mentioned adverse conditions. The one application of dimethoate increased the plant stand and growth over the untreated check. The plant stand and plant growth in the plots receiving weekly applications of dimethoate were increased 67% and 44%, respectively, over the check.

TABLE 2.—LEAFMINER INFESTATIONS AND YIELDS RELATIVE TO INSECTICIDAL APPLICATIONS. PROGRESO, TEXAS, 1960.

	Insecticide treatment		
Observation	Weekly applications	One application	No applications
Mined cotyledons per 50 plants on July 21	8	70	70
% mined leaves on August 4	0	0	0.2
% mined leaves on August 25	0	0.1	0.1
% seedling mortality on July 28	30	53	54
Plants per 12 ft. of row on August 18	40	32	24
Av. plant height on September 8	6.9 in.	5.5 in.	4.8 in.
Yield (Ton/acre)	6.29	5.80	4.75

Fruit yields from the plots receiving either the weekly insecticide applications or the single insecticide application were greater than those of the check because the plant stand was reduced in the check plot. The fruit size and the average weight of fruit per plant were greater for the check plots than for the treatments.

The effect of leafminer damage to peppers in this test must be evaluated along with the damage that resulted from adversely high temperatures and the accumulation of salt from irrigation water. The combination of these factors caused a greater loss of plants than could be attributed to any of these factors individually. Protection of pepper seedlings as afforded by the use of insecticides provided a greater plant stand than fields not treated with insecticides. This protection would be of most benefit for summer plantings when high temperatures and salt accumulations are also a problem. The weekly applications of dimethoate were made to obtain plots completely free of leafminer damage and it is not intended that such a procedure should be followed by commercial producers.

EXPERIMENT 3.—Plots one row wide and 25 feet in length were arranged in a randomized complete block design for the evaluation of various insecticides, fungicides, surfactants, and a nematocide on Southern peas for leafminer control (Table 3). Dimethoate at all rates, EPN, malathion, ethion, phosphamidon, demeton, Sevin, and Delnav were effective initially. Only dimethoate at both rates, Delnav and Sevin gave control six days after application. No material gave control 12 days after application.

TABLE 3.—CONTROL OF *Liriomyza munda* WITH FOLIAR SPRAYS OF INSECTICIDES ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5) WESLACO, TEXAS. 1961.

Material *	Actual toxicant (Lbs/A)	Pupae per leaf on days after last application as indicated**		*G. pusillae* adults on days after last application as indicated	
		3	6	3	6
Kepone	1.0	12.0 fg	8.1 abcde	0 c	15 cde
Phosdrin	0.5	5.6 abcdefg	8.0 abcde	3 bc	20 abcde
Ethion	0.75	0.5 ab	4.4 abcde	22 bc	21 abcde
Malathion	1.5	1.5 a	11.9 e	0 c	76 a
Dilan	1.0	12.9 g	11.7 de	77 a	59 abcd
Sevin	3.0	2.2 abcde	1.9 abc	2 bc	14 cde
Zineb	2.0	13.7 g	9.0 bcde	20 bc	75 ab
Dimethoate	0.5	0 a	0 a	0 c	0 e
Dimethoate	1.0	0.2 a	0.2 a	0 c	0 e
Demeton	0.5	1.9 abcd	5.7 abcde	8 bc	47 abcde
Dibrom	0.75	7.4 abcdefg	5.6 abcde	11 bc	43 abcde
Endrin	0.25	10.7 cdefg	5.4 abcde	27 bc	64 abcde
Phosphamidon	0.75	0.4 a	6.8 abcde	0 c	66 abcd
TEPP	0.5	4.8 abcdefg	10.0 cde	6 bc	30 abcde
G 30494	2.0	0.9 ab	7.3 abcde	0 c	36 abcde
AC 24055	2.0	5.8 abcdefg	5.5 abcde	24 bc	35 abcde
Delnav	0.75	2.8 abcdef	0.3 ab	2 bc	0 c
Maneb	3.0	8.9 abcdefg	2.9 abcde	12 bc	10 de

TABLE 3.—CONTROL OF *Liriomyza munda* WITH FOLIAR SPRAYS OF INSECTICIDES ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5) WESLACO, TEXAS. 1961. (Continued)

Material *	Actual toxicant (Lbs/A)	Pupae per leaf on days after last application as indicated**		*G. pusillae* adults on days after last application as indicated	
		3	6	3	6
Karathane	2.0	10.0 cdefg	5.8 abcde	13 bc	14 cde
HRS-16	2.0	8.9 abcdefg	7.6 abcde	42 bc	44 abcde
Sulfer	2.0	4.8 abcdef	4.4 abcde	35 abc	30 abcde
Methyl Parathion	0.5	7.3 abcdefg	3.5 abcde	9 bc	18 cde
Tedion	1.0	11.5 efg	8.3 abcde	26 bc	54 abcde
Pyrellin	2.0	12.5 g	9.2 bcde	49 abc	68 abc
EPN	1.0	0 a	4.6 abcde	0 c	19 bcde
Nemagon	1.0	3.4 abcde	5.2 abcde	4 bc	42 abcde
Terrachlor	3.0	4.3 abcdefg	4.8 abcde	36 abc	35 abcde
Dylox	2.0	0.1 a	3.3 abcde	0 c	20 abcde
Genite	2.0	8.2 abcdefg	5.7 abcde	25 bc	59 abcd
Atlox 3300	1 qt.	9.1 abcdefg	3.4 abcde	43 abc	38 abcde
Oil-A-Cide	6 qt.	11.6 befg	3.3 abcde	27 bc	30 abcde
Check	——	10.8 cdefg	7.1 abcde	38 ab	70 abc

* Applied July 19.

** a, b, c, d, e, f, g. Any two means in the same column and associated with the same superscript letter are not significantly different according to Duncan's multiple range test at 5% level.

TABLE 4.—CONTROL OF *Liriomyza munda* WITH FOLIAR APPICATIONS OF INSECTICIDES ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5), WESLACO, TEXAS. 1961.

Material *	Actual toxicant (Lbs/A)	Pupae per leaf on days after last application as indicated**		Parasite species on days after last application as indicated			
				G. pusillae	*D. variipes*	*G. pusillae*	*D. variipes*
		3	7	7		13	
Delnav	0.25	0.7 ab	1.3 ab	1 bc	4 c	61 b	0 c
Delnav	0.5	1.0 ab	2.6 abc	0 c	5 c	232 ab	106 ab
Zectran	1.0	1.3 abc	7.9 abcd	1 bc	3 c	320 a	59 abc
Zectran	1.5	1.6 abcd	4.9 abcd	3 bc	16 abc	88 b	4 c
Zectran	2.0	0.7 ab	7.0 abcd	1 bc	34 abc	144 ab	41 abc
Zectran	3.0	0.9 ab	7.7 abcd	4 bc	0 c	157 ab	41 abc
Dimethoate	0.125	0.1 a	4.1 abcd	0 c	27 abc	171 ab	61 abc
Dimethoate	0.5	0 a	1.0 ab	0 c	2 c	106 ab	14 bc
Dimethoate	0.75	0.1 a	0.1 a	0 c	10 bc	154 ab	11 bc
Dibrom	0.75	1.9 abcde	6.5 abcd	0 c	2 c	144 ab	17 abc
Dibrom	1.0	2.5 abcde	4.3 abcd	2 bc	8 c	75 b	20 abc
Dibeom	1.5	2.5 abcde	10.9 abcd	2 bc	0 c	112 ab	7 c
Dibrom	2.0	2.6 abcdef	9.7 abcd	1 bc	24 abc	89 b	10 bc
Tedion	1.0	5.0 efghi	14.7 d	1 bc	21 abc	159 ab	113 a
Tedion	1.5	5.9 ghi	8.3 abcd	23 a	12 abc	142 ab	24 abc
Tedion	2.0	6.6 hi	13.3 cd	0 c	0 c	115 ab	16 abc
Tedion	2.5	4.7 defghi	9.0 abcd	7 abc	9 c	98 ab	22 abc
Bayer 39007	0.75	0.3 a	5.8 abcd	0 c	5 c	168 ab	19 abc

TABLE 4.—CONTROL OF *Liriomyza munda* WITH FOLIAR APPICATIONS OF INSECTICIDES ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5), WESLACO, TEXAS. 1961. (Continued)

Material *	Actual toxicant (Lbs/A)	Pupae per leaf on days after last application as indicated**		Parasite species on days after last application as indicated			
				G. pusillae	*D. variipes*	*G. pusillae*	*D. variipes*
		3	7	7		13	
Bayer 39007	1.0	0.6 ab	9.6 abcd	0 c	0 c	150 ab	42 abc
Bayer 39007	1.5	0.1 a	0.8 ab	0 c	9 c	108 ab	25 abc
Bayer 39007	2.0	0.4 ab	5.5 abcd	0 c	16 abc	137 ab	41 abc
Ethion	0.75	0.1 a	0.3 ab	0 c	5 c	155 ab	64 abc
Ethion	1.0	0.3 a	1.0 ab	1 b	11 abc	105 ab	34 abc
Ethion	1.5	0.3 a	0.2 ab	0 c	1 c	152 ab	13 bc
Ethion	2.0	0 a	0.1 a	0 c	1 c	123 ab	0 c
Kepone	1.5	3.3 abcdefg	4.5 abcd	10 abc	5 c	125 ab	0 c
Kepone	2.0	4.6 defghi	7.4 abcd	7 abc	23 abc	110 ab	0 c
Kepone	2.5	3.8 bcdefgh	0.9 ab	9 abc	17 abc	106 ab	0 c
Bayer 29493	0.5	0.7 ab	8.7 abcd	0 c	33 abc	129 ab	13 bc
Bayer 29493	0.75	0 a	1.8 ab	0 c	13 abc	128 ab	0 c
Bayer 29493	1.0	0.1 a	3.4 abc	0 c	32 abc	140 ab	8 bc
Check	—	7.3 i	8.6 abcd	19 ab	50 a	73 b	4 c

* Applied 8/1, 8/15, 2/22-23, 8/28.

** a, b, c, d, e, f, g, h. Any two means in the same column and associated with the same superscript letter are not significantly different according to Duncan's multiple range test at 5% level.

Adult populations of the leafminer parasite, *Ganaspidium pusillae* Weld., were highest three days after application in the Dilan treatment although not significantly higher than the untreated check, Atlox 3300, the fungicide Terrachlor, Pyrellin, and sulphur. Six days after the application more *G. pusillae* adults were found in the malathion treated plots than any of the other treated areas although Dilan was not significantly poorer than malathion. Delnav and dimethoate (at both rates) appeared to be non-selective although few leafminer larvae were found six days after application. The methyl parathion, Karathane, Maneb, Sevin, and Kepone treatments had significantly lower *G. pusillae* populations than did the remaining treatments. Zineb, initially, was significantly poorer than Dilan and appeared to be selective. Twelve days after application no differences were found between treatments, and parasite populations were low although the treatments had little or no effect upon their numbers.

EXPERIMENT 4.—Table 4 shows results from comparisons of various phosphate insecticides and two new carbamates for control of leafminers attacking Southern peas. Bayer 29493, dimethoate, and ethion were the most effective materials at the indicated rates. Seven days after application ethion and dimethoate were the most effective materials. Dibrom, Tedion, and Kepone were ineffective three days after application and the carbamate insecticides Bayer 39007 and Zectran were relatively ineffective. At the low rate, dimethoate gave some indication of selective action three days after application. Both carbamate insecticides appeared to be toxic to the attacking parasite species while Kepone, Tedion, and the untreated check had significantly higher *G. pusillae* populations than did the remainder of the treatments. Ten to 13 days after the insecticidal application, parasite and leafminer infestations were not affected by the foliar applications.

EXPERIMENT 5.—Table 5 compares several compounds in relation to the standard parathion and the untreated check for leafminer control on Southern peas. Three and seven days after the first application all treatments were superior to the untreated check and Telodrin. Parathion, Imidan, Vapona, Bayer 29493, and methyl demeton were equal in effectiveness. Bayer 29493, methyl demeton, and Vapona plots had high populations of parasites three days after application. Imidan and parathion were toxic to *D. variipes* populations and were significantly poorer than the selective materials. Seven days after application no parasites were found.

EXPERIMENT 6.—Results of various toxicants in relation to leafminre infestations and parasite survival on tomatoes are described in Table 6. The most effective material for leafminer control was GC 4072; SD 3562 exhibited initial effectiveness but did not show residual effectiveness.

EXPERIMENT 7.—On Southern peas all the insecticides, when added to the surfactants, B-1956 and X-100, each at three rates, gave significant initial control (Table 7). Delnav in combination with X-100 and B-1956 gave excellent residual control and was significantly better than the remaining toxicant-surfactant combinations. Diazinon and parathion in combination with B-1956 gave increased control as the surfactant concentration was increased. The B-1956 (1 pint concentration) plus toxicant combination equalled the untreated check in leafminer populations at seven days. This was not exhibited in the X-100 insecticide combinations.

TABLE 5.—CONTROL OF *Liriomyza munda* WITH FOLIAR APPLICATIONS OF INSECTICIDES AND PERCENT PARASITE SURVIVAL ON TOMATOES, (HOMESTEAD 24), PROGRESO, TEXAS. 1961.

Treatments*	Actual toxicant (Lbs/A)	Pupae per leaf on days after** last application as indicated		*D. variipes* on days after last application as indicated
		3	7	3
Parathion	0.5	0 a	0 a	0 b
Telodrin (SD 4402)	0.25	0.5 b	0.7 b	16 ab
Imidan (R-1504)	0.6	0.1 a	0 a	1 b
Vapona	0.5	0.1 a	0.2 b	30 a
Bayer 29493	1.0	0 a	0.1 a	29 a
Methyl demeton	0.75	0.1 a	0.1 a	30 a
Check	—	0.4 b	1.6 b	6 ab

* Applied 6/2, 6/16.
** 15 leaflets sampled.

TABLE 6.—CONTROL OF *Liriomyza munda* WITH FOLIAR APPLICATIONS OF INSECTICIDES AND PERCENT PARASITE SURVIVAL ON TOMATOES (HOMESTEAD 24), PROGRESO, TEXAS. 1961.

Treatment*	(Lbs/A)	Pupae per leaf on days after last application as indicated†		*D. variipes* on days after last application as indicated
		3	11	3
Toxaphene	3.0	1.2 ab	3.7 b	1 b
GC 4072	0.75	0 a	0.5 ab	1 b
SD 3562	0.25	0.5 ab	1.0 ab	8 b
Dylox**	3.0	2.0 b	0.2 a	15 a
Genite	2.0	1.5 b	3.4 b	9 b
Check	—	1.2 ab	2.6 ab	12 a

* Applied 4/22, 4/28, 5/8, 6/2.
** Dusts applied 4/24, 4/28, 5/9, 6/2.
† (25 leaves sampled).

TABLE 7.—CONTROL OF *Liriomyza munda* WITH FOLIAR APPLICATIONS OF INSECTICIDE SURFACTANT COMBINATIONS AND INSECTICIDES ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5), WESLACO, TEXAS. 1961.

Material*	Actual toxicant (Lbs/A)	Pupae per leaf on days after last application as indicated**, †		*D. variipes* adults on days after last application as indicated
		3	7	7
Delnav + B-1956	0.5 + 1 pt.	0.1 a	0 a	20 a
Delnav + B-1956	0.5 + 1 qt.	0 a	0 a	0 d
Delnav + B-1956	0.5 + 1.5 qts.	0.1 a	0 a	6 c
Delnav + X-100	0.5 + 1 qt.	0 a	0.7 a	0 d
Delnav + X-100	0.5 + 1 qt.	0 a	0 a	0 d
Delnav + X-100	0.5 + 1.5 qts.	0 a	0.5 a	0 d
Dylox	1.0	0 a	3.4 ab	11 cd
Vapona	0.25	4.6 c	9.4 bcdef	0 d
Imidan	0.5	1.8 ab	11.2 cdef	2 cd
Diazinon + B-1956	0.5 + 1 pt.	0.3 a	14.4 f	6 c
Diazinon + B-1956	0.5 + 1 qt.	0.2 a	12.1 cdef	2 cd
Diazinon + B-1956	0.5 + 1.5 qts.	0 a	7.1 abcdef	2 cd
Diazinon + X-100	0.5 + 1 pt.	0.5 a	9.8 bcdef	1 cd
Diazinon + X-100	0.5 + 1 qt.	0 a	11.2 cdef	0 d
Diazinon + X-100	0.5 + 1.5 qts.	0 a	7.1 abcdef	0 d
Parathion + B-1956	0.5 + 1 pt.	1.6 ab	12.1 cdef	1 cd
Parathion + B-1956	0.5 + 1 qt.	0.1 a	6.5 abcdef	3 cd
Parathion + B-1956	0.5 + 1.5 qts.	0.3 a	5.1 abcde	0 d

TABLE 7.—CONTROL OF *Liriomyza munda* WITH FOLIAR APPLICATIONS OF INSECTICIDE SURFACTANT COMBINATIONS AND INSECTICIDES ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5), WESLACO, TEXAS. 1961. (Continued)

Material*	Actual toxicant (Lbs/A)	Pupae per leaf on days after last application as indicated**, †		*D. variipes* adults on days after last application as indicated
		3	7	7
Parathion + X-100	0.5 + 1 pt.	0.1 a	12.4 ef	0 d
Parathion + X-100	0.5 + 1 qt.	0.1 a	6.4 abcdef	0 d
Parathion + X-100	0.5 + 1.5 qts.	4.6 c	7.2 abcdef	12 b
Dylox + B-1956	1.0 + 1 pt.	0 a	1.9 ab	5 cd
Dylox + B-1956	1.0 + 1 qt.	3.7 bc	4.8 abcde	0 d
Dylox + B-1956	1.0 + 1.5 qts.	0 a	4.3 abcd	0 d
Dylox + X-100	1.0 + 1 pt.	0 a	3.7 abc	0 d
Dylox + X-100	1.0 + 1 qt.	0 a	6.4 abcdef	2 cd
Dylox + X-100	1.0 + 1.5 qts.	0 a	5.4 abcde	3 cd
Check	— —	6.5 d	12.3 ef	12 b

* Applied 8/7 to plots 1 row 25 feet in length.

** a, b, c, d, e, f. Any two means in the same column and associated with the same superscript letter are not significantly different according to Duncan's multiple range test at 5% level.

† Five leaflets per plot sampled.

TABLE 8.—FOLIAR APPLICATIONS OF INSECTICIDES AND THEIR EFFECT UPON *Liriomyza munda* ON PEPPERS (KEYSTONE RESISTANT GIANT), PROGRESO, TEXAS. 1961.

Materials*	Actual toxicant (Lbs/A)	Leafminer pupae per leaf on days after last application as indicated**						
		5	11	3*	3	7	13	7
Delnav	0.75	0.1 ab	7.8 b	0.2 ab	0.7 a	0.1 a	0.8 a	0.1 a
Thiodan	0.75	2.1 c	8.0 b	1.0 b	4.3 b	0.5 b	3.0 b	0.9 c
Diazinon	0.5	0.1 ab	6.9 b	0.1 a	0.5 a	0.3 a	1.6 ab	0 a
Bayer 25141	0.25	0 a	0.4 a	0 a	0.1 a	0 a	0.7 a	0 a
Dibrom	1.0	0.2 ab	8.8 b	0.1 a	0.3 a	0.1 a	2.8 b	0.2 ab
Guthion	1.0	0 a	7.5 b	0 a	0 a	0 a	2.2 ab	0.2 ab
Check	—	0.7 b	10.0 b	1.1 b	4.5 b	0.5 b	2.0 ab	0.7 bc

* Applied 4/21, 4/28, 5/8, 5/26, 6/2, 6/16.

** a, b, c. Any two means in the same column and associated with the same superscript letter are not significantly different according to Duncan's multiple range test at 5% level.

† 10 leaves sampled to 3 days; 15 leaves sampled thereafter.

EXPERIMENT 8.—Diazinon was compared with other phosphate insecticides for leafminer control on peppers in Table 8. Leafminers are a limiting factor to pepper production as high infestations can severely defoliate pepper plants. Five days after the third application all materials except Thiodan effectively reduced leafminer infestations while only Bayer 25141 reduced infestations 11 days after the fourth application.

EXPERIMENT 9.—Six phosphate insecticides (Table 9) were evaluated and compared for leafminer control. The plots were one row wide and 25 feet in length, arranged in a randomized complete block design, and sprayed at 27 gallons per acre and 34 p.s.i. Three days after application Imidan and Dibrom were inferior to ethion and ronnel while seven days after application only ethion was effective. No material was effective 15 days after application and none appeared to be selective as few parasites were found in any of the plots including the untreated check.

TABLE 9.—SCREENING INSECTICIDES FOR LEAFMINER CONTROL ON SOUTHERNPEAS (CALIFORNIA BLACKEYE NO. 5) WITH FOLIAR SPRAYS, WESLACO, TEXAS. 1961.

Material*	Actual toxicant (Lbs/A)	Leafminer pupae per leaf on days after last application as indicated**	
		3	7
Imidan	0.125	2.85 c	4.05 ab
Imidan	0.25	1.70 abcd	3.90 ab
Imidan	0.5	1.65 abcd	2.25 ab
Imidan	0.75	1.45 abc	4.20 abc
Imidan	1.0	0.25 ab	3.15 ab
Ethion	0.25	0.10 a	0.65 ab
Ethion	0.5	0 a	0.75 ab
Ethion	0.75	0.10 a	0.80 ab
Ethion	1.0	0.05 a	0.15 a
Dibrom	1.25	2.35 bcd	2.40 ab
Phosdrin	0.25	2.10 abcd	1.65 ab
Phosdrin	0.75	0.65 abc	2.10 ab
ASP 51	1.0	0.95 abc	1.65 ab
Ronnel	1.0	1.35 abc	1.20 ab
Ronnel	2.0	0 a	1.70 ab
Check	——	3.90 d	2.60 ab

* Applied 8/21.

** a, b, c, d. Any two means in the same column and associated with the same superscript letter are not significantly different according to Duncan's multiple range test at 5% level.

DISCUSSION

The data indicate that a tolerance to methyl parathion is found in leafminer population. Wene (1956) evaluated methyl parathion in 1953 and showed that at identical rates methyl parathion equalled ethyl parathion in leafminer control.

The data do show that losses in peppers are due to leafminer infestation. Weekly applications of dimethoate did increase pepper yields approximately two tons per acre. In fall plantings, however, it is often difficult to distinguish what factor or factors reduce plant height and numbers. Salt content of the water used to irrigate plots when August temperatures are high combined with insect infestations are features to consider when evaluating losses in a small seeded crop such as peppers. Wene et al. (1955) found that in water with a high salt content (2400-2700 ppm) pepper plants were reduced in height and had fewer leaves per plant than did plants irrigated with water containing 420-600 ppm salt. Also, there was a significant increase in the percent leaves per plant infested by leafminers in the high salt content.

Tables 4-7 show that variations exist in *Derostenus variipes* populations. Dylox, Vapona, methyl demeton, Bayer 29493 and dimethoate offer promise as selective toxicants. Vapona, methyl demeton and Bayer 29493 were the only materials not evaluated by Getzin (1959) and found to be relatively selective to *D. variipes* populations. The Triton surfactants, B-1956 and X-100, when combined with Delnav, were very effective in comparison to Parathion and Diazinon. Surfactants have been mentioned only sporadically in entomological literature relative to insects attacking vegetable crops. Small, soft-bodied insects such as leafminers and aphids, as well as mites, probably offer the most promise for the evaluation of the effectiveness of surfactants, either alone or in combination with insecticides.

Carbamate insecticides do not appear to be effective leafminer controlling agents.

The chemical names of the proprietary insecticides used in these evaluations are listed below:

Delnav—2,3-p-dioxanedithion S, S-bis (O,O-diethyl phosphorodithioate)
Diazinon—O,O-diethyl O-(2-idopropyl 1,4 methyl 6 pyrimidinyl phosphorothioate)
EPN—ethyl p-nitrophenyl benzene thiophosphonate
Dylox—dimethyl 2,2,2-trichloro-1-hydroxy-phenyl mercapto methyl phosphorodithioate
Sevin—1-napthyl N-methyl carbamate
Kepone—dacachlorooctahydro 1,3,4-methano-2H chlorobuta (1cd) pentalen 2-one
Phosdrin—1-methoxycarbonyl-1-propen-2-yl dimethyl phosphate
Dilan—2-nitro 1,1-bis (p-chlorophenyl) propane and butane mixture (1-2 ratio)
Zineb—zinc ethylene disdithiocarbamate
Dibrom—1,2-dibromo-2,2-dichloroethyl dimethyl phosphate
TEPP—tetraethyl phyrophosphate
AC 24055—1,1-dimethyl-3-(p-acetamidophenyl) trizine
Maneb—Manganous ethylene disdithiocarbamate
Karathane—dinitro (1-methyl hept yl) phenyl crotonate
HRS—16-Bis(pentachlorocyclopentadienyl)
Tedion—p-chlorophenyl 2,4,5-trichloro phenyl
Pyrellin—pyrethrum, allethrin, pine oil mixtures
Nemagon—1,2-dibromo-3-chloro propane
Terrachlor—penta chlorononitro benzene
Genite—2,4 dichloro phenyl benzene sulfonate
Bayer 39007—o-isopropoxyphenyl methyl carbamate
Zectran—4-dimethyl znimo-3,5-xylyl methyl carbamate
Bayer 29493—O,O-dimethyl O-(4-methylthio)-m-tolyl) phosphorothioate

Vapona (DDVP)—O,O-dimethyl 2,2-dichloro vinyl phosphate
Imidan (R1504)—O,O-dimethyl S-phth alimidomethyl phosphorodithioate
GC 4072—diethyl-1-(2,4 dichlorophenyl)-2-chloro vinyl phosphate
SD 3562—2-dimethyl carbamoyl-1-methyl vinyl dimethyl phosphate
Thiodan—6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide
Bayer 25141—O,O-diethyl O-p-(methyl sulfinyl) phenyl phosphorothioate

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