How long do insecticide applications provide effective control of insect pests?
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Objectives:

1. Determine the duration of control provided by commonly used foliar insecticides for major insect pests (stink bugs, bean leaf beetles, Japanese beetles, and green cloverworm) when exposed to field conditions.
2. Develop a web-based platform to make this information available to producers and crop advisors to help inform management decisions in Illinois soybean fields

This project seeks to measure the residual activity of foliar insecticides in soybean for control of common insect pests. During 2020, we focused on Japanese beetles (*Popillia japonica*) and bean leaf beetles (*Cerotoma trifurcate*), which were present at our Urbana, IL field site at sufficient numbers to conduct a robust evaluation.

<u>Progress in 2020</u>

We conducted four experiments in the field and laboratory to assess the residual control provided by common foliar insecticides. The first two experiments focused on Japanese beetle, while the final two focused on bean leaf beetle. Bioassay design was altered slightly to accommodate the size of Japanese beetle adults (Fig. 1).

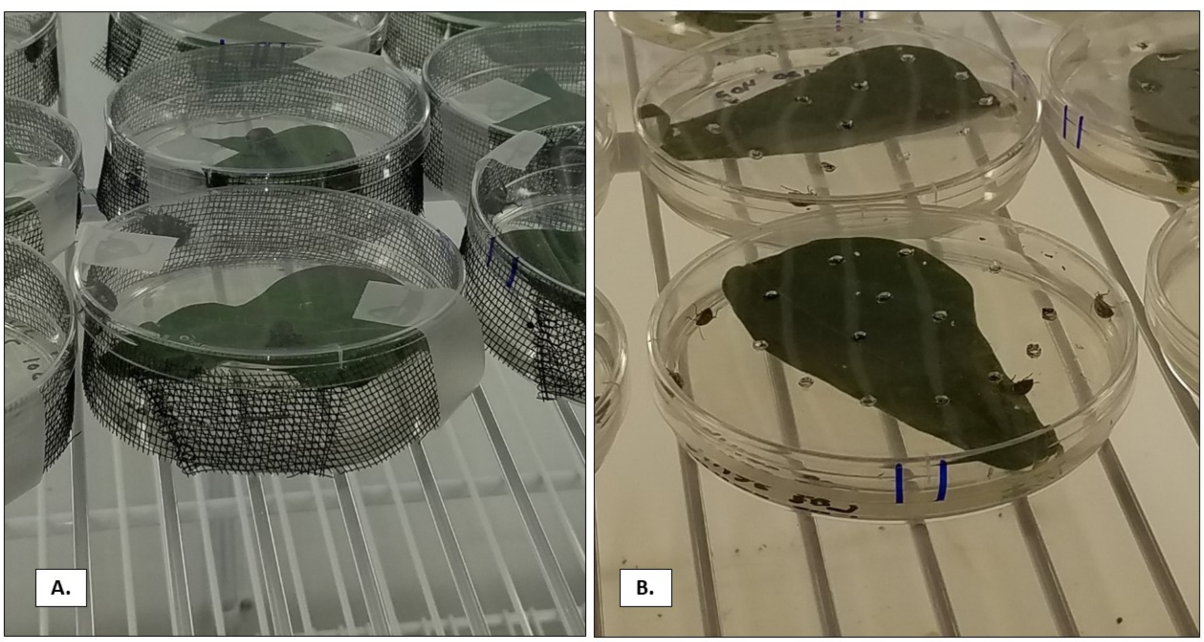

Fig. 1. Bioassay setup for experiments on Japanese beetle (A.) and bean leaf beetle (B.). Mesh rings were used to ventilate the bioassay arena and accommodate the larger size of Japanese beetles.

Each field experiment evaluated three or more insecticide treatments alongside an untreated control. Foliage was collected at various intervals from 1 to 14 days after treatment applications were made and placed on benzamidazole agar media in petri plates, which slows the wilting process of the soybean leaflets. Insects (n = 5 per plate) were then placed on the foliage within the petri plates for 24 hours. After 24 hours of exposure to the foliage, the insects were evaluated to determine percent mortality and percent morbidity (insects dead and those showing symptoms of pesticide exposure). For all preliminary data shown here, percent mortality only is displayed.

Experiment 1 was conducted from July 14-23 and evaluated Warrior (*lambda*-cyhalothrin), Endigo ZC (*lambda*-cyhalothrin + thiamethoxam), and Brigade 2EC (bifenthrin) for control of Japanese beetles.

Table 1. Preliminary results of Field Experiment 1, focused on residual control of Japanese beetles. Treatment applications made on 14 July 2020.

	Percent Mortality			
Treatment	**1 DAT[a]**	**2 DAT**	**6 DAT**	**8 DAT**
Untreated	0 ± 0 a[b]	5 ± 5 a	0 ± 0 a	0 ± 0 a
Warrior II (1.92 oz/a)	13 ± 13 a	0 ± 0 a	0 ± 0 a	0 ± 0 a
Endigo ZC (4.5 oz/a)	20 ± 12 a	5 ± 5 a	5 ± 5 a	5 ± 5 a
Brigade 2EC (4 oz/a)	18 ± 12 a	0 ± 0 a	0 ± 0 a	5 ± 5 a

[a] Days after treatment applications [b] Means followed by the same letter within a column are not different based on the Fisher method of least significant difference ($\alpha = 0.05$)

Overall mortality of Japanese beetles in this bioassay was low, likely due to the ability of the beetles to avoid the insecticide-treated foliage within the bioassay arena. Defoliation was notably different between the untreated plots and the plots that received an insecticide application at 1 day after treatment applications were made (Fig. 2). Foliage was photographed to observe percent defoliation at the completion of each bioassay; further analyses will measure percent defoliation of the foliage for an additional comparison.

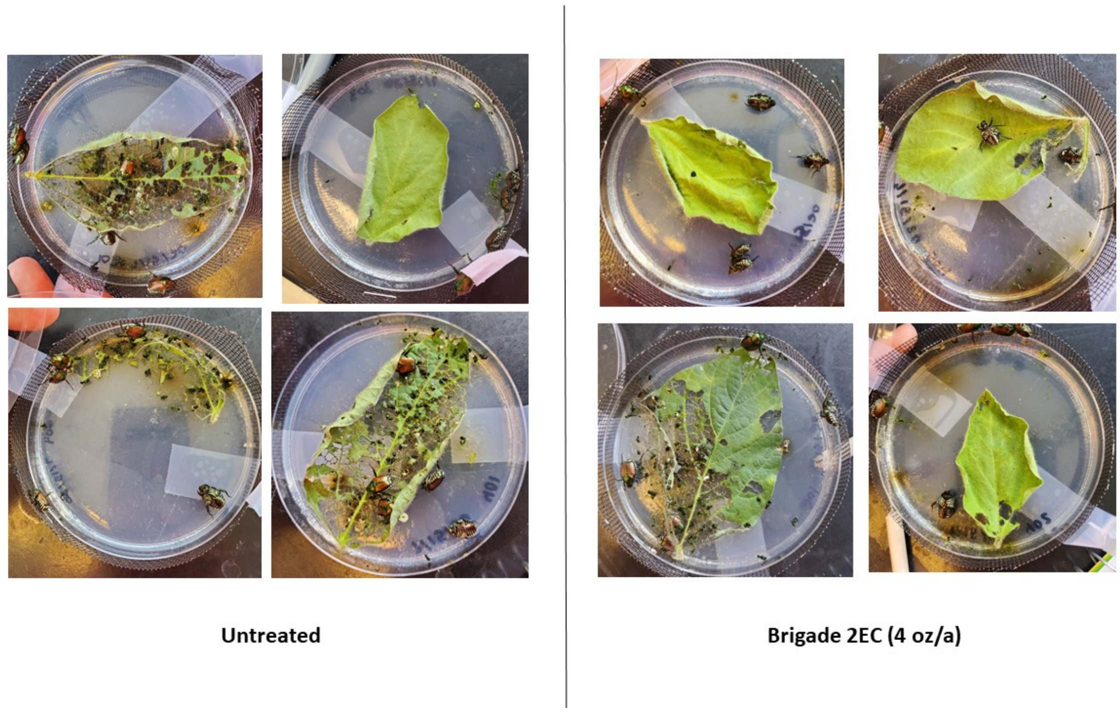

Fig. 2. Comparison of defoliation by Japanese beetles after 24 hours of exposure to soybean foliage either untreated with an insecticide or treated with Brigade 2EC at 4 oz/a.

Experiment 2 was conducted from August 10-13 and evaluated Leverage 360, Baythroid, and Warrior II for control of Japanese beetles. This experiment was concluded earlier than intended (at three days after treatment applications) due to insufficient populations of Japanese beetles remaining in the field.

Table 2. Preliminary results of Experiment 2, focused on residual control of Japanese beetles. Treatment applications were made on 10 August 2020.

	Percent Mortality	
Treatment	**1 DAT[a]**	**3 DAT**
Untreated	0 ± 0 a[b]	5 ± 5 a
Leverage 360 (2.8 oz/a)	15 ± 10 a	20 ± 8 a
Baythroid XL (2.8 oz/a)	9 ± 5 a	5 ± 5 a
Warrior II (1.9 oz/a)	5 ± 5 a	5 ± 5 a

[a] Days after treatment application; [b] Means followed by same letter within a column are not different based on the Fisher method of least significant difference ($\alpha = 0.05$)

There was a great deal of variability in this field experiment, and only Leverage 360 resulted in greater than 10% mortality. As with Experiment 1, percent defoliation was also affected by the treatments, and will be evaluated in further analyses.

Experiment 3 was conducted from August 31-September 14 and evaluated Endigo ZC, Endigo ZCX, Leverage 360, Warrior II, and Brigade 2EC for control of bean leaf beetles.

Table 3. Preliminary results of Experiment 3, focused on residual control of bean leaf beetles. Treatment applications were made on 31 August 2020.

	Percent Mortality			
Treatment	**1 DAT[a]**	**3 DAT**	**7 DAT**	**14 DAT**
Untreated	0 ± 0 b[b]	10 ± 10 a	0 ± 0 a	5 ± 5 a
Endigo ZC (4.5 oz/a)	30 ± 13 ab	18 ± 11 a	15 ± 15 a	5 ± 5 a
Leverage 360 (2.8 oz/a)	55 ± 13 a	30 ± 13 a	25 ± 15 a	25 ± 15 a
Endigo ZCX (4 oz/a)	35 ± 5 a	35 ± 15 a	20 ± 14 a	10 ± 6 a
Warrior II (1.92 oz/a)	51 ± 17 a	20 ± 8 a	0 ± 0 a	5 ± 5 a
Brigade 2EC (4 oz/a)	45 ± 10 a	25 ± 10 a	30 ± 17 a	28 ± 13 a

[a] Days after treatment application; [b] Means followed by same letter within a column are not different based on the Fisher method of least significant difference ($\alpha = 0.05$)

The bioassay we used was originally designed for use with bean leaf beetles, and it performed better as an evaluation tool for this species. By 14 days after treatment, only two materials resulted in greated than 10% mortality (Leverage 360 and Brigade 2EC), which was the highest mortality level observed in the control plates. As with the Japanese beetle experiments, further analyses will examine differences in defoliation levels among the different treatments.

Experiment 4 was conducted from September 2-18 and evaluated Warrior II, Baythroid XL, and Asana for control of bean leaf beetles.

Table 4. Preliminary results of Experiment 4, focused on residual control of bean leaf beetles. Treatment applications were made on 2 September 2020.

	Percent Mortality			
Treatment	**1 DAT[a]**	**5 DAT**	**7 DAT**	**14 DAT**
Untreated	0 ± 0 b[b]	0 ± 0 b	0 ± 0 b	0 ± 0 b
Warrior II (1.92 oz/a)	50 ± 21 a	20 ± 8 a	25 ± 10 a	23 ± 10 a
Baythroid XL (2.8 oz/a)	24 ± 18 ab	0 ± 0 b	15 ± 10 ab	5 ± 5 ab
Asana (6.4 oz/a)	20 ± 8 ab	10 ± 6 ab	0 ± 0 b	5 ± 5 ab

[a] Days after treatment application; [b] Means followed by same letter within a column are not different based on the Fisher method of least significant difference ($\alpha = 0.05$)

Interestingly, the residual activity of Warrior II appeared to be more persistent (though at a reduced level of ~20% mortality) for a longer period of time than in the other assays. As with the other experiments, percent defoliation will be added to these analyses.

Next steps

- Perform further data analyses to estimate the average persistence of the individual materials examined in these field experiments, as well as to determine differences in defoliation levels among the different treatments used in these bioassays
- Create a web-based resource to share this information with farmers and crop advisors
- Improve the Japanese beetle assay to maximize exposure to the treated foliage while minimizing control mortality.
- Optimize the bioassay procedure to collect information on additional insect pests (stink bugs, green cloverworm)
- Conduct a second series of field experiment during Summer 2021