EXPERIMENTAL PLANTING-TIME AND POSTEMERGENCE INSECTICIDES FOR SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder) is a major pest of sugarbeet in the Red River Valley (RRV) growing area. Sugarbeet producers in the U.S. have a limited number of insecticides that are currently registered by the U.S. Environmental Protection Agency (EPA) for root maggot management. With so few root maggot control options, RRV sugarbeet producers have had to rely heavily on the same insecticide mode of action (i.e., acetylcholinesterase [ACHE] inhibition) to manage this pest for 40+ years. Also, it has been a common practice for fields to require two to three applications of these materials each growing season to achieve satisfactory control in areas affected by severe SBRM infestations. This long-term pattern of repeated use of ACHE-inhibiting insecticides has exerted intense selection pressure for the development of insecticide resistance in root maggot populations in the RRV.

Research is critically needed to develop alternative strategies for root maggot management to ensure the long-term sustainability and profitability of sugarbeet production for growers affected by this pest. This experiment was carried out to achieve the following objectives: 1) test several natural and/or botanical insecticides for efficacy at managing the sugarbeet root maggot; and 2) evaluate commercially labeled conventional chemical insecticides that are not currently labeled for use in sugarbeet to determine if their performance would warrant pursuit of labeling for use in the crop for root maggot control.

Materials and Methods:

This experiment was carried out on a commercial sugarbeet field site near St. Thomas (Pembina County), ND. The experiment was planted on 10 May using Betaseed 89RR52 glyphosate-resistant seed. All plots were planted 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. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. The outer "guard" rows (i.e., rows one and six) on each side of the plot served as untreated buffers. 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. All insecticide treatments were single, stand-alone (i.e., planting-time or postemergence) applications. For example, there was no at-plant insecticide in plots assigned to receive a postemergence insecticide, and vice versa.

<u>Planting-time insecticide applications</u>. Counter 20G was used for comparative purposes as a planting-time standard chemical insecticide in this experiment. It was 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 a planter-mounted SmartBox™ computer-controlled insecticide delivery system that was calibrated on the planter immediately before all applications. Planting-time liquid insecticides included Aza-Direct (active ingredient: azadirachtin, a neem tree-derived alkaloid that acts as an insect antifeedant and growth disruptor), Knack 0.86EC (an insect growth regulator insecticide), and Endigo (a combination insecticide containing lambda-cyhalothrin [a pyrethroid insecticide] and thiamethoxam [a neonicotinoid]). The planting-time liquids were delivered in 3-inch T-bands over the open seed furrow by using a planter-mounted, CO_2-propelled spray system that was calibrated to deliver a finished spray volume output of 5 GPA through TeeJet™ 6501E nozzles.

<u>Postemergence insecticide applications</u>. Postemergence insecticide treatments in this experiment included the following sprayable liquid products: Captiva (an insect repellent comprised of capsicum [pepper] extract, garlic oil, and soybean oil]), Dibrom Emulsive (a conventional organophosphate insecticide), Ecozin Plus 1.2%ME (azadirachtin), Evergreen Crop Protection 60-6EC (pyrethrum + a synergist), Veratran D (a botanical material containing insecticidal alkaloids from the Sabadilla plant), Warrior II (a pyrethroid insecticide with Zeon U.V. protection), and Vydate C-LV (a carbamate), and all were compared with Lorsban Advanced as a postemergence

chemical insecticide standard. All postemergence spray treatments were broadcast-applied on 8 June (i.e., about 1 day before peak SBRM fly activity). Sprays were applied from a tractor-mounted, CO_2-propelled spray system equipped with an 11-ft boom that was calibrated to deliver a finished spray volume output of 10 GPA through TeeJet™ 110015VS nozzles.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in both studies on 1 and 2 August by 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. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were extracted from the 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), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Sugarbeet root maggot feeding injury results for this experiment are presented in Table 1. A relatively high root maggot infestation developed for this experiment, which was evidenced by the high level larval feeding injury recorded for the untreated check plots (mean = 6.67 on the 0 to 9 scale of Campbell et al. [2000]) . It is important to note that all insecticide entries in this trial were single-component control tools, which are not recommended in high-risk areas such as St. Thomas, where severe SBRM infestations are common.

A very positive finding in this trial was that all experimental insecticide treatments resulted in significant reductions in root maggot larval feeding injury when compared to that incurred in the untreated check plots. Additionally, all of the experimental insecticides, except Aza-Direct, achieved root protection levels that were not statistically different from the chemical insecticide standards (i.e., Counter 20G and Lorsban Advanced). Although there were very few differences among insecticide treatments in this trial, the following resulted in significantly greater protection from SBRM feeding injury than Aza-Direct: 1) Lorsban Advanced applied postemergence at 1 pt product/ac; 2); postemergence Vydate C-LV at 34 fl oz/ac; 3) Veratran D applied postemergence at 20 lb product/ac; and 4) Counter 20G banded at planting at 7.5 lb product/ac.

Table 1. ***Larval feeding injury*** **in an evaluation of experimental at-plant and postemergence sprays 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)
Lorsban Advanced	1 d Pre-peak Broadcast	1 pt	0.5	4.73 c
Vydate CLV	1 d Pre-peak Broadcast	34 fl oz	1.0	4.80 c
Veratran D	1 d Pre-peak Broadcast	20 lb	0.04	4.97 c
Counter 20G	B	7.5 lb	1.5	5.00 c
Warrior ll	1 d Pre-peak Broadcast	1.92 fl oz	0.03	5.07 bc
Dibrom	1 d Pre-peak Broadcast	1 pt		5.10 bc
Ecozin Plus 1.2% ME	1 d Pre-peak Broadcast	56 fl oz		5.17 bc
Captiva	1 d Pre-peak Broadcast	2 pts		5.23 bc
Endigo ZC	3" TB	4.5 fl oz		5.27 bc
Evergreen Crop Protection	1 d Pre-peak Broadcast	16 fl oz		5.27 bc
Knack 0.86 EC	3" TB	10 fl oz		5.43 bc
Aza-Direct	3" TB	56 fl oz		5.80 b
Check	---	---	---	6.67 a
LSD (0.05)				0.79

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; TB = T-band over open seed furrow

Yield data from this trial are presented in Table 2. Despite large numerical differences in recoverable sucrose yield and root tonnage among treatments, no statistically significant differences were detected. This lack of statistical significance between entries was probably a result of high variability within and between replications caused by frequent rainfall events during the growing season. Nearly 20 inches of rain was received in the plot area after the experiment was planted, and resulted in frequent periods of standing water.

The highest-yielding treatments in this experiment included the following: 1) Vydate C-LV, applied postemergence; 2) Endigo ZC, applied at planting time in a 3-inch T-band; 3) a postemergence spray of Ecozin Plus; and 4) a post spray of Warrior II. These treatments produced recoverable sucrose yield increases of 916 to 1,803 lb/ac above the average sucrose yield from the untreated check plots. The planting-time application of Endigo ZC generated a gross revenue increase of $128/ac above that from the untreated check plots, and about $100/ac more revenue than plots treated at planting with Counter 20G. Similarly, Vydate, Ecozin Plus, and Warrior II postemergence sprays resulted in respective revenue increases of $143, $80, and $77 above the untreated check, which amounted to $87, $12, and $9 more revenue per acre than the postemergence standard, Lorsban Advanced. It should be noted that Counter 20G and Lorsban Advanced were both applied at their respective moderate rates, and not the maximum rates allowed on the label.

Table 2. *Yield parameters* from an evaluation of experimental at-plant and postemergence sprays 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)
Vydate CLV	1 d Pre-peak Broadcast	34 fl oz	1.0	5298 a	22.6 a	13.23 a	342
Endigo ZC	3” TB	4.5 fl oz		5144 a	22.1 a	13.13 a	327
Ecozin Plus 1.2% ME	1 d Pre-peak Broadcast	56 fl oz		4709 a	20.6 a	12.90 a	279
Warrior ll	1 d Pre-peak Broadcast	1.92 fl oz	0.03	4411 a	19.0 a	13.23 a	276
Aza-Direct	3” TB	56 fl oz		4391 a	19.5 a	12.77 a	249
Veratran D	1 d Pre-peak Broadcast	20 lb	0.04	4380 a	20.6 a	12.37 a	194
Knack 0.86 EC	3” TB	10 fl oz		4237 a	19.5 a	12.73 a	207
Dibrom	1 d Pre-peak Broadcast	1 pt		4205 a	18.2 a	13.10 a	259
Lorsban Advanced	1 d Pre-peak Broadcast	1 pt	0.5	4172 a	17.9 a	13.13 a	267
Captiva	1 d Pre-peak Broadcast	2 pts		4035 a	17.2 a	13.37 a	263
Counter 20G	B	7.5 lb	1.5	3744 a	16.3 a	12.93 a	227
Evergreen Crop Protection	1 d Pre-peak Broadcast	16 fl oz		3704 a	16.2 a	12.90 a	222
Check	---	---	---	3495 a	15.5 a	12.90 a	199
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; TB = T-band over open seed furrow

Although no statistically significant differences in yield parameters were detected among treatments in this experiment, it is encouraging that most of the alternative materials evaluated provided equivalent protection from SBRM feeding injury to that of the labeled chemical insecticides. Further testing should be carried out on these and other experimental materials to identify potential alternatives to the currently registered insecticides. Alternative insecticide options could help prevent or delay the development of insecticide resistance in sugarbeet root maggot populations, and could also provide viable tools for growers to sustainably and profitably produce sugarbeet in SBRM-affected areas if the currently available conventional insecticide materials became unavailable due to regulatory action.

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