Characterization of Commercial Corn Hybrids in Response to Different Nitrogen Fertilizer Rates and Plant Populations

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Introduction:

Nitrogen (N) fertilizer rate, plant population, and hybrid selection are three important management factors determining corn yield.

These decisions interact with soil N status and plant N demand depending on the corn genotype and the environmental conditions.

Our objectives were to characterize different commercial corn hybrids from their response to crop management.

Research Approach:

A wide range of current commercial corn hybrids were characterized for their yield response to greater population and N availability (Figure 1).

'Workhorse' hybrids are defined as hybrids that tolerate N loss, have high yield when no N fertilizer is applied (Check Plot), and high initial yield response to N fertilizer (Figure 2).

'Racehorse' hybrids are defined as hybrids that tolerate high plant population and have high yield response to N fertilizer (Figure 2).

Figure 1. Clorotic yellowing characteristic of N deficient corn at Champaign, IL in 2013.

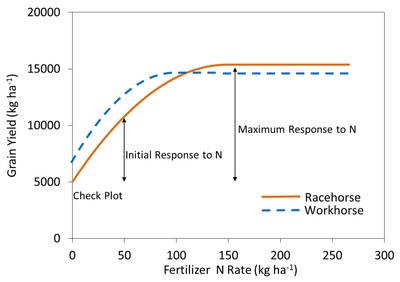

Figure 2. Relationship between N fertilizer rate and corn grain yield for classification of 'Workhorse' and 'Racehorse' hybrids.

Material and Methods:

Hybrids: 64 current commercial hybrids to represent a broad germplasm spectrum.

Locations:

2012: Champaign, DeKalb, and Rushville, IL.

2013: Champaign, DeKalb, and Harrisburg, IL.

N Rates: 0, 67, and 252 kg N ha^{-1} hand-applied as urea at V4-V6 growth stages.

Populations: 79,000 and 111,000 plants ha^{-1}.

Design: RCBD with 4 replications.

Parameters Evaluated:

Check Plot: Yield at 0 kg N ha^{-1}

RTP: Yield response to plant population at 252 kg N ha^{-1}.

= Yield$_{111,000\ plants\ ha^{-1}}$ - Yield $_{79,000\ plants\ ha^{-1}}$

RTN: Maximum yield response to N at 79,000 plants ha^{-1}.

= Yield$_{252\ kg\ N\ ha^{-1}}$ - Yield$_{0\ kg\ N\ ha^{-1}}$

InitN: Initial yield response to N at 79,000 plants ha^{-1}.

= Yield$_{67kg\ ha^{-1}\ N}$ - Yield$_{0\ kg\ N\ ha^{-1}}$

Results:

Hybrids had different yield responses to N and plant population within each environment (Figure 3).

More precipitation in 2013 likely resulted in more fertilizer N uptake, leading to greater yields, at both initial and maximum N.

Greater precipitation in 2013 likely resulted in enhanced mineralization, leading to larger initial N and maximum N responses.

Higher yielding environments of 2013 compared to 2012 were also associated with increased yield response to plant population.

The DeKalb locations exhibited greater average Check Plot yields and lower maximum responses to N than Champaign in 2012 and 2013.

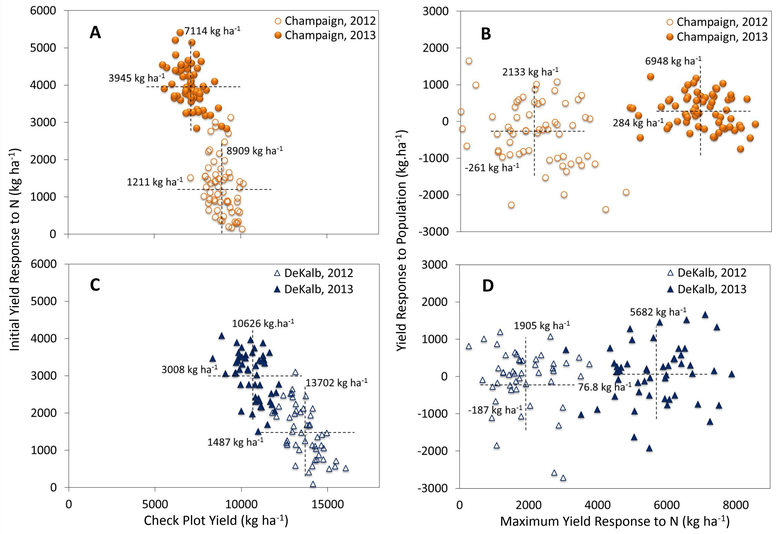

Figure 3. Relationship between initial N response and Check Plot at Champaign (A) and DeKalb (C) and yield response to plant population and maximum N response at Champaign (B) and DeKalb (D) in 2012 and 2013. Dashed lines represent the average responses from all hybrids in each location followed by the average values. Sixty-four hybrids were included in Champaign and 50 in DeKalb where 14 hybrids were not in common for both locations.

Correlating Corn N Responses and Plant Population:

Because there was a significant year effect on Check Plot yield, RTP, RTN, and InitN (data not shown), Pearson correlation coefficients among traits are presented for each year (Table 1).

In both years, hybrids exhibited a negative correlation between Check Plot yield and InitN and between Check Plot yield and RTN emphasizing the challenge for creating hybrids that tolerate N loss and that have a large response to N.

Initial N response and RTN were positively correlated in both years, indicating that hybrids that are tolerant to N loss may also have maximum yield response to N.

Table 1. Pearson correlation coefficients for check plot yield, yield response to population (RTP), yield response to nitrogen (RTN), and yield response to initial N (InitR) at 3 different locations in 2012 and 2013. Bold coefficients indicate significance at P ≤ 0.001.

2012	Check Plot	RTP	RTN
RTP	0.07		
RTN	**-0.30**	-0.04	
InitR	**-0.24**	0.02	**0.45**

2013	Check Plot	RTP	RTN
RTP	-0.02		
RTN	**-0.65**	-0.25	
InitR	**-0.47**	-0.04	**0.64**

Identification of 'Workhorse' and 'Racehorse' Hybrids:

'Workhorse' hybrids with above average Check Plot and InitR are represented in the upper right quadrants from each location in Figures 3A and 3C.

'Racehorse' hybrids with above average RTP and RTN are represented in the upper right quadrants from each location in Figures 3B and 3D.

Hybrids that combined both characteristics ('Workhorse' and 'Racehorse') were also detected. These hybrids are tolerant to N loss and responsive to crop management.

'Workhorse' and 'Racehorse' Indices:

Decile classes were calculated to provide Check Plot, InitN, RTN, and RTP scores for each hybrid per location (1 = lowest and 10 = highest) (Table 2).

The combination of the Check Plot and InitN scores constitute a 'Workhorse' Index and the combination of the RTP and RTN scores constitute a 'Racehorse' Index (2 = lowest and 20 = highest).

For example, Hybrid A was a consistent 'Workhorse' and Hybrid B was a consistent 'Racehorse' across locations in 2013. Hybrids A and B possess contrasting agronomic characteristics and could be suitable for low fertility and high management environments, respectively.

Table.2 Demonstration of average Check Plot, Initial N Response (InitN), Response to Nitrogen (RTN), and Response to Population (RTP) Scores in a 'Workhorse' (Hybrid A) and a 'Racehorse' (Hybrid B) Hybrid at Champaign (CH), DeKalb (DK) and Harrisburg (HB) in 2013.

	CH	DK	HB	CH	DK	HB	CH	DK	HB
	Check Plot Score			**InitN Score**			**'Workhorse' Index**		
Hybrid A	7.5	8.3	7.5	4.8	4.5	5.3	12.3	12.8	12.8
Hybrid B	6.8	7.0	5.5	3.8	6.0	3.5	10.5	13.0	9.0
	RTN score			**RTP score**			**'Racehorse' Index**		
Hybrid A	3.3	3.5	4.5	6.8	4.8	5.3	10.0	8.3	9.8
Hybrid B	5.3	6.3	6.0	7.3	6.8	8.0	12.7	13.0	14.0

Conclusions:

Hybrids differ widely for their responses to N and plant population within environments (Figure 3), and were not associated with a specific seed brand or relative maturity (data not shown).

Identifying hybrids with high a Check Plot yield and a high response to N fertilizer may be challenging since these characteristics appear to be negatively correlated (Table 1).

Hybrids with consistent 'Workhorse' indices should yield better under conditions conducive to N loss, while hybrids with consistent 'Racehorse' indices should be more suitable for management practices for high yield.

Typical variety testing methods using 'standard' agronomic conditions (e.g., 252 kg N ha^{-1} at 79,000 plants ha^{-1}) may be used to determine yield potential, but do not provide information regarding a hybrid's responses to N loss and increased plant population.

'Workhorse' and 'Racehorse' indices can help to better select hybrids according to their potential response to the level of crop management.

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