

---

## ASSESSING THE EFFECT OF CORN HYBRID AND PLANT POPULATION ON NITROGEN RESPONSE

FREC Project #379

**Emerson D. Nafziger and Robert A. Clark**

Professor and Graduate Research Assistant, Dep. of Crop Sciences, University of Illinois, Urbana

---

With the expected commercialization of “nitrogen-use-efficient” hybrids within the next few years, the hybrid x N rate question is going to take on more importance. Nitrogen nutrition of NUE hybrids will presumably need to be managed differently than it is with “normal” hybrids, whether that be using the same rates of N with the expectation of higher yields, or the use of less N with expectation of similar yields.

The question about differential responses of corn hybrids to plant population is also an important one, and one that has been relevant for a long time. Hybrids have long been characterized as to their position along the scale from “fixed-ear” (or determinate) or “flex-ear” (indeterminate) types, with the former better able to maintain ear size as plant populations are increased, and the latter better able to expand ear size if conditions are very good or plant populations are low. Most high-performing hybrids tend to be characterized as “fixed-ear”, and with higher populations recommended for high yields.

While a physiological link between ear flex characteristics and N responsiveness has not been well-established, we hypothesize that simultaneous measurement of responses to N rate and population might prove to be of value in terms of characterizing corn hybrids. Because responses to population are easier to see with consistency than are responses to N rate (which are subject to considerable variation over fields and years), we think that it might be possible to develop a system to more easily characterize hybrids – perhaps a “flexibility index” that would have elements of responsiveness to both N and population.

Results of some preliminary work in Illinois showed, rather surprisingly, that two lower populations (20,000 and 26,667 per acre) actually required more N to reach optimum yield than did two higher plant populations (Nafziger, unpublished.) Raising the N rate from 180 to 240 also resulted in lower yields with the two lower populations but not with the two higher populations, for reasons that are not clear.

A recent publication from Indiana (Boomsma et al., 2009) showed, using rather extreme ranges for population and N rate, that higher populations required more N. Producers also tend to express disbelief in my results, illustrating the need to generate more data. Even though we have some data on the interaction between population and N rate, the data are conflicting and inadequate to answer the important management question regarding these inputs.

The objectives of this study are to answer the question about whether different commercial corn hybrids respond differently to N, and how consistent such responses might be over years and locations; to answer the question of how differently hybrids respond to plant density; and to determine whether or not N and plant density responses among hybrids are related to one another.

## Materials and Methods

A small-plot study was conducted at four locations in Illinois in 2011: on a Flanagan silt loam soil at DeKalb; a Muscatine silt loam soil at Monmouth; a Drummer silty clay loam soil at Urbana; and on a Cisne silt loam soil at Brownstown, in south-central Illinois. Trials were planted in fields on which corn grew in 2010, and all fields were tilled. Herbicide was applied before final tillage and planting. Trials were all planted between May 3 and May 15.

Main plots in the study were N rate, with rates of 0, 80, 160, and 240 lb N/acre applied as sidedress UAN (28%) at about growth stage V3. Plant densities of 18,000, 34,000, and 50,000 were assigned to subplots, and the four Pioneer<sup>®</sup> hybrids used in the study were assigned to sub-subplots within each N rate-plant density subplot. Plant densities were established by planting exact densities; plots were not thinned. Final stands as a percentage of dropped seed numbers were as follows: DeKalb – 90%; Monmouth – 94%; Urbana – 97%; and Brownstown – 96%.

The Pioneer<sup>®</sup> hybrids used, and their characterization (provided by M. Rupert of Pioneer Hi-Bred International) with regard to N and population responsiveness, were: 33D49 (flex-ear, more responsive to N); 33K44 (flex, less responsive to N); 33W84 (fixed, more N responsive); and 34F07 (fixed, less N-responsive).

Each sub-subplot was 4 rows (10 ft.) wide by 23 ft long, with narrow (2-ft.) alleys between ends of plots. Yields were taken by machine-harvest of the center two rows of each sub-subplot, and were converted to 15% moisture.

## Results and Discussion

The 2011 growing season in Illinois ranged from favorable in the northern part of the state to below-average in central Illinois, with a delayed planting season followed by above-average precipitation in May and June to below-average rainfall in July and August. Temperatures were well above average in July and August throughout the state. The corn crop was under stress due to lack of adequate water beginning in mid-July, and as a result kernel numbers and yields were reduced, especially at the Urbana location. At Brownstown, the crop suffered from saturated soil conditions soon after planting, and while growing season rainfall there was close to average, the crop never recovered fully, and yields were very low. Yields were good at DeKalb and Monmouth.

At DeKalb and Monmouth, overall yields were similar, but hybrids performed differently at the two locations, with 33K44 producing the lowest yield at DeKalb and one of the highest yields at Monmouth, and 33W84 showing the inverse of this (Table 1.) Response to N rate and plant population were similar at these two locations, with yields at the three populations similar at zero N, with yields at 34K and 50K both responding to N in a curvilinear fashion, and the low population (18K) responding little to N at rates above 80 lb N/acre (Figures 1 and 2). Hybrids did not respond very consistently to changes in N rate-population combinations; as an example, changing the population from 34 to 50K at the 240-lb N rate decreased yield of 33D49 by 13 bu/acre and increased yield of 34F07 by 18 bu/acre at DeKalb, but had little effect on yield of these (or any) hybrids at Monmouth (Table 1). Raising both N rate (from 160 to 240 lb N/acre) and population (from 34K to 50K) did, however, raise yields of hybrids 33W84 and 34K07 at both locations, but had much less effect, or even lowered yields, of the other two hybrids (Table 1.)

At Urbana, where stress from dry weather was severe, the overall yield average was only 92 bu/acre. At this location, yields without N decreased as population increased, from about 60 bu/acre at 18K to only 20 bu/acre at 50K (Figure 3). The two lower populations (18K and 34K) responded similarly to N rate, though at 18K, yields leveled off at about 120 bu/acre with 80 lb N, while at 34K yield, yield responded up to 160 lb N before dropping back at 240 lb N (Figure 3). In contrast, yields at the highest population (50K) leveled off at only about 80 bu/acre at 80 lb N and did not respond to higher N rates (Figure 3). Among the hybrids, yields averaged over treatments ranged from 100 bu/acre for 33D49 to 81 bu/acre for 34F07 (Table 1). Yield responses to increasing input levels were mostly negative; increasing plant population from 34K to 50K reduced yield more at 240 lb N than at 80 lb N, while going from 160 lb N and 34K to 240 lb N and 50K dropped yields by more than 50 bu/acre (Table 1). Differences among hybrids were not very consistent, though at 50K, 33D49 and 33K44 responded positively to raising the N rate from 80 to 160 lb N/acre, while the other two hybrids responded negatively (data not shown.)

Due to the unusual degree of damage at Brownstown (we strongly considered abandoning this study in mid-season) data from this site are of questionable value. Yields without N were less than 3 bu/acre at the two highest populations, and about 14 bu/acre at the lowest population. The response to N was nearly linear up to 240 lb N/acre, indicating that either a considerable amount of N was lost after application (which is quite likely), that roots were unable to reach what N was there, or both. The response to N rate was similar at all three populations, though as we saw at Urbana, yields were higher at the two lower populations than at the highest population (Figure 4). Performance of hybrids was unlike that at Urbana, however, and responses to changing combinations of inputs were also unlike those at Urbana, providing support to the idea that the type of stress was different at these two low-yielding locations.

The 2011 growing season was favorable at the two northern Illinois locations, where corn responded similarly at increasing rates of N and plant population, though hybrids did not respond very consistently. Optimum N rates were about 200 lb N/acre at DeKalb and 160 at Monmouth, in line with previous findings in these soils. Responses to N were almost exactly the same at 34K and 50K populations, however, and we found no support for the idea that the way to higher corn (following corn) yields is to increase both population and N rate. Still, 50K is a high population, and it's not impossible that an intermediate population such as 42K might have yielded more than 50K did. In the stress environments at Urbana and Brownstown, the two lower populations yielded about the same, and considerably more than the highest population, showing that corn plant population can indeed be too high under some conditions. Adding more N did nothing to alleviate the yield decrease with high population at these two sites. While different hybrids responded to input combinations differently, there was little consistency in hybrid responses over sites, even where stress was low and yields were good.

## References

Boomsma, C.R., J.B. Santini, M. Tollenaar, and T.J. Vyn. 2009. Maize morphophysiological responses to intense crowding and low nitrogen availability: An analysis and review. *Agron. J.* 101:1426-1452.

Table 1. Yields of corn hybrids averaged over all treatments and yield changes from different combinations of treatments at four Illinois locations, 2011.

Hybrid	Location			
	DeKalb	Monmouth	Urbana	Brownstown
	bushels per acre			
	<u>Yield avg over populations and N rates</u>			
33D49	185	185	100	44
33K44	155	184	98	53
33W84	190	170	85	50
34F07	180	171	81	54
	<u>Yield change, 34K to 50K at 80 lb N</u>			
33D49	-19	3	-29	-29
33K44	2	-8	-40	-31
33W84	-18	-3	-23	-4
34F07	4	4	-8	-15
	<u>Yield change, 34K to 50K at 240 lb N</u>			
33D49	-13	-4	-27	-19
33K44	-13	-4	-37	-27
33W84	9	-2	-33	-12
34F07	18	1	-33	-41
	<u>Yield change, 80 lb N to 240 lb N at 34K</u>			
33D49	33	35	-8	28
33K44	41	15	3	44
33W84	5	28	5	34
34F07	14	29	17	28
	<u>Yield change, 80 lb N to 240 lb N at 50K</u>			
33D49	39	27	-6	38
33K44	27	19	6	49
33W84	31	29	-4	25
34F07	28	26	-8	2
	<u>Yield change, 80 lb at 34K to 240 lb N at 50K</u>			
33D49	20	30	-35	9
33K44	29	11	-34	17
33W84	14	26	-27	22
34F07	32	31	-16	-12
	<u>Yield change, 160 lb at 34K to 240 lb N at 50K</u>			
33D49	5	-1	-59	-18
33K44	-2	-12	-46	28
33W84	20	4	-58	13
34F07	21	10	-50	-23

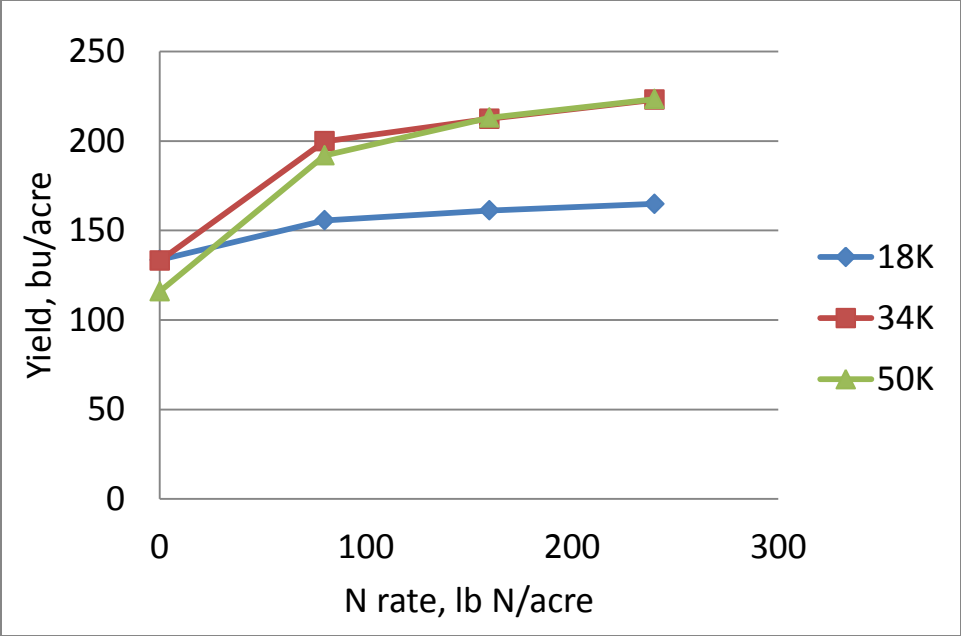


Figure 1. Corn grain yield response to N rate at three plant densities, DeKalb, 2011. Data are averages over four hybrids.

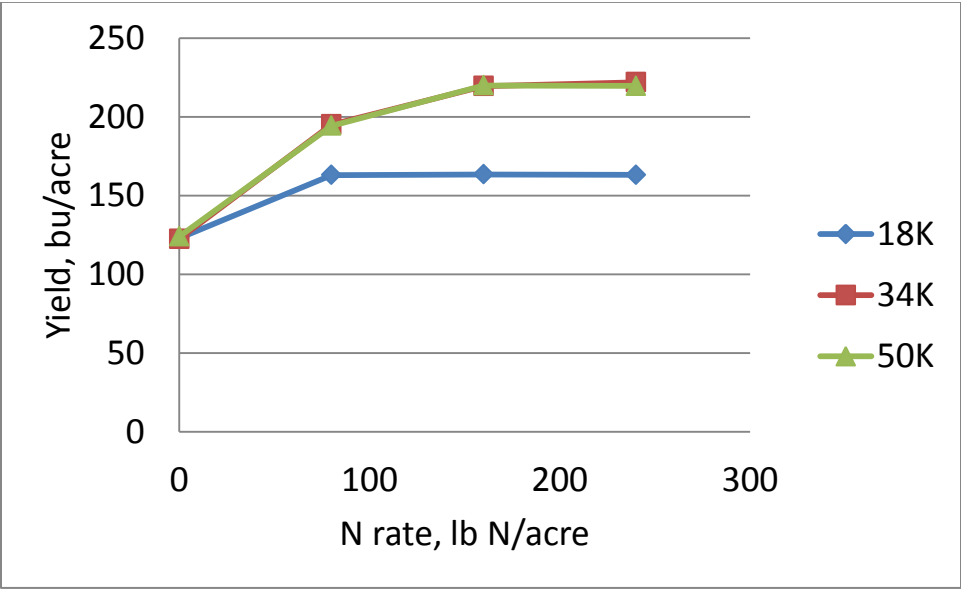


Figure 2. Corn grain yield response to N rate at three plant densities, Monmouth, 2011. Data are averages over four hybrids.

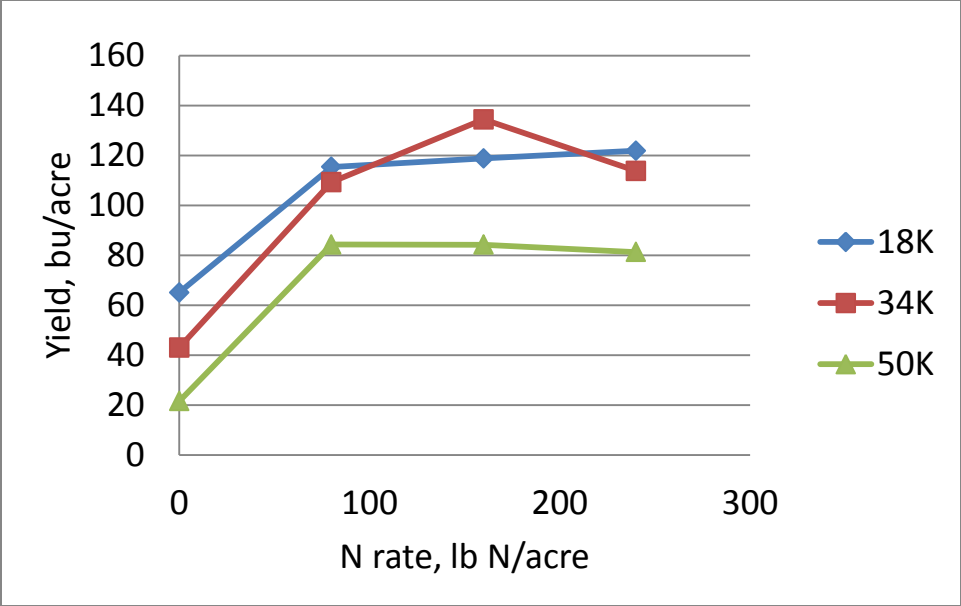


Figure 3. Corn grain yield response to N rate at three plant densities, Urbana, 2011. Data are averages over four hybrids.

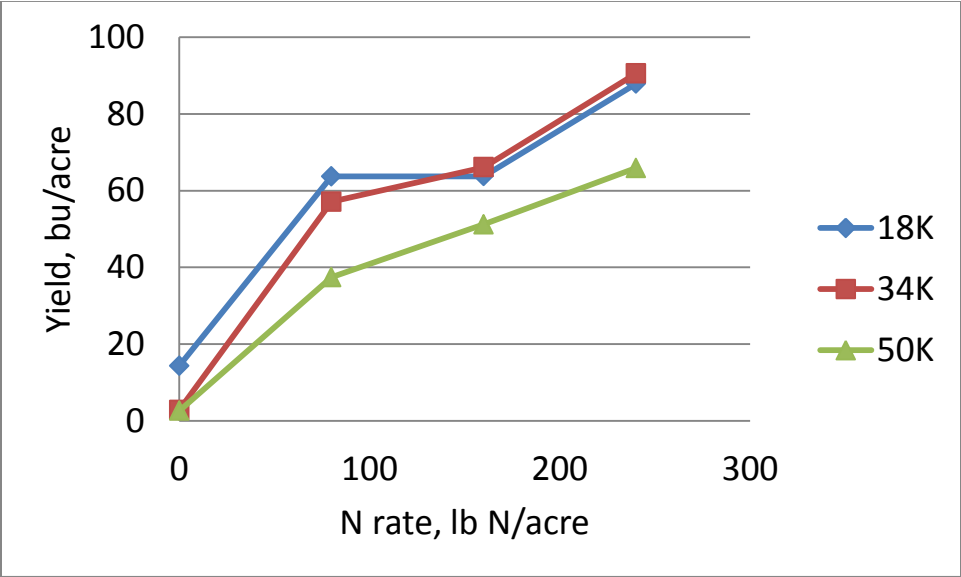


Figure 4. Corn grain yield response to N rate at three plant densities, Brownstown, 2011. Data are averages over four hybrids.