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 most important economic insect pest of sugarbeet in the Red River Valley growing area. Sugarbeet producers in areas at risk of high SBRM infestations control this pest by using planting-time insecticide protection, either in the form of a granular insecticide or an insecticidal seed treatment. Additive protection in moderate- to high-risk areas typically consist of either a banded application of a granular insecticide ahead of the anticipated peak in SBRM fly activity or a broadcast spray application timed closer to peak fly. As such, it is critical that research efforts be directed at determining the most effective combination of planting-time and postemergence insecticide protection to optimize inputs for the control of this important sugarbeet pest.

This investigation included two experiments that were carried out during the 2014 growing season. Study I was initiated with the following objectives: 1) compare Counter 20G granular insecticide with Poncho Beta seed treatment for at-plant SBRM control; 2) determine the efficacy of combining Poncho Beta with Counter 20G at planting time for a one-pass protection system; and 3) assess the impacts of additive postemergence applications of Thimet 20G to plots initially treated with either Counter 20G or Poncho Beta seed treatment for SBRM control.

Study II was carried out to achieve the following objectives: 1) measure the impact of Lorsban Advanced liquid insecticide spray applications on plots initially treated at planting time with Poncho Beta seed treatment or Counter 20G for root maggot control; 2) determine the most effective rate of Lorsban Advanced applied as a postemergence treatment for providing additive control.

Materials and Methods:

Both 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 Poncho Beta insecticide to seed for all seed treatment entries in both studies. The same glyphosate-resistant seed variety (i.e., Betaseed 89RR83) was used for all entries in these experiments. Study I was planted on 29 May and Study II was planted on 30 May. 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 length. 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 throughout the growing season. 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 treatment.

<u>Planting-time insecticide applications</u>. Counter 20G was 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.

<u>Postemergence insecticide applications (Studies I and II)</u>. Postemergence insecticides used in Study I consisted of two granular materials (i.e., Counter 20G and Thimet 20G) and one liquid spray product (i.e., Lorsban Advanced). Postemergence granules (Post B) were applied on 12 June, or about 11 days before the main peak in SBRM fly activity. 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^{TM} metering units. All postemergence granular treatments 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 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 insecticide treatments involved Lorsban Advanced spray applications. Sprays were applied on 17 June (i.e., about 6 days before peak SBRM fly activity) using a tractor-mounted CO_2-propelled spray system equipped with TeeJet^{TM} 110015VS 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 minimize 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 ratings and harvest samples were taken out of the inner 4 rows of each plot.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in both studies between 4 and 5 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 24 September. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were extracted from soil 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 sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

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. The level of root injury that occurred in the untreated check plots (mean = 7.63 on the 0 to 9 scale of Campbell et al. [2000]) suggested 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.

Table 1. *Larval feeding injury* in an evaluation of planting-time insecticide granules, seed treatments, and postemergence granules for sugarbeet root maggot control, St. Thomas, ND, 2014 (Study I)

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Poncho Beta + Counter 20G	Seed 11 d Pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	2.15 e
Counter 20G + Thimet 20G	B 11 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	2.83 de
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	3.28 cd
Counter 20G + Thimet 20G	B 11 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	3.35 cd
Counter 20G	B	8.9 lb	1.8	3.53 cd
Counter 20G	B	7.5 lb	1.5	3.55 cd
Counter 20G	B	5.25 lb	1.05	3.85 cd
Poncho Beta + Thimet 20G	Seed 11 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	4.03 c
Poncho Beta	Seed		68 g a.i./ unit seed	5.73 b
Check	---	----	---	7.63 a
LSD (0.05)				1.03

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

As observed in previous years of testing, trends indicated that dual (i.e., planting-time + postemergence) insecticide programs tended to provide slightly better root protection than single, at-plant treatments. The dual control program consisting of Poncho Beta seed treatment, combined with a postemergence application of Counter 20G at a relatively low (5.25 lb product/ac) rate, provided the highest level of root protection in this trial. The dual application treatment comprised of Counter 20G at its highest labeled rate (8.9 lb product/ac), combined with a postemergence application of Thimet 20G at its highest rate (7 lb/ac) also provided good protection from SBRM feeding injury. As observed in previous years, combining Poncho Beta with Counter 20G at a low (5.25 lb/ac) rate at planting also performed very well with respect to protection from SBRM feeding injury. Single, planting-time applications of Counter 20G also provided significant benefits with respect to root protection, and all rates of this product performed significantly better than Poncho Beta as a stand-alone treatment.

Yield data from Study I are shown in Table 2. Treatment performance in relation to yield parameters followed somewhat similar patterns to those observed in root maggot feeding injury assessments. The top-performing entry with regard to recoverable sucrose and root yield was the dual treatment of Counter 20G at planting time, combined with a postemergence treatment of Thimet 20G, with each material applied at its highest labeled application rate. This program resulted in $712 in gross revenue, which was $361 above that of the untreated check plots. The highest gross economic return in this trial ($740/ac) was achieved by using a dual-protection program of Poncho Beta seed treatment for planting-time protection, and combining it with a planting-time application of Counter 20G at a low (5.25 lb product/ac) rate. The recoverable sucrose and root tonnage produced by this entry were not statistically different from that of a similar program comprised of Poncho Beta plus Counter at postemergence using the same (5.25 lb/ac) rate; however, applying the Counter at planting time with Poncho Beta-treated seed resulted in $154 more revenue than when the Counter was applied at postemergence. All insecticide-based control programs in this study, with the exception of the stand-alone entry of Poncho Beta, were not significantly different from each other in relation to recoverable sucrose and root yield.

Table 2. *Yield parameters* from an evaluation of planting-time insecticide granules, seed treatments, and postemergence granules for sugarbeet root maggot control, St. Thomas, ND, 2014 (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 20G + Thimet 20G	B 11 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	7494 a	26.0 a	15.43 abc	712
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	7487 a	25.3 a	15.73 ab	740
Counter 20G	B	7.5 lb	1.5	7255 a	25.2 a	15.45 abc	685
Counter 20G + Thimet 20G	B 11 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	7078 a	24.4 a	15.53 abc	680
Poncho Beta + Thimet 20G	Seed 11 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	7009 a	25.6 a	14.80 c	605
Counter 20G	B	8.9 lb	1.8	6916 a	24.8 a	14.90 bc	618
Counter 20G	B	5.25 lb	1.05	6664 ab	22.5 abc	15.80 a	660
Poncho Beta + Counter 20G	Seed 11 d Pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	6538 ab	23.4 ab	15.00 abc	586
Poncho Beta	Seed		68 g a.i./ unit seed	5568 bc	19.9 bc	14.93 bc	502
Check	---	----	---	4797 c	18.9 c	13.75 d	351
LSD (0.05)				1215	3.9	0.83	

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

It should be noted that Counter insecticide, irrespective of which formulation (i.e., 15G or 20G) is used, can only be applied once per year. Therefore, if it is applied at planting, it cannot be applied to the same field at postemergence. It also bears noting that the Counter 20G label has been revised to include a 90-day preharvest interval (i.e., PHI, the number of days that must elapse after application before a crop can be harvested) for sugarbeet. This makes Counter 20G a much more feasible product as a postemergence option for sugarbeet root maggot control, as it previously was labeled with a 110-day PHI. The new, 90-day PHI should work well for SBRM management in the Red River Valley, because postemergence granule applications are typically most effective if made in late-May to early-June. However, growers should take care to ensure they are in compliance with this new PHI if choosing to use Counter 20G as a postemergence tool for SBRM control.

Study II. Results from root maggot larval feeding injury assessments for Study II appear in Table 3. The following treatments provided the best root protection in this trial: 1) Counter banded at 7.5 lb + Lorsban Advanced postemergence broadcast at 2 pt/ac; and 2) Counter 20G at 8.9 lb product/ac as an at-plant band. Although these entries incurred the lowest levels of SBRM feeding injury, they were not statistically superior in root protection to that of the following: 1) Counter banded at 7.5 lb product/ac + Lorsban Advanced postemergence broadcast at 1 pt product/ac; and 2) Counter banded at 7.5 lb.

Table 3. *Larval feeding injury* in an evaluation of planting-time insecticide granules, seed treatments, and postemergence sprays for sugarbeet root maggot control, St. Thomas, ND, 2014 (Study II)

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Lorsban Advanced	B 6 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	2.93 c
Counter 20G	B	8.9 lb	1.8	3.23 c
Counter 20G + Lorsban Advanced	B 6 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	4.03 bc
Counter 20G	B	7.5 lb	1.5	4.13 bc
Poncho Beta	Seed		68 g a.i./ unit seed	5.25 ab
Poncho Beta + Lorsban Advanced	Seed 6 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	5.58 ab
Lorsban Advanced	6 d Pre-peak Broadcast	1 pt	1.0	5.75 a
Poncho Beta + Lorsban Advanced	Seed 6 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	5.78 a
Lorsban Advanced	6 d Pre-peak Broadcast	2 pts	1.0	6.65 a
Check	---	----	---	6.78 a
LSD (0.05)				1.56

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

The following entries in Study II failed to provide significant levels of root protection when compared to untreated check plots: 1) Poncho Beta; 2) Poncho Beta + Lorsban Advanced (2 pt/ac); 3) Poncho Beta + Lorsban Advanced (1 pt/ac); 4) Lorsban Advanced at 1 pt product/ac (no at-plant insecticide); 5) Poncho Beta + Lorsban Advanced (1 pt/ac); and 6) Lorsban Advanced at 2 pt product/ac (no at-plant insecticide).

Overall, the SBRM feeding injury trends in this study indicated that the root protection provided by planting-time granular insecticide applications was generally better than that provided by Poncho Beta insecticidal seed treatment. Additionally, no significant increases in root protection were observed when postemergence applications of Lorsban Advanced were added to planting-time applications of Counter 20G or Poncho Beta seed treatment. 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 sprays for effective SBRM control.

Yield results for Study II (Table 4) corresponded closely to the root maggot feeding injury data. For example, the top-performing entries in this study involved Counter 20G applied at planting time, either as a stand-alone (no postemergence insecticide added) program, or when combined with Lorsban Advanced as a postemergence broadcast application. The highest gross economic return in Study II ($592/ac) was achieved by applying Counter 20G at planting time using the moderate (7.5 lb product/ac) rate, and combining it with a postemergence application of Lorsban Advanced at 1 pt product/ac at six days before peak SBRM fly activity. This entry provided a revenue benefit of $336 over that of the revenue from untreated check plots. Interestingly, the stand-alone (planting-time only) application of Counter 20G at its high (8.9 lb product/ac) labeled rate increased gross revenue by $297/ac when compared to the untreated check, which suggested a revenue benefit of approximately $39/ac can be achieved by applying a postemergence treatment of Lorsban Advanced ahead of the anticipated peak in SBRM fly activity.

However, there was no significant difference in recoverable sucrose yield or root yield between the 1- and 2-pt product/ac rates of Lorsban Advanced when added to plots treated at planting with Counter 20G. Also, there was no statistically significant yield benefit from Lorsban Advanced applications in this trial, irrespective of application rate or whether the at-plant insecticide used was Counter 20G or Poncho Beta. Similarly, the postemergence-only entries of Lorsban Advanced (solely included for comparative purposes) failed to provide significant increases in recoverable sucrose or root yield when compared with the untreated check plots. Other entries in Study II that failed to provide significant increases in recoverable sucrose yields over that of the untreated check plots included the following: 1) Poncho Beta + Lorsban Advanced at 1 pt/ac; and 2) Poncho Beta + Lorsban Advanced at 2 pt/ac.

The consistent lack of significant yield impacts from the postemergence Lorsban sprays in Study II could be related to application timing and its relationship to the prolonged period of relatively high SBRM fly activity. Historically, postemergence liquid sprays have performed best when applied closer to (e.g., within two to three days of) peak SBRM fly activity. In this trial, all Lorsban Advanced sprays were applied at six days before peak fly. However, a surge of moderately high activity had occurred about one week before the applications, and persisted for a total of about 2.5 weeks.

Table 4. *Yield parameters* from an evaluation of planting-time insecticide granules, seed treatments, and postemergence sprays for sugarbeet root maggot control, St. Thomas, ND, 2014 (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 6 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	6927 a	25.5 a	14.73 a	592
Counter 20G	B	8.9 lb	1.8	6768 a	25.4 a	14.55 ab	553
Counter 20G + Lorsban Advanced	B 6 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	6606 a	24.7 ab	14.55 ab	544
Poncho Beta	Seed		68 g a.i./ unit seed	6052 ab	23.0 abc	14.43 ab	482
Counter 20G	B	7.5 lb	1.5	5815 abc	21.9 abc	14.50 ab	472
Poncho Beta + Lorsban Advanced	Seed 6 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	4914 bcd	18.9 bc	14.30 ab	380
Lorsban Advanced	6 d Pre-peak Broadcast	1 pt	1.0	4461 bcd	17.7 c	13.83 bc	321
Poncho Beta + Lorsban Advanced	Seed 6 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	4357 cd	17.2 c	13.85 bc	318
Check	---	----	---	4229 cd	17.8 c	13.18 c	256
Lorsban Advanced	6 d Pre-peak Broadcast	2 pts	1.0	4154 d	17.4 c	13.23 c	255
LSD (0.05				1618	6.1	0.86	

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

The three top-performing entries with regard to recoverable sucrose and root yield in Study II provided gross economic returns that ranged between $288 and $336 above that recorded for the untreated check plots. Despite the major significant differences observed between insecticide-protected and untreated plots in both Study I and II, frequent rainfall events that occurred at the St. Thomas site during and after the sugarbeet root maggot feeding period probably decreased the severity of yield and revenue impacts that the pest could have caused in these experiments. Regardless of that fact, the findings in these trials clearly demonstrate the economic importance of the sugarbeet root maggot and underscores the importance of effectively managing it in moderate- to high-risk areas.

References Cited:

Boetel, M. A., R. J. Dregseth, A. J. Schroeder, and C. D. Doetkott. 2006. Conventional and alternative placement of soil insecticides to control sugarbeet root maggot (Diptera: Ulidiidae) larvae. J. Sugar Beet Res. 43: 47–63.

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.