EVALUATION OF EXPERIMENTAL INSECTICIDES FOR MANAGEMENT OF THE SUGARBEET ROOT MAGGOT

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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). Observations during the past 15+ years suggest that economically significant SBRM infestations frequently develop on between 50,000 and 85,000 acres within the RRV production area each year. 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 options available for SBRM control, 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 over 40 years.

In areas affected by severe SBRM infestations, many fields frequently require two to three applications of these materials each growing season to achieve satisfactory control. 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. Therefore, 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 available, EPA-labeled conventional chemical insecticides that are currently not registered for use in sugarbeet to determine if their performance would warrant future pursuit of labeling for use in the crop for SBRM 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 11 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 calibrated on the planter immediately before all applications. Planting-time liquid insecticides included the following: 1) Aza-Direct (active ingredient: azadirachtin, a neem tree-derived insect antifeedant and growth disruptor); 2) Knack 0.86EC (an insect growth regulator insecticide); Endigo (a combination insecticide containing lambda-cyhalothrin [a pyrethroid insecticide] and thiamethoxam [a neonicotinoid]), and Manticor LFR (a combination product comprised of Capture LFR insecticide and Headline fungicide). Planting-time liquid products in this experiment were delivered in 3-inch T-bands over the open seed furrow by using a planter-mounted, CO_2-propelled spray system calibrated to deliver a finished spray volume output of 5 GPA through TeeJet™ 400067E 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 9 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 this trial on 1 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 2 October. 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:

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. Another important aspect of this trial was that a hailstorm, including high winds and locally heavy rainfall, occurred on 9 June. This occurred just 2 days before peak fly was expected, and just a few hours after all postemergence spray treatments were applied. As such, the results of this trial should be interpreted with discretion.

Sugarbeet root maggot feeding injury results for this experiment are presented in Table 1. The average level of SBRM larval feeding injury recorded for the untreated check plots was only 5.33 on the 0 to 9 scale of Campbell et al. [2000]), which indicated that a moderate root maggot infestation developed in the plot area for this experiment.

Table 1. *Larval feeding injury* in an evaluation of experimental at-plant and postemergence sprays for sugarbeet root maggot control, St. Thomas, ND, 2017

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Manticor LFR (bifenthrin + pyraclostrobin)	3" T-band	19 fl oz	0.2 lb bifenthrin + 0.1 lb pyraclostrobin	2.25 e
Counter 20G	B	7.5 lb	1.5	2.55 de
Endigo ZC	3" TB	4.5 fl oz		3.38 cd
Ecozin Plus 1.2% ME	2 d Pre-peak Broadcast	56 fl oz		4.00 bc
Lorsban Advanced	2 d Pre-peak Broadcast	1 pt	0.5	4.30 abc
Dibrom	2 d Pre-peak Broadcast	1 pt		4.33 abc
Evergreen Crop Protection	2 d Pre-peak Broadcast	16 fl oz		4.53 ab
Warrior ll	2 d Pre-peak Broadcast	1.92 fl oz	0.03	4.68 ab
Knack 0.86 EC	3" TB	10 fl oz		4.70 ab
Vydate CLV	2 d Pre-peak Broadcast	34 fl oz	1.0	4.78 ab
Captiva	2 d Pre-peak Broadcast	2 pts		4.90 ab
Aza-Direct	3" TB	56 fl oz		5.08 ab
Veratran D	2 d Pre-peak Broadcast	20 lb	0.04	5.30 a
Check	---	---	---	5.33 a
LSD (0.05)				1.104

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

Entries that provided the greatest levels of root protection (i.e., lowest SBRM feeding injury ratings) included planting-time treatments of Manticor LFR (19 fl oz/ac) and Counter 20G at its moderate rate of 7.5 lb product/ac. Manticor outperformed all treatments, except Counter with regard to protection from larval feeding injury, and Endigo ZC (4.5 fl oz/ac) was the only other treatment that provided a level of root protection that was not significantly different from Counter 20G. The only other treatment that provided a significant reduction in root maggot larval feeding injury when compared to the untreated check plots was Ecozin Plus, applied at 56 fl oz/ac.

Yield data from this trial are shown in Table 2. The highest-yielding treatments included the following: 1) Counter 20G, applied at a moderate rate of 7.5 lb product/ac; 2) Warrior II, applied as a postemergence broadcast at 1.92 fl oz/ac; 3) Manticor LFR, applied at 19 fl oz/ac in a 3-inch T-band at planting; and 4) Ecozin Plus, which was applied as a postemergence broadcast at 56 fl oz/ac. All of these treatments produced root yields of more than 34 tons/ac, which were all significantly greater than that recorded for the untreated check. The following treatments were not significantly outperformed by the top four treatments, and produced significantly more recoverable sucrose yield than the untreated check: 1) Vydate C-LV, applied postemergence at 34 fl oz/ac; 2) Dibrom Emulsive, broadcast-applied 1 pt product/ac; and 3) a postemergence spray of Veratran D at 20 lb product/ac.

It bears repeating that all insecticide-treated entries in this experiment were single-application treatments. Also, it should be noted that five of the top seven treatments in relation to recoverable sucrose and root yield are currently not registered for use in sugarbeet, and three of them represent alternative modes of action to the commonly used ACHE inhibitors. As such these results provide encouragement regarding the future of SBRM management. These alternatives, which included Warrior II and Manticor (both pyrethroid insecticides), Ecozin Plus (azadirachtin, a plant-derived insect antifeedant and growth disruptor), and Veratran D (a plant-derived insecticide containing Sabadilla alkaloids) generated recoverable sucrose yield increases ranging from 1,461 to 2,154 lb/ac above the average sucrose yield from the untreated check plots. Also, all of these treatments generated numerically (not statistically significant) more recoverable sucrose than Lorsban Advanced (the postemergence broadcast spray standard in this trial) and Counter 20G (the conventional planting-time standard). 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 respective labels of those products.

Table 2. ***Yield parameters*** **from an evaluation of experimental at-plant and postemergence sprays for sugarbeet root maggot control, St. Thomas, ND, 2017**

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	11,446 a	37.1 a	16.58 a	1,358
Warrior ll	2 d Pre-peak Broadcast	1.92 fl oz	0.03	10,917 ab	36.4 ab	16.28 a	1,244
Manticor LFR (bifenthrin + pyraclostrobin)	3” T-band	19 fl oz	0.2 lb bifenthrin + 0.1 lb pyraclostrobin	10,694 abc	33.8 abc	16.98 a	1,311
Ecozin Plus 1.2% ME	2 d Pre-peak Broadcast	56 fl oz		10,512 abc	34.2 abc	16.55 a	1,241
Vydate CLV	2 d Pre-peak Broadcast	34 fl oz		10,440 abc	33.2 bc	16.80 a	1,269
Dibrom	2 d Pre-peak Broadcast	1 pt		10,409 abc	34.2 abc	16.35 a	1,210
Veratran D	2 d Pre-peak Broadcast	20 lb	0.04	10,224 a-d	32.9 bc	16.60 a	1,223
Lorsban Advanced	2 d Pre-peak Broadcast	1 pt	0.5	10,070 b-e	32.8 bc	16.48 a	1,185
Captiva	2 d Pre-peak Broadcast	2 pts		10,069 b-e	33.4 abc	16.30 a	1,153
Evergreen Crop Protection	2 d Pre-peak Broadcast	16 fl oz		9,995 b-e	32.6 bc	16.45 a	1,175
Endigo ZC	3” TB	4.5 fl oz		9,988 b-e	33.0 bc	16.30 a	1,150
Knack 0.86 EC	3” TB	10 fl oz		9,500 cde	31.1 cd	16.43 a	1,112
Aza-Direct	3” TB	56 fl oz		8,965 de	28.7 d	16.70 a	1,080
Check	---	---	---	8,763 e	28.1 d	16.75 a	1,054
LSD (0.05				1,353.7	3.82	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

It is encouraging that most of the alternative materials tested 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 used 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 insecticides become unavailable due to regulatory action.

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