3. REPORT: sub-report 2

Project Title

Management Approaches for Thrips and Garden Symphylans in Lettuce 2

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This report is divided into two sub-reports for each pest.

Sub-report 2 : Garden symphylan

Abstract

Surveys showed that garden symphylans are not the only pest that could affect the growth of lettuce seedlings. A species of springtail, *Protaphorura fimata* has been determined as a pest of germinating lettuce seedlings; however, more research is warranted to confirm it. Based on the data, it appears that symphylans are not likely using CO_2 emanating from seeds/roots as a cue to located lettuce seeds/roots as a food source. Pesticide bioassay showed that Belay and Mustang have better activity than Radiant against symphylans.

Objectives

a. Survey of symphylans infestation in lettuce fields in the central coast.
b. Determine if CO_2 sources elicit any stimulatory response to symphylans.
c. Understand the efficacy of insecticide chemistries to symphylans.

Procedures: *Objective 1 Survey of symphylans infestation in lettuce fields in the central coast.*

In 2013, a survey was conducted in lettuce fields to determine the species and level of garden symphylans infestation in lettuce fields of central coast. Seventeen potentially symphylan infested-fields (10 fields in Salinas, 2 field in San Juan Bautista, and 1 field in Gonzales) showing damage symptoms were included in the study. Other crops (broccoli, celery, and kale) fields were also surveyed but they are not included in this report. Al least 10 potato slides were initially placed in soil to determine the presence of garden symphylans. If present were detected, more potato sliced were placed in the soil. Potato slices were replaced every ~2 days.

In 2013, to determine if the springtail species detected in high numbers cause any impact to young lettuce plants, a pest suppression experiment was conducted. This experiment was conducted in a leafy lettuce field in Salinas, CA in March to April 2013, based on high trap captures of springtail before planting. In the field, twelve 40-inch wide beds were assigned for insecticide applications and twelve beds were left unsprayed. To suppress springtail densities on selected beds, maximum label

rates of pyrethroid insecticides were applied three times, 2-d before planting (9 March), at planting (11 March), and 20-d after planting (30 March) using commercial tractor mounted sprayer. Two pyrethroid insecticides, Mustang (zeta-cypermethrin) at 4 fl oz/ acre and Warrior II (λ-cyhalothrin) at 1.6 fl oz/ acre were tank mixed along with an adjuvant (Widespread max) at 2 fl oz/ acre and were applied at 2-d before planting and 20-d after planting but only Warrior II plus adjuvant were applied at planting. Following the first application (2-d before planting), beds were shaped and pre-irrigated. Second (at planting) and third (20-d after planting) insecticide applications were conducted on the surface of the bed. The rate of water volume used for all the applications was 50 gal per acre.

A slice of beet root was used to monitor springtail densities in the sub-surface of the soil. Beet root slices were placed at 3-cm deep soil along the seed line and were covered with disposable white plastic bowls. A total of 16 beet root traps were deployed in treated and untreated beds (n = 8/treatment) at 50 feet spacing starting a week before planting up to five weeks on 7, 15, 22, and 28 March 2013. The beet root traps were exposed for 3-d in the soil and were serviced with fresh beet root slice every week. At the end of each 3-d exposure period, beet root slices were removed, placed into plastic bags and transported to the laboratory in Salinas, CA. The captured springtails were quantified within 24 h.

To determine treatment effects on plant growth, five plots were randomly blocked within treated and untreated beds. The plot size was 100 feet m by 40-inch (bed width). Thirty-five plants were randomly sampled from these plots on 4 April (at pre-thinning stage), 22 April (post-thinning stage), and 30 March 2013 (closer to harvest). All plant samples were cleaned with a soft bush to remove adhered soil particles then fresh and dry weights were recorded. To determine dry weight, plant samples were oven dried at 140^{o}F for 72 h before weighing. In addition, number of all live plants regardless of size of the plant was quantified from each plot.

Results and Discussion

In 2013-14, Four fields (1 in Salinas, 2 fields in San Juan Bautista, and 1 field in Gonzales) were infested with garden symphylans. Four fields in Salinas had a dominate springtail species in the samples. However, two fields in Salinas did not have any symphylan or other organisms in the traps.

The springtail species has been identified as *Protaphorura fimata* (Family: Onychiuridae) by Felipe Soto-Adames (Insect Systematist and Curator of Entomology, Illinois Natural History Survey, University of Illinois). From now on I'm referring to *P. fimata* when I mention springtail.

Four days after planting lettuce seeds, the number of springtail was lower in the insecticide treated than untreated beds (Figure 1). Overall, springtail counts were lower before planting in both the treatments and there was no difference between treatments. Similarly, number of springtail captured on 22 and 28 March during third and fourth weeks after planting, respectively were similar between insecticide-treated or untreated beds.

Number of plants was similar between insecticide-treated and untreated beds before thinning, and near harvest (Table 1). Before thinning, the wet and dry weight of lettuce seedlings was greater in the insecticide-treated than the untreated beds (Table 1; Figure 2). Immediately after thinning, both the fresh and dry weight of plants was greater in the insecticide-treated than in untreated beds.

Similarly, fresh weight of plants were greater in the insecticide treated than in untreated when sampled near harvest.

Procedures *Objective 2 Determine if CO_2 sources elicit any stimulatory response to symphylans.*

I proposed to conduct this experiment using "Y-tube olfactometer". Unfortunately, the symphylans were not moving well on glass surface; thus, the method of using "Y-tube olfactometer"was discontinued.

Instead, choice bioassay arenas were constructed based on a published article (Rijal et al. 2013) (Figure 3). An assay arena had two wells. Alka-Seltzer effervescent tablets were used as a source for CO_2. The major ingredient of Alka-Seltzer effervescent tablet is Calcium carbonate (CaCO3) which releases CO_2 when come in contact with water. Four weights (four doses of CO_2) of tablet or four treatments were used for the experiments. In a choice assay, one well had a dose of alka-Seltzer effervescent tablet in 1-mL of distill water and other well, only had 1-mL of distill water. All the doses were replicated 18 times.

Garden symphylans were field collected for this study. A choice bioassay, five symphylans were released (n=90 symphylans per dose or treatment). Immediately after the release of symphylans to bioassay, the assays were placed in darkness (to simulate soil conditions) and their choice was evaluated after 6 hours.

Results and Discussion

At higher doses, 0.5g and 0.125g of effervescent tablet, symphylans choose to go to well without effervescent tablet (Figure 4). However, at lower doses (at 0.0625 and 0.0312 g), symphylans did not show any preference. This indicates that symphylans were repelled by higher concentrations of CO_2 and they responded to both the wells alike (with or without tablet) at lower doses. The results suggest that symphylans may not be using a higher levels of CO_2 emanating from the seeds or decomposing organic matter (due to activity of microorganisms) as a cue to locate their food source.

This project is ongoing.

Procedures *Objective 3* Understand the efficacy of pesticide chemistries to symphylans.

I proposed to conduct this experiment using "petri dish assay". I decided to change that assay with more realistic assay.

The soil "Clear lake clay" was collected and was naturally infested with symphylans. The soil was oven dried for ~24 hours at >100^{o}C. Twenty five grams of oven dried soil was added to 100 mL cup. Pesticide solutions prepared in distill water and Table 2 shows the details. Seven mL of pesticide solution was added into a 100 mL cup (= 28 % wt/wt). After drenching the pesticide solution, the soil was stirred within the cup.

Garden symphylans were field collected for this pesticide bioassay. In a bioassay (cup), 10 symphylans were released. Each treatment (pesticide) was replicated 15 times. The live, immobile

and dead symphylans were evaluated after 72 hours.

Results and Discussion

After 72 hours, a greater suppression of symphylans was observed in Belay and Mustang treatments than other treatments (Figure 5a). A greater number of symphylans was immobile in Mustang treatment than other treatments (Figure 5b). The symphylan mortality was greater in Belay and Mustang than Radiant treatment (Figure 5c). Belay and Mustang provided a level of symphylan suppression whereas; Radiant caused minimum negative effects to symphylans.

This project is ongoing.

Table 1. Effects of *P. fimata* suppression treatment on germinating lettuce seeds in the field.

Sample date	Variable (Mean ± SE)	Treatment	
		Untreated check	Insecticide treated
Pre-thinning			
4 April	No. of germinated plants	2318.0 ± 94.5a	2338.0 ± 130.9a
	Wet weight (lb)	0.50 ± 0.03b	0.97 ± 0.03a
	Dry weight (lb)	0.049 ± 0.002b	0.092 ± 0.002a
Post-thinning			
22 April	No. of germinated plants	781.4 ± 26.8a	747.4 ± 20.0a
	Wet weight (lb)	25.2 ± 1.2b	32.6 ± 2.2a
	Dry weight (lb)	3.6 ± 0.1b	4.2 ± 0.2a
30 May	No. of germinated plants	688.0 ± 26.2a	673.6 ± 16.9a
	Wet weight (lb)	528.6 ± 13.1b	674.8 ± 24.5a
	Dry weight	-	-

Symbols following means with similar case letters within same row are not significantly different ($P < 0.05$).

Table 2. Table 1. Active ingredients, application methods, and rates used in the bioassay.

Brand name	Active ingredient	Insecticide class	Rate /Acre	Water volume	Concentration of product (ppm)
Radiant	Spinetoram	Unclassified	10 fl oz	40 gal	1950
Belay	Clothianidin	Neonicotinoid	12 fl oz	40 gal	2340
Mustang	Zeta-Cypermethrin	Pyrethroid	4.3 fl oz	40 gal	840
Untreated check				40 gal	0

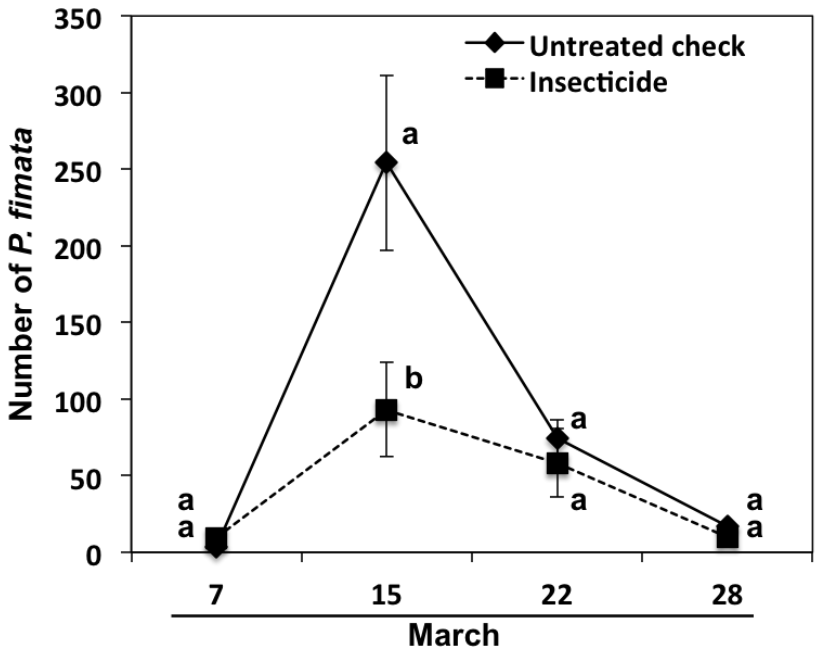

Fig. 1. Mean (± SE) of *P. fimata* densities to insecticide treatment on leaf lettuce field in March 2013. Symbols with similar case letters within sample date are not significantly different ($P < 0.05$).

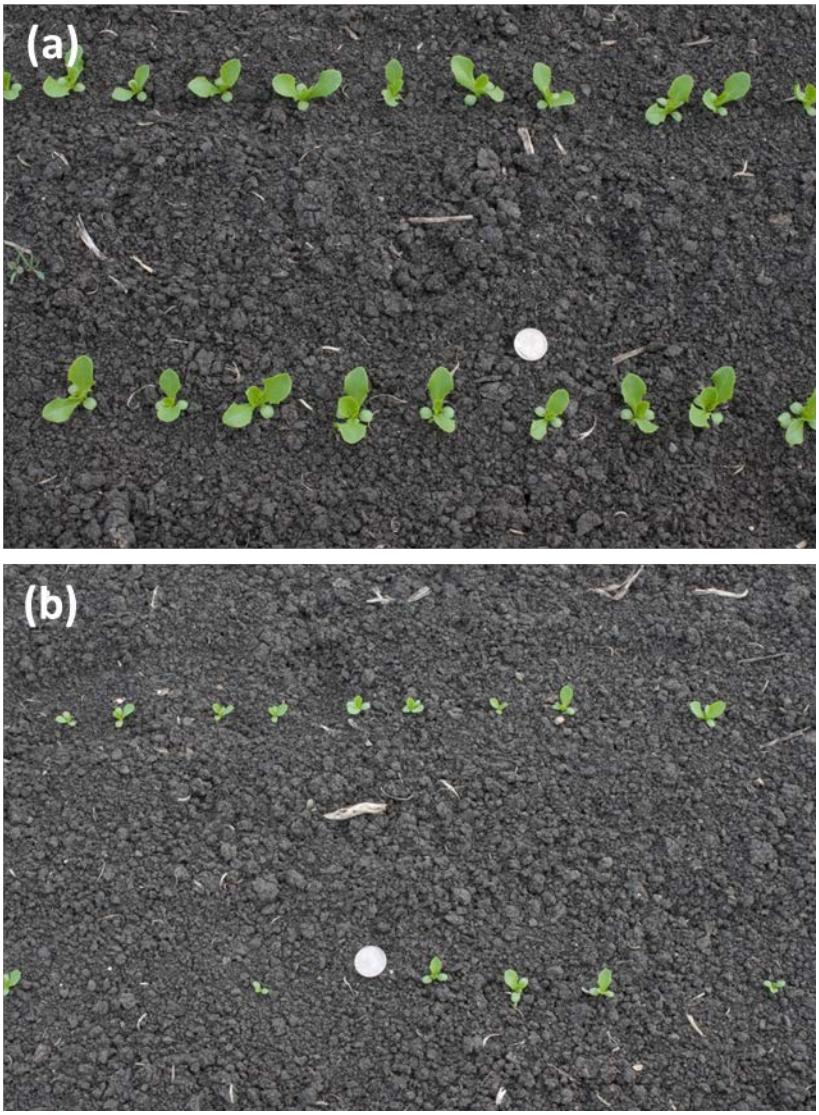

Fig. 2. Effect of *P. fimata* feeding on young seedling of lettuce in field after (a) insecticide treated, and (b) untreated check in March 2013.

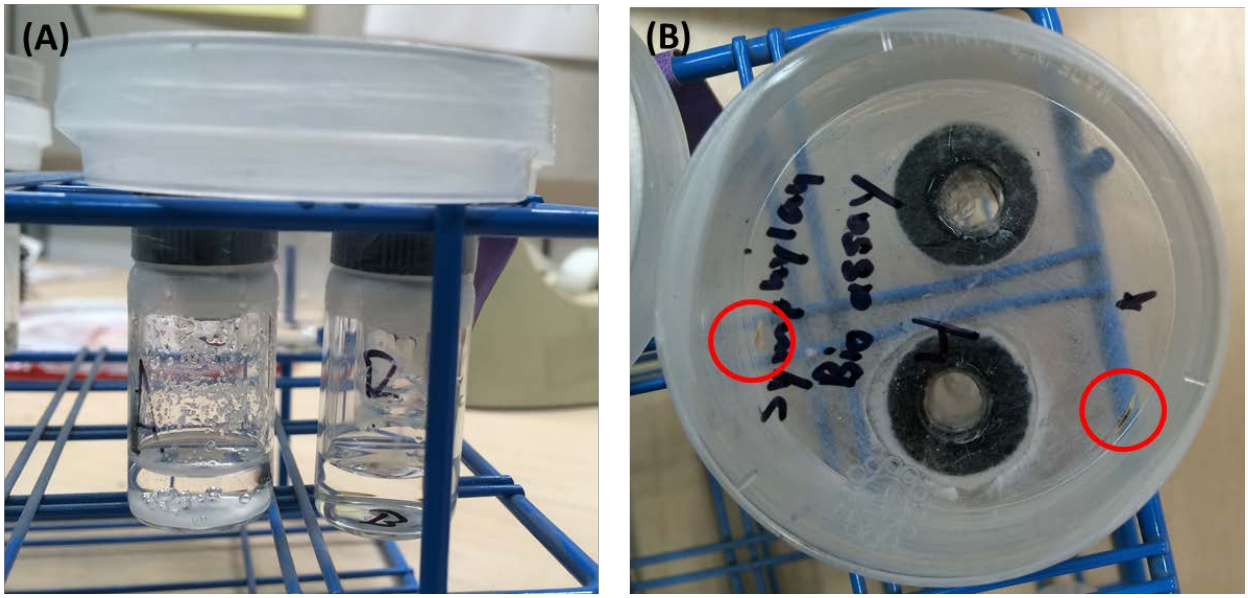

Fig. 3. A choice bioassay to determine the effect of CO_2 gas on garden symphylans when provided a choice with and without various dose of CO_2 (Alka-Seltzer tablet, $CaCO_3$) in an enclosed choice bioassay. Red circles shows the garden symphylans in the bioassay.

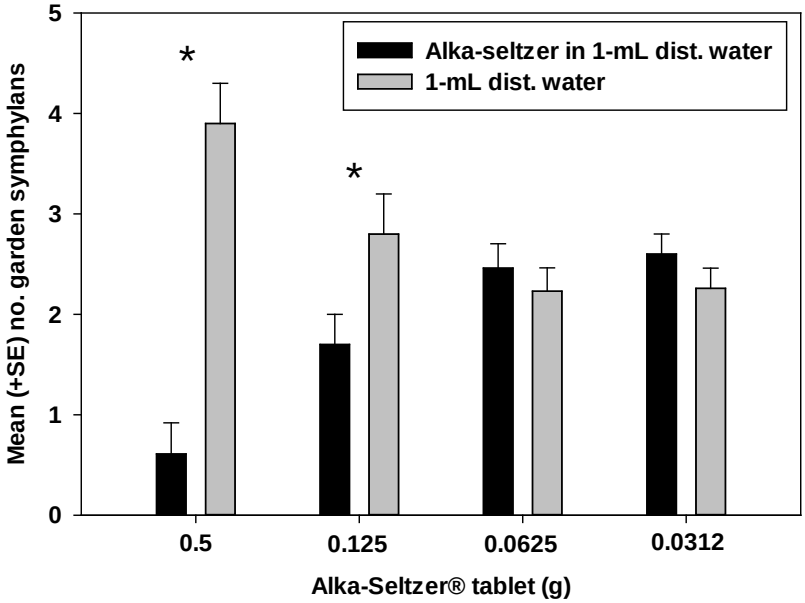

Fig. 4. Effect of CO_2 gas on garden symphylans when provided a choice with and without various dose of CO_2 (Alka-Seltzer tablet, $CaCO_3$) in an enclosed choice bioassay. * indicated significantly different at $P < 0.05$.

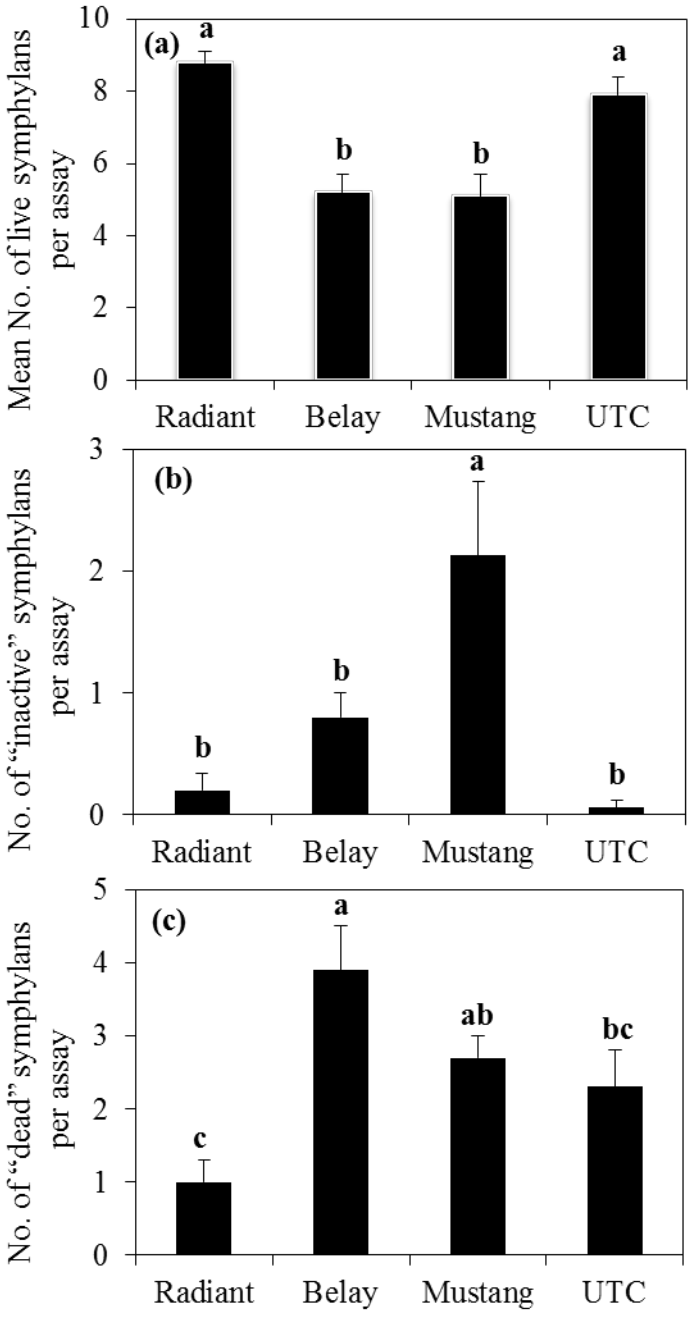

Fig. 5. Efficacy of garden symphylans to various pesticides in lab bioassay. Symbols with similar case letters within sample date are not significantly different ($P < 0.05$).