Annual report for KS-23F (2010 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 2010, hail severely damaged the corn in late July. However, N applied alone still increased yields about 45 bu/a, whereas P applied alone increased yields about 8 bu/a. Nitrogen and P applied together increased yields up to 80 bu/a. Averaged across the past 10 years, N and P fertilization increased corn yields up to 140 bu/a. Application of 120 lb/a N (with P) was sufficient to produce greater than 90% of maximum yield in 2010, which was similar to the 10-year average. Application of 80 instead of 40 lb P_2O_5/a increased yields 5 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 (2001 and 2002), DeKalb C60-12 (2003), Pioneer 34N45 (2004 and 2005), Pioneer 34N50 (2006), Pioneer 33B54 (2007), Pioneer 34B99 (2008), DeKalb 61-69 (2009), and Pioneer 1173H (2010)] 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 2010 were much less than the 10-year average because of considerable hail damage in late July (**Table 1**). Nitrogen alone increased yields 45 bu/a, whereas P alone increased yields less than 10 bu/a. However, N and P applied together increased corn yields up to 80 bu/a. Only 120 lb/a N with P was required to obtain greater than 90% of maximum yield, which is similar to the 10-year average. Corn yields in 2010 (averaged across all N rates) were 5 bu/a greater with 80 than with 40 lb/a P_2O_5, which is similar to the 10-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 2010, N applied alone increased yields about 25 bu/a, whereas N and P applied together increased yields up to 35 bu/a despite considerable hail damage in late July. Averaged across the past 10 years, N and P fertilization increased sorghum yields up to 60 bu/a. Application of 40 lb/a N (with P) was sufficient to produce about 85% of maximum yield in 2010 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 2008–2010) 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 2010 were reduced because of hail in late July (**Table 2**). Nitrogen alone increased yields about 25 bu/a while P alone had no affect on yields. However, N and P applied together increased yields up to 35 bu/a. Averaged across the past 10 years, N and P applied together increased yields up to 60 bu/a. In 2010, 40 lb/a N (with P) produced about 85% 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, 2001-2010.

N	P_2O_5	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
-------- lb/a --------		---------- bu/a ----------										
0	0	54	39	79	67	49	42	49	36	85	20	52
0	40	43	43	95	97	60	68	50	57	110	21	64
0	80	48	44	93	98	51	72	51	52	106	28	64
40	0	71	47	107	92	63	56	77	62	108	23	71
40	40	127	69	147	154	101	129	112	105	148	67	116
40	80	129	76	150	148	100	123	116	104	159	61	117
80	0	75	53	122	118	75	79	107	78	123	34	86
80	40	169	81	188	209	141	162	163	129	179	85	151
80	80	182	84	186	205	147	171	167	139	181	90	155
120	0	56	50	122	103	66	68	106	65	117	28	78
120	40	177	78	194	228	162	176	194	136	202	90	164
120	80	191	85	200	234	170	202	213	151	215	105	177
160	0	76	50	127	136	83	84	132	84	139	49	96
160	40	186	80	190	231	170	180	220	150	210	95	171
160	80	188	85	197	240	172	200	227	146	223	95	177
200	0	130	67	141	162	109	115	159	99	155	65	120
200	40	177	79	197	234	169	181	224	152	207	97	172
200	80	194	95	201	239	191	204	232	157	236	104	185
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	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N × P		0.001	0.133	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Means												
Nitrogen, lb/a												
0		48	42	89	87	53	61	50	48	100	23	60
40		109	64	135	132	88	103	102	91	138	50	101
80		142	73	165	178	121	137	146	115	161	70	131
120		142	71	172	188	133	149	171	118	178	74	139
160		150	71	172	203	142	155	193	127	191	80	148
200		167	80	180	212	156	167	205	136	199	89	159
LSD (0.05)		15	8	9	11	10	15	11	9	12	9	8
P_2O_5, lb/a												
0		77	51	116	113	74	74	105	71	121	36	84
40		147	72	168	192	134	149	160	122	176	76	140
80		155	78	171	194	139	162	168	125	187	81	146
LSD (0.05)		10	6	6	8	7	11	8	6	9	7	5

Table 2. Effect of nitrogen, phosphorus, and potassium fertilizers on irrigated grain sorghum yields, Tribune, KS, 2001-2010.

Fertilizer			Grain sorghum yield										
N	P_2O_5	K_2O	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
---------- lb/a ----------			---------- bu/a ----------										
0	0	0	76	73	80	57	58	84	80	66	64	51	69
0	40	0	81	81	93	73	53	102	97	60	70	51	77
0	40	40	83	82	93	74	54	95	94	65	76	55	78
40	0	0	92	82	92	60	63	102	123	92	84	66	87
40	40	0	124	120	140	112	84	133	146	111	118	77	118
40	40	40	119	121	140	117	84	130	145	105	109	73	116
80	0	0	110	97	108	73	76	111	138	114	115	73	103
80	40	0	138	127	139	103	81	132	159	128	136	86	125
80	40	40	134	131	149	123	92	142	166	126	108	84	127
120	0	0	98	86	97	66	77	101	138	106	113	70	96
120	40	0	134	132	135	106	95	136	164	131	130	88	126
120	40	40	135	127	132	115	98	139	165	136	136	90	128
160	0	0	118	116	122	86	77	123	146	105	108	74	109
160	40	0	141	137	146	120	106	145	170	138	128	92	133
160	40	40	136	133	135	113	91	128	167	133	140	88	128
200	0	0	132	113	131	100	86	134	154	120	110	78	117
200	40	0	139	136	132	115	108	143	168	137	139	84	131
200	40	40	142	143	145	123	101	143	170	135	129	87	133
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	0.018	0.005	0.004	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			0.619	0.920	0.694	0.121	0.803	0.578	0.992	0.745	0.324	0.892	0.968
N × P-K			0.058	0.030	0.008	0.022	0.195	0.210	0.965	0.005	0.053	0.229	0.007
Means													
Nitrogen, lb/a													
0			80	79	88	68	55	93	91	64	70	52	75
40			112	108	124	96	77	121	138	103	104	72	107
80			127	119	132	100	83	128	155	123	120	81	118
120			122	115	121	96	90	125	156	124	126	82	117
160			132	129	134	107	92	132	161	125	125	83	123
200			138	131	136	113	98	140	164	131	126	84	127
LSD (0.05)			8	9	10	11	10	11	9	7	11	5	5
P_2O_5-K_2O, lb/a													
0			104	94	105	74	73	109	130	101	99	68	97
40-0			126	122	131	105	88	132	151	117	120	80	118
40-40			125	123	132	111	87	130	151	117	116	79	118
LSD (0.05)			6	6	7	7	7	7	6	5	7	4	4