# SPRINGTAIL CONTROL IN SUGARBEET ALONG THE MONTANA/NORTH DAKOTA BORDER: EFFICACY OF GRANULAR, SPRAYABLE LIQUID, AND SEED-APPLIED INSECTICIDES

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**Introduction:**

Subterranean (soil-dwelling) springtails are tiny, nearly microscopic, blind, and wingless insects that spend their entire lives below the soil surface (Boetel et al. 2001). These organisms belong to the Collembola, a primitive order of Arthropods, and most species resemble insects; however, due to some unusual anatomical features, they are technically not true insects. In sugarbeet production systems, subterranean springtails tend to thrive in heavy soils with high levels of soil organic matter. Cool and wet weather can be conducive to buildups of springtail infestations because such conditions slow sugarbeet seed germination and seedling development, which renders plants extremely vulnerable to attack by springtails that are not negatively impacted by cool temperatures. Therefore, these pests can cause major sugarbeet stand and yield losses if conditions are conducive to their development and reproduction.

These pests 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. However, in recent years, sugarbeet producers in the western ND and eastern Montana (MonDak) growing area have also experienced significant yield and revenue losses due to major springtail infestations. In some cases, the infestations have been sufficiently severe as to result in failures of some insecticidal approaches aimed at controlling them. We conducted a field experiment in the MonDak growing area to achieve the following objectives in relation to MonDak-area springtail infestations: 1) screen the performance of Counter 20G, a conventional granular insecticide, at different application rates; 2) evaluate the efficacy of both T-banded and dribble in-furrow applications of Mustang Maxx, Midac FC, and Bifender liquid insecticides; 3) compare the efficacy provided by neonicotinoid insecticidal seed treatments (i.e., Cruiser, NipsIt Inside, and Poncho Beta); and 4) determine if springtail management in sugarbeet can be optimized by combining planting-time applications of Midac and Mustang Maxx with Poncho Beta-treated seed.

**Materials & Methods:**

This experiment was established in a grower-owned sugarbeet field near Fairview (Richland County) in northeastern, MT. Plots were planted on 7 May, 2020 using a four-row John Deere 71 Flex planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Betaseed 8524, a glyphosate-tolerant seed variety, was used for all treatments. Individual treatment plots were two rows (24-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 four replications of the treatments.
*NOTE: Two-row plots are the preferred experimental unit size in springtail trials because infestations of these pests are typically patchy. A smaller test area increases the likelihood of having a sufficiently uniform springtail infestation among plots within each replicate of the experiment.*

Insecticidal seed treatment materials (i.e., Cruiser, NipsIt Inside, and Poncho Beta) 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™ computer-controlled insecticide delivery system that was calibrated on the planter immediately before all applications.

Planting-time sprayable liquid insecticides (i.e., Bifender FC, Midac FC, and Mustang Maxx were applied as either 3-inch T-bands or by using dribble-in-furrow (DIF) placement. T-band placement was achieved by orienting the output fan of each nozzle (TeeJet™ 450067E) to be 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$^{TM}$ No. 18 orifice plates were used to provide backpressure for stabilizing the output rate of spray solutions from the microtubes.

Treatment efficacy was compared by using surviving plant stand counts because subterranean springtails cause early-season stand losses that can lead to yield reductions. Stand counts involved counting all living plants within each 25-ft-long row. Plant stand counts were taken on June 1, 9, and 15, 2020, which were 25, 33, and 39 days after planting (DAP), respectively. Raw stand counts were converted to plants per 100 linear row feet for the analysis. All stand count 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 (39 DAP). As such, the best-performing treatment, with regard to surviving sugarbeet plant stand, is listed in the top row. At the initial stand count (25 DAP), the highest stand counts were recorded in plots protected by the following treatment combinations: 1) Poncho Beta-treated seed plus a T-banded application of Mustang Maxx (4 fl oz/ac); and 2) Poncho Beta-treated seed plus a T-banded application of Midac FC (13.6 fl oz/ac). Plots treated with a banded application of Counter 20G at the moderate rate of 5.9 lb product/ac also had plant densities that were not statistically different from Poncho Beta plus T-banded Mustang or Poncho Beta plus T-banded Midac FC, and all of the aforementioned treatments provided significant levels of stand protection when compared to the untreated check.

Other treatments that were not statistically different from all of the aforementioned treatments, but were also not different from the check, included the following (listed in descending order of recorded stand count):

1) Poncho Beta-treated seed;
2) Mustang Maxx T-banded at 4 fl oz/ac (maximum labeled rate per application);
3) NipsIt Inside-treated seed;
4) Poncho Beta-treated seed plus Mustang Maxx, applied DIF at 4 fl oz/ac; and
5) Bifender T-banded at 10.97 fl oz/ac.

| **Table 1.** ***Plant stand counts*** **from an evaluation of planting-time granular, liquid, and seed treatment insecticides for springtail control, Fairview, MT, 2020** | | | | | | |
|---|---|---|---|---|---|---|
| **Treatment/form.** | **Placement[a]** | **Rate (product/ac)** | **Rate (lb a.i./ac)** | **Stand count[b] (plants / 100 ft)** | | |
| | | | | **25 DAP[c]** | **33 DAP[c]** | **39 DAP[c]** |
| Poncho Beta + Mustang Maxx | Seed 3" TB | 4 fl oz | 68 g a.i./ unit seed 0.025 | 135.0 a | 161.0 a | 164.0 a |
| Poncho Beta + Mustang Maxx | Seed DIF | 4 fl oz | 68 g a.i./ unit seed 0.025 | 114.0 a-e | 152.0 a-d | 163.0 ab |
| Poncho Beta | Seed | | 68 g a.i./ unit seed | 127.0 abc | 150.0 a-e | 158.0 ab |
| Poncho Beta + Midac FC | Seed 3" TB | 13.6 fl oz | 68 g a.i./ unit seed 0.18 | 135.0 a | 157.0 ab | 158.0 ab |
| Counter 20G | B | 5.9 lb | 1.2 | 133.0 ab | 154.0 abc | 153.0 abc |
| Cruiser 5FS | Seed | | 60 g a.i./ unit seed | 109.0 a-e | 143.0 a-f | 152.0 abc |
| Nipslt Inside | Seed | | 60 g a.i./ unit seed | 118.0 a-e | 131.0 a-g | 150.0 a-d |
| Midac FC | DIF | 13.6 fl oz | 0.18 | 101.0 b-e | 120.0 a-g | 136.0 a-e |
| Bifender FC | 3" TB | 10.97 fl oz | 0.15 | 102.0 a-e | 132.0 a-g | 127.0 a-e |
| Mustang Maxx | 3" TB | 4 fl oz | 0.025 | 122.0 a-d | 123.0 a-g | 126.0 a-e |
| Counter 20G | B | 7.5 lb | 1.5 | 85.0 e | 115.0 b-g | 122.0 b-e |
| Midac FC | 3" TB | 13.6 fl oz | 0.18 | 93.0 de | 105.0 fg | 114.0 cde |
| Mustang Maxx | DIF | 4 fl oz | 0.025 | 99.0 cde | 113.0 c-g | 109.0 de |
| Bifender FC | 3" TB | 6.6 fl oz | 0.09 | 99.0 cde | 107.0 efg | 107.0 e |
| Counter 20G | B | 4.5 lb | 0.9 | 96.0 cde | 109.0 d-g | 102.0 e |
| Check | --- | ---- | --- | 99.0 cde | 96.0 g | 102.0 e |
| LSD (0.05) | | | | 33.57 | 43.83 | 41.68 |

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

[b]Surviving plant stands were counted on June 1, 9, and 15, 2020 (i.e., 25, 33, and 39 days after planting, respectively).

[c]DAP = Days after planting

Interestingly, at 25 DAP, plots treated with the moderate rate of Counter 20G (5.9 lb product/ac) had significantly greater plant stand densities than those treated with Counter at either 4.5 or 7.5 lb product/ac. This could have been a product of two independent causal factors. First, the lower rate may not provide sufficient control of the springtail species present in this field. Second, the higher rate may have had a negative impact on seedling emergence timing or possibly seedling survival that was independent of springtail feeding injury.

Results from the second series of plant stand counts, conducted at 33 DAP, were somewhat similar to the first stand counts. The following treatment plots had the highest average stand counts, and all had significantly greater stands than those recorded in the untreated check plots (listed in descending order of recorded stand count):

1) Poncho Beta-treated seed Mustang Maxx T-banded at 4 fl oz/ac;
2) Poncho Beta-treated seed Midac FC T-banded at 13.6 fl oz/ac;
3) Counter 20G banded at 5.9 lb product/ac;
4) Poncho Beta-treated seed Mustang Maxx applied DIF at 4 fl oz/ac;
5) Poncho Beta-treated seed; and
6) Cruiser-treated seed.

A performance pattern at 33 DAP that was similar to that at 25 DAP was that surviving plant stands in plots treated at planting with the moderate (i.e., 5.9-lb) rate of Counter 20G were significantly greater than those in plots that received Counter 20G at the low labeled rate of 4.5 lb product per acre. Plant stands in plots treated with Counter 20G at the higher rate of 7.5 lb product per acre were intermediate between those recorded for plots treated at 4.5 and 5.9, but were not significantly different from either of the other two rates.

At the final stand count date (39 DAP), plant densities had increased in most treatment plots. Similar to the results from the earlier stand assessments, the following treatments resulted in the highest plant densities, and all had significantly greater stands than those recorded in the untreated check plots (listed in descending order of recorded stand count):

1) Poncho Beta-treated seed Mustang Maxx T-banded at 4 fl oz/ac;
2) Poncho Beta-treated seed Mustang Maxx applied DIF at 4 fl oz/ac;
3) Poncho Beta-treated seed;
4) Poncho Beta-treated seed Midac FC T-banded at 13.6 fl oz/ac;
5) Counter 20G banded at 5.9 lb product/ac;
6) Cruiser-treated seed; and
7) NipsIt Inside-treated seed.

Plots in which surviving plant stands were not statistically different from stands in the untreated check plots at 39 DAP included those treated with the following single-component insecticide treatments: Midac FC (i.e., both T-banded and DIF applications), T-banded applications of Bifender (i.e., both 6.6 and 10.97 fl oz/ac), Mustang Maxx (i.e., both T-banded and DIF applications), and Counter 20G when it was applied at either 4.5 or 7.5 lb product per acre.

Yield data from this experiment appear in Table 2. Unfortunately, despite large numerical differences between treatments, no significant differences could be detected in the yield analyses. This was probably due to a large amount of variability in springtail infestations and potentially other unidentified agronomic factors among and within replicates in the plot area.

Despite a lack of statistically significant differences in yield parameters among treatments, several general performance patterns were evident, with some corresponding to and reinforcing the stand count results. A few of the yield responses appeared to contradict some of the stand count results. For example, in comparing the three application rates of Counter 20G, plots treated at the intermediate rate (i.e., 5.9 lb product/ac) had greater plant stands than those treated with the lower and higher rates (i.e., 4.5 and 7.5 ) of the insecticide. However, plots treated with the 7.5-lb rate of Counter 20G produced considerably more recoverable sucrose and root tonnage than those treated with either the moderate or low rate of that product. Also, plots treated with the 7.5-lb rate of Counter 20G generated $250 and $359 more in gross revenue than those treated with Counter at 5.9 and 4.5 lb product per acre, respectively. At a minimum, these results suggest that producers choosing to use Counter 20G for springtail management in the MonDak growing area should avoid using the 4.5-lb rate of this product.

| **Table 2.** ***Yield parameters*** **from evaluation of planting-time granular, liquid, and seed treatment insecticides for springtail control, Fairview, MT, 2020** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **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 | B | 7.5 lb | 1.5 | 9,469 a | 27.6 a | 17.08 a | 1397 |
| Midac FC | 3” TB | 13.6 fl oz | 0.18 | 8,916 a | 26.2 a | 17.03 a | 1304 |
| Poncho Beta + Midac FC | Seed 3” TB | 13.6 fl oz | 68 g a.i./ unit seed 0.18 | 8,767 a | 25.0 a | 17.48 a | 1324 |
| Poncho Beta + Mustang Maxx | Seed 3” TB | 4 fl oz | 68 g a.i./ unit seed 0.025 | 8,459 a | 23.7 a | 17.81 a | 1302 |
| Cruiser 5FS | Seed | | 60 g a.i./ unit seed | 8,327 a | 23.6 a | 17.62 a | 1265 |
| Poncho Beta | Seed | | 68 g a.i./ unit seed | 8,271 a | 23.4 a | 17.68 a | 1260 |
| Poncho Beta + Mustang Maxx | Seed DIF | 4 fl oz | 68 g a.i./ unit seed 0.025 | 8,173 a | 23.6 a | 17.39 a | 1219 |
| Nipslt Inside | Seed | | 60 g a.i./ unit seed | 8,012 a | 22.8 a | 17.66 a | 1215 |
| Mustang Maxx | 3” TB | 4 fl oz | 0.025 | 7,962 a | 23.2 a | 17.43 a | 1176 |
| Counter 20G | B | 5.9 lb | 1.2 | 7,904 a | 21.7 a | 17.54 a | 1147 |
| Midac FC | DIF | 13.6 fl oz | 0.15 | 7,538 a | 22.0 a | 17.14 a | 1110 |
| Mustang Maxx | DIF | 4 fl oz | 0.025 | 7,262 a | 20.2 a | 18.00 a | 1126 |
| Bifender FC | 3” TB | 10.97 fl oz | 0.15 | 7,074 a | 19.9 a | 17.64 a | 1086 |
| Counter 20G | B | 4.5 lb | 0.9 | 6,737 a | 18.9 a | 17.97 a | 1038 |
| Bifender FC | 3” TB | 6.6 fl oz | 0.09 | 6,660 b | 19.3 a | 17.38 a | 992 |
| Check | --- | ---- | --- | 6,633 b | 18.6 a | 17.89 a | 1022 |
| 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 = banded at planting; T-band = 3” swath over open seed furrow at planting; Seed = insecticidal seed treatment

Another surprising result in the yield data was that plots protected by the T-banded application of Midac FC produced the second-highest recoverable sucrose yield and root yield in the trial. This also is somewhat contrary to the stand count data, in which plots treated with Midac that was delivered via DIF placement had numerically, but not significantly, lower surviving plant stands than those in which the Midac was delivered in 3” T-bands.

Yield-related findings that corresponded well with stand count data involved the use of Mustang Maxx. First of all, the general trend was that plots that received Mustang Maxx tended to yield better when the insecticide was delivered as a 3” T-band than when it was applied by using DIF placement. This was the case for Mustang-only treatments and for those that involved an integrated combination of Poncho Beta-treated seed plus Mustang Maxx. A very positive finding was that combining Poncho Beta-treated seed with Mustang Maxx resulted in numerically greater recoverable sucrose yield and root tonnage than sole reliance on either Poncho Beta-treated seed or Mustang Maxx alone.

At a minimum, it should be noted that the highest-yielding entry in the trial, Counter 20G banded at 7.5 lb product per acre, produced a yield increase of more than 2,800 lb in recoverable sucrose above the untreated check. Also, the five best-yielding entries in this trial generated between $243 and $375/ac in gross economic return when compared with the revenue generated by the untreated check. Therefore, despite a lack of significant yield differences among treatments in this study, the findings demonstrate the significance of subterranean springtails as serious economic pests of sugarbeet and also illustrate the importance of effectively managing them.

MonDak area growers planning to grow sugarbeet in areas with a known history of problems with springtails, especially in areas of reported seed treatment insecticide failures, 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, Mustang Maxx should probably be integrated with a neonicotinoid insecticidal seed treatment of the grower’s choosing. Another effective option would be to equip the planter with granular application technology, and protect the crop from springtail infestations with planting-time bands of Counter 20G, and apply the insecticide at a minimum of 5.9 lb product per acre. Growers interested in using Midac FC for springtail control in the MonDak growing area should probably integrate it with a neonicotinoid-treated seed treatment until its efficacy against these pests is better understood and characterized. This research should be continued to pursue consistently effective springtail management tools in this growing area. Finally, it should be noted that Bifender FC, a sprayable liquid insecticide product, was not registered for use in sugarbeet at the time this research was conducted or published.

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