ASSESSING THE USE OF ENHANCED EFFICIENCY FERTILIZERS ON SUGARBEET YIELD AND QUALITY

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ABSTRACT

A field study was initiated in Frankenmuth, MI to study the effects of enhanced efficiency fertilizers in comparison to standard nitrogen (N) programs on sugarbeet (*Beta vulgaris* L.) yield and quality. The study was arranged as an 8 treatment randomized complete block design with four replications. All treatments received 40 pounds N/A as 28% UAN applied as a 2x2 (in) at planting with total N applications at 160 pounds N/A. Treatments consisted of urea sidedressed with light cultivation, N applied pre-emergence with a urease and nitrification inhibitor, urea applied pre-emergence with and without a urease inhibitor, UAN banded sidedress with and without a urease inhibitor with no cultivation, ammonium polyphosphate (10-34-0) applied as a pop-up with urea sidedressed with light cultivation, and a 75:25 ratio of polymer-coated urea:urea applied pre-emergence. A significant ($P < 0.05$) decrease in population was seen where N was applied pre-emergence without a urease inhibitor. Digital image analysis of canopy coverage resulted in significant ($P < 0.05$) differences throughout the growing season. Sugarbeets that received a pop-up treatment resulted in a significantly greater percentage of canopy coverage on 3 of 7 dates. First year preliminary data suggest that using enhanced efficiency fertilizers in comparison to standard N programs did not result in significant differences in final yield or % sugar where seasonal rainfall events did not result in N loss conditions. However when applying N pre-emergence, urea alone resulted in a significantly reduced stand whereas N applied with a polymer coating, a urease inhibitor, or a urease plus nitrification inhibitor did not reduce beet population.

INTRODUCTION

Michigan sugarbeet production ranks fourth in the U.S. with production concentrated in northeastern Michigan on higher pH loam and clay-rich soils (USDA, 2015). Nitrogen fertilizer is critical when growing sugarbeets as root yield and sugar percentage must be balanced for optimal return. Improper use of N can lead to impurities in the roots and cause a decrease in sugar content (Khan, 2015). Environmental conditions often determine the effectiveness of N applications with wet conditions resulting in N loss through leaching and denitrification while dry conditions often reduce plant response to N. Achieving rapid early canopy development is paramount for increasing sugar content as this increases light interception and photosynthesis within the plant. Improving N management programs with enhanced efficiency fertilizers may impact yield and sugar quality, but few scientific data are available on non-irrigated, low organic matter soils.

The objective of this experiment was to study the effects of enhanced efficiency fertilizers in comparison to a standard N management program on sugarbeet yield and quality.

MATERIALS AND METHODS

A field experiment was conducted 6 May 2014 at the Saginaw Valley Research and Extension Center in Frankenmuth, MI, on a Tappan-Londo loam complex (fine-loamy, mixed, active, calcareous, mesic Typic Endoaquolls and fine-loamy, mixed, semiactive, mesic Aeric Glossaqualfs) following corn (Zea mays L.). The experimental design was a randomized complete block design with four replications. Soil characteristics included 8.0 pH, 41 ppm P, and 162 ppm K. Individual six row plots were 15 feet wide by 35 feet long with 30 inch row spacing and planted at a seeding rate of 50,000 seeds/A with 4.25 inch seed spacing. The sugarbeet variety used was 'Crystal RR059'. All treatments received 40 pounds N/A as urea ammonium nitrate (UAN, 28-0-0) applied as a 2x2 (in) at planting with total N applications at 160 pounds N/A. Treatments consisted of urea (46-0-0) sidedressed with light cultivation, N applied pre-emergence with a urease and nitrification inhibitor, urea applied pre-emergence with and without a urease inhibitor, UAN banded sidedress with and without a urease inhibitor with no cultivation, ammonium polyphosphate (10-34-0) applied as a pop-up with remaining N as urea sidedressed with light cultivation, and a 75:25 ratio of polymer-coated urea (44-0-0):urea applied pre-emergence. Environmental data were recorded throughout the growing season and obtained from the Michigan Automated Weather Network (http://www.agweather.geo.msu.edu/mawn/).

Plants per 175 square feet were counted at 15 and 25 days after planting and prior to harvest. Chlorophyll readings were collected with a Minolta SPAD (soil plant analysis development) 502 chlorophyll meter to determine sugarbeet leaf greenness in June 2014 (Spectrum Technologies, Inc., Plainfield, IL). Plant tissue samples were collected in June and July 2014 (25 leaves and petioles per plot), dried, ground to pass through a 1-mm mesh screen, and analyzed for total N. Digital images were taken from the 2-4 leaf stage until canopy closure on a weekly basis to determine percent ground coverage. Photos were cropped and resized and analyzed for percent ground coverage using Sigma Scan Pro 5 (Systat Software, Inc., San Jose, CA). At harvest beet tops were collected from 10 feet of row, fresh weight recorded, and subsamples dried and analyzed for total N. Four beet roots were collected at harvest, washed, and weighed. A saw was used to collect beet pulp from the four sugarbeets with pulp fresh weight recorded. Pulp samples were frozen, freeze dried, and analyzed for total N using a micro-Kjeldahl digestion method and colorimetric analysis through a Lachat rapid flow injector autoanalyzer (Lachat Instruments, Milwaukee, WI) (Nelson and Sommers, 1973; Bremner, 1996).

The sugarbeet roots from the center two rows of each plot were harvested on 6 Oct. 2014 with a mechanical harvester and weighed. A root subsample (10 roots per plot) was collected from each plot to be analyzed for sugar and purity components including recoverable white sugar per acre (RWSA), recoverable white sugar per ton (RWST), % sugar, % clear juice purity, NH_2, and amino-N at the Michigan Sugar Company laboratory (Michigan Sugar Company, Bay City, MI).

Data were subjected to analysis of variance using PROC GLIMMIX in SAS (SAS Institute, 2012) to determine the significance of treatment. When ANOVA generated a significant *F* value ($P \leq 0.05$), treatment means were separated using Fisher's protected LSD.

PRELIMINARY RESULTS AND DISCUSSION

Precipitation was below average early in the growing season of 2014 (Fig. 1) as 5.8 inches of rainfall was received in the months of May and June. Treatments did not significantly affect root yield or sugar quality (Table 1). A lack of large precipitation events reduced opportunities

for N loss likely limiting the effectiveness of the enhanced efficiency fertilizer treatments on sugar yield and quality.

A significant decrease in population was observed where N was applied pre-emergence as compared to N application with a urease and or nitrification inhibitor (Table 2). Nitrogen applied with a urease inhibitor or a urease nitrification inhibitor combination may have limited N release soon after planting preventing saltation issues with the seed and increasing stand count as compared to non-stabilized N. Digital image analysis of canopy coverage resulted in significant differences throughout the growing season. On 3 of the 7 dates in 2014, sugarbeets receiving pop-up fertilizer resulted in significantly greater canopy coverage as compared to all other treatments (Table 3).

PROJECT CONTINUATION

A second year of research for this study is currently underway and will continue to investigate the impact of enhanced efficiency fertilizers on sugarbeet production. Despite being one of the earliest planted crops in Michigan, few data on sugarbeets and enhanced efficiency fertilizers are available. Variable spring weather conditions will only increase the importance of these findings.

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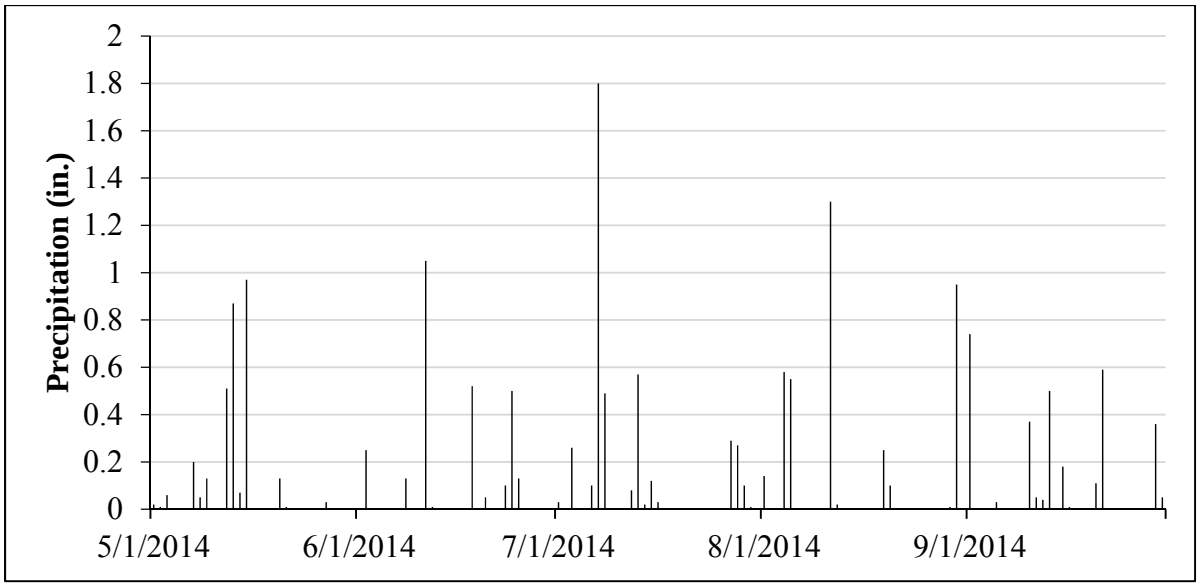

Figure 1. Daily precipitation in Frankenmuth, MI from May-Sept. of the 2014 growing season.

Table 1. Treatment effect on sugarbeet yield and % sugar, Frankenmuth, MI, 2014.

Treatment†	Yield	Sugar
	----tons/A----	------%------
Urea sidedressed w/cultivation	38.5 a*	18.3 a
N w/urease & nitrification inhibitor pre-emergence	34.8 a	18.4 a
Urea w/urease inhibitor pre-emergence	36.9 a	18.8 a
UAN sidedressed no cultivation	37.6 a	18.9 a
UAN sidedressed w/urease inhibitor	36.7 a	18.7 a
Urea pre-emergence	35.2 a	18.7 a
Urea sidedressed w/cultivation♀	36.9 a	18.5 a
PCU:urea pre-emergence (75:25 ratio)	34.5 a	18.8 a
P>F	0.76	0.75

* Values with the same lower case letter are not significantly different (α=0.05).
†All treatments received 40 lbs. N/A applied as a 2x2 at planting with the remaining 120 lbs. of N being applied as pre-emergence or sidedressed at the 2-4 leaf stage with the exception of the pop-up treatment.
♀3 gallons of ammonium polyphosphate was applied as a pop-up at planting and remaining N totaled 116 lbs. versus 120 lbs. of N.

Table 2. Treatment effect on plants/175 sq. ft. at 15 and 25 days after planting, Frankenmuth, MI, 2014.

Treatment†	15 DAP	25 DAP
	plants/175 sq. ft.	plants/175 sq. ft.
Urea sidedressed w/cultivation	174 a*	168 a
N w/urease & nitrification inhibitor pre-emergence	168 ab	160 ab
Urea w/urease inhibitor pre-emergence	152 c	145 b
UAN sidedressed no cultivation	167 ab	160 ab
UAN sidedressed w/urease inhibitor	174 a	164 a
Urea pre-emergence	127 d	127 c
Urea sidedressed w/cultivation♀	159 bc	157 ab
PCU:urea pre-emergence (75:25 ratio)	165 abc	159 ab
P>F	<0.01	<0.01

* Values with the same lower case letter are not significantly different (α=0.05).
†All treatments received 40 lbs. N/A applied as a 2x2 at planting with the remaining 120 lbs. of N being applied as pre-emergence or sidedressed at the 2-4 leaf stage with the exception of the pop-up treatment.
♀3 gallons of ammonium polyphosphate was applied as a pop-up at planting and remaining N totaled 116 lbs. versus 120 lbs. of N.

Table 3. Treatment effect on the percentage of canopy coverage throughout the growing season, Frankenmuth, MI, 2014.

Treatment†	May 29	June 12	June 26
	---%---	---%---	---%---
Urea sidedressed w/cultivation	2.99 b*	23.64 ab	78.12 ab
N w/urease & nitrification inhibitor pre-emergence	1.41 d	19.39 c	67.12 c
Urea w/urease inhibitor pre-emergence	1.57 cd	21.36 bc	72.26 bc
UAN sidedressed no cultivation	1.62 cd	19.33 c	66.42 c
UAN sidedressed w/urease inhibitor	1.84 c	20.61 bc	68.61 c
Urea pre-emergence	1.53 cd	20.46 bc	73.12 abc
Urea sidedressed w/cultivation♀	3.78 a	25.97 a	79.94 a
PCU:urea pre-emergence (75:25 ratio)	1.79 c	20.30 c	76.43 ab
Significance P>F	<0.01	0.03	0.03

* Values with the same lower case letter are not significantly different (α=0.05).

†All treatments received 40 lbs. N/A applied as a 2x2 at planting with the remaining 120 lbs. of N being applied as pre-emergence or sidedressed at the 2-4 leaf stage with the exception of the pop-up treatment.

♀3 gallons of ammonium polyphosphate was applied as a pop-up at planting and remaining N totaled 116 lbs. versus 120 lbs. of N.

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