

Annual report for KS-23F (2007 season)**LONG-TERM NITROGEN AND PHOSPHORUS FERTILIZATION
OF IRRIGATED CORN AND SORGHUM****Alan Schlegel, Kansas State University****Introduction**

This study was initiated in 1961 to determine responses of continuous corn and grain sorghum grown under flood irrigation to N, P, and K fertilization. The study was conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit to corn from K fertilization was observed in 30 years and soil K levels remained high so the K treatment on corn was discontinued in 1992 and replaced with a higher P rate. The remainder of this report is in two parts- one for corn and the other for grain sorghum.

Summary (Corn)

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated corn in western Kansas. In 2007, N applied alone increased yields about 110 bu/a, while P applied alone had no effect on yield. When N and P were applied together, yields were increased up to 180 bu/a. Averaged across the past 10 years, corn yields were increased up to 135 bu/a by N and P fertilization. Application of 120 lb N/a (with P) was sufficient to produce >90% of maximum yield in 2007, which was slightly less than the 10-year average. Phosphorus increased corn yields in 2007 an average of 80 bu/a when applied with at least 120 lb N/a. Application of 80 instead of 40 lb P₂O₅/a increased yields 8 bu/a.

Procedures (Corn)

Initial fertilizer treatments in 1961 were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P₂O₅/a and zero K; and with 40 lb P₂O₅/a and 40 lb K₂O/a. In 1992, the treatments were changed with the K variable being replaced by a higher rate of P (80 lb P₂O₅/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. The corn hybrids were Pioneer 3395IR (1998), Pioneer 33A14 (2000), Pioneer 33R93 (2001 and 2002), DeKalb C60-12 (2003), Pioneer 34N45 (2004 and 2005), Pioneer 34N50 (2006), and Pioneer 33B54 (2007) planted at about 30-32,000 seeds/a in late April or early May. Hail damaged the 2005 and 2002 crop and destroyed the 1999 crop. The corn was irrigated to minimize water stress. Furrow irrigation was used through 2000 and sprinkler irrigation since 2001. The center 2 rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture.

Results (Corn)

Corn yields in 2007 were higher than the 10-year average (Table 1). Nitrogen alone increased yields 110 bu/a while P alone increased yields only 2 bu/a. However, N and P applied together increased corn yields up to 180 bu/a. Only 120 lb N/a with P was required to obtain >90% of maximum yield. Over the past 10 years, 120 lb N/a with P has produced 95% of maximum yield. Corn yields (averaged across all N rates) were 8 bu/a greater with 80 than with 40 lb P₂O₅/a in 2007 which is similar to the 10-year average.

Table 1. Effect of N, P, and K fertilizers on irrigated corn yields, Tribune, KS, 1998-2007.

N	P ₂ O ₅	1998 *	200 0	2001	2002	2003	2004	2005	2006	2007	Mean
----- lb/acre -----		----- bu/acre -----									
0	0	49	131	54	39	79	67	49	42	49	62
0	40	55	152	43	43	95	97	60	68	50	74
0	80	55	153	48	44	93	98	51	72	51	74
40	0	76	150	71	47	107	92	63	56	77	82
40	40	107	195	127	69	147	154	101	129	112	127
40	80	95	202	129	76	150	148	100	123	116	127
80	0	95	149	75	53	122	118	75	79	107	97
80	40	155	205	169	81	188	209	141	162	163	164
80	80	149	211	182	84	186	205	147	171	167	167
120	0	92	143	56	50	122	103	66	68	106	90
120	40	180	204	177	78	194	228	162	176	194	177
120	80	179	224	191	85	200	234	170	202	213	189
160	0	101	154	76	50	127	136	83	84	132	105
160	40	186	203	186	80	190	231	170	180	220	183
160	80	185	214	188	85	197	240	172	200	227	190
200	0	130	165	130	67	141	162	109	115	159	131
200	40	188	207	177	79	197	234	169	181	224	184
200	80	197	218	194	95	201	239	191	204	232	197
<u>ANOVA</u>											
<u>(P>F)</u>											
Nitrogen			0.00				0.001		0.001	0.001	0.001
		0.001	1	0.001	0.001	0.001		0.001			
Linear			0.00				0.001		0.001	0.001	0.001
		0.001	1	0.001	0.001	0.001		0.001			
Quadratic			0.00				0.001		0.001	0.001	0.001
		0.001	1	0.001	0.001	0.001		0.001			
Phosphorus			0.00				0.001		0.001	0.001	0.001
		0.001	1	0.001	0.001	0.001		0.001			
Linear			0.00					0.001	0.001	0.001	0.001
		0.001	1	0.001	0.001	0.001	0.001		0.001	0.001	0.001
Quadratic			0.00				0.001	0.001	0.001	0.001	0.001
		0.001	1	0.001	0.007	0.001					
N x P			0.00				0.001	0.001	0.001	0.001	0.001
		0.001	8	0.001	0.133	0.001					
<u>MEANS</u>											
Nitrogen, lb/a		0					87	53	61	50	70
		53	145	48	42	89					
	40	93	182	109	64	135	132	88	103	102	112
	80	133	188	142	73	165	178	121	137	146	143
	120	150	190	142	71	172	188	133	149	171	152
	160	157	190	150	71	172	203	142	155	193	159
	200	172	197	167	80	180	212	156	167	205	171
	LSD _{0.05}	11	10	15	8	9	11	10	15	11	8
P ₂ O ₅ , lb/a		0				116	113	74	74	105	94
		91	149	77	51						
	40	145	194	147	72	168	192	134	149	160	151
	80	143	204	155	78	171	194	139	162	168	157
	LSD _{0.05}	7	7	10	6	6	8	7	11	8	5

* No yield data for 1999 because of hail damage.

Summary (Grain Sorghum)

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated grain sorghum in western Kansas. In 2007, N and P applied alone increased yields about 70 and 15 bu/a, respectively; while N and P applied together increased yields up to 90 bu/a. Averaged across the past 10 years, sorghum yields were increased up to 60 bu/a by N and P fertilization. Application of 40 lb N/a (with P) was sufficient to produce >85% of maximum yield although yields continued to increase at N rates of 120 lb N/a in 2007. Application of K has had no effect on sorghum yield throughout the study period.

Procedures (Grain Sorghum)

Fertilizer treatments initiated in 1961 were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P₂O₅/a and zero K; and with 40 lb P₂O₅/a and 40 lb K₂O/a. All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. Sorghum (Pioneer 8500/8505 from 1998-2007) was planted in late May or early June. Irrigation was used to minimize water stress. Furrow irrigation was used through 2000 and sprinkler irrigation since 2001. The center 2 rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 12.5% moisture.

Results (Grain Sorghum)

Grain sorghum yields in 2007 were the highest of the past 10 years (Table 1). Nitrogen alone increased yields more than 70 bu/a while P alone increased yields about 15 bu/a, while N and P applied together increased yields up to 90 bu/a. Averaged across the past 10-yr, N and P applied together has increased yields up to 60 bu/a. In 2007, 40 lb N/a (with P) produced more than 85% of maximum yields which is about 5% less than the 10-yr average. Sorghum yields were not affected by K fertilization, which has been the case throughout the study period.

Table 2. Effect of N, P, and K fertilizers on irrigated sorghum yields, Tribune, KS, 1998-2007.

N	P ₂ O ₅	K ₂ O	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
----- lb/acre -----			----- bu/acre -----										
0	0	0	77	74	77	76	73	80	57	58	84	80	74
0	40	0	77	85	87	81	81	93	73	53	102	97	84
0	40	40	76	84	83	83	82	93	74	54	95	94	83
40	0	0	91	83	88	92	82	92	60	63	102	123	89
40	40	0	118	117	116	124	120	140	112	84	133	146	123
40	40	40	114	114	114	119	121	140	117	84	130	145	121
80	0	0	111	94	97	110	97	108	73	76	111	138	103
80	40	0	125	113	116	138	127	139	103	81	132	159	125
80	40	40	130	123	120	134	131	149	123	92	142	166	133
120	0	0	102	76	82	98	86	97	66	77	101	138	93
120	40	0	125	102	116	134	132	135	106	95	136	164	126
120	40	40	128	105	118	135	127	132	115	98	139	165	127
160	0	0	118	100	96	118	116	122	86	77	123	146	112
160	40	0	131	116	118	141	137	146	120	106	145	170	134
160	40	40	124	107	115	136	133	135	113	91	128	167	126
200	0	0	121	113	104	132	113	131	100	86	134	154	120
200	40	0	133	110	114	139	136	132	115	108	143	168	131
200	40	40	130	120	120	142	143	145	123	101	143	170	135
<u>ANOVA (P>F)</u>													
Nitrogen			0.001	0.001	0.001	0.001	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	0.001	0.001	0.001	0.001
Quadratic			0.001	0.227	0.001	0.001	0.001	0.001	0.018	0.005	0.004	0.001	0.001
P-K			0.001	0.001	0.001	0.001	0.001	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	0.001	0.001	0.001	0.001	0.001
P vs P-K			0.649	0.741	0.803	0.619	0.920	0.694	0.121	0.803	0.578	0.992	0.829
N x P-K			0.186	0.482	0.061	0.058	0.030	0.008	0.022	0.195	0.210	0.965	0.019
<u>MEANS</u>													
Nitrogen			76	81	82	80	79	88	68	55	93	91	80
0 lb/a			76	81	82	80	79	88	68	55	93	91	80
40			108	105	106	112	108	124	96	77	121	138	111
80			122	110	111	127	119	132	100	83	128	155	120
120			118	95	105	122	115	121	96	90	125	156	115
160			124	108	110	132	129	134	107	92	132	161	124
200			128	115	113	138	131	136	113	98	140	164	129
LSD _{0.05}			8	13	7	8	9	10	11	10	11	9	7
P ₂ O ₅ -K ₂ O			103	90	91	104	94	105	74	73	109	130	98
0 lb/a			103	90	91	104	94	105	74	73	109	130	98
40- 0			118	107	111	126	122	131	105	88	132	151	120
40-40			117	109	112	125	123	132	111	87	130	151	121
LSD _{0.05}			6	9	5	6	6	7	7	7	7	6	5