Project Title

Effect of insecticides coated to head lettuce seeds for springtails, leafminers and western flower thrips control

Project Investigator

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Abstract

A series of laboratory and field studies were conducted to determine if the insecticides coated lettuce seeds are an option to control key lettuce pests such as springtails (*Protaphorura fimata*), leafminers (*Liriomyza* spp.) and western flower thrips (*Frankliniella occidentalis*). These pests can cause serious economic injury to lettuce plants in the Salinas Valley. Three insecticides, spinosad, thiamethoxam and clothianidin were coated on the head lettuce 'Regency' following commercial seed coating procedure. Laboratory studies were conducted in containers with springtail (*P. fimata*) infested soil. The data show that all three insecticides spinosad, clothianidin and thiamethoxam treated seeds significantly reduced the incidence of springtail feeding injury when compared with untreated seeds. Among insecticides, superior performance in efficacy was noted in the following order: clothianidin > thiamethoxam > spinosad. Two field trials were conducted against springtails using the same seed treatments, however, the springtail pressure was so low that conclusive data were not obtained.

A field trial was conducted to determine the efficacy of seed coated insecticides (same treatments) on leafminers and western flower thrips incidence and their infestation. No notable effect of insecticide was found on leafminers or western flower thrips infestation or their injuries on the head lettuce.

Objective

To determine efficacy of insecticide coated seeds against springtails, leafminers and western flower thrips in the laboratory and field.

Procedures

Springtail. This experiment was conducted in two steps. First step was to evaluate the insecticide coated seeds in the laboratory settings and second, evaluate in the field. For the laboratory component, springtail (*P. fimata*) colonies were maintained in sealed clear plastic containers and were fed with fish food flakes at biweekly intervals. These containers had about 50 g (Clear Lake Clay) soil. These containers had varying springtail pressure; thus, only those containers with moderate to high pressure (colony size) was included in the experiment.

The head lettuce seed ‘Regency’ was coated with clothianidin, thiamethoxam, and spinosad (Table 1). The seeds were coated by Dr. Alan Taylor at Cornell University and coating technique mirrored commercial seed coating procedure. The number of insecticides was scaled down to three insecticides (as initially proposed) as only these insecticides have readily available seed coating formulation and interest of the chemical companies. Insecticides such as pyrethroids have no seed coating formulation available on any commercial crops in the US. I also pursued to coat the newer insecticides such as chlorantraniliprole (Coragen) or cyantraniliprole (Verimark) on lettuce seeds for research purpose but the chemical companies have no interest for seed coating with them. Currently, clothianidin (NipSit) is the only formulation registered for head lettuce.

Three seeds of each insecticide treatment were randomly placed on the soil of the each container. An additional treatment with no Thiram (fungicide) coating was added to determine if Thiram itself affected springtail feeding. This experiment was conducted in three sets where five container replicates were set at a given time for a total of 15 replications in completely randomized design. The insecticide coated seeds were exposed to springtails for 7 days. After 7 days, the seeds were evaluated for number of seeds germinated, number of plants with feeding injury, total number of feeding injury sites, fresh weight and plant height.

Two field trials were conducted using the same treatments in commercial lettuce field with a history of springtail problems. In the first experiment, five replicates of each treatment were assigned to two 10-feet long 80”beds (with six seed lines/bed) (plot) according to a randomized completely block design. The difference in the second experiment was that the plot length was 25 feet long on 40”beds (with two seed lines/bed) (plot). Insecticide coated seeds were planted using hand-held seeder (Fig. 1). Plants were evaluated after two weeks after planting and there was no sign of springtail feeding damage on the entire field. The plants were not evaluated thereafter and experiments were discontinued.

Leafminers, and western flower thrips. A study was conducted on head lettuce in Gonzales, CA. Four replicates of each treatment were assigned to two 25-feet long 40”beds (with two seed lines/bed) (plot) according to a randomized completely block design. Insecticide coated seeds were planted using hand held seeder. The treatments were same as springtail trial (Table 1). Ten plant samples were randomly collected from each plot on 3 and 20 June, and 1 July 2016 and were transported to the lab for evaluation. The first sample was collected before thinning the seed rows. Each plant was cut into individual leaves and every leaf was washed under running water to dislodge all the leafminer larvae and thrips. Thrips were collected by filtering the wash water through a fine mesh screen. Larval and adult thrips and leafminer larvae trapped were removed from the mesh screen, stored in alcohol and evaluated. Two leaves were randomly selected from each plant (for toal of 20 leaves) to assess leafminer and thrips feeding injuries. A scale was developed to determine the overall feeding injury on the leaves (Fig. 2). In addition, total number of stippling injury and leafmining, and discrete thrips feeding injury were quantified. The data were subjected to ANOVA using PROC GLM procedure of SAS (SAS Institute 2010, ver 9.3, Cary, NC).

Results

Springtail. In the laboratory studies, number of seeds germination was greater with clothianidin, thiamethoxam coated treatment than untreated (Table 2, Fig. 3). There was no difference in seed germination between untreated, Thiram coated and uncoated seeds. The springtail injury was lower in clothianidin, and thiamethoxam coated seeds than untreated seeds. The fresh weight was greater in clothianidin than untreated plants, although there was no difference in the shoot length.

Leafminers and western flower thrips. There was no treatment effects with seed coating with insecticides on western flower thrips (Table 3) and leafminers infestation (Table 4). Because very few leafminer larvae were collected, the data were not presented.

Conclusion

Results show that clothianidin, and thiamethoxam have the potential to reduce springtail injury to lettuce seeds as seed coating. Clothianidin (NipSit) in particular, is now registered on head lettuce and could be used for springtail control. This is an important information in that springtails attack the germinating seeds of lettuce especially in the spring time. During spring, we get some rain showers and the wet conditions in the field after planting makes insecticide application along seed line almost impossible. If the insecticide coated seeds are planted, the grower or PCA could avoid at-plant insecticide application which is typically targeted toward springtails. Application of insecticides such as neonicotinoids and pyrethroids along the seed line will protect the germinating seeds from springtail feeding. I will conduct more field trials in the following years. Secondly, the study also show that insecticide seed coating may not be an effective option for leafminers and thrips control in head lettuce.

Table 1. Insecticide seed coating treatments used for springtail and leafminer experiments.

Treatment	Trade name	Application rate	Rate for 100 g pellets
Check (Thiram)	Thiram 42S	8 fl ounces / cwt (250 mg ai/100 g seed)	12.1 mg ai
Spinosad	Regard Thiram 42S	0.75 mg ai per seed 8 fl ounces / cwt	3.85 g ai 12.1 mg ai
Thiamethoxam	Cruiser 70WS Thiram 42S	0.75 mg ai per seed 8 fl ounces / cwt	3.85 g ai 12.1 mg ai
Clothianidin	NipSit Thiram 42S	0.75 mg ai per seed 8 fl ounces / cwt	3.85 g ai 12.1 mg ai

Table 2. Effect of insecticide coating on head lettuce seeds for springtail control in the laboratory.

Treatment	No. of germinated seeds	No. of seedlings with feeding injury	No. of discrete feeding injury sites	Fresh weight (g)	Plant height (cm)
UTC without Thiram	1.9 ± 0.3 b	2.1 ± 0.3 a	9.3 ± 3.2 a	0.011 ± 0.003 b	2.76 ± 0.76 a
UTC with Thiram	2.1 ± 0.3 b	2.1 ± 0.6 ab	6.2 ± 0.6 a	0.012 ± 0.001 b	4.43 ± 0.95 a
Spinosad	2.6 ± 0.3 ab	1.1 ± 0.3 bc	1.1 ± 0.3 b	0.019 ± 0.001 ab	6.00 ± 0.32 a
Thiamethoxam	3.0 ± 0.0 a	0.4 ± 0.2 c	0.3 ± 0.1 b	0.013 ± 0.003 ab	4.43 ± 1.16 a
Clothianidin	2.9 ± 0.1 a	0.3 ± 0.2 c	0.2 ± 0.1 b	0.021 ± 0.001 a	5.10 ± 0.54 a
F (df1, df2)	5.5 (4, 51)	14.2 (4, 48)	18.2 (4, 47)	4.7 (4, 47)	2.2 (4, 47)
P	< 0.001	< 0.001	< 0.001	0.008	0.086

Means within columns followed by the same letter are not significantly different according to ANOVA and LSD test at $\alpha = 0.05$.

Table 3. Effect of insecticide coating on head lettuce seeds for western flower thrips control in the field.

Treatment	Sample 1: 3-Jun			Sample 2: 20-Jun			Sample 3: 1-Jul	
	No. of thrips injury sites	Thrips damage scale	No. of thrips	No. of thrips injury sites	Thrips damage scale	No. of thrips	No. of thrips injury sites	Thrips damage scale
Untreated	9.1 ± 1.2 a	1.81 ± 0.28 a	20.5 ± 4.9 a	9.8 ± 2.3 a	1.6 ± 0.1 a	18.3 ± 2.9 a	10.6 ± 0.5 a	1.4 ± 0.1 a
Spinosad	5.7 ± 1.2 a	1.41 ± 0.21 a	18.3 ± 5.3 a	12.1 ± 3.1 a	1.7 ± 0.2 a	20.0 ± 6.0 a	12.1 ± 2.4 a	1.3 ± 0.1 a
Thiamethoxam	6.1 ± 0.5 a	1.43 ± 0.22 a	11.3 ± 5.7 a	9.3 ± 0.8 a	1.5 ± 0.1 a	37.5 ± 13.3 a	15.7 ± 6.9 a	1.7 ± 0.5 a
Clothianidin	6.3 ± 1.7 a	1.28 ± 0.22 a	12.0 ± 5.6 a	12.0 ± 2.4 a	1.9 ± 0.3 a	27.8 ± 3.8 a	16.3 ± 2.2 a	1.8 ± 0.2 a

Means within columns followed by the same letter are not significantly different according to ANOVA and LSD test at $\alpha = 0.05$.

Table 4. Effect of insecticide coating on head lettuce seeds for leafminer control in the field.

Treatment	Sample 1: 3-Jun			Sample 2: 20-Jun			Sample 3: 1-Jul		
	No. of stippling injury	No. of leafmining	No. of leafminers	No. of stippling injury	No. of leafmining	No. of leafminers	No. of stippling injury	No. of leafmining	No. of leafminers
Untreated	14.9 ± 6.3 a	-[a]	0.5 ± 0.3 a	49.7 ± 8.2 a	1.1 ± 0.5 a	1.3 ± 0.5 a	52.2 ± 4.1 a	0.4 ± 0.2 a	-[b]
Spinosad	15.7 ± 5.9 a	-	0.3 ± 0.3 a	46.6 ± 1.7 a	1.0 ± 0.4 a	1.3 ± 0.8 a	43.3 ± 12.2 a	0.2 ± 0.1 a	-
Thiamethoxam	15.6 ± 5.5 a	-	2.3 ± 1.3 a	48.8 ± 8.7 a	0.5 ± 0.2 a	3.0 ± 1.8 a	58.7 ± 29.9 a	0.2 ± 0.1 a	-
Clothianidin	10.3 ± 4.1 a	-	0.8 ± 0.5 a	54.1 ± 9.3 a	1.9 ± 1.4 a	1.0 ± 0.6 a	73.7 ± 20.6 a	0.3 ± 0.1 a	-

[a]no leafmining was detected. [b]leafminers were low and was not recorded. Means within columns followed by the same letter are not significantly different according to ANOVA and LSD test at $\alpha = 0.05$.

Fig. 1. The leafminer (stippling) and thrips feeding injury scale developed to evaluate the samples where 0 = no injury; 1 = < 25% leaf area injured; 2 = 25-50% leaf area injured; 3 = 51-75% leaf area injured; and 4 = >75% leaf area injured.

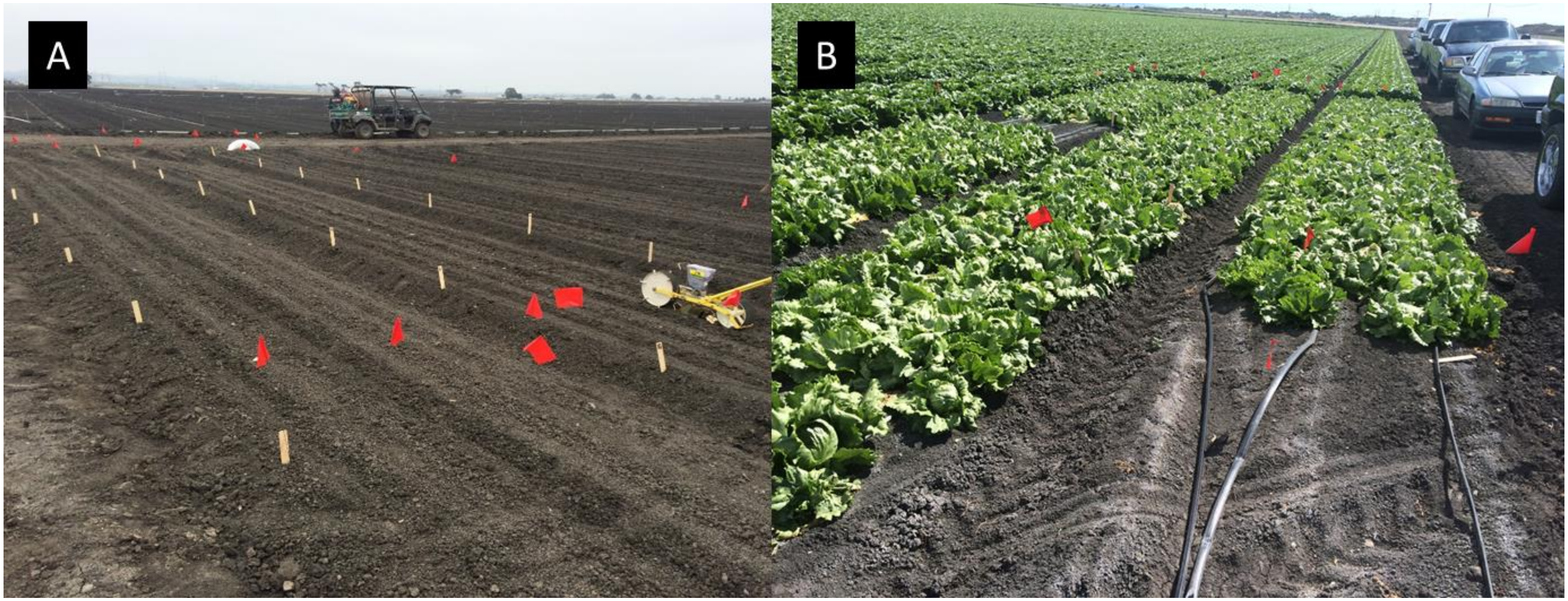

Fig. 2. Set-up for springtail trial in Castroville in 2016 (A) when seeds are planted, and (B) plants are near harvest. The springtail infestation was very poor and the plants were not evaluated for springtail damage.

Fig. 3. (A) Set-up for springtail trial in the laboratory. Three insecticide coated seeds were compared with untreated seeds. (B) The springtail containers retained in a controlled conditions in the laboratory.