APPLICATION TIMING AND RATE EFFECTS ON POSTEMERGENCE INSECTICIDE SPRAYS FOR ROOT MAGGOT CONTROL

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Introduction:

Severe infestations of the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), occur commonly in central and northern portions of the Red River Valley (RRV) growing area of North Dakota and Minnesota. As such the SBRM is an ongoing threat to farm profitability for producers in the area. This intense insect pressure typically requires aggressive pest management programs to ensure adequate protection of the sugarbeet crop. Pest management programs in areas at high risk for damaging SBRM infestations usually consist of either a granular insecticide or an insecticidal seed treatment at planting, followed by an additive postemergence insecticide application when the localized infestation level warrants it. The most commonly used approach for postemergence root maggot control in the RRV is a broadcast application of a sprayable liquid insecticide product.

Beginning with the 2010 growing season, federal label changes resulted in a 10-day reapplication interval for all sprayable liquid insecticide products containing the active ingredient chlorpyrifos (e.g., Lorsban 4E, Lorsban Advanced, and all generic versions). The label revision lengthened the reapplication interval by three days. This change may have compromised the ability of sugarbeet growers to effectively manage the SBRM with chlorpyrifos-based products, because fly activity peaks usually rise and fall relatively quickly, often subsiding in about seven days. In an effort to address this potential problem, research was undertaken to achieve the following objectives regarding postemergence SBRM management: 1) determine the most effective timing schemes for repeated applications of Lorsban Advanced sprays that adhere to its 10-day reapplication restriction; 2) assess the impact of application rate on Lorsban Advanced performance; and 3) evaluate Mustang Maxx as a single postemergence tool and as rotated with Lorsban Advanced applications for postemergence SBRM control.

Materials and Methods:

This experiment was conducted on a commercial sugarbeet field site near St. Thomas in rural Pembina County, ND. Betaseed 89RR52 glyphosate-resistant seed was used for all treatments. Plots were planted on 11 May. All plots were planted using a 6-row Monosem NG Plus 4 7x7 planter set to deliver seed 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” 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.

<u>Planting-time insecticide applications</u>. Planting-time applications of Counter 20G were 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 planter-mounted SmartBox™ computer-controlled insecticide delivery system that had been calibrated on the planter before all applications.

<u>Postemergence insecticide applications.</u> Additive postemergence insecticides used included Lorsban Advanced and Mustang Maxx. Treatments that included postemergence applications involved both single and double postemergence spray applications at varying rates. Treatment timings compared included six, five, and three days pre-peak SBRM fly activity (i.e., 5, 6, and 8 June, respectively, and five, four, and eight days after peak fly (i.e., 15, 16, and 19 June, resp.). Liquid insecticide solutions were delivered with a tractor-mounted CO_2-propelled spray system equipped with TeeJet™ 110015VS nozzles calibrated to deliver applications in a finished output volume of 10 GPA.

<u>Root injury ratings</u>: Sugarbeet root maggot feeding injury was assessed in this experiment 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 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:

NOTE: Results of this trial should be interpreted with some degree of discretion, because a strong hailstorm occurred in the plot area just two days before the anticipated peak in SBRM fly activity. As a result, we estimate that at least 40-60% of the fly population in the immediate vicinity of this trial site were likely killed.

Sugarbeet root maggot feeding injury ratings in the untreated check plots averaged 4.8 on the 0 to 9 scale of Campbell et al. (2000) (Table 1). This suggested that a moderate SBRM infestation was present for the experiment.

Table 1. *Larval feeding injury* in an assessment of postemergence insecticide spray timing, rate, and frequency impacts on sugarbeet root maggot control, St. Thomas, ND, 2017

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 5 d Pre-peak Broadcast 5 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	1.28 c
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	1.33 c
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 5 d Pre-peak Broadcast 5 d Post-peak Broadcast	7.5 lb 1 pts 1 pts	1.5 1.0 1.0	1.35 c
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 3 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	1.38 c
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 6 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	1.40 bc
Counter 20G + Lorsban Advanced + Mustang Maxx	B 3 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 1 pt 4 fl oz	1.5 0.5 0.025	1.60 bc
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 6 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	1.70 bc
Counter 20G + Mustang Maxx + Lorsban Advanced	B 3 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 4 fl oz 1 pt	1.5 0.025 0.5	1.80 bc
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	1.98 bc
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	2.03 bc
Counter 20G	B	8.9 lb	1.8	2.10 bc
Counter 20G + Mustang Maxx	B 3 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	2.25 bc
Counter 20G	B	7.5 lb	1.5	2.48 b
Check	---	---	---	4.80 a
LSD (0.05)				1.091

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

The moderate feeding pressure resulted in very few significant differences among treatments in this experiment. All insecticide treatments, whether involving single at-plant applications, or at-plant/postemergence combinations, provided significant reductions in feeding injury when compared to the untreated check. There were no statistically significant differences in root protection among any of the treatments in this trial that included both a planting-time application of Counter 20G plus at least one postemergence spray of either Lorsban Advanced or Mustang Maxx. No rate-related differences in performance were observed either, although general patterns indicated that the best protection from root maggot feeding injury was provided by entries that involved combining planting-time with aggressive postemergence control programs comprised of two spray applications.

The following treatments provided the best average protection from SBRM feeding injury in this trial:

1) planting-time Counter 20G at 8.9 lb/ac + two 2-pt/ac applications of Lorsban Advanced at 5 days pre-and 5 days post-peak;
2) planting-time Counter at 8.9 lb/ac + one 2-pt/ac postemergence application of Lorsban Advanced at 3 days pre-peak;
3) planting-time Counter at 7.5 lb/ac + two 1-pt/ac postemergence applications of Lorsban Advanced at 5 days pre- and 5 days post-peak; and
4) planting-time Counter at 7.5 lb/ac + two 1-pt/ac postemergence applications of Lorsban Advanced at 3 days pre-peak and 8 days post-peak.

Treatment timing, in relation to the required 10-day reapplication interval, did not have a significant impact on performance of Lorsban Advanced applications in relation to preventing SBRM feeding injury. Another trend observed suggested that the high (2 pt/ac) rate of Lorsban Advanced tended to provide slightly better root protection than the 1 pt/ac rate. In treatment combinations that included postemergence applications of both Lorsban Advanced and Mustang Maxx, control appeared to be slightly improved by applying the Lorsban Advanced during the pre-peak application, and following with a post-peak application of Mustang Maxx. Another pattern observed was that splitting 2 pts of Lorsban Advanced into two 1-pt applications spaced 10 days apart appeared to provide a slight improvement in root protection, although the difference was not statistically significant.

Yield results and associated gross economic returns from this trial are presented in Table 2. All insecticide treatments provided significant increases in both recoverable sucrose yield and root tonnage. As observed with root injury rating data, there were also very few significant differences among insecticide treatments with respect to recoverable sucrose yield. This was probably a product of the atypically moderate SBRM larval feeding pressure that occurred following the pre-peak-fly hailstorm. Variability within and between replicates in the plot area due to standing water in some plots during the SBRM egg-laying period could have also contributed to the relatively low incidence of significant differences in this experiment.

The best overall treatments in this trial with regard to recoverable sucrose yield included the following:

1) planting-time Counter 20G at 7.5 lb/ac + two 2-pt/ac applications of Lorsban Advanced at 6 days pre-and 4 days post-peak;
2) planting-time Counter at 7.5 lb/ac + two 1-pt/ac postemergence applications of Lorsban Advanced at 6 days pre- and 4 days post-peak;
3) planting-time Counter at 7.5 lb/ac + two 2-pt/ac postemergence applications of Lorsban Advanced at 5 days pre- and 5 days post-peak; and
4) planting-time Counter at 7.5 lb/ac + postemergence Lorsban Advanced (1 pt/ac) at 3 days pre-peak + Mustang Maxx (4 fl oz/ac) at 4 days post-peak.

There were no significant different differences among these four treatments with regard to either recoverable sucrose yield or root tonnage. Although significant yield differences were rare in this study, it should be noted that these top four treatments all included a planting-time application of Counter 20G at its moderate rate (7.5 lb/ac). These results may suggest that, under moderate SBRM feeding pressure, a moderate rate of at-plant protection, followed by more aggressive postemergence control strategy (i.e., two split applications of a postemergence liquid insecticide spray), may allow growers to optimize sucrose yield and revenue.

In comparisons among dual- and triple-insecticide component programs, there were two key findings. First, the top-yielding treatment consisted of Counter 20G applied at planting at 7.5 lb product per acre combined with two postemergence applications of Lorsban Advanced at 2 pts/ac. In that program, adding a second application of Lorsban Advanced generated significantly greater recoverable sucrose yield (1,401 lb increase) and root tonnage (3.5-ton increase), and $223 more in gross revenue than a similar program that only included a single 2-pt/ac application of Lorsban Advanced. Second, the program that included the same moderate rate of Counter (7.5 lb/ac) at planting, followed by two split applications of postemergence Lorsban Advanced at 1 pt/ac (6 days pre- and 4 days post-peak), also produced significantly more sucrose and root yield than when the Lorsban Advanced was applied in a single 2-pt/ac application. The program involving two split postemergence applications of Lorsban Advanced at 1 pt/ac generated $249 more gross economic return than when the Lorsban was applied as a single 2-pt application.

Table 2. *Yield parameters* from an assessment of postemergence insecticide spray timing, rate, and frequency impacts on 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 + Lorsban Advanced + Lorsban Advanced	B 6 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	12,187 a	39.7 ab	16.60 a	1,436
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 6 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	12,015 a	38.9 ab	16.70 a	1,427
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 5 d Pre-peak Broadcast 5 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	12,007 a	40.0 a	16.43 a	1,367
Counter 20G + Lorsban Advanced + Mustang Maxx	B 3 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 1 pt 4 fl oz	1.5 0.5 0.025	11,827 ab	40.2 a	16.10 a	1,310
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 3 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	11,697 ab	38.4 abc	16.50 a	1,363
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	11,544 ab	37.5 bc	16.60 a	1,363
Counter 20G	B	8.9 lb	1.8	11,499 ab	38.9 ab	16.18 a	1,283
Counter 20G + Mustang Maxx	B 3 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	11,441 ab	37.5 bc	16.50 a	1,333
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 5 d Pre-peak Broadcast 5 d Post-peak Broadcast	7.5 lb 1 pts 1 pts	1.5 1.0 1.0	11,347 ab	39.1 ab	15.93 a	1,229
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	11,295 ab	39.8 a	15.70 a	1,178
Counter 20G + Mustang Maxx + Lorsban Advanced	B 3 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 4 fl oz 1 pt	1.5 0.025 0.5	11,264 ab	37.5 bc	16.30 a	1,285
Counter 20G	B	7.5 lb	1.5	11,258 ab	37.9 abc	16.20 a	1,264
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	10,781 b	36.2 c	16.20 a	1,213
Check	---	---	---	9,182 c	30.9 d	16.10 a	1,030
LSD (0.05				1,198.6	2.29	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

Meaningful trends observed in this trial involved treatment timing and order. For example, numerically (i.e., not statistically significant) greater recoverable sucrose yield was produced when the first applications of Lorsban Advanced in dual postemergence sprays were applied earlier (6 days pre- + 4 days post-peak vs. 5 days pre- + 5 days post-peak and 3 days pre- + 8 days post-peak). Also, in postemergence spray programs where Lorsban Advanced and Mustang Maxx were alternated, applying the Lorsban on the pre-peak spray and following it with Mustang Maxx resulted in numerically greater recoverable sucrose yield and significantly more root tonnage than when the Mustang was applied first.

Despite the moderate SBRM feeding pressure that was present during this experiment, most of the SBRM control programs evaluated in this experiment provided effective SBRM control that translated to major yield benefits. Another general conclusion that can be drawn is that the root protection, yield, and revenue benefits from additive postemergence insecticides demonstrate that they are cost-effective tools to use in areas where damaging SBRM populations occur.

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