NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM
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CORN

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated corn in western Kansas. In 2006, N and P applied alone increased yields about 70 and 30 bu/A, respectively; however, N and P applied together increased yields up to 160 bu/A. Averaged across the past 10 years, corn yields were increased up to 125 bu/A by N and P fertilization. Application of 120 lb N/A (with P) was sufficient to produce maximum yields in 2006, which was slightly more than the 10-year average. Phosphorus increased corn yields in 2006 an average of more than 100 bu/A when applied with at least 120 lb N/A. Application of 80 instead of 40 lb P_2O_5/A increased yields 20 bu/A when applied with at least 120 lb N/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

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 P_2O_5/A and zero K; and with 40 lb P_2O_5/A and 40 lb K_2O/A. In 1992, the treatments were changed with the K variable being replaced by a higher rate of P (80 lb P_2O_5/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 3225 (1997), Pioneer 3395IR (1998), Pioneer 33A14 (2000), Pioneer 33R93 (2001 and 2002), DeKalb C60-12 (2003), Pioneer 34N45 (2004 and 2005), and Pioneer 34N50 (2006) 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 yields in 2006 were similar to the 10-year average (**Table 1**). Nitrogen alone increased yields up to 70 bu/A while P alone increased yields only 30 bu/A. However, N and P applied together increased corn yields up to 162 bu/A. Only 120 lb N/A with P was required to obtain maximum yields. 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 13 bu/A greater with 80 than with 40 lb P_2O_5/A in 2006 which is considerably greater than the 10-year average. Also, with N rates of 120 lb N/A or greater in 2006 the higher P rate increased yields more than 20 bu/A.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1997-2006.

Nitrogen	P_2O_5	Grain Yield									
		1997	1998*	2000	2001	2002	2003	2004	2005	2006	Mean
- - - - lb/A - - - -		- bu/A- -									
0	0	66	49	131	54	39	79	67	49	42	64
0	40	79	55	152	43	43	95	97	60	68	77
0	80	83	55	153	48	44	93	98	51	72	78
40	0	86	76	150	71	47	107	92	63	56	83
40	40	111	107	195	127	69	147	154	101	129	127
40	80	114	95	202	129	76	150	148	100	123	126
80	0	130	95	149	75	53	122	118	75	79	100
80	40	153	155	205	169	81	188	209	141	162	163
80	80	155	149	211	182	84	186	205	147	171	166
120	0	105	92	143	56	50	122	103	66	68	89
120	40	173	180	204	177	78	194	228	162	176	175
120	80	162	179	224	191	85	200	234	170	202	183
160	0	108	101	154	76	50	127	136	83	84	102
160	40	169	186	203	186	80	190	231	170	180	177
160	80	187	185	214	188	85	197	240	172	200	185
200	0	110	130	165	130	67	141	162	109	115	125
200	40	185	188	207	177	79	197	234	169	181	180
200	80	193	197	218	194	95	201	239	191	204	192
ANOVA											
N		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
P_2O_5		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	0.007	0.001	0.001	0.001	0.001	0.001
N x P		0.001	0.001	0.008	0.001	0.133	0.001	0.001	0.001	0.001	0.001
MEANS											
N, lb/A	0	76	53	145	48	42	89	87	53	61	73
	40	104	93	182	109	64	135	132	88	103	112
	80	146	133	188	142	73	165	178	121	137	143
	120	147	150	190	142	71	172	188	133	149	149
	160	155	157	190	150	71	172	203	142	155	155
	200	163	172	197	167	80	180	212	156	167	166
	$LSD_{0.05}$	12	11	10	15	8	9	11	10	15	7
P_2O_5, lb/A	0	101	91	149	77	51	116	113	74	74	94
	40	145	145	194	147	72	168	192	134	149	150
	80	149	143	204	155	78	171	194	139	162	155
	$LSD_{0.05}$	9	7	7	10	6	6	8	7	11	5

*Note: There was no yield data for 1999 because of hail damage.

GRAIN SORGHUM

Summary

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 2006, N and P applied alone increased yields about 50 and 18 bu/A, respectively; while N and P applied together increased yields more than 65 bu/A. Averaged across the past 10 years, sorghum yields were increased more than 50 bu/A by N and P fertilization. Application of 40 lb N/A (with P) was sufficient to produce >90% of maximum yield in 2006 and for the 10-year average. 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

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 P_2O_5/A and zero K; and with 40 lb P_2O_5/A and 40 lb K_2O/A. All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. Sorghum (Pioneer 8414 in 1997, and Pioneer 8500/8505 from 1998-2006) 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 and discussion

Grain sorghum yields were very good in 2006 and greater than the 10-year average (**Table 2**). Nitrogen alone increased yields up to 50 bu/A while P alone increased yields up to 18 bu/A, while N and P applied together increased yields up to 60 bu/A. Averaged across the past 10-yr, N and P applied together has increased yields up to 55 bu/A. In 2006, 40 lb N/A (with P) produced more than 90% of maximum yields which is similar to 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, 1997-2006.

N	P_2O_5	K_2O	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
- - - - - lb/A - - - -			- bu/A -										
0	0	0	81	77	74	77	76	73	80	57	58	84	74
0	40	0	75	77	85	87	81	81	93	73	53	102	82
0	40	40	83	76	84	83	83	82	93	74	54	95	82
40	0	0	104	91	83	88	92	82	92	60	63	102	87
40	40	0	114	118	117	116	124	120	140	112	84	133	119
40	40	40	121	114	114	114	119	121	140	117	84	130	119
80	0	0	100	111	94	97	110	97	108	73	76	111	99
80	40	0	121	125	113	116	138	127	139	103	81	132	121
80	40	40	130	130	123	120	134	131	149	123	92	142	129
120	0	0	91	102	76	82	98	86	97	66	77	101	88
120	40	0	124	125	102	116	134	132	135	106	95	136	122
120	40	40	128	128	105	118	135	127	132	115	98	139	124
160	0	0	118	118	100	96	118	116	122	86	77	123	109
160	40	0	116	131	116	118	141	137	146	120	106	145	129
160	40	40	119	124	107	115	136	133	135	113	91	128	121
200	0	0	107	121	113	104	132	113	131	100	86	134	115
200	40	0	126	133	110	114	139	136	132	115	108	143	126
200	40	40	115	130	120	120	142	143	145	123	101	143	129
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	0.227	0.001	0.001	0.001	0.001	0.018	0.005	0.004	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			0.436	0.649	0.741	0.803	0.619	0.920	0.694	0.121	0.803	0.578	0.742
N x P-K			0.045	0.186	0.482	0.061	0.058	0.030	0.008	0.022	0.195	0.210	0.016
MEANS													
Nitrogen	0 lb/A		80	76	81	82	80	79	88	68	55	93	79
	40		113	108	105	106	112	108	124	96	77	121	108
	80		117	122	110	111	127	119	132	100	83	128	116
	120		114	118	95	105	122	115	121	96	90	125	111
	160		118	124	108	110	132	129	134	107	92	132	120
	200		116	128	115	113	138	131	136	113	98	140	124
	$LSD_{0.05}$		10	8	13	7	8	9	10	11	10	11	7
P_2O_5-K_2O	0 lb/A		100	103	90	91	104	94	105	74	73	109	95
	40- 0		113	118	107	111	126	122	131	105	88	132	116
	40-40		116	117	109	112	125	123	132	111	87	130	117
	$LSD_{0.05}$		7	6	9	5	6	6	7	7	7	7	5