EVALUATION OF MIDAC FC® AND PONCHO BETA® FOR SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the most common and widespread insect pest of sugarbeet in the Red River Valley (RRV) growing area. Sugarbeet producers in the RRV that commonly face damaging SBRM infestations typically manage this pest by using a two-pronged approach that involves planting-time protection with a granular, liquid, or seed-applied insecticide, and following it with at least one postemergence insecticide application to avoid major yield and revenue loss.

Sugarbeet producers have had to mostly rely on insecticides belonging to the same mode of action, acetylcholinesterase (ACHE) inhibition for managing the SBRM for well over four decades, because only a small number of insecticide products have been commercially available for use in the crop. This long-term, repeated use of ACHE inhibitor insecticides has exerted a considerable amount of selection pressure for the development of ACHE insecticide resistance in RRV sugarbeet root maggot populations.

In August of 2021, the U.S. Environmental Protection Agency (EPA) revoked all food crop tolerances for chlorpyrifos, which has been the most commonly used postemergence insecticide active ingredient for postemergence SBRM control for several years. Therefore, it is critical that non-ACHE insecticide options be pursued to manage this serious economic pest.

In recent years, EPA approved registration of Midac FC for use in sugarbeet. Imidacloprid, the active ingredient in Midac FC, is a neonicotinoid insecticide. This class involves an entirely different mode of action (i.e., antagonism of the postsynaptic nicotine acetylcholine receptor in the central nervous system) for insect control from that of the long-used ACHE-based insecticides. Other neonicotinoids have been used as insecticidal seed treatments for sugarbeet insect pest control since 2008. One purported benefit of Midac FC is its compatibility for tank mixing with starter fertilizer formulations. Inclusion of starter fertilizer with sugarbeet planting is commonly practiced by Red River Valley producers, especially in the central and northern Valley. However, little is known about its potential impacts, either positive or negative, on insecticide performance, plant safety, or resulting crop yield.

The key objective of this experiment was to evaluate the efficacy of Midac FC for sugarbeet root maggot control. Secondarily, this research was conducted to determine the impacts of combining Midac with 10-34-0 starter fertilizer, and also integrating it with Poncho Beta insecticidal seed treatment for single-pass insect and fertility management in sugarbeet. A third objective was to monitor for potential negative impacts (e.g., phytotoxicity) from dual- and multiple-component combinations of Midac, Poncho Beta, and 10-34-0 starter fertilizer.

Materials and Methods:

This field experiment was conducted near St. Thomas in rural Pembina County, ND during the 2022 growing season. Betaseed 8961 glyphosate-tolerant seed was used for all treatments in the trial, and it was planted on May 27, 2022 by using a 6-row Monosem NG Plus 4 7x7 planter set to deliver seed 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 by 35 long, with the four centermost rows treated. Insecticide was excluded from each of the outside rows (i.e., rows 1 and 6) of the planter, and those “guard rows” served as untreated buffers. Thirty-five-foot alleys between replicates were maintained weed-free by using periodic cultivation throughout the growing season. The experiment was arranged in a randomized complete block design with four replications of the treatments.

Midac FC was applied using dribble in-furrow (DIF) placement by orienting microtubes (1/4” outside diam.) directly into the open seed furrow. Inline Teejet™ No. 24 orifice plates were used to stabilize the output rate of the spray solutions from the microtubes. Most at-plant treatments included 10-34-0 fertilizer (i.e., 10, 34, and 0%

nitrogen, phosphorus, and potassium, respectively), which was diluted to a 3:2 gallon ratio of fertilizer to water. Water used for all spray solutions in this experiment was adjusted to pH 6.0 several days before use. All planting-time liquid applications were delivered in a finished spray volume output of 5 GPA.

Non-fertilizer entries included Counter 20G at two application rates (i.e., 7.5 and 8.9 lb product/ac), and a true untreated check. A fertilizer-only check was also included as a control for comparative purposes. Counter 20G was evaluated as a stand-alone treatment and also in combination with a concurrent application of the fertilizer/water solution. 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 a planter-mounted SmartBox™ insecticide delivery system that had been calibrated on the planter before all applications.

Plant Stand Counts: To determine treatment impacts on seedling emergence and survival throughout the growing season, surviving plant stands were counted on June 21, and July 7 and 14, 2022 (i.e., 25, 41, and 48 days after planting [DAP], respectively). Plant stand assessments involved counting all living plants within each 35-ft-long row of each plot. Raw stand counts were then converted to plants per 100 linear row feet for the analysis.

Root injury ratings: Sugarbeet root maggot feeding injury ratings were conducted on August 2, 2022. Sampling consisted of 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 a dead plant) of Campbell et al. (2000).

Harvest: Plots were harvested on October 6, 2022. Immediately before harvest, all foliage was removed from plots by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were then extracted from soil using a mechanical harvester and weighed in the field using a harvester-mounted 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 plant stand, root injury rating, and harvest data were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012). Means were compared by using Fisher's protected least significant difference (LSD) test at a 0.05 alpha level for declaring significant differences.

Results and Discussion:

The results from all three plant stand counts is presented in Table 1. Treatments are tabulated in descending order of mean surviving plant stand recorded at the final count (48 DAP). Thus, careful attention is required to assess stand count comparisons from the previous dates. Interpretation of this data should also be made considering the fact that impacts of the insecticide and fertilizer treatments on seedling establishment would be most apparent during the earlier stand counts. Conversely, the later, and especially the final stand counts would be more likely to reflect treatment impacts on seedling survival in relation to protection from SBRM larval feeding injury.

The highest plant densities at the first stand count (i.e., 25 DAP) were observed plots treated with an at-plant application of Counter 20G at its high (i.e., 8.9 lb product/ac) labeled rate; however, plant stands in most other insecticide treatments were not significantly lower than those in plots treated with that rate of Counter. Exceptions, in which stands were statistically lower than those recorded for plots treated with Counter at 8.9 lb, included the Midac/10-34-0 starter fertilizer tank mixture and the combination treatment comprised of Counter at 7.5 lb/ac and a concurrent application of starter fertilizer. Additionally, the stand counts recorded for those two lesser-performing treatments were not statistically different from the counts recorded in the untreated check or the fertilizer check.

By the time the 41 DAP counts were conducted (July 7), the majority of SBRM fly activity had ceased, suggesting that most of the infestation would have been about three weeks into the larval root-feeding period. The highest plant stands at 41 DAP were recorded in plots that received the treatment combination comprised of Poncho Beta-treated seed and a planting-time-applied tank mixture of Midac plus 10-34-0 starter fertilizer; however, there were no significant differences between any of the insecticide-treated plots in the experiment. Additionally, all treatments that included an insecticide, irrespective of whether starter fertilizer was included, resulted in significantly greater plant stands than those recorded in the untreated check and the fertilizer control.

Surviving plant stand counts conducted at 48 DAP corresponded closely to those conducted at 41 DAP in that the highest plant stands were recorded in plots planted with Poncho Beta-treated seed and an at-plant, DIF-applied tank mixture of Midac plus 10-34-0 starter fertilizer. Also reflective of the previous counts was that there were no significant differences in plant stands among insecticide-based treatments in the experiment. Interestingly, at this final stand count, the starter fertilizer check had significantly less plants per 100 ft than the untreated check.

Collectively, the data from this series of three plant stand counts suggests that 10-34-0 starter fertilizer itself can reduce or delay sugarbeet seedling emergence, at least under the light-textured soil conditions that characterized this field location. This finding corresponds with the results from previous work on similar treatments that included starter fertilizer.

Table 1. ***Plant stand counts*** **from an evaluation of Poncho Beta insecticidal seed treatment and Midac FC® insecticide for sugarbeet root maggot control, St. Thomas, ND, ND, 2022**

Treatment/form.[a]	Placement[b]	Rate (product/ ac)	Rate (lb a.i./ac)	Stand count[c] (plants / 100 ft) 25 DAP[c]	41 DAP[c]	48 DAP[c]
Poncho Beta + Midac FC + 10-34-0	Seed DIF	13.6 fl oz 5 GPA	68 g a.i./ unit seed 0.18	233.2 ab	220.0 a	225.2 a
Midac FC + 10-34-0	DIF	13.6 fl oz 5 GPA	0.18	224.8 bcd	207.5 a	215.7 a
Counter 20G	B	8.9 lb	1.8	240.7 a	209.6 a	215.2 a
Counter 20G	B	7.5 lb	1.5	232.5 abc	205.5 a	210.4 a
Poncho Beta + 10-34-0	Seed DIF	5 GPA	68 g a.i./ unit seed	229.8 abc	215.2 a	206.2 a
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5	220.7 cd	206.2 a	203.0 a
Check	-----	----	-----	228.0 bcd	165.2 b	142.3 b
10-34-0 fertilizer check	DIF	5 GPA	-----	217.5 d	157.0 b	115.4 c
LSD (0.05)				11.95	20.41	23.84

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]At-plant sprays were delivered in a 10-34-0 starter fertilizer/water carrier (3:2 gal. H_2O to fertilizer) at an output volume of 5 GPA.
[b]B = 5-inch at-plant band; Post B = postemergence band (i.e., 4-inch width for granular products; 10-inch width for sprayable liquid formulations); DIF = dribble in-furrow
[c]Surviving plant stands were counted on 21 June, and 7 and 14 July, 2022 (i.e., 25, 41, and 48 days after planting [DAP], respectively).

Sugarbeet root maggot feeding injury rating results from this experiment are presented in Table 2. Average root injury ratings in the untreated check (6.68) and fertilizer-only check (7.35) indicated that a moderately high SBRM infestation was present for the study. All insecticide treatments provided significant reductions in root maggot larval feeding injury when compared to that recorded for the untreated check and fertilizer-only check.

Table 2. ***Larval feeding injury*** **from an evaluation of Poncho Beta® insecticidal seed treatment and Midac FC® insecticide for sugarbeet root maggot control, St. Thomas, ND, 2022**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5	3.65 c
Counter 20G	B	8.9 lb	1.8	3.90 bc
Poncho Beta + Midac FC + 10-34-0	Seed DIF	13.6 fl oz 5 GPA	68 g a.i./ unit seed 0.18	3.95 bc
Midac FC + 10-34-0	DIF	13.6 fl oz 5 GPA	0.18	4.45 bc
Counter 20G	B	7.5 lb	1.5	4.78 bc
Poncho Beta + 10-34-0	Seed DIF	5 GPA	68 g a.i./ unit seed	4.93 b
Check	-----	----	-----	6.68 a
10-34-0 fertilizer check	DIF	5 GPA	-----	7.35 a
LSD (0.05)				1.199

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]Carrier for at-plant treatments that included starter fertilizer involved a 3:2 gal. ratio of H_2O to liquid 10-34-0 fertilizer. Output volume was 5 GPA.
[b]Seed = insecticidal seed treatment; B = 5-inch band at planting; 3" TB = 3-inch band over open seed furrow at planting; DIF = dribble in-furrow at planting

The lowest root maggot feeding injury ratings (i.e., greatest SBRM control) in this trial occurred in plots that received a combination treatment consisting of a planting-time banded application of Counter 20G at its moderate, 7.5-lb rate, with a concurrent application of starter fertilizer. However, the only treatment to which that combination was superior in providing SBRM control was the Poncho Beta plus 10-34-0 starter fertilizer treatment.

Yield data from this experiment are provided in Table 3. The top-yielding treatment in the trial, with regard to both recoverable sucrose yield and root tonnage, was the combination of Poncho Beta-treated seed plus a DIF-applied tank mixture of Midac FC and starter fertilizer. Combining these two pest management tools (i.e., Poncho Beta-treated seed and Midac FC) increased gross economic return by $191/ac over Poncho Beta alone and by $60/ac over Midac alone. Additionally, plots managed with the Poncho Beta/Midac/starter fertilizer combination increased recoverable sucrose yield by 3,721 lb and root yield by 11.5 tons per acre, and generated $713/ac in additional revenue per acre when compared to the fertilizer-only check. These results suggest that this combination could be a beneficial planting-time management approach that could be coupled with an effective postemergence insecticide component to manage high SBRM infestations.

All other treatments that included an insecticide produced similar levels of recoverable sucrose yield and root tonnage which were not significantly different from the top-yielding Poncho Beta/Midac/starter fertilizer combination. However, the highest overall gross economic return in the experiment was generated by plots treated with Counter 20G at planting by using its high labeled rate of 8.9 lb product per acre, which generated $21/ac more revenue than the Poncho Beta/Midac/starter fertilizer combination.

Two other concerning results in this study involved the inclusion of 10-34-0 starter fertilizer. In treatments that involved a planting-time application of Counter 20G at 7.5 lb product per acre, the inclusion of a DIF application of 10-34-0 fertilizer resulted in a $74 reduction in gross revenue when compared to the revenue generated by the stand-alone treatment of Counter without the fertilizer. Even more striking was that the 10-34-0 starter fertilizer check produced significantly lower recoverable sucrose yield and root tonnage (i.e., by 20.2% and 18.4%, respectively), as well as a gross revenue loss of $271/ac when compared to the untreated check.

Table 3. *Yield parameters* from an evaluation of Poncho Beta® insecticidal seed treatment and Midac FC® insecticide for sugarbeet root maggot control, St. Thomas, ND, 2022

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 + Midac FC + 10-34-0	Seed DIF	 13.6 fl oz 5 GPA	68 g a.i./ unit seed 0.18	8,836 a	27.1 a	17.20 a	1,704
Counter 20G	B	8.9 lb	1.8	8,793 a	26.4 ab	17.53 a	1,725
Counter 20G	B	7.5 lb	1.5	8,600 a	25.4 ab	17.72 a	1,711
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5	8,383 a	25.3 ab	17.37 a	1,637
Midac FC + 10-34-0	DIF	13.6 fl oz 5 GPA	0.18	8,341 a	24.9 ab	17.55 a	1,644
Poncho Beta + 10-34-0	Seed DIF	 5 GPA	68 g a.i./ unit seed	7,730 a	23.3 b	17.49 a	1,513
Check	-----	----	-----	6,412 b	19.2 c	17.53 a	1,262
10-34-0 fertilizer check	DIF	5 GPA	-----	5,115 c	15.6 d	17.20 a	991
LSD (0.05)				1,257.0	3.50	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).

[a]Carrier for at-plant treatments that included starter fertilizer involved a 3:2 gal. ratio of H_2O to liquid 10-34-0 fertilizer. Output volume was 5 GPA.

[b]Seed = insecticidal seed treatment; B = 5-inch band at planting; 3" TB = 3-inch band over open seed furrow at planting; DIF = dribble in-furrow at planting

Overall results of this trial suggest that, for growers intending on applying Counter 20G at planting and also including a concurrent application of 10-34-0 starter fertilizer, it is advisable to dilute the fertilizer to at least the 3:2 gallon (i.e., 3 gallons of fertilizer to 2 gallons of water) ratio used in this study, or even further, especially if planning on including a planting-time application of Counter 20G. Results also suggest that combining Poncho Beta-treated seed with an application of Midac FC plus 10-34-0 starter fertilizer may improve SBRM control and resulting yield and gross revenue over that of either Poncho Beta or Midac FC alone, although the improvements observed in 2022 were not statistically significant.

It should be noted that previous NDSU research suggests that Midac FC performs at a comparable level to that of the moderate rate of Counter 20G (i.e., 7.5 lb product/ac). Thus, if planting-time insecticide protection is limited to Midac FC, the grower should plan on making a postemergence rescue insecticide application to augment SBRM control, especially in areas where economically moderately high or greater root maggot infestations are expected. Finally, most of the treatments tested in this trial need further testing to determine the repeatability of these results. This is especially the case concerning the safety of combining Counter 20G applications with concurrent starter fertilizer applications.

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