Japanese Beetle Insecticide Efficacy Evaluation in Central Iowa

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Japanese beetle, *Popillia japonica* Newman (Coleoptera: Scarabaeidae), is an invasive insect from Asia first confirmed in the United States in 1916. Japanese beetle is a generalist pest, feeding on more than 300 plant species. Japanese beetle larvae (grubs) are destructive to turfgrass roots and have limited mobility in the soil, and adults feed mainly between leaf veins. The significance of this invasive species in the Midwestern United States is increasing, with first detection in Iowa in 1994.

Life cycle. Japanese beetle has one generation per year. Adults begin emerging from the soil in mid-to-late June to early July and live four to six weeks. Females spend this time alternating between feeding, mating, and ovipositing eggs. They will enter the soil a dozen or more times, laying up to 60 individual eggs. Eggs hatch within 10–14 days and development to third instars requires about six weeks. Third instars overwinter up to six inches below the soil surface. Diapause ends the following spring when soil temperatures exceed 50°F, and grubs begin to move back upward in the soil profile to continue feeding for another four to eight weeks. The pupal stage lasts 7–17 days and the newly-molted adults remain in the soil for 2–14 days prior to emergence.

Feeding injury. Japanese beetle adults feed on the interveinal tissue of soybean, *Glycine max* (L.) leaves, creating a characteristic skeletonized appearance. Japanese beetle is known for forming large aggregations, which may make defoliation appear severe; however, adults are highly mobile and likely do not feed in one place for long.

Management. The severity and abundance of Japanese beetle in Iowa fluctuates. Scouting can be difficult due to their high mobility, but it is crucial to obtain a representative field sample as they have been found to aggregate along the field edges. Additionally, Japanese beetle exhibits a top-down feeding pattern in soybean, so sampling the entire plant is equally important to capture the amount of photosynthetic area affected. This will be important to determine whether border treatment will suffice or if whole-field treatment is warranted. Because adults are highly mobile, re-infestations are common after insecticide applications are made.

Methods and Materials

Plot establishment. Pioneer 24T76E brand soybean was planted in 30-in. rows using conventional production practices June 5. Plots were six rows wide and 50 ft long. Ten treatments were evaluated (Table 1), which were arranged in a randomized complete block design with four replications.

Sampling protocol. Sampling for Japanese beetle was done six times (three pre- and three post-spray). Three trifoliates were chosen at random from the top, middle, and bottom of each of 10 randomly selected plants. The leaflets with the most and least defoliation on each trifoliate were discarded, and percent defoliation estimated for the remaining leaflet. Ten sweeps were taken from the center four rows of each plot and the number of Japanese beetles present recorded.

Insecticide applications. Foliar treatments were applied July 29 using a backpack sprayer with 20 gallons of water/acre at 40 lb of pressure/square inch.

Yield. Each plot was harvested using a small plot combine. The middle four rows of each treatment were harvested October 15. Yields were determined by weighing grain with a hopper, which rested on a digital scale sensor custom designed for each combine. Yields were corrected to 13 percent moisture and reported in bushels/acre (Table 2).

Statistical analysis. A one-way analysis of variance (ANOVA) was used to determine the effect of treatment on beetle densities at the first sampling date after insecticide application, percent defoliation at the final sampling date, and yield at harvest. A least significant differences (LSD) test was used to achieve mean separation for all treatments (alpha = 0.05) using SAS® software.

Results and Conclusions

In the untreated control treatments, beetle populations peaked at 7.25 ± 2.25 (± standard error of the mean) per 10 sweeps July 23. The untreated control and Transform had higher beetle numbers than all other treatments after insecticide application (Table 2). All treatments had beetle numbers and defoliation well below levels that would translate to measurable yield losses, and no significant differences in yield were observed among treatments (Table 2).

Acknowledgements

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Table 1. List of treatments and rates for Japanese beetle in 2020 at the ISU Johnson Farm, Story Co.

Treatment and formulation	Group[a]	Active ingredient(s)	Rate[b]	Timing
1. Untreated Control	-----	-----	-----	-----
2. Transform 50WG	4C	sulfoxaflor	1.06 oz	July 29
3. Warrior II CS	3A	lambda-cyhalothrin	1.6 fl oz	July 29
4. chlorpyrifos + lambda-cyhalothrin EW	1B + 3A	chlorpyrifos + lambda-cyhalothrin	16.0 fl oz	July 29
5. bifenthrin + sulfoxaflor SE (A)	3A + 4C	bifenthrin + sulfoxaflor	6.9 fl oz	July 29
6. bifenthrin + sulfoxaflor SE (B)	3A + 4C	bifenthrin + sulfoxaflor	8.56 fl oz	July 29
7. bifenthrin + sulfoxaflor SE (C)	3A + 4C	bifenthrin + sulfoxaflor	10.3 fl oz	July 29
8. Sniper EC (A)	3A	bifenthrin	3.2 fl oz	July 29
9. Sniper EC (B)	3A	bifenthrin	4.0 fl oz	July 29
10. Sniper EC (C)	3A	bifenthrin	4.8 fl oz	July 29

[a]Insecticide group according to the Insecticide Resistance Action Committee (http://www.irac-online.org/).
[b]Rate per acre unless noted.

Table 2. List of beetle density, percent defoliation, and yield for treatments for Japanese beetle in 2020 at the ISU Johnson Farm, Story Co.

Treatment and formulation	Beetles ± SEM[a]	Beetles - LSD[b]	Defoliation ± SEM[c]	Defoliation - LSD[d]	Yield ± SEM[e]	Yield - LSD[f]
1. Untreated Control	6.00 ± 2.45	B	3.31 ± 0.33	AB	57.82 ± 1.57	E
2. Transform 50WG	10.25 ± 1.11	C	2.83 ± 0.50	AB	59.87 ± 0.77	BCDE
3. Warrior II CS	0.25 ± 0.25	A	3.83 ± 0.83	ABC	60.54 ± 2.05	ABCDE
4. chlorpyrifos + lambda-cyhalothrin EW	2.00 ± 0.41	A	4.63 ± 0.99	BC	60.10 ± 2.07	BCDE
5. bifenthrin + sulfoxaflor SE (A)	0.75 ± 0.25	A	2.38 ± 0.47	A	64.82 ± 0.87	AB
6. bifenthrin + sulfoxaflor SE (B)	1.00 ± 0.58	A	2.28 ± 0.39	A	65.37 ± 2.85	A
7. bifenthrin + sulfoxaflor SE (C)	0.50 ± 0.29	A	2.61 ± 0.28	A	64.35 ± 1.43	ABC
8. Sniper EC (A)	1.00 ± 0.41	A	3.41 ± 0.94	AB	59.18 ± 2.97	DE
9. Sniper EC (B)	0.25 ± 0.25	A	5.64 ± 1.38	C	63.49 ± 0.94	ABCD
10. Sniper EC (C)	1.00 ± 0.71	A	2.73 ± 0.34	AB	59.35 ± 0.78	CDE

[a]Beetles is the number of beetles two days after treatment ± the standard error of the mean (SEM.).
[b]LSD (least significant difference) of beetles at alpha = 0.05 ($P < 0.0001$; $F = 11.70$; df = 9, 27).
[c]Defoliation is the percent defoliation at the final sampling date ± SEM.
[d]LSD of defoliation at alpha = 0.05 ($P = 0.04$; $F = 2.41$; df = 9, 27).
[e]Yield is reported in bushels/acre ± SEM.
[f]LSD of yield at alpha = 0.05 ($P = 0.03$; $F = 2.50$; df = 9, 27).