

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 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 P₂O₅/acre. Fertilizers were broadcast by hand on 20 March 1997 for corn and 26 March 1997 for sorghum. Corn (Pioneer 3225) was planted on 6 May and sorghum (Pioneer 8414) was planted on 5 June. Both studies were furrow irrigated as needed during the growing season. All plots were machine harvested (11 October for corn and 20 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. Corn yields increased with increased N rates in 1997 with 200 lb N/acre producing the greatest yields. Maximum grain sorghum yields were obtained with only 40 lb N/acre with P.
2. Phosphorus fertilization increases grain yields of irrigated corn and grain sorghum. A yield response from P fertilizer has been observed for over 30 years in this long term

study. This response has increased with time and in 1997 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 P₂O₅/acre although there was a trend towards higher yields at the higher N rates. 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.

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 optimal N rate (with P) for corn remains relatively constant at about 160 lb N/acre (although there are some year-to-year variations). Fertilizer P at 40 lb P₂O₅/acre appears to be adequate for producing optimum grain yield of corn. For grain sorghum, the optimal N rate varies considerably from year-to-year. In some years 40 lb N/acre is sufficient to produce over 100 bu/acre of grain sorghum. In other years, over 100 lb N/acre is required to produce the same yield. Phosphorus fertilization increases grain sorghum yields much less than corn yields. Corn yields are routinely increased 75 bu/acre by P fertilization (when applied with adequate N) compared to about 20 bu/acre for grain sorghum. Potassium fertilization has no effect on grain sorghum yields.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1992-1997.

Nitrogen P ₂ O ₅		Grain Yield						Avg 1997
		1992	1993	1994	1995	1996	1997	
--- lb/a ---		----- bu/acre-----						
0	0	73	43	47	22	58	66	62
0	40	88	50	43	27	64	79	72
0	80	80	52	48	26	73	83	78
40	0	90	62	66	34	87	86	87
40	40	128	103	104	68	111	111	111
40	80	128	104	105	65	106	114	110
80	0	91	68	66	34	95	130	113
80	40	157	138	129	94	164	153	159
80	80	140	144	127	93	159	155	157
120	0	98	71	70	39	97	105	101
120	40	162	151	147	100	185	173	179
120	80	157	153	154	111	183	162	173
160	0	115	88	78	44	103	108	106
160	40	169	175	162	103	185	169	177
160	80	178	174	167	100	195	187	191
200	0	111	82	80	62	110	110	110
200	40	187	169	171	106	180	185	183
200	80	165	181	174	109	190	193	192
<u>ANOVA</u>								
Nitrogen		0.001	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	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001
P ₂ O ₅		0.001	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	0.001
Quadratic		0.001	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	0.001
<u>MEANS</u>								
Nitrogen 0 lb/a		80	48	46	25	65	76	
	40	116	90	92	56	102	104	
	80	129	116	107	74	139	146	
	120	139	125	124	83	155	147	
	160	154	146	136	82	161	155	
	200	154	144	142	92	160	163	
	LSD .05	14	7	13	7	10	12	
P ₂ O ₅ 0 lb/a		96	69	68	39	92	101	
	40	149	131	126	83	148	145	
	80	141	135	129	84	151	149	
	LSD .05	10	5	9	5	7	9	

Table 1. Effect of N, P, and K fertilizers on irrigated sorghum. Tribune, KS, 1992-1997.

Nitrogen	P ₂ O ₅	K ₂ O	Grain Yield				
			1992	1993	1994*	1996	1997
0	0	0	27	46	64	74	81
0	40	0	28	42	82	77	75
0	40	40	35	37	78	79	83
40	0	0	46	69	76	74	104
40	40	0	72	97	113	100	114
40	40	40	72	92	112	101	121
80	0	0	68	91	96	73	100
80	40	0	85	105	123	103	121
80	40	40	85	118	131	103	130
120	0	0	56	77	91	79	91
120	40	0	87	120	131	94	124
120	40	40	90	117	133	99	128
160	0	0	62	93	105	85	118
160	40	0	92	122	137	92	116
160	40	40	88	123	125	91	119
200	0	0	80	107	114	86	107
200	40	0	91	127	133	109	126
200	40	40	103	123	130	95	115
ANOVA							
Nitrogen			0.001	0.001	0.001	0.003	0.001
Linear			0.001	0.001	0.001	0.002	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001
P-K			0.001	0.001	0.001	0.001	0.001
Zero P vs P			0.001	0.001	0.001	0.001	0.001
P vs P-K			0.431	0.888	0.734	0.727	0.436
N x P-K			0.420	0.006	0.797	0.185	0.045
N _l * Zero P vs P-K			0.189	0.012	0.860	0.833	0.464
N _l * P vs P-K			0.814	0.958	0.777	0.196	0.150
N _q * Zero P vs P-K			0.049	0.001	0.060	0.051	0.007
N _q * P vs P-K			0.318	0.325	0.581	0.298	0.401
MEANS							
Nitrogen	lb/a						
	0		30	42	75	77	80
	40		64	86	100	92	113
	80		80	104	117	93	117
	120		78	105	118	91	114
	160		81	113	122	89	118
	200		91	119	126	97	116
	LSD _{.05}		10	10	14	9	10
P-K	lb/a						
	0-0		56	81	91	79	100
	40-0		76	102	120	96	113
	40-40		79	102	118	95	116
	LSD _{.05}		7	7	10	7	7

*Note: There was no yield data for 1995.