SUPPRESSION OF GARDEN SYMPHYLAN, SCUTIGERELLA IMMACULATA, WITH INSECTICIDES BANDED AT-PLANTING , II

Report
to

Oregon Processed Vegetable Commission

by

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INTRODUCTION:

The garden symphylan, Scutigerella immaculata, was once a major limiting factor in Willamette Valley vegetable production. Infestations were occasionally so severe that vegetables could not be established and production was unprofitable. Introduction of Dyfonate (Fonofos) approximately 30 years ago provided cost effective suppression of Symphylans for the first time. Broadcast application of Dyfonate was registered for a wide range of crops including beans, broccoli, corn, cauliflower, peppermint and strawberry. Two additional products, Lorsban (Chlorpyrofos) and Mocap (Ethoprop), were registered for Symphylans in the 1980's, but Dyfonate remained the most widely used chemical control. Lorsban and Mocap were not labeled for use on as many crops, and on some they are only registered for band application at planting using reduced rates. Intensive use of Dyfonate during the 1970's reduced Symphylan densities on most vegetable farms. By the 1980's less than 25% of fields scheduled for vegetable planting exceeded a treatment threshold for Symphylans (Weinzierl & Fisher, 1984; Willamette Agricultural Consulting, unpublished data). Management of Symphylans became relatively easy.

Two recent events have made management of Symphylans more difficult in vegetable production. First, crop rotations alternating vegetables with grass seed are more frequent and perennial grasses tend to favor Symphylans population increases. Densities greater than 10/sq. ft. were rarely encountered in the 80's and early 90's, but they are now fairly common following perennial ryegrass and tall fescue (Willamette Agricultural Consulting, unpublished data). Second, the manufacture of Dyfonate has been discontinued. Lorsban and Mocap are still registered for Symphylans, but on several crops (e.g. broccoli, cauliflower, cucumbers) these products are not registered for broadcast application at the high rate (2-3 lb. ai/ac) needed to suppress Symphylans. OSU field trials for Symphylan suppression have all been conducted with broadcast application at high rates (Glenn Fisher, personal communication). The efficacy of band applications has not been studied in replicated field trials and it is uncertain whether band applications of Lorsban or Mocap would protect vegetables from the high densities of Symphylans found after some grass seed crops. There is evidence of Symphylan injury following band applications and growers have sometimes changed their crop rotation rather than risk losses to high densities of this pest.

This project completed one on-farm trial comparing banded and broadcast applications of Lorsban and Mocap in 2001. The trial was conducted in a field with high densities of Symphylans that was planted to sweet corn. All banded and broadcast applications suppressed Symphylans, but there were clear differences among treatments. Lorsban 4E, broadcast prior to planting, was more effective than any other treatment. Lorsban 15G and Mocap 10G banded at planting were less effective due to the reduced rate and the smaller volume of soil treated with this application method. Mocap EC, broadcast prior to planting, was only as effective as the banded applications, even though it was used at higher rates and treated a larger volume of soil. Symphylans did not affect seedling emergence or early growth of corn in the untreated check at a density of 10.9/0.5 sq. ft. sample. However, ten weeks after application corn was taller in all banded and broadcast treatments. The Mocap broadcast produced the greatest increase in height (18%), even though it did not suppress Symphylans as effectively as the Lorsban broadcast. Banded applications of Lorsban and Mocap increased plant height to an intermediate degree (14%) and Lorsban broadcast produced the least improvement (10%).

Our 2001 trial demonstrated the efficacy of banded Lorsban and Mocap against Symphylans in corn, but it leaves uncertainty concerning the efficacy of band applications in other crops and concerning the long term impact of band applications relative to broadcast treatments. In 2002, comparison of banded and broadcast treatment with Lorsban and Mocap was repeated in cauliflower. An additional application method, Lorsban banded post-plant, and a new soil insecticide, Platinum (Thiamethoxam), were also included in the study.

METHODS:

Site Selection

An on-farm site for this study was selected from fields sampled by Willamette Agricultural Consulting as part of its regular Symphylan monitoring service. Symphylan populations in the Willamette Valley are often low and may be highly variable within fields. This natural variability can mask treatment effects and make it difficult to obtain meaningful results from field studies. More than 70 fields were evaluated to locate a Symphylan infestation that was suitable for this experiment. The field selected was on the Kraemer Farm east of Monitor in Clackamas County. The soil is Woodburn silt loam and has grown a variety of irrigated and dryland crops. This field had not received a broadcast treatment for Symphylans during the previous six years and crop damage by Symphylans had not been observed. Recent crop history and preliminary Symphylan sampling data are shown in Table 1. Symphylan density was relatively high and was also highly variable. The entire field averaged 3.6 Symphs /0.5 sq. ft. sample, with a 95% confidence interval greater than 50% of the mean. Test plots were placed in the most heavily infested area in an attempt to minimize the effect of variability and to increase the likelihood of a damaging Symphylan population in the test plots.

Sampling Method

A heavy duty spade was used to dig soil samples 0.5 sq. ft. in area and 12" deep. The soil was divided into top (0-6") and bottom (6-12") subsamples to assess variation in Symphylan densities with soil depth. The samples were placed on plastic sheets, sifted by hand and the active stages of Symphylan counted. Pretreatment samples were collected at random. The post treatment samples were centered on the plant rows, but were also sited at random within plots. Pretreatment samples were taken on 6/01/02, after initial soil preparation had been completed. The 2001 trial showed that Symphylan populations continued to decline for up to 10 weeks after treatment so post- treatment samples were delayed until 8/9/02. The test plots were inspected periodically for plant injury and stand density was measured on 8/9/02, by counting the number of plants per ten feet of row.

Soil Preparation & Chemical Treatment

This field had been disced in September, 2002, to break up the perennial ryegrass sod. Preplant soil preparation consisted of discing on 5/24/02, moldboard plowing on 6/1/02, and rototilling on 6/5/02. Test plots and the entire field were planted to cauliflower (cv. Arctica) on 6/11/02. Treatments included an untreated check (UTC), preplant incorporated broadcast applications of Lorsban 4E and Mocap EC; at-planting band applications of Lorsban 4E and Platinum; and a post-plant band application of Lorsban 50W (Table 2). Broadcast applications were made on 6/7/02; they were applied in 20 gal. water/ac. and were incorporated immediately with a rototiller set to a depth of 4". This would incorporate the chemical into the top 3" of soil. Band treatments were applied at seeding on 6/11/02; the Lorsban 4E was applied in 15 gal. water/ac. and the Platinum was applied in 20 gal. water/ac. Both were sprayed in a 6" wide band behind the press wheel of the planter and incorporated by a drag chain. This would place them in the top 1" of soil. The Lorsban 50W post-plant treatment was made on 7/10/02. It was mixed with 20 gal. water/ac., applied as an 8" band over the plant rows and followed by irrigation within eight hours. All treatments except the Platinum were applied with standard farm application equipment. Platinum was applied with backpack sprayers using hand held fan-type nozzles.

Plot Design & Data Analysis

Treatments were applied to eight row (26.7' x 80') plots with four replicates of each treatment in a randomized complete block design (Figure 1). Eight soil samples for Symphylans were taken from each plot for a total of 32 samples per treatment. Four samples for stand density were taken from each plot for a total of 16 samples per treatment. This sampling data was analyzed by analysis of variance and Duncan's Multiple Range Test (significance level $P<0.05$). The Symphylan counts were transformed to square root (x+.5) before analysis (Sokal & Rohlf, 1969). Analysis of the stand density was performed on the untransformed data.

RESULTS & DISCUSSION:

Pretreatment samples were taken on 6/1/02, ten days before planting and treatment (DBT). Symphylan counts were first analyzed from the composite totals of the 0-6" and 6-12" subsamples. When the 192 composite samples were pooled, the entire experimental area had a mean Symphylan density of 4.2/sample. This was not significantly different from the preliminary survey on 5/16/02 ($P<0.05$). There were also no significant differences among the four 80'x160' blocks (Figure 2b). Pretreatment densities for the six treatments ranged from 1.5 to 8.0 Symphylans/sample. There were significant differences in pretreatment densities among the six treatments (Table 2). The Lorsban Band-at-Plant and Lorsban Post-Plant treatment plots had higher densities of Symphylan than the Lorsban Broadcast, Platinum Band-at-Plant and UTC plots. These differences occurred by chance during the randomization process. When the top (0-6") and bottom (6-12") subsamples were compared, the bottom had significantly greater numbers of Symphylans than the top (Table 4). However, both top and bottom subsamples had the same significant differences among the six treatments as the composite (0-12") samples (Table 3).

Post-treatment samples were taken on 8/9/02, 59 days after treatment (DAT). The UTC and the five chemical treatments each had significantly lower numbers of Symphylans than the pretreatment samples (Table 6). The declines ranged from 80% to 97%. There were still significant differences between top and bottom subsamples (Table 4); but there were no significant differences among treatments in the top or bottom subsamples or in the composite (0-12") samples (Table 2&3).

Cauliflower seedlings emerged uniformly in all treatments and grew normally. Plant growth and stand density did not appear to be affected by the treatments at any time during the season. Measurements of stand density on 8/9/02, showed no significant differences among the chemical treatments or between the chemical treatments and the untreated check (Table 5).

Useful conclusions concerning the efficacy of these five chemical treatments in cauliflower cannot be drawn from this study. The dramatic decline in Symphylan numbers between pre- and post-treatment samples masks any effect from the chemical applications. Two possible reasons for the decline in Symphylan numbers are mass movement to soil strata below 12" to avoid adverse conditions near the surface or mortality of Symphylans caused in some manner by the cauliflower.

Symphylans may move deeper in the soil to avoid high temperatures or dry soil (Umble et. al., 2002). However, the plots were irrigated during July and August, the top 12" of soil was relatively moist and cauliflower plants did not show signs of water or heat stress. Soil temperatures were not measured in the field on 8/9/02; but on that date OSU's Hyslop Farm near Corvallis, recorded a mean soil temperature of 79 F at a depth of 4" (Oregon Climate Service). This is nearly identical to the 78 F the station recorded 7/20/01, when post-treatment samples were taken for our 2001study. On 7/20/01, the UTC had 11.1 Symphylans/sample which was not significantly different than the pretreatment density on 5/3/01 (Todd, 2001). These soil moisture observations and the comparison to soil temperature and sampling records from 2001, give no indication that conditions on 8/9/02, were harsh enough to drive Symphylans out of the top 12" of soil.

Cauliflower has not been tested directly for toxic effects on Symphylans, but in the laboratory survival of Symphylans is affected by the type of plant growing in their soil environment. At least one crop, potato, has suppressed Symphylan populations (Umble, 2002). There is also a cover crop study showing Symphylan suppression by residues of 'Micah' barley (Peachey, personal communication), and there is circumstantial evidence of Symphylan suppression by cauliflower. Our monitoring data, though limited, shows a decline in density following cauliflower in 75% of fields sampled before and after this crop (Willamette Agricultural Consulting, unpublished data). There is enough evidence to justify further testing of the hypothesis that cauliflower suppresses Symphylans.

CONCLUSIONS:

This study was designed to answer the following questions raised by our 2001 Symphylan project:

- Do band treatments for Symphylans improve growth in other vegetable crops besides corn?
- Would post transplant band applications of Lorsban (used in broccoli and cauliflower) be as effective as at-plant application to direct seeded crops?
- Is the difference in Symphylan suppression between band and broadcast applications consistent?
- Are band applications consistently as effective as broadcast applications at improving plant growth?
- Are the differences in Symphylan suppression or growth improvement between Lorsban and Mocap consistent?
- Do either broadcast or band treatments provide multi-year suppression of Symphylans?

These questions remain unanswered and additional field studies are needed, if they are to be addressed. It would also be useful to resample these plots next spring to determine whether the decline in Symphylan numbers is maintained over the winter. If the density remained low, it would be further evidence of a suppressive effect on Symphylans by cauliflower.

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Table 1. Crop history and preliminary Symphylan survey: Field 156; Kraemer Farms.

			Preplant Symphylan Density*	
			No. / 0.5 sq. ft.	
Year	Crop	Soil Insecticide	Mean	95% CL
1996	Perennial Ryegrass	None	--	
1997	Broccoli	post-plant Lorsban band	--	
1998	Bean	None	--	
1999	Perennial Ryegrass	None	--	
2000	Perennial Ryegrass	None	--	
2001	Perennial Ryegrass	None	--	
2002	Cauliflower	post-plant Lorsban band	3.6	+/- 2.5

*Willamette Agricultural Consulting, unpublished data.

Table 2. Impact of broadcast and band application of soil insecticides on Symphylan densities in composite 0-12" samples. Field 156, Kraemer Farms; 2002.

Treatment	Rate	Application		No. Symphylans / Sample	
				Pretreat	Post-treat
	lb. a.i./ac.	Method	Date	10 DBT	59 DAT
UTC	--	--	--	1.5 a*	0.1 a
Lorsban 4E	2.0	Broadcast	6/7	2.5 a	0.5 a
Mocap EC	3.0	Broadcast	6/7	3.4 ab	0.1 a
Lorsban 4E	1.0	Band-at-Plant	6/11	6.9 bc	0.5 a
Platinum	0.125	Band-at-Plant	6/11	2.4 a	0.1 a
Lorsban 50W	1.0	Band Post-Plant	7/10	8.0 c	0.8 a

*Numbers within columns followed by same letter are not significantly different ($P<0.05$).

Table 3a. Impact of broadcast and band application of soil insecticides on Symphylan densities in top (0-6") subsamples. Field 156, Kraemer Farms; 2002.

Treatment	Rate	Application		No. Symphylans / Sample	
				Pretreat	Post-treat
	lb. a.i./ac.	Method	Date	10 DBT	59 DAT
UTC	--	--	--	0.5 a*	0.09 a
Lorsban 4E	2.0	Broadcast	6/7	0.9 a	0.03 a
Mocap EC	3.0	Broadcast	6/7	1.2 ab	0.03 a
Lorsban 4E	1.0	Band-at-Plant	6/11	1.5 bc	0.09 a
Platinum	0.125	Band-at-Plant	6/11	0.7 a	0.03 a
Lorsban 50W	1.0	Band Post-Plant	7/10	2.4 c	0.12 a

*Numbers within columns followed by same letter are not significantly different (P<0.05).

Table 3b. Impact of broadcast and band application of soil insecticides on Symphylan densities in bottom (6-12") subsamples. Field 156, Kraemer Farms; 2002.

Treatment	Rate	Application		No. Symphylans / Sample	
				Pretreat	Post-treat
	lb. a.i./ac.	Method	Date	10 DBT	59 DAT
UTC	--	--	--	0.9 a*	0.06 a
Lorsban 4E	2.0	Broadcast	6/7	1.6 a	0.47 a
Mocap EC	3.0	Broadcast	6/7	2.2 ab	0.09 a
Lorsban 4E	1.0	Band-at-Plant	6/11	5.4 bc	0.44 a
Platinum	0.125	Band-at-Plant	6/11	1.8 a	0.06 a
Lorsban 50W	1.0	Band Post-Plant	7/10	5.7 c	0.62 a

*Numbers within columns followed by same letter are not significantly different (P<0.05).

Table 4. Variation in Symphylan population densities with soil depth. Field 156, Kraemer Farms; 2002.

	No. Symphylans / Sample	
	Pretreat 10 DBT	Post-treat 59 DAT
Top (0-6")	1.2 a*	0.1 a
Bottom (6-12")	2.9 b	0.3 b

*Numbers within columns followed by same letter are not significantly different (P<0.05).

Table 5. Impact of Symphylan treatment on stand density in cauliflower. Field 156, Kraemer Farms; 2002.

Treatment	Rate lb. a.i./ac.	Application Method	Date	No. Plants / 10 ft. of Row Post-treat 59 DAT
UTC	--	--	--	5.9 a*
Lorsban 4E	2.0	Broadcast	6/7	5.5 a
Mocap EC	3.0	Broadcast	6/7	6.1 a
Lorsban 4E	1.0	Band-at-Plant	6/11	5.8 a
Platinum	0.125	Band-at-Plant	6/11	5.9 a
Lorsban 50W	1.0	Band Post-Plant	7/10	5.7 a

*Numbers within columns followed by same letter are not significantly different (P<0.05)

Table 6. Decline in Symphylan densities following cauliflower planting. Field 156, Kraemer Farms; 2002.

	No. Symphylans / Sample					
Treatment:	UTC	Lorsban 4E	Mocap EC	Lorsban 4E	Platinum	Lorsban 50W
Rate (lb ai/ac):	--	2.0	3.0	1.0	0.125	1.0
Preplant (6/1)	1.5 a*	2.5 a	3.4 a	6.9 a	2.4 a	8.0 a
Post-plant (8/9)	0.1 b	0.5 b	0.1 b	0.5 b	0.1 b	0.8 b

*Numbers within columns followed by same letter are not significantly different (P<0.05).

Figure 1. Experimental plot design for Symphylan suppression experiment. Individual plots are 26.7' x 80'; total area 1.18 acres.

Blk III	Lorsban postpl	Lorsban postpl	Blk I
	Mocap bdcst	Lorsban band	
	Lorsban band	Platinum band	
	Platinum band	Mocap bdcst	
	Lorsban bdcst	Lorsban bdcst	
	UTC	UTC	
Blk IV	Lorsban bdcst	Lorsban bdcst	Blk II
	Mocap bdcst	Mocap bdcst	
	Lorsban band	Lorsban band	
	Lorsban postpl	Lorsban postpl	
	UTC	UTC	
	Platinum band	Platinum band	

Figure 2a. Pretreatment Symphylan densities (No./0.5 sq. ft.) in individual 26.7'x80' plots; n=8.

	4.8	13.0	
	2.4	8.9	
Blk III	4.9	2.6	Blk I
	1.8	7.5	
	2.4	3.8	
	1.5	1.8	
	1.8	2.0	
	1.4	2.5	
	2.1	11.5	
Blk IV	10.0	4.5	Blk II
	1.4	1.2	
	3.0	2.4	

Figure 2b. Pretreatment Symphylan densities (No./0.5 sq. ft.) in 80'x160' blocks, I-IV. (n=48)

Blk I	6.2 a
Blk II	4.0 a
Blk III	2.9 a
Blk IV	3.5 a