

Evaluation of Organic Pest Management Treatments for Bean Leaf Beetle and Soybean Aphid, Neely-Kinyon-2013

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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 overwintering 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 overwintering 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 [*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. We were also interested in monitoring the performance of the new aphid-resistant varieties.

Materials and Methods

Blue River 29AR9 soybean aphid-resistant soybeans were planted at the Neely-Kinyon Farm on May 24, 2013, at a rate of 175,000 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 2 and 12, and row cultivations on June 21, 27, and July 2. Soybeans were “walked” on July 17 to remove any remaining weeds. Treatments were applied on July 3, 17, August 2, 16, and September 3. Pest and beneficial insect sampling occurred on July 10, 24, August 9, 23, and September 10. 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 trial were excellent in 2013, averaging 62bu/acre over all treatments (Table 1), with no significant differences between treatments. Yields were excellent despite the drought. There also were no significant differences in grain quality among treatments in 2013 (Table 2). Grain quality was excellent for organic soybeans, with an average protein content of 35%, 19% oil, 4.7% fiber, and 23% carbohydrates.

Overall, the organic treatments did not affect pest or beneficial insect populations compared to the control, except for 4 out of 75 comparisons (Tables 3-12). The seasonal average aphid population was 6 aphids per 8 sweeps, with peak aphid populations averaging 15 aphids per 8 sweeps on July 24 (Table 5), compared to 337 aphids per 8 sweeps on the non-resistant soybean variety in 2008. These averages were higher than 2012 aphid populations of less than 1 aphid per 8 sweeps. There was only one sampling date, September 10, when aphids were greater in the control (1.25 aphids per 8 sweeps) than in the organic treatments, averaging 0.06 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 August 9. This compared to an average of less than 1 beetle per 8 sweeps in 2012. While the drought did not affect bean leaf beetle populations, thrips increased under dry conditions. In 2013, thrips averaged 4 thrips per 8 sweeps. Peak populations for thrips occurred on July 10 when populations averaged 7 thrips per 8 sweeps. Thrips populations were less than in 2012, when thrips averaged 102 thrips per 8 sweeps. Corn rootworms were present in all sweeps throughout the

season, but averaged only 1 beetle per 8 sweeps, with no differences among treatments. Highest numerical populations were observed on September 10.

The seasonal average of 3 beneficial insects per 8 sweeps, with the August 23 peak population of 5 beneficial insects per 8 sweeps included numerous species of beneficial insects collected over the season. There was only one sampling date, August 9, when there were statistical differences, with the karanja oil + neem having higher numbers of beneficial insects compared to the other treatments. The most predominant beneficial insect was the minute pirate bug (MPB), *Orius insidiosus*, which attacks aphids, whiteflies and thrips. The seasonal average was 1 minute pirate bug per 8 sweeps and peak population was 3 minute pirate bugs per 8 sweeps on August 23. Spiders were also observed at every sampling date and averaged less than 1 per 8 sweeps overall, with peak populations on July 24. Other beneficial insects included wasps, nabids and green lacewings (Tables 3-12).

No soybean diseases were observed in sufficient quantities to warrant comparisons in 2013, including no signs of soybean rust. Seed staining averaged 0.76% (Table 1). With very few significant differences in pest and beneficial insects among treatments, it was interesting to note the highest pest numbers were observed for aphids and thrips, but these populations were very low. We will continue this trial in 2014 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 Evan Duyvejonck, Meaghan Daley, Grace Wang, Ryan Vanderhoff-Yarbrough, Andres Glasener, Allison Dittmer 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 TerraMax, Ham Lake, MN. 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, 10-13-2013.

| Rotation | Yield (bu/acre) | Staining (%) |
|---------------------|--------------------|-----------------|
| Control | 65.17 | 0.75 |
| Karanja oil + Neem | 59.71 | 0.77 |
| Micro AF | 63.32 | 0.67 |
| Neemix | 59.56 | 0.69 |
| Pyganic | 64.08 | 0.90 |
| LSD _{0.05} | NS | NS |

Table 2. Soybean grain quality in the Soybean Pest Management experiment, Neely-Kinyon Farm, 11-8-2013.

| Rotation | Moisture (%) | Protein (%) | Oil (%) | Fiber (%) | Carbohydrates (%) |
|---------------------|-----------------|----------------|------------|--------------|----------------------|
| Control | 11.18 | 35.18 | 19.30 | 4.73 | 22.80 |
| Karanja oil + Neem | 11.48 | 35.00 | 19.30 | 4.73 | 22.98 |
| Micro AF | 11.20 | 35.00 | 19.35 | 4.73 | 22.93 |
| Neemix | 11.38 | 35.03 | 19.50 | 4.70 | 22.80 |
| Pyganic | 11.48 | 35.18 | 19.30 | 4.70 | 22.83 |
| LSD _{0.05} | NS | NS | NS | NS | NS |

Table 3. Key pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 7-10-2013 (number per 8 sweeps).

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn rootworms | Minute pirate bugs | Spiders | Total beneficial insects |
|---------------------|--------|----------------------|--------|-------------------|-----------------------|---------|-----------------------------|
| Control | 0.00 | 0.00 | 6.75 | 0.00 | 1.00 | 0.50 | 2.25 |
| Karanja oil + Neem | 0.67 | 0.00 | 9.33 | 0.00 | 1.00 | 0.00 | 5.00 |
| Micro AF | 0.25 | 0.00 | 10.25 | 0.25 | 0.75 | 0.00 | 2.00 |
| Neemix | 0.00 | 0.00 | 3.75 | 0.00 | 0.00 | 0.00 | 0.50 |
| Pyganic | 0.25 | 0.00 | 6.00 | 0.25 | 0.00 | 0.00 | 2.25 |
| LSD _{0.05} | NS | NS | NS | NS | NS | NS | NS |

Table 4. Other pest and beneficial insects in the Soybean PestManagement experiment, Neely-Kinyon Farm, 7-10-13 (number per 8 sweeps).

| Rotation | Caterpillars | Whiteflies | Grass-hoppers | Leaf-hoppers | Tarnished plant bugs | Nabids | Green lacewings | Wasps |
|---------------------|--------------|------------|---------------|--------------|----------------------|--------|-----------------|-------|
| Control | 0.25 | 8.00 | 2.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 |
| Karanja oil + Neem | 0.25 | 6.67 | 2.00 | 0.33 | 0.67 | 0.00 | 2.00 | 0.67 |
| Micro AF | 0.25 | 6.50 | 1.25 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 |
| Neemix | 0.00 | 3.00 | 1.50 | 0.25 | 0.25 | 0.00 | 0.00 | 0.25 |
| Pyganic | 0.00 | 4.00 | 1.25 | 0.00 | 0.25 | 0.00 | 0.25 | 0.00 |
| LSD _{0.05} | NS | NS | NS | NS | NS | NS | NS | NS |

Table 5. Key pest and beneficial insects in the Soybean PestManagement experiment, Neely-Kinyon Farm, 7-24-13 (number per 8 sweeps).

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn rootworms | Minute pirate bugs | Spiders | Total beneficial insects |
|---------------------|--------|-------------------|--------|----------------|--------------------|---------|--------------------------|
| Control | 18.50 | 0.00 | 2.75 | 0.00 | 0.00 | 0.25 | 0.50 |
| Karanja oil + Neem | 19.50 | 0.00 | 2.50 | 0.00 | 0.00 | 1.00 | 2.00 |
| Micro AF | 16.25 | 0.00 | 2.50 | 0.00 | 0.00 | 0.75 | 0.75 |
| Neemix | 8.00 | 0.00 | 2.00 | 0.00 | 0.50 | 0.25 | 1.25 |
| Pyganic | 11.00 | 0.00 | 1.25 | 0.25 | 0.50 | 0.25 | 1.75 |
| LSD _{0.05} | NS | - | NS | NS | NS | NS | NS |

Table 6. Other pest and beneficial insects in the Soybean PestManagement experiment, Neely-Kinyon Farm, 7-24-13 (number per 8 sweeps).

| Rotation | Caterpillars | Whiteflies | Grass-hoppers | Leaf-hoppers | Tarnished plant bugs | Nabids | Green lacewings | Wasps |
|---------------------|--------------|------------|---------------|--------------|----------------------|--------|-----------------|-------|
| Control | 0.25 | 3.25 | 1.50 | 1.25 | 0.00 | 0.25 | 0.00 | 0.50 |
| Karanja oil + Neem | 0.00 | 1.75 | 0.75 | 0.25 | 0.00 | 0.75 | 0.00 | 0.25 |
| Micro AF | 0.00 | 5.75 | 1.00 | 0.75 | 0.00 | 0.00 | 0.00 | 0.25 |
| Neemix | 0.00 | 1.00 | 0.00 | 0.75 | 0.00 | 0.25 | 0.25 | 0.25 |
| Pyganic | 0.25 | 2.50 | 0.75 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| LSD _{0.05} | NS | NS | NS | NS | - | NS | NS | NS |

Table 7. Key pest and beneficial insects in the Soybean PestManagement experiment, Neely-Kinyon Farm, 8-9-13 (number per 8 sweeps).

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn rootworms | Minute pirate bugs | Spiders | Total beneficial insects |
|---------------------|--------|-------------------|--------|----------------|--------------------|---------|--------------------------|
| Control | 11.00 | 1.25 | 2.50 | 0.25 | 0.00 | 0.25 | 1.75±0.51b |
| Karanja oil + Neem | 6.25 | 0.50 | 3.75 | 0.00 | 1.00 | 0.75 | 3.50±0.51a |
| Micro AF | 2.75 | 1.50 | 3.75 | 0.00 | 0.25 | 0.50 | 1.25±0.51b |
| Neemix | 9.75 | 0.50 | 4.75 | 0.50 | 0.50 | 0.00 | 1.00±0.51b |
| Pyganic | 3.00 | 0.25 | 2.75 | 0.00 | 0.50 | 0.00 | 1.50±0.51b |
| LSD _{0.05} | NS | NS | NS | NS | NS | NS | 0.2179 |

Table 8. Other pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 8-9-13 (number per 8 sweeps).

| Rotation | Caterpillars | Whiteflies | Grasshoppers | Leafhoppers | Tarnished Plant bugs | Nabids | Green lacewings | Wasps |
|----------------------|--------------|------------|--------------|-------------|----------------------|--------|-----------------|-------|
| Control | 0.75 | 22.00 | 0.25 | 0.50 | 0.00 | 0.50 | 0.00 | 1.00 |
| Karanja oil + Neemix | 0.25 | 34.50 | 0.50 | 0.25 | 0.00 | 0.25 | 0.25 | 1.00 |
| Micro AF | 0.50 | 19.25 | 0.50 | 0.25 | 0.00 | 0.25 | 0.25 | 0.00 |
| Neemix | 0.50 | 26.25 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.25 |
| Pyganic | 0.25 | 15.75 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.25 |
| LSD _{0.05} | NS | NS | NS | NS | - | NS | NS | NS |

Table 9. Key pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 8-23-13 (number per 8 sweeps).

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn rootworms | Minute pirate bugs | Spiders | Total beneficial insects |
|---------------------|--------|-------------------|--------|----------------|--------------------|---------|--------------------------|
| Control | 11.00 | 0.00 | 2.00 | 1.00 | 4.00 | 0.33 | 5.00 |
| Karanja oil + Neem | 5.75 | 0.00 | 2.75 | 0.25 | 3.25 | 0.25 | 4.75 |
| Micro AF | 14.75 | 0.00 | 2.75 | 1.00 | 2.00 | 0.25 | 4.25 |
| Neemix | 5.00 | 0.00 | 4.00 | 2.00 | 3.25 | 0.25 | 4.25 |
| Pyganic | 10.00 | 0.25 | 1.75 | 1.75 | 3.75 | 0.75 | 5.50 |
| LSD _{0.05} | NS | NS | NS | NS | NS | NS | NS |

Table 10. Other pest and beneficial insects in the Soybean Pest Management experiment, Neely-Kinyon Farm, 8-23-13 (number per 8 sweeps).

| Rotation | Caterpillars | Whiteflies | Grass-hoppers | Leaf-hoppers | Tarnished Plant bugs | Nabids | Green lacewings | Wasps |
|---------------------|--------------|------------|---------------|--------------|----------------------|-------------|-----------------|-------|
| Control | 0.33 | 3.67 | 0.33 | 0.00 | 0.00 | 0.00±0.20b | 0.00 | 0.00 |
| Karanja oil + Neem | 0.00 | 3.50 | 0.75 | 0.25 | 0.00 | 0.75±0.18a | 0.00 | 1.25 |
| Micro AF | 0.50 | 6.50 | 0.50 | 0.25 | 0.00 | 0.00±0.18b | 0.50 | 0.25 |
| Neemix | 0.00 | 7.75 | 0.00 | 0.00 | 0.00 | 0.50±0.18ab | 0.25 | 0.25 |
| Pyganic | 0.00 | 6.50 | 0.50 | 0.25 | 0.00 | 0.00±0.18b | 0.25 | 0.50 |
| LSD _{0.05} | NS | NS | NS | NS | - | 0.1708 | NS | NS |

Table 11. Key pest and beneficial insects in the Soybean PestManagement experiment, Neely-Kinyon Farm, 9-10-13 (number per 8 sweeps).

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn rootworms | Minute pirate bugs | Spiders | Total beneficial insects |
|---------------------|------------|-------------------|--------|----------------|--------------------|---------|--------------------------|
| Control | 1.25±0.27a | 0.00 | 5.50 | 7.50 | 2.50 | 0.25 | 4.75 |
| Karanja oil + Neem | 0.25±0.27b | 0.00 | 2.25 | 6.25 | 1.75 | 0.25 | 3.75 |
| Micro AF | 0.00±0.27b | 0.00 | 6.75 | 4.25 | 0.75 | 0.00 | 2.00 |
| Neemix | 0.00±0.27b | 0.25 | 8.50 | 6.50 | 1.75 | 0.00 | 5.75 |
| Pyganic | 0.00±0.27b | 0.00 | 3.50 | 4.50 | 1.00 | 0.00 | 3.50 |
| LSD _{0.05} | 0.0874 | NS | NS | NS | NS | NS | NS |

Table 12. Other pest and beneficial insects in the Soybean PestManagement experiment, Neely-Kinyon Farm, 9-10-13 (number per 8 sweeps).

| Rotation | Caterpillars | Whiteflies | Grass-hoppers | Leaf-hoppers | Tarnished Plant bugs | Nabids | Green lacewings | Wasps |
|---------------------|--------------|------------|---------------|--------------|----------------------|--------|-----------------|-------|
| Control | 0.25 | 1.00 | 0.75±0.27b | 0.00 | 1.00 | 0.25 | 0.00 | 0.00 |
| Karanja oil + Neem | 0.00 | 0.50 | 0.25±0.27b | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 |
| Micro AF | 0.00 | 0.00 | 1.75±0.27a | 0.00 | 0.25 | 0.25 | 1.00 | 0.25 |
| Neemix | 0.00 | 2.25 | 0.00±0.27b | 0.00 | 0.25 | 0.25 | 0.00 | 0.25 |
| Pyganic | 0.00 | 0.25 | 0.00±0.27b | 0.00 | 0.50 | 0.00 | 0.75 | 0.25 |
| LSD _{0.05} | NS | NS | 0.1978 | - | NS | NS | NS | NS |