STARTER N AND P EFFECTS ON EARLY MATURING CORN PLANTED EARLY

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ABSTRACT

Short-season corn planted early is a water-use management option being investigated in the central plains states. This study was conducted in an attempt to determine optimum starter N and P fertilizer rates and to compare subsurface banded versus surface applications of P for short-season corn planted early. Each location had a 3x3 factorial arrangement of N and P (0, 20 and 40 lbs N or P_2O_5/acre) placed 2 inches below and beside the seed as well as one or both application methods of surface broadcast or surface banded (20 or 40 lbs P_2O_5). Above ground dry matter yields at the V6 stage were significantly influenced by P rate with increasing yields with increasing P rate for one site for two years. Grain yields were also significantly influenced by P rate with the 40 lb P_2O_5/acre rate having lower yields as compared to the 20 lb P_2O_5/acre rate at one site both years. Single degree of freedom contrasts generally indicated that banded P was superior to surface applications for above ground dry matter yields (V6), whole plant P concentrations, ear leaf P concentrations and grain yield.

INTRODUCTION AND OBJECTIVES

Dry-land corn production has always been a risky venture in the Plains states. Droughty conditions are relatively common during July and August, which are critical growth periods for full-season corn hybrids. Consequently, much of the corn acreage has been replaced by sorghum, soybeans, or wheat. The potential exists to increase the acreage of dry-land corn in the Central Plains through the practice of planting early maturing (approx. 100 day) corn early in the growing season. This allows the corn to pass through its critical growth periods prior to the typical droughty periods. Total yield potentials are less than that of full-season corn but yields are generally more consistent. In central and eastern Kansas, early corn would be planted from mid-March to early April.

Little information is available on the need for starter fertilizer with early corn production. The corn is typically planted into cool, moist soils which strongly suggests a need for phosphorus, possibly even on soils that test medium to high in available P. Nitrogen may also promote the growth of the young corn plants under the sometimes less than ideal growing conditions.

The objectives of the research reported here were to demonstrate the need for starter N and P fertilizers and to determine the optimum starter fertilizer rates for early maturing corn planted early in the growing season.

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METHODS

A single location was used in 1990 (Manhattan, KS) and three locations were used in 1991 (Manhattan, Scandia and Powhattan). Bray P1 P values for the surface horizons were 42, 45, and 23 lbs P/acre for Manhattan, Scandia and Powhattan, respectively. Pioneer variety #3751 was planted at approximately 26,300 seeds/acre on 8 April 1990 and at 29,000 seeds/acre on 28 March, 3 April, and 5 April, 1991 at Manhattan, Powhattan and Scandia, respectively. In Manhattan the experiment consisted of a factorial arrangement of 0, 20 or 40 lbs N/acre and/or 0, 20, 40 lbs P_2O_5/acre placed in a 2" x 2" relationship to the seed. Nitrogen was supplied as UAN (28-0-0) and P was supplied as ammonium polyphosphate (10-34-0). Twenty or 40 lbs P_2O_5/acre broadcast treatments were also included for a total of 11 treatments. The same 11 treatments were used at the remaining locations except that 1 lb Zn/acre, 20 lbs K_2O/acre and 5 lbs S/acre were also applied with the starter fertilizers. Twenty or 40 lbs P_2O_5/acre was also applied as a surface band approximately 6 inches wide directly over the row. One treatment of 20 lbs N/acre and 20 lbs P_2O_5/acre without Zn, K_2O or S was also included for a total of 14 treatments at Scandia and Powhattan. All treatments received supplemental N to bring the total N application up to 100 lbs/acre. Ammonium nitrate was used in 1990 and UAN was used in 1991. A randomized complete block design was used.

Whole plant samples were taken at the V6 stage (approx.) and above ground dry matter yields were calculated. Ear leaf samples were taken at 50% silking. Grain and stover yields were measured.

RESULTS AND DISCUSSION

Growing conditions were very favorable in 1990 and extremely poor for 1991 at all locations. Total precipitation amounts were far below average and hot and dry conditions prevailed prior to silking. Excessive variability was a problem.

The analysis of variance utilizing all treatments indicated that the only significant treatment effects were on the above ground dry matter yields (V6) and the corresponding whole plant P concentrations for the Manhattan location in 1991 (Table 1). Individual treatment means for above ground dry matter yields (V6) and grain yields for all locations and both years are presented for the readers information, but will not be discussed in detail (Table 2).

Significant P effects were noted for grain yield, above ground dry matter yields (V6), whole plant P concentrations and ear leaf P concentrations when the factorial arrangement of treatments was considered. Significant N effects were found for grain yield, stover yield, above ground dry matter yields (V6), whole plant P concentrations and ear leaf P concentrations. No significant N*P interactions were found.

Forty lb P_2O_5/acre produced significantly higher above ground dry matter yields (V6) as compared to 0 lb P_2O_5/acre for the 1990 and 1991 Manhattan location. A similar trend was seen in 1991 for Scandia, but the differences were not statistically significant (Table 2). Grain yields were significantly lower at 40 lbs P_2O_5/acre as compared to 20 lbs P_2O_5/acre in 1990 at Manhattan and as compared to 0 or 20 lbs P_2O_5/acre in 1991 at Manhattan. When this effect was noted in 1990, it was hypothesized that it was due to P effects on silking dates. Date of 50% silking data were collected in 1991 at all locations and no significant differences were found (data not shown). No significant differences in grain yield due to P rate were found at Scandia or Powhattan.

Whole plant P concentrations were significantly higher at the 40 lb P_2O_5/acre rate as compared to 0 lb P_2O_5/acre in 1990 and 1991 at Manhattan. The 20 lb P_2O_5/acre rate was significantly higher than the 0 or 40 lb P_2O_5/acre rates in 1991 at Manhattan (Table 4). These differences correspond to the differences in above ground dry matter yields (V6) noted earlier. The only significant differences in ear leaf P concentration that were found were at Scandia where the 40 lb P_2O_5/acre rate was significantly higher than the remaining two rates.

Whole plant and ear leaf P concentrations were also significantly affected by N rate for 1991 at Manhattan and Scandia, respectively, (Table 5). The 0 lb N/acre rate had significantly lower whole plant P concentrations as compared to the remaining two rates at Manhattan. The 0 lb N/acre rate had significantly lower ear leaf P concentrations as compared to the 40 lb N/acre rate at Scandia. These data suggest that there may have been a slight enhancement of P availability from the N. The above ground dry matter yields (V6) for Scandia in 1991 indicate a significant reduction in yield when comparing the 0 to the 40 lb N/acre rate, however and the differences in P concentration may be due to a dilution effect (Table 6).

The 1991 Manhattan data shows significantly higher grain and stover yields at the 20 lb N/acre rate as compared to 0 or 40 lb N/acre rates (Table 6). The reason for these differences is not known at this time.

Significant single degree of freedom contrasts were found for various contrasts, years and locations (Table 7). The P versus no P contrast indicated that P had significantly higher ear leaf P concentrations at Scandia, significantly lower ear leaf Zn concentration at Scandia, significantly higher above ground dry matter yields (V6) at Manhattan in 1991 and significantly higher whole plant P concentration at Manhattan in 1990. The presence of P obviously produced the higher tissue P concentrations and the increased dry matter yields. The effect of P on tissue Zn concentrations may be an expression of the Zn-P interaction where Zn availability is decreased in the presence of high levels of P.

Increased P availability is also the probable reason for the increased above ground dry matter yields (V6) at Manhattan in 1991 and increased whole plant P concentration at Manhattan in 1990 when contrasting band applied P versus surface broadcast.

The banded P versus surface P applications (surface banded plus broadcast) contrast was significant for grain yield at Scandia (Table 7). Banded P applications had a significantly higher yield as compared to the surface applications. When banded P was contrasted with the two surface applications separately, only the contrast with surface band P applications was significant.

Ear leaf K concentrations at Powhattan were significantly different for this same contrast and likely reflects differences in positional K availability.

Opposite effects in ear leaf K concentrations were found when surface banded applications were contrasted against surface broadcast applications. For 1991 in Scandia the surface banded treatments had significantly higher ear leaf K concentrations as compared to the surface broadcast whereas the 91 POW the opposite was true. Soil test K levels at both sites were in the very high range (>321 lb K/acre).

Table 1. Analysis of variance results for all treatments.

Measurement	90 Man	91 Man	91 Scan	91 Pow
Grain Yield	n.s.	n.s.	n.s.	n.s.
Stover Yield	n.s.	n.s.	n.s.	n.s.
Above ground dry matter (V6)	n.s.	*	n.s.	-[1]
Whole plant P conc. (V6)	n.s.	*	-	-
Ear Leaf P	n.s.	n.s.	n.s.	n.s.

[1]Not available

Table 2. Above ground dry matter yields at the V6 stage of growth and grain yields.

Treatment		90 Man	91 Man	91 Scan	90 Man	91 Man	91 Scan	91 Pow
N lb/acre	P lb P_2O_5/acre	------------- lbs/acre	-------------	-------------	------------- bu/acre	-------------	-------------	-------------
0	0	153	338	491	125	31	30	53
0	20	169	352	536	128	42	61	48
0	40	226	430	527	111	15	44	45
20	0	143	324	411	125	69	33	50
20	20	202	428	486	135	63	31	52
20	40	202	411	524	124	43	25	47
40	0	139	335	386	129	47	28	47
40	20	155	367	425	130	33	48	51
40	40	174	413	459	107	24	24	49
0	20 sbcst	144	320	460	119	51	42	50
0	40 sbcst	169	333	415	123	32	41	41
0	20 sband	-	-	523	-	-	33	39
0	40 sband	-	-	505	-	-	23	45
20	20 no K,S or Zn	-	-	508	-	-	10	50
	LSD (0.05)	n.s.	82	n.s.	n.s.	n.s.	n.s.	n.s.
Phosphorus Means								
--------- lb P_2O_5/acre ---------								
0		146	332	429	126	49	31	50
20		184	382	482	131	46	47	50
40		201	418	504	114	27	31	47
LSD (0.05)		46	64	n.s.	12	17	n.s.	n.s.

Table 3. Analysis of variance results for the factorial arrangement of treatments. The N * P interactions were not significant.

Measurement	90 Man N	90 Man P	91 Man N	91 Man P	91 Scan N	91 Scan P	91 Pow N	91 Pow P
Grain yield	n.s.	*	*	*	n.s.	n.s.	n.s.	n.s.
Stover yield	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.
Above ground dry matter (V6)	n.s.	*	n.s.	*	*	n.s.	-[1]	-
Whole plant P conc. (V6)	n.s.	*	*	*	-	-	-	-
Ear leaf P	n.s.	n.s.	n.s.	n.s.	*	*	n.s.	n.s.

[1]Not available

Table 4. Phosphorus concentrations in whole plant and ear leaf samples averaged across N rates.

	- whole plant -		------------ ear leaf ------------			
Phosphorus Rate	90 Man	91 Man	90 Man	91 Man	91 Scan	91 Pow
-- lbs P_2O_5/acre --	---------------------- % ----------------------					
0	0.44	0.44	0.27	0.25	0.23	0.22
20	0.45	0.51	0.27	0.26	0.22	0.23
40	0.46	0.47	0.26	0.26	0.24	0.22
LSD (.05)	0.02	0.03	n.s.	n.s.	0.01	n.s.

Table 5. Phosphorus concentrations in whole plant and ear leaf samples averaged across P rates.

N rate	Whole plant - 91 Man	Ear leaf - 91 Scan
- lb N/acre -	---------- % ---------	--------- % ---------
0	0.44	0.23
20	0.51	0.22
40	0.47	0.24
LSD (0.05)	0.03	0.01

Table 6. Above ground dry matter yields at V6, grain yields and stover yields averaged across P rates.

	----------- 91 Man -----------		------ 91 Scan -----
Nitrogen rate	Grain yield	Stover yield	Above ground dry matter (V6)
- lb N/acre -	- bu/acre -	- lb/acre -	------ lb/acre ----
0	29	2938	578
20	58	3587	474
40	34	3092	424
LSD (0.05)	17	385	65

Table 7. Significant single degree of freedom contrasts.

Sample	Contrast	Means	Pr>F
91 Scandia Ear leaf P concentration	P vs. no P	.24 vs .22%	.01
91 Scandia Ear leaf Zn concentration	P vs. no P	16 vs 19 ppm	.004
91 Manhattan Above ground dry matter yield (V6)	P vs. no P	382 vs. 332 lb/acre	.02
90 Manhattan Whole plant P concentration	P vs. no P	0.45 vs. 0.44 %	.04
91 Manhattan Above ground dry matter yield (V6)	Band vs. Surface broadcast	347 vs. 327 lb/acre	.003
90 Manhattan Whole plant P concentration	Band vs. Surface broadcast	0.46 vs 0.44 %	.01
91 Powhattan Grain yield	Band vs. Surface applications	49 vs. 44 bu/acre	.04
91 Powhattan Grain yield	Band vs. Surface band	49 vs. 42 bu/acre	.03
91 Powhattan Ear leaf K concentration	Band vs. Surface band	1.94 vs. 1.80 %	.03
91 Scandia Ear leaf K concentration	Surface band vs. Surface broadcast	2.87 vs. 2.77 %	.03
91 Powhattan Ear leaf K concentration	Surface band vs. Surface broadcast	1.80 vs. 1.97 %	.02

PROCEEDINGS OF THE TWENTY-FIRST

NORTH CENTRAL EXTENSION - INDUSTRY SOIL FERTILITY CONFERENCE

November 13-14, 1991, Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 7

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