THREE-YEAR PERFORMANCE SUMMARY ON MOVENTO HL® INSECTICIDE FOR POSTEMERGENCE SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the most economically significant insect pest of sugarbeet in the Red River Valley (RRV) growing area. In areas at moderate to high risk of damaging SBRM infestations, RRV sugarbeet producers typically manage this pest by prophylactically protecting their crop at planting time with either a granular insecticide or an insecticidal seed treatment during planting operations. In areas where severe SBRM infestations frequently develop, planting-time control efforts are often augmented by one to two postemergence insecticide applications. As far back as the mid-1970s, most of these applications have involved the use of insecticides in the organophosphate and carbamate classes to manage the sugarbeet root maggot. Both of these insecticide classes kill insects through the same mode of action, acetylcholinesterase (ACHE) inhibition.

Grower dependence on a single mode of action for SBRM control in the Red River Valley has been largely due to two factors. First, a limited number of insecticide products have been registered for use in the crop for much of this time. Second, despite frequent screening efforts on a variety of insecticides belonging to alternative modes of action, very few insecticidal products tested in screening programs have shown promise as viable options for SBRM control. As a result of this long-term, repeated use of ACHE inhibitor insecticides, the threat of insecticide resistance development in RRV sugarbeet root maggot populations has been a looming concern for pest management advisors and producers for several years.

In 2017, the U.S. Environmental Protection Agency approved the registration of Movento HL insecticide for use in sugarbeet. The addition of this product is encouraging from an insect resistance management perspective, because the active ingredient in Movento (i.e., spirotetramat) belongs to the lipid biosynthesis inhibitor (LBI) insecticide class, which is an alternative mode of action to the commonly used ACHE inhibitors. Thus far, after significant screening efforts have been conducted on insect species with known resistance to other insecticides, there is no evidence of cross resistance between the LBI insecticides and other classes. This project was carried out to evaluate the efficacy of Movento HL as a postemergence tool for sugarbeet root maggot control. A secondary objective was to assess the performance of dual-insecticide programs for SBRM management that include Poncho Beta as the planting-time insecticide component and Movento HL as the postemergence rescue component.

Materials and Methods:

This three-year experiment was conducted on grower-owned field sites near St. Thomas in rural Pembina County, ND during the 2016-2018 growing seasons. Betaseed 89RR52 glyphosate-resistant seed was used for all treatments each year. Plots were planted on 11 May in 2016 and 2018, and on 10 May in 2017. 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. Insecticide was excluded from each of the outside rows (i.e., rows 1 and 6) of the planter, and those "guard rows" served as untreated buffers. Each plot was 35 feet long, and 35-foot alleys between replicates were maintained weed-free by using periodic cultivation throughout the growing season. The experiment was arranged in a randomized complete block design with four replications in 2016 and 2018, and three replications in 2017.

Planting-time insecticide applications: 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.

Postemergence insecticide applications: Additive postemergence insecticides in this trial included Movento HL, Lorsban Advanced, and Mustang Maxx. Insecticide application timings evaluated included the

following: 1) Lorsban Advanced and Mustang Maxx, applied between two and three days before peak SBRM fly activity; 2) Movento HL at 6-7 days pre-peak; and 3) Movento HL applied either one day before or on the peak fly activity date. Postemergence liquid insecticide solutions were delivered by using a tractor-mounted CO_2-propelled spray system equipped with TeeJet™ 110015VS nozzles and calibrated to deliver applications in a finished output volume of 10 GPA. All Movento sprays included methylated seed oil at the recommended rate of 0.25% v/v.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in this experiment between 30 July and 3 August each year. Sampling 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: Plots were harvested on 20 September in 2016, 3 October in 2017, and 25 September in 2018. Immediately (i.e., between 10 and 60 min) before harvest of each year, all foliage was removed from plots by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were then 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) according to the general linear models (GLM) procedure (SAS Institute, 2012). Treatment means were compared by using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance. Initial analyses indicated that there were no significant treatment × year interactions for root injury ratings ($P = 0.7445$), recoverable sucrose yield ($P = 0.2636$), root yield ($P = 0.1345$), or percent sucrose content data ($P = 0.4321$). As such, three-year combined analyses were performed on all data from this experiment.

Results and Discussion:

Sugarbeet root maggot feeding injury results from this three-year trial are presented in Table 1. Moderate to high SBRM infestations were present during these evaluations, with the lowest feeding pressure occurring in 2017, and the highest occurring in 2018. The average SBRM feeding injury rating for the untreated check plots across study years was 6.37 on the 0 to 9 scale of Campbell et al. [2000]); however, the average feeding injury recorded for all insecticide-protected plots was significantly lower than that in the untreated check.

The lowest average root maggot feeding injury was observed in plots protected by the dual insecticide program comprised of Poncho Beta-treated seed plus a postemergence application of Mustang Maxx at 4 fl oz of product/ac. Other entries that were not significantly outperformed by this treatment included the following: 1) Poncho Beta plus a postemergence application of Lorsban Advanced at its high (2 pts product/ac) labeled rate; 2) Counter 20G at planting time at its moderate rate of 7.5 lb product/ac; and 3) Poncho Beta plus Movento HL, applied at 2.5 fl oz of product/ac at peak SBRM fly activity. There was no significant difference in SBRM feeding injury between applications of Movento HL made at peak fly activity and those made at about one week pre-peak.

Table 1. *Larval feeding injury* in a comparison of Movento HL®, Lorsban Advanced, and Mustang Maxx for postemergence sugarbeet root maggot control, St. Thomas, ND, 2016 – 2017

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Poncho Beta + Mustang Maxx	Seed 2-3 d Pre-peak Broadcast	4 fl oz	68 g a.i./ unit seed 0.025	4.07 d
Poncho Beta + Lorsban Advanced	Seed 2-3 d Pre-peak Broadcast	2.0 pts	68 g a.i./ unit seed 1.0	4.23 cd
Counter 20G	B	7.5 lb	1.5	4.30 bcd
Poncho Beta + Movento HL + MSO	Seed Peak fly (or 1 d pre-peak)	2.5 fl oz	68 g a.i./ unit seed 0.078	4.52 bcd
Poncho Beta + Movento HL + MSO	Seed 6-7 d Pre-peak Broadcast	2.5 fl oz	68 g a.i./ unit seed 0.078	4.61 bc
Poncho Beta	Seed		68 g a.i./ unit seed	4.74 b
Check	-----	----	-----	6.37 a
LSD (0.05)				0.504

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 data from this experiment are shown in Table 2. Similar to the results from root injury rating comparisons, all insecticide treatments provided significant increases in recoverable sucrose yield, root tonnage, and percent sucrose content in comparison to the untreated check.

The two best-performing treatments with regard to recoverable sucrose and root yield included the combination of Poncho Beta seed treatment plus a postemergence application of Lorsban Advanced at its high labeled rate of 2 pts product/ac, and Poncho Beta seed plus a postemergence application of Mustang Maxx at its high labeled rate (4 fl oz/ac).

These treatment programs produced averages of 3,207 and 2,810 lb more recoverable sucrose per acre, respectively than the untreated check throughout the three-year duration of this experiment. They also generated revenue increases of $438 and $395/ac, respectively, when compared to the check plots. Revenue benefits from Movento HL ranged from $9/ac for the peak fly application to $23/ac for the 7-day pre-peak application when compared to Poncho Beta plots that did not receive a postemergence spray. Increases in gross revenue from the postemergence applications of Lorsban Advanced and Mustang Maxx in plots initially protected by Poncho Beta-treated seed were $188 and $145/ac, respectively.

Table 2. *Yield parameters* from a comparison of Movento HL®, Lorsban Advanced, and Mustang Maxx for postemergence sugarbeet root maggot control, St. Thomas, ND, 2016 – 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)
Poncho Beta + Lorsban Advanced	Seed 2-3 d Pre-peak Broadcast	2.0 pts	68 g a.i./ unit seed 1.0	8,714 a	28.7 a	16.2 a	1,012
Poncho Beta + Mustang Maxx	Seed 2-3 d Pre-peak Broadcast	4 fl oz	68 g a.i./ unit seed 0.025	8,317 a	27.4 ab	16.1 a	969
Poncho Beta + Movento HL + MSO	Seed 6-7 d Pre-peak Broadcast	2.5 fl oz	68 g a.i./ unit seed 0.078	7,532 b	25.4 bc	15.9 a	847
Poncho Beta + Movento HL + MSO	Seed Peak fly (or 1 d pre-peak)	2.5 fl oz	68 g a.i./ unit seed 0.078	7,397 b	24.9 c	15.7 a	833
Poncho Beta	Seed		68 g a.i./ unit seed	7,233 b	25.1 c	15.8 a	824
Counter 20G	B	7.5 lb	1.5	7,392 b	24.0 c	16.0 a	831
Check	-----	----	-----	5,507 c	19.5 d	15.1 b	574
LSD (0.05)				676.5	2.06	0.53	

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

All insecticide treatments, whether comprised of a single planting-time application of Counter 20G, Poncho Beta seed treatment alone, or dual-insecticide programs that included Poncho Beta seed plus a postemergence insecticide spray, provided significant increases in percent sucrose content when compared to the untreated check. However, there were no significant differences in sucrose content among insecticide treatments.

The results from this three-year study show that, under moderate to moderately high SBRM infestation levels, major yield and revenue benefits can be achieved in control programs that combine a neonicotinoid seed treatment insecticide and a postemergence sprayable insecticide. Results also suggest that yields and revenue are markedly increased by the postemergence insecticide. Although there were no significant differences in regard to root protection from SBRM feeding activity or resulting yield parameters between the two timings tested for Movento HL applications, results suggest slight improvements by applying this product earlier. This pattern may have been due to the systemic movement of Movento within the plant. Applying it earlier may have resulted in higher concentrations of insecticide active ingredient in roots when SBRM larval feeding injury was occurring. Further research is needed to evaluate Movento under higher SBRM infestations to fully characterize its SBRM control capability. Research should also focus on optimizing Movento application timing and use rate. The EPA-approved label allows for a higher application rate of 4.5 fl oz/ac. It is uncertain at this time as to whether applying this product at its maximum labeled rate, if shown to be more efficacious, will be economically practical.

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