# SPRINGTAIL CONTROL IN SUGARBEET: EFFICACY OF GRANULAR, SPRAYABLE LIQUID, AND SEED-APPLIED INSECTICIDES

Mark A. Boetel, Professor
Jacob J. Rikhus, Research Specialist

Department of Entomology, North Dakota State University, Fargo, ND

## Introduction:

Springtails are wingless, nearly microscopic, insect-like organisms that belong to the Collembola, a primitive order of Arthropods. Subterranean springtails are also blind, spending their entire lives below the soil surface (Boetel et al. 2001). In sugarbeet production systems, subterranean springtails tend to thrive in heavy soils with high levels of soil organic matter, and multiple species within at least two genera have been identified as damaging sugarbeet in North Dakota and eastern Montana. Cool and wet weather can be conducive to springtail damage because those conditions slow sugarbeet seed germination and seedling development, rendering young seedlings extremely vulnerable to attack by springtails that are tolerant to the moisture and cold. In such cases, these pests can cause major sugarbeet stand and yield losses if not properly controlled.

Subterranean springtails have been recognized as a serious threat to sugarbeet production in the central and southern Red River Valley of Minnesota and North Dakota since the late-1990s. Impacts from these pests on the sugarbeet crop are most evident in early spring, and usually involve wilting and dying seedlings within irregular-shaped patches within the field. The size of damaged areas within a field can range from a few-hundred square feet to patches that can exceed 10 acres.

We conducted a field experiment in Clay County, Minnesota to achieve the following objectives in relation to springtail control: 1) screen the performance of Counter 20G, a conventional granular insecticide, at three different application rates; 2) compare the efficacy of T-banded and dribble in-furrow applications of Mustang Maxx; 3) evaluate Midac FC as a liquid insecticide option; 4) compare the efficacy provided by neonicotinoid insecticidal seed treatments (i.e., Cruiser, NipsIt Inside, and Poncho Beta); 5) determine if springtail management in sugarbeet can be optimized by combining planting-time applications of Midac and Mustang Maxx with Poncho Beta-treated seed; and 6) assess Movento HL as a postemergence rescue insecticide treatment for springtail control.

## Materials & Methods:

This experiment was established in a commercial sugarbeet field near Glyndon (Clay County), MN. Plots were planted on July 6, 2022 by 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. Betaseed 8961, a glyphosate-tolerant sugarbeet variety, was used for all treatments. Individual treatment plots were two rows (22-inch spacing) wide and 25 feet long, and 25-ft wide tilled alleys were maintained between replicates throughout the growing season. The experiment was arranged in a randomized complete block design with ten replications of the treatments. *NOTE: Two-row plots are the preferred experimental unit size in springtail trials because infestations of these pests are usually patchy. A smaller test area increases the likelihood of uniform springtail densities among plots within replicates of an experiment.*

Insecticidal seed treatment materials were applied to seed by Germain's Technology Group (Fargo, ND). Counter 20G insecticide granules were applied by using band placement (Boetel et al. 2006), which consisted of 5-inch swaths delivered through Gandy™ row banders. Planting granular output rates were regulated by using a planter-mounted SmartBox™ electronically-controlled insecticide delivery system that was calibrated on the planter before all applications.

Midac FC was applied by using dribble-in-furrow (DIF) placement, and Mustang Maxx was applied either in 3-inch T-bands or by using DIF placement. T-band placement of Mustang Maxx was achieved by orienting the output fan of each nozzle (TeeJet™ 450067E) directly perpendicular to the row, and nozzle height was adjusted on each row to achieve the desired 3-inch band width 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. 18 orifice plates were used to provide backpressure for stabilizing the output rate of spray solutions from the microtubes.

<u>Plant stand counts</u>: Treatment efficacy was compared by conducting counts of surviving plants in each plot because subterranean springtails cause early-season stand losses that can lead to yield reductions. Stand counts

involved counting all living plants within each of two 25-ft-long rows per plot. Counts were conducted on July 19 and 27, and August 9, 2022, which were 13, 21, and 34 days after planting (DAP), respectively.

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. All plots were harvested on October 12, 2022. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from both 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: Raw data from plant stand counts were converted to plants per 100 linear row feet for the analysis. All stand count and yield data 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:**

Plant stand count data for this trial appear in Table 1. The treatments are presented in descending order of performance as observed at the last stand count (34 DAP). As such, the best-performing treatment, according to sugarbeet plant stand protection at 34 DAP, is listed in the top row.

At the initial stand count (13 DAP), the highest stand counts were recorded in plots protected by Poncho Beta-treated seed plus a postemergence 10-inch band of Movento HL (2.5 fl oz/ac). However, it should be pointed out that Poncho Beta was responsible for the stand protection in this treatment at this count date, because Movento was not applied until July 28 (i.e., 9 days after these counts).

Other treatments with excellent plant stands at 13 DAP included the following (listed in descending order of recorded stand count at 13 DAP):

1) Poncho Beta-treated seed plus Mustang Maxx (T-banded at planting, 4 fl oz/ac);
2) Counter 20G (planting-time band, 5.9 lb product/ac);
3) Counter 20G (planting-time band, 7.5 lb product/ac); and
4) NipsIt Inside-treated seed.

All insecticide treatments, except the DIF application of Mustang Maxx, provided statistically significant levels of springtail control (i.e., protection from stand loss associated with springtail feeding injury) when compared to the untreated check plots at 13 DAP. Relatively low stand counts (i.e., high stand losses) were also recorded in plots established with the treatment combination of Poncho Beta-treated seed plus a DIF application of Mustang Maxx. Those counts were not statistically different from the Mustang-only plots when the insecticide was applied DIF, thus suggesting that dribble-in-furrow may not be the optimal placement method for applying Mustang Maxx. Another interesting result at 13 DAP was that the treatment combination of Poncho Beta-treated seed plus a T-band application of Mustang Maxx resulted in significantly greater surviving plant stands than those recorded for either Poncho Beta alone or the T-banded application of Mustang Maxx alone. Additionally, in the direct comparison of dribble-in-furrow versus T-band placement of Mustang Maxx, the latter was superior in protecting plants from mortality associated with springtail damage.

At 21 DAP, excellent plant stands were being maintained by several treatments. The highest average plant densities per 100 row ft were recorded in plots treated with a planting-time application of Counter 20G at a moderate rate of 5.9 lb product per acre. Excellent stands, which were not significantly different from that of the 5.9-lb Counter 20G treatment, were also observed in the following treatments (listed in descending order of average plant stand at 21 DAP):

1) Poncho Beta-treated seed plus Movento HL (postemergence 10-inch bands, 2.5 fl oz/ac);
2) Counter 20G (planting-time band, 7.5 lb product/ac);
3) Poncho Beta-treated seed plus Mustang Maxx (T-banded at planting, 4 fl oz/ac);
4) Cruiser-treated seed;

5) Poncho Beta-treated seed;

6) Counter 20G (planting-time band, 4.5 lb product/ac); and

7) Poncho Beta-treated seed plus Midac FC (DIF, 13.6 fl oz/ac).

**Table 1.** ***Plant stand counts*** **from an evaluation of planting-time, seed-applied, and postemergence foliar insecticides for springtail control, Glyndon, MN, 2022**

| Treatment/form. | Placement[a] | Rate (product/ac) | Rate (lb a.i./ac) | Stand count[b] (plants / 100 ft) | | |
|---|---|---|---|---|---|---|
| | | | | 13 DAP[c] | 21 DAP[c] | 34 DAP[c] |
| Poncho Beta +<br>Mustang Maxx | Seed<br>3" TB | <br>4 fl oz | 68 g a.i./ unit seed<br>0.025 | 176.2 ab | 185.4 ab | 179.2 a |
| Counter 20G | B | 7.5 lb | 1.5 | 164.6 abc | 187.6 ab | 172.4 ab |
| Poncho Beta +<br>Movento HL | Seed<br>10" Post B | <br>2.5 fl oz | 68 g a.i./ unit seed<br>0.078 | 176.6 a | 192.8 ab | 172.4 ab |
| Poncho Beta +<br>Midac FC | Seed<br>DIF | <br>13.6 fl oz | 68 g a.i./ unit seed<br>0.18 | 160.2 bc | 171.0 ab | 170.8 ab |
| Counter 20G | B | 5.9 lb | 1.2 | 166.2 abc | 196.4 a | 167.2 ab |
| Cruiser 5FS | Seed | | 60 g a.i./ unit seed | 155.2 c | 180.0 ab | 162.2 ab |
| Poncho Beta | Seed | | 68 g a.i./ unit seed | 154.2 c | 176.8 ab | 158.0 b |
| NipsIt Inside | Seed | | 60 g a.i./ unit seed | 164.4 abc | 168.6 b | 158.0 b |
| Counter 20G | B | 4.5 lb | 0.9 | 153.2 c | 172.4 ab | 155.0 b |
| Poncho Beta +<br>Mustang Maxx | Seed<br>DIF | <br>4 fl oz | 68 g a.i./ unit seed<br>0.025 | 88.8 de | 109.8 cd | 112.0 c |
| Mustang Maxx | 3" TB | 4 fl oz | 0.025 | 98.8 d | 108.4 cd | 106.8 c |
| Midac FC | DIF | 13.6 fl oz | 0.18 | 97.4 d | 112.2 c | 106.8 c |
| Mustang Maxx | DIF | 4 fl oz | 0.025 | 76.6 ef | 101.2 cd | 83.8 d |
| Check | --- | --- | --- | 63.2 f | 82.4 d | 62.0 e |
| LSD (0.05) | | | | 16.39 | 27.74 | 17.92 |

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; T-band = 3" swath over open seed furrow at planting; Seed = insecticidal seed treatment; Post B = postemergence band

[b]Surviving plant stands were counted on July 19 and 27, and Aug. 9 (i.e., 13, 21, and 34 days after planting [DAP], respectively).

[c]DAP = Days after planting

Plots planted with NipsIt Inside insecticidal seed treatment had significantly lower plant stands in comparison to that recorded in plots treated with Counter 20G at 5.9 lb product per acre at 21 DAP; however, they did not differ statistically from any of the other seven above-listed treatments at that stand count date. All of the aforementioned eight treatments, including NipsIt Inside and Counter 20G (i.e., all application rates) resulted in significantly greater numbers of surviving plants at 21 DAP than the following treatments: 1) Poncho Beta-treated seed plus Mustang Maxx, applied DIF at 4 fl oz/ac; 2) Mustang Maxx alone at 4 fl oz/ac (i.e., both DIF and 3-inch T-band); 3) Midac FC applied alone, DIF at 13.6 fl oz/ac; and 4) the untreated check. However, the only treatments that failed to provide a significant stand improvement compared to the untreated check at 21 DAP were both single planting-time treatments of Mustang Maxx (i.e., DIF and 3" T-band), and the combination treatment comprised of Poncho Beta plus the DIF application of Mustang Maxx.

Results from the final stand counts, which were conducted at 34 DAP, were somewhat similar to those taken at 21 DAP. All insecticide-treated plots had greater plant stands than the untreated check; however, the largest average number of surviving plants was recorded in plots protected by the combination treatment of Poncho Beta-treated seed plus a planting-time application of Mustang Maxx that was delivered in 3-inch T-bands. That treatment resulted in a final average plant stand that was nearly three times that recorded for the untreated check.

Other treatments that resulted in favorable final plant stands that were not statistically different from the top treatment included the following (listed in descending order of surviving plant stand at 34 DAP):

1) Counter 20G (planting-time band, 7.5 lb product/ac);

2) Poncho Beta-treated seed plus Movento HL (postemergence, 10-inch bands, 2.5 fl oz/ac);

3) Poncho Beta-treated seed plus Midac FC (DIF, 13.6 fl oz/ac);

4) Counter 20G (planting-time band, 5.9 lb product/ac); and

5) Cruiser-treated seed.

Treatment combination of Poncho Beta seed plus a 3-inch T-band of Mustang Maxx also resulted in surviving plant stands that were significantly (60%) greater than those in plots treated with the Poncho Beta/Mustang Maxx combination when the Mustang was applied DIF. Similarly, in plots treated with a stand-alone application of Mustang Maxx, surviving stands were significantly (27.4%) greater when the insecticide was applied as a 3-inch T-band than when it was delivered by using DIF placement.

There were no significant differences in surviving plant stands among seed treatment insecticides at 34 DAP, although plots planted with Cruiser-treated seed were the only seed treatment-protected plots in which plant stands were not significantly different from the top treatment at 34 DAP. Similarly, there were no statistically significant differences among application rates of Counter 20G, although the higher rates (i.e., 7.5 and 5.9 lb product/ac) were the only Counter treatments that were not statistically outperformed by the top-performing treatment (i.e., Poncho Beta/Mustang Maxx, 3” T-band) with respect to surviving plant stands at 34 DAP. This finding suggests that producers planning on using Counter 20G for at-plant protection in high-risk areas for losses associated with springtail damage should apply the insecticide at a minimum of 5.9 lb product per acre.

Yield results from this experiment appear in Table 2. NOTE: as stated in the Materials and Methods section of this report, this trial was planted at an unusually late date (i.e., July 6; shortly after the infestation was detected), which resulted in atypically low yields for even the most effective insecticide treatments in this trial. However, the overall performance patterns observed in relation to yield parameters provided excellent insights on the efficacy of the insecticides tested.

**Table 2. *Yield parameters* from an evaluation of planting-time, seed-applied, and postemergence foliar insecticides for springtail control, Glyndon, MN, 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 + Mustang Maxx | Seed 3” TB | 4 fl oz | 68 g a.i./ unit seed 0.025 | 4,631 a | 17.0 a | 15.19 ab | 738 |
| Counter 20G | B | 5.9 lb | 1.2 | 4,576 ab | 17.0 a | 15.10 ab | 718 |
| Counter 20G | B | 7.5 lb | 1.5 | 4,444 ab | 16.3 ab | 15.21 a | 709 |
| NipsIt Inside | Seed | | 60 g a.i./ unit seed | 4,417 ab | 16.1 ab | 15.26 a | 708 |
| Poncho Beta + Movento HL | Seed 10” Post B | 2.5 fl oz | 68 g a.i./ unit seed 0.078 | 4,396 ab | 16.0 ab | 15.26 a | 711 |
| Counter 20G | B | 4.5 lb | 0.9 | 4,329 ab | 16.5 ab | 14.77 bc | 654 |
| Cruiser 5FS | Seed | | 60 g a.i./ unit seed | 4,249 ab | 15.8 ab | 15.10 ab | 667 |
| Poncho Beta + Midac FC | Seed DIF | 13.6 fl oz | 68 g a.i./ unit seed 0.18 | 4,181 b | 15.3 b | 15.24 a | 670 |
| Poncho Beta | Seed | | 68 g a.i./ unit seed | 4,176 b | 15.2 bc | 15.35 a | 674 |
| Midac FC | DIF | 13.6 fl oz | 0.18 | 3,658 c | 13.7 cd | 15.02 abc | 569 |
| Mustang Maxx | 3” TB | 4 fl oz | 0.025 | 3,539 c | 13.1 d | 15.10 ab | 559 |
| Poncho Beta + Mustang Maxx | Seed DIF | 4 fl oz | 68 g a.i./ unit seed 0.025 | 3,338 c | 12.9 d | 14.61 cd | 498 |
| Mustang Maxx | DIF | 4 fl oz | 0.025 | 3,230 c | 12.8 d | 14.26 de | 464 |
| Check | --- | ---- | --- | 2,574 d | 10.5 e | 13.98 e | 354 |
| LSD (0.05) | | | | 432.3 | 1.55 | 0.424 | |

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; T-band = 3” swath over open seed furrow at planting; Seed = insecticidal seed treatment

Yield results corresponded closely with the patterns observed in the last two counts of surviving plant stands. For example, the highest recoverable sucrose yield, root tonnage, and gross economic return were achieved by protecting plots with a combination of Poncho Beta-treated seed plus a planting-time 3-inch T-band of Mustang Maxx at its maximum labeled rate of 4 fl oz per acre. That treatment increased sucrose yield by over 2,000 lb, added nearly seven tons of root yield, and provided a gross revenue increase of $384 when compared to the untreated check. Other treatments that provided excellent yield benefits, and which were not significantly different from the top-yielding treatment (i.e., Poncho Beta/Mustang Maxx, 3-inch T-band) in generating either recoverable sucrose yield or root tonnage included the following:

1) Counter 20G (planting-time band, 5.9 lb product/ac);
2) Counter 20G (planting-time band, 7.5 lb product/ac);
3) NipsIt Inside seed treatment;
4) Poncho Beta-treated seed plus Movento HL (postemergence, 10-inch bands, 2.5 fl oz/ac);
5) Counter 20G (planting-time band, 4.5 lb product/ac); and
6) Cruiser-treated seed.

The top-yielding treatment (i.e., Poncho Beta-treated seed plus a 3-inch T-band of Mustang Maxx), as well as all of the above-listed treatments, resulted in significantly greater recoverable sucrose yield and root tonnage than the stand-alone applications of Midac FC, Mustang Maxx (i.e., either DIF or 3" T-band), and the combination treatment comprised of Poncho Beta-treated seed plus DIF-applied Mustang Maxx. This pattern reflected stand count results, and it also has been observed in previous testing; however, the dramatic superiority of the 3-inch T-band over DIF placement of Mustang Maxx in this experiment was somewhat surprising.

An important overall finding from this trial was that the top-yielding treatments, which were not significantly different from each other in recoverable sucrose or root yield, provided gross revenue increases ranging between $313 and $385 per acre when compared with the untreated check. Additionally, even the lowest-yielding insecticide treatment (i.e., Mustang Maxx, applied DIF) resulted in a revenue increase of $110/ac.

Collectively, these findings demonstrate the significance of subterranean springtails as serious economic pests of sugarbeet and also illustrate the importance of effectively managing them. Sugarbeet producers planning to grow sugarbeet in areas with a known history of springtail infestations should seriously consider using one of the better-performing control tools from this trial. If choosing to use a planting-time application of Mustang Maxx, it is strongly recommended that the product be applied in 3-inch T-bands to optimize performance. If that is not a practical option, it may be advisable to equip the planter with granular application equipment, and protect the crop from springtail infestations with planting-time bands of Counter 20G. Growers choosing to use Counter 20G in a springtail risk area should apply it at a rate between 5.9 and 7.5 lb product per acre.

Growers interested in using Midac FC for springtail control should probably integrate it with a neonicotinoid-treated seed treatment until its efficacy against these pests is better understood and characterized. Finally, the positive results from using Movento HL as a postemergence rescue insecticide treatment for springtail control in this trial are encouraging, but this the first such observation on Movento for springtail management. Further research is needed to determine the repeatability of those results. Additionally research should be continued on several other treatments in this study to identify consistently effective tools for managing subterranean springtails in the Red River Valley sugarbeet production area.

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