NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN

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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 2008, N applied alone increased yields about 60 bu/a, while P applied alone increased yields about 20 bu/a. However, when N and P were applied together, yields were increased up to 120 bu/a. Averaged across the past 9 years, corn yields were increased up to 130 bu/a by N and P fertilization. Application of 120 lb N/a (with P) was sufficient to produce >90% of maximum yield in 2008, which was similar to the 9-year average. Phosphorus increased corn yields in 2008 more than 50 bu/a when applied with at least 120 lb N/a. Application of 80 instead of 40 lb P_2O_5/a increased yields only 3 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

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 33A14 (2000), Pioneer 33R93 (2001 and 2002), DeKalb C60-12 (2003), Pioneer 34N45 (2004 and 2005), Pioneer 34N50 (2006), Pioneer 33B54 (2007), and Pioneer 34B99 (2008) 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 yields in 2008 were less than the 9-year average (Table 1). Nitrogen alone increased yields 60 bu/a while P alone increased yields 20 bu/a. However, N and P applied together increased corn yields up to 120 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 only 3 bu/a greater with 80 than with 40 lb P_2O_5/a in 2008 which is less than the 9-year average.

Table 1. Effect of N and P fertilization on irrigated corn yield, Tribune, KS, 2000-2008.

N	P_2O_5	2000	2001	2002	2003	2004	2005	2006	2007	2008	Mean
- - - - - lb/acre - - - - -		- bu/acre -									
0	0	131	54	39	79	67	49	42	49	36	60
0	40	152	43	43	95	97	60	68	50	57	74
0	80	153	48	44	93	98	51	72	51	52	74
40	0	150	71	47	107	92	63	56	77	62	81
40	40	195	127	69	147	154	101	129	112	105	126
40	80	202	129	76	150	148	100	123	116	104	128
80	0	149	75	53	122	118	75	79	107	78	95
80	40	205	169	81	188	209	141	162	163	129	161
80	80	211	182	84	186	205	147	171	167	139	166
120	0	143	56	50	122	103	66	68	106	65	87
120	40	204	177	78	194	228	162	176	194	136	172
120	80	224	191	85	200	234	170	202	213	151	186
160	0	154	76	50	127	136	83	84	132	84	103
160	40	203	186	80	190	231	170	180	220	150	179
160	80	214	188	85	197	240	172	200	227	146	185
200	0	165	130	67	141	162	109	115	159	99	127
200	40	207	177	79	197	234	169	181	224	152	180
200	80	218	194	95	201	239	191	204	232	157	192
ANOVA (P>F)											
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	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.008	0.001	0.133	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MEANS											
Nitrogen, lb/a	0	145	48	42	89	87	53	61	50	48	69
	40	182	109	64	135	132	88	103	102	91	112
	80	188	142	73	165	178	121	137	146	115	141
	120	190	142	71	172	188	133	149	171	118	148
	160	190	150	71	172	203	142	155	193	127	156
	200	197	167	80	180	212	156	167	205	136	167
	$LSD_{0.05}$	10	15	8	9	11	10	15	11	9	8
P_2O_5, lb/a	0	149	77	51	116	113	74	74	105	71	92
	40	194	147	72	168	192	134	149	160	122	149
	80	204	155	78	171	194	139	162	168	125	155
	$LSD_{0.05}$	7	10	6	6	8	7	11	8	6	5

N, P, AND K FERTILIZATION OF IRRIGATED GRAIN SORGHUM

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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 2008, N applied alone increased yields about 54 bu/a while P alone did not affect yield, however N and P applied together increased yields up to 71 bu/a. Averaged across the past 10 years, sorghum yields were increased up to 62 bu/a by N and P fertilization. Application of 40 lb N/a (with P) was sufficient to produce >80% of maximum yield although yields continued to increase at N rates up to 160 lb N/a in 2008. 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 8500/8505 from 1999-2007 and Pioneer 85G46 in 2008) 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. Soil samples were taken after harvest in 2005 and analyzed for soil test P. Without P fertilization, soil test P levels were 6 to 9 ppm P (Mehlich-3) across all N rates. With P fertilization, soil test P levels were >20 ppm P (Mehlich 3).

RESULTS

Grain sorghum yields in 2008 were similar to the average of the past 10 years (Table 1). Nitrogen alone increased yields more than 50 bu/a while P alone did not affect yields, however N and P applied together increased yields up to 71 bu/a. Averaged across the past 10-yr, N and P applied together has increased yields up to 60 bu/a. In 2008, 40 lb N/a (with P) produced more than 80% of maximum yields which is about 10% less than the 10-yr average. Sorghum yields were not affected by K fertilization, which has been the case throughout the study period.

Table 1. Effect of N, P, and K fertilizers on irrigated sorghum yields, Tribune, KS, 1999-2008.

N	P_2O_5	K_2O	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Mean
- - - - - lb/acre - - - -			- bu/acre -										
0	0	0	74	77	76	73	80	57	58	84	80	66	73
0	40	0	85	87	81	81	93	73	53	102	97	60	82
0	40	40	84	83	83	82	93	74	54	95	94	65	82
40	0	0	83	88	92	82	92	60	63	102	123	92	89
40	40	0	117	116	124	120	140	112	84	133	146	111	122
40	40	40	114	114	119	121	140	117	84	130	145	105	120
80	0	0	94	97	110	97	108	73	76	111	138	114	103
80	40	0	113	116	138	127	139	103	81	132	159	128	125
80	40	40	123	120	134	131	149	123	92	142	166	126	132
120	0	0	76	82	98	86	97	66	77	101	138	106	93
120	40	0	102	116	134	132	135	106	95	136	164	131	126
120	40	40	105	118	135	127	132	115	98	139	165	136	128
160	0	0	100	96	118	116	122	86	77	123	146	105	110
160	40	0	116	118	141	137	146	120	106	145	170	138	135
160	40	40	107	115	136	133	135	113	91	128	167	133	127
200	0	0	113	104	132	113	131	100	86	134	154	120	120
200	40	0	110	114	139	136	132	115	108	143	168	137	131
200	40	40	120	120	142	143	145	123	101	143	170	135	135
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			0.227	0.001	0.001	0.001	0.001	0.018	0.005	0.004	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			0.741	0.803	0.619	0.920	0.694	0.121	0.803	0.578	0.992	0.745	0.804
N x P-K			0.482	0.061	0.058	0.030	0.008	0.022	0.195	0.210	0.965	0.005	0.012
MEANS													
Nitrogen	0 lb/a		81	82	80	79	88	68	55	93	91	64	79
	40		105	106	112	108	124	96	77	121	138	103	110
	80		110	111	127	119	132	100	83	128	155	123	120
	120		95	105	122	115	121	96	90	125	156	124	116
	160		108	110	132	129	134	107	92	132	161	125	124
	200		115	113	138	131	136	113	98	140	164	131	129
	$LSD_{0.05}$		13	7	8	9	10	11	10	11	9	7	6
P_2O_5-K_2O	0 lb/a		90	91	104	94	105	74	73	109	130	101	98
	40- 0		107	111	126	122	131	105	88	132	151	117	120
	40-40		109	112	125	123	132	111	87	130	151	117	121
	$LSD_{0.05}$		9	5	6	6	7	7	7	7	6	5	5