Characterizing Commercial Corn Hybrids for Yield Responses to Agronomic Management

Crop Physiology

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QUESTION: ***Do current commercial corn hybrids differ in their yield potential and response to agronomic management?***

OBJECTIVE: ***Characterize corn hybrids for their responses in grain yield to N fertility, plant density, and row spacing.***

INTRODUCTION

- Nitrogen (N) fertilizer rate, plant population, and hybrid selection are some of the most important decisions made by a farmer each year in the production of corn (*Zea mays* L.).
- These decisions interact with soil N status and plant N demand depending on the environmental conditions and the corn hybrid.
- Narrowing row spacing increases plant-to-plant spacing within the row, and is potentially a better arrangement to accommodate higher plant densities for most hybrids.
- Maximizing a hybrid's yield potential requires correct environmental placement and implementing the appropriate agronomic management.

RESEARCH APPROACH

A wide range of current commercial hybrids from several leading seed brands were characterized for their yield responses to N availability, increased plant density, and narrower row spacing.

'Workhorse' hybrids exhibit tolerance to N loss and have acceptable yields in low fertility environments (Figure 1).

'Racehorse' hybrids exhibit greater than average yield increases in response to agronomic management such as N fertilization, high plant density, and narrow row spacing.

Figure 1. Two hybrids grown in a low N environment (67 kg N ha^{-1}) at Champaign, IL in 2017. Less severe chlorotic yellowing of the hybrid on the left suggests a higher tolerance to N loss.

MATERIALS AND METHODS

Hybrids: 68 commercial hybrids representing a broad germplasm spectrum and ranging in relative maturity from 104-120 days.

Locations: Yorkville (41°N), Champaign (40°N), and Harrisburg (37°N), Illinois.

Nitrogen: broadcast applied at the V3 growth stage as urea (46-0-0) and protected with Limus.

Treatments: hybrids were evaluated across the two row spacings, three plant densities, and three N rates outlined in Table 1. Treatments were arranged in a split-split block experimental design with four replications.

Table 1. Six treatments used in the evaluation of commercial corn hybrids for their yield responses to N fertilization, planting density, and row spacing.

Treatment	Row Spacing	Plant Density	Nitrogen
	cm	plants ha^{-1}	kg N ha^{-1}
Check	76	79,000	0
Low N	76	79,000	67
High N	76	79,000	314
Intermediate Density	76	94,000	314
High Density	76	109,000	314
Narrow Rows	51	109,000	314

YIELD RESPONSES TO MANAGEMENT

- Exceptional yields were obtained in the unfertilized (check) plots in 2017 at all locations, which led to less yield response to N fertilization than expected (Table 2).
- There was a wide range in yields amongst the 44 hybrids tested at each location in response to each N level (Table 2).
- Averaged across all hybrids and locations, plant density increase from 79,000 to 94,000 plants ha^{-1} contributed to the greatest yield response, while minimal yield was gained when increasing to 109,000 plants ha^{-1}.
- On average, the 51 cm row spacing was a better arrangement of the highest plant density (Table 2), although there was a high degree of variability among the hybrids (Figure 3).

Table 2. Final grain yield as affected by nitrogen rate (at 79,000 plants ha^{-1}), plant density (at 314 kg N ha^{-1} and 76 cm row spacing), and row spacing (at 109,000 plants ha^{-1}) at three locations in Illinois in 2017. Values represent the average and the range in yield of 44 hybrids at each location expressed on a 0% moisture basis.

Location	Nitrogen Rate (kg ha^{-1})		
	0	67	314
	Mg ha^{-1}		
Yorkville	12.0 (10.2-14.0)	14.0 (10.5-17.4)	15.2 (11.3-17.7)
Champaign	11.2 (9.0-13.3)	13.6 (11.0-15.2)	14.1 (11.6-16.7)
Harrisburg	12.3 (11.2-14.1)	14.8 (13.3-16.5)	15.2 (13.8-17.0)
Average	11.8 C†	14.1 B	14.8 A
Location	**Plant Density (plants ha^{-1})**		
	79,000	94,000	109,000
	Mg ha^{-1}		
Yorkville	15.2 (11.3-17.7)	15.6 (11.8-18.9)	15.7 (12.0-17.9)
Champaign	14.1 (11.6-16.7)	14.5 (11.8-16.6)	14.7 (12.2-17.1)
Harrisburg	15.2 (13.8-17.0)	16.0 (14.4-17.6)	16.3 (14.8-18.2)
Average	14.8 C	15.4 B	15.5 A
Location	**Row Spacing (cm)**		
	76	51	
	Mg ha^{-1}		
Yorkville	15.7 (12.0-17.9)	16.5 (12.2-20.1)	
Champaign	14.7 (12.2-17.1)	15.0 (10.5-17.4)	
Harrisburg	16.3 (14.8-18.2)	16.7 (14.6-19.7)	
Average	15.5 B	16.1 A	

† Mean separation tests were conducted using an LSD calculation with Tukey adjustment. Letters compare nitrogen level, plant density, and row spacing separately. Similar letters are not significantly different at $P \leq 0.10$.

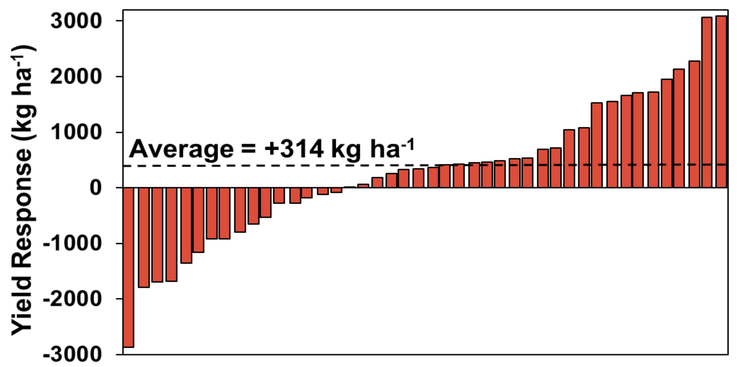

Figure 3. Yield response of 44 commercial corn hybrids to narrower row spacing (yield change between 76 and 51 cm row spacing at 109,000 plants ha^{-1} and 314 kg N ha^{-1}) at Champaign, IL in 2017.

HYBRID CHARACTERIZATION

'Workhorse' index (WHI) is based on the check plot yield (yield at 0 kg N ha^{-1}) and the yield response to low N (RTLowN; yield change between 0 and 67 kg N ha^{-1}).

'Racehorse' index (RHI) is comprised of the yield response to: high N (RTN; yield change between 0 and 280 kg N ha^{-1} at 79,000 plants ha^{-1}), intermediate plant density (RTIntPop; yield change between 79,000 and 94,000 plants ha^{-1} at 314 kg N ha^{-1}), high plant density (RTHiPop; yield change between 94,000 and 109,000 plants ha^{-1} in a 76 cm row spacing), and row spacing (RTRS; yield change between 76 and 51 cm row spacing at 109,000 plants ha^{-1}) evaluations.

- Hybrids were ranked by their yield responses to each parameter and 'Racehorse' and Workhorse' indices for each hybrid were estimated using a multiple regression approach with the Smith-Hazel index.
- Index weights calculated for each parameter suggest that Check plot yield and RTN and RTRS were the most important in determining a hybrid's WHI and RHI respectively (Table 3).
- Hybrids of similar yield potential with contrasting WHI and RHI suggest the potential for those hybrids to respond differently to N loss or intensified agronomic management (Table 4).

Table 3. Relative weights for each parameter used in the characterization of hybrids at three sites in Illinois in 2017.

Check	RTLowN	RTN	RTIntPop	RTHiPop	RTRS
0.94	0.06	0.50	0.12	0.03	0.34

Table 4. Ten hybrids ranked by their yield under standard management (314 kg N ha^{-1} and 79,000 plants ha^{-1}) and their corresponding 'Workhorse' (WHI) and 'Racehorse' (RHI) indexes averaged across three sites in Illinois in 2017.

Hybrid	Yield (Mg ha^{-1})	WHI	RHI
1	15.8	9.6	5.6
2	15.8	4.9	8.1
3	15.8	4.9	7.7
4	15.7	4.0	7.1
5	15.6	5.2	6.2
6	15.5	7.2	4.8
7	15.3	7.3	6.0
8	15.3	3.7	7.1
9	15.2	7.6	4.9
10	15.2	7.5	5.5

CONCLUSION

- Commercial corn hybrids differ drastically in their ability to tolerate low N environments and in their responses to N fertilization, plant densities, and row spacing.
- Highest yields of 2017 were achieved with 'Racehorse' type hybrids at high densities in narrow rows.
- Narrow rows are a better arrangement of high densities for most hybrids.
- Typical variety testing trials under standard management do not accurately represent a hybrid's yield stability across yield environments or responsiveness to intensive agronomic management.

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