SOYBEAN APHID CONTROL WITH SEED TREATMENTS

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BACKGROUND

Soybean aphid, *Aphis glycines*, causes both direct and indirect effects on soybean that can lead to yield loss and reduced seed quality. Direct feeding damage (plant sap removal) results in subsequent plant stress, stunting and yield loss. Indirectly, soybean aphids have been found to reduce photosynthetic rate in soybean (Macedo et al. 2003). Winged soybean aphid morphs occur early in the growing season as females migrate from the primary (overwintering) host, buckthorn (*Rhamnus* spp.), to the secondary host, soybean, for the asexual development phase (Zhang and Zhong 1982). A summer winged morph develops later in the growing season as females respond to crowding and decreased host quality by dispersal flight to uncolonized plants and fields (Steffey 2003). It is the winged soybean aphids that are capable of transmitting viruses to soybean (*alfalfa mosaic virus, soybean mosaic virus*) as they probe and feed between infected and uninfected plants in the process of movement between fields. Because soybean viruses can be transmitted rapidly by winged aphids, there are no thresholds to control this indirect damage (yield loss and seed mottling effects) caused by soybean aphid (Grau 2003).

Status of Chemical Control Tactics for Soybean Aphid (winter 2004)

Soybean aphid chemical control tactics, and ultimately overall management strategies, should take into account both the direct and indirect effects of soybean aphid on the crop. As in the previous three years since soybean aphid emerged in the Midwest, the primary control tactic to manage direct effects of soybean aphid feeding during the 2003 growing season was to apply a pyrethroid foliar insecticide by ground or air. Examples of pyrethroids commonly applied include Asana XL (active ingredient esfenvalerate); Warrior (lambda-cyhalothrin); and Mustang Max (zeta-cypermethrin). Baythroid (cyfluthrin) is also labeled for soybean aphid. Among other broad spectrum chemical classes, the organophosphates dimethoate and Lorsban 4E (chlorpyrifos), and the carbamate Furadan 4F (carbofuran) are registered for soybean aphid.

Other than winged morphs, aphids are relatively sedentary on the plant as they feed with piercing-sucking mouthparts. In other words, they do not move quickly enough through the canopy following a foliar pyrethroid application (nor does their feeding mechanism permit them) to encounter additional treated plant surfaces or ingest active ingredient. For pesticides that work primarily by contact activity it is critical that a lethal dose be delivered to the site at which the aphid is located (Cullen et al. 2000). Contact activity materials are relied upon to manage direct soybean aphid effects by reducing pest population pressure and plant stress quickly. In the long term, contact activity materials are expected to be most effective if used in an IPM program for which soybean aphid economic thresholds, optimal spray timing and delivery methods have been determined.

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Insecticidal seed treatment applied to soybeans by the manufacturer or seed company before they are bagged and sold is another developing option for soybean aphid control. 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. BPMV is of particular concern in food grade soybean production due to cosmetic effects of “mottled” seed. This Section 18 registration for Gaucho on soybeans was limited to soybeans grown for seed and identity preserved food grade soybeans (Jensen 2003).
Insecticidal seed treatments to soybean for soybean aphid control have yet to be registered and continue to be in the pre-label, development phase at the time this article was written (winter 2004).

Unlike the broad spectrum contact activity materials discussed previously, nicotinoid seed treatments have selective activity against piercing-sucking insects with negligible effects on non-target organisms (e.g. natural enemies important in regulating aphid population growth). This systemic mode of action means that soybean aphids will ingest active ingredient in the process of feeding, thus preventing further direct feeding stress and reducing virus transmission by protecting plants from potential vectors as winged aphids arrive in a field.

Nicotinoid seed treatments typically have activity within a growing plant for at least 4 to 6 weeks after germination, sometimes longer, depending on active ingredient, seed treatment rate, crop, and target pest susceptibility. Thus, nicotinoid seed treatments are expected to be best suited for early to mid-season protection against both direct and indirect effects of soybean aphid. Soybeans are treated on a grams active ingredient per 100 Kg of seed basis. For example, “Poncho 62.5” and “Cruiser 30” would equate to 62.5 grams clothianidin/100 Kg seed and 30 grams thiamethoxam/100Kg seed, respectively. The situation is different for corn seed treatment where field corn seed can range in size (e.g. 1400-2800 seeds/lb.) and seed is sold on a seed count basis. In order to obtain the same active ingredient rate per seedling, nicotinoid seed treatments are made to field corn on a *milligrams* active ingredient *per kernel* basis.

UW SOYBEAN APHID INSECTICIDE EFFICACY TRIALS 2003

Foliar insecticides and insecticidal seed treatments were evaluated in three different trials for efficacy against soybean aphid at the Arlington Agricultural Research Station, Arlington, Wisconsin. The foliar insecticide trial, designed to evaluate residual activity as measured by aphid counts at successive intervals post treatment, included 9 treatments (7 pyrethroids and 2 organophosphates) in a completely randomized block design (CRBD) with four replicates per treatment. Post treatment aphid counts (Table 1) were significantly different ($P < 0.05$) by treatment at three post treatment sampling dates, suggestive of varying residual activity between treatments.

Two soybean seed treatment trials, with aphid counts and yield data as response variables, were conducted to evaluate how long insecticidal seed treatment activity extends into the growing season. With the exception of cultivar (Trial A, NK S19-V2; Trial B, NK S240K4) and treatment variables, experimental design was the same for both seed treatment trials. Trial A included five treatments: Poncho 62.5 (clothianidin); Poncho 125; Gaucho 62.5 (imidacloprid); Cruiser 62.5 (thiamethoxam); and an untreated check. Trial B included four treatments: Cruiser 30; Cruiser 50; Gaucho 62.5; and an untreated check. Plots were seeded in 30 inch rows in a CRBD with four replicates per treatment on 9 June 2003. Each treatment replicate was 10 ft (4 rows) wide by 25 ft long. Aphid counts were taken from each plot beginning with initial aphid colonization (8 July) and continuing at weekly intervals through 13 August, when untreated check plot populations began to decline. Whole plant aphid counts were taken on 10 plants per replicate, randomly selected from the middle two rows of each plot, and mean aphids/plant determined for each plot across sampling dates. Yield data were recorded at harvest on 16 October.

Table 1. Soybean aphid foliar insecticide trial. Mean aphids/plant 4 days, 1 week and 2 weeks post treatment[1]. Treated July 31st at R2 (500+ aphids/plant).

Treatment	4 days	1 week	2 weeks
Untreated	996.5 **a**	1518.8 **a**	1823.5 **a**
Warrior 1CS 3.84 oz.	26.3 **f**	22.2 **e**	72.6 e
dimethoate 1 pt.	36.2 **e**	45.5 **d**	147.0 c
Baythroid 2.8 oz.*	181.5 d	344.5 **b**	476.0 **b**
Mustang Max 4.0 oz.	203.2 d	200.3 **c**	307.8 c
Mustang Max + NIS	353.9 **b**	437.1 **b**	440.6 **b**
Capture 2.56 oz.*	1.1 **g**	9.6 **f**	50.8 **f**
Asana 6.4 oz.	330.4 **b**	346.5 **b**	349.3 b
Asana 9.6 oz.	204.6 **c**	368.3 **b**	168.9 **c**
Lorsban 4E 2.0 pt.	0.5 **g**	15.3 **e**	91.9 **d**

[1]Mean yields (bu/A) within a column followed by a different letter are significantly different at $\alpha = 0.05$ (Fishers exact test).

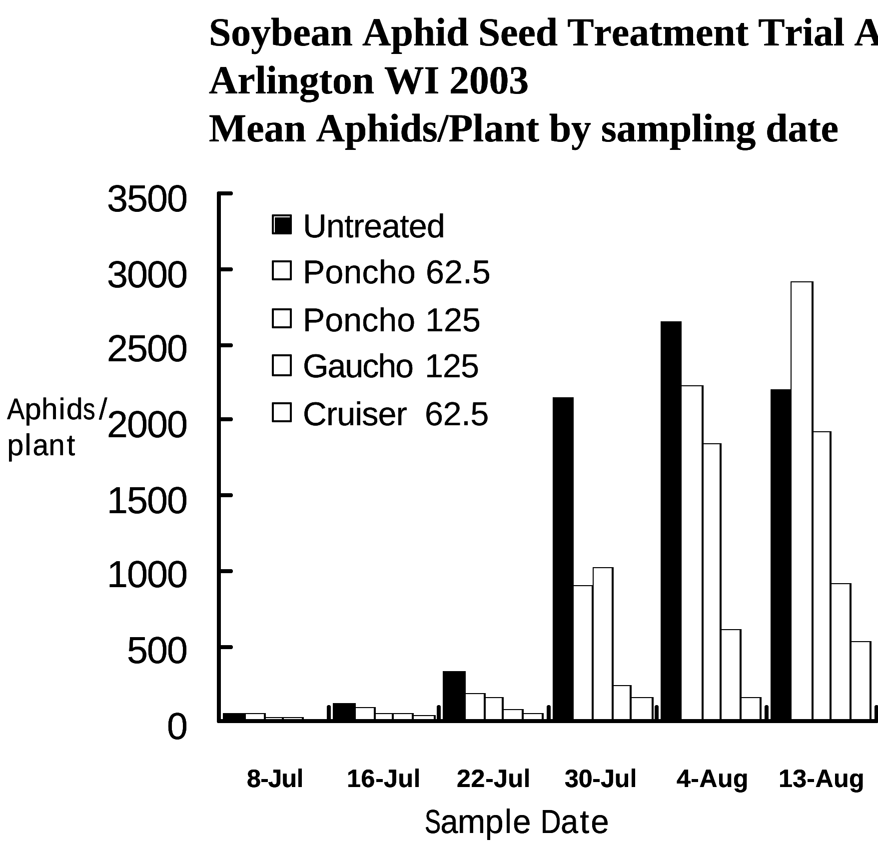
*Baythroid (recently registered for soybean aphid); Capture (not currently registered for soybean aphid).

Figure 1 illustrates a significant difference ($P < 0.05$) in mean aphids per plant between treatments at each sample date for trial A. The same pattern was observed in trial B (Figure 2). As measured by mean aphids per plant, Cruiser (thiamethoxam) at the 50 and 62.5 grams a.i. /100 Kg seed rates, and Gaucho (imidacloprid) at the 62.5 grams a.i. /100 Kg seed rate appeared to have the longest systemic activity into the growing season at approximately 65 days between seeding and the final aphid count on 13 August when plants were in the R3 stage. Mean separation results for yields in each trial reflected this same pattern with the highest yields corresponding to treatments with the lowest aphid counts on 13 August (Tables 2 and 3).

Planting date will be an important consideration when incorporating insecticide seed treated soybeans into a soybean aphid IPM program if/when nicotinoid seed treatments are registered on soybean for efficacy against soybean aphid. Plots in the study reported here were late planted (9 June). A rapid, exponential aphid population increase occurred in both trials over the span of one week in late July. In Trial A, mean aphids per plant increased from 337/plant on 22 July to 2,155/plant on 30 July (Figure 1). In Trial B, mean aphids per plant increased from 233/plant on 22 July to 857/plant on 30 July (Figure 2). During this rapid population increase in the untreated check plots, several seed treatments maintained significantly lower aphid populations. Treatment differences are attributed to continued systemic activity of active ingredient within the plant during the late July aphid population increase, and variation in product performance.

Had our study plots been planted earlier (e.g. early May), systemic insecticide activity may have declined significantly in seed treated plots by 22 July when aphid populations increased. Similar studies will be conducted during the 2004 growing season, incorporating both early and late planted fields in order to obtain additional data on the interaction between planting date, timing of aphid colonization and duration of systemic activity within the plant.

Figure 1. Nicotinoid seed treatment on soybean for efficacy against soybean aphid (Trial A). Mean aphids per plant across sampling dates[1]. University of Wisconsin, 2003.



[1]Mean aphids/plant significantly different across sample dates at $\alpha = 0.05$ (Fishers exact test):

July 8	$P < 0.0001$; $F = 8.38$; df, 4
July 16	$P < 0.0001$; $F = 17.8$; df, 4
July 22	$P < 0.0001$; $F = 28.96$; df, 4
July 30	$P < 0.0001$; $F = 69.42$; df, 4
August 4	$P < 0.0001$; $F = 54.74$; df, 4
August 13	$P < 0.0001$, $F = 52.05$; df, 4

Table 2. Nicotinoid seed treatment on soybean for efficacy against soybean aphid (Trial A). Mean yield (bu/A) by treatment[1]. (P = 0.1151; F = 2.33; df = 4). University of Wisconsin, 2003.

Treatment	Yield (bu/A)
Untreated	38.1 b
Poncho 62.5	42.2 ab
Poncho 125	44.3 ab
Gaucho 125	43.2 ab
Cruiser 62.5	52.8 a

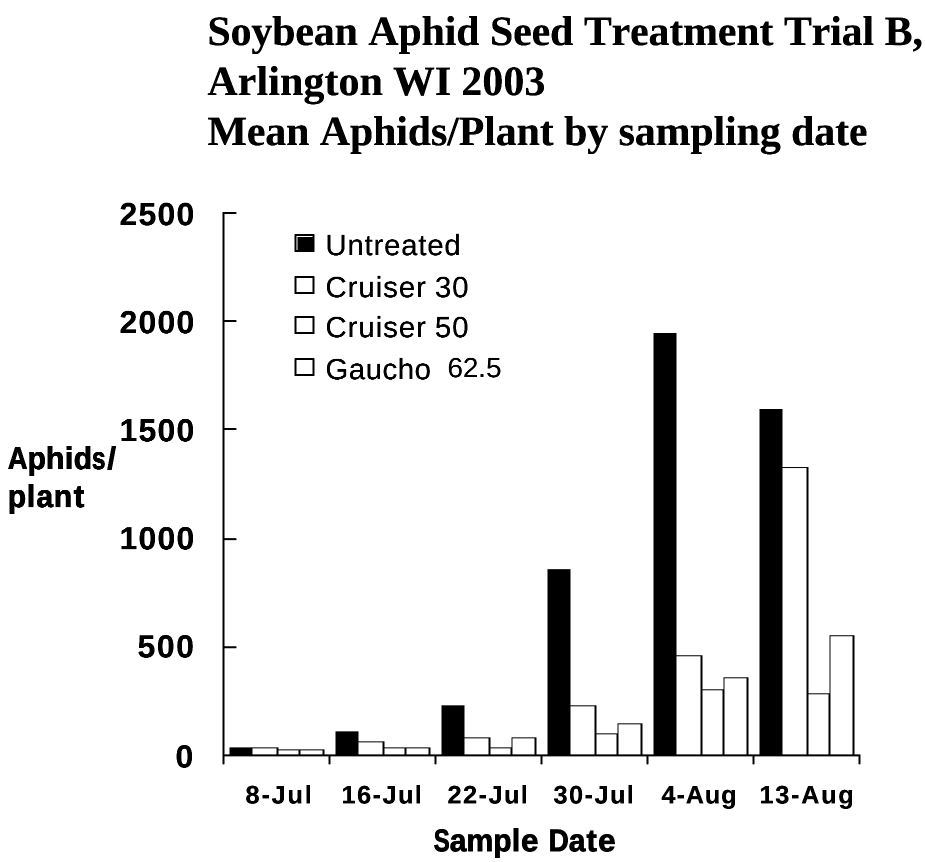
[1]Mean yields (bu/A) followed by a different letter are significantly different at α = 0.05 (Fishers exact test).

Table 3. Nicotinoid seed treatment on soybean for efficacy against soybean aphid (Trial B). Mean yield (bu/A) by treatment[1]. (P = 0.1151; F = 2.33; df = 4). University of Wisconsin, 2003

Treatment	Yield (bu/A)
Untreated	38.1 **c**
Cruiser 30	43.6 b**c**
Cruiser 50	49.7 **a**b
Gaucho 62.5	41.3 **bc**

[1]Mean yield (bu/A) followed by a different letter are significantly different by at α = 0.05 (Fishers exact test).

Figure 2. Nicotinoid seed treatment on soybean for efficacy against soybean aphid (Trial B). Mean aphids per plant across sampling dates[1]. University of Wisconsin, 2003.



[1]Mean aphids/plant significantly different across sample dates at $\alpha=0.05$ (Fishers exact test):

test):	July 8	$P = 0.0122$; $F = 3.00$; df, 5
	July 16	$P < 0.0001$; $F = 18.66$; df, 5
	July 22	$P < 0.0001$; $F = 30.54$; df, 5
	July 30	$P < 0.0001$; $F = 41.77$; df, 5
	August 4	$P < 0.0001$; $F = 446.93$; df, 5
	August 13	$P < 0.0001$, $F = 313.33$; df, 5

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