Annual report for KS-23F (2012 season)

Long-Term 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 2012, N applied alone increased yields 84 bu/a, whereas P applied alone increased yields less than 10 bu/a. Nitrogen and P applied together increased yields up to 174 bu/a. This is somewhat greater than the 10 year average, where N and P fertilization increased corn yields up to 145 bu/a. Application of 120 lb/a N (with P) produced about 82% of maximum yield in 2012, which was less than the 10-year average of 94%. Application of 80 instead of 40 lb P_2O_5/a increased average yields 8 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 potassium (K) fertilization. The study is 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)

This field study is conducted at the Tribune Unit of the Southwest Research-Extension Center. Fertilizer treatments initiated in 1961 are N rates of 0, 40, 80, 120, 160, and 200 lb/a without P and K; with 40 lb/a P_2O_5 and zero K; and with 40 lb/a P_2O_5 and 40 lb/a K_2O. The treatments were changed in 1992; the K variable was replaced by a higher rate of P (80 lb/a P_2O_5). All fertilizers were broadcast by hand in the spring and incorporated before planting. The soil is a Ulysses silt loam. The corn hybrids [DeKalb C60-12 (2003), Pioneer 34N45 (2004 and 2005), Pioneer 34N50 (2006), Pioneer 33B54 (2007), Pioneer 34B99 (2008), DeKalb 61-69 (2009), Pioneer 1173H (2010), Pioneer 1151XR (2011), and Pioneer 0832 (2012)] were planted at about 30,000 to 32,000 seeds/a in late April or early May. Hail damaged the 2005 and 2010 crops. The corn is irrigated to minimize water stress. Sprinkler irrigation has been used since 2001. The center two rows of each plot are machine harvested after physiological maturity. Grain yields are adjusted to 15.5% moisture.

Results (corn)

Corn yields in 2012 were much greater than the 10-year average (**Table 1**). Nitrogen alone increased yields 84 bu/a, whereas P alone increased yields less than 10 bu/a. However, N and P applied together increased corn yields up to 174 bu/a. Maximum yield was obtained with 200 lb/a N with 80 lb/a P_2O_5. Reducing N or P rates reduced yields by at least 8% which is greater than the 10-year average of 4%. Corn yields in 2012 (averaged across all N rates) were 8 bu/a greater with 80 than with 40 lb/a P_2O_5, which is slightly greater than the 10-year average of 5 bu/a.

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 2012, N applied alone increased yields almost 70 bu/a, whereas N and P applied together increased yields up to 100 bu/a. Averaged across the past 10 years, N and P fertilization increased sorghum yields more than 65 bu/a. Application of 40 lb/a N (with P) was sufficient to produce about 80% of maximum yield in 2012 which was slightly less than the 10-yr average. Application of potassium (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 is 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)

This field study is conducted at the Tribune Unit of the Southwest Research-Extension Center. Fertilizer treatments initiated in 1961 are N rates of 0, 40, 80, 120, 160, and 200 lb/a N without P and K; with 40 lb/a P_2O_5 and zero K; and with 40 lb/a P_2O_5 and 40 lb/a K_2O. All fertilizers are broadcast by hand in the spring and incorporated before planting. The soil is a Ulysses silt loam. Sorghum (Pioneer 8500/8505 from 2003–2007, Pioneer 85G46 in 2008–2011, and Pioneer 84G62 in 2012) was planted in late May or early June. Irrigation is used to minimize water stress. Sprinkler irrigation has been used since 2001. The center two rows of each plot are machine harvested after physiological maturity. Grain yields are adjusted to 12.5% moisture.

Results (sorghum)

Grain sorghum yields in 2012 were 24% greater than the 10-year average yields (**Table 2**). Nitrogen alone increased yields 69 bu/a while P alone increased yields 12 bu/a. However, N and P applied together increased yields up to 100 bu/a. Averaged across the past 10 years, N and P applied together increased yields more than 65 bu/a. In 2012, 40 lb/a N (with P) produced about 79% of maximum yields, which is slightly less than the 10-year average of 86%. Sorghum yields were not affected by K fertilization, which has been the case throughout the study period.

Table 1. Effect of nitrogen and phosphorus fertilization on irrigated corn, Tribune, KS, 2003-2012.

N	P_2O_5	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	**Mean**
lb/a		bu/a										
0	0	79	67	49	42	49	36	85	20	92	86	**60**
0	40	95	97	60	68	50	57	110	21	111	85	**75**
0	80	93	98	51	72	51	52	106	28	105	94	**75**
40	0	107	92	63	56	77	62	108	23	114	109	**81**
40	40	147	154	101	129	112	105	148	67	195	138	**130**
40	80	150	148	100	123	116	104	159	61	194	135	**129**
80	0	122	118	75	79	107	78	123	34	136	128	**100**
80	40	188	209	141	162	163	129	179	85	212	197	**167**
80	80	186	205	147	171	167	139	181	90	220	194	**170**
120	0	122	103	66	68	106	65	117	28	119	134	**93**
120	40	194	228	162	176	194	136	202	90	222	213	**182**
120	80	200	234	170	202	213	151	215	105	225	211	**193**
160	0	127	136	83	84	132	84	139	49	157	158	**115**
160	40	190	231	170	180	220	150	210	95	229	227	**190**
160	80	197	240	172	200	227	146	223	95	226	239	**197**
200	0	141	162	109	115	159	99	155	65	179	170	**135**
200	40	197	234	169	181	224	152	207	97	218	225	**190**
200	80	201	239	191	204	232	157	236	104	231	260	**205**
ANOVA (P>F)												
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	0.001	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	**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	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	**0.001**
N × P		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	**0.001**
Means												
Nitrogen, lb/a												
0		89	87	53	61	50	48	100	23	103	88	**70**
40		135	132	88	103	102	91	138	50	167	127	**113**
80		165	178	121	137	146	115	161	70	189	173	**145**
120		172	188	133	149	171	118	178	74	189	186	**156**
160		172	203	142	155	193	127	191	80	204	208	**167**
200		180	212	156	167	205	136	199	89	209	218	**177**
LSD (0.05)		9	11	10	15	11	9	12	9	13	10	**8**
P_2O_5, lb/a												
0		116	113	74	74	105	71	121	36	133	131	**97**
40		168	192	134	149	160	122	176	76	198	181	**156**
80		171	194	139	162	168	125	187	81	200	189	**161**
LSD (0.05)		6	8	7	11	8	6	9	7	9	7	**6**

Table 2. Effect of nitrogen, phosphorus, and potassium fertilizers on irrigated grain sorghum yields, Tribune, KS, 2003-2012.

Fertilizer			Grain sorghum yield										
N	P_2O_5	K_2O	2003	2004	2005*	2006	2007	2008	2009	2010	2011	2012	**Mean**
- - - - - - - - - lb/a - - - - - - - - -			- bu/a -										
0	0	0	80	57	58	84	80	66	64	51	75	78	**70**
0	40	0	93	73	53	102	97	60	70	51	83	90	**78**
0	40	40	93	74	54	95	94	65	76	55	88	93	**80**
40	0	0	92	60	63	102	123	92	84	66	106	115	**92**
40	40	0	140	112	84	133	146	111	118	77	121	140	**120**
40	40	40	140	117	84	130	145	105	109	73	125	132	**117**
80	0	0	108	73	76	111	138	114	115	73	117	132	**107**
80	40	0	139	103	81	132	159	128	136	86	140	163	**129**
80	40	40	149	123	92	142	166	126	108	84	138	161	**131**
120	0	0	97	66	77	101	138	106	113	70	116	130	**102**
120	40	0	135	106	95	136	164	131	130	88	145	172	**132**
120	40	40	132	115	98	139	165	136	136	90	147	175	**135**
160	0	0	122	86	77	123	146	105	108	74	124	149	**113**
160	40	0	146	120	106	145	170	138	128	92	152	178	**139**
160	40	40	135	113	91	128	167	133	140	88	151	174	**134**
200	0	0	131	100	86	134	154	120	110	78	128	147	**120**
200	40	0	132	115	108	143	168	137	139	84	141	171	**135**
200	40	40	145	123	101	143	170	135	129	87	152	175	**137**
ANOVA (P>F)													
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	0.018	0.005	0.004	0.001	0.001	0.001	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	**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			0.694	0.121	0.803	0.578	0.992	0.745	0.324	0.892	0.278	0.826	**0.888**
N × P-K			0.008	0.022	0.195	0.210	0.965	0.005	0.053	0.229	0.542	0.186	**0.033**
Means													
Nitrogen, lb/a													
0			88	68	55	93	91	64	70	52	82	87	**76**
40			124	96	77	121	138	103	104	72	117	129	**109**
80			132	100	83	128	155	123	120	81	132	152	**122**
120			121	96	90	125	156	124	126	82	136	159	**123**
160			134	107	92	132	161	125	125	83	142	167	**128**
200			136	113	98	140	164	131	126	84	141	165	**131**
LSD (0.05)			10	11	10	11	9	7	11	5	8	9	**5**
P_2O_5-K_2O, lb/a													
0			105	74	73	109	130	101	99	68	111	125	**101**
40-0			131	105	88	132	151	117	120	80	130	152	**122**
40-40			132	111	87	130	151	117	116	79	133	152	**122**
LSD (0.05)			7	7	7	7	6	5	7	4	6	6	**4**