Fertigation of Sugarbeet: Application Timing

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Rationale: Sugarbeet producers have reported limited success achieving acceptable yields on well-drained, sandy soils. One possible explanation is that these soils do not retain nitrate-N well enough to provide sufficient N late in the growing season if all fertilizer N is applied preplant. If late season N availability is indeed limiting yield, split application of N is a likely remedy. Given that many sandy textured soils are irrigated using overhead sprinkler systems, fertigation is a convenient method of applying in-season N. Liquid urea-ammonium nitrate (UAN) fertilizer can be applied through a sprinkler system at any growth stage, even after the crop has reached full canopy. However, sugarbeet grower contracts usually do not allow application of N fertilizer after June 30 because of the negative impact late season N has on sucrose content and impurities. This restriction on late season N application is largely based on research from fine textured soils, but effects in sandy soils have not been as thoroughly evaluated.

Objective: Evaluate the impact on sugarbeet yield when the N fertilizer application period is extended beyond June 30 on a sandy loam soil.

Treatments: 1) N applied every 7-8 days beginning June 15; ending June 30
2) N applied every 14-16 days beginning June 15; ending July 15
3) N applied every 28 to 32 days beginning June 15; ending August 15

Methods: The three-year study was conducted from 2007 to 2009 at the NDSU Williston Research Extension Center Irrigation Research and Development Project at Nesson Valley in western North Dakota. Soil at the research facility is a well-drained sandy loam. Conventional tillage practices were used. Tillage and preplant fertilizer application were done in the spring. The preplant level of residual soil N was estimated to be about 30 lbs per acre based on soil samples collected the previous fall following malt barley harvest. Urea was applied preplant to all plots at a rate of 60 lbs N per acre. Each of three in-season N applications consisted of 25 lbs N per acre for a season-total fertilizer N application rate of 135 lbs N per acre resulting in 165 lbs per acre total available N (residual soil nitrate + fertilizer N). In-season N was applied as UAN (28% N) through a linear-move sprinkler system set for a water application rate of 0.5 inches per acre. The same amount of N was applied regardless of application timing. Individual plots were 50 feet x 60 feet. Two 20-ft^2 harvest areas within each plot were harvested by hand so that yield components could be determined.

Results: Interval between fertigation applications had little impact on sugarbeet yield components. When averaged across the three study years, root yield, root sucrose content and adjusted sucrose yield varied by only 0.4 tons/acre, 0.4%, and 364 lbs/acre, respectively, for the different N application timing treatments and none of these differences was statistically significant.

When results from each year are evaluated separately (Table 1), it remains clear that extending the N application period into July or August did not increase root yield. Root sucrose content was significantly affected by N application timing only in 2009 when the latest fertigation treatment (ending August 15) caused a 0.6 percentage point decrease compared to the conventional treatment (ending June 30). As with root yield, the effect of N application interval

on sucrose yield was not statistically significant. While we can't make any conclusions within acceptable confidence limits, it is noteworthy that the numerically lowest sucrose yield value in each of the three years occurred when the last N application occurred on August 15. Gross economic return from implementing the alternative fertigation intervals was negligible (3-year average of −$4.97/acre) when the last application was July 15 and was consistently negative (3-year average of −$59.09/acre) when the last application occurred on August 15.

Differences among treatments are small, but there are some interesting patterns, especially as the three years are compared. In the 2007 growing season (April through October), average air temperature was near normal and total precipitation was 1.93 inches below average (Table 2). Irrigation compensated for this deficit but what may be more important is that there was an above average rain event totaling 1.92 inches in late May. This is likely to have caused some nitrate-N to leach and may help explain the lower root yield and higher root sucrose content observed in 2007. Moreover, because that rain event occurred before fertigation applications began on June 15, it affected all treatments equally resulting in little if any difference in yield across treatments. In contrast, while it was somewhat cooler during the 2008 growing season, there were no unusually heavy rain events to cause nitrate leaching. As a result, root yield with the conventional practice was good (32.4 tons/acre) and root sucrose content was a little below average (17.22%) suggesting good N availability throughout the growing season. Extending the last N application into July or August did not affect root yield but may have decreased sucrose content slightly. This seems reasonable given that weather conditions were good for plant growth but did not favor nitrate-N leaching. In 2009, the temperature was much cooler but precipitation was near average. However, there was a significant leaching event July 7 and 8 when 2.87 inches of rain fell. The conditions were exacerbated three days prior (July 3 and 4) when separate rain event, combined with a very light irrigation, resulted in 1.43 inches of water for a 6 day total of 4.3 inches. These events, combined with overall cooler conditions, seem to have reduced yield of all treatments more or less equally. Applying N after the July 7-8 rain event (i.e., July 15 or August 15) did not increase root yield. However, there was a significant decrease in root sucrose content when the last N application was delayed until August 15, causing the largest decrease in gross return observed (−$77.62/acre) in the three-year study.

In this study, we did not evaluate the practice of adding additional N (i.e., above the recommended N rate) after June 30. This may have been beneficial in 2007 when early season leaching may have decreased N availability throughout the growing season. Conversely, a late (August 15) application of N in 2009 was detrimental even after a substantial leaching event in early July 2009. Thus, overall results suggest that applying additional N late in the growing season is not beneficial even on sandy textured soils where N is easily leached.

Conclusions:

1) Increasing the interval of three fertigation events from 8 days (ending June 30) to either 16 days (ending July 15) or 32 days (ending Aug 15) did not improve yield.

2) In two of three years, late N application reduced root sucrose content by an average of 0.49 percentage points.

3) Gross return was reduced by an average of $59/acre when the last fertigation occurred on August 15. This was due to reduced root sucrose content.

Table 1. Sugarbeet yield and quality as affected by N fertigation interval and last application date.

Interval (days)	Date of last N application	Root Yield (tons/acre)	Root Sucrose (%)	SLM (%)	Sucrose Yield† (lbs/acre)	Return‡ vs. 8-d interval ($/acre)
			2007			
8	June 30	28.4	18.51	0.676	10122	--
16	July 15	29.2	18.38	0.731	10331	+$27.25
32	Aug 15	27.8	18.54	0.703	9904	−$28.49
		ns	***ns***	***ns***	***ns***	
			2008			
8	June 30	32.4	17.22	0.901	10569	--
16	July 15	32.3	16.80	0.980	10202	−$59.05
32	Aug 15	31.9	16.85	0.887	10193	−$71.15
		ns	***ns***	***ns***	***ns***	
			2009			
8	June 30	28.2	18.28	1.061	9715	--
16	July 15	28.7	18.20	1.056	9837	+$16.88
32	Aug 15	28.0	17.68	1.044	9300	−$77.62
		ns	*****	***ns***	***ns***	

†, adjusted for SLM (sugar loss to molasses)

‡, Gross return per acre of the conventional timing (8 days) subtracted from the gross return of the alternative timing (16 or 32 day). Gross return was calculated based on a payment of $49/ton at 17.5% sucrose adjusted by $4/ton for each percentage point change in percent sucrose. SLM was not included in the calculation.

ns, treatment means within the year indicated are not significantly different

*, treatment means within the year indicated are significantly different at a 95% confidence level

Table 2. Growing season (April through October) temperature and precipitation compared to long-term averages for each of three study years at the research site east of Williston, ND (source: https://ndawn.ndsu.nodak.edu/).

Year	Departure from average		Months with excess precipitation	Departure from average monthly precipitation (inches) †
	Temperature (°F)	Precipitation (inches)		
2007	−0.003	−1.93	May	+1.92 (1.82)
2008	−1.641	−3.15	None	--
2009	−3.062	−0.61	July	+1.86 (2.87)

†, number in parentheses is the largest precipitation event during the month