Evaluation of Organic Pest Management Treatments for Bean Leaf Beetle and Soybean Aphid, Neely-Kinyon Farm-2015

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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 (*Cerotoma trifurcata* 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 [*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 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 [*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

Blue River 30C3 organic soybeans were planted at the Neely-Kinyon Farm on June 9, 2015, 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 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 19 and 22 and row cultivations on June 29, July 8, and July 14. Soybeans were “walked” on August 2 to remove any remaining weeds above the canopy. Treatments were applied on July 24, August 18, September 1, September 14, and September 28. A visual pest and beneficial insect count was taken on soybean plants in three randomly-selected 10-ft of row per plot on July 16. Pest and beneficial insect sampling occurred by sweeping two 10-ft rows of soybeans (8 sweeps total) with a 15-inch diameter net on August 10, 25, September 9, and 30. Soybeans were harvested on October 13. Soybean grain

quality was determined at the ISU Grain Quality Lab (Ames, IA).

Results and Discussion

Yields in the organic soybean pest management trial were excellent in 2015, averaging 64.5 bu/acre over all treatments (Table 1), with no significant differences between treatments. Yields were less than the average of 69 bu/acre in 2014. There also were no significant differences in grain quality among treatments in 2015 (Table 2). Grain quality was excellent for organic soybeans, with an average protein content of 36.5%, 19.3% oil, 4.5% fiber, and 21.6% carbohydrates.

Overall, the organic treatments did not affect pest or beneficial insect populations compared to the control (Tables 3-11). The visual count taken on July 16 showed low numbers of insect pests, with aphids averaging less than 2 aphids per 8 sweeps. A lower population of less than 1 aphid per 8 sweeps in the control treatment compared to 3 aphids per 8 sweeps in the Neemix treatment was not biologically significant (Table 3). The seasonal average aphid population was 2 aphids per 8 sweeps, with peak aphid populations averaging 3 aphids per 8 sweeps on August 10 (Table 4), compared to 337 aphids per 8 sweeps on the non-resistant soybean variety, BR 34A7, in 2008. These averages were higher, although not biologically significant, than the 2014 aphid populations of less than 1 aphid per 8 sweeps. The seasonal average bean leaf beetle population was 2 beetles per 8 sweeps, and the peak bean leaf beetle population was 4 beetles per 8 sweeps on September 9 (Table 8). This compared to an average of less than 1 beetle per 8 sweeps in 2014. In 2015, thrips averaged 13 thrips per 8 sweeps. Peak populations for thrips occurred on September 9 when populations averaged 26 thrips per 8 sweeps. This is higher than the 2014 average of 2 thrips per 8 sweeps. Whiteflies averaged 4 whiteflies per 8 sweeps, which was less than the average of 9 whiteflies per 8 sweeps in 2014. Peak populations of 7 whiteflies per 8 sweeps occurred on August 25. Corn rootworms were present in all sweeps throughout the season, and averaged 2 beetles per 8 sweeps, with no differences among treatments. Highest numerical populations were observed on August 25. On August 10, grasshoppoers were lower in the Pyganic treatment compared to the control and Micro AF treatments, but there were no differences among the other treatments (Table 5).

The seasonal average of 4 beneficial insects per 8 sweeps, with the August 25 peak population of 7 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), *Orius insidiosus*, which attacks aphids, whiteflies and thrips. The seasonal average was 2 minute pirate bugs per 8 sweeps and peak population was 4 minute pirate bugs per 8 sweeps on September 9. Spiders were also observed at every sampling date and averaged 1 per 8 sweeps overall, with peak populations on August 25. Other beneficial insects included wasps, nabids and green lacewings (Tables 3-11).

No soybean diseases were observed in sufficient quantities to warrant comparisons in 2015, including no signs of soybean rust. Seed staining averaged 1.1% (Table 12), which was similar to 2014 data. Although differences in pest and beneficial insects were minimal among treatments, it was interesting to note the highest pest numbers were observed for

whiteflies and thrips, which are more prominent species in drought months. We will continue this trial in 2016 with new organic-compliant products.

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Table 1. Yields in the Soybean Pest Management experiment, Neely-Kinyon Farm, 2015.

Treatment	Bu/acre
Control	67.60
Pyganic	62.95
Neemix	62.15
Karanja oil+Neemix	65.27
Micro AF	64.56
$LSD_{0.05}$	NS [z]

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 2. Soybean grain quality in the Soybean Pest Management experiment, Neely-Kinyon Farm, 11/27/15.

Treatment	Moisture (%)	Protein (%)	Oil (%)	Fiber (%)	Carbohydrates (%)
Control	9.03	36.83	19.25	4.53	21.40
Pyganic	9.05	36.30	19.43	4.55	21.73
Neemix	9.03	36.55	19.33	4.53	21.60
Karanja oil+Neemix	9.03	36.38	19.38	4.58	21.70
Micro AF	8.98	36.65	19.33	4.53	21.50
$LSD_{0.05}$	NS [z]	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 3. Visual insect count (numbers per 10 ft of row) in the Soybean Pest Management experiment, Neely-Kinyon Farm, 7/16/15.

Treatment	Bean leaf beetles	Cucumber beetles	Aphids
Control	0.00	0.00	0.17c [y]
Pyganic	0.00	0.08	1.33abc
Neemix	0.00	0.00	2.58a
Karanja oil+Neemix	0.00	0.00	1.58ab
Micro AF	0.00	0.00	1.17bc
$LSD_{0.05}$	--	NS [z]	0.0046

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 4. Key soybean pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 8/10/2015 (number per 8 sweeps).

Treatment	Aphids	Bean leaf beetles	Thrips	Corn rootworm	Minute pirate bugs	Spiders	Total beneficial insects
Control	2.25	1.50	3.75	0.75	1.75	0.75	3.75
Pyganic	2.75	1.00	4.50	0.25	1.75	1.25	4.00
Neemix	3.00	0.50	6.50	0.75	2.25	1.00	4.25
Karanja oil+Neemix	2.50	0.50	6.00	0.50	2.50	0.50	4.00
Micro AF	2.00	1.00	5.25	1.00	4.25	1.25	6.50
$LSD_{0.05}$	NS [z]	NS	NS	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 5. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 8/10/2015 (number per 8 sweeps).

Treatment	Caterpillars	Nabids	Whiteflies	Grasshoppers	Green lacewings	Leafhoppers	Tarnished plant bugs	Wasps
Control	0.25	0.00b[y]	3.75	2.00ab[y]	0.00	1.00	0.00	1.00
Pyganic	0.25	0.00b	7.25	0.25c	0.00	0.50	0.00	0.75
Neemix	0.50	0.25b	3.75	0.75bc	0.00	0.50	0.00	0.50
Karanja oil+Neemix	0.25	0.00b	6.00	1.00bc	0.00	0.00	0.25	0.75
Micro AF	0.00	1.00a	6.25	2.50a	0.00	1.00	0.25	0.75
$LSD_{0.05}$	NS [z]	0.1047	NS	0.0182	--	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 6. Key soybean pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 8/25/2015 (number per 8 sweeps).

Treatment	Aphids	Bean leaf beetles	Thrips	Corn rootworm	Minute pirate bugs	Spiders	Total beneficial insects
Control	2.25	0.75	19.00	3.00	1.75	2.75	4.25
Pyganic	0.75	2.25	22.00	5.50	1.50	3.00	7.50
Neemix	2.00	1.50	15.00	4.75	2.50	3.00	8.50
Karanja oil+Neemix	1.75	1.25	18.00	3.75	1.75	3.75	9.25
Micro AF	3.75	2.00	13.75	6.00	2.00	1.75	5.75
$LSD_{0.05}$	NS [z]	NS	NS	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 7. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 8/25/2015 (number per 8 sweeps).

Treatment	Caterpillars	Nabids	Whiteflies	Grasshoppers	Green lacewings	Leafhoppers	Tarnished plant bugs	Wasps
Control	0.50	0.25	4.50	2.25	0.25	1.50	0.00	0.25
Pyganic	0.50	0.50	7.50	1.25	0.50	0.75	0.00	1.25
Neemix	0.25	0.00	7.00	0.00	0.25	1.00	0.00	2.50
Karanja oil+Neemix	0.25	0.75	10.75	1.00	0.25	1.75	0.50	2.00
Micro AF	0.25	0.50	7.00	1.00	0.25	0.25	0.00	1.25
$LSD_{0.05}$	NS [z]	NS	NS	NS	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 8. Key soybean pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 9/9/2015 (number per 8 sweeps).

Treatment	Aphids	Bean leaf beetles	Thrips	Corn rootworm	Minute pirate bugs	Spiders	Total beneficial insects
Control	1.00	4.00	27.75	2.50	2.75	1.00	3.00
Pyganic	1.25	3.00	23.00	2.00	5.00	1.00	4.00
Neemix	2.00	3.25	31.00	2.75	3.50	1.00	3.25
Karanja oil+Neemix	0.50	2.75	28.00	4.50	3.00	2.75	6.25
Micro AF	2.50	4.75	21.00	3.75	4.25	1.25	4.75
$LSD_{0.05}$	NS [z]	NS	NS	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 9. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 9/9/2015 (number per 8 sweeps).

Treatment	Caterpillars	Nabids	Whiteflies	Grasshoppers	Green lacewings	Leafhoppers	Tarnished plant bugs	Wasps
Control	0.00	1.50	4.50	0.25	0.25	0.75	0.25	0.00
Pyganic	0.00	2.00	1.00	0.25	0.25	0.50	0.00	0.50
Neemix	0.25	0.50	1.50	0.50	0.25	1.25	0.25	0.75
Karanja oil+Neemix	0.25	2.00	2.00	0.00	0.00	0.00	0.00	0.75
Micro AF	0.75	1.00	0.75	0.50	1.50	1.00	0.50	0.25
$LSD_{0.05}$	NS [z]	NS	NS	NS	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 10. Key soybean pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 9/30/2015 (number per 8 sweeps).

Treatment	Aphids	Bean leaf beetles	Thrips	Corn rootworm	Minute pirate bugs	Spiders	Total beneficial insects
Control	0.00	0.75	1.50	0.00	0.00	1.00	1.25
Pyganic	0.00	0.25	1.00	0.25	0.00	0.50	1.25
Neemix	0.00	0.50	1.25	0.50	0.25	0.75	1.50
Karanja oil+Neemix	0.00	0.75	1.25	1.25	0.25	0.75	1.75
Micro AF	0.00	0.50	1.75	0.00	0.25	0.00	0.75
$LSD_{0.05}$	--	NS [z]	NS	NS	NS	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 11. Other pest and beneficial insects in Soybean Pest Management experiment, Neely-Kinyon Farm, 9/30/2015 (number per 8 sweeps).

Treatment	Caterpillars	Nabids	White flies	Grasshoppers	Green lacewings	Leafhoppers	Tarnished plant bugs	Wasps
Control	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.25
Pyganic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
Neemix	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00
Karanja oil+Neemix	0.00	0.00	0.00	0.00	0.00	0.25	1.00	0.25
Micro AF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
$LSD_{0.05}$	--	--	--	--	--	NS [z]	NS	NS

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 12. Soybean staining in the Soybean Pest Management experiment, Neely-Kinyon Farm, 8/18/2015.

Treatment	Stained soybeans (%)
Control	1.16
Pyganic	1.00
Neemix	1.16
Karanja oil+Neemix	1.01
Micro AF	1.13
$LSD_{0.05}$	NS [z]

[z] Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).