YIELD AND QUALITY OF SUGARBEET TREATED WITH TANK MIXTURES OF FOLIAR FUNGICIDES, INSECTICIDES, AND GLYPHOSATE HERBICIDE: A TWO-YEAR STUDY

Mark A. Boetel, Professor
Robert J. Dregseth and Allen J. Schroeder, Research Specialists

Department of Entomology, North Dakota State University, Fargo, ND

Introduction:

Most U.S. sugarbeet producers that grow the crop for processing have incorporated Roundup-Ready™ (glyphosate-resistant) sugarbeet technology on their farms. This trend has also occurred in the Red River Valley of North Dakota and Minnesota. In most cases, RRV growers apply up to two applications of the herbicide to manage weeds in their sugarbeet fields. However, the need often arises for growers to also manage other crop pests, such as insects and diseases. In some cases, it can be advantageous to combine two or more crop protection materials as a tank mixture for a single application. If biologically feasible, applications that control more than one crop pest (e.g., weed, insect, and/ or pathogen) in a single pass across the field, tank mixing can save producers time and input costs associated with fuel, equipment wear and tear, and equipment depreciation. However, information on the crop safety and compatibility of fungicide, insecticide, and herbicide tank mixtures is somewhat sparse in the available body of literature. This type of information would likely be useful to producers, crop protection specialists, sugar company agriculturists, farm agronomists, and other crop production advisors involved with sugarbeet production.

The objective of this experiment was to determine the crop safety of tank mixtures comprised of Roundup PowerMAX™ herbicide with postemergence liquid foliar fungicides and insecticides for use in sugarbeet. The tank mixtures evaluated were designed to reflect mid- to late-summer crop protection scenarios, such as those requiring control of Cercospora leaf spot, a foliar insect pest (e.g., Lygus bug, cutworms, webworms, or grasshoppers), in addition to a late application of glyphosate for weed management. IMPORTANT: It should be noted that the intent of this experiment was <u>not</u> to evaluate pesticide performance in managing any of the aforementioned pests. Rather, it was to assess the relative safety of pesticide tank mixtures with regard to plant health, and to determine whether any such combinations should not be used in sugarbeet production due to potential risks of phytotoxicity and associated yield loss.

Materials and Methods:

This study was conducted in 2012 at the NDSU Prosper Experiment Farm near Prosper (Cass County), ND, and in a grower's field near Hillsboro (Traill County), ND. Plots were planted on 15 May in 2012 and 18 June in 2013 using a 6-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. Seed varieties in 2012 and 2013 were SES VanderHave SV36917RR and SX Wrangler RR (both glyphosate-resistant), respectively. Individual treatment plots were 35 ft long by 6 rows (22-inch spacing) wide with the 4 centermost rows treated. The outer row on each side served as an untreated buffer. Plant-free, 25-foot alleys were established between replicates. The experiment was arranged in a randomized complete block design with four replications of the treatments. Plots were thinned to a population of 130 plants per 100 row ft each year to establish consistent plant stands for subsequent treatment comparisons on the basis of yield and quality, and to eliminate unwanted confounding effects associated with uneven plant populations among plots. Similarly, to avoid potential confounding effects from soil-dwelling pests (e.g., springtails, wireworms, etc.), Counter 20G was applied at planting time in 5-inch bands at the low labeled rate (4.5 lb product/ac) to all plots, including the checks. Delivery of Counter granules was regulated by using planter-mounted Noble™ metering units that had been calibrated on the planter before all applications.

All treatments in the experiment were postemergence sprays, which were applied on 19 July in 2012 and 16 August in 2013 by using a tractor-mounted CO_2-propelled spray system. The sprayer was calibrated to deliver a finished spray output volume of 15 GPA. All sprays were broadcast applied. TeeJet™ AIXR 110015 nozzles were used for the applications in 2012, and TeeJet™ AIXR 11002 nozzles were used in 2013. The highest labeled rates of the insecticides (i.e., Lorsban Advanced and MustangMax), fungicides (i.e., Proline, Quadris, and Super Tin), and Roundup PowerMAX were used for all treatments to create worst-case scenarios for assessing potential risks of the pesticides and tank mixtures thereof. In addition to single, two-way, and three-way tank mixture combinations, a water-only (i.e., 15 GPA) check and a surfactant check (i.e., Veracity™ at a rate of 3 qt/100 gallons of spray solution) were included in the trial for comparative purposes.

Harvest: Plots were harvested on 17 September in 2012 and 25 October in 2013. The foliage was removed from all plots immediately before harvest by using a commercial-grade mechanical defoliator. Shortly thereafter, all beets were extracted from the center 2 rows of each plot by using a mechanical harvester, and weighed in the field using a harvester-mounted 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 analysis of sugar content and quality.

Data analysis: Gross revenue values were calculated based on the grower payment schedule for the 2013 crop as per a grower-owned sugar processing cooperative in the region. All data from harvest samples were subjected to analysis of variance using the general linear models procedure (SAS Institute, 1999), and treatment means were compared by using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

The initial analysis of the data from both years indicated that there was no significant treatment X year interaction for recoverable sucrose yield (P = 0.4752), root yield (P = 0.6461), or percent sucrose content (P = 0.8156), which allowed a subsequent combined analysis of the data for all three response variables. The results for yield, quality, and revenue from this trial are presented in Table 1. There were no significant differences between any treatments with regard to recoverable sucrose yield, root yield, or percent sucrose. The highest average yields in this study were from plots that received the following single-component treatments: 1) Lorsban Advanced; 2) Super Tin; 3) Quadris; 4) the water-only check; and 5) the Veracity-only check. Plots treated with the single-component application of Proline also produced relatively high yields compared to the remaining treatments in the experiment. This pattern could suggest that there is at least some risk of possible yield and revenue loss from some of the other, single-pesticide treatments tested and, potentially, even more risk from tank mixtures comprised of more than one pesticide.

The highest-yielding and, potentially, safest tank-mix combinations in this two-year experiment included the following: 1) Lorsban Advanced + Roundup PowerMAX + Proline; 2) MustangMax + Quadris; 3) MustangMax+ Roundup PowerMAX + Proline; 4) MustangMax + Roundup PowerMAX + Quadris; and 5) MustangMax + Proline. These results, although not statistically significant, could suggest that MustangMax may be a relatively safe tank-mix insecticide partner with Roundup PowerMAX herbicide and either Proline or Quadris as the fungicide component. Moreover, trends in these results suggest that, of the two insecticides evaluated in this experiment, MustangMax tended to be a safer insecticidal component of the tank mixtures tested.

It should be noted that weather conditions during spray applications for this experiment should have presented a somewhat worst-case scenario for the likelihood of crop injury and associated yield loss. The high temperature at Prosper during spray applications was 93°F, and highs during the subsequent three days were 100, 89, and 99°F (NDAWN, 2012). Although such extreme heat did not occur during treatment applications at Hillsboro in 2013, the ambient temperature during plot spraying was 83°F, and daily highs reached 92 and 95°F within 4 days postapplication. Thus, if any of these treatment combinations are likely to cause crop injury, it should have been detected under the moderately warm to extremely hot weather conditions that occurred during and shortly after treatment applications.

Due to the overall absence of statistically significant differences in this study, it cannot be concluded that any of the treatments, either single or those involving tank-mixed combinations, pose a significant threat of phytotoxicity and associated yield and revenue loss in sugarbeet. However, the large (i.e., over 1,200 lb recoverable sucrose) yield differences suggest that major losses are at least possible with some tank-mixed combinations. The overall lack of statistical significance associated with differences among treatments in this study could have been associated with the large distance between and total area among treatments in the experiment. Despite the occurrence of large numerical differences between some treatments, the overall result of no statistical significance between treatments precludes us from determining whether any are safer or more hazardous to sugarbeet plant health than others. The relatively large numerical differences among treatment responses in this experiment suggest that these results be interpreted with a moderate degree of caution, because major reductions in yield and associated gross economic return could have serious consequences to individual growers if similar results occur on their farms.

Table 1. Two-year combined analysis of *yield parameters* from an evaluation of single and tank-mixed combinations of foliar insecticides, fungicides, and Roundup PowerMAX herbicide in sugarbeet, Hillsboro and Prosper, ND, 2012-2013

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Surfactant Check (Veracity)	Broadcast	3 qt/100 gal		7737	24.4	17.0	885
Lorsban Advanced	Broadcast	2 pts	1.0	7601	24.3	16.9	854
Lorsban Advanced + Roundup PowerMAX + Proline 480SC	Broadcast	2 pts 32 floz/ac 5 fl oz/ac	1.0 1.13 ae [a] 0.16	7595	24.2	17.0	859
Check	---	---	---	7565	23.7	17.2	872
MustangMAX + Quadris	Broadcast	4 fl oz/ac 15.4 fl oz/ac	0.025 0.25	7528	24.0	17.0	849
MustangMax + Roundup PowerMAX + Proline 480SC	Broadcast	4 fl oz/ac 32fl oz/ac 5 fl oz/ac	0.025 1.13 ae [a] 0.16	7525	23.8	17.1	857
MustangMax	Broadcast	4 fl oz/ac	0.025	7515	23.8	17.0	852
MustangMax + Roundup PowerMAX + Quadris	Broadcast	4 fl oz/ac 32 fl oz/ac 15.4 fl oz/ac	0.025 1.13 ae [a] 0.25	7443	23.8	16.9	834
MustangMax + Proline 480SC	Broadcast	4 fl oz/ac 5 fl oz/ac	0.025 0.16	7410	23.8	16.8	828
MustangMAX + Super Tin 4L	Broadcast	4 fl oz/ac 8 fl oz/ac	0.025 0.25	7384	23.6	16.9	828
Super Tin 4L	Broadcast	8 fl oz/ac	0.25	7310	23.5	16.8	812
Quadris	Broadcast	15.4 fl oz/ac	0.25	7296	23.3	16.8	819
Lorsban Advanced + Quadris	Broadcast	2 pts 15.4 fl oz/ac	1.0 0.25	7286	23.4	16.9	814
Lorsban Advanced + Super Tin 4L	Broadcast	2 pts 8 fl oz/ac	1.0 0.25	7263	23.1	17.1	819
Proline 480SC	Broadcast	5 fl oz/ac	0.16	7240	23.2	16.9	808
Roundup PowerMAX	Broadcast	32 fl oz/ac	1.13 ae [a]	7165	22.3	17.3	831
Lorsban Advanced + Roundup PowerMAX	Broadcast	2 pts 32 fl oz/ac	1.0 1.13 ae [a]	7124	23.2	16.6	781
MustangMax + Roundup PowerMAX + Super Tin 4L	Broadcast	4 fl oz/ac 32 fl oz/ac 8 fl oz/ac	0.025 1.13 ae [a] 0.25	7079	22.7	16.8	793
Lorsban Advanced + Roundup PowerMAX + Super Tin 4L	Broadcast	2 pts 32 fl oz/ac 8 fl oz/ac	1.0 1.13 ae [a] 0.25	7010	22.1	17.1	800
Lorsban Advanced + Roundup PowerMAX + Quadris	Broadcast	2 pts 32 fl oz/ac 15.4 fl oz/ac	1.0 1.13 ae [a] 0.25	6998	22.6	16.7	774
MustangMax + Roundup PowerMAX	Broadcast	4 fl oz/ac 32 fl oz/ac	0.025 1.13 ae [a]	6710	21.5	16.9	752
Lorsban Advanced + Proline 480SC	Broadcast	2 pts 5 fl oz/ac	1.0 0.16	6378	20.8	16.6	698
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]Glyphosate acid equivalent per acre

References Cited:

NDAWN. The North Dakota Agricultural Weather Network. North Dakota State University. http://ndawn.ndsu.nodak.edu. Accessed January 7, 2013 and January 15, 2014.

SAS Institute. 2008. The SAS System for Windows. Version 9.2. SAS Institute Inc., 2002-2008. Cary, NC.