EXPERIMENTAL SEED TREATMENTS AND LIQUID INSECTICIDES FOR SUGARBEET ROOT MAGGOT CONTROL

Mark A. Boetel, Professor
Robert J. Dregseth and Allen J. Schroeder, Research Specialists

Department of Entomology, North Dakota State University, Fargo, ND

Introduction:

In recent years, insecticidal seed treatment technology has been widely adopted by sugarbeet producers in the Red River Valley growing area for managing insect pests such as the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder). However, the currently registered seed treatment materials tend to provide lower levels of SBRM control than conventional, planting-time-applied granular insecticides. As such, ongoing research at NDSU is aimed at screening experimental insecticides to determine if more efficacious materials and alternative insecticide chemistries can be developed for use in sugarbeet insect pest management. The objective of this series of studies was to conduct preliminary screening on several experimental insecticidal seed treatment materials and two experimental liquid insecticides to determine their potential as tools for managing the sugarbeet root maggot.

Materials and Methods:

This experiment involved two studies (I and II) that were carried out on a commercial field site near St. Thomas (Pembina County) in northeastern North Dakota. Both studies were established by using a six-row John Deere 71 Flex planter that was set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row. Plots were 35 ft long by six rows (22-inch spacing) wide with the four centermost rows treated. The outer "guard" row on each side of the plot served as an untreated buffer. Twenty-five-foot-wide alleys were established between replicates, and they were maintained weed-free throughout the growing season by using a standard field cultivator. Both experiments were arranged in a randomized complete block design with four replications of the treatments. To avoid cross-contamination between treatments, planter seed hoppers were completely disassembled, cleaned, and re-assembled after the application of each insecticidal seed treatment entry. In both experiments, Counter 20G was used as the planting-time granular insecticide standard, and all Counter entries were applied by using band (B) placement. This involved delivering granules in 5-inch swaths over rows through Gandy™ row banders positioned behind the seed drop zone and ahead of the planter's rear packer wheels. Granular output was regulated by using planter-mounted Noble™ metering units that were calibrated on the planter prior to planting.

Seed treatment insecticides for Study I were applied to seed by Syngenta, Inc., and Hilleshög 9047RR (glyphosate-resistant) seed was used for all treatments. Study I was planted on 11 May, 2012. The experimental liquid insecticides (i.e., Force CS and Endigo ZC) were applied to plots at planting in 5-inch "T-bands" by directing TeeJet™ 8001E nozzles over open seed furrows using a tractor-mounted CO_2-propelled spray system. The unit was calibrated immediately before applications to deliver a finished spray volume of 5 gallons per acre.

Study II was planted on 14 May, 2012 using SES VanderHave SV36918RR [glyphosate-resistant]) seed for all entries. Insecticidal seed treatments for Study II were applied by personnel from Valent USA Corporation.

Root injury ratings: Treatment effectiveness in preventing root maggot feeding injury was assessed in Study I and II on 23 July by rating roots from each plot in accordance with the 0 to 9 root injury scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or a dead plant) of Campbell et al. (2000). Sampling involved randomly collecting ten roots from each plot (i.e., five roots from each of the outer two treated rows of each plot) and hand-washing them in water-filled 5-gallon plastic buckets.

Harvest: Treatment performance was also compared on the basis of sugarbeet yield and quality variables. All plots in both studies were harvested on 18 September. Immediately before harvest, the foliage from all treatment plots was removed by using a commercial-grade mechanical defoliator. After defoliation, all beets from the center 2 rows of each plot were collected from the soil using a mechanical harvester and weighed in the field by using a digital scale. A representative subsample of 12-18 beets was collected from each plot and analyzed for sucrose concentration, tare soil weight, and quality/impurities.

Data analysis: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2008), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Root maggot feeding injury sustained by plants in the untreated check plots of Study I averaged 8.0 on the 0 to 9 rating scale (Campbell et al. 2000), thus suggesting that a severe infestation of root maggot larvae was present (Table 1). Despite the high SBRM pressure in the plot area, all insecticide-treated entries (i.e., seed treatments, at-plant granules, and those that included at-plant liquid sprays) provided significant levels of root protection from larval feeding injury when compared to that sustained in the untreated check plots.

The best root protection (i.e., lowest root feeding injury) in Study I occurred in plots treated with Counter 20G as a stand-alone treatment and when it was combined with the A9765 experimental seed treatment. However, neither of these entries outperformed the entry that consisted of A9765 + Force 2.08CS. Significant improvements in root protection were achieved by adding either a planting-time application of Counter 20G or Force 2.08CS to the A9765 seed treatment. A9765 provided a comparable level of root protection from SBRM feeding injury to that of Poncho Beta. No significant improvements in root protection were observed with the spray applications of Endigo 2.71ZC or from the remaining experimental seed treatment materials (i.e., A13219 and A17960).

Table 1. *Larval feeding injury ratings* from evaluation of experimental seed treatments and experimental liquid insecticides for sugarbeet root maggot control (Study I), St. Thomas, ND, 2012

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G	B	7.5 lb	1.5	4.78 g
A9765 + Counter 20G	Seed B	 7.5 lb	60 g a.i./ unit seed 1.5	4.88 fg
A9765 + Force 2.08CS	Seed 5" TB	 13.5 fl oz	60 g a.i./ unit seed	5.25 efg
A9765 + Endigo 2.71ZC	Seed 5" TB	 9.7 fl oz	60 g a.i./ unit seed	5.65 def
Poncho Beta	Seed		68 g a.i./ unit seed	5.93 cde
A9765	Seed		60 g a.i./ unit seed	6.10 bcd
A9765 + A13219	Seed		60 g a.i./ unit seed 8 g ai/ unit	6.13 bcd
A9765 + A17960	Seed		60 g a.i./ unit seed 0.2 mg/ seed	6.60 bc
A9765 + A13219 + Endigo 2.71ZC	Seed Seed 5" TB	 9.7 fl oz	60 g a.i./ unit seed 8 g ai/ unit	6.85 b
Check	---	----	---	8.00 a
LSD (0.05)				0.81

Means within a column sharing a letter are not significantly ($P = 0.05$) different from each other (Fisher's Protected LSD).
[a]B = band; Seed = insecticidal seed treatment; TB = T-band over open seed furrow

Yield results from Study I (Table 2) were somewhat similar to the SBRM feeding injury data. For example, the highest recoverable sucrose and root yield values were recorded for A9765 + Counter 20G. This treatment combination increased root yield by 13.3 tons/ac and gross revenue by $904/ac when compared to the untreated check plots. The stand-alone entry of Counter 20G and the combination entry of A9765 seed treatment + Endigo spray also provided excellent improvements in sucrose yield, root tonnage, percent sucrose, and gross revenue, and neither of these treatments was outperformed by A9765 + Counter 20G.

Combining a planting-time T-band spray application of either Endigo or Force to plots planted with A9765-treated seed appeared to provide a significant benefit with regard to both recoverable sucrose and root yield parameters; however, this benefit disappeared when A13219 was included with A9765 as a seed treatment combination. The reason for this disparity is unclear at this time but it bears noting that, in two entries where A13219 was included in a seed treatment combination with A9765, lower yields were observed when compared to similar treatments that lacked A13219.

Table 2. *Yield parameters* from evaluation of experimental seed treatments and experimental liquid insecticides for sugarbeet root maggot control (Study I), St. Thomas, ND, 2012

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
A9765 + Counter 20G	Seed B	 7.5 lb	60 g a.i./ unit seed 1.5	8614 a	27.2 a	17.20 a	1407
Counter 20G	B	7.5 lb	1.5	7830 ab	25.0 ab	17.00 ab	1265
A9765 + Endigo 2.71ZC	Seed 5" TB	 9.7 fl oz	60 g a.i./ unit seed	7446 ab	24.0 abc	16.88 ab	1190
A9765 + Force 2.08CS	Seed 5" TB	 13.5 fl oz	60 g a.i./ unit seed	6815 bc	22.2 bcd	16.80 ab	1080
A9765 + A 13219 + Endigo 2.71ZC	Seed Seed 5" TB	 9.7 fl oz	60 g a.i./ unit seed 8 g ai/ unit	5995 cd	19.9 cde	16.45 ab	927
Poncho Beta	Seed		68 g a.i./ unit seed	5900 cd	19.4 cde	16.58 ab	923
A9765 + A17960	Seed		60 g a.i./ unit seed 0.2 mg/ seed	5706 cd	19.1 de	16.33 b	875
A9765	Seed		60 g a.i./ unit seed	5133 de	16.9 ef	16.63 ab	804
A9765 + A13219	Seed		60 g a.i./ unit seed 8 g ai/ unit	5046 de	16.6 ef	16.58 ab	793
Check	---	----	---	3742 e	13.9 f	15.20 c	503
LSD (0.05)				1448	4.7	0.81	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD).
[a]B = band; Seed = insecticidal seed treatment; TB = T-band over open seed furrow

The only entries in Study I that did not produce statistically significant improvements in recoverable sucrose yield and root tonnage were A9765 and the seed treatment combination of A9765 + A13219. As observed with root injury rating comparisons, there was no significant impact on yield parameters from A17960 or A13219 experimental seed treatment materials.

All insecticide-treated plots, irrespective of whether a seed treatment, granular material, or at-plant spray was included, provided substantial increases in gross economic return. In comparison to the estimated gross revenue generated from the untreated check plots, these revenue increases ranged from $290/ac for the seed treatment combination that consisted of A9765 + A13219 to an increase of $904/ac for A9765 + planting-time Counter 20G.

In Study II, results from root maggot feeding injury ratings showed that both rates of Counter 20G provided significantly greater levels of root protection than all of the insecticidal seed treatments (Table 3). All seed treatment entries, except NipsIt Inside + SeedTrt-D at 0.87 fl oz/seed unit, resulted in significantly lower root maggot feeding injury than the untreated check plots. No consistent rate-related differences in root protection were apparent among entries that contained the coded seed treatment compounds; however, roots protected by the seed treatment combination of NipsIt Inside + SeedTrt-D at its high (5.20 fl oz/seed unit) had significantly lower levels of SBRM feeding injury than those protected with NipsIt Inside + SeedTrt-D at the 0.87-oz rate.

Table 3. *Larval feeding injury ratings* from evaluation of NipsIt Inside, Poncho Beta, Counter 20G, and experimental seed treatments for sugarbeet root maggot control (Study II), St. Thomas, ND, 2012				
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Root injury (0-9)**
Counter 20G	B	8.9 lb	1.8	4.10 d
Counter 20G	B	7.5 lb	1.5	4.18 d
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i. / unit seed 5.20 fl oz / unit seed	6.10 c
NipsIt Inside + SeedTrt-C	Seed Seed		60 g a.i. / unit seed 1 fl oz / unit seed	6.28 bc
NipsIt Inside	Seed		60 g a.i. / unit seed	6.38 bc
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i. / unit seed 2.60 fl oz / unit seed	6.45 bc
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i. / unit seed 0.44 fl oz / unit seed	6.48 bc
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i. / unit seed 1.74 fl oz / unit seed	6.70 bc
Poncho Beta	Seed		68 g a.i. / unit seed	6.93 bc
NipsIt Inside + SeedTrt-C	Seed Seed		60 g a.i. / unit seed 4 fl oz / unit seed	6.95 bc
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i. / unit seed 0.87 fl oz / unit seed	7.18 ab
Check	-----	----	-----	8.08 a
LSD (0.05)				1.05

Means within a column sharing a letter are not significantly ($P = 0.05$) different from each other (Fisher's Protected LSD).
[a]B = band; Seed = insecticidal seed treatment

Results from yield comparisons in Study II appear in Table 4. Despite the severe SBRM infestation that developed in these plots, several insecticide-protected entries provided good control of this pest. The seed treatment combination of NipsIt Inside + SeedTrt-C at 4 fl oz/seed unit, resulted in significantly greater root tonnage than all other seed treatment entries in this experiment. This entry resulted in a root yield increase of 8.1 tons/ac and a gross revenue benefit of $557/ac when compared to the untreated check.

Table 4. *Yield parameters* from comparison of NipsIt Inside, Poncho Beta, Counter 20G, and experimental seed treatments for sugarbeet root maggot control (Study II), St. Thomas, ND, 2012							
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Sucrose yield (lb/ac)**	**Root yield (T/ac)**	**Sucrose (%)**	**Gross return ($/ac)**
NipsIt Inside + SeedTrt-C	Seed Seed		60 g a.i./ unit seed 4 fl oz / unit seed	7017 a	21.0 a	17.87 a	1208
Counter 20G	B	7.5 lb	1.5	5995 ab	17.5 b	18.27 a	1054
Counter 20G	B	8.9 lb	1.8	5840 ab	17.1 b	18.13 a	1023
NipsIt Inside	Seed		60 g a.i./ unit seed	5720 b	17.1 b	17.97 a	986
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i./ unit seed 5.20 fl oz / unit seed	5520 b	16.2 b	18.23 a	965
Poncho Beta	Seed		68 g a.i./ unit seed	5509 b	16.8 b	17.73 a	933
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i./ unit seed 2.60 fl oz / unit seed	5443 bc	16.1 b	18.07 a	950
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i./ unit seed 1.74 fl oz / unit seed	5096 bcd	15.1 bc	18.17 a	884
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i./ unit seed 0.87 fl oz / unit seed	4271 cde	12.8 cd	17.73 a	734
Check	-----	----	-----	4033 de	12.9 cd	17.00 a	651
NipsIt Inside + SeedTrt-C	Seed Seed		60 g a.i./ unit seed 1 fl oz / unit seed	3987 de	13.0 cd	16.73 a	633
NipsIt Inside + SeedTrt-D	Seed Seed		60 g a.i./ unit seed 0.44 fl oz / unit seed	3806 e	11.8 d	17.37 a	632
LSD (0.05)				1213	2.8	NS	

Means within a column sharing a letter are not significantly ($P = 0.05$) different from each other (Fisher's Protected LSD).
[a]B = band; Seed = insecticidal seed treatment

Differences with regard to seed treatment application rates were not always significant, but were much more apparent and consistent in the yield data from this experiment. Seed treatment combinations that included higher rates (i.e., 2.6 to 5.2 fl oz/seed unit) of SeedTrt-D were not outperformed by either rate of Counter 20G with respect to recoverable sucrose and root yields; whereas the seed treatment combinations that contained lower rates (i.e., 0.87 to 1.74 fl oz/unit) of SeedTrt-D did not provide a significant increase in recoverable sucrose when compared to the untreated check plots. Similarly, the combination of NipsIt Inside + SeedTrt-C at 4 fl oz/seed unit was statistically superior with regard to recoverable sucrose yield and root tonnage to the same combination when SeedTrt-C was applied to seed at the lower, 1-oz rate.

References Cited:

Campbell, L. G., J. D. Eide, L. J. Smith, and G. A. Smith. 2000. Control of the sugarbeet root maggot with the fungus *Metarhizium anisopliae*. J. Sugar Beet Res. 37: 57–69.

SAS Institute. 2008. The SAS System for Windows. Version 9.2. SAS Institute Inc., 2002-2008. Cary, NC.