KJ-2000

NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

Alan Schlegel

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated corn and grain sorghum in western Kansas. In 2000, N and P fertilization increased corn yields up to 90 bu/acre. Averaged across the past eight years, corn yields were increased more than 100 bu/a by N and P fertilization. Application of 160 lb N/a generally is sufficient to maximize corn yields. Phosphorus increased corn yields by 70 bu/a when applied with at least 120 lb N/a. Application of 40 lb P_2O_5/a has been adequate for corn until this year, when yields were increased by a higher P rate. Grain sorghum yields averaged across eight years were increased 50 bu/a by N and 20 bu/a by P fertilization. Application of 80 lb N/a was sufficient to maximize yields in most years. Potassium (K) fertilization had no effect on sorghum yield.

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 in the corn study was discontinued in 1992 and replaced with a higher P rate.

Procedures

Initial fertilizer treatments in 1961 to corn and grain sorghum in adjacent fields 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 for the corn study 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 hybrid was Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), Pioneer 3395IR (1998), and Pioneer 33A14 (2000) planted at 32,000 seeds/a in late April or early May. The 1999 corn crop was lost to hail. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, and Pioneer 8505 from 1998-2000) was planted in late May or early June. Both studies were furrow irrigated to minimize water stress. The center 2 rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum.

Results

Corn yields in 2000 were higher than the long-term average (Table 1). Nitrogen and P fertilization increased corn yields by up to 90 bu/a. Grain yield in the control treatments were 131 bu/a, approximately twice as high as in any of the previous seven years. Only 80 lb N/a was required to obtain near maximum yields compared to the long-term average of about 160 lb N/a. Hail severely damaged the corn in 1999 and the study was not harvested. This appears to have increased the amount of residual N for the 2000 crop. Corn yields were 10 bu/a greater with 80 compared to 40 lb P_2O_5/a. This was the first year that yields were significantly higher with the higher P rate.

Grain sorghum yields in 2000 were similar to the long-term average (Table 2). Maximum sorghum yields were obtained with only 40 lb N/a when applied with P. Phosphorus increased yields by about 20 bu/a for all treatments receiving N, which was similar to the long-term average. Potassium fertilization had no effect on yield.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1992-2000.

Nitrogen	P_2O_5	Grain Yield 1992	1993	1994	1995	1996	1997	1998*	2000	Mean
---- lb/a ----		---------- bu/acre ----------								
0	0	73	43	47	22	58	66	49	131	61
0	40	88	50	43	27	64	79	55	152	70
0	80	80	52	48	26	73	83	55	153	71
40	0	90	62	66	34	87	86	76	150	81
40	40	128	103	104	68	111	111	107	195	116
40	80	128	104	105	65	106	114	95	202	115
80	0	91	68	66	34	95	130	95	149	91
80	40	157	138	129	94	164	153	155	205	149
80	80	140	144	127	93	159	155	149	211	147
120	0	98	71	70	39	97	105	92	143	89
120	40	162	151	147	100	185	173	180	204	163
120	80	157	153	154	111	183	162	179	224	165
160	0	115	88	78	44	103	108	101	154	99
160	40	169	175	162	103	185	169	186	203	169
160	80	178	174	167	100	195	187	185	214	175
200	0	111	82	80	62	110	110	130	165	106
200	40	187	169	171	106	180	185	188	207	174
200	80	165	181	174	109	190	193	197	218	178
ANOVA										
N		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
Quadratic		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
Linear		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
N x P		0.013	0.001	0.001	0.001	0.001	0.001	0.001	0.008	0.001
MEANS										
N, lb/a	0	80	48	46	25	65	76	53	145	67
	40	116	90	92	56	102	104	93	182	104
	80	129	116	107	74	139	146	133	188	129
	120	139	125	124	83	155	147	150	190	139
	160	154	146	136	82	161	155	157	190	147
	200	154	144	142	92	160	163	172	197	153
	$LSD_{0.05}$	14	7	13	7	10	12	11	10	5
P_2O_5, lb/a	0	96	69	68	39	92	101	91	149	88
	40	149	131	126	83	148	145	145	194	140
	80	141	135	129	84	151	149	143	204	142
	$LSD_{0.05}$	10	5	9	5	7	9	7	7	4

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

Table 2. Effect of N, P, and K fertilizers on irrigated sorghum. Tribune, KS, 1992-2000.

N	P_2O_5	K_2O	Grain yield 1992	1993	1994*	1996	1997	1998	1999	2000	Mean
lb/a			bu/acre								
0	0	0	27	46	64	74	81	77	74	77	65
0	40	0	28	42	82	77	75	77	85	87	69
0	40	40	35	37	78	79	83	76	84	83	69
40	0	0	46	69	76	74	104	91	83	88	79
40	40	0	72	97	113	100	114	118	117	116	106
40	40	40	72	92	112	101	121	114	114	114	105
80	0	0	68	91	96	73	100	111	94	97	92
80	40	0	85	105	123	103	121	125	113	116	112
80	40	40	85	118	131	103	130	130	123	120	118
120	0	0	56	77	91	79	91	102	76	82	82
120	40	0	87	120	131	94	124	125	102	116	113
120	40	40	90	117	133	99	128	128	105	118	115
160	0	0	62	93	105	85	118	118	100	96	97
160	40	0	92	122	137	92	116	131	116	118	116
160	40	40	88	123	125	91	119	124	107	115	112
200	0	0	80	107	114	86	107	121	113	104	105
200	40	0	91	127	133	109	126	133	110	114	118
200	40	40	103	123	130	95	115	130	120	120	118
ANOVA											
Nitrogen			0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
Linear			0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001	0.001	0.227	0.001	0.001
P-K			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
P vs. P-K			0.431	0.888	0.734	0.727	0.436	0.649	0.741	0.803	0.858
N x P-K			0.420	0.006	0.797	0.185	0.045	0.186	0.482	0.061	0.035
MEANS											
Nitrogen											
0	lb/acre		30	42	75	77	80	76	81	82	67
40			64	86	100	92	113	108	105	106	97
80			80	104	117	93	117	122	110	111	107
120			78	105	118	91	114	118	95	105	103
160			81	113	122	89	118	124	108	110	108
200			91	119	126	97	116	128	115	113	113
$LSD_{0.05}$			10	10	14	9	10	8	13	7	7
P_2O_5-K_2O											
0-0	lb/acre		56	81	91	79	100	103	90	91	86
40-0			76	102	120	96	113	118	107	111	106
40-40			79	102	118	95	116	117	109	112	106
$LSD_{0.05}$			7	7	10	7	7	6	9	5	5

*Note: There was no yield data for 1995 because of early freeze damage.