Research Report of Progress
Grant-in-Aid Program , 1981
The Potash/Phosphate Institute

Potassium and Phosphorus Research on Field Crops

Agronomy Department
Kansas Agricultural Experiment Station
Kansas State University
Manhattan, Kansas 66506

REPORT OF 1981 PHOSPHORUS AND POTASSIUM RESEARCH
RECEIVING SUPPORT FROM THE POTASH/PHOSPHATE INSTITUTE

Compiled by David A. Whitney, Agronomy Department
Kansas State University

In this report research results from studies conducted in 1981 receiving partial support from PPI are presented. The support from PPI was utilized for the soil and plant analytical results reported. Much of the discussion and research results are taken from the 1981 Kansas Fertilizer Research Report of Progress. Several researchers at the Branch Experiment Stations and Experiment Fields were involved in conducting the studies and recognition of these personnel for their work is intended.

I. PRODUCTION AND QUALITY OF IRRIGATED ALFALFA

MANAGEMENT OF IRRIGATED ALFALFA

Sandyland Experiment Field
Jim Ball, George TenEyck and David Whitney

An irrigated alfalfa management study was designed during 1974-1975 by several people including R. L. Vanderlip, Larry Murphy, Gerry Posler, E. Sorenson, Dave Kissel and the authors.

The objectives of this study are to (1) determine the forage yield and nutrient removal of alfalfa to various levels of P_2O_5 applied preplant, annually and split during the growing season; to three levels of K_2O and to one level of sulfur: (2) the forage yield, forage quality and stand persistence to three cutting management systems: and, (3) whether an additional late fall cutting will reduce stand persistence under different fertility rates. This study is located on two sandy soil types; Pratt loamy fine sand and Naron loamy fine sand. Two fertility treatments were changed in the spring of 1981. The sulfur treatment was dropped and replaced with 640 lbs/A K_2O instead of 80 lbs/A and the split P_2O_5 treatment was changed to 120 lbs P_2O_5 applied annually plus 320 lbs/A K_2O instead of 80 lbs/A. The split P_2O_5 application and the sulfur treatment were not showing differences from similar treatments and with the declining soil test K levels, it was decided to include some high K_2O rate treatments.

Two varieties, Kanza and Marathon, were seeded September 4, 1975 following wheat. The cutting managements are as follows: cutting each time at the bud stage; cutting each time at the 1/10 bloom stage; and cutting alternately at the bud stage and full bloom stage. Four cuttings were harvested in 1976 and are not included in the following data. Five cuttings were made in 1977 and 1978 with the additional late fall cutting being made only on the bud stage in 1977 and on the bud stage and 1/10 bloom in 1978. In 1979, 1980, and 1981, five cuttings were taken from the bud and 1/10 bloom areas and four cuttings were taken from the alternate cut area and all areas had the late fall cuttings for the two fertility treatments.

The 1981 results shown in Table 65 are for the Kanza variety only. The highest forage and crude protein yields since the beginning of the study were obtained in 1981. Top yield of 12.7 tons/A of alfalfa adjusted to 15% moisture was obtained on a high level P_2O_5 plot with six cuttings harvested. This has been the highest yielding treatment for the study over the past five years. The unfertilized plot yield increased this

year over last year. Part of the reason for this is that the alfalfa roots are now extending over into adjacent plots that have high levels of P_2O_5. The higher forage yields also made higher removal of the nutrients, P and K. This year is the first year that the soil test from the 80 lbs/A P_2O_5 application has not been near the beginning soil test reading of 19 lbs/A P. These results would indicate that between 80 and 120 lbs/A P_2O_5 annual application is needed to maintain the original level of P in the soil. The K soil test values are near the 1980 values. With the changes in the two treatments, the higher K rates should show some increase in soil K but this was not reflected in higher forage yields in 1981. The analysis of the forage showed higher levels of K and therefore more K was removed from these plots. Nutrient removal of P and K were higher in 1981 with the higher yielding treatments removing 60-65 lbs P/A and 390 to 425 lbs K/A.

In summary, application of between 80 and 120 lbs/A P_2O_5 is needed each year to obtain optimum yield and to maintain the level of P in the soil. With the treatments in this study, there has been no yield advantage for applying potassium fertilizer. For optimum alfalfa production on other soils, soil testing is needed to monitor the nutrient level in the soil.

FERTILIZATION OF IRRIGATED ALFALFA

Kansas River Valley Experiment Field
L. D. Maddux and P. L. Barnes

This study was initiated in 1976 to evaluate the effects of phosphorus fertilizer applied preplant and plowed down and annual treatments of nitrogen, phosphorus and potassium on irrigated alfalfa. Kanza alfalfa was seeded April 13, 1976 at 10 pounds per acre. Annual treatments of phosphorus and potassium were applied October 31. Harvests were made May 11, June 16, July 16, August 17 and October 2 with a flail harvester.

Annual treatments of phosphorus fertilizer increased the percent phosphorus in all five cuttings of the alfalfa forage at both the 40 and 80 pounds P_2O_5 per acre rates (Table 57). The annual application of 80 pounds per acre of K_2O increased the potassium content of all five cuttings of the alfalfa forage.

A thin stand of alfalfa was obtained when this study was established. The original stand has been fairly well maintained, but the total yield of about 6 Ton/a could have been better with an optimum stand. There was a trend, although not significant, for forage yield to increase with preplant applications of phosphorus. The annual applications of P and K combined increased total yield by about one-third ton per acre compared to P or K used alone. This would seem to stress the need for a balanced fertility program.

Soil levels of phosphorus have increased slightly with the 80 pounds P_2O_5 per acre annual treatment, while plots not receiving phosphate have decreased to a low level from the original 40 pound available P_2O_5 per acre soil test value. Potassium soil test levels have declined from the 1976 value of 450 pounds exchangeable K_2O per acre even with the annual applications of potash.

Table 65. MANAGEMENT OF IRRIGATED KANZA ALFALFA

Sandyland Experiment Field

J. Ball, G. TenEyck, and D. Whitney

Fertilizer Treatment, Lbs/A			Forage Yield, Tons/A @ 15% Moisture					Crude Protein Yield Lbs/A				
P_2O_5		K_2O										
Preplant	Annual	Annual	1981	1980	1979	1978	1977	1981	1980	1979	1978	1977
0	0	0	9.1	7.1	7.4	7.7	8.1	3050	2640	2909	2718	3040
0	40	80	10.6	8.5	8.9	9.3	9.3	3707	3103	3581	3266	3585
0	80	80	11.4	8.8	9.5	9.7	9.3	3973	3427	3875	3466	3566
0	120	80	12.1	9.5	10.0	10.6	9.6	4063	3656	4124	3858	3732
320	0	80	10.1	8.3	9.0	9.9	9.4	3488	3175	3609	3623	3613
320	40	80	11.4	9.1	9.7	10.7	9.9	3927	3387	3931	3801	3753
320	80	80	12.1	9.2	9.7	10.3	9.5	4169	3647	4047	3704	3629
320	120	80	11.9	9.5	9.6	10.6	9.8	4262	3681	3964	3803	3773
0	120	0	11.9	9.6	9.6	10.5	9.6	4247	3783	3991	3907	3779
0	120	160	11.9	9.5	9.9	10.6	10.0	4121	3696	3981	3799	3752
0	120	320 1/	12.0	9.2	9.8	10.0	9.2	4115	3574	3962	3587	3544
0	120	640 1/	11.6	9.2	9.9	10.3	9.9	4064	3589	4078	3668	3729
320	120	80 2/	12.7	10.0	10.6	11.6	9.6	4407	3827	4290	4081	3635
0	0	80 2/	9.5	7.8	8.3	8.3	8.3	3186	2844	3225	2914	3046
	LSD (.05)		--	--	--	1.1	0.8	--	--	--	445	328

			Nutrient Removal, Lbs/A									
			Available P - Lbs/A					Exchangeable K - Lbs/A				
			1981	1980	1979	1978	1977	1981	1980	1979	1978	1977
0	0	0	33	26	30	27	33	314	265	286	341	363
0	40	80	43	35	41	35	44	366	317	358	415	426
0	80	80	51	44	50	42	49	376	341	373	449	429
0	120	80	59	53	59	49	53	389	360	396	479	452
320	0	80	39	34	41	40	46	363	325	356	466	432
320	40	80	49	42	52	45	52	382	340	387	480	456
320	80	80	55	49	58	48	54	403	364	376	463	436
320	120	80	63	54	59	51	59	399	357	384	485	460
0	120	0	60	53	59	53	54	351	329	356	472	429
0	120	160	56	50	56	49	54	408	379	396	491	451
0	120	320 1/	69	45	52	43	48	445	346	393	467	424
0	120	640 1/	57	50	59	48	53	472	346	386	470	436
320	120	80 2/	65	57	69	57	57	403	359	402	506	437
0	0	80 2/	34	29	35	28	33	356	302	324	374	367
	LSD (.05)		--	--	--	7	6	--	--	--	54	43

			Soil Test Results, Lbs/A							
			Available P				Exchangeable K			
			1981	1980	1979	1978	1981	1980	1979	1978
0	0	0	7	9	9	10	103	107	93	109
0	40	80	9	10	11	16	115	106	89	131
0	80	80	14	17	16	18	104	100	88	127
0	120	80	25	27	26	27	93	93	88	112
320	0	80	11	13	18	26	106	109	82	131
320	40	80	15	22	28	36	101	100	88	121
320	80	80	29	31	38	42	101	96	82	119
320	120	80	40	46	40	55	95	102	79	122
0	120	0	27	30	22	26	83	89	77	113
0	120	160	25	25	26	23	100	113	85	119
0	120	320 1/	18	20	24	23	108	102	83	134
0	120	640 1/	24	32	31	29	93	92	83	118
320	120	80 2/	49	49	45	49	83	86	73	125
0	0	80 2/	8	9	9	12	93	103	85	133

1/ These two treatments were changed in 1981. (See narrative for explanation.)

2/ Additional cutting taken in late fall.

Initial Soil Test Level: P = 19 Lbs/A, K = 252 Lbs/A
Soil Samples Taken: 4/4/81, 4/1/80, 3/30/79, 4/3/78

TABLE 57. EFFECT OF P AND K ON FORAGE YIELD, PERCENT NITROGEN, PERCENT PHOSPHORUS AND PERCENT POTASSIUM OF IRRIGATED ALFALFA, 1981

Kansas River Valley Experiment Field
L. D. Maddux and P. L. Barnes

Fertilizers, lb/a			Cut 1				Cut 2				Cut 3			
Pre	Annual		Forage	Protein			Forage	Protein			Forage	Protein		
P_2O_5	P_2O_5	K_2O	yield[1]	%	%P	%K	yield[1]	%	%P	%K	yield[1]	%	%P	%K
0	0	80	1.50	17.81	.185	2.40	0.87	17.88	.235	3.19	1.07	16.25	.184	2.47
0	40	0	1.72	17.31	.241	1.99	0.95	18.73	.314	2.71	1.16	16.56	.226	2.03
0	40	80	1.82	17.25	.235	2.55	1.08	17.52	.299	3.03	1.18	16.21	.226	2.30
0	80	80	1.79	17.63	.260	2.33	1.09	18.44	.329	2.75	1.24	16.23	.239	2.24
80	0	80	1.64	16.63	.187	2.54	1.02	18.65	.252	3.06	1.31	15.71	.190	2.56
80	40	0	1.75	16.96	.231	2.08	0.97	18.48	.293	2.71	1.14	17.15	.233	2.13
80	40	80	1.80	17.65	.239	2.34	1.11	16.63	.293	2.72	1.21	17.23	.239	2.46
160	0	80	1.73	17.17	.201	2.50	1.01	17.77	.274	3.07	1.18	16.23	.207	2.43
160	40	0	1.83	18.02	.261	1.97	1.00	18.50	.290	2.61	1.12	17.38	.233	2.01
160	40	80	1.71	17.04	.242	2.49	1.03	17.31	.309	3.08	1.12	16.63	.234	2.38
160	80	80	1.86	17.63	.279	2.39	1.05	17.90	.351	3.02	1.23	16.25	.245	2.45
Preplant P_2O_5 Means:														
0			1.71	17.36	.230	2.36	1.00	18.13	.294	2.97	1.17	16.46	.219	2.28
80			1.66	16.80	.233	2.40	1.04	18.05	.287	2.87	1.22	16.51	.226	2.37
160			1.80	17.20	.246	2.37	1.05	17.65	.306	2.94	1.20	16.41	.230	2.34
LSD(.05)			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Annual Fertilizer Means:														
0-0-80			1.62	17.20	.191	2.48	0.96	18.10	.254	3.11	1.19	16.06	.194	2.49
0-40-0			1.76	17.43	.244	2.01	0.97	18.57	.299	2.68	1.14	17.03	.231	2.06
0-40-80			1.78	17.31	.239	2.46	1.08	17.15	.300	2.95	1.22	16.69	.233	2.38
0-80-80			1.72	17.26	.271	2.40	1.07	18.31	.330	2.88	1.22	16.32	.241	2.33
LSD(.05)			NS	NS	.011	.09	.07	NS	.014	.15	NS	NS	.010	.07

Fertilizers, lb/a			Cut 4				Cut 5				Total	Soil Test Lev[2]	
Pre	Annual		Forage	Protein			Forage	Protein			Forage	Avail.	Exch.
P_2O_5	P_2O_5	K_2O	yield[1]	%	%P	%K	yield[1]	%	%P	%K	yield[1]	P_2O_5	K_2O
0	0	80	1.00	17.94	.215	2.82	0.70	19.58	.197	2.85	5.13	11	312
0	40	0	1.02	18.58	.262	2.46	0.78	19.35	.232	2.42	5.63	28	240
0	40	80	0.99	18.71	.253	2.78	0.79	18.29	.230	2.76	5.86	30	323
0	80	80	1.03	17.25	.280	2.71	0.81	18.52	.253	2.60	5.97	41	287
80	0	80	1.12	17.94	.216	2.77	0.78	18.31	.204	2.83	5.88	12	309
80	40	0	1.05	18.00	.262	2.62	0.73	18.60	.234	2.47	5 63	31	237
80	40	80	1.10	17.90	.255	2.61	0.84	18.94	.246	2.60	6.06	32	304
80	80	80	1.11	17.90	.263	2.63	0.80	18.69	.254	2.79	5.72	55	282
160	0	80	1.07	17.92	.225	2.67	0.79	18.73	.210	2.77	5.79	17	286
160	40	0	1.05	18.50	.260	2.49	0.77	19.44	.246	2.37	5.77	36	233
160	40	80	1.09	18.21	.247	2.59	0.78	19.77	.241	2.71	5.88	32	271
160	80	80	1.14	17.88	.273	2.59	0.85	19.15	.254	2.62	6.12	54	271
Preplant P_2O_5 Means:													
0			1.03	18.27	.253	2.64	0.77	19.10	.228	2.66	5.65	28	291
80			1.09	17.91	.249	2.66	0.79	18.76	.235	2.68	5.83	33	283
160			1.08	18.00	.251	2.63	0.80	19.25	.238	2.63	5.89	35	265
LSD(.05)			NS	NS	NS	NS	NS	NS	NS	NS			
Annual Fertilizer Means													
0-0-80			1.07	17.93	.219	2.75	0.76	18.88	.204	2.81	5.60	13	302
0-40-0			1.04	18.36	.261	2.52	0.76	19.13	.237	2.42	5.68	32	237
0-40-80			1.06	18.27	.252	2.66	0.80	19.00	.239	2.69	5.94	31	299
0-80-80			1.09	17.67	.272	2.65	0.82	18.78	.254	2.67	5.94	50	280
LSD(.05)			NS	NS	.010	.11	.03	NS	.011	.08	.15		

[1] Machine harvested yields corrected to 15% moisture, tons/a.

[2] 0-6" soil depth.

EFFECT OF RATE AND FREQUENCY OF APPLICATION OF TWO PHOSPHORUS SOURCES ON GRAIN SORGHUM

East Central Kansas Experiment Field

K. A. Janssen, D. A. Whitney and D. E. Kissel

The question is frequently asked, is it necessary to apply phosphorus fertilizer annually, or can it be applied less often at a higher rate? To answer this question, a phosphorus rate and frequency of application study was begun on grain sorghum at the East Central Kansas Experiment Field in 1974.

Procedure: Treatment variables each year have included a control plot with no phosphorus fertilizer applied, 50 lbs. P_2O_5/a applied annually, 100 lbs. P_2O_5/a applied every other year, and 200 lbs. P_2O_5/a applied once every four years. Thus, over a four year application period all P plots received the same amount of phosphorus. Two phosphorus sources, ammonium orthophosphate (18-46-0) and ammonium polyphosphate (10-34-0) are also being evaluated.

In 1981, as in previous years, the fertilizer phosphorus was applied in the spring and incorporated by disking. Northrup King 2778 grain sorghum was planted June 25, 1981. Furdan 10G at 12 lbs. product/a was applied in the furrow at planting. Ramrod-atrazine flowable at 4 qt./a (pre-emergence), plus one cultivation was used to control weeds. Leaf tissue samples were collected at the boot stage. Harvest was October 22. Results for 1981 and multi-year yield averages are presented in Table 69.

Results: 1981 yield data again demonstrate the excellent yield response obtainable with phosphorus on this phosphorus deficient Woodson silty clay loam soil. Grain sorghum yield in 1981 was, on the average, increased 24 bu/a where phosphorus fertilizer had been applied compared to no phosphorus. Eight-year yield averages show an average yield response of 16.7 bu/a.

Frequency of phosphorus application (annual, biannual, and application once every four years) had no influence on grain sorghum yield in 1981, as in all previous years except 1974 and 1978. In 1974, the first year of the study when P soil test levels were low, the 50 lbs. P_2O_5/a annual rate did not yield as well as the 100 lbs. P_2O_5/a biannual rate, or the 200 lbs. P_2O_5/a rate applied every four years. This inital yield difference was simply a rate effect with the higher initial P applications yielding best. In the fourth year of the study, 1978, the 200 lbs. P_2O_5/a rate that had been applied four years previously did not yield as well as the 50 lbs. P_2O_5/a rate applied annually. In this situation, application span was influencing yield.

Yield results for the second four year's application, 1978-1981, show no difference in yield due to P application span (annual, biannual, or application every four years). The lack of response is likely due to increased soil P levels resulting from the four previous years of P application. Soil test data in Table 69 show a near doubling of soil P test levels from 1976 through 1980.

1981 plant tissue analysis also confirm the lack of any difference between the rate and frequency of phosphorus applications. Phosphorus in the grain sorghum at the boot stage was lower where no phosphorus was applied, but was no different for annual, biannual, or application of phosphorus every four years.

The two phosphorus sources, ammonium orthophosphate (18-46-0) and ammonium polyphosphate (10-34-0), produced similar results in 1981 as in previous years of this study.

Conclusions: Rate and frequency of phosphorus application was found to be a yield influencing factor initially in this study when soil P test levels were low, but as soil P test levels increased with repeated P applications, response differences diminished.

These data suggest that on low P test soils, annual and biannual phosphorus applications are best, while on higher P test soils, phosphorus application span could be widened to as much as four years without adversly influencing grain sorghum yield.

EFFECT OF P FERTILIZER PLACEMENT AND N SOURCE ON EARLY PLANT GROWTH, COMPOSITION AND YIELD OF GRAIN SORGHUM

East Central Kansas Experiment Field

K. A. Janssen and D. A. Whitney

A study to evaluate P fertilizer placement with two N sources on grain sorghum was begun at the East Central Kansas Experiment Field in 1980. The experimental site (Woodson silty clay loam soil), initially tested low in soil available phosphorus (22 lbs. P/a) and medium in exchangeable potassium (182 lbs. K/a).

Procedure: Treatments were anhydrous ammonia knifed (6-8" deep on 15" centers) and ammonium nitrate broadcast, with P fertilizer broadcast, knifed (6-8" deep on 15" centers) and banded (2" side and 2" below the seed at planting time). The N application rate was 100 lbs. N/a. Phosphorus was applied at 40 lbs. P_2O_5/a using 18-46-0 fertilizer for broadcast and banded P applications and 10-34-0 fertilizer for knifed P applications. All fertilizers, except the banded fertilizer at planting time, were applied just prior to seedbed preparation. NC+ 170 grain sorghum was planted June 25. Furdan 10G at 12 lbs. product/a was applied in the furrow at planting. Ramrod-atrazine, flowable, at 4 qt./a (pre-emergence), plus one cultivation was used to control weeds. Whole plants were collected on July 20 for plant dry weights to measure early plant growth differences and for tissue analysis. Leaf samples for tissue analysis were also collected at the boot stage. Grain harvest was October 23. Results are presented in Table 70.

Results: Seedling grain sorghum growth was influenced by both P fertilizer and method of application. Significant increases in plant dry weight occurred at the six-leaf growth stage with bandplaced P fertilizer at planting time increasing plant dry weight most (1.9 times) followed by knifed P fertilizer (1.5 times) and broadcast P fertilizer (1.4 times). Nitrogen sources, anhydrous ammonia knifed and ammonium nitrate broadcast, produced no differences in early plant growth and did not interact with phosphorus.

Plant tissue P was influenced more by P placement at the six-leaf growth stage than at the boot stage. Highest P tissue levels were present in plants in which the phosphorus fertilizer was banded at planting time (.464 % P) followed by knifed P (.390 % P) and broadcast P (.373 % P) fertilizer. The opposite was true at the boot stage, although the difference were not statistically significant.

Maturity of the grain sorghum was advanced by the application of phosphorus. The grain sorghum in the bandplaced P fertilizer at planting time treatment, which produced the most early plant growth and was highest in tissue P, was a week to ten days ahead in maturity compared to the knifed and broadcast P fertilizer treatments. This difference in maturity was evidently a detriment to yield in 1981 because yield was less for banded P (115.8 bu/a) compared to knifed P (128.9 bu/a) and broadcast P (130.2 bu/a). A similar yield reduction with advanced maturity was observed in this study last year. Last year was an exeptionally dry year. This year moisture was above average through August, but September was dry with only .75 inches of rain. Evidently, this dry period somehow again reduced the yield potential of the more advanced banded P fertilized sorghum. Broadcast P and knifed P fertilizer treatments yielded essentially the same, both significantly higher than the non-P fertilized check.

Conclusions: Because of treatment induced maturity difference, moisture stress, and their interaction with yield the past two years, no conclusions can be drawn at this time concerning the merits of banded P at planting time vs. knifed P vs. broadcast P for grain sorghum. Plans are to continue this study in 1982, hopefully, under more favorable moisture conditions.

Table 69. EFFECT OF RATE AND FREQUENCY OF APPLICATION OF TWO PHOSPHORUS SOURCES ON GRAIN SORGHUM.

East Central Kansas Experiment Field

K. A. Janssen, D. A. Whitney and D. E. Kissel

Phosphorus Carrier	Rate and Frequency of Application		Grain Yield @ 12.5%		1981[1/] Leaf Tissue Composition		Soil Available P	
			1981	8 yr. Avg.			4/76	4/80
	Lbs. P_2O_5/a		Bu/a	Bu/a	%P	%N	Lbs/a	
----	0		81.3	50.5	.257	3.06	7	10
AOP(18-46-0)	50	Annually(74'-81')	107.2	68.5	.358	3.12	14	29
AOP	100	Biannually(74',76',78',80')	106.2	66.2	.338	3.05	12	29
AOP	200	Every 4 yrs.(74',78')	104.6	68.9	.362	3.16	18	44
APP(10-34-0)	50	Annually(74'-81')	103.9	68.4	.342	3.04	13	26
APP	100	Biannually(74',76',78',80')	103.6	66.5	.342	2.99	13	24
APP	200	Every 4 yrs.(74',78')	107.3	64.8	.345	3.09	16	26
LSD .05			8.3	--	.017	NS	3	6
Mean Values:								
Carrier								
AOP (ammonium orthophosphate)			106.0	67.9	.353	3.11	15	34
APP (ammonium polyphosphate)			104.9	66.6	.343	3.04	14	25
LSD .05			NS	--	NS	NS	NS	6
P - Rate & Frequency Applied								
50 lbs. P_2O_5 Annually			105.6	68.5	.350	3.08	14	28
100 lbs. P_2O_5 Biannually			104.9	66.3	.340	3.02	12	27
200 lbs. P_2O_5 Every 4 yrs.			106.0	66.7	.354	3.13	17	35
LSD .05			NS	--	NS	NS	2	NS

[1/] Leaf below flag leaf at boot stage.

Table 70. EFFECT OF P FERTILIZER PLACEMENT AND N SOURCE ON EARLY PLANT GROWTH, COMPOSITION AND YIELD OF GRAIN SORGHUM

East Central Kansas Experiment Field

K. A. Janssen and D. A. Whitney

N Application @ 100 lbs. N/a		P Application @ 40 lbs. P_2O_5/a		Grain Yield @ 12.5%	Plant Dry Weight 6-Leaf Stage	Plant[2/] Tissue Composition @ 6-Leaf		Boot	
Source	Method[1/]	Source	Method	bu/a	g/8 Plants	%N	%P	%N	%P
NH_4NO_3	BC	--	--	111.8	13.9	3.93	.294	2.78	.312
NH_4NO_3	BC	18-46-0	BC	133.6	21.0	4.06	.370	3.10	.389
NH_4NO_3	BC	10-34-0	KN	129.4	23.9	4.02	.386	2.92	.366
NH_4NO_3	BC	18-46-0	BD	118.2	28.1	3.90	.478	2.94	.366
NH_3	KN	--	--	106.6	16.2	3.89	.312	2.93	.325
NH_3	KN	18-46-0	BC	126.8	22.2	4.10	.376	2.98	.392
NH_3	KN	10-34-0	KN	128.5	21.6	4.08	.394	3.11	.391
NH_3	KN	18-46-0	BD	113.4	28.8	3.95	.451	3.10	.373
LSD .05				10.4	4.3	NS	.029	NS	.030
Mean Values:									
N-Source									
NH_4NO_3 Broadcast				123.3	21.7	3.98	.382	2.94	.358
NH_3 Knifed				118.8	22.2	4.00	.383	3.03	.370
LSD .05				NS	NS	NS	NS	NS	NS
P Application Method									
--				109.2	15.1	3.91	.303	2.85	.318
BC				130.2	21.6	4.08	.373	3.04	.390
KN				128.9	22.8	4.05	.390	3.02	.378
BD				115.8	28.5	3.92	.464	3.02	.369
LSD .05				7.4	3.0	NS	.020	NS	.021

[1/] BC (Broadcast).
KN (Knifed into soil 6-8" deep on 15" centers).
BD (Bandplaced at planting, 2" side and 2" below seed).

[2/] 6-Leaf Stage - Whole plant, above ground.
Boot Stage - Leaf below flag leaf.

Soybean Response to Nitrogen and Phosphorus in a Long Term N-P Study

K. A. Janssen, D. A. Whitney, and D. E. Kissel

Evaluation of long term annual applications of nitrogen and phosphorus on dry land grain sorghum has been underway at the East-Central Kansas Experiment Field since 1974. As a result of an extremely wet spring and delayed planting in 1981, this experiment was planted to soybeans. This provided an opporunity to assess soybean yield response to nitrogen and phosphorus.

Procedure: The N rates and P rates in Table 11 have been broadcast and incorporated each spring since 1974, with the 1981 application broadcast April 27 and incorporated April 29. Douglas soybeans were planted July 7. Lasso at 2 qt/a, plus Sencor 4 at 1 pt/a, plus one cultivation were used to control weeds. Harvest was December 14. Results are presented in Table 11 .

Results: Maximum yield potential was not realized due to the lateness of planting, but despite this soybean response to phosphorus was excellent. Averaged across all N rates, the zero phosphorus treatment produced 21.4 bu/a, the 40 lb P_2O_5/a rate produced 29.0 bu/a, and the 80 lb P_2O_5/a rate produced 31.3 bu/a. This is a yield increase of 35 and 45%, respectively. Corresponding 1980 soil phosphorus test levels for these treatments were 14, 31, and 51 lbs P/a. Fourteen pounds of phosphorus per acre is a low P test, 31 lbs P/a is a medium P test, and 51 lbs P/a is borderline between medium and high. Increasing the soil P test level from 14 to 31 lbs P/a increased yield 7.6 bu/a. Increasing the soil P test level to 51 lbs P/a increased yield an additional 2.3 bu/a. These data demonstrate the importance of maintaining at least a medium phosphorus soil test level for soybean production.

Soybean response to nitrogen was not evident. Nitrogen application rates ranging from 40 to 120 lbs N/a did not increase soybean yield, nor did residual N from long term N application.

Conclusions: Soybean yield was greatly influenced by soil phosphorus. Soil P test levels in the medium range were necessary for optimum soybean production.

Application of nitrogen did not increase soybean yield, reaffirming the consensus that nitrogen on soybeans is a poor investment.

Table 11. Effect of long term N-P fertilization on soybean yield and soil available P, Ottawa, 1981

Rate[1/] lb/a N	P_2O_5	Yield @ 13.0% bu/a	1980 Soil available P lb/a
0	0	18.6	14
0	40	31.1	34
0	80	29.3	60
40	0	22.0	14
40	40	27.6	34
40	80	31.5	50
80	0	24.3	15
80	40	31.1	30
80	80	32.7	49
120	0	20.8	15
120	40	28.4	28
120	80	33.1	48
160	0	21.6	14
160	40	30.6	26
160	80	30.0	46
LSD (.05)		4.5	7
Mean Values			
P_2O_5 Rate			
0		21.4	14
40		29.0	31
80		31.3	51
LSD (.05)		2.0	4
N Rate			
0		26.4	36
40		27.1	33
80		29.4	31
120		27.4	30
160		27.4	29
LSD (.05)		NS	NS

[1/] Annual applications since 1974.

LONG-TERM IRRIGATED CORN AND GRAIN SORGHUM FERTILIZATION AT TRIBUNE BRANCH EXPERIMENT STATION

Roy E. Gwin and P. J. Gallagher

Long-Term Irrigated Corn Fertility Study

The 1981 yields of the long-term fertilization study of irrigated corn at Tribune are reported in Table 23.

This study has been under way since 1961, and involves variables of nitrogen, phosphorus and potassium rates. The objectives of this investigation have varied somewhat through the years but essentially involve evaluation of responses of continuous irrigated corn to various rates of nitrogen, study the response of corn to simultaneous applications of nitrogen and phosphorus, evaluation of effects of applied potassium on the yield of irrigated corn in western Kansas, comparison of yield effects of two rates of phosphorus under identical rates of nitrogen applications (1968-1973), and to measure response of residual phosphorus draw-down (1974-1981).

Procedurally, this investigation has varied somewhat since its beginning in 1961. In 1961, fertilizer was applied broadcast and these same rates of nitrogen, phosphorus and potassium have been applied to the same plot each year since. In 1968 and 1969, a uniform application of 10 pounds of zinc was applied to the experimental area, and an additional 17.5 pounds of phosphorus was applied to one-half of the original plot areas. From 1970-1973, no zinc was applied, but the additional 17.5 pounds of phosphorus per acre was continued on half the plot area. In 1974, and subsequent years, all phosphorus was discontinued on this half of the plot to study available phosphorus drawdown during continuous corn production.

Yield data for this continuing investigation has indicated a consistent response to nitrogen over the years. Applications up to 160 pounds of nitrogen per acre have generally increased the yield of irrigated corn. Yield responses to phosphorus applications were observed for the first time in 1965. Since that date, the response to phosphorus has been significant and consistent at nitrogen rates of 120 pounds per acre and above. The additional 17.5 pounds of phosphorus initiated in 1968 produced significant yield increases only on the plots which had not received phosphorus prior to that date. Where 17.5 pounds of elemental phosphorus (40 pounds P_2O_5/A) has been applied each year since 1961, the additional 17.5 pounds of phosphorus rate (40 pounds P_2O_5/A) did not produce any significant yield increases.

Potassium applications have had negligible effects throughout the years. This is not surprising considering the extremely high potassium test on this area which averages near 1000 pounds or above exchangeable potassium per acre.

The 1981 yields were much below average. The plot was planted April 24 and a May 10 freeze burned back all growth to the ground and damaged stands, and a September 3rd hail defoliated all corn and further cut yields. The yield differences for higher nitrogen rates were not as great as in previous years, but continued to increase through the 160 pounds per acre rate. Phosphorus increased yields significantly.

In 1980 and 1981, the treatments with 45 pounds per acre residual phosphorus yielded significantly higher than the no phosphorus check plots. Those with a residual of 18 pounds per acre in 1973 were not higher than the no phosphorus check plots. There was a significant difference between the annual 17.5 pounds per acre phosphorus treatments and the 45 pounds per acre residual phosphorus plots in 1981 and since 1978. See results below:

Soil Test Values lbs/A available P December 1973	Average Yields (120, 160, 200 lbs N/A combined) Bu/A at 15.5% moisture								
	1974	1975	1976	1977	1978	1979	1980	1981	Average 1974-81
11 1/	77	123	166	162	136	142	124	99	129
18 2/	95	144	182	174	138	153	124	98	139
25* 3/	97	168	198	211	184	195	164	136	169
45 4/	89	166	194	199	172	172	147	114	157
LSD 5%	19	19	20	--	--	--	--	--	--

* 17.5 lbs/A of phosphorus was applied each year.

1/ Continuous corn, nitrogen only 1961-1981.

2/ 1961-1967 only nitrogen, 1968-1973 nitrogen plus 17.5 lbs/A of P, 1974-1981 nitrogen only.

3/ 1961-1981 nitrogen plus 17.5 lbs/A of P.

4/ 1961-1967 nitrogen plus 17.5 lbs/A of P, 1968-1973 nitrogen plus 35 lbs/A of P, 1974-1981 nitrogen only.

The nitrogen only plots have been significantly increasing yields at 80 pounds per acre level, but not above this level since 1972.

The decline of available soil phosphorus to approximately 11 pounds per acre resulted in the initiation of phosphorus responses in 1965. Where 17.5 pounds of P per acre (40 P_2O_5) have been maintained through the life of the study, soil test levels have remained constant at about 25 pounds per acre of available phosphorus.

Long-Term Irrigated Grain Sorghum Fertility Study

Results of an irrigated grain sorghum investigation conducted adjacent to the corn study reported previously have produced data quite similar to the corn study. The yields were disappointing over the 1973-1976 years. In the years 1975-1981, the yield was increased significantly only through 40 pounds per acre of applied nitrogen. Phosphorus increased yields and there was no difference in yield for residual zinc. (Table 24.)

In 1981, yields were drastically lowered by a hail on September 3. Little use of this data can be made but it is included for the long time average - and response is similar to good years.

Phosphorus response began about 5 years after the test was initiated and has been consistent since that time. Maximum yields have been obtained from 80-120 pounds of nitrogen per acre per year, and at no time has potassium increased yields.

Soil test levels have reacted similar to the corn test, except the levels were still a little higher on the no phosphorus treatments. Soil test values have consistently been a good predictor of plant responses.

Effect of Long-term Fertilization on Grain Quality at Tribune

To assess the effect of fertilization with N, P and K on grain nutrient content, grain samples were retained from the 1981 harvest of the irrigated corn and grain sorghum studies at Tribune discussed above and analyzed for N, P and K. The results in the following tables show that nitrogen fertilization increase nitrogen content in both the corn and grain sorghum. Maximum grain N content occurred at a higher N rate than did maximum yield, however, the increase in grain N content with N application was much greater with N rates that also resulted in a yield increase.

For the irrigated corn there was a decrease in grain P content with increasing N rates with or without P application reflecting a greater total demand for P with increased yield. With grain sorghum there was a decrease in grain P content with increasing N rate only on plots not receiving P fertilization. For both corn and grain sorghum there was an increase in grain P content with P fertilization.

The grain K content was not affected by N, P or K fertilization. This is undoubtedly the result of abundant available K in this soil.

FORAGE QUALITY WITH FERTILIZATION AT THE SOUTHEAST KANSAS EXPERIMENT STATION

Effects of N, P, and K Rates and Methods of Application on Tall Fescue.

R. E. Lamond and J. L. Moyer (Table 32)

Cool season grass pastures, especially tall fescue, are extremely important in southeast Kansas not only for pasture but as a hay crop. To optimize fescue production, N is routinely applied but many soils will also respond to P and K.

Procedure: This study was continued in 1981 to evaluate N rates (12, 100, 150 lb/A), P rates (0, 40 lb P_2O_5/A), and K rates (0, 40 lb K_2O/A). The N-P-K treatments were applied either broadcast on the surface or knifed in about 8 inches deep on 15-inch centers. N was supplied as UAN (28% N) solution, P as 10-34-0 liquid and K as 0-0-10 solution. Broadcast treatments were put through flat spray nozzles. The site for this study tested in the low range for both P and K.

Results: Fescue yields in this study were good, especially in light of the dry spring encountered. N application up to 150 lb/A significantly increased forage production and N levels in the forage. The application of 40 lb P_2O_5/A also significantly increased forage production, boosting yields nearly 300 lb/A. P concentrations in the forage were also significantly increased by P fertilization. K fertilization had no effect on forage yields. The knifed method of application produced significantly higher forage yields than broadcast applications, boosting yields nearly 1200 lb/A. This was the third year in a row that the knifed method has given superior performance. Apparently, nutrient utilization by the fescue is greater when the fertilizer is placed deeper in root zone than when placed on the surface. This work will be continued in 1982.

Table 23. Effects of Nitrogen, Phosphorus and Potassium on Yield of Irrigated Corn, 1961-81, Tribune.

Treatments [2] N	P	K	Yields, bushels per acre [1] 1975		1976		1977		1978		1979		1980		1981		1968-73 Average		61-81 Avg.	1974-81 Average	
lbs/A																					
0	0	0	56	60[4]	106	110[4]	93	87[4]	85	83[4]	97	88[4]	73	75[4]	74	68[4]	68	71[3]	65	76	74[4]
40	0	0	105	103	146	151	148	161	128	134	126	132	112	118	93	94	115	115	105	114	118
80	0	0	119	133	150	167	151	171	137	138	141	141	109	124	92	91	133	142	124	122	131
120	0	0	124	146	167	176	164	178	132	133	127	151	121	129	91	98	133	159	128	125	137
160	0	0	120	136	162	183	167	177	137	145	157	165	122	120	103	103	142	171	136	130	142
200	0	0	126	151	169	186	157	166	138	136	141	142	128	122	101	92	145	170	138	131	137
0	17	0	49	56	114	113	97	100	88	87	79	85	71	74	69	66	70	71	66	73	76
40	17	0	109	116	165	162	145	145	141	150	137	143	128	130	102	109	122	122	113	123	127
80	17	0	157	153	187	178	176	191	163	170	172	158	150	143	119	115	149	149	141	150	149
120	17	0	167	163	186	183	204	197	184	169	184	156	152	147	124	103	166	167	156	162	151
160	17	0	173	169	198	194	211	199	185	171	211	165	174	157	145	117	175	174	165	175	158
200	17	0	163	166	209	204	219	202	184	175	189	196	150	142	135	119	174	177	164	168	160
0	17	33	57	63	127	122	104	110	90	86	80	84	75	79	70	75	70	70	68	78	80
40	17	33	104	95	160	157	156	148	156	144	137	130	140	132	111	99	122	116	114	128	119
80	17	33	146	146	179	179	183	191	174	162	158	163	157	145	119	104	142	146	139	149	146
120	17	33	159	152	179	187	208	196	174	167	172	172	165	154	125	112	164	168	155	160	155
160	17	33	172	168	211	190	199	198	178	161	200	170	173	137	133	108	174	178	164	171	152
200	17	33	174	157	203	203	207	207	182	162	198	184	167	142	155	124	174	176	166	173	160

[1] Corrected to 15.5% moisture

[2] 10 lbs. of zinc added to entire plot area as $ZnSO_4$ in 1968 and 1969.

[3] 17 lbs of phosphorus were added to half the plots.

[4] For 1974 through 1981, all phosphorus was discontinued in order to follow phosphorus soil test value decline.

Table 24. Effects of Nitrogen, Phosphorus and Potassium on Yield of Irrigated Grain Sorghum, 1961-81, Tribune.

Treatment			1975		1976		1977		1978		1979		1980		1981	Averages 1968-73		61-81	1974-80	
			0	5-lbs	0	5-lbs	0	5-lbs	0	5-lbs	0	5-lbs	0	5-lbs	0	RS	RS		0	5-lbs
N	P	K	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	671	626		Zn	Zn
			bu/A		bu/A		bu/A		bu/A		bu/A		bu/A		bu/A				bu/A	
0	0	0	71	72	92	91	120	129	87	90	83	85	62	58	57	61	68	71	79	80
40	0	0	77	74	106	106	142	134	100	96	102	99	84	91	76	92	95	96	102	95
80	0	0	84	85	103	104	139	138	106	105	113	112	97	91	76	112	108	109	111	100
120	0	0	77	75	100	100	133	131	100	105	113	109	98	90	67	110	106	108	110	97
160	0	0	69	74	103	107	136	132	113	112	115	107	104	92	74	107	101	107	109	100
200	0	0	79	75	99	104	126	130	102	108	109	106	105	99	71	113	107	109	111	96
0	17	0	72	83	96	109	129	129	85	89	84	84	60	62	54	63	71	73	74	81
40	17	0	106	107	114	115	147	148	104	110	119	115	90	92	73	104	106	106	107	107
80	17	0	87	98	118	117	146	152	110	117	128	134	122	112	78	121	118	116	118	112
120	17	0	92	79	114	116	144	146	121	119	134	132	130	120	87	126	120	118	122	115
160	17	0	95	102	122	126	149	145	119	119	144	139	119	126	83	130	123	123	125	117
200	17	0	96	101	112	124	149	148	116	113	148	146	123	119	83	130	123	124	126	117
0	17	33	76	73	100	103	123	127	92	93	85	81	65	63	59	63	70	74	75	82
40	17	33	102	94	123	109	147	146	100	103	118	112	105	98	84	103	107	107	108	108
80	17	33	99	105	121	119	150	147	114	113	123	124	110	118	83	123	120	118	120	113
120	17	33	90	93	119	121	149	150	119	121	139	142	120	127	83	127	123	123	125	118
160	17	33	92	98	114	115	146	147	119	114	136	136	124	124	82	127	124	123	125	114
200	17	33	86	91	118	116	147	145	119	113	142	131	113	119	88	127	124	121	123	113

Yields corrected to 12.5% moisture.

EFFECT ON N, P AND K FERTILIZATION ON YIELD AND GRAIN NUTRIENT CONTENT OF IRRIGATED GRAIN SORGHUM, TRIBUNE EXPT. STATION, 1981.

Treatment			1981 Grain	Grain Nutrient Content		
N	P_2O_5	K_2O	Yield	N	P	K
---lb/A---			bu/A	----- % -----		
0	0	0	57	1.32	.29	.38
40	0	0	76	1.43	.24	.35
80	0	0	76	1.67	.24	.36
120	0	0	67	1.72	.21	.34
160	0	0	74	1.74	.20	.35
200	0	0	71	1.78	.23	.37
0	40	0	54	1.38	.32	.41
40	40	0	73	1.54	.31	.39
80	40	0	78	1.79	.31	.39
120	40	0	87	1.59	.29	.38
160	40	0	83	1.69	.31	.38
200	40	0	83	1.63	.30	.39
0	40	40	59	1.48	.32	.38
40	40	40	84	1.44	.28	.37
80	40	40	83	1.57	.31	.40
120	40	40	83	1.66	.30	.39
160	40	40	82	1.74	.29	.39
200	40	40	88	1.71	.29	.37

EFFECT OF N, P, AND K FERTILIZATION ON YIELD AND GRAIN NUTRIENT CONTENT OF IRRIGATED CORN, TRIBUNE EXPERIMENT STATION, 1981.

TREATMENT			1981 GRAIN YIELD	GRAIN NUTRIENT CONTENT		
N	P_2O_5	K_2O		N	P	K
--- BU/A ---			BU/A	----- % -----		
0	0	0	74	1.05	.23	.38
40	0	0	93	1.15	.23	.38
80	0	0	92	1.38	.19	.37
120	0	0	91	1.45	.20	.34
160	0	0	103	1.33	.19	.33
200	0	0	101	1.48	.17	.33
0	40	0	69	1.10	.30	.41
40	40	0	102	1.16	.28	.40
80	40	0	119	1.20	.24	.39
120	40	0	124	1.34	.26	.38
160	40	0	145	1.32	.23	.36
200	40	0	135	1.40	.23	.36
0	40	40	70	1.01	.29	.41
40	40	40	111	1.23	.30	.39
80	40	40	119	1.25	.29	.38
120	40	40	125	1.31	.27	.37
160	40	40	133	1.42	.22	.38
200	40	40	155	1.44	.22	.36

Table 32. N-P-K Rates and Methods on Tall Fescue. Every Farm, Neosho Co.

R. E. Lamond

Southeast Kansas Branch Experiment Station

N	P_2O_5	K_2O	N-P-K Method	1981 Forage Yield lbs/A	Forage Composition %N	%P	%K	2 Yr Avg Yield lbs/A
	lbs/A							
12	0	0	Broadcast	2630	1.45	.17	1.45	2491
12	0	40	"	3200	1.31	.14	1.49	2702
12	40	0	"	3090	1.41	.18	1.58	2679
12	40	40	"	2854	1.35	.18	1.52	2741
100	0	0	"	3770	1.77	.14	1.52	3559
100	0	40	"	3276	1.82	.15	1.73	3297
100	40	0	"	3747	1.73	.20	1.63	3748
100	40	40	"	3438	1.62	.19	1.69	3637
150	0	0	"	3356	2.07	.16	1.67	3526
150	0	40	"	3389	1.91	.14	1.51	3467
150	40	0	"	4443	1.86	.20	1.57	4308
150	40	40	"	3692	1.84	.20	1.74	4142
12	0	0	Knifed	3342	1.29	.14	1.27	3001
12	0	40	"	3380	1.33	.14	1.35	2836
12	40	0	"	3760	1.28	.15	1.33	3553
12	40	40	"	4125	1.31	.15	1.42	3718
100	0	0	"	4240	1.57	.13	1.37	3941
100	0	40	"	4828	1.66	.14	1.61	4314
100	40	0	"	4829	1.69	.16	1.49	4461
100	40	40	"	5082	1.77	.17	1.58	4713
150	0	0	"	5226	1.77	.14	1.51	4652
150	0	40	"	5650	1.58	.13	1.39	4724
150	40	0	"	5452	1.90	.16	1.44	4972
150	40	40	"	5153	1.86	.16	1.43	4933
Treatment LSD(.05)				864	.22	.02	.21	
Mean Values:								
N Rate lbs/A		12		3298	1.34	.16	1.43	2966
		100		4151	1.70	.16	1.58	3959
		150		4545	1.85	.16	1.53	4341
		LSD(.05)		306	.08	NS	.07	
P_2O_5 Rate lbs/A		0		3857	1.63	.14	1.49	3543
		40		4139	1.64	.18	1.54	3967
		LSD(.05)		250	NS	.01	NS	
K_2O Rate lbs/A		0		3990	1.65	.16	1.49	3741
		40		4006	1.61	.16	1.54	3769
		LSD(.05)		NS	NS	NS	NS	
N-P-K Method		Broadcast		3407	1.68	.17	1.59	3358
		Knifed		4589	1.58	.15	1.43	4152
		LSD(.05)		250	.06	.01	.06	