# MIDAC FC® INSECTICIDE FOR SUGARBEET ROOT MAGGOT CONTROL: RESULTS FROM A TWO-YEAR SCREENING TRIAL

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**Introduction:**

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the key insect pest of sugarbeet in the Red River Valley (RRV) growing area. In areas at moderate to high risk of damaging SBRM infestations, RRV sugarbeet producers typically manage this pest by initially using either a granular, liquid, or seed treatment insecticide during planting operations. Additionally, in cases where moderately high to severe SBRM fly infestations develop, one to two postemergence insecticide applications are necessary to protect the crop from major yield and revenue loss. Since the mid-1970s, most of these applications have involved the use of insecticides in the organophosphate and carbamate classes to manage the sugarbeet root maggot. Both of these insecticide classes kill insects through the same mode of action, which is acetylcholinesterase (ACHE) inhibition.

Grower dependence on this single insecticide mode of action for SBRM control in the Red River Valley has been largely due to two factors. First, a limited number of insecticide products have been registered for use in the crop for several decades. Second, despite frequent screening efforts on a variety of insecticides belonging to other modes of action, very few candidate insecticide products tested have shown promise as viable alternatives for SBRM control. As a result of this long-term, repeated use of ACHE inhibitor insecticides, the threat of insecticide resistance development in RRV sugarbeet root maggot populations has been a serious concern of pest management advisors and producers for several years.

In 2019, the U.S. Environmental Protection Agency (EPA) approved the registration of Midac FC for use in sugarbeet and potato. Although the current EPA-issued Midac FC label does not specifically list sugarbeet root maggot as a target pest, Vive Crop Protection has issued a Section 2(ee) recommendation for planting-time applications of this product for SBRM control. The 2(ee) recommendation is a legal designation, offered to end-users by the registrant, as permitted by EPA through statutory authority under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1910. The FIFRA 2(ee) designation allows a user to apply "*a pesticide against any target pest not specified on the labeling if the application is to the crop, animal, or site specified on the labeling, unless the Administrator has required that the labeling specifically state that the pesticide may be used only for the pests specified on the labeling after the Administrator has determined that the use of the pesticide against other pests would cause an unreasonable adverse effect on the environment*." This provides legal permission for producers and other applicators to use Midac FC for sugarbeet root maggot management in sugarbeet. However, they must be in physical possession of the published 2(ee) recommendation/product bulletin at the time the product is being applied.

Imidacloprid, the active ingredient in Midac FC, belongs to the neonicotinoid insecticide class, which involves a different mode of action in insects (i.e., antagonism of the postsynaptic nicotine acetylcholine receptor in the central nervous system). Although neonicotinoids offer an alternative action mode, it should be noted that insecticides from this class have been widely used as seed treatments for insect management in sugarbeet since 2008. As such, although Midac FC provides an alternative to the ACHE inhibitors, which have been used for more than four decades, it does not offer a truly novel insecticide mode of action for SBRM management.

This project was carried out to evaluate the efficacy of Midac FC, and also Bifender FC, which is not yet registered for use in sugarbeet, as planting-time insecticides for sugarbeet root maggot control. A secondary objective was to determine the compatibility of these products with 10-34-0 starter fertilizer in planting-time applications (only tested in 2018).

**Materials and Methods:**

This two-year experiment was conducted on grower-owned field sites near St. Thomas in rural Pembina County, ND during the 2018 and 2019 growing seasons. Betaseed 89RR52 glyphosate-resistant seed was used for all treatments in 2018, and Betaseed 8524 (also glyphosate-resistant) was the variety used in 2019. Plots were planted on 14 May in 2018, and on 15 May in 2019. All plots were planted 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, 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. Each plot was 35 feet long, and 35-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 three replications of the treatments.

Planting-time insecticide applications: Planting-time applications of Counter 20G were applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular application rates were regulated by using planter-mounted SmartBox™ computer-controlled insecticide delivery system that had been calibrated on the planter before all applications.

Planting-time liquid insecticides included Bifender FC (active ingredient bifenthrin, a pyrethroid insecticide), and Midac FC (active ingredient imidacloprid, a neonicotinoid). In 2018, all treatments involving Bifender and Midac were applied in a 100% 10-34-0 (N-P-K) starter fertilizer solution through Teejet™ 650067 flat fan nozzles. In 2019, all planting-time applications of Midac FC and Bifender FC were applied in a 100% water-based (i.e., no starter fertilizer) spray solution, and the water used was adjusted to pH 6.0 about one week before use. All planting-time liquid insecticides were applied in a finished spray volume output of 5 GPA during both test years.

Bifender FC was applied by using both dribble-in-furrow (DIF) and T-band placement, whereas Midac was only applied via DIF placement. T-band placement was achieved by orienting the output fan of each nozzle (TeeJet™ 400067E) to be directly perpendicular to the row, and nozzle height was adjusted on each row to achieve a 3-inch band over the open seed furrow. Dribble in-furrow applications were made by orienting microtubes (1/4" outside diam.) directly into the open seed furrow. Inline Teejet™ No.29 orifice plates were used to stabilize the output rate of the spray solutions from the microtubes. To establish consistent fertility for all treatments, the same rate of starter fertilizer was also applied to Counter-treated plots and the untreated checks. An additional no-fertilizer control was included in 2018 to monitor for potential phytotoxicity; however, none was detected, so that treatment was eliminated from the final combined two-year data analysis.

Root injury ratings: Sugarbeet root maggot feeding injury ratings were conducted on 31 July each year. 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 dead beet) of Campbell et al. (2000).

Harvest: Plots were harvested on 25 September in 2018, and on 19 September in 2019. Immediately (i.e., between 10 and 60 min) before harvest of each year, 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 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) according to the general linear models (GLM) procedure (SAS Institute, 2012). Treatment means were compared by using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance. Initial analyses indicated that there were no significant treatment × year interactions for root injury ratings ($P = 0.1766$), recoverable sucrose yield ($P$ = 0. 3397), root yield ($P = 0.1412$), or percent sucrose content data ($P = 0.1264$). As such, two-year combined analyses were performed on all data from this experiment.

**Results and Discussion:**

Results from sugarbeet root maggot feeding injury ratings in this two-year trial are presented in Table 1. Moderate to high SBRM infestations were present during these evaluations, with feeding pressure in 2018 being higher than that observed in 2019. Averaged across years, the SBRM feeding injury rating for the untreated check plots was 6.17 on the 0 to 9 scale of Campbell et al. [2000]).

All insecticide treatments in this study provided significant reductions in SBRM feeding injury when compared to that recorded for the untreated check plots. The lowest average root maggot feeding injury was observed in plots protected by the T-banded application of Bifender FC (the only experimental product (i.e., not registered for use in sugarbeet) screened in the experiment. The level of root protection provided by the T-banded application of Bifender was significantly greater (i.e., lower larval feeding injury) than that provided by Midac and the dribble-in-furrow (DIF) application of Bifender. Counter 20G also provided good root protection, despite being applied at a moderate labeled rate (7.5 lb product/ac), and it was not significantly outperformed by the T-banded application of Bifender. Also, there was no significant difference between DIF applications of Midac FC and Bifender FC when both products were applied by using DIF placement.

**Table 1. *Larval feeding injury* from a two-year field trial on Midac FC, Bifender FC, and Counter 20G for sugarbeet root maggot control, St. Thomas, ND, 2016 – 2017**

| Treatment/form. | Placement[a] | Rate (product/ac) | Rate (lb a.i./ac) | Root injury (0-9) |
|---|---|---|---|---|
| Bifender FC | 3” TB | 7.84 fl oz | 0.107 | 3.53 c |
| Counter 20G | B | 7.5 lb | 1.5 | 4.23 bc |
| Midac FC | DIF | 13.6 fl oz | 0.179 | 4.52 b |
| Bifender FC | DIF | 7.84 fl oz | 0.107 | 4.83 b |
| Check | --- | --- | --- | 6.17 a |
| LSD (0.05) | | | | 0.710 |

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; 3” TB = 3-inch T-band; DIF = dribble in-furrow

Yield data from this experiment are shown in Table 2. All insecticide treatments, except the DIF application of Bifender FC, provided significant increases in recoverable sucrose yield in comparison to the untreated check. Plots protected by the T-banded application of Bifender produced significantly greater recoverable sucrose yield than all other insecticide treatments in the study, including Midac FC and the moderate rate (7.5 lb/ac) of Counter 20G. Applying Bifender via T-band placement was also statistically superior to DIF placement of Bifender in relation to both recoverable sucrose yield and root yield. Plots protected by the T-banded application of Bifender FC produced significantly greater root yields than all other treatments in the experiment, except those treated with Midac. Additionally, the T-banded application of Bifender was the only treatment in the trial that resulted in statistically greater root yield than the untreated check.

**Table 2. *Yield parameters* from a two-year field trial on Midac FC, Bifender FC, and Counter 20G for sugarbeet root maggot control, St. Thomas, ND, 2016 – 2017**

| Treatment/form. | Placement[a] | Rate (product/ac) | Rate (lb a.i./ac) | Sucrose yield (lb/ac) | Root yield (T/ac) | Sucrose (%) | Gross return/ ac |
|---|---|---|---|---|---|---|---|
| Bifender FC | 3” TB | 7.84 fl oz | 0.107 | 8899 a | 30.2 a | 16.18 a | $1,141 |
| Midac FC | DIF | 13.6 fl oz | 0.179 | 8009 b | 27.7 ab | 16.18 a | $1,001 |
| Counter 20G | B | 7.5 lb | 1.5 | 7904 b | 27.5 b | 16.00 a | $984 |
| Bifender FC | DIF | 7.84 fl oz | 0.107 | 7092 c | 25.4 b | 15.68 a | $845 |
| Check | --- | --- | --- | 6991 c | 25.2 b | 15.63 a | $823 |
| LSD (0.05) | | | | 748.7 | 2.54 | 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

Although all insecticide treatments in this trial involved a single application, which is not recommended for areas at risk of to high SBRM population pressure, most of them provided excellent increases in gross economic return. The top-performing treatment, T-banded Bifender FC, generated $1,141 in gross revenue, which was an increase of $318/ac when compared to the untreated check. Similarly, the Midac FC application resulted in a revenue increase of $178/ac, and the Counter treatment improved gross economic return by $161/ac. As such, these treatments would have easily paid for themselves in the added revenue.

Bifender FC tended to perform better than most treatments in this experiment when it was applied by using T-band placement; however, our overall results (i.e., root injury ratings and yield data) suggest that Midac FC was also providing moderate levels of SBRM control. This was demonstrated by two factors. The first was the fact that Midac-treated plots produced significantly more recoverable sucrose yield (i.e., an additional 1,018 lb/ac) than the untreated check plots and the DIF application of Bifender. Secondly, the recoverable sucrose and root yields produced by Midac-treated plots were not significantly different from those produced by plots protected by the moderate rate (7.5 lb product/ac) of Counter 20G. Additional testing on Midac should include comparisons of T-band versus DIF placement to determine the most effective approach at applying this new sugarbeet insecticide.

Overall, our findings suggest with fairly strong likelihood that combining Midac with other pest management tools, such as a postemergence rescue insecticide application if the infestation warrants it, should enable producers to successfully protect their sugarbeet crop from otherwise economically damaging SBRM populations. Moreover, such programs, which integrate different insecticide modes of action, should be used by RRV sugarbeet growers to help slow or prevent the onset of insecticide resistance in area populations of the sugarbeet root maggot.

Finally, it is critical to state that, although it performed well in this experiment when applied as a T-band, Bifender FC is not yet registered for use in sugarbeet, and it is uncertain as to whether it ever will be. As such, until it receives registration for sugarbeet, applying Bifender to the crop would be an illegal application that could lead to a serious fine and also condemnation of the harvest from the affected field.

**References Cited:**

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**Acknowledgments:**

The authors greatly appreciate Wayne and Austin Lessard for allowing us to conduct this research on their farm. Sincere gratitude is extended to the Sugarbeet Research and Education Board of Minnesota and North Dakota for providing significant funding to support this project. We also appreciate the contributions of Alex Baker, Juliana Hanson, Clara Jastram, Zane Miller, Brett Skarda, Rachel Stevens, Claire Stoltenow, and Kenan Stoltenow for assistance with plot maintenance, stand counting, root sample collection, and data entry. This work was also partially supported by the U.S. Department of Agriculture, National Institute of Food and Agriculture, under Hatch project number ND02398.