Evaluation of Organic Pest Management Treatments for Bean Leaf Beetle and Soybean Aphid, Neely-Kinyon-2014

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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-ERS, 2005). Critical challenges associated with organic soybean production include weed control, bean leaf beetles (*Cerotomatrifurcata*Förster), soybean aphid (*Aphis glycines* Matsumura), and soybean diseases, including the potential for soybean rust. Bean leaf beetle primarily vectors the seed-staining bean pod mottle virus (BPMV) and for providing sites for other seed-staining fungi such as purple stain [*Cercosporakikuchii* (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 had 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

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 [*Trombidiumhyperi*(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

Blue River 30C3 soybean aphid-resistant soybeans were planted at the Neely-Kinyon Farm on May 31, 2014, at a rate of 174,000 seeds/acre. The experimental design consisted of a randomized complete block design of four 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 45TM (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 rotary hoeings on June 11 and 13 and row cultivations on June 24, July 9, and July 16. Soybeans were “walked” on August 19 to remove any remaining weeds. Treatments were applied on July 10, 22, and August 10. Pest and beneficial insect sampling occurred on July 17, 29, and August17. Soybeans were harvested on October 26. Soybean grain quality was determined at the ISU Grain Quality Lab (Ames, IA).

Results and Discussion

Yields in the organic soybean trial were excellent in 2014, averaging 69bu/acre over all treatments (Table 1), with no

significant differences between treatments. Yields were greater than the average of 62 bu/acre in 2013. There also were no significant differences in grain quality among treatments in 2014 (Table 2). Grain quality was excellent for organic soybeans, with an average protein content of 36%, 18% oil, 4.8% fiber, and 24% carbohydrates.

The organic treatments did not affect pest or beneficial insect populations compared to the control (Tables 3-8). The seasonal average aphid population was less than 1 aphid per 8 sweeps, with peak aphid populations averaging 1 aphid per 8 sweeps on July 29 (Table 3), compared to 337 aphids per 8 sweeps on the non-resistant soybean variety, BR 34A7, in 2008. These averages were lower than the 2013 aphid populations of 6 aphids per 8 sweeps. The seasonal average bean leaf beetle population was less than 1 beetle per 8 sweeps, and the peak bean leaf beetle population was less than 1 beetle per 8 sweeps on July 29 (Table 5). This compared to an average of less than 1 beetle per 8 sweeps in 2013. In 2014, thrips averaged 2 thrips per 8 sweeps. Peak populations for thrips occurred on July 29 when populations averaged 5 thrips per 8 sweeps. Whiteflies averaged 9 whiteflies per 8 sweeps, which was similar to the average of 8 whiteflies per 8 sweeps in 2013. Peak populations of 19 whiteflies per 8 sweeps occurred on July 29. Corn rootworms were present in all sweeps throughout the season, but averaged less than 1 beetle per 8 sweeps, with no differences among treatments. Highest numerical populations were observed onJuly 29.

The seasonal average of 2 beneficial insects per 8 sweeps, with the July17 peak population of 2 beneficial insects per 8 sweeps included numerous species of beneficial insects collected over the season. The most predominant beneficial insect was the minute pirate bug (MPB), *Oriusinsidiosus*, which attacks aphids, whiteflies and thrips. The seasonal average was less than 1 minute pirate bug per 8 sweeps and peak population was 1 minute pirate bug per 8 sweeps on July29. Spiders were also observed at every sampling date and averaged less than 1 per 8 sweeps overall, with peak populations on July 17. Other beneficial insects included wasps, nabids and green lacewings (Tables 3-12).

No soybean diseases were observed in sufficient quantities to warrant comparisons in 2014, including no signs of soybean rust. Seed staining averaged 1.0% (Table 1), which was similar to 2013 data. Although no significant differences in pest and beneficial insects were found among treatments, it was interesting to note the highest pest numbers were observed for whitefliesand thrips, which are more prominent species in drought months. We will continue this trial in 2015 with new organic-compliant products.

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 Meaghan Daley, Levi Graber, Andy Corbett, Andres Glasener, and Bob Turnbull 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 and staining in the Soybean Pest Management experiment, Neely-Kinyon Farm, 2014.

Rotation	Yield (bu/acre)	Staining (%)
Control	74.77	0.81
Karanja oil + Neemix	69.34	1.19
Micro AF	68.50	0.81
Neemix	72.04	1.22
Pyganic	67.45	0.81
$LSD_{0.05}$	NS	NS

Table 2. Soybean grain quality in the Soybean Pest Management experiment, Neely-Kinyon Farm, 2014.

Rotation	Moisture (%)	Protein (%)	Oil (%)	Fiber (%)	Carbohydrates (%)
Control	11.73	35.48	17.93	4.84	23.76
Karanja oil + Neemix	11.78	35.50	18.05	4.82	23.63
Micro AF	11.75	35.38	17.96	4.85	23.81
Neemix	11.75	35.59	18.08	4.81	23.53
Pyganic	11.73	35.49	17.84	4.85	23.82
$LSD_{0.05}$	NS	NS	NS	NS	NS

Table 3. Key pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 7-17-2014 (number per 8 sweeps).

Rotation	Aphids	Bean leaf beetles	Thrips	Corn rootworms	Minute pirate bugs	Spiders	Total beneficial insects
Control	0.25	0.25	1.25	0.25	0.00	1.25	2.00
Karanja oil + Neemix	0.00	0.00	1.33	0.00	0.33	0.33	1.67
Micro AF	1.25	0.00	1.50	0.00	1.00	2.00	4.00
Neemix	0.50	0.00	0.75	0.50	0.25	1.50	2.25
Pyganic	1.00	0.00	1.25	0.00	0.50	1.00	1.75
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Table 4. Other pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 7-17-2014 (number per 8 sweeps).

Rotation	Cater-pillars	Whiteflies	Grass-hoppers	Leaf-hoppers	Tarnished plant bugs	Nabids	Green lacewings	Wasps
Control	0.25	6.00	3.25	0.50	0.50	0.25	0.50	0.25
Karanja oil + Neemix	0.00	5.00	1.67	1.00	0.00	0.00	1.00	0.00
Micro AF	0.50	8.25	2.50	1.50	1.00	0.25	0.50	0.25
Neemix	0.00	6.75	1.75	1.00	0.75	0.00	0.25	0.25
Pyganic	0.00	6.75	2.75	1.25	0.00	0.00	0.00	0.25
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Key pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 7-29-2014 (number per 8 sweeps).

Rotation	Aphids	Bean leaf beetles	Thrips	Corn rootworms	Minute pirate bugs	Spiders	Total beneficial insects
Control	0.50	1.25	3.00	0.75	1.25	0.75	2.00
Karanja oil + Neemix	1.25	0.50	3.50	0.25	1.25	0.00	1.75
Micro AF	1.50	0.50	7.50	0.50	1.75	0.75	2.75
Neemix	1.00	0.25	3.00	1.50	1.00	0.75	2.50
Pyganic	1.25	0.50	4.25	0.25	0.75	0.50	1.50
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Table 6. Other pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 7-29-2014 (number per 8 sweeps).

Rotation	Cater-pillars	Whiteflies	Grass-hoppers	Leaf-hoppers	Tarnished plant bugs	Nabids	Green lacewings	Wasps
Control	0.00	19.75	2.00	1.50	0.50	0.00	0.00	0.00
Karanja oil + Neemix	0.25	17.25	1.25	1.50	0.50	1.00	0.00	0.00
Micro AF	0.00	30.50	1.00	1.50	0.50	0.25	0.00	0.00
Neemix	0.00	11.00	2.75	0.25	0.50	0.25	0.25	0.00
Pyganic	0.00	14.50	3.00	0.50	0.25	0.25	0.00	0.00
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	-

Table 7. Key pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 9-18-2014 (number per 8 sweeps).

Rotation	Aphids	Bean leaf beetles	Thrips	Corn rootworms	Minute pirate bugs	Spiders	Total beneficial insects
Control	0.75	0.00	0.00	0.25	0.50	0.50	1.00
Karanja oil + Neemix	0.33	0.00	0.67	0.33	1.33	0.33	2.00
Micro AF	0.25	0.25	0.25	0.00	0.75	0.50	1.25
Neemix	0.00	0.00	1.00	0.00	1.50	0.00	2.00
Pyganic	1.00	0.00	0.25	0.25	1.25	0.00	1.50
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Table 8. Other pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 9-18-2014 (number per 8 sweeps).

Rotation	Cater-pillars	Whiteflies	Grass-hoppers	Leaf-hoppers	Tarnished Plant bugs	Nabids	Green lacewings	Wasps
Control	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Karanja oil + Neemix	0.00	1.67	0.33	0.33	0.33	0.33	0.00	0.00
Micro AF	0.00	0.25	0.50	0.25	0.25	0.00	0.00	0.00
Neemix	0.25	0.50	0.25	0.25	0.00	0.25	0.00	0.00
Pyganic	0.00	0.50	0.75	0.00	0.00	0.25	0.00	0.00
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	-	-