ALTERNATIVE AND INTEGRATED STRATEGIES FOR SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is a threat for producers in up to two-thirds of the sugarbeet producing acres in the United States on an annual basis. It also is the most serious insect pest of sugarbeet in the Red River Valley (RRV) growing area. Granular formulations of organophosphate and carbamate insecticides have been used to control this insect for over three decades. Although most granular insecticide applications in the RRV are carried out during sugarbeet planting, some infestations are sufficiently high to justify the need for additional postemeregence rescue applications of materials with the same mode of action. Thus, the development of insecticide resistance to these materials has been a concern for several years.

In recent years, seed treatment insecticides have been registered for use in sugarbeet; however, most seed treatment materials have provided only suppression or moderate protection against the relatively high SBRM infestations that commonly develop in the RRV. Similarly, experimental bioinsecticide formulations, containing spores of the insect-pathogenic fungus, *Metarhizium anisopliae*, also have performed at only low to moderate levels against SBRM larvae.

This experiment was carried out to assess the efficacy of *M. anisopliae*-based bioinsecticide granules (strain MA1200), insecticidal seed treatments, and combinations thereof for SBRM control. We also sought to determine if the moisture-absorbing polymer, Zeba Farm, could increase the efficacy of MA1200 for controlling SBRM under field conditions. Because previous research has shown that seed treatments and *M. anisopliae*-based applications have shown low to moderate efficacy in previous testing, we planned this experiment for a field site expected to have a moderate SBRM infestation rather than the typically high infestations used for most of our trials.

Materials and Methods:

This experiment was planted on 20 May at a field site near Minto (Walsh County), ND. Seed treatment insecticides were applied to seed by a custom seed-coating company (Germains Seed Technology, Fargo, ND). The same seed variety (Betaseed 87RR3800; glyphosate-resistant) was used for all treatments (i.e., seed treatments, bioinsecticide treatments, conventional insecticide entries, and the untreated check) in this study. Plots were planted using a six-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. Plots were six rows (22-inch spacing) wide with the four 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 25-foot tilled alleys were maintained between replicates. The experiment was arranged in a randomized complete block design with four replications of the treatments. To avoid cross-contamination of seed between treatment applications, planter seed hoppers were completely disassembled, cleaned, and re-assembled after the application of each seed treatment.

Counter 20G was used as the planting-time granular insecticide standard, and it was applied at 7.5 lb product/ac as a band application. Insecticidal seed treatments tested included Poncho Beta and Cruiser 5FS. Corn meal-based *M. anisopliae* (MA1200) granules were applied at 20 and 30 lb product/ac. A granular formulation of the moisture-absorbent agent, Zeba Farm, was applied either alone at 4 or 6 lb product/ac or at the 4-lb rate and combined with MA1200.

Treatment performance was initially compared on the basis of SBRM feeding injury ratings by using the 0 to 9 scale of Campbell et al. (2000). Performance evaluations were also conducted by asessing sugarbeet yield parameters. Plots were harvested on 6 October, 2010. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the 4 center rows of each plot were lifted 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 Quality 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:

Root maggot feeding injury rating comparisons from this experiment are listed in Table 1. The SBRM infestation that developed in this trial area was low, as was evidenced by the average root injury level of 2.88 (0 to 9 scale; Campbell et al. 2000) that occurred in the untreated check plots. A low level of SBRM pressure was preferred for this trial, because alternative control tools (e.g., insecticidal seed treatments, MA1200 biocontrol fungus granules, reduced rates of conventional chemical insecticides, etc.) have not performed well in previous testing against high SBRM infestations.

Results of this trial indicated that a reduced (7.5 lb product/ac) rate of the conventional granular chemical insecticide, Counter 20G, provided a significant reduction in root maggot feeding injury when compared to that sustained by plants in the untreated check plots. Other treatments that provided significant reductions in SBRM feeding injury included the following 1) MA1200 fungus granules, applied at 20 lb product/ac using spoon placement; 2) Cruiser 5FS seed treatment; and 3) the integrated program consisting of Poncho Beta plus MA1200 granules. Although combining Poncho Beta seed treatment with MA1200 granules appeared to have a slight additive benefit when compared with single applications of these tools, the integrated combination treatment consisting of both materials did not result in a significant increase in SBRM control when compared to the performance of either of these materials applied singly.

Table 1. *Larval feeding injury* in evaluation of integrated control tools for sugarbeet root maggot control, Minto, ND, 2010

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G	B	7.5 lb	1.5	1.30 d
MA1200 G	S	20 lb		1.78 cd
Cruiser 5FS	Seed	60 g a.i./ unit seed		1.78 cd
Poncho Beta + MA1200 G	Seed IF	68 g a.i./ unit seed 20 lb		1.95 bcd
MA1200 G	IF	30 lb		2.08 a-d
MA1200 G	MIF	20 lb		2.10 a-d
MA1200 G	IF	20 lb		2.13 a-d
Poncho Beta	Seed	68 g a.i./ unit seed		2.20 abc
MA1200 G	B	20 lb		2.28 abc
Zeba Farm	IF	6 lb		2.33 abc
Cruiser 5FS + MA1200 G	Seed IF	60 g a.i./ unit seed 20 lb		2.50 abc
Zeba Farm + MA1200 G	IF	4 lb 20 lb		2.65 ab
Zeba Farm	IF	4 lb		2.75 ab
Check	---	----	---	2.88 a
LSD (0.05)				0.83

Means within a column sharing a letter are not significantly (*P* = 0.05) different from each other (Fisher's Protected LSD test).
[a] B = Band; MIF = modified in-furrow; IF = direct in-furrow; S = spoon; Seed = insecticidal seed treatment

There appeared to be no additive effect on SBRM control from combining Cruiser 5FS with MA1200 granules. Similarly, no significant impact on SBRM control was observed when Zeba Farm granules were applied alone at a rate of 4 lb product/ac or at 4 and 6 lb product/ac with MA1200 granules. Granule placement method appeared to have little or no effect on performance of MA1200, because root injury rating means for plots treated with fungus granules using spoon, band, direct in-furrow, or modified in-furrow placement were not significantly different from each other. Also, there was no significant difference with respect to root maggot feeding injury between the 20- and 30-lb rates of MA1200.

As shown in Table 2, yield comparisons supported root injury rating data from this trial. For example, significant increases in recoverable sucrose were achieved by applying the following treatments for SBRM control: 1) Cruiser 5FS seed treatment; 2) Poncho Beta seed treatment + MA1200 granules; and 3) Cruiser 5FS + MA1200 granules) Counter 20G banded at 7.5 lb product/ac. All of these treatments, in addition to the stand-alone entry of Poncho Beta, also produced significant root tonnage increases over that of the untreated check.

Combining *Metarhizium*-based MA1200 granules with Poncho Beta seed treatment produced an increase in gross revenue of $191 per acre when compared to that from plots protected solely by Poncho Beta seed treatment. As observed with root injury rating data for this trial, combining MA1200 granules with Cruiser seed treatment did not provide a significant yield benefit or increase in revenue when this integrated strategy was compared with either of its component control tools applied separately. Also reflective of root injury rating data was our finding that Zeba Farm imposed no significant yield or revenue benefit in this trial. The 2010 growing season was probably not an optimal year for testing the impacts of Zeba Farm, because it is a moisture-absorbing polymer-based granular product. Impacts of Zeba Farm on *Metarhizium* fungal granules, as well as potential effects on seedling establishment and plant development, might be more substantial in a year characterized by lower (or at least near normal) amounts of rainfall. This research should be continued, because the development and optimization of alternative tools for SBRM management, especially those that could allow producers less reliance on chemical insecticides, is a worthy pursuit for sustaining the future of production agriculture.

Table 2. *Yield parameters* from evaluation of integrated control tools for sugarbeet root maggot control, Minto, ND, 2010

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Cruiser 5FS	seed	60 g a.i./ unit seed		10443 a	30.2 a	18.73 a	1774
Poncho Beta + MA1200 G	seed IF	68 g a.i./ unit seed 20 lb		10218 ab	30.4 a	18.25 a	1690
Cruiser 5FS + MA1200 G	seed IF	60 g a.i./ unit seed 20 lb		9857 abc	30.3 a	17.80 a	1584
Counter 20G	B	7.5 lb	1.5	9651 a-d	30.4 a	17.53 a	1516
Poncho Beta	seed	68 g a.i./ unit seed		9506 b-e	29.8 ab	17.58 a	1499
MA1200 G	S	20 lb		9284 cde	27.5 bc	18.40 a	1542
MA1200 G	MIF	20 lb		8991 de	27.5 bc	17.88 a	1449
MA1200 G	IF	30 lb		8968 de	27.5 bc	17.98 a	1444
Check	---	----	---	8959 de	27.3 c	17.93 a	1452
Zeba Farm	IF	4 lb		8921 de	26.8 c	18.18 a	1464
MA1200 G	B	20 lb		8900 de	27.6 bc	17.75 a	1416
Zeba Farm	IF	6 lb		8873 de	26.7 c	18.13 a	1453
Zeba Farm + MA1200 G	 IF	4 lb 20 lb		8848 de	26.4 c	18.30 a	1459
MA1200 G	IF	20 lb		8692 e	26.7 c	17.93 a	1396
LSD (0.05)				821	2.4	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 = band; MIF = modified in-furrow; IF = direct in-furrow; S = spoon; Seed = insecticidal seed treatment

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