Evaluation of Organic Pest Management Treatments for Bean Leaf Beetle and Soybean Aphid—Neely-Kinyon Trial, 2008

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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 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 34A7 soybeans were planted at the Neely-Kinyon Farm on June 20, 2008, and re-planted at the same rate at 200,000 seeds/acre. Soybeans were planted in a completely randomized design with four replications of each treatment measuring 20 x 30 feet with a 20-foot border between plots. The following treatments were applied: PyGanic® (McLaughlin Gormely King Corp, Minneapolis, MN) at 1 pt/acre, Hexacide® (EcoSMART Technologies, Inc., Franklin, TN) applied at 3 pt/acre, Entrust® (Dow Agrosciences LLC, Indianapolis, IN) applied at 2 oz/acre, and Aphrid™ (TerraMax, Inc., Ham Lake, MN) at 45 grams/acre. All treatments were compared with a control. Plots were maintained with rotary hoeings on June 30 and July 7, cultivation on July 17, 22, and 30. Soybeans were "walked" on August 1 and 14 for large weeds. Treatments were applied every 2 weeks from July 17 to September October 3. Bean leaf beetle and beneficial insect sampling occurred on alternate weeks from July 3 to October 2. Soybeans were harvested on November 19. The percentage of stained soybeans was determined by previously described methods.

Results and Discussion

Peak bean leaf beetle populations on September 25 averaged 27 beetles per 8 sweeps, which was higher than the 2007 peak population of 12 beetles per 8 sweeps (Table 1). Peak populations were observed at an earlier date of July 24 in 2007. In 2008, there were significant differences among treatments, with Entrust™ plots significantly lower at 7 beetles per 8 sweeps compared to 32 beetles per 8 sweeps in the control. Peak aphid populations were observed on August 22, when aphid populations averaged 337 aphids per 8 sweeps, compared to 2007, when aphid populations were 36% of 2008 numbers at 120 aphids per 8 sweeps on August 6, 2007 (Table 1). Aphrid™ plots had the lowest number of aphids at peak populations (168 vs. 355 aphids per 8 sweeps in the control), but because of high variability, populations were not significantly different between control, Aphrid™, Pyganic™ and Hexacide™ plots.

The seasonal average for bean leaf beetles was 10 beetles per 8 sweeps over the course of the summer compared to 3 beetles per 8 sweeps in 2007 (Table 1). There were no differences in seasonal average beetle numbers among treatments, although seasonal average in Entrust™ plots was 6 beetles per 8 sweeps compared to 12 beetles per 8 sweeps in control plots.

Seasonal average soybean aphid populations were 89 aphids per 8 sweeps, with no differences among treatments (Table 1). The Aphrid™ plots had 44 aphids per 8 sweeps versus 68 aphids per 8 sweeps in the control plots, but there were no significant differences among treatments (Table 1). Beneficial insect populations were high, averaging 13 insects per 8 sweeps. There were no significant differences among treatments, signifying minimal effect from the organic insecticides on natural enemies. Beneficial arthropods found in 2008 included lady beetles, lacewings, damsel bugs, parasitic wasps, and assassin bugs, and spiders, and averaged five per plant.

Yields were not affected by pest management techniques, averaging 32 bu/acre over all treatments. Seed staining averaged 23% in 2008, and soybeans from Entrust™ plots had significantly less staining (14%). The other treatments not differ from the controls, but stained soybeans from Pyganic and Aphrid™ plots were numerically lower than the control plots (Table 1). There were no significant differences in grain quality among treatments in 2008 (Table 2). Grain quality was excellent for organic, tofu-type soybeans, with an average protein content of 34%, 18% oil, and 25% carbohydrates. The trial will be continued in 2009 with new organic–complaint treatments.

References

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Table 1. Insect populations, soybean staining, and yield, Neely-Kinyon, 2008.

Treatment	Peak Aphid Population /8 sweeps	Peak Beetle Population /8 sweeps	Seasonal average				Staining (%)	Yield (bu/acre)
			Bean leaf beetle population /8 sweeps	Aphid population /8 sweeps	Pest insect population /8 sweeps	Beneficial insect population /8 sweeps		
Control	355.0b	31.5a	11.8	67.8	89.2	11.3	26.3a	31.9
Pyganic®	295.0b	29.8a	10.9	62.3	81.7	12.4	25.0ab	31.6
Aphrid™	167.5bc	35.3a	11.6	44.3	67.5	13.9	22.5ab	30.9
Hexacide®	305.0b	29.8a	10.8	60.7	92.8	11.1	29.4a	32.4
Entrust®	562.5a	7.0b	5.78	101.1	114.2	13.7	13.5b	29.6
LSD 0.05	163.0	10.1	NS	NS	NS	NS	3.08	NS

Table 2. Grain quality analyses, Neely-Kinyon, 2008.

Treatment	Protein (%)	Oil (%)	Fiber (%)	Carbohydrates (%)	Moisture (%)
Control	33.53	18.15	4.98	25.4	17.5
Pyganic®	34.28	18.30	4.98	24.5	17.5
Aphrid™	34.15	18.13	4.98	24.8	17.3
Hexacide®	33.75	18.25	14.98	25.0	17.4
Entrust®	34.20	18.53	14.93	24.4	17.0
LSD 0.05	NS	NS	NS	NS	NS