PERFORMANCE OF SINGLE-, DUAL-, AND TRIPLE-COMPONENT INSECTICIDE PROGRAMS UNDER MODERATE AND SEVERE SUGARBEET ROOT MAGGOT PRESSURE SITUATIONS

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Introduction:

Severe infestations of the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), occur on a frequent basis in central and northern portions of the Red River Valley (RRV) of North Dakota and Minnesota. Published research has demonstrated that this pest is capable of causing more than 45% yield losses in the absence of effective control measures (Boetel et al. 2010). High population levels of this pest often require aggressive management programs to ensure adequate protection of the sugarbeet crop. Control programs in areas at high risk of economic loss from this pest usually consist of either a granular insecticide or an insecticidal seed treatment at planting, followed by an additive postemergence insecticide application when the SBRM infestation warrants it. Broadcast applications of sprayable liquid insecticides, applied on an as-needed, rescue basis, are the most commonly used postemergence tools for SBRM control in the RRV. However, the use of postemergence granular insecticide products has increased in recent years. An advantage of postemergence sprays is that growers can use a "wait and see" approach, and make informed decisions on whether rescue insecticide treatments are needed based on current fly activity levels in their fields. This research was carried out to determine the most effective combinations of planting-time and postemergence insecticides to optimize sugarbeet root maggot control under both moderate and severe infestation levels.

This project involved two experiments. The objectives of Study I were to: 1) compare Counter 20G granular insecticide with Poncho Beta seed treatment for at-plant SBRM control; 2) assess the efficacy of combining Poncho Beta with Counter 20G at planting time for a one-pass SBRM control system; 3) determine 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; 4) measure the performance of Counter 20G as a postemergence control option; and 5) determine if SBRM control can be maximized by employing a three-component (i.e., seed treatment insecticide + at-plant or postemergence granular insecticide + postemergence liquid spray) management program.

The objectives of Study II were to: 1) measure the impacts of Poncho Beta seed treatment and Counter 20G (at differing application rates) on root maggot control in dual-insecticide programs that include postemergence Lorsban Advanced liquid insecticide spray applications; and 2) assess the effect of application rate on performance of Lorsban Advanced for postemergence root maggot control.

Materials and Methods:

Studies I and II were established on a commercial sugarbeet field site near St. Thomas (Pembina County), ND, and Study II was repeated at a similar field site near Thompson, ND. Betaseed 89RR52 glyphosate-resistant seed was used for all entries in both experiments, and a professional seed preparation company (Germains Seed Technology, Fargo, ND) applied Poncho Beta to seed for all entries that included an insecticidal seed treatment in these trials. Both experiments were planted on 10 May at St. Thomas, and Study II was planted on 15 May at the Thompson location. All plots were planted using a 6-row Monosem NG Plus 4 7x7 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. No insecticide was applied to the outer "guard" rows (i.e., rows one and six) of each plot, as those rows served as untreated buffers. Each plot was 35 feet long, and 35-foot alleys between replicates were maintained weed-free throughout the growing season by using tillage operations. Both experiments were arranged in a randomized complete block design with four replications of the treatments at each location.

<u>Planting-time insecticide applications</u>: Counter 20G was applied in both trials 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 a planter-mounted SmartBox™ computer-controlled insecticide

delivery system that was calibrated on the planter immediately before all applications.

Postemergence insecticide applications: Postemergence insecticides 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 band-applied granules (Post B) were applied on 31 May at both locations (i.e., 7 days before peak SBRM fly activity at St. Thomas and 5 days pre-peak at Thompson). Band placement of postemergence granules was achieved by using Kinze™ row banders that were attached to a tractor-mounted tool bar and adjusted to a height to deliver the insecticides in 4-inch bands. Similar to at-plant insecticide applications, postemergence granular output rates were also regulated by using a SmartBox™ system mounted on a tractor-drawn four-row toolbar. All postemergence granular applications were incorporated by 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 of each row unit. This system effectively stirred soil around the bases of sugarbeet seedlings and incorporated granules as the unit passed through each plot.

The postemergence spray applications of Lorsban Advanced in both studies and at both locations were broadcast-applied on 4 June (i.e., about 3 days before peak SBRM fly activity at St. Thomas, and one day pre-peak at Thompson). Sprays were applied from a tractor-mounted CO_2-propelled spray system equipped with an 11-ft boom that was calibrated to deliver a finished spray volume output of 10 GPA through TeeJet™ 110015VS nozzles.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in both studies at St. Thomas on 30 July and in Study II at Thompson on 2 August. At each location, ten beet roots were randomly collected per plot (five from each of the outer two treated rows). Each root was hand-washed and scored 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 and 20 September at St. Thomas and Thompson, respectively. 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, 2012), 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 = 7.9 on the 0 to 9 scale of Campbell et al. [2000]) suggested that a severe SBRM infestation was present at St. Thomas. All insecticide-protected plots had significantly lower levels of SBRM feeding injury than the untreated check, regardless of whether involving a seed treatment, single at-plant granular application, dual-, or triple-application insecticide combination was used for SBRM control.

The lowest overall root injury rating mean (i.e., highest root protection level) in Study I occurred in plots that received the combination treatment comprised of Poncho Beta-treated seed, followed by a postemergence application of Counter 20G at its high labeled rate of 8.9 lb product per acre. Root maggot feeding injury in that treatment was significantly lower than that in all other treatments, except the combination of Counter 20G applied at planting at 7.5 lb, combined with a postemergence application of Thimet 20G at its high rate of 7 lb product per acre. The treatment combination of Poncho Beta seed treatment plus a postemergence application of Counter 20G at its high (8.9 lb product/ac) rate provided significantly greater root protection than the treatment consisting of Poncho Beta plus the same rate of Counter applied at planting time, suggesting that Counter may be a very effective option as a postemergence SBRM control tool.

All dual- and triple-insecticide programs provided significant improvements in root protection from SBRM feeding injury when compared with any single-component program, irrespective of whether the at-plant protection involved Poncho Beta or any rate of Counter 20G. Triple-component programs, consisting of Poncho Beta-treated seed plus either Counter 20G at planting or a postemergence application of Thimet 20G, and followed by a postemergence spray of Lorsban, did not result in improved root protection when compared with similar plots that were not treated with the additional application of Lorsban Advanced. These results suggest that there was no significant improvement in root protection from the postemergence spray of Lorsban Advanced when Poncho Beta was combined with a granular insecticide at either planting or postemergence timing.

Table 1. ***Larval feeding injury*** **in an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence insecticides, St. Thomas, ND, 2018**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 8.9 lb	68 g a.i./ unit seed 1.8	4.28 e
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	4.73 de
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	4.85 d
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	5.03 cd
Poncho Beta + Thimet 20G	Seed 7 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	5.05 cd
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	5.10 cd
Poncho Beta + Thimet 20G + Lorsban Advanced	Seed 7 d Pre-peak Post B 3 d Pre-peak Broadcast	 7 lb 1 pt	68 g a.i./ unit seed 1.4 0.5	5.10 cd
Poncho Beta + Counter 20G + Lorsban Advanced	Seed B 3 d Pre-peak Broadcast	 8.9 lb 1 pt	68 g a.i./unit seed 1.8 0.5	5.25 cd
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	5.48 c
Poncho Beta	Seed		68 g a.i./ unit seed	6.20 b
Counter 20G	B	8.9 lb	1.8	6.35 b
Counter 20G	B	7.5 lb	1.5	6.43 b
Counter 20G	B	5.25 lb	1.05	6.45 b
Check	---	----	---	7.90 a
LSD (0.05)				0.538

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

Yield data from Study I are presented in Table 2. All insecticide treatments in this experiment, irrespective of whether involving a single at-plant application of Counter 20G or Poncho Beta insecticidal seed treatment or a dual- or triple-component insecticide program, resulted in statistically significant increases in recoverable sucrose yield, root tonnage, and percent sucrose content. Although yield increases are common in root maggot control experiments, consistent sucrose content increases such as those observed in this trial are somewhat rare, and likely were a product of the severe SBRM infestation that was present at the St. Thomas location in 2018.

As observed in the SBRM feeding injury data for Study I, trends suggested better performance with dual- and triple-insecticide programs. The top-yielding entry in this study involved Poncho Beta-treated seed, combined with a postemergence application of Counter 20G at its high (8.9 lb product/ac) labeled rate. That entry generated $275/ac greater revenue than plots protected solely by Poncho Beta seed treatment, and a revenue increase of $705/ac over the gross revenue generated by untreated check plots. Other entries that were not statistically outperformed by this treatment in relation to both recoverable sucrose yield and root tonnage included the following: 1) Poncho Beta + Counter 20G applied at postemergence at 5.25 lb/ac; 2) the triple-component program consisting of Poncho Beta seed treatment, combined with an at-plant application of Counter 20G at its high (8.9 lb product/ac) rate and a postemergence spray application of Lorsban Advanced at its moderate (1 pt/ac) rate; 3) Counter 20G applied at planting time + postemergence Thimet at 7 lb product/ac; and 4) Poncho Beta + postemergence Thimet 20G at 7 lb/ac + Lorsban Advanced applied postemergence at 1 pt/ac. These five top-performing treatments generated between $283 and $333/ac more gross revenue than any of the single at-plant protection programs involving either Poncho Beta or Counter 20G, and between $664 and $713/ac more revenue than the untreated check plots. These economic benefits would have easily paid for the product and application costs associated with their use, and provided significant amounts of additional net revenue per acre.

Another finding in yield results that corresponded with root injury rating data was that Counter 20G performed well when applied postemergence. In plots where the high (8.9-lb) rate of Counter was combined with Poncho Beta-treated seed, recoverable sucrose yield and root tonnage were significantly greater than in similar plots where the Counter was applied at the same rate, but at planting time.

Table 2. *Yield parameters* from an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence insecticides, St. Thomas, ND, 2018

Treatment/ form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 8.9 lb	68 g a.i./ unit seed 1.8	9110 a	30.6 a	16.28 b-e	1075
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	9106 a	30.6 a	16.38 a-e	1073
Poncho Beta + Counter 20G + Lorsban Advanced	Seed B 3 d Pre-peak Broadcast	 8.9 lb 1 pt	68 g a.i./unit seed 1.8 0.5	9005 a	29.8 ab	16.38 a-e	1083
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	8971 ab	28.7 abc	16.90 ab	1134
Poncho Beta + Thimet 20G + Lorsban Advanced	Seed 7 d Pre-peak Post B 3 d Pre-peak Broadcast	 7 lb 1 pt	68 g a.i./ unit seed 1.4 0.5	8879 ab	30.0 ab	16.15 cde	1038
Poncho Beta + Thimet 20G	Seed 7 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	8483 ab	26.9 bcd	17.00 a	1081
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	8351 ab	28.2 abc	16.20 b-e	977
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	8203 abc	26.4 cd	16.85 abc	1028
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	7970 bc	25.8 cd	16.68 a-d	988
Poncho Beta	Seed		68 g a.i./ unit seed	7238 cd	25.3 cde	15.85 e	800
Counter 20G	B	8.9 lb	1.8	6946 de	23.7 def	16.10 de	801
Counter 20G	B	7.5 lb	1.5	6473 de	21.9 ef	16.23 b-e	754
Counter 20G	B	5.25 lb	1.05	6148 e	20.4 f	16.33 a-e	735
Check	---	----	---	4208 f	16.6 g	14.45 f	370
LSD (0.05)				1015.4	3.44	0.723	

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

In comparing dual- and triple-component SBRM control programs, the addition of Lorsban Advanced (1 pt/ac) to plots initially planted with Poncho Beta-treated seed and treated at planting with Counter 20G at 8.9 lb product per acre resulted in significant increases in both recoverable sucrose yield and root yield (i.e., 1,140 lb and 4.8 tons/ac, respectively). A similar trend occurred when the low (5.25 lb/ac) rate of at-plant Counter 20G was used, but only root tonnage was statistically greater in plots that received the Lorsban Advanced application. The supplemental application of Lorsban Advanced in these comparisons returned $45 to $87/ac in gross revenue over Poncho Beta/Counter 20G plots that did not receive the postemergence spray of Lorsban. In plots initially treated with Poncho Beta and treated at postemergence with Thimet 20G, there was no significant yield benefit from adding a postemergence spray of Lorsban Advanced.

The gross economic return generated by using stand-alone planting-time applications of Counter 20G ranged between $365 and $431/ac, which would have significantly exceeded the treatment cost and provided substantial additional net revenue. The use of Poncho Beta as a stand-alone form of protection generated an increase of $430/ac in gross return, which also would have also easily paid for the cost of the treatment and provided a major increase in net revenue per acre. Although these results demonstrate the economic benefits of at-plant protection against SBRM feeding injury and associated yield/revenue loss, they also clearly demonstrate the economic value of applying an additive insecticide, either in the form of a planting-time insecticide (if insecticide-treated seed is used), or a postemergence insecticide application (regardless of whether the initial at-plant protection consists of a seed treatment or a granular insecticide).

It should be noted that Counter insecticide can only be applied once per year. Therefore, if Counter 20G is applied at planting, it cannot be applied postemergence to the same field. It also bears noting that Counter 20G is now labeled with 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 a much more feasible product as a postemergence option for sugarbeet root maggot control than it had been in the past, as it previously was labeled with a 110-day PHI. The 90-day PHI should work well for Red River Valley growers choosing to use Counter 20G for SBRM management. Postemergence granule applications for SBRM control in the area are typically most effective if made in late-May to early-June. If this product were to be applied to a field on June 1, the 90-day PHI would expire before September 1, which is typically the earliest that pre-pile sugarbeet harvest operations begin in the Valley.

Study II. This experiment, conducted at both St. Thomas and Thompson, ND, involved evaluations of dual-insecticide programs, comprised of either Counter 20G or Poncho Beta for the planting-time component and Lorsban Advanced (either 1 or 2 pts/ac) as the postemergence component, for SBRM control. Results from evaluations of sugarbeet root maggot larval feeding injury in Study II at **St. Thomas** indicated that a severe SBRM larval infestation was present for this trial. This is supported by the high average root maggot feeding injury rating (i.e., 8.25) recorded for the untreated check plots (Table 3). All insecticide-treated entries provided significant reductions in SBRM feeding injury when compared to that recorded in the untreated check.

The treatment combination of Counter 20G at planting, plus a postemergence application of Lorsban Advanced at its high (2 pts product/ac) rate, was the most effective program at preventing SBRM larval feeding injury at St. Thomas. This combination resulted in significantly lower feeding injury than all other treatments, except the combination of a planting-time application of Counter at 7.5 lb product/ac with a postemergence application of Lorsban at the same (2 pts/ac) rate. In entries that included Counter at planting (both 7.5- and 8.9-lb rates), the use of Lorsban Advanced was more effective at its high (2-pt) rate than the lower (1-pt) rate. It also should be noted that the addition of Lorsban Advanced at the lower rate (1 pt/ac) did not significantly improve root protection in plots initially treated with Counter at either 7.5 or 8.9 lb/ac when compared to corresponding plots that had only received the at-plant Counter application (i.e., no postemergence insecticide).

All four of the top-performing treatments at St. Thomas, with regard to protection from SBRM larval feeding injury, involved using Counter for the at-plant insecticide, including the single application (i.e., no postemergence insecticide) at 8.9 lb/ac. This suggests a slight advantage in root protection by using Counter as the at-plant protection tool. The most important overall trends with regard to root protection in this trial suggest that the rate of postemergence liquid insecticide used is more important for root protection than the at-plant insecticide rate, because there were no rate-related differences between plots that received the 7.5- and 8.9-lb rates of Counter, irrespective of whether the treatments were single applications of Counter or combinations that involved Counter plus a postemergence Lorsban spray.

Table 3. *Larval feeding injury* in an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	3.98 e
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	4.30 de
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	4.90 cd
Counter 20G	B	8.9 lb	1.8	5.33 bc
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	5.40 bc
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	5.50 bc
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	5.68 b
Poncho Beta	Seed		68 g a.i./ unit seed	5.70 b
Counter 20G	B	7.5 lb	1.5	5.73 b
Check	---	----	---	8.25 a
LSD (0.05)				0.742

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

Yield results for Study II at **St. Thomas** (Table 4) corresponded closely with the root maggot feeding injury rating data. The top-performing treatments, with regard to recoverable sucrose yield in Study II included the following: 1) Counter banded at 8.9 lb product/ac + Lorsban Advanced postemergence at 2 pts/ac; 2) Counter banded at 7.5 lb product/ac + Lorsban Advanced at 2 pts/ac; 3) Counter banded at 8.9 lb product/ac + Lorsban Advanced postemergence at 1 pt/ac; and 4) Poncho Beta-treated seed + Lorsban Advanced at 2 pts/ac. There were no significant differences among these treatments with respect to recoverable sucrose yield or root tonnage produced. The best treatment overall, regarding recoverable sucrose yield and gross economic return, was Counter banded at 8.9 lb product/ac + Lorsban Advanced postemergence at 2 pts/ac.

Table 4. *Yield parameters* from an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, St. Thomas, ND, 2018

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 Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	9088 a	29.5 a	16.68 a	1123
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	8819 ab	29.8 a	16.23 a	1032
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	8390 abc	27.6 a	16.48 a	1019
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	2 pts	68 g a.i./ unit seed 1.0	8168 abc	28.0 a	16.00 a	935
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	8077 bc	28.3 a	15.80 a	889
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	1 pt	68 g a.i./ unit seed 0.5	7879 cd	27.8 a	15.80 a	859
Poncho Beta	Seed		68 g a.i./ unit seed	7077 de	23.4 b	16.58 a	852
Counter 20G	B	7.5 lb	1.5	6948 de	23.7 b	16.10 a	799
Counter 20G	B	8.9 lb	1.8	6434 e	21.8 b	16.10 a	747
Check	---	----	---	5251 f	18.9 c	15.18 a	552
LSD (0.05)				934.7	3.11	NS	

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

As observed in root injury rating data at St. Thomas, there was no significant difference in either recoverable sucrose yield or root tonnage between the 1- and 2-pts/ac rates of Lorsban Advanced in plots initially treated with the high (8.9 lb product/ac) rate of Counter 20G. When the lower (7.5-lb) rate of Counter was used at planting, the addition of the full rate (2 pts/ac) of Lorsban Advanced resulted in significantly greater levels of recoverable sucrose per acre than when the Lorsban was applied at 1 pt/ac. In plots initially treated with Poncho Beta, there was no significant difference in either recoverable sucrose yield or root tonnage between those that received Lorsban Advanced at 1 pt/ac and those that received Lorsban at the 2-pt/ac rate. The 1 pt/ac rate of Lorsban Advanced did not provide a significant increase in sucrose yield over plots that had only been protected by Poncho Beta seed treatment; however, that rate did results in significantly greater root tonnage when compared to the Poncho Beta-only plots. There were no significant differences in recoverable sucrose or root yields between any of the single-component (i.e., at-plant-only) insecticide programs in Study II, irrespective of whether the insecticide involved Counter 20G or Poncho Beta.

Although statistical significance testing is not performed on gross economic return, it bears noting that applying Lorsban Advanced at its high rate provided major economic benefits at the St. Thomas location. For example, when Lorsban Advanced was applied at 2 pts/ac to plots initially treated with Counter 20G, gross revenues were between $104 and $143/ac greater than those recorded in similar plots where the 1-pt/ac rate of Lorsban was used. Similarly, when Poncho Beta-treated seed was used for at-plant protection, gross revenue in plots that received the full labeled rate (2 pts/ac) of Lorsban Advanced generated $76/ac gross economic return than Poncho Beta plots treated with a postemergence application of Lorsban Advanced at the 1-pt/ac rate.

Results from sugarbeet root maggot feeding injury assessments in Study II at the **Thompson, ND** location appear in Table 5. The average feeding injury recorded in untreated check plots (5.7 on the 0 to 9 scale) suggests that a moderate root maggot infestation was present at the Thompson location. However, general trends in treatment performance were similar to those observed at St. Thomas. All insecticide programs, including single at-plant protection and dual-application (i.e., planting-time plus postemergence) treatments, resulted in significant reductions in sugarbeet root maggot feeding injury when compared to that observed in the untreated check plots. The lowest overall root maggot feeding injury in this trial occurred in plots protected by the treatment combination of Counter 20G at its high (8.9 lb/ac) rate plus a postemergence application of Lorsban Advanced at 2 pts product/ac. However, that treatment was not significantly superior to the following treatments: 1) Counter 20G at planting at 8.9 lb product/ac + postemergence Lorsban Advanced at 1 pt/ac; or Counter 20G at planting at 7.5 lb product/ac + a postemergence application of Lorsban Advanced at 2 pts/ac.

Under the more moderate SBRM pressure that occurred at the Thompson location, there was no significant advantage by using the higher (2 pts/ac) versus the lower (1-pt) rate of Lorsban Advanced in plots treated at planting with Counter 20G, irrespective of whether the Counter was applied at either 7.5 or 8.9 lb product/ac. Similarly, increasing the Lorsban Advanced rate from 1 to 2 pts product per acre in plots initially protected with Poncho Beta-treated seed did not provide a significant increase in root protection from SBRM feeding injury.

Table 5. *Larval feeding injury* in an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, Thompson, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	2.35 d
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	2.78 cd
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	3.20 bcd
Counter 20G	B	8.9 lb	1.8	3.28 bc
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	3.38 bc
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	3.43 bc
Poncho Beta	Seed		68 g a.i./ unit seed	3.80 b
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	3.80 b
Counter 20G	B	7.5 lb	1.5	3.85 b
Check	---	----	---	5.70 a
LSD (0.05)				0.891

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Seed = insecticidal seed treatment; Post Broad. = postemergence

Yield results from Study II at the **Thompson** location are provided in Table 6. Despite the differences observed in root maggot feeding injury ratings among treatments at this location, there were no statistically significant differences between any of the treatments in relation to recoverable sucrose, root tonnage, or percent sucrose, including comparisons between insecticide-protected treatments and the untreated check. This is partially due to the moderate SBRM infestation that developed at Thompson, but also likely a product of treatment plot variability among replicates.

Despite the lack of significant differences in yield parameters at Thompson, it is worth considering the relative gross economic returns provided by various insecticide regimes tested. For example, insecticide protection resulted in gross revenue increases ranging from $62 to $282/ac when compared to the untreated check. Although dual-insecticide (i.e., planting-time plus postemergence) programs tended to provide greater levels of recoverable sucrose yield and root tonnage, harvest quality (mainly percent sucrose content) appeared to negatively impact the gross economic return of some of the higher-yielding treatments. It appears that, under such low to moderate SBRM pressure, a grower could optimize gross economic return by either: 1) using Poncho Beta seed treatment as a stand-alone treatment and wait to determine if high SBRM fly numbers develop; or 2) minimizing the amount of postemergence Lorsban Advanced if Counter 20G is used (at either the 7.5 lb or 8.9 product/ac rate) as the planting-time component of a dual-insecticide program.

Table 6. ***Yield parameters*** **from an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, Thompson, ND, 2018 (2)**

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 Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	10,886 a	36.2 a	16.55 a	1298
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	10,755 a	35.5 a	16.68 a	1346
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	10,584 a	35.7 a	16.40 a	1240
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	1 pt	68 g a.i./ unit seed 0.5	10,471 a	35.4 a	16.28 a	1157
Poncho Beta	Seed		68 g a.i./ unit seed	10,348 a	32.4 a	17.38 a	1377
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	2 pts	68 g a.i./ unit seed 1.0	10,154 a	33.2 a	16.73 a	1267
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	10,113 a	32.6 a	16.88 a	1164
Counter 20G	B	8.9 lb	1.8	9,905 a	31.7 a	17.00 a	1286
Counter 20G	B	7.5 lb	1.5	9,555 a	31.2 a	16.83 a	1169
Check	---	----	---	9,192 a	30.9 a	16.38 a	1095
LSD (0.05)				NS	NS	NS	

Means within a column sharing a letter are not significantly (*P* = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Seed = insecticidal seed treatment; Post Broad. = postemergence

In general, the results from Study II indicate that effective root maggot control, especially under high SBRM infestation levels such as those that developed at St. Thomas for this trial, can result in significant yield and revenue increases. The results from our Thompson location also demonstrate that, under low to moderate SBRM pressure, even single-component insecticide programs can provide economic benefits that would still easily justify their use. In either scenario, these results show that effective pest management in relation to the associated risk of economic damage from sugarbeet root maggot feeding injury can contribute substantially to maximizing economic returns from sugarbeet production in areas affected by this pest.

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