Annual report for KS-23F (2011 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 2011, N applied alone increased yields 87 bu/a, whereas P applied alone increased yields 13-19 bu/a. Nitrogen and P applied together increased yields up to 139 bu/a. This is similar to the past 10 years, where N and P fertilization increased corn yields up to 130 bu/a. Application of 120 lb/a N (with P) was sufficient to produce about 95% of maximum yield in 2011, which was similar to the 10-year average. Application of 80 instead of 40 lb P_2O_5/a increased average yields only 2 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 [Pioneer 33R93 (2002), 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), and Pioneer 1151XR (2011)] were planted at about 30,000 to 32,000 seeds/a in late April or early May. Hail damaged the 2002, 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 2011 were much greater than the 10-year average (**Table 1**). Nitrogen alone increased yields 87 bu/a, whereas P alone increased yields less than 20 bu/a. However, N and P applied together increased corn yields up to 139 bu/a. Only 120 lb/a N with P was required to obtain 95% of maximum yield, which is similar to the 10-year average. Corn yields in 2011 (averaged across all N rates) were only 2 bu/a greater with 80 than with 40 lb/a P_2O_5, which is slightly less 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 2011, N applied alone increased yields about 50 bu/a, whereas N and P applied together increased yields up to 75 bu/a. Averaged across the past 10 years, N and P fertilization increased sorghum yields more than 60 bu/a. Application of 40 lb/a N (with P) was sufficient to produce about 80% of maximum yield in 2011 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 1998–2007 and Pioneer 85G46 in 2008–2011) is planted in late May or early June. Irrigation is used to minimize water stress. Furrow irrigation was used through 2000, and 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 2011 were greater than the 10-year average yields (**Table 2**). Nitrogen alone increased yields about 50 bu/a while P alone had increased yields less than 10 bu/a. However, N and P applied together increased yields up to 75 bu/a. Averaged across the past 10 years, N and P applied together increased yields more than 60 bu/a. In 2011, 40 lb/a N (with P) produced about 80% of maximum yields, which is slightly less than the 10-year average. 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, 2002-2011.

N	P_2O_5	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Mean
- - - - - - - - lb/a - - - - - - - -		- bu/a -										
0	0	39	79	67	49	42	49	36	85	20	92	56
0	40	43	95	97	60	68	50	57	110	21	111	71
0	80	44	93	98	51	72	51	52	106	28	105	70
40	0	47	107	92	63	56	77	62	108	23	114	75
40	40	69	147	154	101	129	112	105	148	67	195	123
40	80	76	150	148	100	123	116	104	159	61	194	123
80	0	53	122	118	75	79	107	78	123	34	136	92
80	40	81	188	209	141	162	163	129	179	85	212	155
80	80	84	186	205	147	171	167	139	181	90	220	159
120	0	50	122	103	66	68	106	65	117	28	119	84
120	40	78	194	228	162	176	194	136	202	90	222	168
120	80	85	200	234	170	202	213	151	215	105	225	180
160	0	50	127	136	83	84	132	84	139	49	157	104
160	40	80	190	231	170	180	220	150	210	95	229	176
160	80	85	197	240	172	200	227	146	223	95	226	181
200	0	67	141	162	109	115	159	99	155	65	179	125
200	40	79	197	234	169	181	224	152	207	97	218	176
200	80	95	201	239	191	204	232	157	236	104	231	189
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		0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N × P		0.133	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		42	89	87	53	61	50	48	100	23	103	66
40		64	135	132	88	103	102	91	138	50	167	107
80		73	165	178	121	137	146	115	161	70	189	135
120		71	172	188	133	149	171	118	178	74	189	144
160		71	172	203	142	155	193	127	191	80	204	154
200		80	180	212	156	167	205	136	199	89	209	163
LSD (0.05)		8	9	11	10	15	11	9	12	9	13	8
P_2O_5, lb/a												
0		51	116	113	74	74	105	71	121	36	133	89
40		72	168	192	134	149	160	122	176	76	198	145
80		78	171	194	139	162	168	125	187	81	200	150
LSD (0.05)		6	6	8	7	11	8	6	9	7	9	6

Table 2. Effect of nitrogen, phosphorus, and potassium fertilizers on irrigated grain sorghum yields, Tribune, KS, 2002-2011.

Fertilizer			Grain sorghum yield										
N	P_2O_5	K_2O	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Mean
- - - - - - - - - lb/a - - - - - - - - -			- bu/a -										
0	0	0	73	80	57	58	84	80	66	64	51	75	69
0	40	0	81	93	73	53	102	97	60	70	51	83	77
0	40	40	82	93	74	54	95	94	65	76	55	88	78
40	0	0	82	92	60	63	102	123	92	84	66	106	88
40	40	0	120	140	112	84	133	146	111	118	77	121	118
40	40	40	121	140	117	84	130	145	105	109	73	125	116
80	0	0	97	108	73	76	111	138	114	115	73	117	103
80	40	0	127	139	103	81	132	159	128	136	86	140	125
80	40	40	131	149	123	92	142	166	126	108	84	138	127
120	0	0	86	97	66	77	101	138	106	113	70	116	98
120	40	0	132	135	106	95	136	164	131	130	88	145	127
120	40	40	127	132	115	98	139	165	136	136	90	147	130
160	0	0	116	122	86	77	123	146	105	108	74	124	109
160	40	0	137	146	120	106	145	170	138	128	92	152	135
160	40	40	133	135	113	91	128	167	133	140	88	151	129
200	0	0	113	131	100	86	134	154	120	110	78	128	117
200	40	0	136	132	115	108	143	168	137	139	84	141	131
200	40	40	143	145	123	101	143	170	135	129	87	152	134
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	0.018	0.005	0.004	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			0.920	0.694	0.121	0.803	0.578	0.992	0.745	0.324	0.892	0.278	0.839
N × P-K			0.030	0.008	0.022	0.195	0.210	0.965	0.005	0.053	0.229	0.542	0.013
Means													
Nitrogen, lb/a													
0			79	88	68	55	93	91	64	70	52	82	75
40			108	124	96	77	121	138	103	104	72	117	107
80			119	132	100	83	128	155	123	120	81	132	119
120			115	121	96	90	125	156	124	126	82	136	118
160			129	134	107	92	132	161	125	125	83	142	124
200			131	136	113	98	140	164	131	126	84	141	127
LSD (0.05)			9	10	11	10	11	9	7	11	5	8	5
P_2O_5-K_2O, lb/a													
0			94	105	74	73	109	130	101	99	68	111	97
40-0			122	131	105	88	132	151	117	120	80	130	119
40-40			123	132	111	87	130	151	117	116	79	133	119
LSD (0.05)			6	7	7	7	7	6	5	7	4	6	4