Early vs. Late Nitrogen Strategies for Michigan Corn Production

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Introduction

- Increased climate variability and concern for Great Lakes Basin water quality may require improved corn (*Zea mays* L.) nitrogen (N) management strategies that simultaneously deliver N to the crop and reduce the risk for N loss.
- Michigan corn growers often apply some N at planting to increase early season growth. Methods may include spring pre-plant incorporated (PPI) N and starter fertilizers applied in-furrow or sub-surface banded 5 cm beside and 5 cm below the seed furrow (5x5).
- Corn N uptake increases at V6 – V8 suggesting opportunities may exist to increase synchrony of N availability with corn uptake by delaying N applications.
- Relative to the upper Midwest, Michigan's growing season is compressed and growers often utilize shorter-season relative maturity hybrids.
- Further investigations are needed to identify corn growth and yield response to current MI grower strategies using delayed N applications.

Objective

Evaluate corn growth and grain yield response to three N strategies representative of Michigan corn grower practices that involve multiple N-placements and timings applied at a single N rate.

Materials and Methods

- Two field sites (Lansing and Richville, MI).
- Conv. tillage following soybean.
- RCBD with four replications, plot size = 4.5 m x 12.1 m.
- 10 treatments: 9 N-management treatments + untreated control.
  - Treatment combinations of N placement and timing.
  - Treatments grouped into three strategies: PPI N (1-d prior to planting), in-furrow starter (8 kg N ha^{-1}), or 5x5 starter (45 kg N ha^{-1}).
  - PPI's: urea (100%), PCU and urea blend (75/25), poultry manure (PM) (4-3-2; 2.2 Mg ha^{-1}).
  - Sidedress (SD) N timings: early (V4) or late (V11) and 50/50 split V4/V11.
  - One pass systems: urea and PCU/urea only.
  - Two pass systems: starter or PM + full SD.
  - Treatments equalized to site-specific maximum return to nitrogen rate (MRTN): Richville=202 kg N ha^{-1}; Lansing=157 kg N ha^{-1}.
- Corn seeded: 28 Apr. to 19 May, V4 SD: 28 May to 09 Jun., V11 SD: 25 Jun to 07 Jul.
- Corn (98-d) was seeded in 76-cm rows at 84,016 seeds ha^{-1}.
- Data measurables included: corn V6 NDVI, R1 rel. chlorophyll content (SPAD) (normalized to non-limiting N plot), grain yield.

Table 1. April – June rainfall percent (%) departure from 30-yr mean (1981 – 2010) for Lansing and Richville, MI 2014 – 2016.

Year	April	May	June
Lansing	Percent (%) departure from 30-yr mean		
2014	-70	-2	+39
2015	-69	+29	+116
2016	+2	-38	-80
Richville			
2014	+25	-7	-22
2015	-38	-13	-24
2016	-59	-52	-57

Table 2. Lansing, MI: N placement and timing effects on corn grain yield in 2014, 2015, and 2016.

Treatment	2014		2015		2016	
In-furrow N + V4 SD	14.5	ab†	12.2	bc	12.2	a
In-furrow N + V11 SD	13.4	d	12.7	bc	11.8	a
In-furrow N + split SD	14.4	abc	13.2	ab	12.0	a
Urea PPI 100%	13.6	cd	11.9	c	11.8	a
PCU/urea PPI (75/25)	13.3	d	12.0	c	12.4	a
PM PPI + V11 SD	14.7	a	13.9	a	12.1	a
5x5 N + V4 SD	13.9	bcd	12.8	bc	13.1	a
5x5 N + V11 SD	13.4	d	13.1	ab	12.4	a
5x5 N + split SD	14.2	abc	12.7	bc	12.7	a
P > *F*	0.0102		0.0464		0.3490	
Multiple *df* contrasts						
One pass system	13.5	b	11.9	b	12.1	a
Two pass system	14.0	a	12.9	a	12.3	a
P > *F*	0.0829		0.0125		0.5385	

†Values with the same lower case letter are not significantly different (α=0.1).
Yield of untreated plots: 7.2, 5.9, and 8.5 Mg ha^{-1} in 2014, 2015, and 2016, respectively.

Table 3. Richville, MI: N placement and timing effects on corn grain yield in 2014, 2015, and 2016.

Treatment	2014		2015		2016	
In-furrow N + V4 SD	14.0	bc†	12.7	a	13.8	a
In-furrow N + V11 SD	13.6	c	11.4	a	12.4	b
In-furrow N + split SD	14.5	ab	12.4	a	12.9	ab
Urea PPI 100%	15.0	a	11.2	a	11.2	c
PCU/urea PPI (75/25)	14.7	ab	11.5	a	11.1	c
PM PPI + V11 SD	14.5	ab	12.0	a	13.3	ab
5x5 N + V4 SD	14.4	abc	11.9	a	13.0	ab
5x5 N + V11 SD	13.7	c	12.6	a	12.8	b
5x5 N + split SD	14.6	ab	12.3	a	13.3	ab
P > *F*	0.0490		0.1328		0.0001	
Multiple *df* contrasts						
One pass system	14.9	a	11.3	b	11.2	b
Two pass system	14.0	b	12.1	a	13.0	a
P > *F*	0.0017		0.0222		<.0001	

†Values with the same lower case letter are not significantly different (α=0.1).
Yield of untreated plots: 6.0, 7.2, and 5.8 Mg ha^{-1} in 2014, 2015, and 2016, respectively.

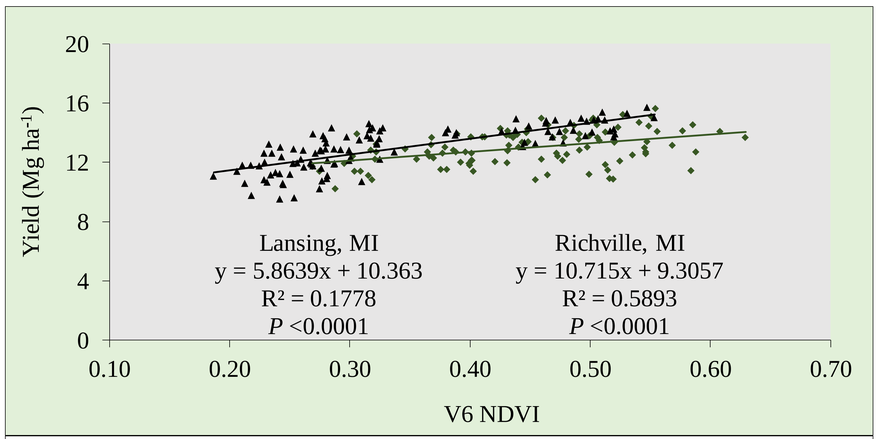

Figure 1. Relationship of V6 normalized difference vegetation index (NDVI) and grain yield observed across three years (2014 – 2016) of treatments in Lansing (green) and Richville (black), MI. n=105.

Figure 2. Corn growth response to in-furrow starter N at V11 SD time. [Left] Corn received full V4 SD (total N=157 kg N ha^{-1}). [Right] Corn received only in-furrow starter N (8 kg N ha^{-1}) and displays signs of N stress (i.e. firing).

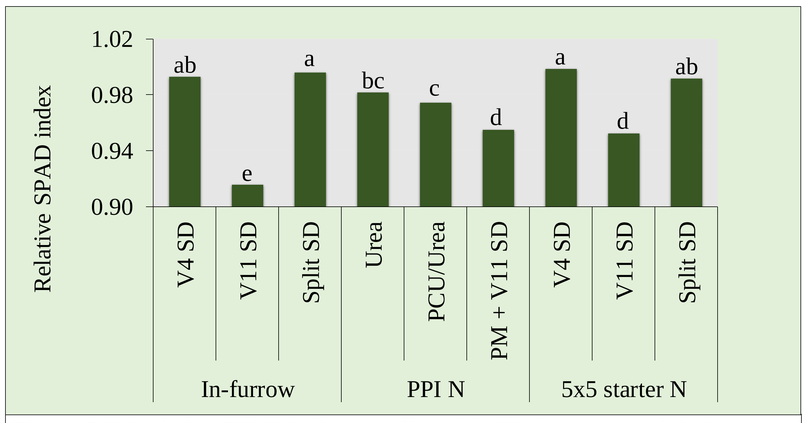

Figure 3. R1 relative SPAD indices as affected by N placement and timing combinations ($P \leq 0.0001$) combined across sites and years.

Results and Discussion

Lansing and Richville, MI

- Lansing: 2014 cumulative May – Jun. rainfall was near normal; 2015 was 145% above normal; 2016 was 118% below normal (Table 1). Rainfall in 2015 and 2016 resulted in contrasting wet and dry soils, respectively.
- Richville: 2014 cumulative Apr. – Jun. rainfall was near normal; 75 – 168% below normal in 2015 – 2016, respectively (Table 1). Below normal rainfall in 2015 and 2016 resulted in dry soil conditions.
- Except for PM in a wet year (i.e. Lansing, 2015), no yield gains were observed when full SD was delayed from V4 to V11 (Tables 2 and 3). When rainfall was at or below normal the in-furrow strategy + V11 SD reduced grain yield up to 1.4 Mg ha^{-1} but the 5x5 strategy provided consistency among SD timings. Two pass systems improved yield up to 1.8 Mg ha^{-1} in wet and dry soils.
- Corn yield potential is realized early, and the ability of N strategies to meet early corn N demands may influence the success of SD N application timings in Michigan (Fig. 1).
- Reduced N rates required by the in-furrow starter placement increased N stress when full SD was delayed (V11) (Fig. 2). Full V11 SD reduced R1 rel. chlorophyll content compared to V4 SD and suggest a reduced capacity for photosynthesis and yield maintenance.
- No yield gains to V11 N application suggests use of late SD N as a rescue application but not as a standard management practice.