Evaluating a novel insecticide rotation strategy against adult carrot weevil using conventional & electrostatic sprayer technology

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Why was this project funded? (Project Objectives)

The carrot weevil is the most destructive pest of carrots and parsley grown across the Great Lakes- and Mid-Atlantic regions of North America. To date, growers lack options for highly effective insecticides to improve crop protection against this beetle. Furthermore, some newer insecticides labeled for this pest are quite expensive, and it may be unclear if purchasing these products is worth the investment. Difficulties managing the carrot weevil in parsley are due to a combination of factors, including proper timing of insecticide application (challenging because adult beetles are hard to detect), and good coverage/penetration of the crop canopy (challenging because the foliage becomes dense and thick with maturity). However, we can attempt to address these limiting factors by testing the best available insecticides labeled for this pest and incorporating advanced sprayer technology. **This project was funded to test the efficacy of a novel insecticide rotation strategy against adult carrot weevils, and determine if application with conventional or electrostatic sprayer (ESS) technology improves crop protection.** Our goal was to provide Ohio parsley growers with up-to-date information on the level of protection provided by a novel insecticide rotation, and thereby inform their decisions to incorporate novel products or rotations into current spray regimes.

Project outline (Materials & Methods)

Based on results of carrot weevil research at the Muck Crops Research Station in 2017 & 2018, we tested a novel insecticide rotation against adult carrot weevils using both conventional and ESS technology. We included three products with differing modes of action in the rotation: Exirel (15 fl. oz./A + LI-700 adjuvant at 0.25% v/v), followed by (fb) Baythroid XL (2.8 fl. oz./A), followed by Malathion (2 pints/A). We repeated this entire rotation twice during the growing season of 2019, for a total of 6 foliar insecticide applications, each made 7-10 days apart. We tested the same insecticide rates for both conventional and electrostatic sprayer treatments. Insecticides were applied using a conventional CK sprayer at 30 PSI, 36.4 gallons per acre (GPA), and 20” nozzle spacing moving at 2.73 mph, and an electrostatic sprayer at 15 PSI, 11 GPA, and 9” nozzle spacing moving at 2.44 mph. Foliar insecticides were applied to all treatment plots on the dates listed below in Table 1.

Date	Insecticide product		
	Exirel	Baythroid XL	Malathion
12-Jun	x		
19-Jun*		x	
25-Jun			x
3-Jul	x		
11-Jul		x	
18-Jul			x

*Soil application of Admire Pro applied once to all treatment plots.

In addition to foliar sprays, we included a single soil application (sidedress) of Admire Pro (10.5 fl. oz./A) to a subset of research plots mid-season on June 19, 2019. We added this soil application to determine if an insecticide specifically targeting eggs and developing larvae in plant roots might further improve crop protection. This experiment included five treatments with four replicates each, following a randomized complete block design. Experimental plots were 20 feet x 5 feet long and consisted of 3 rows of parsley, each spaced 18 inches apart.

Parsley was direct seeded with *dark green Italian* parsley on April 25, 2019. We scouted and counted the number of carrot weevil egg scars on 20 parsley plants in each plot once every two weeks, beginning June 19, 2019 and ending July 15, 2019. We evaluated the effects of insecticide rotation on the severity of root damage (tunneling) on 10 parsley plants per plot which were pulled on July 23, 2019. We rated roots using a 1-7 scale where "1" indicates tunneling damage 1 cm below the root crown (least amount of damage) and "7" indicates tunneling damage 7 cm below the root crown (most severe level of damage). Finally, we estimated parsley yields on July 23, 2019 by harvesting three, one-meter lengths of row in each plot and recording the fresh weight of foliage. We analyzed carrot weevil egg scar data using repeated measures analysis of variance (ANOVA) to determine if differences existed in the number of egg scars found among treatments over time. Parsley yield and root damage data were analyzed using ANOVA and mean comparisons by least significant difference (LSD) to determine if differences existed in the fresh weights and severity of root damage among treatments at the end of the experiment. All analyses were carried out in SAS version 9.3.

<u>What was discovered?</u> (Results)

Presence and number of egg scars on parsley. We found a significant interaction between treatment and date on the number of egg scars found in parsley plots over time ($F_{14,19} = 9.01$, $P < 0.0001$). In other words, the number of egg scars found in plots varied among treatments on some dates but not others (Figure 1). We found very few egg scars in parsley plots on the first scouting date (19-Jun), regardless of insecticide treatment (Figure 1, 19-Jun). By the second scouting date (1-Jul), untreated control plots began to accumulate more egg scars, with a trend for significantly more egg scars than plots sprayed with a conventional sprayer and sidedressed with Admire Pro (Figure 2, blue versus green bars). By the last scouting date (15-Jul), untreated control plots showed the highest numbers of egg scars, while

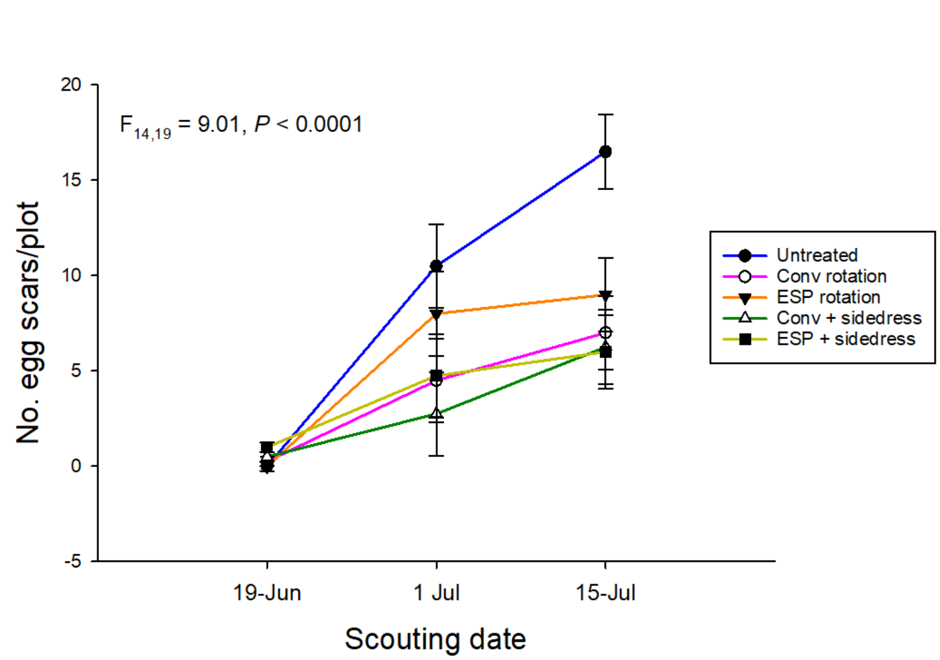

Figure 1. The no. of egg scars in each treatment over time

plots sprayed with the insecticide rotation had significantly fewer egg scars, regardless of sprayer type (Figure 3). However, it is important to note that the number of egg scars increased over time across all parsley plots, regardless of insecticide treatment.

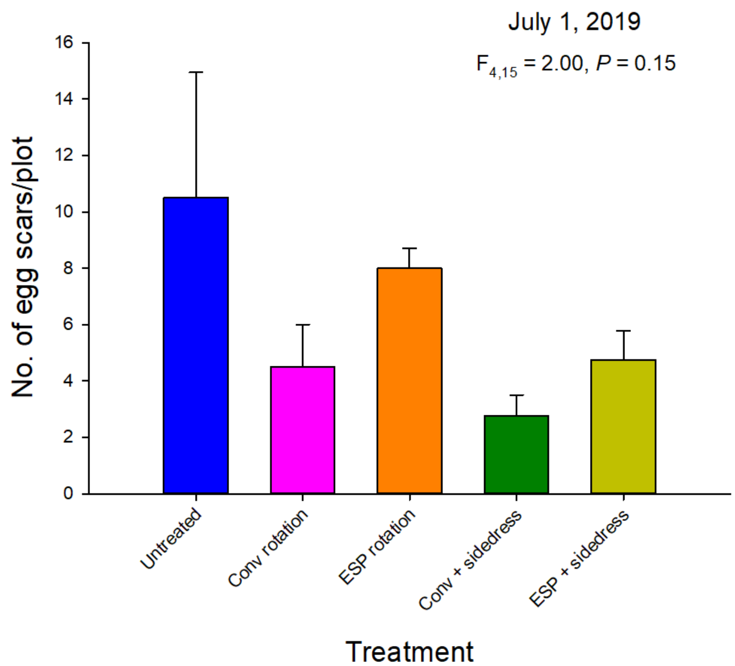

Figure 2. The no. of egg scars in each treatment on 2nd scouting date.

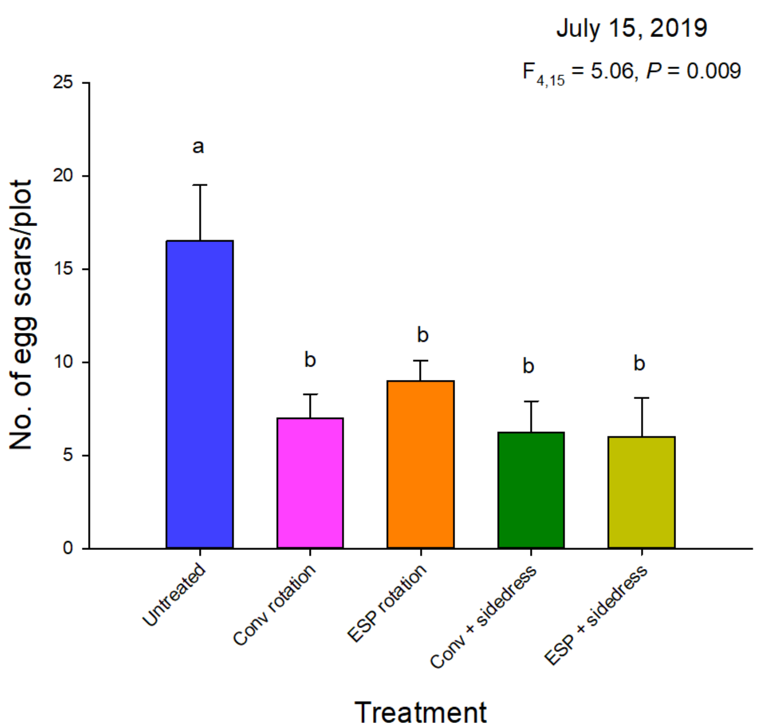

Figure 3. The no. of egg scars in each treatment on final scouting date.

Root damage. There were no significant differences in the severity of root damage across treatments at the time of root harvest on July 23, 2019 ($F_{4,15} = 0.30$, $P = 0.87$) (Figure 4). Overall, the incidence of severe root damage in 2019 was low. On average, parsley roots from untreated control plots showed tunneling damage by carrot weevil larvae roughly 2 cm below the root crown, while experimental plots treated with a rotation of Exirel fb Baythroid XL, fb Malathion showed tunneling damage 1.5 - 1.8 cm below the root crown. Insecticide application with conventional or ESS technology did not have any significant effects on severity of root damage.

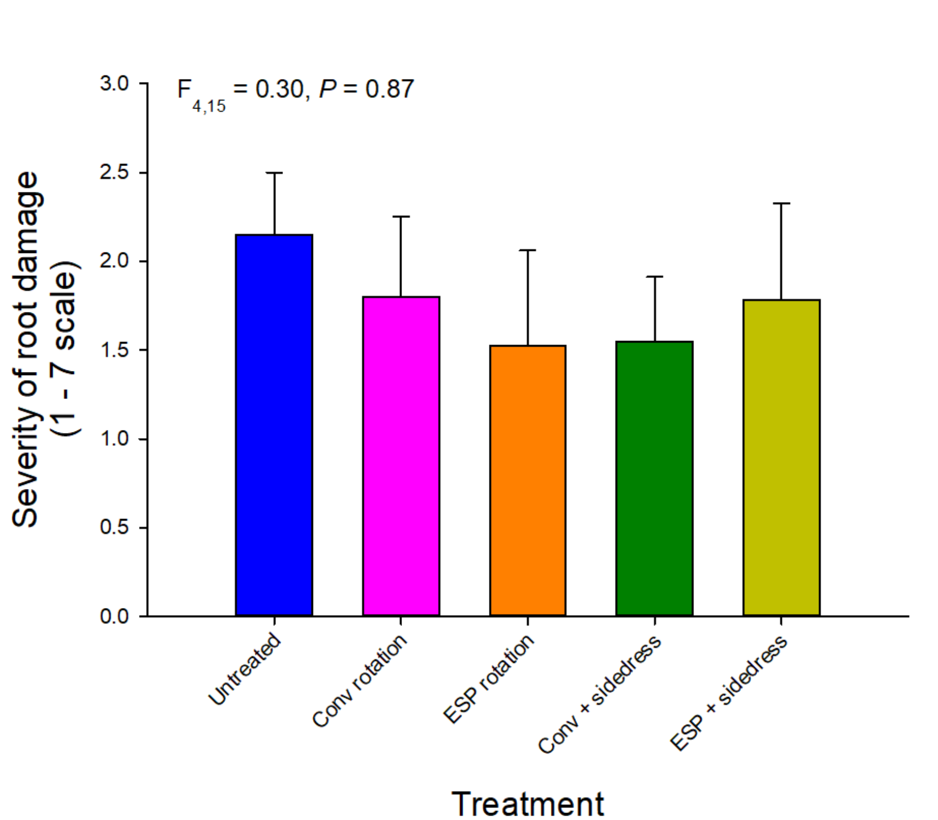

Figure 4. The severity of root damage (tunneling) at harvest.

Parsley yield. There were no significant differences in parsley yield across treatments at the time of harvest on July 23, 2019 ($F_{4,15} = 0.87$, $P = 0.50$) (Figure 5). On average, untreated control plots yielded 2.15 lbs of fresh parsley, while experimental plots treated with a rotation of Exirel fb Baythroid XL fb Malathion yielded between 2.70 - 3.00 lbs of fresh parsley. Insecticide application with conventional or ESS technology did not have any significant effects on parsley yield.

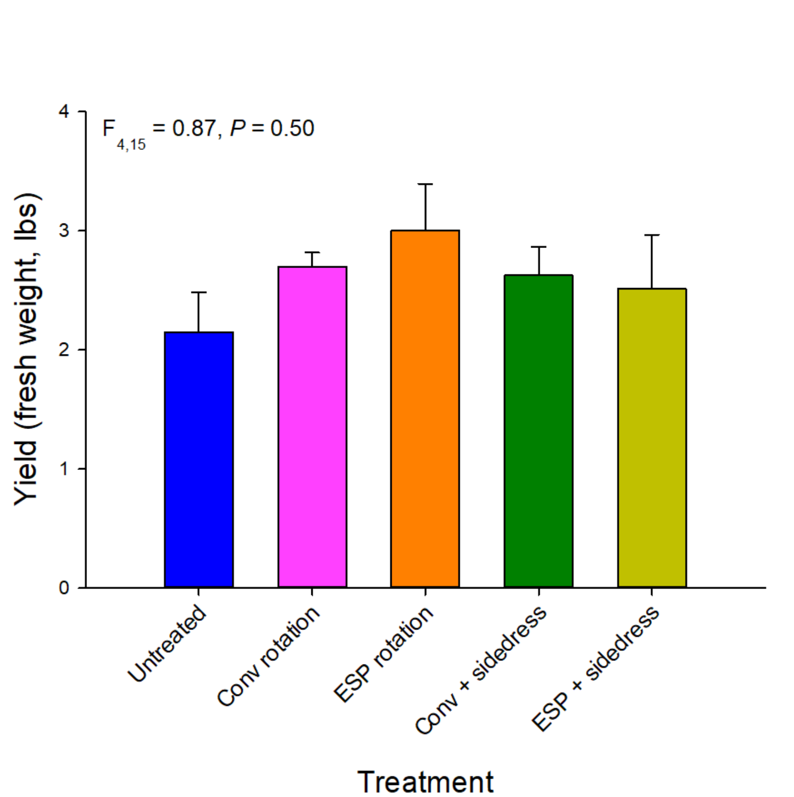

Figure 5. Fresh weights of parsley, collected July 23, 2019 from three, 1-m lengths of row in each treatment plot.

<u>What are the take-home messages?</u> (Discussion)

The 2019 growing season was a strange one, with a lot of rain, particularly during the time when carrot weevils would have been walking in search of host plants. We found almost 2/3 fewer carrot weevils in our monitoring traps during 2019, as compared to the numbers we observed in traps in 2017 and 2018. This may suggest that their populations or activity levels were negatively affected by heavy rainfall, which may have contributed to less pressure on parsley plants in this experiment (good for growers, not so great for our experiment). ☺ The fact that we did not see differences in severity of root damage may also be due to the early date of root harvesting. Although we did not observe strong differences between root damage or yields when parsley was sprayed with a conventional versus an electrostatic sprayer, it was clear that the insecticides applied in this rotation do reduce egg-laying activity compared to unsprayed plants. Last but not least, it wasn't clear from this study whether sidedressing an insecticide to target carrot weevil larvae improves suppression. Moving forward, incorporating different rotations of insecticides, with or without soil insecticides, will continue to grow our understanding of how we might best manage these weevils in Ohio parsley fields.

<u>Acknowledgements</u>

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