COMBINING SEED TREATMENTS OR PLANTING-TIME INSECTICIDES WITH POSTEMERGENCE TOOLS FOR SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder) continues to be the key insect pest of sugarbeet in the Red River Valley growing area. Sugarbeet growers in the region have typically relied on planting-time granular insecticides to control this pest for several decades, and postemergence insecticide applications are commonly used for additive protection in the more heavily infested areas. In recent years, insecticidal seed treatments have been widely adopted by Valley growers for at-plant protection from sugarbeet insect pests. Seed treatment technology is attractive to growers as an insecticide option because no on-farm equipment calibration is required to achieve the desired application rate, no specialized application equipment is needed on the planter to apply protection, and insecticidal seed treatments allow for significant reductions in the amount of insecticide active ingredient applied to the environment for insect management. In addition to the relatively new seed treatment options for growers, the marketplace has also recently seen the introduction of a 20G (i.e., 20% granular) formulation of Counter (i.e., terbufos) insecticide, which is replacing the longstanding 15G formulation.

This investigation included two experiments that were carried out during the 2011 growing season. Study I was initiated with the following objectives: 1) determine whether there are differences in SBRM control efficacy between Counter 15G and 20G formulations; 2) compare conventional granular insecticides with Poncho Beta seed treatment for SBRM control; 3) assess the impacts of additive postemergence applications of Thimet 20G to plots initially treated with either Counter 20G or Poncho Beta seed treatment.

Study II was carried out to achieve the following objectives: 1) compare registered and experimental liquid insecticides (i.e., Mustang Max and HGW86 20SC [experimental]) with Poncho Beta seed treatment and Counter 20G for planting-time control of the SBRM; 2) assess the capability of postemergence liquid insecticides (i.e., Lorsban Advanced and HGW86 10OD [experimental]) for providing additive SBRM control.

Materials and Methods:

These experiments were established on a commercial sugarbeet field site near St. Thomas in rural Pembina County, ND. A professional seed preparation company (Germains Seed Technology, Fargo, ND) applied seed treatment insecticides to seed for all entries in both studies. Additionally, the same seed variety (SES VanderHave 36812RR [glyphosate-resistant]) was used for all entries in these experiments. Study I was planted on 26 May and Study II was planted on 6 June. All 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 and seed dispensation equipment were completely disassembled, cleaned, and re-assembled after the application of each seed treatment entry.

<u>Planting-time insecticide applications</u>. Counter 15G and 20G were applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular application rates were regulated by using planter-mounted Noble™ metering units that had been calibrated on the planter before all applications. Planting-time applications of Mustang Max were applied in 3-inch T-bands over open seed furrows, whereas HGW86 was applied directly into seed furrows at planting. All planting-time liquid applications were delivered by using a tractor-mounted CO_2-propelled spray system that was calibrated to deliver a finished spray volume of 5 GPA using TeeJet™ 6501E nozzles.

Postemergence insecticide applications. Postemergence insecticides used in Study I consisted of two granular materials (i.e., Counter 20G and Thimet 20G. Postemergence granules (Post B) were applied on 17 June, or about 3 days before the initial peak in SBRM fly activity. However, the highest peak occurred on 27 June (10 d after the applications). Band placement of postemergence granules was achieved by using Kinze™ row banders attached to a tractor-mounted tool bar and adjusted to a height needed to deliver the insecticides in 4-inch bands. As with at-plant applications, postemergence granular application rates were controlled by using planter-mounted Noble™ metering units, and granules were incorporated using two pairs of rotary tines that straddled each row on the tool bar. A paired set of tines was positioned ahead of each bander, and a second pair of tines was mounted behind the granular drop zone. This system effectively stirred soil around the bases of sugarbeet seedlings and incorporated granules as the unit passed through each plot.

In Study II, all postemergence insecticides used were liquid materials (i.e., Lorsban Advanced HGW86 10 OD). Postemergence liquid applications were carried out on 17 June (i.e., about 3 days before the initial peak in SBRM fly activity) using a tractor-mounted CO_2-propelled spray system equipped with TeeJet™ 11002VS nozzles. The system was calibrated to deliver a finished spray volume of 10 GPA as a broadcast application. Plots assigned to receive postemergence broadcasts of liquid insecticides were three tractor passes (i.e., 33 ft rather than the standard 11-ft width) wide to reduce the likelihood of flies exposed to a foliar liquid insecticide treatment in one plot moving into and colonizing a neighboring plot. However, all root maggot feeding injury and yield assessments were taken out of the center 4 rows of each plot.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in Studies I and II on 3 and 4 August, respectively, by randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, 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. Plots for both studies were harvested on 27 September. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center 2 rows of each plot were lifted using a mechanical harvester, and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and analyzed for sucrose content and quality.

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:

Study I. Sugarbeet root maggot feeding injury rating results for Study I are presented in Table 1. Root injury ratings in the untreated check plots (mean = 8.3 on the 0 to 9 scale of Campbell et al. [2000]) indicated that a relatively high SBRM infestation was present for this study. All insecticide-protected plots had significantly lower levels of root maggot feeding injury than the untreated check, irrespective of whether a seed treatment, single at-plant granular application, or dual-treated combination was used for SBRM control.

As observed in previous years of testing, trends indicated that dual (planting-time + postemergence) insecticide programs tended to provide slightly better root protection than single, at-plant treatments. For example, the dual control program consisting of Counter 20G at its high (8.9 lb product/ac) labeled rate, combined with a postemergence application of Thimet 20G at its high (7 lb product/ac) rate, provided significantly greater root protection than any other treatment in this trial. The dual application treatment that included Poncho Beta seed treatment and a postemergence application of Counter 20G also provided good protection from SBRM feeding injury.

Root injury rating data also indicated that there were no significant differences in performance between the 15G and 20G formulations of Counter insecticide when the same rate (either 1.5 or 1.8 lb) of active ingredient was applied per acre. Both formulations, when applied at the highest labeled application rate of active ingredient per acre, provided good protection from SBRM feeding injury, even if they were applied as stand-alone (i.e., without a postemergence insecticide) treatments.

Table 1. *Larval feeding injury* in evaluation of planting-time granules, seed treatments and postemergence granules for sugarbeet root maggot control, St. Thomas, ND, 2011 (Study I)				
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Root injury (0-9)**
Counter 20G + Thimet 20G	B 3 d pre-peak Post B	8.9 lb 7 lb	1.8 1.4	3.73 f
Counter 20G + Thimet 20G	B 3 d pre-peak Post B	7.5 lb 7 lb	1.5 1.4	5.00 e
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	5.17 de
Counter 15G	B	11.9 lb	1.8	5.37 de
Counter 20G	B	8.9 lb	1.8	5.47 cde
Poncho Beta + Counter 20G	Seed 3 d pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	5.87 b-e
Counter 20G	B	7.5 lb	1.5	5.97 b-e
Poncho Beta + Thimet 20G	Seed 3 d pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	6.00 b-e
Counter 15G	B	10 lb	1.5	6.30 bcd
Counter 20G	B	5.25 lb	1.05	6.63 bc
Poncho Beta	Seed		68 g a.i./ unit seed	6.73 b
Check	---	----	---	8.30 a
LSD (0.05)				1.18

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

Yield data from Study I are shown in Table 2. There were no statistically significant differences among any of the treatments with regard to recoverable sucrose yield or root tonnage. However, patterns of performance with regard to yield parameters were somewhat similar to those observed in root maggot feeding injury assessments. Interestingly, the top-performing entry with regard to recoverable sucrose yield, root yield, and gross economic return was the stand-alone entry of Counter 15G, applied at its highest labeled rate (11.9 lb product/ac). Other entries that resulted in the highest average yields in Study I included the following: 1) Counter 20G banded at planting (7.5 lb product/ac) + Thimet 20G postemergence band (7 lb product/ac); 2) Poncho Beta + Counter 20G postemergence band (5.25 lb/ac); and 3) Poncho Beta + Counter 20G planting-time band (5.25 lb/ac).

Table 2. *Yield parameters* from evaluation of planting-time granules, seed treatments & postemergence granules for sugarbeet root maggot control, St. Thomas, ND, 2011 (Study I)							
Treatment/ form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Sucrose yield (lb/ac)**	**Root yield (T/ac)**	**Sucrose (%)**	**Gross return ($/ac)**
Counter 15G	B	11.9 lb	1.8	6113 a	22.2 a	15.30 abc	855
Counter 20G + Thimet 20G	B 3 d pre-peak Post B	7.5 lb 7 lb	1.5 1.4	5563 a	20.2 a	15.23 abc	780
Poncho Beta + Counter 20G	Seed 3 d pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	5456 a	18.9 a	15.80 a	811
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	5380 a	18.6 a	15.80 a	804
Counter 20G + Thimet 20G	B 3 d pre-peak Post B	8.9 lb 7 lb	1.8 1.4	4958 a	18.4 a	15.00 abc	673
Counter 20G	B	5.25 lb	1.05	4763 a	17.3 a	15.20 abc	666
Counter 20G	B	8.9 lb	1.8	4604 a	16.1 a	15.33 ab	677
Poncho Beta + Thimet 20G	Seed 3 d pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	4573 a	16.7 a	15.23 abc	633
Counter 20G	B	7.5 lb	1.5	4521 a	17.2 a	14.73 bcd	585
Poncho Beta	Seed		68 g a.i./ unit seed	4151 a	17.0 a	13.90 d	471
Counter 15G	B	10 lb	1.5	4128 a	15.4 a	14.93 abc	556
Check	---	----	---	4128 a	16.3 a	14.37 cd	501
LSD (0.05)				NS	NS	0.95	

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

Percent sucrose data indicated that most of the entries in this study produced favorable sugar concentrations; however, plots protected with the stand-alone treatment of Poncho Beta had a significantly lower sucrose concentration than most other entries. The untreated check plots also produced significantly lower sucrose concentrations per sample than most other treatments.

It should be noted that Counter insecticide (both 15G and 20G formulations) can only be applied once per year. Thus, if either of these products were applied at planting, they could not be applied to the same field at postemergence. Additionally, it bears noting that using a Counter product as a postemergence material will not always be a viable option for commercial sugarbeet production because both 15G and 20G formulations are labeled with a 110-day preharvest interval. Thus, if an application were made in early to mid-June for SBRM management, no treated portion of the field could be harvested until mid- to late-September at the earliest.

Study II. Results from root maggot larval feeding injury assessments for Study II appear in Table 3. The best root protection was provided by the following treatments: 1) Counter 20G banded at 8.9 lb product/ac; 2) Counter banded at 7.5 lb product/ac + Lorsban Advanced postemergence broadcast at 1 pt product/ac; 3) Counter banded at 7.5 lb; and 4) Counter banded at 7.5 lb + Lorsban Advanced postemergence broadcast at 2 pt/ac. Entries that failed to provide significant levels of root protection included Poncho Beta + Lorsban Advanced (2 pt/ac); Poncho Beta without a postemergence insecticide, Poncho Beta + Lorsban Advanced (1 pt), Mustang MAX 0.8EC at planting time, HGW86 20SC at planting, HGW86 20SC at planting + HGW86 10OD postemergence, and Mustang MAX 0.8EC + Lorsban Advanced at 2 pt product/ac. Overall, the trends in this study indicated that the protection provided by planting-time granular insecticide applications was generally better than the at-plant protection provided by Poncho Beta seed treatment and the liquid insecticides (i.e., Mustang Max, or HGW86 20SC). Additionally, no significant increases in root protection were observed when postemergence applications of Lorsban Advanced or the experimental insecticide (i.e., HGW86) were added to planting-time applications of Counter 20G, Poncho Beta seed treatment, or Mustang MAX. This was probably due to the unusually high and extended period of SBRM fly activity, which also resulted in a high SBRM larval infestation in these plots. The long period of fly activity also made it difficult to effectively time the postemergence insecticide applications for optimal SBRM control.

Table 3. *Larval feeding injury* in evaluation of planting-time granules, liquids, seed treatments, and postemergence liquid insecticides for sugarbeet root maggot control, St. Thomas, ND (Study II)

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G	B	8.9 lb	1.8	3.90 e
Counter 20G + Lorsban Advanced	B 3 d post-peak Broadcast	7.5 lb 1 pt	1.5 0.5	4.70 de
Counter 20G	B	7.5 lb	1.5	4.88 d
Counter 20G + Lorsban Advanced	B 3 d post-peak Broadcast	7.5 lb 2 pt	1.5 1.0	5.28 cd
Poncho Beta + Lorsban Advanced	Seed 3 d post-peak Broadcast	2 pt	68 g a.i./ unit seed 1.0	6.10 bc
Poncho Beta	Seed		68 g a.i./ unit seed	6.38 ab
Poncho Beta + Lorsban Advanced	Seed 3 d post-peak Broadcast	1 pt	68 g a.i./ unit seed 0.5	6.43 ab
MustangMAX 0.8EC	3” TB	4 fl oz	0.025	6.65 ab
Check	---	----	---	6.83 ab
HGW86 20SC	IF		0.352	6.85 ab
HGW86 20SC + HGW86 10OD	IF 3 d post-peak Broadcast		0.352 0.176	7.05 a
MustangMAX 0.8EC + Lorsban Advanced	3” TB 3 d post-peak Broadcast	4 fl oz 2 pt	0.025 1.0	7.05 a
LSD (0.05)				0.85

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

Yield results for Study II (Table 4) corresponded closely to those from root maggot feeding injury ratings. For example, the top-performing entries in this study involved Counter 20G applied at planting time (either as stand-alone (no postemergence) treatments or when combined with Lorsban Advanced as a postemergence broadcast application. Adding Lorsban Advanced augmented recoverable sucrose yield by at least 600 lb/ac when compared to a stand-alone application of Counter, and this translated to increases in gross economic return of $165-167/ac. These observed revenue increases clearly demonstrate the economic value and thereby, justify the Lorsban Advanced applications under relatively high SBRM pressure such as that which was present for this study.

Control programs in Study II involving Poncho Beta as the planting-time insecticide provided significant sucrose yield increases when compared to the untreated check; however, dual programs consisting of Counter 20G and a postemergence broadcast application of Lorsban Advanced were superior to Poncho-based entries. Entries in this experiment that failed to provide significant increases in recoverable sucrose yields included the single at-plant application of Mustang Max, and both the single and dual applications of the experimental insecticide, HGW86.

The top-performing entries with regard to recoverable sucrose and root yield in Study II provided gross economic returns that were about twice as much as (i.e., increases of over $500/ac) those from the untreated check plots. This demonstrates the economic significance of the sugarbeet root maggot and underscores the importance of effectively managing it when moderately high infestations develop.

Table 4. ***Yield parameters*** **from evaluation of planting-time granules, liquids, seed treatments, and postemergence liquid insecticides for sugarbeet root maggot control, St. Thomas, ND, 2011 (Study II)**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Counter 20G + Lorsban Advanced	B 3 d post-peak Broadcast	7.5 lb 1 pt	1.5 0.5	7452 a	24.9 a	16.30 ab	1162
Counter 20G + Lorsban Advanced	B 3 d post-peak Broadcast	7.5 lb 2 pt	1.5 1.0	7345 a	24.3 a	16.43 a	1160
Counter 20G	B	8.9 lb	1.8	6942 ab	23.6 ab	16.03 ab	1059
Counter 20G	B	7.5 lb	1.5	6742 ab	23.5 ab	15.70 ab	995
Poncho Beta + Lorsban Advanced	Seed 3 d post-peak Broadcast	2 pt	68 g a.i./ unit seed 1.0	6095 bc	20.6 bc	16.10 ab	939
Poncho Beta + Lorsban Advanced	Seed 3 d post-peak Broadcast	1 pt	68 g a.i./ unit seed 0.5	5560 cd	19.0 cd	15.90 ab	841
Poncho Beta	Seed		68 g a.i./ unit seed	5458 cd	18.7 cd	15.90 ab	826
MustangMAX 0.8EC + Lorsban Advanced	3” TB 3 d post-peak Broadcast	4 fl oz 2 pt	0.025 1.0	5409 cd	18.7 cd	15.90 ab	811
MustangMAX 0.8EC	3” TB	4 fl oz	0.025	5210 cde	17.8 cd	16.03 ab	790
HGW86 20SC + HGW86 10OD	IF 3 d post-peak Broadcast		0.352 0.176	5020 de	18.1 cd	15.45 bc	711
HGW86 20SC	IF		0.352	5008 de	17.8 cd	15.40 bc	721
Check	---	----	---	4335 e	16.7 d	14.65 c	551
LSD (0.05)				1071	3.5	0.90	

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

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