

Annual report for KS-23F (2009 season)**NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED
CORN AND GRAIN SORGHUM**

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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 2009, N applied alone increased yields about 60 bu/a, while P applied alone increased yields about 25 bu/a. However, when N and P were applied together, yields were increased up to 150 bu/a. Averaged across the past 9 years, corn yields were increased up to 140 bu/a by N and P fertilization. Application of 120 lb N/a (with P) was sufficient to produce >90% of maximum yield in 2009, which was similar to the 9-year average. Phosphorus increased corn yields in 2009 more than 80 bu/a when applied with at least 120 lb N/a. Application of 80 instead of 40 lb P₂O₅/a increased yields 11 bu/a.

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 was discontinued in 1992 and replaced with a higher P rate.

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 33R93 (2001 and 2002), DeKalb C60-12 (2003), Pioneer 34N45 (2004 and 2005), Pioneer 34N50 (2006), Pioneer 33B54 (2007), Pioneer 34B99 (2008) and DeKalb 61-69 (2009) planted at about 30-32,000 seeds/a in late April or early May. Hail damaged the 2005 and 2002 crops. The corn was irrigated to minimize water stress. Furrow irrigation was used in 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 2009 were greater than the 9-year average (**Table 1**). Nitrogen alone increased yields 60 bu/a while P alone increased yields 25 bu/a. However, N and P applied together increased corn yields up to 150 bu/a. Only 120 lb N/a with P was required to obtain >90% of maximum yield, which is similar to the 9-year average. Corn yields (averaged across all N rates) were 11 bu/a greater with 80 than with 40 lb P₂O₅/a in 2009 which is greater than the 9-year average.

Summary (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 2009, N and P applied alone increased yields about 45 and 6 bu/a, respectively; while N and P applied together increased yields up to 75 bu/a. Averaged across the past 9 years, sorghum yields were increased up to 65 bu/a by N and P fertilization. Application of 40 lb N/a (with P) was sufficient to produce ~85% of maximum yield in 2009. Application of K has had no effect on sorghum yield throughout the study period.

Introduction

This study was initiated in 1961 to determine responses of continuous 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. The irrigation system was changed from flood to sprinkler in 2001.

Procedures (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 and Pioneer 85G46 in 2008-2009) 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 (sorghum)

Grain sorghum yields in 2009 were similar to the average of the past 9 years (**Table 2**). Nitrogen alone increased yields about 45 bu/a while P alone increased yields only about 5 bu/a, however N and P applied together increased yields up to 75 bu/a. Averaged across the past 9-yr, N and P applied together has increased yields up to 65 bu/a. In 2009, 40 lb N/a (with P) produced about 85% of maximum yields which is about 5% less than the 9-yr average. Sorghum yields were not affected by K fertilization, which has been the case throughout the study period.

Table 1. Effect of N and P fertilization on irrigated corn yield, Tribune, KS, 2001-2009.

N	P ₂ O ₅	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
----- lb/acre -----		----- bu/acre -----									
0	0	54	39	79	67	49	42	49	36	85	55
0	40	43	43	95	97	60	68	50	57	110	69
0	80	48	44	93	98	51	72	51	52	106	68
40	0	71	47	107	92	63	56	77	62	108	76
40	40	127	69	147	154	101	129	112	105	148	121
40	80	129	76	150	148	100	123	116	104	159	123
80	0	75	53	122	118	75	79	107	78	123	92
80	40	169	81	188	209	141	162	163	129	179	158
80	80	182	84	186	205	147	171	167	139	181	162
120	0	56	50	122	103	66	68	106	65	117	84
120	40	177	78	194	228	162	176	194	136	202	172
120	80	191	85	200	234	170	202	213	151	215	185
160	0	76	50	127	136	83	84	132	84	139	101
160	40	186	80	190	231	170	180	220	150	210	180
160	80	188	85	197	240	172	200	227	146	223	186
200	0	130	67	141	162	109	115	159	99	155	126
200	40	177	79	197	234	169	181	224	152	207	180
200	80	194	95	201	239	191	204	232	157	236	194
<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
Linear		0.001	0.001	0.001	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	0.001	0.001	0.001
Phosphorus		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
Quadratic		0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.001	0.133	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
<u>MEANS</u>											
Nitrogen, lb/a	0	48	42	89	87	53	61	50	48	100	64
	40	109	64	135	132	88	103	102	91	138	107
	80	142	73	165	178	121	137	146	115	161	137
	120	142	71	172	188	133	149	171	118	178	147
	160	150	71	172	203	142	155	193	127	191	156
	200	167	80	180	212	156	167	205	136	199	167
	LSD _{0.05}	15	8	9	11	10	15	11	9	12	8
P ₂ O ₅ , lb/a	0	77	51	116	113	74	74	105	71	121	89
	40	147	72	168	192	134	149	160	122	176	147
	80	155	78	171	194	139	162	168	125	187	153
	LSD _{0.05}	10	6	6	8	7	11	8	6	9	6

Table 2. Effect of N, P, and K fertilizers on irrigated sorghum yields, Tribune, KS, 2001-2009.

N	P ₂ O ₅	K ₂ O	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
----- lb/acre -----			----- bu/acre -----									
0	0	0	76	73	80	57	58	84	80	66	64	71
0	40	0	81	81	93	73	53	102	97	60	70	80
0	40	40	83	82	93	74	54	95	94	65	76	81
40	0	0	92	82	92	60	63	102	123	92	84	89
40	40	0	124	120	140	112	84	133	146	111	118	123
40	40	40	119	121	140	117	84	130	145	105	109	120
80	0	0	110	97	108	73	76	111	138	114	115	106
80	40	0	138	127	139	103	81	132	159	128	136	129
80	40	40	134	131	149	123	92	142	166	126	108	132
120	0	0	98	86	97	66	77	101	138	106	113	99
120	40	0	134	132	135	106	95	136	164	131	130	131
120	40	40	135	127	132	115	98	139	165	136	136	133
160	0	0	118	116	122	86	77	123	146	105	108	113
160	40	0	141	137	146	120	106	145	170	138	128	138
160	40	40	136	133	135	113	91	128	167	133	140	133
200	0	0	132	113	131	100	86	134	154	120	110	122
200	40	0	139	136	132	115	108	143	168	137	139	137
200	40	40	142	143	145	123	101	143	170	135	129	138
<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
Linear			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic			0.001	0.001	0.001	0.018	0.005	0.004	0.001	0.001	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
Zero P vs P			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P vs P-K			0.619	0.920	0.694	0.121	0.803	0.578	0.992	0.745	0.324	0.975
N x P-K			0.058	0.030	0.008	0.022	0.195	0.210	0.965	0.005	0.053	0.010
<u>MEANS</u>												
Nitrogen			80	79	88	68	55	93	91	64	70	77
40			112	108	124	96	77	121	138	103	104	111
80			127	119	132	100	83	128	155	123	120	122
120			122	115	121	96	90	125	156	124	126	121
160			132	129	134	107	92	132	161	125	125	128
200			138	131	136	113	98	140	164	131	126	132
LSD _{0.05}			8	9	10	11	10	11	9	7	11	6
P ₂ O ₅ -K ₂ O			104	94	105	74	73	109	130	101	99	100
40-0			126	122	131	105	88	132	151	117	120	123
40-40			125	123	132	111	87	130	151	117	116	123
LSD _{0.05}			6	6	7	7	7	7	6	5	7	4