PRELIMINARY ASSESSMENT OF EXPERIMENTAL SEED TREATMENT COMBINATIONS FOR SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The most important economic insect pest of sugarbeet in the Red River Valley (RRV) is the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder). Growers in the RRV have achieved good control of the SBRM for several years by using conventional planting-time granular insecticides in combination with postemergence insecticide applications. However, because insecticides belonging to the same mode of action have been used to control this insect for several decades, with many fields requiring two to three applications within a season for adequate control, the threat of insecticide resistance in regional populations has long been an area of concern. To address this threat, research has been underway for the past several years to identify effective insecticides from alternative chemical classes for sustainable management of this important insect pest.

Recent interest on insect control in sugarbeet has been focused on the use of insecticidal seed treatments. Three seed treatment insecticides have recently received Environmental Protection Agency registration for use in sugarbeet, and this technology has been widely adopted by sugarbeet producers in the Red River Valley growing area. However, the currently registered seed treatment materials have thus far tended to provide lower levels of control than conventional planting-time insecticides. Thus, additional screening of experimental insecticides, including newly developed seed treatments, is considered a worthy pursuit of research efforts. The overriding objective of this experiment was to conduct preliminary screening on several experimental insecticidal seed treatment materials to determine their potential for future use as tools to manage the sugarbeet root maggot.

Materials and Methods:

This experiment was established at a commercial field site near St. Thomas (Pembina County) and at a second site near Forest River (Walsh County), ND. Seed treatment insecticides for the experiment were applied to seed by Syngenta, Inc., and Hilleshög HM100001 (glyphosate-resistant) seed was used for all treatments. Plots were planted on 19 May, 2011 at Forest River and on 3 June at St. Thomas.

Plots were planted using a six-row John Deere 71 Flex planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row. Plots were 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. Each plot was 35 feet long, and 25-foot tilled alleys were maintained between replicates. The experiment was arranged in a randomized complete block design with four replications of the treatments. To avoid cross-contamination of seed between treatment applications, planter seed hoppers were completely disassembled, cleaned, and re-assembled after the application of each seed treatment entry.

Counter 20G was used as the planting-time granular insecticide standard in both experiments, and it was applied at its highest (8.9 lb product/ac) rate by using band (B) placement (Boetel et al. 2006). 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. The experimental liquid insecticides (Force CS and Endigo ZC) were applied directly over the open seed furrow as 5-inch T-bands using a tractor-mounted CO_2 spray unit. The unit was calibrated to deliver a finished spray volume of 5 GPA using TeeJet™ 8001E nozzles.

<u>Root injury ratings</u>: Assessments of root maggot feeding injury were carried out between 2 and 3 August for experiments and locations. Rating procedures consisted of first randomly collecting ten beet roots per plot (five from each of the outer two treated rows), then hand-washing the roots and scoring them in accordance with the 0 to

9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. All plots for these experiments were harvested between 26 and 27 September. Immediately before each experiment was harvested, 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 using a digital scale. A representative subsample of 12-16 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 data from the St. Thomas location are presented in Table 1. The average root injury rating of 7.3 (0 to 9 scale of Campbell et al. [2000]) for the untreated check plots in this test indicated that a relatively high root maggot infestation was present at St. Thomas. Both Counter-based entries resulted in the lowest average root maggot feeding injury at St. Thomas, but adding the coded seed treatment insecticide A9765 did not appear to augment control. Results indicated that the combinations of A9765+Force CS liquid insecticide and A9765+Endigo liquid spray provided significant reductions in root maggot feeding injury over the untreated check. These combinations were also superior to the singular entry of A9765 seed treatment, suggesting that Force and Endigo provided the majority of SBRM control in the combination treatments. Poncho Beta and the coded entries of A13219 and A17960 did not appear to provide appreciable levels of protection from SBRM feeding injury.

Table 1. *Larval feeding injury* in evaluation of experimental seed treatment for sugarbeet root maggot control, St. Thomas, ND, 2011

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G	B	8.9 lb	1.8	4.75 e
A9765 + Counter 20G	Seed B	 8.9 lb	60 g a.i./ unit seed 1.8	5.53 de
A9765 + Force CS	Seed 5" TB	 13.5 fl oz	60 g a.i./ unit seed 0.22	6.03 cd
A9765 + Endigo ZC	Seed 5" TB	 9.7 fl oz	60 g a.i./ unit seed 0.16	6.23 bcd
A9765 + A17960	Seed		60 g a.i./ unit seed 0.2 mg/ seed	6.48 a-d
A9765 + A13219	Seed		60 g a.i./ unit seed 8 g a.i./ unit	6.58 abc
Poncho Beta	Seed		68 g a.i./ unit seed	6.90 abc
A9765	Seed		60 g a.i./ unit seed	6.95 abc
Check	---	----	---	7.05 ab
A9765 + A17960	Seed		60 g a.i./ unit seed 0.1 mg/ seed	7.30 a
LSD (0.05)				0.99

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 assessments for Study I at St. Thomas (Table 2) corresponded with root injury data, and again showed that entries including Counter 20G performed well at managing the sugarbeet root maggot. The top-yielding entry in this experiment was A9765+Counter 20G (8.9 lb product/ac), and it resulted in a revenue increase of $313/ac when compared to the gross revenue recorded for the untreated check. Also reflective of the root rating data was that the seed treatment/at-plant liquid insecticide (i.e., Force CS and Endigo ZC) combinations resulted in significant increases in recoverable sucrose and root tonnage yields over that observed in the untreated check. Revenue increases over that of the untreated check from these combinations were $202/ac for A9765+Force 2.08CS and $92/ac for A9765+Endigo ZC. These combinations were not significantly outperformed by the Counter-based entries in this experiment at St. Thomas. The coded insecticide, A9765, also provided significant increases in recoverable sucrose and root tonnage; however, as observed with root maggot feeding injury ratings, Poncho Beta, A31219, and A17960 did not appear to positively impact yield parameters in this study.

Table 2. *Yield parameters* from evaluation of experimental seed treatment for sugarbeet root maggot control, St. Thomas, ND, 2011

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	 8.9 lb	60 g a.i./ unit seed 1.8	7101 a	26.1 a	15.30 a	977
Counter 20G	B	8.9 lb	1.8	6564 ab	23.8 ab	15.55 a	920
A9765 + Force CS	Seed 5” TB	 13.5 fl oz	60 g a.i./ unit seed 0.22	6446 ab	24.0 ab	15.18 a	866
A9765 + Endigo ZC	Seed 5” TB	 9.4 fl oz	60 g a.i./ unit seed 0.16	5890 abc	22.6 bc	14.88 a	756
A9765	Seed		60 g a.i./ unit seed	5677 bcd	21.4 bcd	15.03 a	751
A9765 + A13219	Seed		60 g a.i./ unit seed 8 g a.i./ unit	5548 b-e	21.0 bcd	15.05 a	730
A9765 + A17960	Seed		60 g a.i./ unit seed 0.2 mg/ seed	5394 b-e	19.5 cde	15.50 a	759
A9765 + A17960	Seed		60 g a.i./ unit seed 0.1 mg/ seed	4940 cde	18.4 def	15.05 a	664
Poncho Beta	Seed		68 g a.i./ unit seed	4447 de	16.4 ef	15.15 a	610
Check	---	----	---	4435 e	15.3 f	16.18 a	664
LSD (0.05)				1235	3.3	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; TB = T-band over open seed furrow

A low infestation of sugarbeet root maggot larvae developed at the Forest River location for this experiment, as was evidenced by the average root feeding injury rating of 3.6 (0 to 9 scale of Campbell et al. [2000]) recorded for the untreated check plots (Table 3). Despite the lower SBRM infestation, the results from Forest River corresponded closely with those observed at St. Thomas. For example, the lowest average root maggot feeding injury was observed in plots protected with the combination treatment of A9765 insecticidal seed treatment plus an at-plant application of Counter 20G at its high (8.9 lb product/ac) rate, and similar levels of protection were observed with A9765+Endigo ZC and the stand-alone entry of Counter 20G applied at planting time. The only entries in this test at Forest River that failed to result in significant reductions in root maggot feeding injury when compared to the untreated check were the A9765 and Poncho Beta seed treatments.

Table 3. *Larval feeding injury* in evaluation of experimental seed treatment for sugarbeet root maggot control, Forest River, ND, 2011

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
A9765 + Counter 20G	Seed B	 8.9 lb	60 g a.i./ unit seed 1.8	2.15 c
A9765 + Endigo ZC	Seed 5” TB	 9.41 fl oz	60 g a.i./ unit seed 0.16	2.18 c
Counter 20G	B	8.9 lb	1.8	2.18 c
A9765 + Force CS	Seed 5” TB	 13.5 fl oz	60 g a.i./ unit seed 0.22	2.50 bc
A9765 + A17960	Seed		60 g a.i./ unit seed 0.1 mg/ seed	2.68 bc
A9765 + A13219	Seed		60 g a.i./ unit seed 8 g a.i./ unit	2.73 bc
A9765 + A17960	Seed		60 g a.i./ unit seed 0.2 mg/ seed	2.78 bc
A9765	Seed		60 g a.i./ unit seed	2.80 abc
Poncho Beta	Seed		68 g a.i./ unit seed	3.28 ab
Check	---	----	---	3.60 a
LSD (0.05)				0.82

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 for the Forest River location of this experiment are presented in Table 4. Overall, yields at Forest River were much higher than those observed at St. Thomas. This was largely a result of the Forest River site being planted over two weeks earlier than St. Thomas. Unfortunately, due to excessive rainfall and some drainage problems at this location, plant vigor was highly variable across the plot area. The resulting high variability in yields between replicates prevented the detection of statistically significant differences for recoverable sucrose and root yield between treatments. These results should also be interpreted with discretion because of the low SBRM infestation that was present for the experiment.

Although there were no statistically significant differences between treatments for recoverable sucrose or root yield parameters at Forest River, some interesting performance patterns were evident. For example, most of the entries that involved the coded seed treatment insecticide (A9765) provided large, albeit nonsignificant, increases (1,196 to 2,772 lb/ac) in recoverable sucrose and root yield (3.4 to 4.8 tons/ac) when compared to the untreated check. Interestingly, the following seed treatment entries resulted in significantly higher percent sucrose concentrations than the untreated check: A9765+A17960 (0.1 and 0.2 mg/unit of seed), A9765 +A13219, and A9765 alone. This suggests that further testing should be carried out to determine the repeatability of the results.

Gross revenue from plots established with seed treatments involving A9765 were also excellent, with returns ranging from $218 to $680/ac over that from the untreated check. Yield benefits from Counter, Poncho Beta, Force CS, and Endigo ZC were as not apparent at this location as observed at St. Thomas; however, combining A9765 seed treatment with the planting-time application of Counter 20G resulted in a $60/ac increase in revenue over that in the Counter-only entry.

As mentioned above, results from the Forest River site of this study were the product of a light SBRM infestation, coupled with high variability in growing conditions among replicates. Further testing should be carried out on these materials under more normal growing conditions to determine their potential for managing the sugarbeet root maggot and other insect pests of economic significance in the Red River Valley.

Table 4. *Yield parameters* from evaluation of experimental seed treatment for sugarbeet root maggot control, Forest River ND, 2011

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 + A17960	Seed		60 g a.i./ unit seed 0.1 mg/ seed	8411 a	28.3 a	16.48 abc	1300
A9765 + A13219	Seed		60 g a.i./ unit seed 8 g a.i./ unit	8364 a	27.4 a	16.73 a	1337
A9765 + A17960	Seed		60 g a.i./ unit seed 0.2 mg/ seed	7967 a	26.5 a	16.60 ab	1246
A9765	Seed		60 g a.i./ unit seed	7900 a	26.7 a	16.35 abc	1214
A9765 + Force CS	Seed 5” TB	13.5 fl oz	60 g a.i./ unit seed 0.22	7844 a	29.5 a	15.45 bcd	1042
A9765 + Counter 20G	Seed B	8.9 lb	60 g a.i./ unit seed 1.8	7437 a	29.5 a	14.93 d	899
A9765 + Endigo ZC	Seed 5” TB	9.4 fl oz	60 g a.i./ unit seed 0.16	6835 a	26.9 a	14.85 d	838
Counter 20G	B	8.9 lb	1.8	6834 a	26.9 a	14.85 d	839
Poncho Beta	Seed		68 g a.i./ unit seed	6615 a	24.5 a	15.40 cd	899
Check	---	----	---	5639 a	23.5 a	14.48 d	620
LSD (0.05)				NS	NS	1.16	

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

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