AT-PLANT AND POSTEMERGENCE INSECTICIDE COMBINATIONS TO MANAGE SUGARBEET ROOT MAGGOT

Mark A. Boetel[1], Peter C. Hakk[2], and Reed R. Thoma[3]

[1]Professor and Sugarbeet Extension Entomologist, School of Natural Resource Sciences, North Dakota State University, Fargo, ND; [2]Research Specialist, School of Natural Resource Sciences, North Dakota State University, Fargo, ND; and [3]Graduate Research Assistant, School of Natural Resource Sciences, North Dakota State University, Fargo, ND

Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the most economically damaging insect pest of sugarbeet in central and northern portions of the Red River Valley (RRV) of North Dakota and Minnesota. Previous research has shown that this insect is capable of causing more than 45% yield losses in the absence of effective control measures (Boetel et al. 2010). Sugarbeet root maggot management programs in areas at high risk of economic loss from this pest usually consist of planting-time protection, in the form of a granular, liquid, and/or seed treatment insecticide, followed by an additive postemergence insecticide application (i.e., either a granular or sprayable liquid product) when the SBRM infestation level warrants such action. Postemergence liquid insecticide treatments, applied on an as-needed, rescue basis, are the most commonly used postemergence tools for SBRM control in the region. An advantage of postemergence sprays is that they allow growers to use a "wait and see" approach to make informed decisions on whether rescue insecticide treatments are needed based on current SBRM fly activity levels in their fields. This project involved two experiments with a common overall objective of developing effective strategies to combine planting-time and postemergence insecticide tools for improving growers' ability to protect fields from sugarbeet root maggot feeding injury while also optimizing sugarbeet yield, quality, and economic return.

Materials and Methods:

Both of these experiments were conducted on a commercial sugarbeet field site near St. Thomas (Pembina County), ND during the 2025 growing season. Betaseed 8018 glyphosate-resistant seed (with or without Poncho Beta insecticidal seed treatment, depending on the experiment) was used for both experiments. Both experiments were planted on May 6, 2025. 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.

Planting-time insecticide applications: 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 consisted of two granular materials (i.e., Counter 20G and Thimet 20G) that were both band-applied (Post B) on June 2 (i.e., 5 days before peak SBRM fly activity). Delivery of postemergence banded granules was achieved by using Kinze™ row banders 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. Granules 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.

All postemergence sprayable liquid applications in these two experiments were delivered as broadcasts. All applications of Pilot 4E in Study I were made on June 4 (i.e., 3 days before SBRM peak fly activity). Single applications of Pilot 4E and Mustang Maxx in Study II were applied on June 5 (i.e., 2 days before peak fly), whereas, split applications of Pilot 4E in were made 10 days apart on June 3 and 13 (i.e., 4 days before and 6 days after SBRM peak fly activity). 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 output volume of 10 GPA through TeeJet™ 11001VS nozzles.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed for these experiments on August 7 (Study I) and August 11 (Study II). Rating procedures consisted of randomly collecting ten sugarbeet roots (i.e., five from each of the outer two treated rows) per plot, hand-washing them in a bucket of water, and scoring each 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. Study I was harvested on October 8, and Study II was harvested on October 2. 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 2025), 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. Results from sugarbeet root maggot feeding injury ratings for Study I are presented in Table 1. The level of root injury sustained by roots in the untreated check plots (mean = 5.93 on the 0 to 9 scale of Campbell et al. [2000]) suggested that a moderate SBRM infestation was present for the experiment. Significantly lower levels of SBRM feeding injury were recorded in all insecticide-protected treatments in Study I when compared to the untreated check. This showed that all insecticide treatments, including the stand-alone treatments of either Counter 20G or Poncho Beta seed treatment, as well as the multiple-component insecticide combinations, provided significant levels of protection from SBRM feeding injury.

The greatest root protection (i.e., lowest overall SBRM larval injury) in Study I occurred in plots treated at planting with Counter 20G at its high (8.9 lb product/ac) rate, then subsequently treated with a dual postemergence insecticide program comprised of Thimet 20G at its high rate (7 lb product per acre, applied 5 days before SBRM peak fly activity) that was followed by a broadcast spray of Pilot 4E at its maximum labeled rate of 2 pts of product per acre at 3 days pre-peak. Although that treatment sustained the lowest average SBRM feeding injury, it was not statistically superior to the following entries that also provided excellent root protection:

1) Counter 20G (7.5 lb/ac, at-plant band) + Thimet (7 lb/ac, 5d pre-peak) + Pilot 4E (2 pts/ac, 3d pre-peak;
2) Poncho Beta + Counter 20G (8.9 lb/ac, at-plant band) + Thimet (7 lb/ac banded, 5d before peak); and
3) Counter 20G (8.9 lb/ac, at-plant band) + Thimet (7 lb/ac banded, 5d before peak)

The remaining entries in this experiment performed at similar levels with respect to protection from root maggot feeding injury, irrespective of whether comprised of single, dual, or multi-component treatments. The relative infrequency of statistically significant differences in SBRM feeding injury among treatments in this experiment could either be a result of inter-plot variability or an artifact of the moderate root maggot infestation that developed in the plot area.

Table 1. ***Larval feeding injury*** **in an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence insecticides, for sugarbeet root maggot control, St. Thomas, ND, 2025 (Study I)**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	8.9 lb 7 lb 2 pts	1.8 1.4 1.0	2.95 d
Counter 20G + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	7.5 lb 7 lb 2 pts	1.5 1.4 1.0	3.40 cd
Poncho Beta + Counter 20G + Thimet 20G	Seed B 5 d Pre-peak Post B	 8.9 lb 7 lb	68 g a.i./ unit seed 1.8 1.4	3.60 bcd
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	4.00 bcd
Poncho Beta + Counter 20G + Thimet 20G	Seed B 3 d Pre-peak Post B	 7.5 lb 7 lb	68 g a.i./ unit seed 1.5 1.4	4.10 bc
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	4.25 bc
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	4.30 bc
Poncho Beta	Seed		68 g a.i./ unit seed	4.40 bc
Poncho Beta + Thimet 20G + Pilot 4E	Seed 5 d Pre-peak Post B 3 d Pre-peak Post B	 7 lb 2 pts	68 g a.i./ unit seed 1.4 1.0	4.45 bc
Counter 20G	B	8.9 lb	1.8	4.60 b
Poncho Beta + Thimet 20G +	Seed 5 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	4.70 b
Check	---	----	---	5.93 a
LSD (0.05)				

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; Post B = 4-inch postemergence band; Seed = insecticidal seed treatment

Yield data from Study I are presented in Table 2. Most insecticide treatments in this experiment resulted in statistically significant increases in recoverable sucrose yield when compared to the untreated check. The highest recoverable sucrose yield in this trial was produced by plots treated at planting with Counter 20G at its moderate (7.5 lb product/ac) rate, then subsequently treated with a dual postemergence insecticide program comprised of Thimet 20G at its high rate (7 lb product per acre, applied 5 days before SBRM peak fly activity) and a broadcast spray of Pilot 4E at its maximum labeled rate of 2 pts of product per acre at 3 days pre-peak. This top performer in the trial generated a gross revenue (not including product or application costs) of $2,036 per acre, which was $522/ac greater gross economic return than that recorded for the untreated check.

The following entries in Study I also provided excellent yields and gross economic returns, and were not statistically outperformed in relation to sucrose yield or root tonnage by the aforementioned top-performing treatment (i.e., Counter 20G at planting [7.5 lb/ac] + Thimet 20G [5d before peak fly, 7 lb/ac] + Pilot 4E [2 pts/ac, 3d pre-peak]):

1) Poncho Beta + Counter 20G (8.9 lb/ac, banded at planting) + Thimet 20G (7 lb/ac, 2d before peak fly);
2) Poncho Beta + Thimet 20G (7 lb/ac, 2d before peak fly) + Pilot 4E (2 pts/ac, 3d pre-peak;
3) Counter 20G (8.9 lb/ac, banded at planting) + Thimet 20G (7 lb/ac, 5d before peak fly);
4) Poncho Beta + Counter 20G (8.9 lb/ac, banded at planting); and
5) Poncho Beta.

Although these control programs resulted in numerically lower gross economic return than the aforementioned top-yielding treatment, they still generated between $335 and $490/ac more gross revenue than that recorded for the untreated check plots. Additionally, these revenue increases would have easily paid for the product and application costs associated with their use, and also would have provided excellent net returns in revenue per acre for a producer.

Table 2. *Yield parameters* from an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence insecticides, for sugarbeet root maggot control, St. Thomas, ND, 2025 (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 + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	7.5 lb 7 lb 2 pts	1.5 1.4 1.0	13,377 a	38.9 a	18.27 a	2,036
Poncho Beta + Counter 20G + Thimet 20G	Seed B 5 d Pre-peak Post B	 8.9 lb 7 lb	68 g a.i./ unit seed 1.8 1.4	13,374 a	39.4 a	18.12 a	2,004
Poncho Beta + Thimet 20G + Pilot 4E	Seed 5 d Pre-peak Post B 3 d Pre-peak Post B	 7 lb 2 pts	68 g a.i./ unit seed 1.4 1.0	13,139 a	38.4 a	18.24 a	1,990
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	12,866 ab	37.5 a	18.31 a	1,951
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	12,797 ab	37.1 ab	18.39 a	1,957
Poncho Beta	Seed		68 g a.i./ unit seed	12,662 ab	37.9 a	17.98 a	1,849
Counter 20G + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	8.9 lb 7 lb 2 pts	1.8 1.4 1.0	11,761 bc	33.4 bc	18.68 a	1,849
Poncho Beta + Counter 20G + Thimet 20G	Seed B 3 d Pre-peak Post B	 7.5 lb 7 lb	68 g a.i./ unit seed 1.5 1.4	11,550 bc	33.4 bc	18.40 a	1,776
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	11,075 cd	32.4 cd	18.20 a	1,671
Poncho Beta + Thimet 20G +	Seed 5 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	10,863 cd	31.6 cd	18.28 a	1,657
Counter 20G	B	8.9 lb	1.8	10,417 cd	29.8 cd	18.60 a	1,621
Check	---	----	---	9,867 d	28.5 d	18.37 a	1,514
LSD (0.05)				1363.9	3.98	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; Post B = 4-inch postemergence band; Seed = insecticidal seed treatment

Root injury rating data in Study II also indicated that there was no major benefit by using split post-emergence applications of Pilot 4E, because there were no significant differences among either Counter 20G or Poncho Beta based treatment combinations when Pilot was applied either once at its full labeled rate (2 pts/ac) or the moderate rate of 1 pt product per acre. This suggests that, under moderate SBRM pressure such as that present for this study, input costs could be saved by simply making a well-timed single application of Pilot 4E or a similar postemergence sprayable liquid insecticide.

Trends in Study I indicated that, despite the relatively moderate SBRM infestation pressure, triple-component insecticide programs generated numerically more sucrose yield, root tonnage, and gross revenue than single-component programs, although the differences were not always statistically significant. Interestingly, in triple-component programs that involved Counter 20G at planting, followed by Thimet 20G and a follow-up application of Pilot 4E, applying the Counter at its moderate (7.5 lb/ac) rate resulted in statistically greater recoverable sucrose and root yields than when the Counter was applied at its high label rate of 8.9 lb product per acre. This was also the case with gross revenue returns, which were $187/ac greater when the at-plant application of Counter was made at the moderate rate instead of the maximum rate.

Study II. Similar to the results from Study I, evaluations of SBRM larval feeding injury in Study II indicated that a moderate SBRM infestation developed for this trial. This was supported by the moderate level of feeding injury (i.e., 6.25 rating on the 0 to 9 scale) recorded for the untreated check plots (Table 3). All insecticide-treated entries in Study II provided significant reductions in SBRM feeding injury when compared to the untreated check, however, there were very few significant differences in root protection among insecticide treatments.

The treatment combination involving Counter 20G applied at planting at its maximum labeled rate (8.9 lb product per acre) and combined with a single postemergence application of Pilot 4E at its high rate (2 pts/ac) provided the greatest level of protection from SBRM feeding injury (i.e., lowest root ratings) in Study II. However, that treatment was not statistically different from a similar combination that involved the same high (8.9-lb) rate of Counter at planting, combined with a postemergence application of Pilot at the lower rate of 1 pt product per acre.

Similarly, the aforementioned top-performing treatment combination of Counter at 8.9 lb plus Pilot at its high (2-pt) rate was not statistically different in regard to root protection against SBRM larval damage from the combination comprised of using Poncho Beta treated seed and following with a 2-pt application of Pilot 4E at postemergence. However, when the rate of Pilot 4E in the latter combination was reduced to 1 pint per acre, it allowed significantly greater SBRM feeding injury on roots.

Table 3. ***Larval feeding injury*** **from an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence liquid insecticide sprays, for sugarbeet root maggot control, St. Thomas, ND, 2025 (Study II)**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	3.75 d
Counter 20G + Pilot 4E + Pilot 4E	B 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	4.28 cd
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	4.28 cd
Poncho Beta + Pilot 4E + Pilot 4E	Seed 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	 1 pt 1 pt	68 g a.i./ unit seed 0.5 0.5	4.33 bcd
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	4.33 bcd
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	4.45 bcd
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	4.68 bc
Poncho Beta	Seed		68 g a.i./ unit seed	4.88 bc
Counter 20G + Mustang Maxx	B 2 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	4.88 bc
Counter 20G	B	8.9 lb	1.8	5.13 bc
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	5.18 b
Check	---	----	---	6.25 a
LSD (0.05)				0.892

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 at-plant band; Seed = insecticidal seed treatment; Pre-Peak = before sugarbeet root maggot peak fly activity.

Yield results for Study II are presented in Table 4. Corresponding to the results from the SBRM feeding injury rating data, the yield analyses showed that nearly all insecticide programs provided significant increases in both recoverable sucrose yield and root tonnage in this trial.

One trend that was apparent in the yield data from this trial was that higher yields and gross revenues were generally more common in treatment combinations that involved Poncho Beta insecticide-treated seed as the at-plant component. For example, the highest overall recoverable sucrose yield in Study II was observed in plots initially protected at planting with Poncho Beta seed treatment plus a postemergence foliar application of Pilot 4E at its moderate (1 pt/ac) rate. Interestingly, that treatment combination produced numerically greater recoverable sucrose yield and root tonnage than a similar combination of Poncho Beta-treated seed that was followed by two postemergence applications of Pilot 4E, also applied at 1 pt/ac. That finding suggests two things. First, it indicates that, under moderate SBRM infestation levels such as that which developed for this trial, it may not be necessary to use the maximum rate of Pilot 4E (or a similar insecticide) to achieve excellent root maggot control while also producing excellent yields and revenue. Secondly, these results also suggest that a well-timed single postemergence insecticide spray can be sufficient for good control under moderate SBRM infestations. The only treatments that failed to result in significant recoverable sucrose and root yield increases in Study II were the stand-alone treatment of Counter 20G at its high (8.9 lb/ac) rate and the combination treatment of Counter 20G at its moderate (7.5-lb) rate plus a postemergence application of Pilot 4E, also applied at its respective moderate rate of 1 pt/ac.

The results of Studies I and II demonstrate the economic importance of the sugarbeet root maggot as an economic pest of sugarbeet in the Red River Valley. Economic benefits of effective SBRM management can easily exceed $500 per acre, even under moderate infestation levels. As such, the development implementation of effective control tools will continue to be critical to sustaining the profitability of sugarbeet production and

maximizing economic returns in areas affected by this pest. The overall results of these trials also show that, by combining at-plant insecticide protection involving either a granular insecticide such as Counter 20G or an insecticidal seed treatment (e.g., Poncho Beta, Cruiser, or NipsIt Inside), and combining it with a postemergence rescue insecticide (e.g., Thimet 20G or Pilot 4E) application can result in effective SBRM management and profitable sugarbeet production in areas affected by this pest.

Table 4. *Yield parameters* from an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence liquid insecticide sprays, for sugarbeet root maggot control, St. Thomas, ND, 2025 (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)
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	12,744 a	38.6 ab	17.70 a	1,829
Poncho Beta + Pilot 4E + Pilot 4E	Seed 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	 1 pt 1 pt	68 g a.i./ unit seed 0.5 0.5	12,669 a	39.3 a	17.33 a	1,757
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	12,150 ab	37.2 abc	17.55 a	1,720
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	11,710 bc	34.8 c-f	17.93 a	1,728
Poncho Beta	Seed		68 g a.i./ unit seed	11,651 bcd	35.8 bcd	17.52 a	1,640
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	11,410 b-e	34.4 c-g	17.71 a	1,649
Counter 20G + Pilot 4E + Pilot 4E	B 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	11,341 b-e	35.6 b-e	17.18 a	1,539
Counter 20G + Mustang Maxx	B 2 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	10,907 cde	32.6 e-h	17.93 a	1,600
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	10,707 de	32.2 fgh	17.80 a	1,557
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	10,590 ef	31.4 gh	18.03 a	1,572
Counter 20G	B	8.9 lb	1.8	10,565 ef	32.8 d-h	17.34 a	1,458
Check	---	----	---	9,662 f	30.2 h	17.18 a	1,321
LSD (0.05)				958.1	3.17	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 at-plant band; Seed = insecticidal seed treatment; Pre-Peak = before sugarbeet root maggot peak fly activity.

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