Evaluation of Organic Pest Management Treatments for Bean Leaf Beetle and Soybean Aphid – Neely-Kinyon Trial, 2011

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Introduction

Annual organic soybean [*Glycine max* (L.) Merr.] production in the U.S. has risen to more than 150,000 acres (USDA-AMS, 2010). Critical challenges associated with organic soybean production include weed control and bean leaf beetles (*Cerotoma trifurcata* Förster) – primarily as vectors for the seed-staining bean pod mottle virus (BPMV) and for providing sites for other seed-staining fungi such as purple stain [*Cercospora kikuchii* (Mastsumoto & Tomoyasu) M.W. Gardener] and *Fusarium* spp. Bean leaf beetles generally have two generations a year in Iowa, with over-wintering adults from the previous year's second generation primarily feeding on vegetative soybean stages. First-generation adults, which require an average of 1,212 degree days with a developmental base threshold of 46 °F, usually peak during the early reproductive soybean stage (Lam et al., 2001). Second-generation adults, whose numbers are dependent on the first-generation population size, peak during the pod-filling stage. Feeding by first-generation beetles on soybean leaves seldom results in economic yield losses, but when the second-generation adults emerge from the soil to feed on seed pods, crop damage in late summer can be very significant. The second-generation adults overwinter in the soil and leaf litter where they remain until spring of the following year. The severity of the over-wintering period is a key factor in determining insect survival, with snow cover (Lam and Pedigo, 2000a) and woodland areas (Lam and Pedigo, 2000b) aiding survival. Both generations of bean leaf beetles can transmit the BPMV, although disease incidence is generally greater during pod setting and filling because higher amounts of rainfall often create ideal conditions for spreading the disease. BPMV has been reported to cause yield losses >50% and in 1999, it was estimated that soybean yield losses reached 155,778 metric tons in Iowa due to soybean viruses. The soybean aphid (*Aphis glycines* Matsumura) is native to China and Japan, and was a new pest in Iowa in 2000. Soybean aphid can reduce yields by direct feeding, and interfering with photosynthesis and growth. Natural enemies, including beneficial fungi, such as *Pandora neoaphidis*, can infect aphids and give them a red color. Spraying fungicides can decrease the activity of this beneficial fungus.

The majority of organic crops grown in Iowa are soybeans destined for the Japanese and domestic tofu and soymilk market. These soybeans are bred for a specific seed size and protein requirement. In addition, the Japanese market requires a white seed color, which is more of an aesthetic than food quality distinction. Producers became concerned and requested assistance from Land Grant Universities when the rejection rate for stained organic tofu beans began increasing in 2000. The amount of stained soybean seed increased from northeast to southwest Iowa because of warmer winter temperatures in the southern counties of the state. Stained soybean seed is currently rejected for food-grade markets (e.g., tofu), but increasing demand for organic meat and a small premium for organic feed-grade soybean has encouraged producers to continue growing the crop. Reducing the extent of soybean staining was of great economic importance to organic producers who rely on the premiums associated with unstained seed.

Regulations governing organic production require an integrated systems approach to pest management, including biological insect control for managing most insect pests. Natural enemies of the bean leaf beetle include ectoparasites that primarily feed on larvae in the soil include mites [*Trombidium hyperi* (Acari: Trombidiidae)] and the parasitic fly, *Medina* n. sp. (Diptera: Tachinidae). In addition, enhancement of soil organic matter is required by organic standards, as healthy soil containing beneficial soil microbial populations is associated with improved plant health and increased pest resistance or tolerance.

The use of several organic-compliant pest management treatments was reported by organic farmers to help manage bean leaf beetles and reduce transmission of virus or fungal agents responsible for seed coat staining. Our objectives in this experiment were to examine the effect of organic–compliant pest management treatments currently in use by organic farmers for management of bean leaf beetle populations and soybean staining. Natural products tested included soil and plant leaf treatments, in addition to insecticidal products. Products tested varied over the years based on recommendations by the Organic Agriculture Advisory Committee who met annually to review results and recommend changes, including new products with reported efficacy against bean leaf beetles. In addition, soybean varieties were evaluated for preference by bean leaf beetles and propensity for staining.

Materials and Methods

In the insect management treatment trial, Blue River 29AR9 soybean aphid-resistant soybeans were planted at the Neely-Kinyon Farm on May 19, 2011, at a rate of 200,000 seeds/acre. The experimental design consisted of a randomized complete block design of five treatments with four replications of each in plots measuring 20 x 10 feet with a 5-foot border between plots. The following treatments were studied: PyGanic® (McLaughlin Gormley King Corp, Minneapolis, MN) at 1.6 quart/acre, Neemix® (Certis USA, LLC, Columbia, MD) applied at 0.46 quart/acre, Neem Blend 45™ (karanja and neem oils) (Green Dance World Organics, Paw Paw, MI) at 0.23 quart/acre, MicroAF (TerraMax, Inc., Ham Lake, MN) at 0.23 quart/acre, and a control (no sprays). Plots were maintained with three rotary hoeings on May 30, June 2 and June 6, and three row cultivations on June 15, 20 and 29. Treatments were applied every 2 weeks from July 1 to August 10. Pest and beneficial insect sampling occurred on alternate weeks from July 8 to September 11. Soybeans were harvested on October 4. The percentage of stained soybeans was determined by previously described methods.

Results and Discussion

Peak aphid populations were observed on August 18, when aphid populations averaged 1 aphid per 8 sweeps across all treatments, which was 0.28% of 2008 levels when aphid populations peaked at 337 aphids per 8 sweeps in the non-aphid-resistant variety on August 22, 2008 (Table 1). The Neemix® plots had significantly higher aphid populations than all other treatments when aphid populations peaked on August 18, averaging 2.25 aphids per 8 sweeps and 0.50 aphids per 8 sweeps, respectively. The average seasonal aphid population was 0.50 aphids per 8 sweeps, dramatically lower than 2008 levels of 89 aphids per 8 sweeps.

Peak bean leaf beetle populations observed on August 5 averaged 29 beetles per 8 sweeps across all treatments (Table 2). In 2011, there were no significant differences in bean leaf beetle populations on any of the sampling dates in 2011. The seasonal average for bean leaf beetles was 12 beetles per 8 sweeps over the course of the summer, compared to 10 beetles per 8 sweeps in 2008 (Table 2).

Beneficial insect populations peaked on August 5, averaging 23 insects per 8 sweeps, with seasonal averages at 9 insects per 8 sweeps (Table 3). There were no significant differences among treatments, signifying minimal effect from the organic insecticides on natural enemies. Beneficial arthropods found in 2011 included minute pirate bugs (MPB), spiders, lady beetles, lacewings, damsel bugs, parasitic wasps, and assassin bugs.

Pest insect populations peaked on August 5, the same date as the beneficial insect peak (Table 4). Pest insect populations on that date averaged 95 insects per 8 sweeps, with seasonal averages at 42 insects per 8 sweeps. No significant differences were found among treatments. Pest insects found in 2011 included bean leaf beetles, aphids, corn rootworms, grasshoppers, leafhoppers, thrips, and weevils.

Yields of the new, aphid-resistant soybean variety were excellent in 2011, averaging 59 bu/acre, with no significant differences among treatments (Table 5). No soybean diseases were observed in sufficient quantities, including no signs of soybean rust. Seed staining averaged 9.0% with no significant differences among treatments (Table 5). There were no significant differences in grain quality among treatments in 2011 (Table 5). Grain quality was excellent, with an average protein content of 35%, 18% oil, and 24% carbohydrates. The trial will be repeated in 2012 with organic–compliant treatments.

References

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Table 1. Aphid populations per 8 sweeps, 2011.

Treatment	8 July	20 July	5 Aug.	18 Aug.	11 Sept.	Seasonal Average
Control	0.00b	0.25	1.25	1.00ab	1.50	0.80
PyGanic®	1.00a	0.00	1.00	0.25b	0.75	0.60
Neemix®	0.00b	0.00	0.00	2.25a	1.00	0.65
Neemix Blend 45™	0.50ab	0.00	0.00	0.50b	0.00	0.20
Micro AF®	0.00b	0.00	0.00	0.75b	0.50	0.25
$LSD_{0.05}$	0.67	NS	NS	1.31	NS	NS

[z]Means within a column are not significantly different (NS), or significantly different at $p \leq 0.05$ (Fisher's protected LSD test).

Table 2. Bean leaf beetle populations per 8 sweeps, 2011.

Treatment	8 July	20 July	5 Aug.	18 Aug.	11 Sept.	Seasonal Average
Control	0.50	5.50	21.25	3.00	24.75	11.00
PyGanic®	0.75	3.75	31.25	4.00	24.75	12.90
Neemix®	1.25	3.75	32.75	3.00	18.50	11.85
Neemix Blend 45™	1.00	3.25	31.25	2.25	23.50	12.25
Micro AF®	1.00	1.25	26.25	2.00	24.00	10.90
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS

[z]Means within a column are not significantly different (NS), or significantly different at $p \leq 0.05$ (Fisher's protected LSD test).

Table 3. Total beneficial insect populations per 8 sweeps, 2011.

Treatment	8 July	20 July	5 Aug.	18 Aug.	11 Sept.	Seasonal Average
Control	10.75	3.25	22.75	14.00	3.00	10.75
PyGanic®	9.25	4.00	18.50	10.00	2.25	8.80
Neemix®	6.25	3.50	22.75	8.00	2.75	8.65
Neemix Blend 45™	7.50	2.50	18.25	11.67	1.25	8.23
Micro AF®	6.00	5.00	34.00	7.25	2.00	10.85
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS

[z]Means within a column are not significantly different (NS), or significantly different at $p \leq 0.05$ (Fisher's protected LSD test).

Table 4. Total pest insect populations per 8 sweeps, 2011.

Treatment	8 July	20 July	5 Aug.	18 Aug.	11 Sept.	Seasonal Average
Control	29.50	19.50	73.50	43.00	37.00	40.50
PyGanic®	24.50	9.00	73.75	49.00	34.25	38.10
Neemix®	26.75	12.75	95.00	33.75	25.00	38.65
Neemix Blend 45™	27.00	16.50	103.50	41.50	32.50	44.20
Micro AF®	30.25	8.25	128.75	40.25	31.00	47.70
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS

[z]Means within a column are not significantly different (NS), or significantly different at $p \leq 0.05$ (Fisher's protected LSD test).

Table 5. Soybean grain quality and staining parameters, 2011.

Treatment	Yield (bu/acre)	Staining (%)	Grain moisture (%)	Protein (%)	Oil (%)	Fiber (%)	Carbos
Control	58.46	9.20	8.73	35.48	17.83	4.85	23.85
PyGanic®	55.54	9.00	8.93	35.34	17.78	4.88	24.01
Neemix®	57.29	11.95	8.90	35.45	17.60	4.88	24.07
Neemix Blend 45™	59.97	8.73	8.65	35.13	17.90	4.89	24.09
Micro AF®	62.85	5.95	8.55	35.35	17.70	4.88	24.07
LSD $_{0.05}$	NS	NS	NS	NS	NS	NS	NS

[z]Means within a column are not significantly different (NS), or significantly different at $p \leq 0.05$ (Fisher's protected LSD test).