SHOULD P AND K FERTILIZATION BE MATCHED TO PLANT POPULATIONS FOR CORN?

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INTRODUCTION

Fertilization practices and plant populations are major factors involved with corn production. Several researchers have investigated the effects of various fertilizer management practices. Likewise, the impact of plant population on corn production has been evaluated in a variety of production environments.

The combined effects of plant population and fertilization, however, have not been thoroughly evaluated. Specifically, there has been very little study of the influence of plant populations in combination with management of potash and phosphate fertilizer on corn growth and yield. Therefore, the study described in the following paragraphs was conducted to measure the effect of plant population, phosphate and potash fertilizer management, and relative soil test levels of P and K on both grain yield and total dry matter production.

EXPERIMENTAL PROCEDURE

This study was conducted in two parts. The research with phosphate was conducted at the Southwest Experiment Station at Lamberton. Fields of cooperating farmers were used to evaluate the effect of potash fertilization. Each part will be described and discussed separately.

Phosphate Study:

For this study, five plant populations (23,000, 28,000, 33,000, 38,000, 43,000 plants per acre) were combined with four phosphate fertilization practices (none used, 40 lb. P_2O_5 per acre in a starter, 100 lb. P_2O_5 per acre broadcast, 200 lb. P_2O_5 per acre broadcast) in a complete factorial design with four replications. The soil was classified as a Normania silty clay loam. Soil samples (0-6 inches) were collected prior to the start of the study and the results are summarized in Table 1. This study was conducted at the same site for two years.

A John Deere Max-Emerge planter was used. Weeds were controlled with a combination of preemergence herbicides and cultivation. Grain yields were corrected to 15.5% moisture.

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Table 1. Relevant soil test values for the Normania silty clay loam at the site used for the phosphate study.

Soil Test Parameter	Value
pH	6.9
P (Bray and Kurtz #1)	6.3 ppm
K (1 N $NH_4C_2H_3O_2$)	108 ppm

Potash Study:

This study was conducted for three years in fields of cooperating farmers in Goodhue County, Minnesota. Soils at the experimental sites were classified as either Timula silt loam or Mt. Carroll silt loam. Soil samples (0-6 inches) were collected prior to the establishment of the research each year. Results are summarized in Table 2.

Table 2. Relevant soil test values for the silt loam soils at the three experimental sites used for the potash study.

Soil Test Parameter	F (91)	S (92)	S (93)
pH	7.3	7.0	7.1
P (Bray and Kurtz #1), ppm	26.0	24.0	21.0
K (1N $NH_4C_2H_3O_2$), ppm	106	77	92

For this study, five plant populations (23,000, 28,000, 33,000, 38,000, 43,000 plants per acre) were combined with four potash fertilization practices (none used, 40 lb. K_2O per acre in a starter, 100 lb. K_2O per acre broadcast, 200 lb. K_2O per acre broadcast) in a complete factorial design with four replications.

A John Deere Max-Emerge planter was used. Management practices such as variety selection and herbicide use changed each year; but, all practices used were appropriate for a high yield environment.

Total dry matter production was measured at physiological maturity. Grain yields were corrected to 15.5% moisture.

RESULTS AND DISCUSSION

Phosphate Study:

The effects of plant population and phosphate fertilizer management on corn grain yield averaged over two years are summarized in Table 3. When averaged over all phosphate fertilization practices, highest yields were produced by a planted population of 33,000 plants per acre. There was also no significant interaction between planted population and method and rate of phosphate fertilization.

Table 3. The effect of phosphate fertilization and planted population on grain yield of corn. Southwest Experiment Station, 1991-92 Ave.

Phosphate Rate	Placement	Planted Population (plants/acre) 23,000	28,000	33,000	38,000	43,000	Ave.
lb. P_2O_5/acre		bu./acre					
0	-	123	127	120	132	129	126
40	starter	134	145	149	155	137	144
100	broadcast	139	139	155	150	152	147
200	broadcast	149	143	142	140	141	143
	Ave:	136	139	143	144	140	

The grain yield response to phosphate fertilization was substantial. Use of phosphate in both 1991 and 1992 increased the two-year average yields by approximately 20 bushels per acre. The use of 40 lb. P_2O_5 per acre in a starter produced yields equivalent to the broadcast application of either 100 or 200 lb. P_2O_5 per acre. All broadcast phosphate was incorporated with a field cultivator before planting. These results confirm the efficiency of lower rates of phosphate applied in a band near the seed at planting. With a low soil test level for phosphorus at this site (6.3 ppm), a response to phosphate fertilization would be expected.

The absence of a significant interaction between planted population and phosphate application suggests that rates of phosphate applied for corn do not have to be adjusted for planted population. An increase in planted population from 23,000 to 33,000 plants per acre produced an average increase of 7 bu. per acre. With this limited increase in yield, substantial changes in rate of phosphate fertilizer needed should not be expected.

In contrast to grain yield, there was a general linear increase in total dry matter production with increases in planted population (Table 4). Phosphate fertilization also produced a substantial increase in total dry matter production. This is consistent with grain yield observations.

Table 4. The effect of phosphate fertilization and planted population on total dry matter yield of corn. Southwest Experiment Station. 1991-92 Ave.

Phosphate Rate	Placement	Planted Population (plants/acre) 23,000	28,000	33,000	38,000	43,000	Ave.
lb. P_2O_5/acre		ton dry matter/acre					
0	-	6.3	6.9	6.6	7.5	7.7	7.0
40	starter	7.7	7.3	7.8	7.9	8.1	7.8
100	broadcast	7.6	7.4	8.3	8.6	8.9	8.0
200	broadcast	7.1	7.0	7.9	8.1	8.6	7.7
	Ave:	7.2	7.2	7.7	8.0	8.3	

As with grain production, there was no significant interaction between planted population and total dry matter production. This information provides further evidence that changes in planted population do not need to substantially alter phosphate recommendations for corn.

Harvest index was computed by dividing the dry weight of grain produced by total dry matter production. In general, harvest index was not affected by phosphate fertilization (Table 5). There was also a general decrease in this index as planted population increased. As planted population increased, total dry matter production increased faster than grain production.

Table 5. The effect of phosphate fertilization and planted population on corn harvest index. Southwest Experiment Station. 1991-92 Ave.

Phosphate Rate	Placement	Planted Population (plants/acre) 23,000	28,000	33,000	38,000	43,000	Ave.
lb. P_2O_5/acre		index					
0	-	.462	.435	.430	.417	.369	.428
40	starter	.412	.470	.452	.464	.401	.439
100	broadcast	.433	.445	.442	.412	.404	.427
200	broadcast	.497	.483	.425	.409	.388	.440
	Ave:	.451	.458	.438	.426	.397	

Potash Study:

Studies to evaluate the effect of management of potash fertilizer and planted population were conducted in southeast Minnesota in 1991, 1992, and 1993. The soil test value for K (0-6 in.) at the site selected for study in 1991 was in the medium range. However, soil test values for K in the root zone below 6 inches were medium to high and there was no measured response to potash fertilization at this site. Therefore, information collected from this site will be excluded from the discussion.

There was a small, but significant, increase in average corn grain yield as planted population was increased from 23,00 to 33,000 plants per acre (Table 6). These observations are consistent with those from the phosphate study. Weather during the growing season varies considerably from southeast to southwest Minnesota. Yet, optimum planted population did not change. These data indicate that a planted population of approximately 33,000 plants per acre is suitable for a large portion of Minnesota.

Table 6. Corn grain yield as affected by potash fertilization and planted population.
Southeast Minnesota, 1991-92 Ave.

Potash		Planted Population (plants/acre)					
Rate	Placement	23,000	28,000	33,000	38,000	43,000	Ave.
lb. K_2O/acre		bu./acre					
0	-	114	117	119	114	115	116
40	starter	135	132	136	139	130	134
100	broadcast	128	126	132	130	127	129
200	broadcast	133	136	135	133	126	133
	Ave:	128	128	131	129	125	

Use of potash at sites selected in 1992 and 1993 produced a substantial increase in grain yield (Table 6). Soil test values for K throughout the root zone, at these sites, were relatively low and a response to potash fertilization would be expected.

The use of 40 lb. K_2O per acre in a starter fertilizer produced yields which were equivalent to those resulting from the broadcast application of both 100 and 200 lb. K_2O per acre. These results are consistent with those from the phosphate study and confirm the efficiency of banded application of phosphate and potash fertilizers at planting.

There was no significant interaction between planted population and management of potash fertilizer. Compared to the control, the yield increase resulting from the broadcast application of 100 lb. K_2O per acre varied from 9 to 16 bu. per acre. Therefore, there is no indication that rate of potash applied should be adjusted for planted population.

Average dry matter production for the experimental sites selected for 1992 and 1993 is summarized in Table 7. When averaged over all potash management treatments, highest dry matter yields were associated with a planted population of 28,000 plants per acre.

Use of potash fertilizer produced a substantial increase in dry matter production. The efficiency of potash applied in a starter band is also confirmed by the measurement of total dry matter production.

Table 7. Total dry matter production by corn as affected by potash fertilization and planted population. Southeast Minnesota. 1991-92 Ave.

Potash Rate	Placement	Planted Population (plants/acre) 23,000	28,000	33,000	38,000	43,000	Ave.
lb. K_2O/acre		ton dry matter/acre					
0	-	5.9	5.8	5.7	6.1	5.8	5.9
40	starter	6.2	7.1	6.8	6.9	6.6	6.7
100	broadcast	5.7	6.4	6.5	6.8	6.5	6.4
200	broadcast	6.2	6.6	6.8	7.0	7.1	6.7
	Ave:	6.0	6.5	6.5	6.7	6.5	

There was no significant interaction between potash fertilizer management and planted population. This observation supports the previous conclusion that rates of potash fertilizer do not need to be adjusted for plant population.

Average harvest index values are summarized in Table 8. Consistent with the results of the phosphate study, harvest index declined as the planted population increased. Potash fertilization had no significant effect on harvest index.

Table 8. Harvest index as affected by potash fertilization and planted population. Southeast Minnesota. 1991-92 Ave.

Potash Rate	Placement	Planted Population (plants/acre) 23,000	28,000	33,000	38,000	43,000	Ave.
lb. K_2O /acre		index					
0	-	.457	.477	.494	.442	.469	.468
40	starter	.515	.430	.473	.477	.466	.472
100	broadcast	.531	.466	.477	.452	.459	.477
200	broadcast	.508	.488	.470	.450	.400	.467
	Ave:	.503	.465	.479	.455	.454	

SUMMARY

This study was conducted from 1991 through the 1993 growing season in both southeastern and southwestern Minnesota to determine if management of phosphate and potash fertilizers should be adjusted for planted population of corn. Although growing season environments varied substantially across the state in both 1992 and 1993, results from both regions were consistent.

Optimum grain yields in both regions resulted from a planted population of 33,000 plants per acre. In 1992 and 1993, grain yields did not increase substantially as plant population was increased from 23,000 to 33,000 plants per acre.

Grain yields were improved by phosphate use when the soil test level for P was in the low range. Likewise, potash use produced substantial increases in yield when soil test levels for K throughout the root zone were relatively low. Both studies demonstrated the efficiency of phosphate and potash fertilizers applied in a starter band at planting. Yields resulting from this fertilizer management strategy were equivalent to yields resulting from the broadcast applications of 100 or 200 lb. P_2O_5 or K_2O per acre.

Throughout the study, there was no significant interaction between fertilizer management and planted population. The data collected lead to the conclusion that rate and placement of both phosphate and potash fertilizers do not need to be adjusted for plant populations of corn.

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