BEAN LEAF BEETLE CONTROL WITH SEED TREATMENTS

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INTRODUCTION

Concurrent with relatively mild Midwestern winters over the past few years, the Bean leaf beetle, *Ceratoma trifurcata*, has been more successful in surviving the overwintering portion of its life cycle (Bradshaw et al. 2003). As a result, the number of bean leaf beetles emerging in the spring has increased throughout the Upper Midwest, including Wisconsin (Grau et al. 2003), in recent years. Greater population densities of the overwintered population, and subsequent first generation, bean leaf beetles are of concern to soybean producers due to both direct and indirect damage potential. Bean leaf beetle feeding damage (defoliation) is direct damage. Thresholds have been established for bean leaf beetle defoliation. Refer to UWEX publication A3646, *Pest Management in Wisconsin Field Crops*, for specific defoliation threshold information (Boerboom et al. 2004). Indirect damage is linked to the role of bean leaf beetle as a vector of *bean pod mottle virus* (BPMV) (Giesler et al. 2002). Treatment thresholds for prevention of BPMV are not yet available.

Bean leaf beetle overwinters in the adult stage beneath leaf litter, adjacent or near soybean fields. The overwintered adult population feeds on alternate hosts until soybeans emerge at which point beetles move into soybean fields to lay eggs of the first generation which will develop in the soil and emerge as adults in early July. Overwintered adults have been recovered from wild legumes (showy tick trefoil, *Desmodium canadense*), alfalfa and clover in Wisconsin, and at least one of these (*D. canadense*) is known to be a weedy host of BPMV (Hill and Grau 2003). The bean leaf beetle feeds on soybeans or other legumes infected with BPMV and transmits the virus particles to the next plant on which it feeds. BPMV can reduce soybean yields between 3 and 52% (Gergerich 1999) with infected plants producing fewer, smaller and lower weight seeds.

Because both overwintered population and first generation bean leaf beetles can transmit BPMV to soybeans, and early infection poses the greatest risk in the life of a soybean plant, the question that growers are asking – and researchers are pursuing (Kurtzweil et al. 2002; Bradshaw and Rice 2003) – is whether reducing bean leaf beetle impact early on can protect plants from BPMV infection. There are three approaches to accomplishing this task, one cultural and two chemical. The cultural control approach is to delay soybean planting so that seedlings are exposed to feeding activity of overwintered bean leaf beetles for a limited time. Bean leaf beetle feeding typically peaks in May (depending on growing degree days), and tapers off into early June. Thus, later planted fields can escape incoming overwintered BLB adults entering fields during the early part of May (Zinkand 2002).

A current chemical control tactic for BPMV is foliar application of a contact activity insecticide (e.g. pyrethroids) to suppress bean leaf beetles after soybean emergence – at the V2 growth stage (C. Grau, personal communication). A second chemical control tactic, still largely

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in the pre-label, trial phase, is insecticidal seed treatment applied by the manufacturer or seed company prior to sale and planting. The nicotinoid insecticide class has systemic activity within the treated plant. When applied as a seed treatment, active ingredient is taken up into the germinating seedling and translocated to developing root, stem and leaf tissues. This technology, already registered in field corn, has seen limited registration on soybean. Gaucho (active ingredient, imidacloprid) received a Section 18 emergency exemption registration in Wisconsin during the 2003 planting season for control of *bean pod mottle virus* transmitted by the bean leaf beetle. The Section 18 Gaucho seed treatment registration on soybean was limited to soybeans grown for seed and identity preserved food grade soybeans (Jensen 2003). BPMV is of particular concern in food grade soybean production due to cosmetic effects of "mottled" seed. The Gaucho Section 18 registration on soybeans expired 1 June 2003 and nicotinoid seed treatments continue to be in the pre-label, development phase at the time this article was written (winter 2004).

The bean leaf beetle-*bean pod mottle virus* interaction study reported here was designed to evaluate five different chemical treatment combinations for suppressing bean leaf beetle populations and to answer the question "do nicotinoid insecticidal seed treatments applied to soybeans prior to planting provide significant protection against early season feeding by the overwintered bean leaf beetle population and subsequent first generation?"

The 2003 UW soybean insect-virus bean leaf beetle study evaluated the following strategies:

1. **Seed treatment alone** to protect against early-season feeding by the overwintered population.
2. **Early-season foliar insecticide alone** timed to suppress the overwintered population.
3. **Seed treatment <u>plus</u> an early-season foliar insecticide** to protect seedlings from overwintered beetle feeding while suppressing the overwintered population.
4. **Seed treatment <u>plus</u> a mid-season foliar insecticide** to protect seedlings from overwintered beetle feeding and suppress the subsequent first-generation.
5. **Early- <u>and</u> mid-season foliar insecticide** applications to suppress both overwintered and first-generation populations.

MATERIALS AND METHODS

<u>Planting</u>: The bean leaf beetle-*bean pod mottle virus* interaction study was conducted at the Rock County Farm near Janesville, WI. Plots were seeded 13 May 2003 using a Hefty plot planter at the rate of 7.2 viable seeds per foot of row (172K viable seeds/acre) to a depth of 1". The cultivar planted in this trial was NK S24-K4, with each replicate 10 ft. (4 rows) wide by 25 ft. long.

<u>Treatments and Experimental Design</u>: Treatments were assigned to plots in a completely randomized block design, with four replicates per treatment. Early season foliar applications of pyrethroid insecticide were made 2 June 2003 when soybeans were at the V1 growth stage. Mid-season pyrethroid foliar applications were made 15 July 2003 when weekly bean leaf beetle (BLB) drop cloth sample counts showed first generation activity to be increasing in the plots.

TRIAL A

Early-season Treatments (overwintered BLB population activity)

Insecticidal Seed Treatment alone

Poncho FS600 (a.i. clothianidin) at 62.5 grams a.i. / 100 Kg seed
Poncho FS600 (a.i. clothianidin) at 125 grams a.i. / 100 Kg seed
Gaucho SL600 (a.i. imidacloprid) at 62.5 grams a.i. /100 Kg seed

Foliar Applied Contact Activity Insecticide @ V1 soybean stage alone

Capture 2EC (a.i. bifenthrin) at 2.56 oz. /a
Baythroid 2E (a.i. cyfluthrin) at 1.0 oz. /a
Baythroid 2E (a.i. cyfluthrin) at 1.6 oz. /a
Asana XL (a.i. esfenvalerate) at 6.4 oz. /a
Asana XL (a.i. esfenvalerate) at 9.6 oz. /a
Mustang Max 0.8 EC (a.i. zeta-cypermethrin) at 4.0 oz. /a
Mustang Max 0.8 EC at 4.0 oz. with a non-ionic surfactant (NIS)

Early- *AND* Mid-season Treatments (overwintered and first gen. BLB population activity)

Insecticidal Seed Treatment PLUS Foliar Applied Contact Activity Insecticide

Poncho FS600 62.5 (ST) + Baythroid 2E 2.0 oz. at 1st generation BLB population increase
Gaucho SL600 62.5 (ST) + Baythroid 2E 2.0 oz. at 1st generation BLB population increase
Baythroid 2E 1.0 oz. at soybean V1 + Baythroid 2.0 oz. at 1st generation BLB population increase
Baythroid 2E 1.6 oz. at soybean V1 + Baythroid 2.0 oz. at 1st generation BLB population increase

Untreated Check

TRIAL B

Early-season Treatments (overwintered BLB population activity)

Insecticidal Seed Treatment alone

Cruiser 5FS (a.i. thiamethoxam) at 30 grams a.i. / 100 Kg seed
Cruiser 5FS (a.i. thiamethoxam) at 50 grams a.i. / 100 Kg seed
Gaucho FS600 (a.i. imidacloprid) at 62.5 grams a.i. / 100 Kg seed

Foliar Applied Contact Activity Insecticide @ V1 soybean stage (no seed treatment)

Warrior 1CS (a.i. lambda cyhalothrin) at 3.2 oz. /a

Early- *AND* Mid-season Treatments (overwintered and first gen. BLB population activity)

Insecticidal Seed Treatment PLUS Foliar Applied Contact Activity Insecticide

Cruiser 30 (ST) + Warrior 1CS 3.2 oz. at 1st generation BLB population increase
Cruiser 50 (ST) + Warrior 1CS 3.2 oz. at 1st generation BLB population increase

Untreated Check

Early-season Protection from Bean Leaf Beetle Feeding

Soybean seedlings were assessed for bean leaf beetle feeding damage (round, regular feeding holes in leaves) at three dates (1 June, 5 June and 10 June) from the V1 development stage through V2/V3. Two 3 foot sections of row were randomly selected from the inner two rows of each plot. A total seedling stand count per 3ft was taken, and the number of seedlings with any bean leaf beetle feeding damage was recorded.

BPMV Incidence

Twenty leaves were collected from each plot at two different intervals during the growing season corresponding to bean leaf beetle population activity as determined by weekly drop cloth sampling (BLB/ft. of row). The first batch of leaves was collected on 25 June after overwintered BLB had declined but before first generation adults emerged. The second batch of leaves was collected 20 August following the first generation population peak. Leaves were returned to the laboratory and stored in the freezer. Leaf samples were ground to a sap in Phosphate Buffer Solution and tested by Enzyme-Linked Immuno Sorbent Assay (ELISA) (Agrios 1988) to detect the presence of BPMV between treatments.

ELISA tests were conducted to answer the following questions: 1) were BLB populations high enough at our study site during 2003 to transmit detectable levels of BPMV?; 2) if so, what were the relative contributions of BPMV transmitted by overwintered vs. first generation BLB?; and 3) did the early and mid-season seed treatment and foliar insecticides applied in this trial result in significant differences in BPMV incidence between treatments?

RESULTS AND DISCUSSION

Note: Overwintered Bean leaf beetle populations as measured by BLB / ft. of row, did not reach threshold levels. First generation defoliation was also non-significant ($P > 0.05$) across treatments with all plots between 1 and 3 % defoliation. Therefore, BLB population data and first generation leaf defoliation data are not presented.

Early-season Protection from Bean Leaf Beetle Feeding

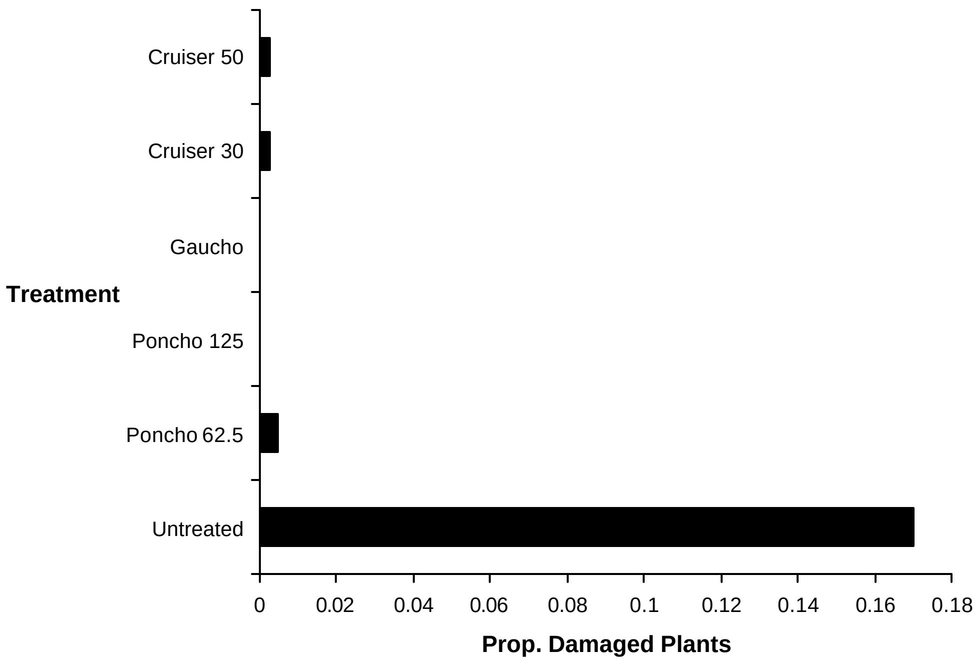
Figure 1. illustrates the proportion of soybean seedlings per 3 ft. of row with bean leaf beetle feeding injury on 1 June 2003, 19 days after planting. Results demonstrate that all five seed treatments provided protection from bean leaf beetle feeding up to the V1 stage with little to no feeding injury observed. The Untreated plots had a significantly ($P > 0.05$) higher proportion of feeding injury at 0.17 as compared with the seed treatment plots. Foliar insecticide applications were made the following day on 2 June, thus the Untreated BLB feeding damage proportion reported in Figure 1 was representative of all non-seed treated plots prior to the V1 foliar insecticide application.

Soybean plants assessed for bean leaf beetle feeding injury on 10 June indicated increased evidence of BLB feeding across all treatments 28 days after planting (Figure 2). However, all five seed treatments continued to have a significantly ($P < 0.05$) lower proportion of BLB feeding injury, ranging from 0.23 to 0.76, as compared with non-seed treated plots.

YIELD EVALUATION

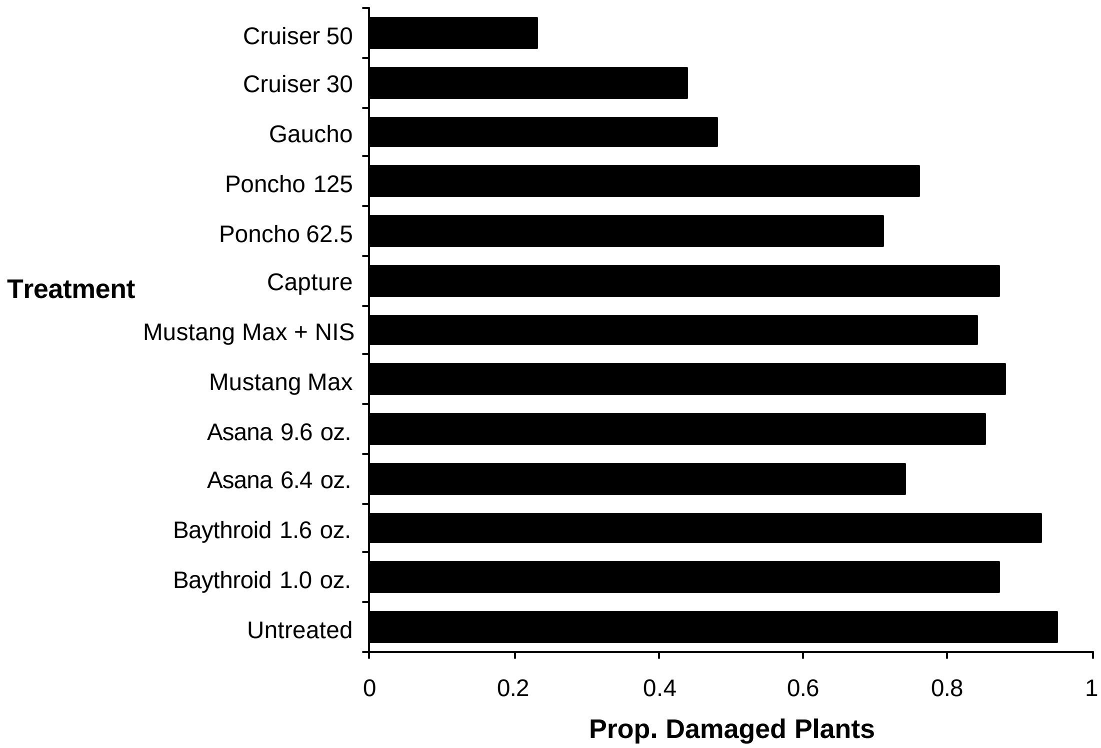
Yield results from the 15 treatments in Trial A were not significantly different by overall analysis of variance (PROC GLM, SAS Institute 2003) at $P = 0.2289$ (Table 1). However, from a production standpoint, means separation did rank four out of five of the seed treatments among the highest yielding plots. Trial B (7 treatments) yield results were significantly different ($P < 0.05$) by overall analysis of variance (PROC GLM, SAS Institute 2003) at $P = 0.0043$. Table 2 ranks Trial B treatment yield means from highest to lowest with the seed treatments ranking above the Warrior application alone.

Figure 1. Proportion of soybean seedlings per 3 ft. of row with bean leaf beetle feeding injury. Sampled 1 June 2003 at V1 soybean growth stage, 19 days after planting. Rock County Farm, Janesville, WI. University of Wisconsin 2003.



Treatment differences significant by Proc GLM (SAS Institute, 2003) at $\alpha = 0.05$. ($P < 0.0001$; $F = 50.16$; $df = 5$).

Figure 2. Proportion of soybean seedlings per 3 ft. of row with bean leaf beetle feeding injury. Sampled 10 June 2003 at approx. V3 soybean growth stage, 28 days after planting. Rock County Farm, Janesville, WI. University of Wisconsin 2003.



Treatment differences significant by Proc GLM (SAS Institute, 2003) at $\alpha = 0.05$. ($P < 0.0001$; $F = 5.56$; $df = 12$).

Table 1. Nicotinoid seed treatment on soybean (Trial A) for efficacy against bean leaf beetle. Mean yield (bu/A) by treatment (P = 0.2289; F = 1.33; df = 14). Rock County Farm, Janesville, WI. University of Wisconsin, 2003.

Treatment	Yield (bu/A)
Poncho 62.5 + Baythroid 2oz. (1st Gen.)	43.4 a
Poncho 62.5	41.1 ab
Gaucho 62.5	40.9 ab
Gaucho 62.5 + Baythroid 2 oz. (1st Gen.)	40.8 ab
Capture 2.56 oz. (V1)	39.4 abc
Baythroid 1oz. (V1)	39.4 abc
Baythroid 1.6 oz. (V1) + 2 oz. (1st Gen.)	38.7 bc
Asana 6.4oz. (V1)	38.6 bc
Treatment	**Yield (bu/A)**
Poncho 125	38.6 bc
Baythroid 1.6 oz. (V1)	38.6 bc
Asana 9.6 oz. (V1)	37.8 bc
Baythroid 1oz. (V1) + 2 oz. (1st Gen.)	37.7 bc
Untreated	37.4 bc
Mustang Max 4.0 oz. (V1)	36.9 bc
Mustang Max 4.0 oz. + NIS (V1)	36.2 c

Means within a column followed by a different letter are significantly different at $\alpha = 0.05$ (Fishers exact test).

Table 2. Nicotinoid seed treatment trial on soybean (Trial B) for efficacy against bean leaf beetle. Mean yield (bu/A) by treatment ($P = 0.0043$; $F = 4.30$; df = 6). Rock County Farm, Janesville, WI. University of Wisconsin, 2003.

Treatment	Yield (bu/A)
Cruiser 50	44.7 a
Gaucho 62.5	44.6 a
Cruiser 30 + Warrior 3.2 oz. (1st Gen.)	43.8 a
Cruiser 30	40.9 ab
Cruiser 50 + Warrior 3.2 oz. (1st Gen.)	38.6 b
Warrior 3.2 oz. (V1)	38.1 b
Untreated	37.4 b

Means within a column followed by a different letter are significantly different at $\alpha = 0.05$ (Fishers exact test).

Other factors that likely influenced yield results in this study were drought conditions during the mid to later portion of the 2003 growing season, and the presence of soybean aphid, *Aphis glycines*, in our study plots.

BPMV INCIDENCE

ELISA tests of both leaf sampling dates corresponding with overwintered population and first generation bean leaf beetle feeding activity, respectively, resulted in no detectable presence of BPMV.

CONCLUSIONS

Neither overwintered nor first generation bean leaf beetle densities approached direct damage defoliation thresholds in this study. Therefore, direct damage was not a likely factor in yield differences observed (Tables 1 and 2). Nicotinoid seed treatments provided significant protection against early season bean leaf beetle feeding activity in this study (Figures 1 and 2). However, BPMV was not detected in either of the two leaf sampling batches (overwintered or first generation intervals). Our results suggest that 2003 bean leaf beetle populations were not high enough and/or BPMV inoculum levels in soybean and alternate hosts were insufficient to cause detectable BPMV transmission in our study plots. One possible explanation for yield differences observed in this study is that the nicotinoid seed treatments protected the plants from soybean aphid feeding (direct feeding damage and potential *alfalfa mosaic virus* and/or *soybean mosaic virus* transmission).

Preliminary results from this study do suggest that nicotinoid seed treatments reduce the impact of overwintered bean leaf beetle feeding on emerging seedlings (Figure 1). Similar studies will be conducted during the 2004 growing season and future years in which higher bean leaf beetle populations and BPMV transmission in untreated plots will allow us to test insecticidal seed treatments as a preventative control tactic for BPMV.

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