

## LONG TERM FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

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## 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, N and P fertilization increased corn yields more than 100 bu/acre. Application of 160 lb N/a tended to be sufficient to maximize corn yields. Phosphorus increased corn yields by 75 bu/a when applied with at least 120 lb N/a. Application of 40 lb P<sub>2</sub>O<sub>5</sub>/a was adequate for corn and higher rates were not necessary. Grain sorghum yields were increased over 40 bu/a by N and about 20 bu/a by P fertilization. Application of 80 lb N/a was sufficient to maximize yields in most years. Potassium fertilization had no effect on sorghum yield.

## INTRODUCTION

This study was initiated in 1961 to determine responses of continuous corn grown under flood irrigation to nitrogen, phosphorus, and potassium fertilization. The study is conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit to K fertilization was observed in 30 years and soil K levels remained high so the K treatment was discontinued in 1992. However, a yield increase from P fertilization has been observed since 1965 and there was concern that the level of P fertilization may not be adequate. So, beginning in 1992, a higher P rate was added to the study which replaced the K treatment.

## PROCEDURE

Initial fertilizer treatments in 1961 to corn and grain sorghum in adjacent fields were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P<sub>2</sub>O<sub>5</sub>/a and zero K; and with 40 lb P<sub>2</sub>O<sub>5</sub>/a and 40 lb K<sub>2</sub>O/a. In 1992, the treatments for the corn study were changed with the K variable being replaced by a higher rate of P (80 lb P<sub>2</sub>O<sub>5</sub>/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. The corn hybrid was Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), and Pioneer 3395IR (1998) planted at 32,000 seeds/a in late April or early May. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, and Pioneer 8505 in 1998) was planted in late May or early June. Both studies were furrow irrigated to minimize water stress. The center 2 rows of all plots were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum.

## RESULTS

Nitrogen and P fertilization increased corn yields averaged across the seven year period by over 100 bu/a. In 1995, hail during the growing season reduced overall yields about 40% but yields were still increased up to 80 bu/a by N and P fertilization. The apparent N fertilizer requirement was about 160 lb/a. Application of 40 lb P<sub>2</sub>O<sub>5</sub>/a increased yields more than 70 bu/a when applied with at least 120 lb N/a. There was no significant yield difference between applying 40 and 80 lb P<sub>2</sub>O<sub>5</sub>/acre, averaged across all N rates. However, at 160 and 200 lb N/a, corn yields were 4 bu/a greater with 80 than with 40 lb P<sub>2</sub>O<sub>5</sub>/a.

Grain sorghum yields were increased 43 bu/a by application of 80 N/a, averaged across the last six years. Phosphorus increased sorghum yields by about 20 bu/a, while K had no effect on sorghum yields.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1992-1998.

Nitrogen P <sub>2</sub> O <sub>5</sub>		Grain Yield							
		1992	1993	1994	1995	1996	1997	1998	
--- lb/a ---		----- bu/acre-----							
0	0	73	43	47	22	58	66	49	
0	40	88	50	43	27	64	79	55	
0	80	80	52	48	26	73	83	55	
40	0	90	62	66	34	87	86	76	
40	40	128	103	104	68	111	111	107	
40	80	128	104	105	65	106	114	95	
80	0	91	68	66	34	95	130	95	
80	40	157	138	129	94	164	153	155	
80	80	140	144	127	93	159	155	149	
120	0	98	71	70	39	97	105	92	
120	40	162	151	147	100	185	173	180	
120	80	157	153	154	111	183	162	179	
160	0	115	88	78	44	103	108	101	
160	40	169	175	162	103	185	169	186	
160	80	178	174	167	100	195	187	185	
200	0	111	82	80	62	110	110	130	
200	40	187	169	171	106	180	185	188	
200	80	165	181	174	109	190	193	197	
<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 <sub>2</sub> O <sub>5</sub>		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, lb/a		0	80	48	46	25	65	76	53
		40	116	90	92	56	102	104	93
		80	129	116	107	74	139	146	133
		120	139	125	124	83	155	147	150
		160	154	146	136	82	161	155	157
		200	154	144	142	92	160	163	172
	LSD <sub>0.05</sub>		14	7	13	7	10	12	11
P <sub>2</sub> O <sub>5</sub> , lb/a		0	96	69	68	39	92	101	91
		40	149	131	126	83	148	145	145
		80	141	135	129	84	151	149	143
	LSD <sub>0.05</sub>		10	5	9	5	7	9	7

Table 2. Effect of N, P, and K fertilizers on irrigated sorghum. Tribune, KS, 1992-1998.

N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Grain Yield					
			1992	1993	1994*	1996	1997	1998
----- lb/a -----			----- bu/acre -----					
0	0	0	27	46	64	74	81	77
0	40	0	28	42	82	77	75	77
0	40	40	35	37	78	79	83	76
40	0	0	46	69	76	74	104	91
40	40	0	72	97	113	100	114	118
40	40	40	72	92	112	101	121	114
80	0	0	68	91	96	73	100	111
80	40	0	85	105	123	103	121	125
80	40	40	85	118	131	103	130	130
120	0	0	56	77	91	79	91	102
120	40	0	87	120	131	94	124	125
120	40	40	90	117	133	99	128	128
160	0	0	62	93	105	85	118	118
160	40	0	92	122	137	92	116	131
160	40	40	88	123	125	91	119	124
200	0	0	80	107	114	86	107	121
200	40	0	91	127	133	109	126	133
200	40	40	103	123	130	95	115	130
<u>ANOVA</u>								
Nitrogen			0.001	0.001	0.001	0.003	0.001	0.001
Linear			0.001	0.001	0.001	0.002	0.001	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001	0.001
P-K			0.001	0.001	0.001	0.001	0.001	0.001
Zero P vs P			0.001	0.001	0.001	0.001	0.001	0.001
P vs P-K			0.431	0.888	0.734	0.727	0.436	0.649
N x P-K			0.420	0.006	0.797	0.185	0.045	0.186
<u>MEANS</u>								
Nitrogen								
0 lb/acre			30	42	75	77	80	76
40			64	86	100	92	113	108
80			80	104	117	93	117	122
120			78	105	118	91	114	118
160			81	113	122	89	118	124
200			91	119	126	97	116	128
LSD <sub>.05</sub>			10	10	14	9	10	8
P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O								
0-0 lb/acre			56	81	91	79	100	103
40-0			76	102	120	96	113	118
40-40			79	102	118	95	116	117
LSD <sub>.05</sub>			7	7	10	7	7	6

\*Note: There was no yield data for 1995