Evaluation of Organic Pest Management Treatments for Bean Leaf Beetle and Soybean Aphid – Neely-Kinyon Trial, 2012

Kathleen Delate, professor
Ryan Rice and Ning Wang,
research assistants
Departments of Horticulture & Agronomy
Kirk Schwarte, ag specialist

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 22, 2012, at a rate of 175,000 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) (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 June 1, June 8 and June 13, and four row cultivations on June 18, 26 and 29 as well as July13. The plots were also “walked” once to remove weeds on July 24. Treatments were applied on June 28, July 14, and August 11 and 22. Pest and beneficial insect sampling occurred on July 19, 31 and August 17. Soybeans were harvested on October 8. The percentage of stained soybeans was determined by previously described methods.

Results and Discussion

Yields of the new, aphid-resistant soybean variety were excellent in 2012, averaging 49.5 bu/acre, with no significant differences among treatments (Table 1). This represented a 17% decrease in yield

from 2011, due to the drought of 2012. There were no significant differences in grain quality among treatments in 2012 (Table 2). Grain quality was excellent, with an average protein content of 35%, 19.4% oil, and 22.9% carbohydrates.

Pest insects found in 2012 included aphids, bean leaf beetles, whiteflies, thrips, corn rootworms, grasshoppers, leafhoppers, and tarnished plant bugs. Peak aphid populations were observed on July 31, when aphid populations averaged 1.2 aphids per 8 sweeps across all treatments, which was 0.36% of 2008 levels when aphid populations peaked at 337 aphids per 8 sweeps in the non-aphid-resistant variety on August 22, 2008 (Tables 3-8). There were no differences in aphid populations between treatments in 2012. The average seasonal aphid population was 1.3 aphids per 8 sweeps, dramatically lower than 2008 levels of 89 aphids per 8 sweeps with susceptible varieties.

Peak bean leaf beetle populations observed on July 19 averaged 1.75 beetles per 8 sweeps across all treatments (Table 3). In 2012, there were no significant differences in bean leaf beetle populations on any of the sampling dates. The seasonal average for bean leaf beetles was approximately one beetle (0.7) per 8 sweeps over the course of the summer, compared to 12 beetles per 8 sweeps in 2011.

Beneficial insect populations peaked on July 31, averaging 18.9 insects per 8 sweeps, with seasonal averages at 9 insects per 8 sweeps (Table 3). There were no significant differences between the organic pest management treatments and the control plots, signifying minimal effect from the organic insecticides on natural enemies. On July 31, the average total beneficial insects in the karanja oil + neem treatment, at 33 beneficials/8 sweeps, were greater than those observed in the other spray treatments, which averaged 14 beneficials/8 sweeps. Beneficial arthropods found in 2012 included minute pirate bugs (MPB), spiders, lacewings, damsel bugs (nabids), parasitic wasps, and green lacewings.

Whitefly and thrips populations were greater in 2012 than in 2011 due to the dry weather. Whitefly populations peaked on July 31, averaging 85.5 whiteflies/8 sweeps across all treatments, but significantly less whiteflies were observed in Pyganic plots compared with the control, Micro AF and karanja oil + neem plots (Tables 4, 6, 8). Thrips populations peaked on July 31, averaging 262 thrips/8 sweeps across all treatments. Seasonal thrips averages were 102 insects per 8 sweeps. No significant differences were found among treatments. In other comparisons, there were less leafhoppers in the Neemix and Pyganic treatments compared to the controls on August 17 (Table 8).

No soybean diseases were observed in sufficient quantities, including no signs of soybean rust. Although no seed staining was determined in 2012, when BLB populations averaged 12 beetles/8 sweeps in 2011, seed staining was 1.1%, suggesting seed staining would be even less in 2012 when the average beetle population was much lower. The trial will be repeated in 2013 with organic–compliant treatments.

References

Delate, K., M. Duffy, C. Chase, A. Holste, H. Friedrich, and N. Wantate. 2003. An economic comparison of organic and conventional grain crops in a long-term agroecological research (LTAR) site in Iowa. The American Journal of Alternative Agriculture Vol. 18 (2): 59–69.

Lam, W-K. F., and L. P. Pedigo. 2000a. Cold tolerance of overwintering bean leaf beetles (*Coleoptera: Chrysomelidae*). Environ-entomol. 29(2):157-163.

Lam, W-K. F., and L. P. Pedigo. 2000b. A predictive model for the survival of overwintering bean leaf beetles (*Coleoptera: Chrysomelidae*). Environ-entomol. 29(4):800-806.

Lam, W-K. F., L. P. Pedigo, and P.N. Hinz. 2001. Population dynamics of bean leaf beetles (*Coleoptera: Chrysomelidae*) in central Iowa. Environ. Entomol. 30(3):362-367.

USDA-NOP (National Organic Program). 2010. http://www.ams.usda.gov/nop/indexIE.htm

Acknowledgments

We would like to thank the Leopold Center for Sustainable Agriculture for their support of the Neely-Kinyon organic sites. We also thank the Wallace Foundation for their support. Thanks also go to Grace Wang, Evan Duyvejonck, Jordan Garvey and Justin Kuzila for their help on production, data collection, and analytical aspects of this project. We also thank Blue River Hybrids, Kelly, IA; and Marrone Bio-Innovations, Inc., Davis, CA. Appreciation is expressed to Charles Hurburgh and Glen Rippke of the Grain Quality Lab, ISU.

Table 1. Soybean yield in the Soybean Pest Management experiment, Neely-Kinyon Farm, 2012.

Rotation	Yield (bu/acre)
Control	49.50
Karanja oil + neem	53.28
Micro AF	45.72
Neemix	46.72
Pyganic	52.30
$LSD_{0.05}$	NS

Table 2. Soybean grain quality in the Soybean Pest Management experiment, Neely-Kinyon Farm, 2012.

Rotation	Moisture (%)	Protein (%)	Oil (%)	Fiber (%)	Carbohydrates (%)
Control	8.05	35.05	19.43	4.72	22.81
Karanja oil + neem	7.99	34.99	19.35	4.73	22.93
Micro AF	7.98	35.20	19.34	4.71	22.75
Neemix	8.15	34.93	19.40	4.74	22.94
Pyganic	7.95	35.05	19.40	4.72	22.83
$LSD_{0.05}$	NS	NS	NS	NS	NS

Table 3. Key soybean pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 7-19-2012 (number per 8 sweeps).

Rotation	Aphids	Bean leaf beetles	Thrips	Corn rootworms	Minute pirate bugs	Spiders	Total beneficial insects
Control	0.50	1.25	14.25	1.25	0.50	1.00	4.50
Karanja oil & neem	1.00	2.50	23.75	1.00	0.75	1.50	6.00
Micro AF	0.50	1.50	19.00	1.00	0.25	1.75	5.75
Neemix	1.00	1.75	29.25	1.00	0.50	1.50	8.25
Pyganic	0.75	1.75	38.00	1.25	0.25	1.75	8.50
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Table 4. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 7-19-2012 (number per 8 sweeps).

Rotation	Nabids	Whiteflies	Grass-hoppers	Green lacewings	Leaf-hoppers	Tarnished plant bugs	Wasps
Control	0.50	8.75	0.00	0.00	1.50	0.50	0.25
Karanja oil & neem	0.50	20.50	0.25	0.00	0.75	0.00	1.75
Micro AF	1.00	18.25	0.00	0.25	0.75	0.25	1.00
Neemix	0.00	13.50	0.75	0.00	0.25	0.25	2.00
Pyganic	0.25	22.75	1.25	0.00	1.75	0.25	1.00
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Table 5. Key pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 7-31-2012 (number per 8 sweeps).

Rotation	Aphids	Bean Leaf Beetles	Thrips	Corn rootworms	Minute pirate bugs	Spiders	Total beneficial insects
Control	1.00	0.50	239.75	0.50	9.50	2.75	20.25ab
Karanja oil + neemix	1.50	0.25	388.50	0.75	13.00	3.00	33.00a
Micro AF	2.25	0.25	285.75	0.00	3.75	1.25	15.75b
Neemix	1.25	0.25	231.75	1.00	7.00	1.50	13.25b
Pyganic	0.00	0.25	163.00	0.50	5.25	2.75	12.25b
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	14.87

Table 6. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 7-31-2012 (number per 8 sweeps).

	Whiteflies	Grass-hoppers	Leaf-hoppers	Tarnished plant bugs	Nabids	Green lacewings	Wasps
Control	92.25ab	0.25	1.50	0.75	0.25	0.50	2.25
Karanja oil + Neemix	114.50ab	0.50	2.75	0.50	0.50	0.25	2.75
Micro AF	119.25a	0.75	2.00	1.75	1.25	0.50	1.50
Neemix	71.25bc	0.75	2.50	0.75	0.50	0.50	0.50
Pyganic	30.25c	2.25	0.00	0.50	0.50	0.00	0.50
$LSD_{0.05}$	45.75	NS	NS	NS	NS	NS	NS

Table 7. Key pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 8-17-2012 (number per 8 sweeps).

Rotation	Aphids	Bean leaf beetles	Thrips	Corn rootworms	Minute pirate bugs	Spiders	Total beneficial insects
Control	0.25	0.00	18.75	1.00	4.25	1.25	8.25
Karanja oil & Neemix	0.50	0.25	19.75	0.25	1.75	0.00	4.75
Micro AF	0.25	0.00	16.00	0.50	2.75	2.00	7.75
Neemix	0.50	0.00	18.50	1.25	3.50	1.75	8.00
Pyganic	0.25	0.00	19.75	0.25	1.75	1.50	7.50
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Table 8. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 8-17-2012 (number per 8 sweeps).

Rotation	Whiteflies	Grass-hoppers	Leaf-hoppers	Tarnished Plant bugs	Nabids	Green lacewings	Wasps
Control	10.00	0.25	2.25a	0.00b	0.00	1.00	1.00
Karanja oil & Neemix	7.25	1.25	1.25abc	0.25b	0.00	1.00	0.50
Micro AF	11.25	0.25	2.00ab	1.00a	0.50	1.00	1.00
Neemix	9.50	0.25	0.50c	0.00b	0.25	0.75	0.50
Pyganic	8.00	1.25	1.00bc	0.00b	0.00	1.00	1.00
$LSD_{0.05}$	NS	NS	1.14	0.65	NS	NS	NS