KS-23
1996

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 P_2O_5 acre^{-1} and zero K; and with 40 lb P_2O_5 acre^{-1} and 40 lb K_2O 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 current corn treatments are 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 P_2O_5/acre. Fertilizers were broadcast by hand on 22 February 1996 for corn and 3 May 1996 for sorghum. Corn (Pioneer 3225) was planted on 19 April and sorghum (Golden Acres TE Y-75) was planted on 6 June. Both studies were furrow irrigated as needed during the growing season. All plots were machine harvested (21 October for corn and 7 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 1996 were obtained with 160 lb N/acre which is consistent with long term trends. Grain sorghum yields were lower than long term average yields in 1996. Maximum yields were obtained with only 40 lb N with P. There may have been greater than normal residual soil N because no sorghum was harvested in 1995 (hail on two occasions severely damaged the sorghum in 1995 and no grain was produced).

2. Phosphorus fertilization increases grain yields of irrigated corn and grain sorghum. A yield response from P fertilizer has been observed for about 30 years in this long term study. This response has increased with time and in 1996 corn yields were increased by about 75 bu/acre by P fertilizer when adequate N was also applied. There was no significant difference in applying 80 rather than 40 lb P_2O_5/acre. For grain sorghum, P increased yields by 10-30 bu/acre when applied with N.

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

4. An article was published in the J. Production Agriculture (9:114-118) detailing the economic and environmental impact of long term fertilization (reprint enclosed).

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. Application of the economic optimal N rate does not enhance the potential for nitrate leaching. Fertilizer P at 40 lb P_2O_5/acre appears to be adequate for producing optimum grain yield of corn.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1992-96.

Nitrogen	P_2O_5	Grain yield 1992	1993	1994	1995	1996	Mean
---- lb/a ----		---------- bu/acre ----------					
0	0	73	43	47	22	58	49
0	40	88	50	43	27	64	54
0	80	80	52	48	26	73	56
40	0	90	62	66	34	87	68
40	40	128	103	104	68	111	103
40	80	128	104	105	65	106	102
80	0	91	68	66	34	95	71
80	40	157	138	129	94	164	136
80	80	140	144	127	93	159	133
120	0	98	71	70	39	97	75
120	40	162	151	147	100	185	149
120	80	157	153	154	111	183	152
160	0	115	88	78	44	103	86
160	40	169	175	162	103	185	159
160	80	178	174	167	100	195	163
200	0	111	82	80	62	110	89
200	40	187	169	171	106	180	163
200	80	165	181	174	109	190	164
ANOVA							
Nitrogen		0.001	0.001	0.001	0.001	0.001	0.001
linear		0.001	0.001	0.001	0.001	0.001	0.001
quad.		0.001	0.001	0.001	0.001	0.001	0.001
P_2O_5		0.001	0.001	0.001	0.001	0.001	0.001
linear		0.001	0.001	0.001	0.001	0.001	0.001
quad.		0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.013	0.001	0.001	0.001	0.001	0.001
MEANS							
Nitrogen	0 lb/a	80	48	46	25	65	53
	40	116	90	92	56	102	91
	80	129	116	107	74	139	113
	120	139	125	124	83	155	125
	160	154	146	136	82	161	136
	200	154	144	142	92	160	138
	$LSD_{.05}$	14	7	13	7	10	5
P_2O_5	0 lb/a	96	69	68	39	92	73
	40	149	131	126	83	148	127
	80	141	135	129	84	151	128
	$LSD_{.05}$	10	5	9	5	7	4

Table 2. Effect of N, P, and K fertilization of irrigated grain sorghum on grain yield. Tribune, KS, 1996.

N	P_2O_5	K_2O	Grain	
			Yield	Test weight
- - -lb/a - -			bu/a	lb/bu
0	0	0	74	57.8
0	40	0	77	58.8
0	40	40	79	58.5
40	0	0	74	58.3
40	40	0	100	59.6
40	40	40	101	59.5
80	0	0	73	58.2
80	40	0	103	59.4
80	40	40	103	59.3
120	0	0	79	58.2
120	40	0	94	58.6
120	40	40	99	59.2
160	0	0	85	58.6
160	40	0	92	58.5
160	40	40	91	59.3
200	0	0	86	58.6
200	40	0	109	59.2
200	40	40	95	59.1
ANOVA				
Nitrogen			0.003	0.300
lin.			0.002	0.437
quad.			0.116	0.338
P-K			0.001	0.002
Zero P vs. P			0.001	0.001
P vs. P-K			0.727	0.630
N*P-K			0.185	0.897
Nl*ZeroP vs. P-K			0.833	0.323
Nl*P vs. P-K			0.196	0.385
Nq*ZeroP vs. P-K			0.051	0.654
Nq*P vs. P-K			0.298	0.428

Table 2 (cont.). Effect of N, P, and K fertilization of irrigated grain sorghum on grain yield. Tribune, KS, 1996.

MAIN EFFECT MEANS

	Grain Yield	Grain Test wt.
	bu/a	lb/bu
Nitrogen (lb/acre)		
0	77	58.3
40	92	59.1
80	93	59.0
120	91	58.7
160	89	58.8
200	97	58.9
$LSD_{0.05}$	9	
P_2O_5-K_2O (lb/a)		
0- 0	79	58.3
40- 0	96	59.0
40-40	95	59.1
$LSD_{0.05}$	7	0.5