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Soybean Aphid Efficacy Evaluation

Matthew E. O'Neal
Iowa State University, oneal@iastate.edu

Erin W. Hodgson
Iowa State University, ewh@iastate.edu

Kevin Johnson
Iowa State University

Gregory R. VanNostrand
Iowa State University, gregvn@iastate.edu

Nicholas P. Schmidt
Iowa State University

See next page for additional authors

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Abstract
Soybean, Glycine max (L.), grown in Iowa and most of the north central region of the United States has not required regular insecticide usage. The soybean aphid (Aphis glycines Matsumura) causes yield losses from direct plant feeding and has been shown to transmit several plant viruses. In Iowa, soybean aphid can colonize soybean fields in June and has developed into outbreaks in July and August capable of reducing yields by nearly 25%.

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Authors
Matthew E. O'Neal, Erin W. Hodgson, Kevin Johnson, Gregory R. VanNostrand, Nicholas P. Schmidt, Michael Thomas Mccarville, and Kenneth T. Pecinovsky

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Matt O'Neal, assistant professor
Erin Hodgson, assistant professor
Kevin Johnson, graduate student
Greg VanNostrand, research associate
Nick Schmidt, graduate student
Mike McCarville, graduate student
Department of Entomology
Kenneth Pecinovsky, farm superintendent

Introduction

Soybean, *Glycine max* (L.), grown in Iowa and most of the north central region of the United States has not required regular insecticide usage. The soybean aphid (*Aphis glycines* Matsumura) causes yield losses from direct plant feeding and has been shown to transmit several plant viruses. In Iowa, soybean aphid can colonize soybean fields in June and has developed into outbreaks in July and August capable of reducing yields by nearly 25%.

Materials and Methods

We established plots at the ISU Northeast Research Farm in Floyd County, Iowa. The treatments were arranged in a randomized complete block design with six replications, and soybean (PB2636N RR) was planted in 30-in. rows using no-till production practices on May 5. Each plot was six rows wide and 50 ft long. In total for 2009, we evaluated 25 treatments with products alone or in combination (Table 1). The experiment included two controls: an untreated control and a "zero aphid" treatment in which a tank-mix of two foliar insecticides (λ-cyhalothrin and chlorpyrifos) was applied every time aphids were detected.

Plant stand. Plant stands were taken at V2 on June 9. Two 10-ft sections were randomly selected within each plot, and the number of emerged plants was counted. An average of the plant stand for each treatment is reported (Table 1). The reported stand is the number of plants per 10 ft of row.

Application techniques. Foliar treatments were applied using a backpack sprayer and TeeJet (Springfield, IL) twinjet nozzles (TJ 11002) with 20 gallons of water/acre at 40 lb of pressure/square inch. Seed treatments were applied to the seed in a slurry before planting.

Estimation of soybean aphid populations and cumulative aphid days. Soybean aphids were counted on consecutive plants at randomly selected locations within each plot. The number of plants counted in each plot was variable depending on plant growth stage. After plant emergence, 20 plants/plot were examined. As plants matured, only 5 plants/plot were examined. All aphids (adults, nymphs, and winged aphids) were counted on each plant. Summing aphid days accumulated during the growing season provides a measure of the seasonal aphid exposure that a soybean plant experiences. Cumulative aphid days are calculated with the following equation:

$$\sum_{n=1}^{\infty} = \left(\frac{x_{i-1} + x_i}{2} \right) \times t$$

where x is the mean number of aphids on sample day i, x_{i-1} is the mean number of aphids on the previous sample day, and t is the number of days between samples i - 1 and i.

Yield and statistical analysis. Yields were determined by weighing grain with a grain hopper that rested on a digital scale sensor custom designed for each of the three harvesters. Yields were corrected to 13% moisture and reported as bushels/acre. One-way analysis of variance (ANOVA) was used to determine treatment effects within each experiment. The impact of treatments applied within each experiment on accumulation of aphid days was determined using log-transformed data to meet the assumptions of ANOVA. Means separation for all studies was achieved using a least significant difference test ($P \leq 0.05$). Treatment impacts on yield were determined using untransformed data. All statistical analysis was performed using SAS® software.

Results and Discussion

During the 2009 growing season, foliar insecticides were applied to the zero aphid plots three times (July 23, August 6, and September 1) while other treatments were sprayed on August 6 (Table 1). Soybean aphid populations averaged 10/plant two days prior to the August 6 application. In general, soybean aphid populations in the untreated control plots peaked on September 11 at 787 aphids/plant. The zero aphid control did statistically reduce cumulative aphid days compared with the other insecticide treatments; however, the yield was not statistically higher than most single application treatments (Table 2; Figure 1). The foliar applied insecticides we tested provided similar levels of soybean aphid control and yield protection (Table 2; Figure 1). Overall, a single application of a foliar insecticide provided as much yield protection as three applications applied in the zero aphid treatment. Soybean aphids reached over 10,100 cumulative aphid days in the untreated control treatment.

In 2009, aphid populations measured in untreated control plots reached 10,000 cumulative aphid days at the Northeast Research Farm. This is considered very significant pressure and is approximately three to six times greater exposure than in 2008. As with previous soybean aphid efficacy evaluations, there are few differences in performance among most of the foliar insecticides.

Our recommendation for soybean aphid management is to continue to scout your fields and to apply foliar insecticides when populations exceed 250 aphids/plant (see Ragsdale et al. 2007 for a more detailed description). One well-timed foliar application applied after aphids exceed the economic threshold (ET) will protect yield and increase profits in most situations. Rarely is the ET exceeded twice in a single season and would require multiple applications. We are not recommending seed-applied insecticides (i.e., seed treatments) for aphid management, and we are not recommending one insecticide over another. Most foliar insecticides are very effective at reducing soybean aphid populations if the coverage is sufficient. At this time, achieving small droplet size to penetrate a closed canopy may be the biggest challenge to manage soybean aphid.

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Table 1. Aphid trial, 2009 treatments and rates at Floyd County, IA.

Treatment	Rate[1]	Active ingredient	Target application[2]	Stand[3]
Untreated	-------	-----------	-----------	85.8
Zero Aphid[4]	3.2 fl oz	λ-cyhalothrin	<5 aphids/plant	83.8
	8 fl oz	chlorpyrifos		
Cruiser Maxx	56 g	thiamethoxam	ST	83.1
+ Warrior II[5]	1.6 fl oz	λ-cyhalothrin		
Endigo	3.5 fl oz	thiamethoxam + λ-cyhalothrin	Aug 6	86.5
Warrior II	1.6 fl oz	λ-cyhalothrin	Aug 6	84.3
CMT 560[6]	5 fl oz	spirotetramat + imidacloprid	Aug 6	91.6
CMT 560[6]	6 fl oz	spirotetramat + imidacloprid	Aug 6	93.1
Trilex 6000[6]		trifloxystrobin + metalaxyl	ST	87.0
+ CMT 560	6 fl oz	spirotetramat + imidacloprid	July 23	
Trilex 6000[6]		trifloxystrobin + metalaxyl	ST	83.2
+ CMT 560	6 fl oz	spirotetramat + imidacloprid	Aug 6	
Trilex 6000		trifloxystrobin + metalaxyl	ST	85.9
+ CMT 560	6 fl oz	spirotetramat + imidacloprid	Aug 6	
+ USF0731[7]	2 lb	N/A	Aug 6	
Trilex 6000[6]		trifloxystrobin + metalaxyl	ST	85.9
+ Temprid	3 fl oz	imidacloprid + β-cyfluthrin	Aug 6	
Trilex 6000[6]		trifloxystrobin + metalaxyl	ST	86.0
+ Temprid	3 fl oz	imidacloprid + β-cyfluthrin	Aug 6	
+ USF0731[7]	4 fl oz	N/A	Aug 6	
Asana XL	9.6 fl oz	esfenvalerate	Aug 6	82.8
Hero	5 fl oz	ζ-cypermethrin + bifenthrin	Aug 6	82.8
Nufos	24 fl oz	chlorpyrifos	Aug 6	89.3
Dimethoate	8 fl oz	dimethoate	Aug 6	87.7
Declare	1.02 fl oz	γ-cyhaolothrin	Aug 6	85.1
Declare	1.28 fl oz	γ-cyhaolothrin	Aug 6	84.3
Declare	1.5 fl oz	γ-cyhaolothrin	Aug 6	77.9
Declare	1.28 fl oz	γ-cyhaolothrin	Aug 6	82.9
+ Nufos	24 fl oz	chlorpyrifos	Aug 6	
Tombstone Helios	2.6 fl oz	cyfluthrin	Aug 6	86.3
Belay	3 fl oz	clothianidin	Aug 6	81.3
Belay	6 fl oz	clothianidin	Aug 6	84.3
Lorsban 4E	16 fl oz	chlorpyrifos	Aug 6	86.9
Lorsban Advanced	16 fl oz	chlorpyrifos	Aug 6	83.0

[1]Foliar product rates are given as formulated product/acre, and seed treatments are given as grams active ingredient/100 kg seed.
[2]ST = Seed treatment.
[3]Reported stand number is given as the number of plants/10 ft of row.
[4]Treated with insecticides three times (July 23, August 6, September 1).
[5]Treated September 1 (7 aphids/plant).
[6]Crop oil and Ammonium Sulfate were included as adjuvants and formulated at a rate of 1 qt/acre and 2 lb/acre, respectively.
[7]Pesticide unlabeled at the time of this publication.

Table 2. Aphid trial, 2009 cumulative aphid day exposure and yield at Floyd County, IA.

Treatment	CAD ± SEM	CAD - LSD	Yield ± SEM	Yield – LSD[1]
Untreated	10150.5 ± 1534.7	k	57.2 ± 1.8	ef
Zero Aphid[2]	51.1 ± 10.0	a	62.9 ± 1.4	abcd
Cruiser Maxx + Warrior II[3]	5713.7 ± 538.7	jk	58.5 ± 1.2	def
Endigo	392.7 ± 90.6	b	61.1 ± 1.1	abcdef
Warrior II	820.8 ± 252.8	cdefg	64.1 ± 2.2	abc
CMT 560[4]	2849.0 ± 622.7	c	59.2 ± 1.8	cdef
CMT 560[4]	2223.5 ± 508.1	hi	56.7 ± 1.8	f
Trilex 6000[4] + CMT 560	3800.1 ± 1034.3	ij	64.0 ± 2.2	ab
Trilex 6000[4] + CMT 560	1130.5 ± 248.7	g	63.0 ± 0.8	abcd
Trilex 6000 + CMT 560 + USF0731[5]	1005.9 ± 339.8	efg	65.8 ± 1.8	a
Trilex 6000[4] + Temprid	917.6 ± 136.3	fg	58.9 ± 2.4	def
Trilex 6000[4] + Temprid + USF0731[5]	539.0 ± 129.9	bcde	65.3 ± 1.9	ab
Asana XL	396.0 ± 48.5	bc	63.5 ± 2.0	abcd
Hero	439.0 ± 64.1	bcd	64.5 ± 2.8	ab
Nufos	433.2 ± 24.0	bcd	62.1 ± 1.2	abcde
Dimethoate	3922.9 ± 836.6	ij	57.5 ± 2.7	ef
Declare	665.2 ± 92.3	cdefg	62.8 ± 2.2	abcd
Declare	479.4 ± 68.9	bcde	63.5 ± 2.0	abcd
Declare	410.0 ± 113.4	b	60.3 ± 2.3	bcdef
Declare + Nufos	495.8 ± 102.7	bcde	62.1 ± 2.0	abcde
Tombstone Helios	517.9 ± 49.9	bcdef	62.5 ± 2.6	abcd
Belay	4843.5 ± 826.9	j	58.5 ± 2.7	def
Belay	3750.7 ± 731.3	ij	58.7 ± 2.7	def
Lorsban 4E	756.7 ± 59.4	defg	61.3 ± 2.1	abcdef
Lorsban Advanced	1345.8 ± 337.8	gh	61.2 ± 1.2	abcdef

[1]Least significant difference (LSD). Means labeled with a unique letter were significantly different (P = 0.05).
[2]Treated with insecticides three times (July 23, August 6, September 1).
[3]Treated September 1 (7 aphids/plant).
[4]Crop oil and Ammonium Sulfate were included as adjuvants.
[5]Pesticide unlabeled at the time of this publication.