

PROJECT TITLE: EFFECT OF LONG TERM NITROGEN, PHOSPHORUS, AND POTASSIUM FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

PROJECT LEADER:

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PROJECT LOCATION: West-central Kansas at the Tribune Unit, Southwest Research-Extension Center.

OBJECTIVES:

1. Determine the optimum nitrogen rate for irrigated corn and grain sorghum.
2. Determine whether phosphorus fertilization is necessary for optimum grain production of irrigated corn and grain sorghum.
3. Determine whether potassium fertilization is necessary for optimum grain production of irrigated grain sorghum.
4. Determine the effect of long term N and P applications on nitrate accumulation in the soil profile.

PROCEDURES:

Corn and grain sorghum were grown on Ulysses silt loam in adjacent plot areas. Fertilizer treatments for sorghum were N rates of 0, 40, 80, 120, 160, and 200 lb N acre⁻¹ without P and K; with 40 lb P₂O₅ acre⁻¹ and zero K; and with 40 lb P₂O₅ acre⁻¹ and 40 lb K₂O acre⁻¹. In 1992, the treatments for the corn study were changed with the K variable being replaced by a higher rate of P. The corn treatments in 1993 were N rates of 0 to 200 lb N/acre in 40 lb increments in a factorial arrangement with P at 0, 40 and 80 lb P₂O₅/acre. Fertilizers were broadcast by hand on 18 April 1993 for corn and 27 May 1993 for sorghum. Corn (Pioneer 3379) was planted on 24 April, and sorghum (Golden Acres TE Y-75) was planted on 28 May. Rainfall from planting to harvest was 13.83" for corn and 11.44" for sorghum. Both studies were furrow irrigated as needed during the growing season. All plots were machine harvested (23 October for corn and 11 November for sorghum). Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum.

RESULTS:

1. Nitrogen fertilization is required for optimum production of irrigated corn and grain sorghum in western Kansas. Maximum corn yields in 1993 were obtained with 160 lb N/acre which is consistent with long term trends. Grain sorghum yields were similar to long term averages in 1993 and tended to peak with about 120 lb N/acre, although yields increased slightly with higher N rates.

2. Phosphorus fertilization increases grain yields of irrigated corn and grain sorghum. A yield response from P fertilizer has been observed for over 25 years in this long term study. This response has increased with time and in 1993 corn yields were increased by about 90 bu/acre by P fertilizer when adequate N was also applied. There was no significant difference in applying 80 rather than 40 lb P₂O₅/acre. For grain sorghum, P increased yields by 40 bu/acre at 120 lb N/acre but only about 20 bu/acre at 200 lb N/acre.

3. Phosphorus decreased grain moisture of corn by 4 to 8% at N rates of 120 lb/acre and greater.

4. Grain sorghum yields were not increased by K additions probably because of the high K content of the soil.

INTERPRETIVE SUMMARY

Long term research shows that phosphorus and nitrogen fertilizer must be applied for optimum grain yields of irrigated corn and grain sorghum in western Kansas. In this study, the optimum economic N rate (with P) for corn remains relatively constant at about 160 lb N/acre. Fertilizer P at 40 lb P₂O₅/acre appears to be adequate for producing optimum grain yield of corn. Adequate P fertilization provides for earlier maturity of corn, thereby permitting earlier harvest &/or reducing drying costs.

Table 1. Effect of of N and P fertilization of irrigated corn on grain yield. Tribune, KS, 1993.

N	P205	Grain		
		Yield	Moist	TW
-lb/a -		bu/a	%	lb/bu
0	0	43	24.9	49.8
0	40	50	26.2	50.3
0	80	52	26.6	49.7
40	0	62	25.8	50.2
40	40	103	21.9	53.0
40	80	104	22.2	52.8
80	0	68	27.6	49.8
80	40	138	21.1	52.8
80	80	144	20.9	53.5
120	0	71	28.5	49.5
120	40	151	20.4	54.1
120	80	153	20.6	53.9
160	0	88	25.5	50.8
160	40	175	21.8	53.6
160	80	174	20.5	53.1
200	0	82	27.5	49.6
200	40	169	21.7	53.2
200	80	181	21.0	54.0
ANOVA				
Nitrogen		0.001	0.001	0.002
lin.		0.001	0.001	0.001
quad.		0.001	0.001	0.008
Phosphorus		0.001	0.001	0.001
lin.		0.001	0.001	0.001
quad.		0.001	0.001	0.001
N*P		0.001	0.001	0.249
N ₁ *P ₁		0.001	0.001	0.021
N ₁ *P _q		0.001	0.042	0.461
N _q *P ₁		0.001	0.001	0.139
N _q *P _q		0.004	0.004	0.420

Table 1 (cont). Effect of of N and P fertilization of irrigated corn on grain yield. Tribune, KS, 1993.

MAIN EFFECT MEANS

	Grain		
	Yield	Moist	TW
	bu/a	%	lb/bu
Nitrogen (lb/acre)			
0	48	25.9	49.9
40	90	23.3	52.0
80	116	23.2	52.0
120	125	23.2	52.5
160	146	22.6	52.5
200	144	23.4	52.2
LSD.05	7	1.1	1.3
P₂O₅ (lb/a)			
0	69	26.6	50.0
40	131	22.2	52.8
80	135	22.0	52.8
LSD.05	5	0.8	0.9

Table 2. Effect of of N, P, and K fertilization of irrigated grain sorghum on grain yield. Tribune, KS, 1993.

N	P2O5	K2O	Grain		
			Yield	Moist	TW
- -	-lb/a - -	- -	bu/a	%	lb/bu
0	0	0	46	14.1	50.8
0	40	0	42	14.1	49.1
0	40	40	37	14.4	48.8
40	0	0	69	14.3	51.5
40	40	0	97	14.2	55.3
40	40	40	92	14.3	54.0
80	0	0	91	14.1	54.0
80	40	0	105	14.0	55.0
80	40	40	118	14.1	55.5
120	0	0	77	14.1	53.1
120	40	0	120	14.0	55.3
120	40	40	117	14.1	55.1
160	0	0	93	14.1	54.2
160	40	0	122	14.1	54.8
160	40	40	123	14.0	55.9
200	0	0	107	14.0	56.0
200	40	0	127	14.1	56.1
200	40	40	123	14.1	55.8
ANOVA					
Nitrogen			0.001	0.075	0.001
lin.			0.001	0.014	0.001
quad.			0.001	0.368	0.001
P-K			0.001	0.298	0.100
Zero P vs P			0.001	0.664	0.033
P vs P-K			0.888	0.136	0.848
N*P-K			0.006	0.213	0.173
N1*ZeroP vs P-K			0.012	0.832	0.646
N1*P vs P-K			0.958	0.036	0.556
Nq*ZeroP vs P-K			0.001	0.026	0.009
Nq*P vs P-K			0.325	0.547	0.713

Table 2 (cont). Effect of of N, P, and K fertilization of irrigated grain sorghum on grain yield. Tribune, KS, 1993.

MAIN EFFECT MEANS

	Grain		
	Yield	Moist	TW
	bu/a	%	lb/bu
Nitrogen (lb/acre)			
0	42	14.2	49.5
40	86	14.3	53.6
80	104	14.1	54.8
120	105	14.1	54.5
160	113	14.1	55.0
200	119	14.1	56.0
LSD.05	10	0.2	1.5
P-K (lb/a)			
0- 0	81	14.1	53.3
40- 0	102	14.1	54.3
40-40	102	14.2	54.2
LSD.05	7	0.1	1.0