# EFFECT OF FUNGICIDE, INSECTICIDE, AND HERBICIDE TANK MIXES ON SUGARBEET

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The objective of this research was to evaluate phytotoxicity of fungicide, insecticide, and herbicide tank mixes to sugarbeet.

## MATERIALS AND METHODS

A field trial was conducted at Glyndon, MN in 2010, Prosper, ND in 2011 and Foxhome, MN in 2012. The experimental design was a randomized complete block with four replicates in all years.

At Glyndon, MN in 2010, the field was fertilized with 125 lb/A of Urea on 10 May and incorporated 11 May with 0.5 inches of rainfall. Field plots comprised of six 25-feet long rows spaced 22 inches apart. Plots were planted 18 May, using Crystal 539RR treated with 45 g of Tachigaren/unit of seed and Poncho Beta. Terbufos (Counter 15G) was applied modified in-furrow at 11.9 lbs/A during planting to control sugarbeet insect pests. Weeds were controlled with glyphosate applied on 10 and 22 June, and 18 August. Cercospora leaf spot was controlled with Headline applied 18 August. Treatments (Table 1) were applied 14 June to 4 to 5 leaf beets with a bicycle sprayer calibrated to deliver 17 gpa of solution at 40 p.s.i pressure to the middle four rows of plots using TeeJet 8002 XR flat fan nozzles. Environmental data from application is shown in Table 2.

At Prosper, ND in 2011, the field was fertilized with 92 lbs/A N (200 lb/A of Urea) and incorporated with a field cultivator on 7 June. Field plots comprised of six 30-feet long rows spaced 22 inches apart. Plots were planted 10 June, using SESVanderHave 36811RR treated with 45 g of Tachigaren/unit of seed and Poncho Beta. Terbufos (Counter 15G) was applied modified in-furrow at 6 lbs/A during planting to control sugarbeet insect pests. Weeds were controlled with glyphosate applied on 6 July and 17 August. Cercospora leaf spot was controlled with Eminent applied 17 August. Treatments (Table 3) were applied 12 July to 8 to 12 leaf beets with a bicycle sprayer calibrated to deliver 17 gpa of solution at 40 p.s.i pressure to the middle four rows of plots using TeeJet 8002 XR flat fan nozzles.

At Foxhome, MN in 2012, the field plots comprised six 30-feet long rows spaced 22 inches apart. Plots were planted 10 May using SESVanderHave 36811RR treated with 45 g of Tachigaren/unit of seed and Poncho Beta. Counter Insecticide was not applied. Weeds were controlled with glyphosate applied on 21 June. Cercospora leaf spot was controlled with Topsin applied on 2 July and Headline applied on 19 July and Inspire on 9 August. Treatments (Table 4) were applied 31 May to 2 leaf beets with a four row tractor calibrated to deliver 17 gpa of solution at 60 p.s.i. pressure to the middle four rows of plots using 11002 twin TT nozzles

Plots were defoliated mechanically and harvested using a mechanical harvester on 14 September, 2010, 19 September, 2011 and 27 September, 2012. The middle two rows of each plot were harvested and weighed for root yield. Twelve to 15 random roots from each plot, not including roots on the ends of the plot, were analyzed for quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 8.3.4 software package (Gylling Data Management Inc., Brookings, South Dakota, 2011). The least significant difference (LSD) test was used to compare treatments when the F-test for treatments was significant ($P$=0.05).

## RESULTS AND DISCUSSIONS

The Glyndon site in 2010 was inoculated with Rhizoctonia AG 2-2 IIIB. This experiment was added after inoculation, so the effect of Rhizoctonia should be considered when interpreting these data. Sugarbeet injury was evaluated on 22 June and the tank mix of Quadris + R.U. Powermax + Lorban Advanced gave sugarbeet injury of 25%. This was greater injury than the check or any of the other treatments. All other treatments gave similar injury to the check. No significant differences were observed in yield, percent sugar, or extractable sucrose per acre. This

indicates that while sugarbeet were injured from Quadris + R.U. Powermax + Lorban Advanced early in the season, injury did not result in reduced sugarbeet yield or quality.

The Prosper site in 2011 was a non-disease site. Excessive early season rainfall delayed application of tank-mix treatments. Treatments were scheduled to be applied to 4 to 6 leaf sugarbeet, but standing water and rain events delayed application until sugarbeet were in the 8 to 12 leaf stage. Sugarbeet injury was observed on 12 July, approximately 4 hours after application, for treatments 17 and 18. Injury symptoms were prostrate sugarbeet leaves. No injury was observed from any treatments when plots were evaluated in August and September. No significant differences were observed in percent sugar or extractable sucrose per acre. Significant differences were observed in sugarbeet yield with treatments 9, 13, 18, and 20 yielding less tons per acre than the untreated check. It is unclear whether reduced tonnage for these treatments was due to injury from the treatments or from excessive water.

The Foxhome site in 2012 was planted earliest and harvested latest compared to 2010 and 2011. Environmental conditions were favorable for crop growth although rainfall was lowest (8.2'') compared to an annual average of 13.87 inches. Rainfall for the sites in 2010 was 15.11'' and for 2011 was 14.74''. Treatments were applied on 31 May (when beets were at the two-leaf stage) to get results similar to growers who were applying treatments 7 to 14 days earlier and were reporting phytotoxicity. In this trial, there was some minor speckling of leaves but no significant visual leaf damage. There was no significant reduction in yield, sucrose concentration, and recoverable sucrose between any of the treatments and the non-treated check. It should be noted that when treatments were applied, the air temperature was 61 F and 40% relative humidity, whereas air temperature reached the mid-90s when growers reported leaf burn. The root yield, sucrose concentration and recoverable sucrose were highest in 2012. These results suggest that the sugarbeet plant may be treated with mixtures of insecticides, fungicides, and herbicides in most years without adversely affecting yield from phytotoxicity. It may be safer to apply pesticide mixtures to older plants when air temperature is below 80 F.

It is unclear why the tank mix of Quadris + R.U. Powermax + Lorban Advanced caused sugarbeet injury in 2010 but not in 2011. The difference may be due to environmental differences at or immediately following application or sugarbeet leaf stage at application. The minor leaf speckling was probably a result of the small size of the beets where the leaves were not hardened compared to later leaf stages.

**Table 1. Effect of fungicide, insecticide, and herbicide tank mixes on sugarbeet at Glyndon, MN in 2010.**

| Treatment | Rate in fl oz/A | 22 June Sgbt Injury | Yield | Sugar | Extractable Sucrose |
|---|---|---|---|---|---|
| | | % | Ton/A | % | lb/A |
| Untreated Check | | 0 | 17.6 | 12.9 | 3991 |
| Quadris + R.U. PowerMax[1] + Stinger | 15.4 + 32 + 2 | 4 | 23.5 | 13.8 | 5827 |
| Quadris + R.U. PowerMax + Stinger | 15.4 + 32 + 4 | 9 | 23.7 | 13.7 | 5784 |
| Quadris + R.U. PowerMax + Lorsban Advanced | 15.4 + 32 + 32 | 25 | 18.6 | 13.3 | 4497 |
| Quadris + Lorsban Advanced | 15.4 + 32 | 9 | 19.9 | 12.6 | 4406 |
| **LSD (p≤0.05)** | | **10** | **NS** | **NS** | **NS** |

[1] R.U. PowerMax was always applied with NIS at 0.25% v/v + AMS at 14.5 lb/100 gal

**Table 2. Environmental conditions at application in 2010 and 2011.**

| | Glyndon, MN | Prosper, ND | Foxhome, MN |
|---|---|---|---|
| Date | 14 June, 2010 | 12 July, 2011 | 31 May, 2012 |
| Time | 11:00 am | 8:45 am | 10:45 am |
| Sugarbeet Stage | 4-5 leaf | 8-12 leaf | 2 leaf |
| Air Temperature (F) | 66 | 65 | 61 |
| Relative Humidity (%) | 54 | 40 | 40 |
| Wind Velocity (mph) & Dir. | 4 North | 10 North | 4 Northwest |
| Soil Temperature (F at 5") | 59 | 68 | 55 |
| Soil Moisture | good | good | Good |
| Cloud Cover (%) | 25 | 0 | 15 |

**Table 3. Effect of fungicide, insecticide, and herbicide tank mixes on sugarbeet at Prosper, ND in 2011.**

| | Treatment | Rate in fl oz/A | Yield | Sugar | Extractable Sucrose |
|---|---|---|---|---|---|
| | | | Ton/A | % | lb/A |
| 1 | Untreated Check | | 18.8 | 12.5 | 4093 |
| 2 | Quadris | 15.4 | 19.1 | 12.8 | 4298 |
| 3 | Headline | 9 | 19.2 | 12.8 | 4292 |
| 4 | Proline + NIS | 5.7 + 0.125% v/v | 18.5 | 12.2 | 3867 |
| 5 | Quadris + Lorsban Advanced | 15.4 + 32 | 18.1 | 12.5 | 3959 |
| 6 | Headline + Lorsban Advanced | 9 + 32 | 18.1 | 12.9 | 4082 |
| 7 | Proline + NIS + Lorsban Advanced | 5.7 + 0.125% v/v + 32 | 17.4 | 13.5 | 4189 |
| 8 | Quadris + Mustang Max | 15.4 + 4 | 17.6 | 12.9 | 3960 |
| 9 | Headline + Mustang Max | 9 + 4 | 17.1 | 13.5 | 4126 |
| 10 | Proline + NIS + Mustang Max | 5.7 + 0.125% v/v + 4 | 17.6 | 13.2 | 4159 |
| 11 | Quadris + Lorsban Advanced + R.U. PowerMax[1] | 15.4 + 32 + 32 | 17.3 | 12.4 | 3753 |
| 12 | Headline + Lorsban Advanced + R.U. PowerMax | 9 + 32 + 32 | 17.8 | 12.4 | 3852 |
| 13 | Proline + NIS + Lorsban Advanced + R.U. PowerMax | 5.7 + 0.125% v/v + 32+ 32 | 17.0 | 12.6 | 3777 |
| 14 | Quadris + Mustang Max + R.U. PowerMax | 15.4 + 4 + 32 | 17.2 | 12.8 | 3892 |
| 15 | Headline + Mustang Max + R.U. PowerMax | 9 + 4 + 32 | 17.5 | 12.7 | 3905 |
| 16 | Proline + NIS + Mustang Max + R.U. PowerMax | 5.7 + 0.125% v/v + 4 + 32 | 17.8 | 12.4 | 3846 |
| 17 | Quadris + R.U. PowerMax + Stinger | 15.4 + 32 + 4 | 19.4 | 12.3 | 4114 |
| 18 | Quadris + R.U. PowerMax + Stinger + Lorsban Advanced | 15.4 + 32 + 4 + 32 | 16.7 | 12.7 | 3687 |
| 19 | Quadris + R.U. PowerMax + Select Max | 15.4 + 32 + 12 | 18.3 | 13.0 | 4177 |
| 20 | Quadris + R.U. PowerMax + Select Max + Lorsban Advanced | 15.4 + 32 + 12 + 32 | 16.5 | 12.7 | 3697 |
| | **LSD (p≤0.05)** | | **1.7** | **NS** | **NS** |

[1] R.U. PowerMax was always applied with NIS at 0.25%v/v + AMS at 14.5 lb/100 gal

**Table 4. Sugarbeet phytotoxicity from Fungicide, Insecticide and Herbicide Tank Mixes at Foxhome, MN in 2012**

| Treatment and rate/A | Root yield (t/A) | Sucrose concen-tration (%) | Recoverable sucrose (lb/t) | Recoverable sucrose (lb/A) | Net Rev ($/A)* |
|---|---|---|---|---|---|
| Headline 9 fl oz | 34.1 | 19.3 | 359 | 12,211 | 2,408 |
| Untreated Check | 33.8 | 19.5 | 359 | 12,118 | 2,424 |
| Quadris 15.4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 ai/100 gal + Stinger 4 fl oz | 33.5 | 19.7 | 361 | 12,093 | 2,325 |
| Proline 5.7 fl oz + Mustang Max 4 fl oz + NIS 0.125% v/v | 33.3 | 19.6 | 362 | 12,057 | 2,371 |
| Headline 9 fl oz + Mustang Max 4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100 gal | 32.4 | 19.8 | 365 | 11,851 | 2,302 |
| Proline 5.7 fl oz + Mustang Max 4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100 gal | 32.4 | 19.7 | 365 | 11,831 | 2,299 |
| Quadris 15.4 fl oz + Mustang Max 4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100gal | 33.2 | 19.1 | 353 | 11,712 | 2,257 |
| Proline 5.7 fl oz + Lorsban Advanced 32 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100 gal | 32.5 | 19.6 | 360 | 11,698 | 2,269 |
| Quadris 15.4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100 gal + Select Max 12 fl oz | 33.2 | 19.1 | 350 | 11,602 | 2,231 |
| Quadris 15.4 fl oz + Mustang Max 4 fl oz | 32.4 | 19.4 | 357 | 11,552 | 2,253 |
| Proline 5.7 fl oz + NIS 0.125% v/v | 33.2 | 19.0 | 348 | 11,546 | 2,275 |
| Proline 5.7 fl oz + Lorsban Advanced 32 fl oz + NIS 0.125% v/v | 32.0 | 19.3 | 358 | 11,439 | 2,243 |
| Headline 9 fl oz + Lorsban Advanced 32 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100 gal | 32.3 | 19.4 | 355 | 11,412 | 2,210 |
| Headline 9 fl oz + Lorsban Advanced 32 fl oz | 32.7 | 18.9 | 348 | 11,380 | 2,232 |
| Quadris 15.4 fl oz | 32.3 | 19.1 | 350 | 11,318 | 2,213 |
| Quadris 15.4 fl oz + Lorsban Advanced 32 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100 gal | 30.7 | 20.0 | 369 | 11,301 | 2,171 |
| Quadris 15.4 fl oz + Lorsban Advanced 32 fl oz | 32.6 | 18.8 | 346 | 11,289 | 2,196 |
| Quadris 15.4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100gal + Select Max 12 fl oz + Lorsban Advanced 32 fl oz | 31.5 | 19.3 | 355 | 11,169 | 2,133 |
| Headline 9 fl oz + Mustang Max 4 fl oz | 31.8 | 18.8 | 345 | 10,977 | 2,155 |
| Quadris 15.4 fl oz + PowerMax 32 fl oz + NIS 0.25% v/v + Amstick 14.5 lb ai/100gal + Stinger 4 fl oz + Lorsban Advanced 32 fl oz | 31.3 | 19.2 | 351 | 10,927 | 2,081 |
| LSD (P=0.05) | NS | NS | NS | NS | 169 |

* Net Revenue calculated by multiplying Recoverable Sucrose (lb/A) by $0.20 and subtracting estimated pesticide costs and application costs