

PROJECT TITLE: EFFECT OF LONG TERM NITROGEN, PHOSPHORUS, AND POTASSIUM FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

PROJECT LEADER:

Alan Schlegel
Southwest Research-Extension Center
Rt.1, Box 148
Tribune, KS 67879

PROJECT LOCATION: West-central Kansas at the Tribune Unit, Southwest Research-Extension Center.

OBJECTIVES:

1. Determine the optimum nitrogen rate for irrigated corn and grain sorghum.
2. Determine whether phosphorus fertilization is necessary for optimum grain production of irrigated corn and grain sorghum.
3. Determine whether potassium fertilization is necessary for optimum grain production of irrigated grain sorghum.
4. Determine the effect of long term N and P applications on nitrate accumulation in the soil profile.

PROCEDURES:

Corn and grain sorghum were grown on Ulysses silt loam in adjacent plot areas. Fertilizer treatments for sorghum were N rates of 0, 40, 80, 120, 160, and 200 lb N acre⁻¹ without P and K; with 40 lb P₂O₅ acre⁻¹ and zero K; and with 40 lb P₂O₅ acre⁻¹ and 40 lb K₂O acre⁻¹. In 1992, the treatments for the corn study were changed with the K variable being replaced by a higher rate of P. The corn treatments were N rates of 0 to 200 lb N/acre in 40 lb increments in a factorial arrangement with P at 0, 40 and 80 lb P₂O₅/acre. The treatments for the corn study will remain the same as 1992 in future years. Fertilizers were broadcast by hand on 18 March 1992 for corn and 30 March 1992 for sorghum. Corn (Pioneer 3379) was planted on 23 April, and sorghum (Golden Acres TE Y-75) was planted on 19 May. Rainfall from planting to harvest was 12.44" for corn and 13.01" for sorghum. Both studies were furrow irrigated as needed during the growing season. All plots were machine harvested (21 October for corn and 7 December for sorghum). Sorghum harvest was delayed by inclement weather during November. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum. Cooler than normal temperatures during the summer delayed maturity for sorghum. Consequently, a freeze (about normal time) occurred before physiological maturity which reduced grain test weight and yield.

RESULTS:

1. Nitrogen fertilization is required for optimum production of irrigated corn and grain sorghum in western Kansas. Maximum corn yields in 1992 were obtained with 160 lb N/acre which is consistent with long term trends. Grain sorghum yields were lower in 1992 than long term averages because of cooler than normal summer temperatures and tended to peak with about 80 lb N/acre.
2. Phosphorus fertilization increases grain yields of irrigated corn and grain sorghum. A yield response from P fertilizer has been observed for the last 25 years in this long term study. This response has increased with time and in 1992 corn yields were increased by about 60 bu/acre by P fertilizer when adequate N was also applied.
3. Grain sorghum yields are not increased by K additions due to inherently high K content of the soil.
4. The addition of an extra 40 lb P₂O₅/acre did not increase corn yields in 1992.
5. Application of P fertilizer for 31 years produced higher P levels in the surface soil for both corn and grain sorghum. With corn, P applications increased soil organic matter content.
6. Application of N fertilizer for 31 years reduced P, Zn, and pH levels of the surface soil in both studies. N applications tended to increase soil organic matter content, particularly in the corn study.

INTERPRETIVE SUMMARY

Long term research shows that phosphorus and nitrogen fertilizer must be applied for optimum grain yields of irrigated corn and grain sorghum in western Kansas. In this study, the optimum economic N rate (with P) for corn remains relatively constant at about 160 lb N/acre. Fertilizer P is required to maintain adequate levels of P in the soil and tends to increase soil organic matter content. Long term applications of N fertilizer tend to reduce soil pH while increasing soil organic matter.

Table 1. Effect of N and P on grain yield and yield components of irrigated corn. Tribune, KS, 1992.

N	P ₂ O ₅	Grain			Number		Ear Wt.	Kernel	
		Yield	Moist	TW	Plants	Ears		Number	Wt.
- lb/a -		bu/a	%	lb/bu	10 ⁻³ /acre		lb/ear	#/ear	oz/1000
0	0	73	24.5	51.8	30.0	23.7	0.17	299	9.16
0	40	88	24.5	52.4	30.1	23.9	0.21	361	9.27
0	80	80	23.8	52.7	30.0	26.3	0.17	300	9.17
40	0	90	25.8	51.9	30.0	27.9	0.18	308	9.45
40	40	128	20.3	54.1	29.9	28.8	0.25	423	9.45
40	80	128	20.7	54.2	28.6	26.0	0.27	441	9.96
80	0	91	28.0	51.5	30.5	27.5	0.19	302	9.83
80	40	157	19.3	55.5	30.4	30.7	0.29	447	10.25
80	80	140	19.7	55.0	30.4	27.2	0.29	477	9.59
120	0	98	28.9	51.6	30.9	27.8	0.20	334	9.52
120	40	162	18.5	55.6	31.2	29.6	0.31	477	10.27
120	80	157	18.5	55.8	28.2	26.5	0.33	518	10.33
160	0	115	24.6	52.3	30.3	28.5	0.23	376	9.68
160	40	169	18.7	55.4	28.8	25.3	0.38	598	10.08
160	80	178	18.6	55.8	30.2	29.7	0.34	506	10.63
200	0	111	26.2	52.2	30.4	27.3	0.23	375	9.72
200	40	187	18.3	55.8	29.6	28.3	0.37	558	10.59
200	80	165	18.5	56.1	27.8	27.4	0.34	493	10.89

ANOVA

Nitrogen	0.001	0.001	0.001	0.374	0.001	0.001	0.001	0.001	0.001
lin.	0.001	0.001	0.001	0.339	0.006	0.001	0.001	0.001	0.001
quad.	0.001	0.113	0.010	0.182	0.002	0.029	0.025	0.025	0.052
cubic	0.361	0.562	0.387	0.461	0.077	0.835	0.699	0.699	0.099
quart.	0.149	0.022	0.943	0.241	0.776	0.110	0.060	0.060	0.625
quint.	0.787	0.840	0.920	0.389	0.733	0.972	0.956	0.956	0.923
Phosphorus	0.001	0.001	0.001	0.021	0.535	0.001	0.001	0.001	0.001
lin.	0.001	0.001	0.001	0.007	0.948	0.001	0.001	0.001	0.001
quad.	0.001	0.001	0.001	0.568	0.266	0.001	0.001	0.001	0.026
N*P	0.013	0.001	0.008	0.139	0.014	0.007	0.010	0.010	0.001
N ₁ *P ₁	0.002	0.001	0.001	0.181	0.777	0.004	0.062	0.062	0.001
N ₁ *P _q	0.032	0.003	0.090	0.720	0.487	0.014	0.021	0.021	0.385
N _q *P ₁	0.041	0.001	0.038	0.989	0.162	0.009	0.002	0.002	0.223
N _q *P _q	0.643	0.002	0.059	0.766	0.073	0.445	0.329	0.329	0.436
N _c *P ₁	0.913	0.163	0.771	0.359	0.148	0.394	0.249	0.249	0.575
N _c *P _q	0.164	0.087	0.318	0.432	0.005	0.413	0.324	0.324	0.863
N _{qr} *P ₁	0.677	0.028	0.447	0.509	0.882	0.859	0.813	0.813	0.054
N _{qr} *P _q	0.089	0.234	0.321	0.163	0.019	0.725	0.213	0.213	0.001
N _{qn} *P ₁	0.921	0.165	0.725	0.027	0.261	0.340	0.696	0.696	0.004
N _{qn} *P _q	0.762	0.427	0.675	0.037	0.318	0.231	0.283	0.283	0.325

Table 1 (cont.) Effect of N and P on grain yield and yield components of irrigated corn. Tribune, KS, 1992.

MAIN EFFECT MEANS

	Grain			Number		Ear	Kernel	
	Yield	Moist	TW	Plants	Ears	Wt.	Number	Wt.
	bu/a	%	lb/bu	10^{-3}	/acre	lb/ear	/ear	oz/1000
<u>Nitrogen</u>								
lb/acre								
0	80	24.2	52.3	30.0	24.6	0.19	320	9.2
40	116	22.3	53.4	29.5	27.6	0.24	391	9.6
80	129	22.3	54.0	30.4	28.5	0.25	409	9.9
120	139	22.0	54.4	30.1	28.0	0.28	443	10.0
160	154	20.6	54.5	29.8	27.8	0.31	493	10.1
200	154	21.0	54.7	29.3	27.7	0.31	475	10.4
LSD _{.05}	14	1.2	0.7	1.1	1.8	0.03	42	0.2
<u>Phosphorus</u>								
lb/acre								
0	96	26.3	51.9	30.3	27.1	0.20	332	9.6
40	149	19.9	54.8	30.0	27.8	0.30	477	10.0
80	141	20.0	54.9	29.2	27.2	0.29	456	10.1
LSD _{.05}	10	0.8	0.5	0.8	1.3	0.02	30	0.2

Table 2a. Effect of 31 years of N, P, and K fertilization of irrigated corn on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

N	P ₂ O ₅	K ₂ O	P	K	Ca	Mg	Na	Zn	Fe
-- -lb/a -- -			-- - - - - ppm - - - - -						
0	0	0	6	560	7600	540	47	1.10	5.6
0	40	0	30	640	8200	630	55	1.02	6.0
0	40	40	27	610	7300	530	52	1.08	6.0
40	0	0	4	550	6600	490	46	0.98	5.6
40	40	0	19	580	6300	550	53	1.12	6.4
40	40	40	20	640	6300	530	47	1.02	6.2
80	0	0	4	580	6600	520	47	0.94	5.8
80	40	0	16	620	6100	520	49	0.94	6.0
80	40	40	16	640	6900	540	45	1.00	6.0
120	0	0	5	550	6900	530	46	0.80	5.6
120	40	0	10	580	7400	540	49	0.98	5.6
120	40	40	13	680	7000	540	42	1.02	6.0
160	0	0	4	570	6900	510	47	0.92	5.8
160	40	0	11	590	6200	510	45	0.96	6.2
160	40	40	10	670	7200	510	50	0.82	5.6
200	0	0	4	580	5400	480	49	0.94	6.0
200	40	0	10	570	6400	540	45	1.02	5.6
200	40	40	10	660	6500	510	47	0.94	5.8

ANOVA

Nitrogen	0.001	0.923	0.031	0.042	0.293	0.002	0.449
lin.	0.001	0.705	0.040	0.004	0.065	0.001	0.252
quad.	0.001	0.827	0.690	0.434	0.140	0.024	0.805
cubic	0.433	0.610	0.007	0.222	0.713	0.160	0.240
quart.	0.431	0.542	0.372	0.270	0.578	1.000	0.202
quint.	0.574	0.454	0.657	0.703	0.774	0.497	0.569
P-K	0.001	0.001	0.848	0.022	0.386	0.156	0.106
Zero P vs P	0.001	0.001	0.605	0.027	0.470	0.084	0.037
P vs P-K	0.962	0.001	0.808	0.091	0.241	0.389	0.777
N*P-K	0.001	0.442	0.859	0.306	0.438	0.104	0.124
N ₁ *ZeroP vs P-K	0.001	0.725	0.384	0.579	0.077	0.635	0.013
N ₁ *P vs P-K	0.514	0.018	0.383	0.149	0.111	0.187	0.934
N _q *ZeroP vs P-K	0.024	0.610	0.427	0.210	0.763	0.090	0.408
N _q *P vs P-K	0.396	0.347	0.383	0.017	0.351	0.708	0.940
N _c *ZeroP vs P-K	0.970	0.603	0.808	0.334	0.706	0.488	0.835
N _c *P vs P-K	0.673	0.678	0.825	0.561	0.541	0.738	0.570
N _{qr} *ZeroP vs P-K	0.993	0.951	0.464	0.908	0.568	0.437	0.258
N _{qr} *P vs P-K	0.789	0.579	0.478	0.878	0.324	0.027	0.029
N _{qn} *ZeroP vs P-K	0.496	0.716	0.768	0.498	0.963	0.024	0.562
N _{qn} *P vs P-K	0.504	0.150	0.287	0.692	0.218	0.907	0.178

Table 2a. (cont.) Effect of 31 years of N, P, and K fertilization of irrigated corn on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

MAIN EFFECT MEANS

	P	K	Ca	Mg	Na	Zn	Fe
	- - - - - ppm - - - - -						
<u>Nitrogen</u> (lb/acre)							
0	21	600	7700	570	51	1.07	5.9
40	14	590	6400	530	49	1.04	6.1
80	12	610	6500	530	47	0.96	5.9
120	9	600	7100	530	46	0.93	5.7
160	8	610	6800	510	47	0.90	5.9
200	8	600	6100	510	47	0.97	5.8
LSD _{.05}	3	40	1000	40	5	0.09	0.3
<u>P-K</u> (lb/a)							
0- 0	4	560	6700	510	47	0.95	5.7
40- 0	16	600	6800	550	49	1.01	6.0
40-40	16	650	6900	530	47	0.98	5.9
LSD _{.05}	2	30	700	30	4	0.06	0.2

Table 2b. Effect of 31 years of N, P, and K fertilization of irrigated corn on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

N	P ₂ O ₅	K ₂ O	NH ₄ -N	NO ₃ -N	Total N	OM	CEC	pH
- - -lb/a - - -			- - - ppm - - - - -			%	meq/100g	
0	0	0	4.66	3.68	1080	2.02	23.6	8.14
0	40	0	4.88	5.00	1040	2.10	23.3	8.14
0	40	40	5.26	4.56	1100	2.16	23.2	8.08
40	0	0	5.06	6.28	1100	2.18	22.8	8.12
40	40	0	5.16	4.10	1130	2.26	23.7	8.08
40	40	40	5.02	11.12	1130	2.16	23.8	8.08
80	0	0	5.06	9.08	1140	2.08	23.7	8.10
80	40	0	5.40	6.38	1160	2.34	23.6	8.04
80	40	40	4.92	5.48	1180	2.16	24.2	8.08
120	0	0	5.72	6.58	1120	2.10	24.3	8.06
120	40	0	5.28	7.34	1190	2.40	23.2	8.06
120	40	40	5.06	7.84	1190	2.34	24.1	8.08
160	0	0	5.58	10.24	1150	2.24	23.8	8.06
160	40	0	5.20	5.80	1170	2.26	24.6	8.06
160	40	40	5.50	8.56	1220	2.46	23.4	8.04
200	0	0	5.44	10.04	1190	2.22	23.3	7.98
200	40	0	5.94	11.04	1200	2.38	24.5	7.92
200	40	40	5.90	9.04	1220	2.52	23.6	8.02

ANOVA

Nitrogen	0.004	0.006	0.001	0.014	0.120	0.001
lin.	0.001	0.001	0.001	0.001	0.017	0.001
quad.	0.459	0.997	0.041	0.880	0.154	0.236
cubic	0.697	0.133	0.290	0.783	0.481	0.151
quart.	0.869	0.538	0.808	0.631	0.727	0.567
quint.	0.576	0.836	0.660	0.550	0.531	0.970
P-K	0.933	0.427	0.002	0.011	0.412	0.481
Zero P vs P	0.763	0.584	0.004	0.003	0.240	0.296
P vs P-K	0.827	0.237	0.036	0.862	0.534	0.545
N*P-K	0.373	0.166	0.491	0.624	0.006	0.799
N ₁ *ZeroP vs P-K	0.691	0.402	0.225	0.344	0.526	0.539
N ₁ *P vs P-K	0.868	0.338	0.614	0.231	0.062	0.113
N _q *ZeroP vs P-K	0.033	0.405	0.103	0.851	0.466	0.944
N _q *P vs P-K	0.209	0.353	0.286	0.153	0.019	0.968
N _c *ZeroP vs P-K	0.275	0.757	0.573	0.793	0.012	0.621
N _c *P vs P-K	0.218	0.608	0.307	0.252	0.555	0.161
N _{qr} *ZeroP vs P-K	0.731	0.854	0.999	0.236	0.066	0.840
N _{qr} *P vs P-K	0.438	0.012	0.738	0.438	0.028	0.441
N _{qn} *ZeroP vs P-K	0.321	0.060	0.246	0.730	0.685	0.618
N _{qn} *P vs P-K	0.997	0.374	0.312	0.922	0.198	0.944

Table 2b. (cont.) Effect of 31 years of N, P, and K fertilization of irrigated corn on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

MAIN EFFECT MEANS

	NH ₄ -N	NO ₃ -N	Total N	OM	CEC	pH
	- - - - ppm - - - - -			%	meq/100g	
<u>Nitrogen</u> (lb/acre)						
0	4.93	4.41	1070	2.09	23.4	8.12
40	5.08	7.17	1120	2.20	23.4	8.09
80	5.13	6.98	1160	2.19	23.8	8.07
120	5.35	7.25	1170	2.28	23.9	8.07
160	5.43	8.20	1180	2.32	24.0	8.05
200	5.76	10.04	1200	2.37	23.8	7.97
LSD _{.05}	0.43	2.74	30	0.16	0.5	0.06
<u>P-K</u> (lb/a)						
0- 0	5.25	7.65	1130	2.14	23.6	8.08
40- 0	5.31	6.61	1150	2.29	23.8	8.05
40-40	5.28	7.77	1170	2.30	23.7	8.06
LSD _{.05}	0.30	1.94	20	0.11	0.4	0.04

Table 3. Effect of of N, P, and K fertilization of irrigated grain sorghum on grain yield. Tribune, KS, 1992.

N	P205	K20	Grain		
			Yield	Moist	TW
- - -lb/a - -			bu/a	%	lb/bu
0	0	0	27	20.4	44.9
0	40	0	28	20.3	46.4
0	40	40	35	20.5	47.2
40	0	0	46	20.0	47.7
40	40	0	72	19.8	50.3
40	40	40	72	20.0	50.0
80	0	0	68	19.7	49.9
80	40	0	85	20.1	49.9
80	40	40	85	19.8	50.4
120	0	0	56	20.0	48.2
120	40	0	87	19.3	50.9
120	40	40	90	20.1	49.8
160	0	0	62	19.9	48.4
160	40	0	92	19.6	51.4
160	40	40	88	19.7	50.8
200	0	0	80	19.9	50.8
200	40	0	91	19.6	51.8
200	40	40	103	19.9	50.8

ANOVA

Nitrogen	0.001	0.079	0.001
lin.	0.001	0.011	0.001
quad.	0.001	0.104	0.022
cubic	0.001	0.545	0.008
quart.	0.893	0.543	0.537
quint.	0.425	0.877	0.696
P-K	0.001	0.339	0.004
Zero P vs P	0.001	0.536	0.001
P vs P-K	0.431	0.183	0.632
N*P-K	0.420	0.905	0.838
N1*ZeroP vs P-K	0.189	0.664	0.619
N1*P vs P-K	0.814	0.622	0.313
Nq*ZeroP vs P-K	0.049	0.962	0.780
Nq*P vs P-K	0.318	0.967	0.872
Nc*ZeroP vs P-K	0.831	0.648	0.292
Nc*P vs P-K	0.695	0.571	0.994
Nqr*ZeroP vs P-K	0.284	0.539	0.190
Nqr*P vs P-K	0.443	0.831	0.888
Nqn*ZeroP vs P-K	0.230	0.464	0.404
Nqn*P vs P-K	0.706	0.102	0.429

Table 3 (cont). Effect of of N, P, and K fertilization of irrigated grain sorghum on grain yield. Tribune, KS, 1992.

MAIN EFFECT MEANS

	Grain		
	Yield	Moist	TW
	bu/a	%	lb/bu
Nitrogen (lb/acre)			
0	30	20.4	46.2
40	64	19.9	49.3
80	80	19.9	50.1
120	78	19.8	49.7
160	81	19.7	50.2
200	91	19.8	51.1
LSD.05	10	0.5	1.6
P-K (lb/a)			
0- 0	56	20.0	48.3
40- 0	76	19.8	50.1
40-40	79	20.0	49.8
LSD.05	7	0.3	1.1

Table 4a. Effect of 31 years of N, P, and K fertilization of irrigated grain sorghum on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

N	P2O5	K2O	P	K	Ca	Mg	Na	Zn	Fe
- - -lb/a - -			- - - - - ppm - - - - -						
0	0	0	9	590	5000	460	58	0.78	6.6
0	40	0	34	570	4700	470	53	0.82	7.0
0	40	40	30	640	5000	490	55	0.84	7.2
40	0	0	9	570	4600	470	54	0.68	6.6
40	40	0	32	590	4500	480	56	0.80	7.4
40	40	40	33	650	4300	460	51	0.76	7.2
80	0	0	8	580	4400	470	54	0.64	7.0
80	40	0	24	590	4700	480	54	0.72	7.4
80	40	40	28	660	4400	470	56	0.72	7.0
120	0	0	7	570	5000	460	53	0.66	6.6
120	40	0	21	570	5100	460	59	0.76	7.2
120	40	40	26	630	4600	450	51	0.74	7.8
160	0	0	8	620	4300	440	54	0.72	6.6
160	40	0	25	580	4300	460	53	0.72	8.2
160	40	40	20	640	4700	450	52	0.70	7.6
200	0	0	9	590	4500	460	47	0.68	7.8
200	40	0	21	590	4800	480	48	0.66	8.0
200	40	40	21	640	4500	470	47	0.78	7.8

ANOVA

Nitrogen	0.001	0.340	0.181	0.579	0.020	0.003	0.095
lin.	0.001	0.417	0.342	0.312	0.005	0.001	0.005
quad.	0.204	0.972	0.582	0.606	0.059	0.017	0.338
cubic	0.263	0.468	0.258	0.259	0.136	0.166	0.623
quart.	0.097	0.370	0.089	0.318	0.958	0.772	0.917
quint.	0.635	0.056	0.131	0.653	0.898	0.346	0.917
P-K	0.001	0.001	0.705	0.366	0.482	0.010	0.016
Zero P vs P	0.001	0.002	0.908	0.309	0.836	0.003	0.004
P vs P-K	0.966	0.001	0.409	0.324	0.235	0.646	0.680
N*P-K	0.003	0.461	0.891	0.989	0.769	0.468	0.763
Nl*ZeroP vs P-K	0.001	0.248	0.387	0.971	0.643	0.339	0.907
Nl*P vs P-K	0.937	0.415	0.644	0.563	0.593	0.228	0.658
Nq*ZeroP vs P-K	0.944	0.293	0.863	0.449	0.373	0.450	0.471
Nq*P vs P-K	0.040	0.762	0.497	0.527	0.399	0.089	1.000
Nc*ZeroP vs P-K	0.476	0.034	0.961	0.855	0.568	0.274	0.195
Nc*P vs P-K	0.118	0.927	0.301	0.436	0.951	0.539	0.688
Nqr*ZeroP vs P-K	0.483	0.384	0.911	0.977	0.675	0.513	0.242
Nqr*P vs P-K	0.082	0.967	0.309	0.589	0.790	0.322	0.374
Nqn*ZeroP vs P-K	0.686	0.420	0.479	0.653	0.637	0.384	0.659
Nqn*P vs P-K	0.191	0.468	0.385	0.849	0.061	0.813	0.221

Table 4a. (cont.) Effect of 31 years of N, P, and K fertilization of irrigated grain sorghum on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

MAIN EFFECT MEANS

	P	K	Ca	Mg	Na	Zn	Fe
	----- ppm -----						
Nitrogen (lb/acre)							
0	24	600	4900	470	55	0.81	6.9
40	25	600	4500	470	54	0.75	7.1
80	20	610	4500	470	54	0.69	7.1
120	18	590	4900	460	55	0.72	7.2
160	18	610	4400	450	53	0.71	7.5
200	17	610	4600	470	47	0.71	7.9
LSD.05	3	20	500	30	5	0.06	0.7
P-K (lb/a)							
0- 0	8	580	4600	460	53	0.69	6.9
40- 0	26	580	4700	470	54	0.75	7.5
40-40	26	640	4600	460	52	0.76	7.4
LSD.05	2	10	300	20	3	0.04	0.5

Table 4b. Effect of 31 years of N, P, and K fertilization of irrigated grain sorghum on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

N	P ₂ O ₅	K ₂ O	NH ₄ -N	NO ₃ -N	Total N	OM	CEC	pH
- - -lb/a - -			- - - - ppm - - - - -			%	meq/100g	
0	0	0	3.98	3.52	1040	1.82	22.9	8.02
0	40	0	4.22	2.70	1050	1.70	23.1	8.08
0	40	40	4.26	3.42	1050	1.96	23.1	8.12
40	0	0	4.06	4.32	1080	1.88	22.5	8.04
40	40	0	4.12	5.84	1110	1.98	23.4	7.92
40	40	40	4.36	5.92	1150	1.98	23.3	8.00
80	0	0	4.36	5.78	1100	1.82	23.1	7.94
80	40	0	4.30	9.34	1120	2.00	23.7	7.94
80	40	40	4.50	8.06	1170	1.88	22.8	7.92
120	0	0	4.82	8.02	1120	1.92	23.0	7.90
120	40	0	4.74	10.32	1170	1.98	23.2	7.92
120	40	40	4.48	8.12	1140	1.78	22.9	7.92
160	0	0	4.58	10.04	1150	2.04	23.2	7.90
160	40	0	4.96	13.78	1160	1.86	23.3	7.78
160	40	40	5.14	10.96	1200	1.98	23.3	7.78
200	0	0	4.82	15.78	1200	2.06	23.2	7.72
200	40	0	5.34	11.36	1190	1.90	23.6	7.68
200	40	40	4.52	12.72	1200	2.12	23.0	7.64

ANOVA

Nitrogen	0.001	0.001	0.001	0.134	0.972	0.001
lin.	0.001	0.001	0.001	0.019	0.505	0.001
quad.	0.939	0.940	0.174	0.694	0.866	0.229
cubic	0.226	0.851	0.198	0.182	0.825	0.166
quart.	0.960	0.798	0.511	0.308	0.925	0.896
quint.	0.965	0.494	0.889	0.935	0.573	0.694
P-K	0.501	0.560	0.059	0.664	0.251	0.673
Zero P vs P	0.281	0.433	0.039	0.941	0.294	0.396
P vs P-K	0.643	0.461	0.231	0.369	0.196	0.795
N*P-K	0.563	0.429	0.817	0.184	0.966	0.879
N ₁ *ZeroP vs P-K	0.961	0.342	0.604	0.225	0.536	0.249
N ₁ *P vs P-K	0.114	0.737	0.860	0.940	0.687	0.432
N _q *ZeroP vs P-K	0.523	0.025	0.269	0.620	0.897	0.728
N _q *P vs P-K	0.232	0.199	0.746	0.003	0.784	1.000
N _c *ZeroP vs P-K	0.679	0.575	0.952	0.205	0.511	0.622
N _c *P vs P-K	0.681	0.377	0.401	0.672	0.430	0.950
N _{qr} *ZeroP vs P-K	0.260	0.468	0.645	0.757	0.441	0.141
N _{qr} *P vs P-K	0.272	0.783	0.294	0.439	0.431	0.575
N _{qn} *ZeroP vs P-K	0.422	0.440	0.879	0.748	0.722	0.781
N _{qn} *P vs P-K	0.381	0.870	0.146	0.475	0.552	0.728

Table 4b. (cont.) Effect of 31 years of N, P, and K fertilization of irrigated grain sorghum on soil (0-6") chemical properties. Tribune, KS, Spring 1992.

MAIN EFFECT MEANS

	NH ₄ -N	NO ₃ -N	Total N	OM	CEC	pH
	- - - - ppm - - - - -			%	meq/100g	
<u>Nitrogen</u> (lb/acre)						
0	4.15	3.21	1050	1.83	23.1	8.07
40	4.18	5.36	1110	1.95	23.1	7.99
80	4.39	7.73	1130	1.90	23.2	7.93
120	4.68	8.82	1140	1.89	23.0	7.91
160	4.89	11.59	1170	1.96	23.2	7.82
200	4.89	13.29	1190	2.03	23.3	7.68
LSD .05	0.42	2.63	40	0.15	0.7	0.11
<u>P-K</u> (lb/a)						
0- 0	4.44	7.91	1120	1.92	23.0	7.92
40- 0	4.61	8.89	1130	1.90	23.4	7.89
40-40	4.54	8.20	1150	1.95	23.1	7.90
LSD .05	0.30	1.86	30	0.10	0.5	0.08