CALIFORNIA LEAFY GREENS RESEARCH BOARD
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Project title:
Integrating conservational biocontrol and chemical tactics for managing insect pests in lettuce

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Abstract:
We proposed the use of different insecticides as alternative tools to pyrethroids and neonicotinoids to control aphids in lettuce, and to compare them with current grower standard practices. Additionally, we evaluated the merging between conservational biocontrol and chemical control using insectary plants and the application of selected chemicals in our experimental plots. Our results indicated that it is possible to establish sweet alyssum, as insectary plants, in conventional lettuce fields by using coated alyssum seed in a mixture with the lettuce seed. Alternative insecticides reduced aphid densities in lettuce, similarly to pyrethroids and neonicotinoids. Additionally, the average lettuce head wet weight did not differ among the use of different insecticides nor the presence of insectary plants interplanted in the main crop. The ultimate goal of this research is to provide practical evidence of possible alternatives to pyrethroids and neonicotinoids to control aphids, before the use of these molecules gets regulated in the Salinas Valley.

Objectives:
1. Compare aphid densities between leaf lettuces managed using different pesticide regimes (grower standard vs. alternative approach) with and without insectary plants.

2. Compare the number of insecticide applications between leaf lettuces under different pesticide regimes (grower standard vs. alternative approach) with and without insectary plants.

3. Compare and document the yield between leaf lettuces under different pesticide regimes (grower standard vs. alternative approach) with and without insectary plants.

Procedures:

Objective 1

Experiments were conducted in two commercial lettuce fields in 2018 in Castroville, CA. The experimental design was a strip plot, where treatments were arranged as randomized complete blocks within each strip, with four replications (r = 4). Treatments were: 1) control with no insecticide applications, 2) current regime, including pyrethroid and neonicotinoid applications, and 3) alternative regime, spraying different insecticides. Table 1 shows details for our experimental treatments. Strips (s = 2) were constituted by plots planted with insectary plants, and plots without insectary plants.

Table 1. Insecticides (brand name, active ingredient, rate) used for our experimental treatments

Treatment	Commercial name	IRAC group	Chemical class	Active ingredient	Rate / acre
Control	None	None	None	None	0 fl oz
Current	1. Admire Pro	4A	Neonicotinoid	Imidacloprid	1.3 fl oz
	& Silencer	3B	Pyrethroid	Lambda-cyhalothrin	3.8 fl oz
	2. Movento	23	Tetronic acid	Spirotetramat	5 fl oz
	& Perm-Up	3B	Pyrethroid	Permethrin	8 fl oz
	3. Admire Pro	4A	Neonicotinoid	Imidacloprid	1.3 fl oz
	& Silencer	3B	Pyrethroid	Lambda-cyhalothrin	3.8 fl oz
	4. Sivanto	4D	Butenolides	Flupyradifurone	14 fl oz
	& Perm-Up	3B	Pyrethroid	Permethrin	8 fl oz
Alternative	1. Movento	23	Tetronic acid	Spirotetramat	5 fl oz
	2. Sequoia	4C	Sulfoximines	Sulfoxaflor	2 fl oz
	3. Fulfill	9B	Pyridines	Pymetrozine	2.7 oz
	4. Sivanto	4D	Butenolides	Flupyradifurone	14 fl oz

The first field, planted on July 27th, 2018 was Romaine lettuce and direct seeded on 80-inch beds with six seedlines per bed. Experimental plots were two beds wide by 40 ft long. In this field, alyssum was established as seedlings and transplanted after thinning, using 10 plants per plot (Fig. 1A). The second field, planted on August 14th, 2018 was Tropicana lettuce, and also direct seeded on 40-inch beds with two seedlines per beds. Plots were three beds wide by 45 ft long. Alyssum was direct seeded in the second field (Fig. 1B). Raw alyssum seed was coated similarly to the lettuce at 13.0. We used a mixture of 95% lettuce seed + 5% alyssum seed by weight to fill up the hoppers of the planter. At thinning, crew slowed down to keep as many alyssum plants as possible. However, to avoid affecting the stand count per area, the thinning crew favor the presence of lettuce plants and sometimes killed alyssum plants.

Three lettuce plants were removed from each experimental plot during six different dates, once before all the treatments were deployed, every 7 to 10 days before each insecticide application, and 10 days after the fourth insecticide application. Samples were bagged in the field and took them to the Entomology laboratory in Salinas, CA to quantify aphid densities. Each sampled plant was cut into individual leaves and every leaf was visually inspected to find and count aphids. Densities were expressed as total number of aphids per lettuce plant.

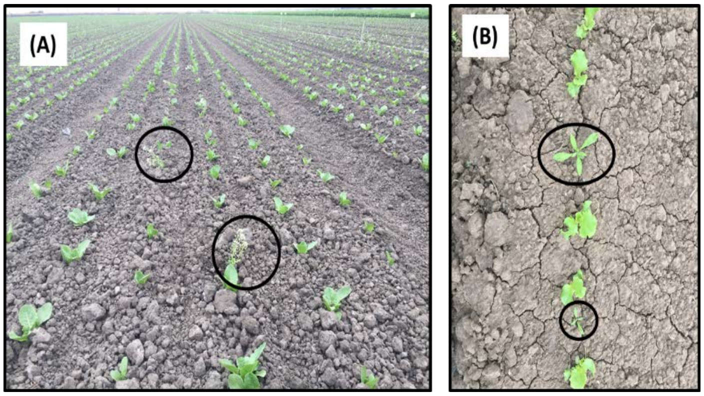

Fig. 1. A) Seedlings of sweet alyssum (circles) transplanted by hand in each experimental plot. If fields are direct seeded, this approach requires additional labor. B) Alyssum plants (circles) germinating in experimental plots, seven days after being direct seeded. We interplanted alyssum with lettuce, using a 95:5% lettuce: alyssum seed ratio by weight.

<u>Objective 2</u>

Different active ingredients were used depending on the experimental treatment (Table 1). All insecticide applications were deployed using a CO_2 backpack sprayer, with either four nozzles / bed for Romaine lettuce and two nozzles / bed for Tropicana lettuce; and targeting 60 gallons of water / acre. Applications were made early in the morning to avoid windy conditions. Table 1 also presents the order in which different insecticides were sprayed throughout this project.

<u>Objective 3</u>

At the end of the growing season and before the commercial harvest, 24 lettuce heads were harvest from the middle of each plot in both experimental fields. Using a scale, the wet weight of each lettuce plant was recorded in the field.

<u>Statistical analysis</u>

To analyze aphid counts per lettuce head and lettuce head wet weight, we used generalized linear mixed models to test for differences among treatments, including insecticide regimes and presence of insectary plants. Degrees of freedom were corrected using the Kenward and Roger procedure. Mean separations were performed using Tukey's test.

Results:

<u>Objective 1</u>

We were successful to establish sweet alyssum, either as seedlings or direct seeded, and to intercrop this insectary plant with lettuce in commercial and conventional fields. Alyssum seedlings were already flowering when transplanted into the experimental field. When planted as seed, alyssum flowering period coincided with the thinning activities in lettuce.

We counted a total of 1,704 aphids from our Romaine lettuce experimental field and 183 aphids from our field with Tropicana lettuce. All aphids were identified as the green peach aphid (*Myzus persicae*, Hemiptera: Aphididae). Aphid densities were influenced by the insecticide treatment used in both of our experimental fields (Fig. 2). Lettuce plants from control plots had the highest densities of aphids (Fig. 2). Similar aphid numbers were recorded from both of our experimental treatments (Fig. 2). On the other hand, aphid densities per lettuce head did not vary between plots with or without alyssum as insectary plant in the Romaine field (df = 1, 34; F = 2.07; P = 0.1596) and in the Tropicana field (df = 1, 7.09; F = 0.15; P = 0.7079). The interaction between strip × treatment also did not influence aphid numbers in our lettuce fields (Romaine: df = 2, 34; F = 0.09; P = 0.9173; Tropicana: df = 2, 28; F = 1.08; P = 0.3544).

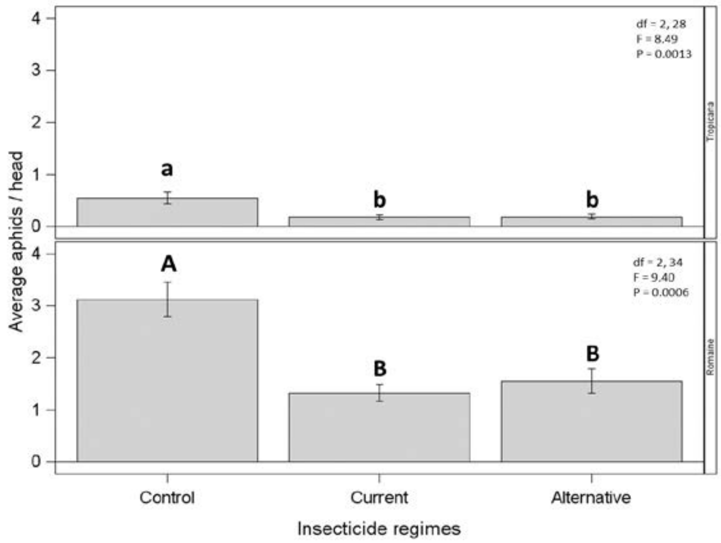

Fig. 2. Average number ± standard errors of aphids per lettuce head documented from our insecticide experimental treatments (X-axis). Means (bars) sharing the same letters are not statistically different. Upper- and lower-case letters denote separate statistical analyses. Top panel presents means for the Tropicana lettuce, and the bottom panel is for the Romaine lettuce.

Objective 2

The presence or absence of sweet alyssum as insectary plants did not influence the number of aphids per lettuce plant, as presented in the previous paragraph. Therefore, number of insecticide applications in our two experimental fields did not vary. All plots received a total of four applications, except for the control plots that had no insecticide applications. Information on the insecticides used and their sequence of application are presented in Table 1.

Objective 3

Individual lettuce wet weight was not influenced by any of our experimental insecticide treatments (Romaine: df = 2, 8; F = 0.30; P = 0.7500; Tropicana: df = 2, 12; F = 1.15; P = 0.3481; Fig. 3) nor the strips of insectary plants (Romaine: df = 1, 4; F = 3.66; P = 0.1284; Tropicana: df = 1, 12; F = 0.95; P = 0.3500). The interaction between our experimental treatments did not affected the wet weight of lettuce heads for Romaine (df = 2, 8; F = 0.05; P = 0.9486) and for Tropicana (df = 2, 12; F = 1.54; P = 0.2537).

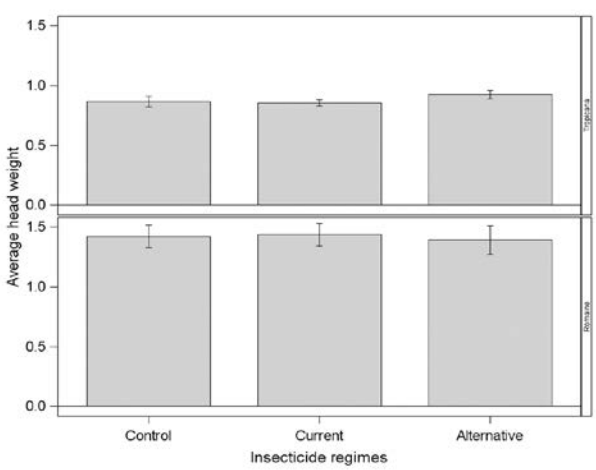

Fig. 3. Average wet weight ± standard errors of a lettuce head documented from our insecticide experimental treatments (X-axis). Means (bars) has no separation (letters), since there is no statistical difference among treatments. Top panel presents means for the Tropicana lettuce, and the bottom panel is for the Romaine lettuce.

Discussion:

A short-term solution to address the issue of pesticides on surface water may be to reduce the use of pyrethroids and neonicotinoids in crops grown in the Salinas Valley. However, there is not clear information on how pest management programs will perform without using these insecticides. There is a need to evaluate how well alternatives insecticides, such as pymetrozine (Fulfill) or sulfoxaflor (Sequoia), will control aphids in lettuce during the absence of using pyrethroids and neonicotinoids, and how economically viable these alternative chemicals are.

Table 2. Planting alyssum in conventional lettuce

	Transplant	Direct-seeded
Herbicide	Kerb	Prefar
Planting	Restricted to a watering event	No restriction
Costs	Seedlings from greenhouse	Seed + coating
Labor	Additional	Training for thinning
Timing of flowering	Flowers always present	Flowers at thinning

This project documents how well insectary plants would fit into conventionally grown lettuce using these alternative and narrow spectrum insecticides. Since our aphid populations were low, we speculate that predators such as hoverflies (Diptera: Syrphidae) were not attracted to our experimental fields, due to the lack of prey (data analysis for beneficials is not shown in this report). Having alyssum intercropped as insectary plants also did not reduce the wet weight of lettuce heads. With no difference in weight, we also could expect that yields will not be negatively impacted if interplanting alyssum in lettuce fields. If any grower would like to test this idea in the field, some considerations for planting alyssum in conventional lettuce are presented in Table 2.

We informally asked several PCAs about the performance for aphid control of our selected insecticides. It seems like our selected sequence for using these alternative insecticides was successful to control aphids in lettuce. We were not able to tell apart how much is the contribution to control aphids from each of our experimental insecticides. Therefore, it is crucial to generate and have efficacy data for each of these active ingredients individually.

In conclusion, we were able to successfully interplant sweet alyssum in conventional lettuce fields. Having the alyssum seed coated at 13.0, similar to lettuce, facilitated the mixing of these two types of seeds. The recommendation is to mix no more than 5% of alyssum seed with the lettuce (ratio by weight) before planting. Under our low aphid pressure scenario, alternatives insecticides were able to control aphids similarly to spraying pyrethroids and neonicotinoids. However, these are preliminary results. There is a need to repeat these types of experiments under higher aphid pressure and in multiple locations along the Salinas Valley.

Acknowledgements:

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