Managing Urea Fertilizer for Optimal N Use and Productivity in Corn

Crop Physiology

Brad J. Bernhard and Frederick E. Below

Crop Physiology Laboratory, Department of Crop Sciences, University of Illinois at Urbana-Champaign

Question: ***What role does proper fertilizer source, placement, and application timing play on corn grain yield?***

Objective: ***Determine the best timing, placement, and form of urea fertilizer for optimal nitrogen (N) use efficiency in corn.***

Introduction:

- Greater nutrient use efficiency by corn (*Zea mays L.*) could reduce fertilizer input costs, decrease the rate of nutrient loss, and enhance crop yields.
- Nutrient use efficiency can be enhanced by Best Management Practices that apply nutrients at the right rate, time, and place using the correct source.
- Keeping nutrients stable and available to the plant increases nutrient use efficiency and may be achieved with fertilizer additives and/or localized placement.
- Nitrogen uptake by corn follows a sigmoidal pattern over time with two-thirds of the total uptake acquired by the VT/R1 growth stage. From V8 to R1, corn takes up N at a rate of 8 kg N ha^{-1} d^{-1} for 21 continuous days (Figure 1).

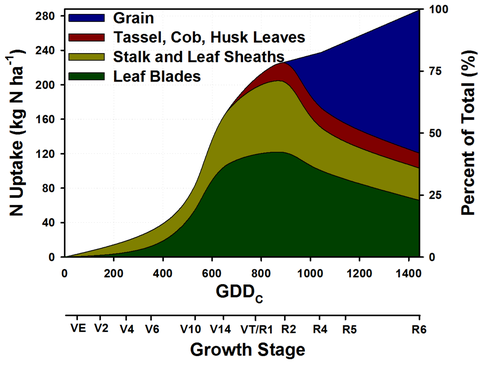

Figure 1. The total corn N uptake and partitioning across four plant fractions: leaf, stalk, reproductive, and grain tissues (Bender et al., Agron. J. 105:161-170 (2013).

Research Approach:

Field plots were planted in 2016 on April 23rd at Champaign, Illinois on a Drummer-Flanagan silty clay loam and on May 5th at Harrisburg, Illinois on a Harco silt loam. Treatments were arranged in a RCB experimental design with 6 replications.

Champaign (CU)
- Corn following 3 years of corn
- 180 kg N ha^{-1} applied total

Harrisburg (HB)
- Corn-soybean rotation
- 157 kg N ha^{-1} applied total

Hybrid Croplan 6640, previously characterized as responsive to N and management, was planted at both sites to target a final stand of approx. 84,000 plants ha^{-1} (34,000 plants $acre^{-1}$).

Photo 1. Single row Y-drop applicator developed for research by 360 Yield Center. This machine is designed to precisely place the nutrient solution on the soil surface directly next to the plant row.

Agronomic factors evaluated:

1) Application timing:

Upfront: all N fertilizer preplant as urea, or

50/50 Split N: 50% of the N upfront preplant as urea, and 50% sidedressed as UAN at the V8 growth stage.

2) Application Method:

Preplant: broadcasted using a handspreader.

V8 Sidedress: either Y-drop applicator (Photo 1), or broadcast sprayed using a backpack sprayer.

3) Fertilizer Additives:

Preplant: urea coated with urease inhibitors: Agrotain or Nutrisphere, or urea coated with Humic Acids: Hydra-Hume or Ultra Boost, and compared to urea with no additive.

V8 Sidedress: UAN blended with urease inhibitors: Agrotain or Nutrisphere, or UAN blended with Humic Acids: Hydra-Hume or Growth Boost, and compared to UAN by Y-drop with no additive.

Results and Discussion:

- **On average, split-applying N resulted in a 9% yield decrease (0.8 Mg ha^{-1}) (Table 1). It appears that applying the full rate of N upfront helped set the yield trajectory of the plant for the rest of the growing season.**
- **Using the Y-drop for fertilizer placement significantly increased yield by 0.3 Mg ha^{-1}, on average, compared to broadcast spraying UAN (Table 1). By placing the nutrient directly next to the crop row, the plant utilized nitrogen better and produced more yield.**
- **Using fertilizer additives with UAN at the V8 growth stage did not significantly effect yield, however, applying Nutrisphere coated urea at preplant did increase yield by 0.4 Mg ha^{-1} compared to non-coated urea (Table 1).**
- **Agrotain-, Nutrisphere-, and Hydra-Hume- coated urea applied at preplant kept the nitrogen more available and significantly increased N accumulation in the plant but this did not always translate into an increase in yield (Table 1).**

Table 1. The effect of N application treatments on final grain yield and R6 total N uptake in Champaign and Harrisburg, IL, and averaged across both locations. Grain yield and R6 total N uptake are presented at 0% moisture concentration.

	Yield			Total N Uptake		
Treatment	CU	HB	**Ave.**	CU	HB	**Ave.**
	Mg ha^{-1}			kg ha^{-1}		
No Applied N	3.4	3.7	**3.5**	89	90	**90**
Upfront N						
Urea	10.8	8.5	**9.6**	292	200	**246**
+Agrotain	10.9	8.8	**9.8**	286	254	**270**
+Nutrisphere	11.0	9.0	**10.0**	293	249	**271**
+Hydra-Hume	10.5	8.4	**9.5**	294	239	**267**
+Ultra Boost	10.7	8.3	**9.5**	303	210	**256**
50/50 Split N‡						
UAN Broadcasted	9.7	7.7	**8.7**	211	180	**196**
UAN Y-dropped	10.1	8.0	**9.0**	227	181	**204**
+Agrotain	10.1	7.7	**8.9**	264	185	**224**
+Nutrisphere	10.1	7.8	**8.9**	249	187	**218**
+Hydra-Hume	10.3	8.0	**9.1**	251	193	**222**
+Growth Boost	9.8	8.0	**8.9**	222	192	**207**
LSD (α = 0.10)	0.5	0.5	**0.3**	31	31	**21**

‡ Half of the total amount of N was applied preplant as urea and half was sidedressed with UAN at the V8 growth stage.

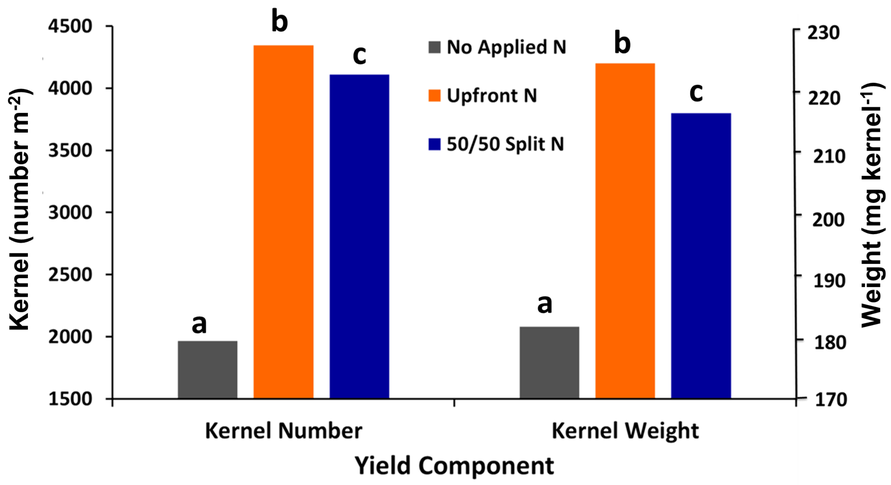

Figure 2. The effect of N application timing on yield components† kernel number and kernel weight. Values are averaged across two locations (Champaign and Harrisburg, IL) and application timing was averaged across fertilizer additives during 2016 from a subsample of grain harvested at maturity.
† Values within each yield component with different letters are significantly different ($P \leq 0.10$)

- **Only applying half of the N upfront resulted in a 6% decrease in kernel number (Figure 2), suggesting that the plant was set back at an early growth stage when the number of kernel rows is determined.**
- **Kernel weight significantly decreased when split-applying the N (Figure 2), suggesting that N availability limited photosynthesis during grain filling.**

Conclusions:

1. Do the environmental benefits of split-applying nitrogen also assist in improving corn production?

× **No, applying half of the nitrogen upfront at planting and half in-season significantly decreased yield as it set the plant back at an early growth stage.**

2. Does more precise in-season fertilizer placement set the potential for higher grain yields?

✓ **Yes, placing the UAN solution directly next to the crop row at the V8 growth stage significantly increased corn grain yield as opposed to broadcasting the solution.**

3. Can fertilizer additives keep nitrogen more available for plants to take up and utilize?

✓ **Yes, the use of some fertilizer additives tended to result in greater N uptake, especially when coated on urea at preplant.**

Special thanks to Verdesian, Helena, Soil Biotics, and 360 Yield Center for supporting this research