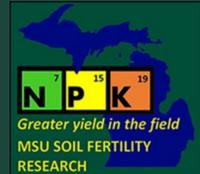




# Finding the "Sweet Spot": Nitrogen Strategies for Variable Sugarbeet Harvest Timings

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## Introduction

- The early harvest campaign is new to Michigan and critical to ensure beet processing completed timely by optimizing factory capacity.
- Few data indicate appropriate nitrogen (N) timings with regard to sugarbeet harvest date and varying environmental factors.
- Weather variability continues to impact sugarbeet acres resulting in extreme dry or wet periods lasting 4-8 weeks at various time points during the season.
- Data on in-season N management strategies may help producers adjust to both climate uncertainty and harvest logistics.
- How late is too late to apply N regarding sugarbeet harvest date?

## Objective

Evaluate the influence of harvest timing (early vs. conv.), starter N (with or without), and seven in-season N fertilizer strategies on sugarbeet root yield, sugar quality, recoverable white sugar, and in-season plant growth and development.

## Materials and Methods

- Field trials initiated in Richville, MI on 27 Apr. 2023 and 25 Apr. 2024
- Soil properties 2023-24 included: 7.7 – 8.1 soil pH, 2.1 - 2.5% SOM, 14 – 17 meq/100g CEC, 14 – 18 ppm Olsen P, and 141 – 166 ppm K
- Trials arranged as split-plot design with a 2x7 factorial subplot in a randomized complete block with four replications. Whole plot factor was harvest timing while subplot factor was starter fertilizer and N sidedress fertilizer (SD) strategy
- Harvest timings: early harvest 2023 on 21 Aug. and conv. harvest on 24 Oct.; early harvest 2024 on 29 Aug. and conv. harvest on 17 Oct.
- Fertilizer strategy: 1) two rates of starter N fertilizer (0 and 60 lbs. N A<sup>-1</sup>) (28-0-0, UAN) applied in 2x2 at planting, and 2) 7 in-season N fertilizer strategies. In-season N fertilizer strategies included: 1) unfertilized control (None), 2) 60 lbs. N A<sup>-1</sup> couler-injected early June (June SD low), 3) 100 lbs. N A<sup>-1</sup> couler-injected early June (June SD high), 4) 60 lbs. N A<sup>-1</sup> surface Y-drop applied early July (July SD low), 5) 100 lbs. N A<sup>-1</sup> surface Y-drop applied early July (July SD high), 6) 60 lbs. N A<sup>-1</sup> surface Y-drop applied early August (August SD low), and 7) 100 lbs. N A<sup>-1</sup> surface Y-drop applied early August (August SD high). All N applications utilized urea ammonium nitrate (UAN, 28-0-0) with July and August applications including a urease inhibitor (NBPT).
- Economic return calculated by subtracting seed, fertilizer, and application costs from estimated profit using New MSC Quality Payment System (\$ A<sup>-1</sup>).
- Statistical analysis performed using SAS 9.4, GLIMMIX procedure at α=0.1.

**Table 1.** Mean monthly precipitation during the sugarbeet growing season, Richville, MI, 2023 and 2024.

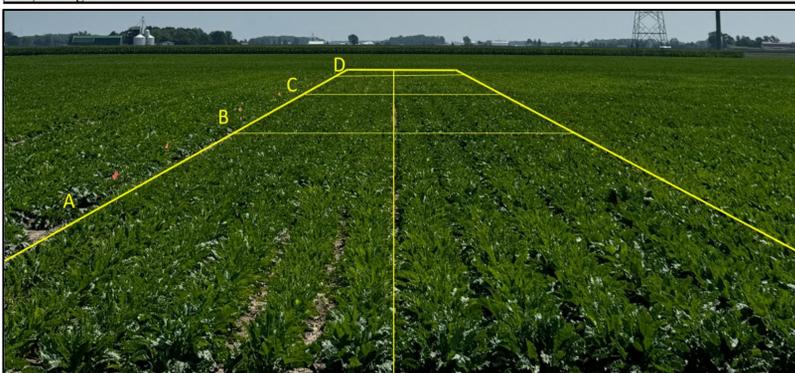
Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
	inches						
30-yr avg <sup>a</sup>	3.61	3.59	3.48	3.36	3.49	2.68	2.93
2023 <sup>b</sup>	3.06	0.98	1.51	5.49	5.91	1.32	2.6
% Change	-15.2	-72.7	-56.6	+63.4	+69.3	-50.7	-11.3
2024	2.76	4.14	3.88	4.27	3.38	1.51	2.24
% Change	-22.2	+13.8	+11.5	+27	-2.8	-44.4	-24.1

<sup>a</sup>30-year means obtained from the National Oceanic and Atmospheric Administration  
<sup>b</sup>Monthly Precipitation collected from MSU Enviro-weather (<https://mawn.geo.msu.edu/>) (<https://www.ncdc.noaa.gov/cdo-web/datatools/normal>)

**Table 2.** Main effects of sugarbeet harvest date, Richville, 2023 & 2024

Year	Treatment	Root Yield	Sugar
2023	Harvest Timing	— T A <sup>-1</sup> —	— % —
	Early: 21 August	14.4 b	13.8 b
	Conv: 24 October	32.3 a	18.1 a
	<b>P &gt; F</b> <sup>†</sup>	<b>&lt;0.0001</b>	<b>0.0002</b>
2024	Early: 29 August	26.8 b	13.03 a
	Conv: 17 October	31.8 a	13.16 a
	<b>P &gt; F</b>	<b>0.0053</b>	<b>NS<sup>a</sup></b>

<sup>†</sup> Values followed by the same lowercase letter are not significantly different at α=0.1.  
<sup>a</sup> ns, not significant.



**Figure 1.** Site overview 31 July 2024. Treatments with (C) late N application (Aug SD), as compared to (B) mid-season N application (July SD) as compared to (A) early N application (June SD). The 2x2 N treatment (right) produced more biomass and closed rows sooner than the no starter treatment (left).

**Table 3.** Interaction & main effects of starter fertilizer & sidedress fertilizer strategy on sugarbeet root yield & sugar content, Richville, MI 2023.

Starter N	Harvest Timing:	Early Harvest*	Conv. Harvest*
		Tons/Acre	
No Starter	No Starter	Avg. 14.4 a	
	Starter		
<b>P &gt; F</b> <sup>†</sup>		<b>NS<sup>a</sup></b>	<b>0.0004</b>
Sidedress Fertilizer Strategy	No SD	12.5 b	26.3 e
	June SD low	14.6 a	34.4 ab
	June SD high	15.3 a	36.7 a
	July SD low	15.7 a	32.7 bcd
	July SD high	14.9 a	34.1 abc
	August SD low	12.5 b	31.3 cd
	August SD high	15.3 a	30.7 d
	<b>P &gt; F</b>		<b>0.0128</b>

Early Harvest: Sugar	No Starter		Starter		<b>P &gt; F</b> <sup>‡</sup>
	%				
No SD	14.81 aA		14.24 aB		<b>0.0210</b>
June SD low	14.03 bA		13.48 bB		<b>0.0360</b>
June SD high	13.73 bcA		13.69 bA		<b>NS</b>
July SD low	14.02 bA		14.24 aA		<b>NS</b>
July SD high	13.72 bcA		13.56 bA		<b>NS</b>
August SD low	13.31 dA		13.63 bA		<b>NS</b>
August SD high	13.51 cdA		13.67 bA		<b>NS</b>
<b>P &gt; F</b>	<b>&lt; 0.0001</b>		<b>0.0077</b>		

**Table 4.** Orthogonal contrast of starter and sidedress fertilizer strategy on sugar beet root yield & sugar content, Richville, MI 2023.

Harvest Timing:	Root Yield (T/A)		Sugar Content (%)		
	Early	Conv.	Early	Conv.	
No Starter	June SD	14.1 a	35.0 a	13.9 b	18.2 a
	July SD	15.5 a	31.9 b	13.9 b	18.3 a
	August SD	13.9 a	28.1 c	13.4 c	18.1 a
	No SD	12.2 a	22.9 d	14.8 a	17.7 a
<b>P &gt; F</b>	<b>NS</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>	<b>NS</b>	
Starter	June SD	15.9 a	36.1 a	13.6 b	18.5 a
	July SD	15.2 ab	34.8 a	13.9 ab	18.3 a
	August SD	13.8 bc	33.9 a	13.6 b	17.7 a
	No SD	12.8 c	29.8 b	14.2 a	18.0 a
<b>P &gt; F</b>	<b>0.0980</b>	<b>0.0465</b>	<b>0.0246</b>	<b>NS</b>	

<sup>a</sup> ns, not significant.  
<sup>†</sup> Means in the same column followed by the same lowercase letter are not significantly different at α=0.10.  
<sup>‡</sup> Means in the same row followed by the same uppercase letter are not significantly different at α=0.10  
<sup>\*</sup>Main effects analyzed due to no interaction between starter fertilizer x sidedress fertilizer strategy.



**Figure 2.** Conv. harvest beets in 2024 became infected with *C. Beticola* (Early Sept.) resulting in less pre-harvest foliar biomass and decreased sugar content due to the disease defoliating and causing the beets to regrow foliar biomass. Photographed 10/10/2024

**Table 5.** Main effects of starter fertilizer & sidedress fertilizer strategy on sugarbeet root yield & sugar content, Richville, MI 2024.

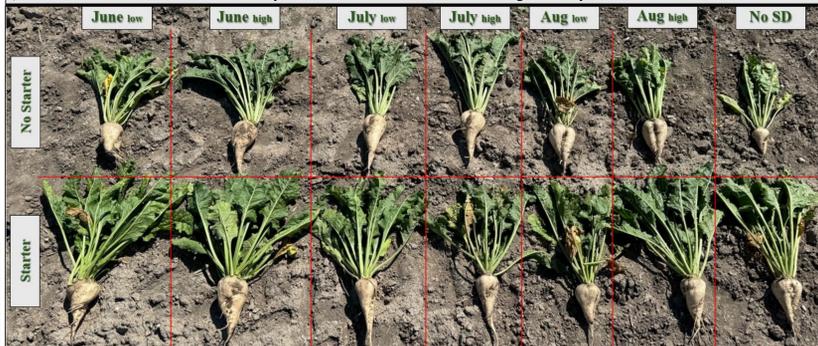
Starter N	Harvest Timing:	Early Harvest*	Conv. Harvest*
		Tons/Acre	
No Starter	No Starter	24.6 b	29.6 b
	Starter	28.9 a	34.1 a
<b>P &gt; F</b> <sup>†</sup>		<b>0.0001</b>	<b>&lt;0.0001</b>
Sidedress Fertilizer Strategy	No SD	23.3 e	27.2 c
	June SD low	30.3 ab	35.4 a
	June SD high	32.3 a	36.3 a
	July SD low	26.8 cd	30.9 b
	July SD high	29.0 bc	34.9 a
	August SD low	24.1 de	28.9 bc
	August SD high	21.5 e	29.3 bc
	<b>P &gt; F</b>		<b>&lt;0.0001</b>
Starter N Avg.		13.03 a	13.15 a
<b>P &gt; F</b>		<b>NS<sup>a</sup></b>	<b>NS</b>
Sidedress Fertilizer Strategy	No SD	13.49 a	12.93 bc
	June SD low	13.31 ab	13.40 ab
	June SD high	13.03 ab	13.61 a
	July SD low	13.05 ab	12.96 bc
	July SD high	13.01 ab	13.81 a
	August SD low	12.91 bc	12.66 c
	August SD high	12.42 c	12.74 c
	<b>P &gt; F</b>		<b>0.0698</b>

<sup>a</sup> ns, not significant.  
<sup>†</sup> Means in the same column followed by the same lowercase letter are not significantly different at α=0.10.  
<sup>‡</sup> Means in the same row followed by the same uppercase letter are not significantly different at α=0.10  
<sup>\*</sup>Main effects analyzed due to no interaction between starter fertilizer x sidedress fertilizer strategy.

**Table 6.** Orthogonal contrast of starter and sidedress fertilizer strategy on sugar beet root yield & sugar content, Richville, MI 2024.

Harvest Date:	Root Yield (T/A)		Sugar Content (%)		
	Early	Conv.	Early	Conv.	
No Starter	June SD	30.7 a	34.8 a	13.2 a	13.4 a
	July SD	25.6 b	30.0 b	12.9 a	13.2 a
	August SD	19.9 c	27.1 b	12.6 a	12.8 a
	No SD	19.6 c	23.0 c	13.2 a	12.8 a
<b>P &gt; F</b> <sup>†</sup>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>	<b>NS<sup>a</sup></b>	<b>NS</b>	
Starter	June SD	31.9 a	36.9 a	13.1 a	13.6 a
	July SD	30.2 ab	35.8 a	13.2 a	13.6 a
	August SD	25.8 c	31.0 b	12.8 a	12.6 b
	No SD	27.1 bc	31.3 b	13.7 a	13.1 ab
<b>P &gt; F</b>	<b>0.0142</b>	<b>0.0464</b>	<b>NS</b>	<b>0.0200</b>	

<sup>a</sup> ns, not significant.  
<sup>†</sup> Means in the same column followed by the same lowercase letter are not significantly different at α=0.10.



**Figure 3.** Sugarbeet visual response to starter N fertilizer and sidedress N strategy. Beets in top row of photo did not receive starter fertilizer while beets located on bottom row did. Pictured from left to right are June SD low, June SD high, July SD low, July SD high, Aug SD low, Aug SD high, and No SD. Photo taken 14 days prior to early harvest.

## Preliminary Results and Discussion

### 2023: Dry to Wet Growing season:

- Conventional harvest (CH) achieved +18 T A<sup>-1</sup> & +4.3% than Early harvest (EH)
- Starter N ineffective for EH root yield (avg. 14.4 T A<sup>-1</sup>); For CH, starter N increased root yield +3.8 T A<sup>-1</sup>
- August (Aug) SD low decreased EH root yield -2.1 & -3.2 T A<sup>-1</sup> from June (Jun) & July (Jul) SD low, respectively; No sig. difference across Jun, Jul, & Aug SD high
- Aug SD low decreased CH root yield -3.1 T A<sup>-1</sup> from Jun SD low; Jul SD low similar to Jun & Aug SD low; Aug SD high decreased root yield -3.4 & -6 T A<sup>-1</sup> from Jul & Jun SD high, respectively
- Without starter, Aug SD low reduced EH sugar content -0.7% from Jun & Jul SD low; With starter, Jul SD low increased sugar content +0.8 & +0.6% from June & Aug SD low, respectively
- No significant difference for CH sugar content across starter fertilizer (18.1% avg.) and SD fertilizer strategy (18.1% avg.)
- Lack of early season moisture made the starter N less effective for EH beets until consistent precipitation began again

### 2024: Wet to Dry Growing season:

- CH yielded +5 T A<sup>-1</sup> than EH, but no impacts on sugar (13.1% avg.)
- Starter N increased root yield +4.3 & +4.5 T A<sup>-1</sup> for EH & CH, respectively
- Jun SD low increased EH root yield +3.5 & +6.2 T A<sup>-1</sup> from Jul & Aug SD low, respectively; Jun SD high increased root yield +3.3 & +10.8 T A<sup>-1</sup> from Jul & Aug SD high, respectively
- Jun SD low increased CH root yield +4.5 & +6.5 T A<sup>-1</sup> from Jul & Aug SD low, respectively; Aug SD high decreased root yield -7 & -5.6 T A<sup>-1</sup> from Jun & Jul SD high, respectively
- Starter N ineffective for EH (13.03% avg.) & CH (13.15% avg.) sugar content
- Jun, Jul, & Aug SD low comparable for EH sugar content, Aug SD high decreased sugar content -0.61 & -0.59% from Jun & Jul SD high, respectively
- Aug SD low decreased CH sugar content -0.74% from Jun SD low; Aug SD high decreased sugar content -0.87 & -1.07% from Jun & Jul SD high, respectively
- Due to an infection of leaf spot (*cercospora beticola*) in early Sept., the conventional harvest beets achieved less foliar biomass and sugar content due to the disease causing defoliation and regrowth during 'bulking'

### Treatment effectiveness environment-year-harvest timing:

- Early Harvest: without early season moisture (2023), Jun & Jul SD trt performed best for root yield; with early season moisture (2024), June SD applications most effective; Starter N only effective with early season moisture 2024
- Conv. Harvest: root yield was less affected by extreme differences between growing seasons; SD applications performed as June SD > July SD ≥ August SD; Starter N was effective with or without early season moisture
- Without early season moisture (2023), all SD trt performed somewhat poorer for EH sugar content than w/ early season moisture (2024), (avg. dif. 0.8%)

