NC STATE UNIVERSITY

N management for high population corn production in wide and narrow rows

DEPARTMENT of SOIL SCIENCE

C.R. Crozier, R.J. Gehl, R.W. Heiniger, & D.H. Hardy; carl_crozier@ncsu.edu

Introduction

Recent trends of planting corn (*Zea mays* L.) at higher populations and in narrow rows could influence optimum N management. If N deficiency occurs, stress at a specific point in the plant's life cycle should have the greatest effect on the yield components determined at that specific growth stage. Specific corn grain yield components have been used for detailed assessments of effects associated with breeding programs, N management, and population. Individual corn yield components contribute to grain yield as the product of the following:

Y=plants/ha x ears/pl x rows/ear x kernels/row x kernel mass

Although there can be considerable overlap in the temporal determination of values for each yield component, in general the order of determination is the same as their order of listing above.

Objectives

- Determine effects of row spacing, N timing, and N rate on corn early-season growth, yield components, and grain yield in high population density systems across North Carolina
- Assess the timing of N stress via early-season N uptake and yield component responses

Methods & Materials

- 13 Non-irrigated experiments in rotation following soybean during 2010-2012
- Regions – Coastal Plain, Piedmont, Mountain
- Experimental design – split-plot RCBD, 4 reps
  - Main plot factor – row width:
    - wide (76-102 cm) or narrow (38-51 cm)
  - Subplot factors – N rate & timing
    - Rates: 0, 45, 90, 134, 179, 224 kg N ha^{-1}
      - All plots received a low rate of starter N: 7 kg N ha^{-1} as 11-37-0 band, except 1 site with 56 kg N ha^{-1} granular broadcast
    - Timing: at planting or sidedress (V5 to V7)
    - 3-4 wide or 6-8 narrow rows by >9 m
- Early season aboveground plant samples, at V5 to V7 prior to sidedress (dry matter and N uptake determined)
- Grain yield: manual harvest, 6.1 m (wide) or 12.2 m (narrow) row segments
- Yield components:
  - population and ear counts from harvested segment
  - 5 ears for row & kernel counts and mean individual kernel mass determination
- Data analysis
  - Factorial analysis of management treatments
    - SAS Proc MIXED, site & rep random
    - Least square means, t test p<0.05 or 0.1
  - N response regressions
    - At each site, pooled across row width & timing based on ANOVA findings
    - SAS Proc GLM linear-plateau regressions

Table 1. Site characteristics, management, and linear-plateau N response parameters.

		Characteristics			Management											Linear-plateau response model				
						Wide-row			Narrow-row				Dates							
Site	Year	County	Soil series	Soil class	Till†	Final popul.§	Row spacing	Within-row plant spacing¶	Final Popul.§	Row spacing	Within-row plant spacing¶	Cultivar‡	Plant	Side-dress (stage)	Harvest	R^2	Y intercept	Slope	Optimum N rate#	Optimum Yield
						ha^{-1}	------ cm ------		ha^{-1}	------ cm ------							Mg ha^{-1}	Mg kg^{-1}	kg ha^{-1}	Mg ha^{-1}
Coastal Plain Region																				
1	2010	Pamlico	Wasda	Histic Humaquepts	CT	84 900	102	12	89 700	51	22	P33M57	4/12	5/10(V5)	8/19	0.96	9.4	0.016	141	11.7
2	2011	Pamlico	Wasda	" "	CT	91 600	102	11	91 300	51	21	P1615HR	4/18	5/16 (V5)	8/16	0.79	8.45	0.0251	52	9.8
3	2012	Pamlico	Wasda	" "	CT	88 200	102	11	91 100	51	22	P1546RRB2	4/9	5/10 (V5)	8/30	0.97	11.86	0.0278	141	15.8
4	2011	Tyrrell	Hydeland	Umbric Endoaqualfs	CT	73 300	91	15	79 400	51	25	P31G71	4/7	5/9 (V5)	8/11	0.96	8.78	0.0079	231††	10.6
5	2011	Perq.	Portsmouth	Typic Umbraquults	CT	57 900	102	17	87 300	51	22	P35H42RRLL	4/22	5/18 (V5)	8/18	0.98	6.62	0.0242	235	12.3
6	2012	Perq.	Portsmouth	" "	NT	77 400	102	13	77 500	51	25	B6733	4/16	5/24 (V6)	9/4	0.98	2.82	0.0224	231††	8.0
7	2012	Pasq.	Perquimans	Typic Endoaquults	CT	85 000	102	12	84 900	51	23	SN68B3111	4/3	5/15 (V5)	8/14	0.98	6.45	0.0234	231††	11.8
8	2010	Perq.	Tomotley	" "	NT	78 900	102	12	77 300	51	25	P35H42	4/23	6/1 (V7)	9/8	0.97	3.73	0.0179	141	6.2
Piedmont Region																				
9	2010	Union	Badin	Typic Hapludults	NT	70 400	76	19	71 300	38	37	P31G71	4/21	5/26 (V5)	9/3	0.91	5.14	0.0197	186	8.8
10	2011	Union	Tatum	" "	NT	75 800	76	17	68 200	38	39	P31G71	4/20	5/26 (V5)	8/23	0.97	4.9	0.0353	96	8.3
Mountain Region																				
11	2010	Hend.	Comus	Fluventic Dystrudepts	CT	82 900	91	13	93 500	51	21	P31G71	4/30	6/7 (V6)	10/21	0.92	13.15	0.0591	52	16.2
12	2011	Hend.	Comus	" "	CT	88 900	91	12	67 600	51	29	P31G71	4/25	6/5 (V6)	10/24	0.99	14.58	0.0306	96	17.5
13	2012	Hend.	Comus	" "	CT	84 900	91	13	87 600	51	22	P31G71	4/29	6/4 (V6)	10/4	0.91	15.57	0.0122	141	17.3

† Till: CT- conventional tillage included multiple combinations of disk & cultivator passes; NT- no-till
‡ Cultivar parent company abbreviations: B- Beck's, P- Pioneer, S- Syngenta
§ Mean population at harvest calculated across all N management treatments
¶ Mean plant within-row spacing calculated from row spacing and final plant population
# Optimum N rate was the minimum fertilizer rate required to attain the yield plateau level
†† No yield plateau detected, so this was the maximum N rate applied.

Table 2. ANOVA results for fixed effects†. Early-season growth & N uptake were sampled before sidedress, so timing effects NA.

	Pre-sidedress							
Effect	Dry matter	N uptake	Plants ha^{-1}	Ears plant^{-1}	Rows ear^{-1}	Kernels row^{-1}	kernel mass	Grain yield
Row width (RW)					+			+
Timing of N (Time)	NA	NA				*	*	+
N rate (N)		+			**	***	***	***
RW x Time	NA	NA				*		*
RW x N	+	+						
Time x N	NA	NA		+				
RW x Time X N	NA	NA						

† To permit factorial consideration of N rate and timing effects, analysis excluded check plot data.
+, *, **, *** indicate significant effects at 0.1, 0.05, 0.01, & 0.001 probability levels, respectively.

Table 3. Aboveground dry matter and N at V5 to V7. Letters indicate differences, p<0.1; with lower-case letters comparing dry matter and upper-case letters comparing plant N.

N rate at planting	Dry matter		Plant N	
	Narrow	Wide	Narrow	Wide
kg ha^{-1}	g plant^{-1}		kg ha^{-1}	
0	2.7 b	2.8 b	8.9 B	8.8 B
45	2.8 b	2.9 ab	9.3 AB	9.0 AB
224	3.4 a	2.6 b	10.1 A	8.9 B

Table 4. Grain yield and component responses to N rate main effect. Letters indicate differences, p<0.05.

N rate†	Rows ear^{-1}	Kernels row^{-1}	Indiv. kernel mass	Grain yield
kg ha^{-1}	#	#	mg	Mg ha^{-1}
0	15.46	27.0	226	8.68
45	15.59 c	29.6 c	237 c	9.96 d
90	15.72 bc	31.2 b	243 b	10.86 c
134	15.91 ab	32.0 ab	247 b	11.34 b
179	15.93 a	32.5 a	253 a	11.75 ab
224	15.89 ab	32.2 ab	253 a	11.79 a
	Relative increase (%)			
	3	19	12	35

† 0N rate treatments excluded to permit factorial effect analysis.

Table 5. Kernels row^{-1} and grain yields resulting from row width and N timing interaction†. Letters indicate differences, p<0.05.

Timing	Kernels row^{-1}		Grain yield	
	Narrow row	Wide row	Narrow row	Wide row
			---- Mg ha^{-1} ----	
At plant	30.2 b	31.6 ab	11.0 B	10.8 B
Sidedress	32.0 a	32.2 ab	11.7 A	11.1 B

† 0N rate treatments excluded to permit factorial effect analysis.

Summary

* Uniform starter fertilizer supported most of the early season N uptake (9 kg N ha^{-1}) , although a minor increase (additional 1 kg N ha^{-1}) occurred with an additional 224 kg N ha^{-1} applied at planting.

•Positive contributions of 3 ear yield components (rows ear^{-1}, kernels row^{-1}, and kernel mass) were associated with grain yield responses to N fertilizer

* Delaying N application until sidedress increased grain yield, although there was an interaction with row width:
  - Highest grain yields occurred with sidedress application to narrow row corn.
  - Sidedress N application and/or more persistent N sources may be needed to maximize the formation of ear yield components & grain yield.

* *In press: Agron J. AJ13-0280*

Acknowledgements
Funded by IPNI & the Corn Growers' Assn of NC.