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Managing the usual suspects in soybean

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Introduction

In the north-central region, a few persistent and many occasional insects occur in soybean. A potential mix of pests is likely to happen each growing season, but the severity is not easily predicted between years. Even though pest abundance can be erratic in Iowa soybean, there has been a steady adoption of insecticidal seed and foliar treatments over the last decade (Ragsdale et al. 2011). In order to preserve chemical efficacy and improve profit margins in soybean, we encourage farmers to use Integrated Pest Management, or IPM. The use of proactive IPM tools is an ideal way to manage a pest complex that often occurs in soybean. Examples of IPM for soybean aphid include genetic, cultural and chemical control; sampling; and knowledge of crop economics (Hodgson et al. 2012). Management of two important Iowa soybean pests, soybean aphid and twospotted spider mite, will be reviewed in this article.

Soybean aphid

For the last decade, Iowa's primary soybean pest has been soybean aphid. Since the arrival of soybean aphid to North America, entomologists have generated considerable research to effectively protect yield in soybean. Population dynamics of this relatively new pest have been erratic between fields and among years, but timely insecticide applications have prevented severe economic loss. A regional consensus economic threshold was published by Ragsdale et al. (2007): an average of 250 aphids per plant on 80% of the field with increasing populations from flowering (R1) through seed set (R5.5).

Aphids in other cropping systems have become genetically resistant to insecticides with repeated exposure and it is a genuine concern for soybean aphid. To monitor product knockdown and efficacy, we establish small plots every summer. Since the efficacy evaluation program began in 2005, most broad spectrum chemistries are effective in killing soybean aphid. To see a summary of product performance, read our Yellow Book publications available online at www.ent.iastate.edu/soybeanaphid/resources.

Host plant resistance is the newest management tool for soybean aphid. Single gene expression varieties containing the *Rag1* gene have been commercially available since 2010; avirulent aphids that feed on resistant plants do not live as long or produce as many offspring. Resistant varieties have the potential to simultaneously reduce insecticide usage and associated production costs, and preserve natural enemies in soybean (Tilmon et al. 2011). Although biotypes exist throughout the north-central region, *Rag1* has often sufficiently protected soybean from yield loss in Iowa and reduced the need for insecticides.

In 2013, the objective of this research was to evaluate management tactics of soybean aphid. A combination of host plant resistance, seed treatments and foliar applications were used to gain a better understanding of soybean production profitability.

Materials and methods

Small plot research was established at the Iowa State University Northwest Research Farm in O'Brien County, Iowa. Each treatment was replicated four times in a randomized complete block design. Plots (6 rows by 50 feet) were planted on 19 June 2013 with Syngenta S20-Y2 and S21-Q3 (*Rag1*) brand seed into a no-till production system with 30-inch rows. We present data from 12 treatments (Table 1). All *Rag1*-containing treatments were analyzed separately.

Table 1. Soybean aphid treatments and rates at the Northwest Research Farm for 2013

Treatment		Active Ingredient(s)	Rate	Application
1.	Untreated control	-----	-----	-----
2.	CruiserMaxx Vibrance	thiamethoxam + fungicides[1]	62.5g/100kg seed[1]	seed treatment
3.	Warrior II CS	λ-cyhalothrin	1.92 fl oz/ac	23 Aug
4.	Warrior II CS + Lorsban Advanced EC	λ-cyhalothrin chlorpyrifos	1.6 fl oz/ac 1 pt/ac	23 Aug
5.	Lorsban Advanced EC	chlorpyrifos	1 pt/ac	23 Aug
6.	Brigade 2EC	bifenthrin	3.0 fl oz/ac	23 Aug
7.	Orthene 97	acephate	1 lb/ac	23 Aug
8.	Magister CS	fenazaquin	12.0 fl oz/ac	23 Aug
9.	*Rag1*	-----	-----	-----
10.	*Rag1* + CruiserMaxx Vibrance	----- thiamethoxam + fungicides[1]	----- 62.5g/100kg seed[1]	----- seed treatment
11.	*Rag1* + CruiserMaxx Vibrance + Warrior II CS	----- thiamethoxam + fungicides[1] λ-cyhalothrin	----- 62.5g/100kg seed[1] 1.92 fl oz/ac	----- seed treatment 23 Aug
12.	*Rag1* + Warrior II CS	----- λ-cyhalothrin	----- 1.92 fl oz/ac	----- 23 Aug

[1] thiamethoxam, 50g/100kg seed; mefenoxam, 7.5g/100kg seed; fludioxinil, 2.5g/100kg seed; and sedaxane, 2.5g/100kg seed.

Plots were sampled weekly from July through September. Initially, twenty whole-plant counts were made for each plot, but gradually sampling was reduced to three plants per plot as aphid infestation levels and plant size increased. Actual aphid numbers from each plot were averaged between the four replications of each treatment. In addition, cumulative aphid days (CAD) were estimated for each treatment to reflect seasonal pressure. Foliar treatments were made on 23 August 2013 and plots were harvested on 21 October 2013.

To compare seasonal aphid accumulation and yield among treatments, data were analyzed using a one-way ANOVA. Mean separations for all treatments were estimated by a least significant difference (LSD) test ($P < 0.10$). Different letters for CAD or yield indicate significantly different treatment effects. All statistical analyses were performed using SAS software (SAS 2012).

Results

There was substantial soybean aphid pressure at the Northwest Research Farm in 2013, with most soybean aphid population growth beginning in mid-August. The untreated control reached the economic threshold the last week of August, or the same week foliar applications were made. Plants were at full pod set (R4) at the time of application. The untreated control exceeded 12,800 CAD by the end of September (Table 2) and had significantly more aphids than all other treatments ($P<0.0001$; $F = 9.23$; df = 7, 3). The highest CAD corresponded to the lowest yield (Table 2). CruiserMaxx Vibrance and Magister also accumulated significantly more aphids than the other treatments. However, Magister is labeled as a miticide and therefore we did not expect it to suppress soybean aphid. Foliar insecticides labeled for soybean aphid did prevent aphids from exceeding the economic injury level for CAD (~5500) and did have significantly greater yields than the untreated control and CruiserMaxx Vibrance treatments ($P<0.0032$; $F = 4.08$; df = 7, 3).

Generally, treatments containing the *Rag1* gene did not yield as well as the susceptible variety (Table 2). The *Rag1*-only treatment had significantly more CAD than other treatments ($P<0.0054$; $F = 6.97$; df = 3, 3). Surprisingly, the treatment containing the *Rag1* gene, CruiserMaxx Vibrance and Warrior had significantly lower yield compared to the other *Rag1* treatments ($P<0.1890$; $F = 1.88$; df = 3, 3).

Conclusions

- Foliar insecticides applied at the economic threshold will protect yield.
- Tank-mixing two chemistries does not necessarily improve yield protection.
- Under heavy soybean aphid pressure, *Rag1* varieties can still yield higher than a susceptible variety and is comparable to a seed treatment.

Table 2. Soybean aphid cumulative exposure and yield at Northwest Research Farm for 2013

Treatment		CAD ± SEM[1]	CAD – LSD[2]	Yield ± SEM[3]	Yield – LSD[4]
1.	Untreated control	12,864.3 ± 2,333.4	c	46.8 ± 1.3	c
2.	CruiserMaxx Vibrance	8,804.8 ± 1,820.4	b	49.2 ± 1.7	b
3.	Warrior II CS	2,183.2 ± 1,056.8	a	52.1 ± 1.3	a
4.	Warrior II CS + Lorsban Advanced EC	1,341.1 ± 344.2	a	52.6 ± 0.5	a
5.	Lorsban Advanced EC	1,385.9 ± 575.0	a	52.3 ± 0.5	a
6.	Brigade 2EC	924.6 ± 192.6	a	52.9 ± 0.7	a
7.	Orthene 97	1,675.2 ± 647.1	a	52.5 ± 0.2	a
8.	Magister CS	6,365.9 ± 1,379.9	b	49.2 ± 1.0	bc
9.	*Rag1*	6,686.7 ± 1,392.7	B	49.2 ± 1.0	AB
10.	*Rag1* + CruiserMaxx Vibrance	109.3 ± 69.5	A	47.2 ± 0.4	BC
11.	*Rag1* + CruiserMaxx Vibrance + Warrior II CS	61.9 ± 50.5	A	46.7 ± 0.3	C
12.	*Rag1* + Warrior II CS	1,867.0 ± 679.0	A	50.1 ± 1.1	A

[1] CAD (cumulative aphid days), or estimated seasonal exposure of soybean aphid ± SEM (standard error of the mean).

[2] LSD (least significant difference) for CAD (cumulative aphid days); $P<0.0001$; $F = 9.23$; df = 7, 3. Letters represent significant differences ($\alpha = 0.10$).

[3] Yield is reported in bushels per acre ± SEM (standard error of the mean).

[4] LSD (least significant difference) for yield; $P<0.0032$; $F = 4.08$; df = 7, 3. Letters represent significant differences ($\alpha = 0.10$).

[5] LSD (least significant difference) for CAD (cumulative aphid days); $P<0.0054$; $F = 6.97$; df = 3, 3. Letters represent significant differences ($\alpha = 0.10$).

[6] LSD (least significant difference) for yield; $P<0.1890$; $F = 1.88$; df = 3, 3. Letters represent significant differences ($\alpha = 0.10$).

Twospotted spider mite

Occasionally, twospotted spider mite becomes a pest of corn and soybean in Iowa. However, spider mite damage is more pronounced in crops during moisture-stressed growing conditions. In 2012 and 2013, drought conditions caused some fields to have significant spider mite feeding and subsequent yield loss.

Twospotted spider mites normally produce 10–20 generations every year in Iowa. This pest can have exponential growth when temperatures are consistently above 85 degrees, humidity is less than 90 percent, and plants are lacking sufficient moisture. Under ideal conditions, spider mites can mature from egg to adult in five days; cooler temperatures can extend development to 19 days.

Spider mites injure plants by crushing cells and removing sap. Heavily infested plants will experience lower chlorophyll content and decreased photosynthesis. Injured plants will have decreased transpiration rates (i.e., cooling potential) compared to healthy plants (Haile and Higley 2003). Yield losses exceeding 40 percent are possible in drought-stressed growing conditions (Bynum et al. 1990). Spider mite damage is not reversible on injured leaves, but rain events and mite suppression can help new growth on plants. Spider mites prefer to feed on the undersides of leaves, and typically start building colonies in the lower plant canopy and along field edges. Initial feeding injury can be described as white spots, stippling or discoloration of the leaves. As mite populations increase, they will move to the upper canopy to feed. Large infestations are usually accompanied with fine silken webbing. Prolonged spider mite feeding can cause premature leafdrop and death.

There are not specific spider mite density thresholds. Instead foliar applications should be based on your estimation of plant quality. For corn, the goal is to prevent spider mites from reaching the ear leaf. Consider treating when most plants are infested in the lower canopy and discoloration is starting. Treatments should be made between silking and dough (R1–R4). The most important soybean growth stages to protect are full pod through beginning seed set (R4–R5). In soybean, consider using a 0-5 rating scale to make treatment decisions:

- 0 no spider mites or feeding damage observed;
- 1 spider mites detected on a few plants, and minor stippling on lower leaves;
- 2 spider mites detected on most plants, stippling common on lower leaves, and small patches of yellowing plants can be found;
- 3 spider mites can be found in the middle canopy, yellow plants common and some premature leaf loss (THRESHOLD);
- 4 spider mites and stippling can be found in the upper canopy, and prematue leafdrop is common (ECONOMIC LOSS); and
- 5 spider mites are easy to find in the upper canopy, plants are browning, and some plants are dead.

Product selection is extremely important for spider mite management (Ostlie and Potter 2012). Some products will not kill eggs, and populations can rebound and continue to injure plants. Most products labeled for corn and soybean in Iowa rely on direct contact to successfully reduce spider mites. Therefore, use sufficient volume to reach mites in the lower canopy and on the undersides of leaves (e.g., 20 gpa by ground or 5 gpa by aerial application). Continue scouting after an application to determine if additional sprays are required. Consider rotating chemistries if additional sprays are needed.

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