ROLE OF ROOT ARCHITECTURE IN RESPONSE TO IN-SEASON NITROGEN APPLICATIONS TO MAIZE

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OBJECTIVE: ***Assess if differences in maize hybrid rooting characteristics affect grain yield and N accumulation in response to nitrogen rate and timing.***

INTRODUCTION

Traditionally, high-yielding maize (*Zea mays* L.) breeding programs have focused on above-ground phenotypes, with less attention given to root biomass and architecture due to the complexity associated with the quantification of those traits.

Nitrogen (N) accumulation differs among hybrids and is hypothesized to be associated with root characteristics. Linking root architecture and its implications for grain yield and N uptake may benefit future breeding and management programs.

RESEARCH APPROACH

Location and Weather:

Experiments were done at Champaign, IL in 2023, and experienced 38% of the 30-year average rainfall in both May and June and 67% of normal in July.

Hybrid and Population Experiments:

In one experiment, eight genetically-distinct hybrids were evaluated for their response to split-applied N at a standard plant population. In a second trial, two hybrids known to differ in root architecture were evaluated for both their response to split-applied N and population. N treatments were a reduced rate of 135 kg N ha^{-1}, a standard rate of 200 kg N ha^{-1}, both applied preplant, or a split-application of 135 kg N ha^{-1} preplant with an additional 65 kg N ha^{-1} applied y-drop at V6. Plant populations were 69,000, 84,000, or 99,000 plants ha^{-1}, with 84,000 as the standard.

Root Measurements:

Four roots were dug from each plot of both trials at the R3 plant growth stage and measured using the Corn Root Imaging Platform (CROP) (Figure 1). Four images per root were taken and averaged to measure root angle, and pixels containing root biomass were converted to cm^2 as an estimate of relative root area.

RESULTS

- Providing 200 kg ha^{-1}, compared to 135 kg ha^{-1}, resulted in greater grain yield, although there was no difference in grain yield whether that N was preplant or split-applied (Table 1).
- Relative root area was unaffected by the N level, but consecutively decreased with greater plant populations (Table 1).
- Considerable variation was observed for root characteristics among hybrids, but the relationship between the relative root area and root angle was inconsistent across hybrids (Figure 2).
- There was no correlation between any of the root parameters with grain yield, but relative root area was positively correlated with grain N concentration (Table 2, Figure 3).

Table 1. Effect of N treatment or plant population on grain yield and relative root area. N treatments are averaged across eight hybrids and population values are averaged over two hybrids and three N treatments. Yield values are 0% moisture.

N Treatment	Grain Yield	Relative Root Area
kg ha^{-1}	Mg ha^{-1}	cm^2
135	10.8	134
200	11.3	135
135 + 65	11.2	135
LSD (α = 0.1)	0.4	ns
Population	**Grain Yield**	**Relative Root Area**
plants ha^{-1}	Mg ha^{-1}	cm^2
69,000	11.7	138
84,000	11.8	122
99,000	11.4	112
LSD (α = 0.1)	0.3	6

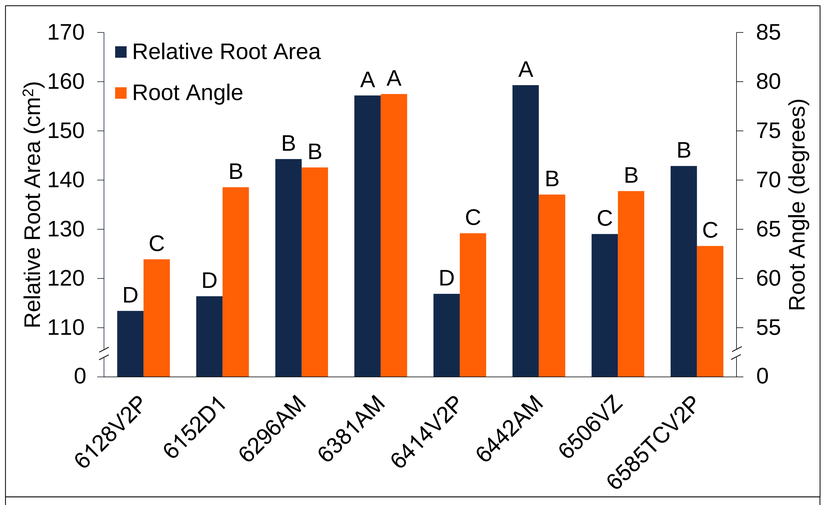

Figure 2. Effect of hybrid on relative root area and root angle. Values are averaged over three N treatments. Bars within each parameter labeled with different letters are significantly different at $P \leq 0.1$ using Fisher's LSD separation test.

Table 2. Pearson correlation coefficients between grain parameters and root parameters of both the hybrid and population trials.

	Grain Yield	Kernel Number	Kernel Weight	Grain N %	Grain N kg ha^{-1}
	r				
Relative Root Area	-0.0617	0.0149	-0.2196*	0.3700*	0.0963
Root Angle	0.0330	0.0362	-0.0325	-0.0940	-0.0579
Root Weight	0.0330	-0.0795	0.1156	0.0528	0.0323

*Significant at the 0.001 probability level.

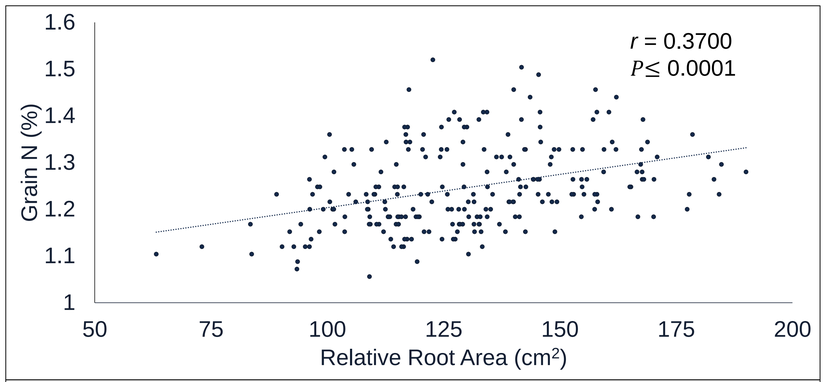

Figure 3. Scatter diagram between relative root area and grain N concentration. Values are from both the hybrid and population trials.

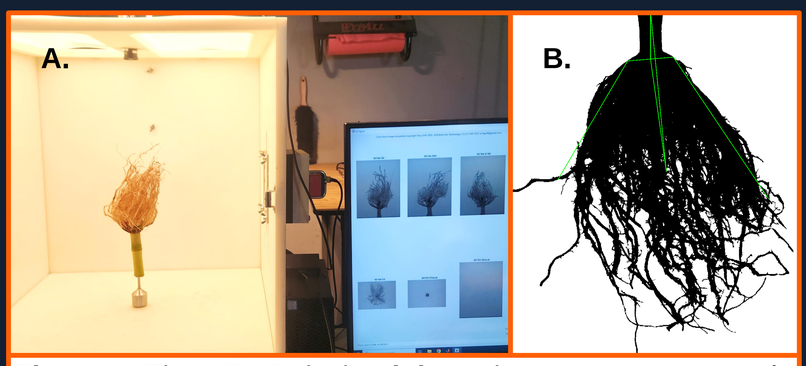

Figure 1. The CROP device **(A)** used to measure root angle and relative root area from an image of a maize root **(B)**.

Special thanks to Beck's Hybrids for supporting this research.

CONCLUSIONS

- While a higher rate of N increased grain yield, there was no yield gain from split-applying N in this dry growing season, and there was no relationship between hybrid root characteristics and their response to N.
- Commercial hybrids exhibited considerable variation in their root architecture, and the positive correlation between relative root area and grain N concentration suggests that differences in root architecture can affect the utilization of N.