# RATE AND PLACEMENT IMPACTS ON REGISTERED SOIL INSECTICIDES FOR CONTROL OF THE SUGARBEET ROOT MAGGOT

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## Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the key economic insect pest of sugarbeet in the Red River Valley of MN and ND. High feeding injury levels can be sufficient to kill sugarbeet plants, especially under dry soil conditions. Thus, the insect can cause major stand reductions and significant yield losses. This project was carried out to evaluate the performance of registered insecticides at planting time using varying rates and different placement methods for controlling the sugarbeet root maggot.

## Materials and Methods:

Research sites for this experiment were near St. Thomas, ND and Crookston, MN were planted on May 12 and May 15, respectively. Treatments included planting-time applications of Counter 15G, Counter 20CR, Lorsban 15G, and Mustang 0.8EC, and the experiment were arranged in a randomized complete block design with four replications. Insecticide treatments were applied using standard or after-market insecticide delivery equipment mounted on the planter. Noble metering units were used to regulate delivery of granular insecticide materials, and ***banded*** applications of granules were delivered in a 5-inch swath over the row using Gandy$^{TM}$ banders. ***Modified in-furrow*** placement consisted of dropping granules down a standard planter-equipped in-furrow tube over the row; however, granules were directed near the rear press wheel so some soil would cover the seed before the insecticide reached the row. This placement method resulted in a 2- to 3-inch band with the heaviest insecticide concentrations being placed immediately over the row (it is critical that the insecticide does not come in contact with the seed when using this application technique).

A Raven$^{TM}$ liquid application system was used to meter delivery rates of planting-time liquid insecticide treatments. Planting-time Vydate applications were also carried out using the Raven$^{TM}$ liquid application system with a finished spray volume of 15GPA being delivered to the rows using Teejet$^{TM}$ 8002E nozzles in a 5-inch band. Postemergence granules were applied directly over the row in 4-inch bands through Kinze$^{TM}$ banders and output was regulated by using Noble metering units. Postemergence liquid treatments were applied in 7-inch bands by using a tractor-mounted tool bar and a $CO_2$-powered canister system that delivered a spray volume of 15 GPA through four Teejet$^{TM}$ 6502E nozzles.

Treatment performance in preventing sugarbeet root maggot feeding injury was assessed by rating 10 beets per plot on the 0 to 9 damage rating scale of Campbell et al. (2000). Criteria for individual points on the scale are presented in Appendix 1 of this report. Yield impacts of the treatments were also evaluated. All foliage was removed from the plots using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were lifted using a mechanical harvester. Total harvested beets were weighed in the field by using a digital scale. A representative subsample of beets (approx. 12) was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for analysis of sugar content and quality. All data were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure, and means were separated using the Fisher protected least significant difference (LSD) test at a 0.05 level of significance for treatment effects on root injury, sugarbeet root yield, total recoverable sucrose per acre, and percent sucrose content.

## Results:

Maggot infestations ranged from moderate to slightly high in the trials at St. Thomas, and pressure was quite low at Crookston. This range of severe to low root maggot feeding pressure provides an excellent stage for comparing performance of control tactics. Varying conditions, not only with regard to the root maggot infestation level, but also under other agronomic differences relating to soil characteristics and rainfall received are also important justifications for conducting this research in different locations. Specific agronomic information (e.g., rainfall information, etc.) for St. Thomas and Crookston are presented in Appendix 2 and 3, respectively, at the end of this report.

**St. Thomas.** Root injury ratings in the untreated check plots at St. Thomas indicated a moderate sugarbeet root maggot infestation (Table 1). All insecticide applications resulted in significant reductions in maggot feeding injury at this location. Although not always significant, Counter 15G and 20CR tended to perform better when applied using modified in-furrow placement. Root protection provided by Counter 15G was not impacted by rate when applied in a band. Beet plots treated with modified in-furrow applications of Counter 15G at the standard (10 lb/ac) rate had the least amount of feeding injury in the entire test, although the 10-lb rate did not outperform 7 lbs. Two of the higher labeled rates (7 and 10 lb/ac) of Counter 15G applied modified in-furrow provided better protection than the 5.9-lb rate. Lorsban 15G plots treated at the 10- and 13.4-lb application rates had numerically lower root injury ratings than the 6.7-lb treatment, although none of the rates were significantly different.

**Table 1. Effect of rate, formulation, and placement method on registered insecticide performance in preventing sugarbeet root maggot *feeding injury*, St. Thomas, ND, 2003**

| Treatment/form. | Placement | Rate (lb product/ac) | Rate (lb ai/ac) | Root injury (0-9) |
|---|---|---|---|---|
| Counter 15G | M | 10 | 1.5 | 3.73 h |
| Counter 20CR | M | 7.5 | 1.5 | 4.00 gh |
| Counter 20CR | M | 9 | 1.8 | 4.13 fgh |
| Counter 15G | M | 7 | 1.05 | 4.13 fgh |
| Counter 15G | B | 11.9 | 1.8 | 4.15 fgh |
| Counter 15G | B | 7 | 1.05 | 4.33 efg |
| Counter 15G | M | 11.9 | 1.8 | 4.53 defg |
| Counter 15G | B | 10 | 1.5 | 4.60 def |
| Counter 20CR | B | 9 | 1.8 | 4.65 cdef |
| Lorsban 15G | B | 10 | 1.5 | 4.73 bcdee |
| Lorsban 15G | B | 13.4 | 2.0 | 4.83 bcde |
| Counter 15G | M | 5.9 | 0.9 | 4.88 bcde |
| Counter 20CR | B | 4.5 | 0.9 | 4.95 bcd |
| Counter 20CR | M | 4.5 | 0.9 | 4.98 bcd |
| Counter 20CR | B | 7.5 | 1.5 | 5.05 bcd |
| Counter 15G | B | 5.9 | 0.9 | 5.20 bc |
| Lorsban 15G | B | 6.7 | 1.0 | 5.28 b |
| Check | --- | --- | --- | 6.38 a |
| LSD (0.05) | | | | 0.56 |

Yield impacts in this study were not statistically detectable (Table 2). This occurs often in years where root maggot pressure is at moderate or lower levels, and differences are even less likely to be detectable when adequate soil moisture is present at depths of 3 inches and deeper. This restricts feeding by root maggot larvae to more shallow depths in the soil profile and away from the tip of the sugarbeet tap root. Adequate moisture also allows the plant to tolerate more feeding injury and recover by assimilating water and nutrients from the soil. Plants that only sustain feeding injury on the upper portions of the root will not likely incur economic yield losses. Yield trends generally supported the data from root injury ratings. As seen in the root injury data, the higher application rates of Counter 15G tended to yield more recoverable sucrose than the lowest rate when the product was applied modified in-furrow. This trend was also evident in data for sugarbeet root yield. Applying the standard rate (10 lb) of Counter in a band gave the highest average recoverable sucrose in the experiment. Correspondingly, this treatment gave the best economic return at an average of $97/ac more than that from the untreated check.

**Table 2. Effect of rate, formulation, and placement method on *yield parameters* in plots treated with registered insecticides to control sugarbeet root maggot larvae, St. Thomas, ND, 2003**

| Treatment/form. | Placement | Rate (lb product/ac) | Rate (lb ai/ac) | Recoverable sucrose (lb/ac) | Root yield (T/ac) | Sucrose (%) | Gross return ($/ac) |
|---|---|---|---|---|---|---|---|
| Counter 15G | B | 10 | 1.5 | 7731 a | 26.1 a | 16.50 a | 845 |
| Counter 15G | M | 11.9 | 1.8 | 7624 a | 26.3 a | 16.33 a | 814 |
| Counter 20CR | M | 7.5 | 1.5 | 7421 a | 25.6 a | 16.28 a | 790 |
| Counter 15G | B | 5.9 | 0.9 | 7364 a | 25.1 a | 16.33 a | 797 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Counter 20CR | M | 9 | 1.8 | 7300 a | 25.7 a | 16.15 a | 763 |
| Counter 15G | B | 7 | 1.05 | 7257 a | 26.2 a | 15.68 a | 735 |
| Counter 15G | M | 10 | 1.5 | 7232 a | 25.8 a | 15.93 a | 741 |
| Lorsban 15G | B | 13.4 | 2.0 | 7135 a | 24.5 a | 16.25 a | 764 |
| Counter 15G | M | 7 | 1.05 | 7117 a | 25.0 a | 16.05 a | 744 |
| Counter 20CR | M | 4.5 | 0.9 | 7087 a | 25.0 a | 16.05 a | 738 |
| Counter 20CR | B | 9 | 1.8 | 7082 a | 24.8 a | 16.13 a | 742 |
| Lorsban 15G | B | 6.7 | 1.0 | 7076 a | 24.0 a | 16.43 a | 767 |
| Lorsban 15G | B | 10 | 1.5 | 7052 a | 25.8 a | 15.68 a | 703 |
| Check | --- | --- | --- | 7037 a | 24.4 a | 16.18 a | 748 |
| Counter 20CR | B | 4.5 | 0.9 | 6986 a | 24.5 a | 16.15 a | 730 |
| Counter 15G | B | 11.9 | 1.8 | 6970 a | 24.9 a | 15.88 a | 714 |
| Counter 15G | M | 5.9 | 0.9 | 6873 a | 24.2 a | 16.03 a | 717 |
| Counter 20CR | B | 7.5 | 1.5 | 6725 a | 23.9 a | 16.00 a | 692 |
| LSD (0.05) | | | | NS | NS | NS | |

**Crookston.** Root maggot feeding injury was light at this location with damage ratings averaging only 3.68 and 4.2 for the untreated check and fertilizer-only treatments, respectively (Table 3). Feeding damage was so low that no statistical differences were detected between treatments, even when the best-performing products were compared with the check.

No significant yield responses were observed when comparing different rates of either Counter 15G, 20CR, or Lorsban 15G insecticides when applied using band placement. Although root maggot feeding injury was light at Crookston, the yield data from this location was much more interesting. Modified in-furrow applications of Counter 15G had significantly lower recoverable sucrose and root yields (Tons/ac) than banded treatments. This was the case when the insecticide was applied at both 5.9 and 10 lb of product per acre. Also, plots treated with Counter 15G at 10 lb product/ac using modified in-furrow placement produced significantly lower levels of recoverable sucrose than those treated at 5.9 and 7 lb/ac using the same placement method. Yield losses were not observed when application methods of Counter 20CR were compared.

**Table 3. Performance of registered insecticides in managing sugarbeet root maggot, Crookston, MN, 2003**

| Treatment/ Formulation | Place-ment | Rate (lb product/ac) | Rate lb (ai/ac) | Recoverable Sucrose (lb/ac) | (lb/T) | Yield (T/ac) | Sucrose (%) | LTM (%) | Root injury (0-9) |
|---|---|---|---|---|---|---|---|---|---|
| Counter 15G | B | 5.9 | 0.9 | 6594 | 318.5 | 20.68 | 16.95 | 1.03 | 3.50 |
| Lorsban 15G | B | 6.7 | 1.0 | 6492 | 314.5 | 20.64 | 16.73 | 1.00 | 3.25 |
| Counter 15G | B | 10 | 1.5 | 6340 | 319.5 | 19.84 | 16.98 | 1.00 | 3.40 |
| Lorsban 15G | B | 10 | 1.5 | 6305 | 317.5 | 19.84 | 16.88 | 1.00 | 3.25 |
| Counter 15G | B | 7 | 1.05 | 6288 | 314.5 | 20.00 | 16.83 | 1.10 | 3.48 |
| Counter 20 CR | B | 4.5 | 0.9 | 6224 | 317.5 | 19.60 | 16.90 | 1.03 | 3.48 |
| Counter 20 CR | B | 7.5 | 1.5 | 6155 | 314.0 | 19.60 | 16.80 | 1.10 | 3.50 |
| Counter 20CR | M | 4.5 | 0.9 | 6133 | 318.0 | 19.24 | 16.85 | 0.95 | 3.95 |
| Mustang + 10-34-0 | IF | 4.0 oz + 3 gal | 0.025 --- | 6129 | 305.0 | 20.08 | 16.30 | 1.05 | 3.95 |
| Counter 15G | M | 7 | 1.05 | 6050 | 318.0 | 19.00 | 16.93 | 1.03 | 3.73 |
| Counter 15G | M | 5.9 | 0.9 | 6004 | 310.0 | 19.36 | 16.63 | 1.13 | 3.58 |
| 10-34-0 | IF | --- | 3 gal | 5864 | 316.0 | 18.53 | 16.80 | 1.00 | 4.20 |
| Counter 20CR | M | 7.5 | 1.5 | 5744 | 314.5 | 18.25 | 16.75 | 1.03 | 3.75 |
| Mustang | IF | 4.0 oz | 0.025 | 5664 | 298.0 | 19.00 | 16.03 | 1.13 | 3.53 |
| Counter 15G | M | 10 | 1.5 | 5532 | 302.5 | 18.25 | 16.28 | 1.15 | 3.63 |
| Check | --- | --- | --- | 5289 | 316.0 | 16.73 | 16.83 | 1.03 | 3.68 |
| Significance | | | | ** | NS | ** | NS | * | NS |
| LSD (0.05) | | | | 471 | | 1.18 | | 0.11 | |

**Discussion:**

Rate responses were subtle and sometimes nonexistent in this study, especially in comparing the upper treatment rates (i.e., 7 to 11.9 lb of Counter 15G and 10 to 13 lb of Lorsban 15G). Yield losses from applying Counter 15G using modified in-furrow placement were not observed at St. Thomas; however, they suggest that the 20CR formulation may offer a slight margin of improved crop safety over that of the 15G product. Differences between Crookston and St. Thomas could have been due to a variety of

environmental factors. Soils at both sites were loams, but the St. Thomas site received more rainfall (3.14 in. vs. 1.4 in.) during germination and seedling establishment. Further investigation may be needed to confirm these findings and to determine the reasons for apparent differences between St. Thomas and Crookston in crop safety of Counter 15G when applied modified in-furrow.

**Reference Cited:**

**Campbell, L. G., J. D. Eide, L. J. Smith, and G. A. Smith. 2000.** Control of the sugarbeet root maggot with the fungus *Metarhizium anisopliae*. J. Sugarbeet Res. 37: 57–69.

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## Appendix 1: The 0 to 9 rating scale

Treatment performance in preventing sugarbeet root maggot feeding injury was quantified for all root maggot control trials by rating beets on the 0 to 9 damage rating scale of Campbell et al. (2000). Criteria for respective points on the scale are as follows:

0 = no scars

1 = 1 to 4 small (pin head size) scars

2 = 5 to 10 small scars

3 = 3 large scars or scattered small scars

4 = few large scars and /of numerous small scars

5 = several large scars and/or heavy feeding on laterals

6 = up to 1/4 root scarred

7 = 1/4 to 1/2 of root blackened by scars

8 = 1/2 to 3/4 root blackened by scars

9 = more than 3/4 of root area blackened

## Appendix 2: Agronomic Information for St. Thomas Site

| | |
|---|---|
| **Location:** | **Pembina County** - William and Brent Baldwin Farm |
| Sugarbeet Variety: | Van der Have 66240 and Beta 6600 |
| Plot Size: | Six 35-ft long rows, 4 Center rows treated |
| Experimental Design: | Randomized complete block, 4 replicates |
| Soil Name: | Loam |
| % OM, pH: | 4.3% OM, 7.7% pH |
| Previous Crop: | Wheat - 2002 |
| Soil Preparation: | Field cultivator worked once |
| Herbicide: | Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (1.3 fl oz/A) + Select (2 fl oz/A) + |

MSO (1.5% v/v), May 29, 2003
Betamix (0.25 pt/A) + Betanex (0.25 pt/A) + Upbeet (1/8 oz/A) + Select (2 fl oz/A) +
MSO (1.5% v/v), June 5, 2003
Betamix (0.25 pt/A) + Betanex (0.25 pt/A) + Upbeet (1/8 oz/A) + Select (4 fl oz/A)
+ MSO (1.5% v/v), June 14, 2003
Betamix (0.25 pt/A) + Betanex (0.25 pt/A) + Upbeet (1/8 oz/A) + Select (3 fl oz/A) +
MSO (1.5% v/v), June 24, 2003
Betamix (0.25 pt/A) + Betanex (0.25 pt/A) + Upbeet (1/8 oz/A) + Select (2 fl oz/A) +
MSO (1.5% v/v), July 1, 2003
Fungicide: Eminent (12.8 oz/ac) on August 8, 2003
Insecticide: Noble applicators, granules 5" band (B), modified in furrow (M), spoon (S), 3" band over open seed furrow (TB), directly in seed furrow (IF), post granules, 4" band,
Postemergence liquids, 7" band
Planting Depth: 1.25"
Planting Date: May 07, 2003 Planting Date (early)
May 12, 2003 Registered
May 13, 2003 Experimental liquids and Registered granules at planting time, Postemergence granule studies, Postemergence liquid studies, Experimental Insecticide Studies
May 14, 2003 Cover Crop
May 15, 2003 Experimental Seed Treatments and Liquid insecticide studies
May 16, 2003 Planting Date (mid)
May 27, 2003 Planting Date (late)
Post Treatments: June 05, 2003 Vydate (1 wk before peak fly); Experimental Insecticide Studies
June 11, 2003 Postemergence granule studies,
June 16, 2003 Lorsban 4E & Asana; Postemergence liquid studies
Vydate (peak fly); Experimental Insecticide Studies
June 23, 2003 Lorsban 4E; Postemergence liquid studies
Late Thimet;
Rainfall: May 08, 2003 0.01"
May 09, 2003 0.51"
May 10, 2003 0.12"
May 16, 2003 0.21"
May 17, 2003 0.29"
May 18, 2003 0.97"
May 23, 2003 0.15"
May 24, 2003 0.11"
May 29, 2003 0.06"
May 30, 2003 0.71"
**Total/May 3.14"**

June 06, 2003 0.77"
June 07, 2003 0.16"
June 09, 2003 0.91"
June 11, 2003 0.30"
June 12, 2003 0.17"
June 21, 2003 0.17"
June 22, 2003 0.03"
June 23, 2003 0.05"
June 24, 2003 0.08"
June 25, 2003 0.18"
June 26, 2003 0.01"
June 28, 2003 0.02"
**Total/June 2.85"**
July 02, 2003 0.38"
July 09, 2003 0.19"
July 10, 2003 0.03"
July 11, 2003 0.04"
July 14, 2003 0.12"
July 16, 2003 0.02"
July 19, 2003 0.23"

July 31, 2003 0.04"
**Total/July 1.05"**
**Total/August 1.16"**
**Total/September 0.99"**

Damage Ratings: August 4, 5, 6, 7, 11, & 12, 2003
Harvest: September 29, 2003
Harvest Sample: 2 center rows x 35' long - 70' total

## Appendix 3: Agronomic Information for Crookston Site

**Location: University of Minnesota Northwest Research & Outreach Center, Crookston, MN, Polk County**
Sugarbeet Variety: Beta 3820
Plot Size: Six 35-ft long rows, 4 center rows treated
Experimental Design: Randomized complete block, 4 replicates
Soil Name: Wheatville Loam
Previous Crop: Wheat - 2002
Soil Preparation: Alloway Seedbedder
Herbicide: Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (1.3 fl oz/A) + Select (2 fl oz/A) + MSO (1 ½ pt), June 2, 2003
Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (1.3 fl oz/A) + Select (2 fl oz/A) + MSO (1 ½ pt/A), June 6, 2003
Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (1.3 fl oz/A) + Select (2 fl oz/A) + MSO (1 ¾ pt), June 13, 2003
Select (2 fl oz/A) + MSO (1 ½ pt), June 30, 2003
Fungicide: Eminent (13 oz/ac), August 7, 2003 Super Tin (5 oz/ac), August 22, 2003
Headline (9 oz/ac), September 4, 2003
Insecticide: Noble applicators, granules banded (B) 5" band, modified in-furrow (M), directly in seed furrow (IF)
Planting Depth: 1 1/2"
Planting Date: May 15, 2003 Registered Experiment
Rainfall: May 17, 2003 0.24"
May 18, 2003 0.55"
May 23, 2003 0.09"
May 24, 2003 0.11"
May 30, 2003 0.41"
**Total/May 1.40"**
June 07, 2003 0.07"
June 09, 2003 0.45"
June 10, 2003 0.28"
June 11, 2003 0.38"
June 16, 2003 0.14"
June 21, 2003 0.25"
June 22, 2003 0.60"
June 23, 2003 0.20"
June 24, 2003 0.71"
June 25, 2003 0.18"
June 28, 2003 0.16"
**Total/June 3.42"**
July 06, 2003 0.08"
July 09, 2003 0.59"
July 11, 2003 0.06"
July 13, 2003 0.43"
July 14, 2003 0.49"
July 19, 2003 0.04"
July 29, 2003 0.28"
July 31, 2003 0.16"
**Total/July 2.13"**
**Total/August 1.63"**

| | |
|---|---|
| **Total/September** | **3.35"** |

Damage Ratings: August 12, 2003
Harvest: September 23, 2003
Harvest Sample: 2 center rows x 35' long - 70' total