INTEGRATED CONTROL OF THE SUGARBEET ROOT MAGGOT BY COMBINING RESISTANT GERMPLASM AND AN INSECTICIDAL SEED TREATMENT

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is a major economic insect pest of sugarbeet in the Red River Valley (RRV). Sugarbeet producers in this growing area have relied on granular and sprayable liquid insecticides belonging to the same mode of action (i.e., acetylcholinesterase [ACHE] inhibition) to manage the SBRM for more than four decades. Although insecticide classes, including neonicotinoid seed treatment insecticides (e.g., Cruiser 5FS, NipsIt Inside, and Poncho Beta) and sprayable liquid pyrethroid products (i.e., Asana XL and MustangMaxx) have been labeled for use in sugarbeet in recent years, none of these alternatives have proven as efficacious as the conventional ACHE-inhibiting organophosphate and carbamate materials. Growers in areas where high to severe SBRM infestations frequently develop typically need to apply additive postemergence insecticide treatments to achieve good control of this pest. Unfortunately, those applications also have mostly involved additional use of organophosphate insecticides, which continues to exert increased selection pressure on SBRM populations for the potential development of insecticide resistance to these materials. Therefore, research is needed to develop effective alternatives for root maggot management to ensure the long-term sustainability of sugarbeet production in areas affected by this pest. This experiment was carried out to compare the conventional granular organophosphate insecticide, Counter 20G, with the following for efficacy against the sugarbeet root maggot: 1) SBRM-resistant sugarbeet germplasm; 2) Poncho Beta insecticidal seed treatment; and 3) integrated programs comprised of various combinations of these control tools.

Materials and Methods:

This research was carried out in a sugarbeet field site near St. Thomas (Pembina County), ND during the 2016 growing season. The experiment was planted on 16 May by using a 6-row Monosem NG Plus 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Betaseed 89RR52, a glyphosate-resistant sugarbeet seed variety, was used as the susceptible commercial cultivar, and an experimental variety developed by co-author L.G.C. (USDA-ARS, NCSL, Fargo, ND) served as the SBRM-resistant material used in the trial. Each plot was 6 rows (22-inch spacing) wide with the 4 centermost rows treated. The outer "guard" row on each side of the plot served as an untreated buffer. Each plot was 35 feet long, and 35-foot 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.

Poncho Beta was used for all insecticidal seed treatment entries, and it was applied to seed by a custom seed-coating company (Germains Seed Technology, Fargo, ND). To avoid cross-contamination of seed between treatment applications, planter seed hoppers and seed dispensation equipment were completely disassembled, cleaned, and re-assembled after the application of each treatment.

Counter 20G was included in the trial as a planting-time granular insecticide standard at both moderate (7.5 lb) and high (8.9 lb product/ac) rates for comparison with the alternative integrated control entries. All granular treatments were applied by using band (B) placement, which consisted of a 5-inch swath of granules applied to each row through Gandy™ row banders. Granular output rates were regulated by using a planter-mounted SmartBox™ computer-controlled insecticide delivery system that was calibrated on the planter immediately before applications.

Root injury ratings: Root maggot feeding injury was assessed in all plots on 1 August. Ratings 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: Treatment performance was also compared on the basis of sugarbeet yield parameters. Plots were harvested on 19 September. Immediately before harvest, the foliage was removed from all treatment plots by using a commercial-grade mechanical defoliator. After defoliation, all beets from the center two 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: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2008). Treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Results from this trial indicated that a relatively high SBRM infestation was present, as was indicated by the injury ratings in the untreated ("Susceptible") check plots that averaged 7.13 on the zero to nine scale of Campbell et al. (2000) (Table 1). Additionally, root injury ratings in the susceptible seed check plots than in all other treatments, indicating that all control tools tested provided significant reductions in SBRM feeding injury. The combination of SBRM-resistant germplasm with Counter 20G, applied at its highest labeled rate (8.9 lb product/ac), resulted in the greatest level of root protection from SBRM feeding injury in this trial. This entry reduced SBRM feeding injury over that in the susceptible check by 4.1 on the 0 to 9 scale, and was statistically superior to all treatments, except the combination treatment of resistant germplasm that was treated with Poncho Beta seed treatment. In all paired comparisons of the susceptible variety and the SBRM-resistant variety, the latter resulted in significantly lower levels of root maggot feeding injury, irrespective of whether it was used as a stand-alone treatment or combined with either Counter or Poncho Beta. Additionally, the addition of either rate of Counter 20G or Poncho Beta to susceptible seed resulted in roots sustaining significantly lower levels of root maggot feeding injury than that which occurred in the susceptible check plots.

Table 1. *Larval feeding injury* in a trial on integrating host plant resistance with a granular or seed treatment insecticide for sugarbeet root maggot control, St. Thomas, ND, 2016

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Resistant + Counter 20G	--- B	8.9 lb	1.8	3.03 d
Resistant + Poncho Beta	--- Seed		68 g a.i./ unit seed	3.53 cd
Resistant + Counter 20G	B	7.5 lb	1.5	4.13 bc
Counter 20G	B	8.9 lb	1.8	4.33 bc
Resistant check	---	---	---	4.57 b
Counter 20G	B	7.5 lb	1.5	4.70 b
Poncho Beta	Seed		68 g a.i./ unit seed	4.97 b
Susceptible check	---	---	---	7.13 a
LSD (0.05)				0.86

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

Yield results from this trial (Table 2) followed somewhat similar patterns to those observed in root injury rating assessments. Three of the top-four entries in this trial, with regard to recoverable sucrose and root yields, included SBRM-resistant germplasm. However, the impact of root maggot host plant resistance appeared to have less impact on yield parameters than was observed with root maggot feeding injury ratings. For example, when the at-plant insecticide protection involved either Poncho Beta seed treatment or the high (8.9 lb/ac) rate of Counter 20G, there were no significant differences between plots planted with SBRM-resistant seed and those planted with the susceptible variety.

The only treatment in this trial that failed to provide a significant increase in recoverable sucrose yield when compared to the susceptible check was the low rate (7.5 lb/ac) of Counter 20G. However, when the resistant variety was used in plots with Counter at the low rate, plots generated more than 1,100 lb in additional sucrose and a 4.2-ton increase in root yield than was recorded from plots planted with the susceptible variety and treated with the same rate of Counter. Similarly, in plots that had no insecticidal protection, the resistant variety yielded 767 lb more sucrose yield and 2.9 tons more root tonnage than those planted with the susceptible variety.

Table 2. *Yield parameters* in a trial on integrating host plant resistance with a granular or seed treatment insecticide for sugarbeet root maggot control, St. Thomas, ND, 2016

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	Seed		68 g a.i./ unit seed	5585 a	24.5 a	12.87 a	332
Resistant + Poncho Beta	--- Seed		68 g a.i./ unit seed	5381 a	24.1 a	12.80 a	296
Resistant + Counter 20G	B	7.5 lb	1.5	5169 ab	22.8 ab	13.07 a	301
Resistant + Counter 20G	--- B	8.9 lb	1.8	5129 ab	22.5 ab	13.00 a	305
Counter 20G	B	8.9 lb	1.8	4658 bc	19.9 bc	13.20 a	301
Resistant check	---	---	---	4453 c	20.0 bc	12.80 a	239
Counter 20G	B	7.5 lb	1.5	4063 cd	18.2 c	12.83 a	221
Susceptible check	---	---	---	3686 d	17.1 c	12.40 a	175
LSD (0.05)				672.0	3.13	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

Integrated control programs consisting of root maggot-resistant germplasm plus either Poncho Beta or a planting-time application of Counter 20G resulted in gross revenue benefits that ranged from $121/ac to $130/ac. Alternately, the single planting-time applications of Counter 20G, generated revenue benefits of $46 to $126/ac, depending on application rate, when used in plots planted with susceptible seed. Interestingly, the Poncho Beta alone (i.e., on maggot-susceptible seed) entry generated more recoverable sucrose, root tonnage, and gross revenue than any other treatment in this experiment. This phenomenon has not been observed in previous testing. Also different from previous results were the overall low yields observed with all entries in this experiment. These uncharacteristic findings could be associated with the excessive rainfall that occurred repeatedly and resulted in long periods of standing water in the plot area during the 2016 growing season. Irrespective of the generally low yields in this trial, all entries were treated consistently throughout the growing season. As such, these results suggest that sugarbeet production might be sustainable with these alternative tools if conventional organophosphate insecticides were, at some point in the future, removed from federal registration. However, this is not a certainty, as the input costs of these alternative control strategies is not yet known.

References Cited:

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