Long-Term 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 2014, N applied alone increased yields 58 bu/a, whereas P applied alone increased yields only 12 bu/a. Nitrogen and P applied together increased yields up to 152 bu/a. This is slightly above the 10 year average, where N and P fertilization increased corn yields up to 146 bu/a. Application of 120 lb/a N (with P) produced about 91% of maximum yield in 2014, which was similar to the 10-year average. Application of 80 instead of 40 lb P_2O_5/a increased average yields 9 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
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 34N45 (2004 and 2005), Pioneer 34N50 (2006), Pioneer 33B54 (2007), Pioneer 34B99 (2008), DeKalb 61-69 (2009), Pioneer 1173H (2010), Pioneer 1151XR (2011), Pioneer 0832 (2012-2013), and Pioneer 1186AM (2014)] were planted at about 32,000 seeds/a in late April or early May. Hail damaged the 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 yields in 2014 were 17% greater than the 10-year average (Table 1). Nitrogen alone increased yields 58 bu/a, whereas P alone increased yields only 12 bu/a. However, N and P applied together increased corn yields up to 152 bu/a. While maximum yield was obtained with the highest N and P rate, 160 lb/a N with 80 lb/a P_2O_5 caused less than a 2% yield reduction. Corn yields in 2014 (averaged across all N rates) were 9 bu/a greater with 80 than with 40 lb/a P_2O_5.

Table 1. Effect of nitrogen and phosphorus fertilization on irrigated corn, Tribune, KS, 2005-2014.

N	P_2O_5	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	**Mean**
- - - - - - - - lb/a - - - - - - - -		- bu/a -										
0	0	49	42	49	36	85	20	92	86	70	86	**61**
0	40	60	68	50	57	110	21	111	85	80	95	**74**
0	80	51	72	51	52	106	28	105	94	91	98	**75**
40	0	63	56	77	62	108	23	114	109	97	106	**82**
40	40	101	129	112	105	148	67	195	138	125	153	**127**
40	80	100	123	116	104	159	61	194	135	126	149	**127**
80	0	75	79	107	78	123	34	136	128	112	117	**99**
80	40	141	162	163	129	179	85	212	197	170	187	**162**
80	80	147	171	167	139	181	90	220	194	149	179	**164**
120	0	66	68	106	65	117	28	119	134	114	115	**93**
120	40	162	176	194	136	202	90	222	213	204	213	**181**
120	80	170	202	213	151	215	105	225	211	194	216	**190**
160	0	83	84	132	84	139	49	157	158	122	128	**113**
160	40	170	180	220	150	210	95	229	227	199	211	**189**
160	80	172	200	227	146	223	95	226	239	217	233	**198**
200	0	109	115	159	99	155	65	179	170	139	144	**134**
200	40	169	181	224	152	207	97	218	225	198	204	**188**
200	80	191	204	232	157	236	104	231	260	220	238	**207**
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	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	**0.001**
N × P		0.001	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		53	61	50	48	100	23	103	88	80	93	**70**
40		88	103	102	91	138	50	167	127	116	136	**112**
80		121	137	146	115	161	70	189	173	143	161	**142**
120		133	149	171	118	178	74	189	186	171	181	**155**
160		142	155	193	127	191	80	204	208	179	190	**167**
200		156	167	205	136	199	89	209	218	186	196	**176**
$LSD_{(0.05)}$		10	15	11	9	12	9	13	10	10	10	**8**
P_2O_5, lb/a												
0		74	74	105	71	121	36	133	131	109	116	**97**
40		134	149	160	122	176	76	198	181	163	177	**154**
80		139	162	168	125	187	81	200	189	166	186	**160**
$LSD_{(0.05)}$		7	11	8	6	9	7	9	7	7	7	**6**

*Note: Hail events on 8/19/05 and 7/23/10.

Long-Term Nitrogen and Phosphorus 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 2014, N applied alone increased yields 49 bu/a, whereas N and P applied together increased yields up to 81 bu/a. Averaged across the past 10 years, N and P fertilization increased sorghum yields up to 73 bu/a. Application of 40 lb/a N (with P) was sufficient to produce over 80% of maximum yield in 2014 which almost equals 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

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 2003–2007, Pioneer 85G46 in 2008–2011, and Pioneer 84G62 in 2012-2014) was planted in late May or early June. Irrigation is used 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 12.5% moisture.

Results

Grain sorghum yields in 2014 were 18% greater than the 10-year average (Table 1). Nitrogen alone increased yields 49 bu/a while P alone increased yields only 4 bu/a. However, N and P applied together increased yields up to 81 bu/a. Averaged across the past 10 years, N and P applied together increased yields up to 73 bu/a. In 2014, 40 lb/a N (with P) produced about 82% of maximum yield, which almost equals the 10-year average of 83%; 120 lb/a N (with P) and 160 lb/a N (with P) produced 92% and 97% of maximum yield, respectively. Sorghum yields were not affected by K fertilization, which has been the case throughout the study period.

Table 1. Effect of nitrogen, phosphorus, and potassium fertilizers on irrigated grain sorghum yields, Tribune, KS, 2005-2014.

Fertilizer			Grain sorghum yield										
N	P_2O_5	K_2O	2005*	2006	2007	2008	2009	2010	2011	2012	2013	2014	**Mean**
- - - - - - - - - lb/a - - - - - - - - -			- bu/a -										
0	0	0	58	84	80	66	64	51	75	78	62	90	**71**
0	40	0	53	102	97	60	70	51	83	90	77	94	**79**
0	40	40	54	95	94	65	76	55	88	93	72	96	**80**
40	0	0	63	102	123	92	84	66	106	115	94	115	**97**
40	40	0	84	133	146	111	118	77	121	140	114	144	**120**
40	40	40	84	130	145	105	109	73	125	132	110	142	**117**
80	0	0	76	111	138	114	115	73	117	132	102	120	**111**
80	40	0	81	132	159	128	136	86	140	163	136	151	**133**
80	40	40	92	142	166	126	108	84	138	161	133	164	**133**
120	0	0	77	101	138	106	113	70	116	130	100	116	**108**
120	40	0	95	136	164	131	130	88	145	172	137	162	**138**
120	40	40	98	139	165	136	136	90	147	175	142	170	**141**
160	0	0	77	123	146	105	108	74	124	149	117	139	**118**
160	40	0	106	145	170	138	128	92	152	178	146	171	**144**
160	40	40	91	128	167	133	140	88	151	174	143	176	**141**
200	0	0	86	134	154	120	110	78	128	147	119	139	**123**
200	40	0	108	143	168	137	139	84	141	171	136	165	**141**
200	40	40	101	143	170	135	129	87	152	175	138	170	**142**
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			0.005	0.004	0.001	0.001	0.001	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			0.803	0.578	0.992	0.745	0.324	0.892	0.278	0.826	0.644	0.117	**0.967**
N × P-K			0.195	0.210	0.965	0.005	0.053	0.229	0.542	0.186	0.079	0.012	**0.077**
MEANS													
Nitrogen, lb/a													
0			55	93	91	64	70	52	82	87	70	94	**77**
40			77	121	138	103	104	72	117	129	106	134	**112**
80			83	128	155	123	120	81	132	152	124	145	**126**
120			90	125	156	124	126	82	136	159	126	149	**129**
160			92	132	161	125	125	83	142	167	135	162	**134**
200			98	140	164	131	126	84	141	165	131	158	**135**
$LSD_{(0.05)}$			10	11	9	7	11	5	8	9	8	9	**6**
P_2O_5-K_2O, lb/a													
0 - 0			73	109	130	101	99	68	111	125	99	120	**105**
40 - 0			88	132	151	117	120	80	130	152	124	148	**126**
40 - 40			87	130	151	117	116	79	133	152	123	153	**126**
$LSD_{(0.05)}$			7	7	6	5	7	4	6	6	5	6	**4**

*Note. 2005 yields used only blocks 3, 4, & 5.