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WHEAT FERTILIZATION STUDIES IN WESTERN OKLAHOMA - - - - - Progress Report, 1954 - 1955

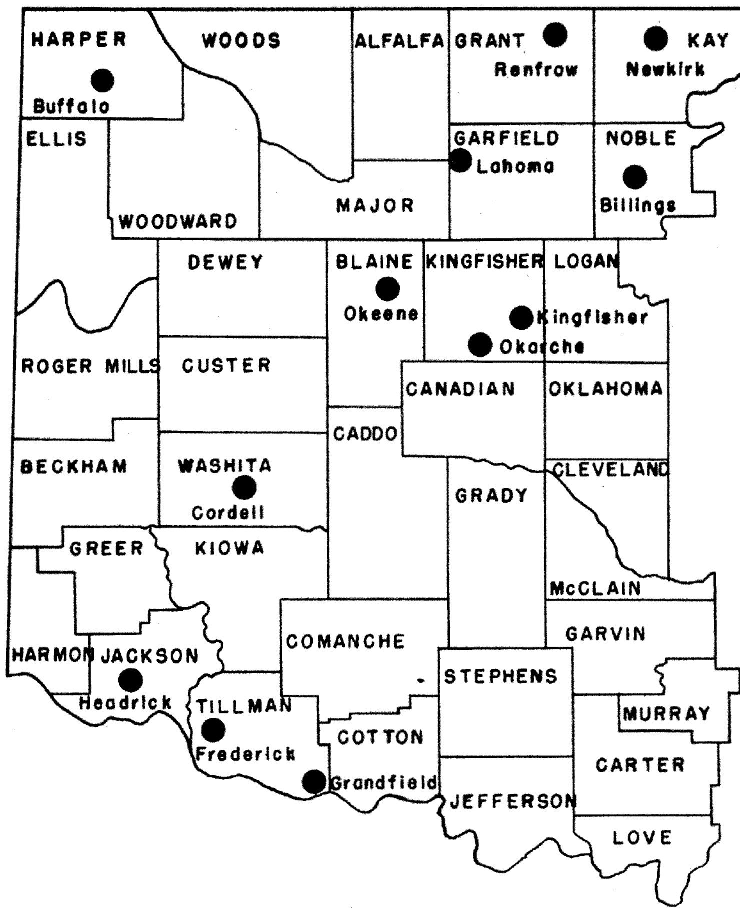

Figure 1. - - - Locations of 12 wheat fertility experiments in western Oklahoma, 1954-55 season.

Agricultural Experiment Station
DIVISION OF AGRICULTURE
Oklahoma A. & M. College, Stillwater

and

Soil and Water Conservation Research Branch
AGRICULTURAL RESEARCH SERVICE
United States Department of Agriculture

PROGRESS REPORT
WHEAT FERTILIZATION STUDIES IN WESTERN OKLAHOMA
1954-55

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This publication reports 1954-55 results of wheat fertility experiments conducted cooperatively by the Oklahoma Agricultural Experiment Station and U. S. Department of Agriculture since 1951. These trials are being continued. Results up to date suggest that:

(1) Phosphorus is the first limiting chemical element in wheat growth on many soils in western Oklahoma. Maximum response from nitrogen fertilizer can be expected only after phosphorus needs are fulfilled. Even when it does not affect grain yields, it stimulates early growth and tillering which is important from standpoints of reducing the danger of wind erosion, establishing stands, and providing winter pasture.

(2) Nitrogen fertilizer, when applied on a soil which contains adequate phosphate, will not decrease wheat yields even at high rates and under extreme drouth conditions.

(3) It may be advisable to delay nitrogen fertilization of wheat until late winter or early spring. In two of four seasons, there were relatively small yield advantages for spring over fall application of nitrogen. In the other two, there were no differences. By late winter, a farmer is in a better position to know the possibilities of raising a crop and the possibilities of obtaining nitrogen response than he is in the fall.

Uniform wheat fertility experiments were initiated in western Oklahoma in the fall of 1951. Additional experiments were conducted in 1952, 1953, 1954, and 1955, and present plans call for a continuation of such experiments for several years. The purpose of these experiments is to determine the kind and rate of fertilizer needed, and the best time for applying it.

This publication, giving results for 1954-55, is the third of a series of progress reports which are published annually. Previous reports are Oklahoma Agricultural Experiment Station Bulletin B-432 and Mimeographed Circular M-270. Conclusions drawn in these reports are only tentative, but should be a good indication of what can be expected from the use of commercial fertilizers on wheat in western Oklahoma. For complete information this report and the preceding ones should be consulted.

Experimental Sites

Experimental sites are shown in Figure 1. They are listed in Table I with soil type, variety of wheat grown, and rainfall information. Previous soil management in all cases was continous wheat.

Table I - Locations of wheat fertility trials, 1954-55

Town	County	Soil Type	Wheat Variety	Long time avg. rainfall	Percent of long time rainfall red'd 7/1/54 - 6/30/55
Newkirk	Kay	Bethany silt loam	Wichita	33.76	61.1
Renfrow	Grant	Tabler silt loam	Triumph	28.62	73.1
Billings	Noble	Kirkland silt loam	Triumph	27.73	78.6
Lahoma	Garfield	Grant very fine sandy loam	Triumph	29.82	65.4
Kingfisher	Kinfisher	Renfrow silty clay loam	Triumph	30.26	63.5
Buffalo	Harper	St. Paul silt loam	Wichita	22.20	73.1
Cordell	Washita	Tillman silt loam	Triumph	26.35	76.5
Headrick	Jackson	Foard silt loam	Triumph	25.49	67.2
Frederick	Tillman	Tillman clay loam	Westar	27.37	78.2
Grandfield	Tillman	Foar silty clay loam	Triumph	29.35	92.2
Okarche	Kingfisher	Kirkland silt loam	Wichita	30.26	70.5

Climatic Conditions

The 1954-55 season was one of below average rainfall. Average monthly rainfall for the 11 locations in relation to long-time average monthly rainfall is shown in Figure 2. Precipitation was below normal in all months except February and May. The average of the 11 locations was 20.49 inches, 7.80 inches below normal. From July through April, precipitation was 8.87 inches, 44.5 percent of the normal 19.92 inches. The soil contained littleavailable moisture at planting time. Sufficient surface moisture was present for germination of seed and emergence of stands at the locations in the northern portion of the area, but the seed was "dusted in" at some central and southern locations. At these locations, germination and emergence took place after light precipitation in December and January. The prolonged drouth which lasted through April caused drastic reductions in wheat yields. Of the total seeded acreage in Oklahoma, only 60 percent was harvested. The state average yield per harvested acre was only 8.0 bushels as compared 15.0 bushels in 1954 and 13.6 bushels, the 1944-53 average.

Experimental Design, Methods, and Materials

Fertilizer treatments are listed in Table II. The experimental design used was a randomized block with 3 replications. Individual plots were one drill width wide (7'7") by 100 or more foot in length. The harvested area was 7 X 100 feet. The wheat was planted with a combination grain and fertilizer drill. The phosphorus fertilizer was applied with the seed at planting. The nitrogen fertilizer was applied with a hand-drawn "Gandy" spreader. Fall applications of nitrogen were made immediately following the planting operation. The spring nitrogen applications were made in February or early March.

The phosphate source used was superphosphate (20% P_2O_5) and the nitrogen source was ammonium nitrate (33.5% N).

Soil samples were collected at each site. The results of soil analyses will not be presented here. Data were taken on yield, on protein and phosphorus content of the grain and on test weight (weight per measured bushel) of the grain. Rainfall and soil moisture records were kept.

Results

Grain yields, grain protein percentages, and test weights of the grain are presented in Tables II, III, and IV, respectively.

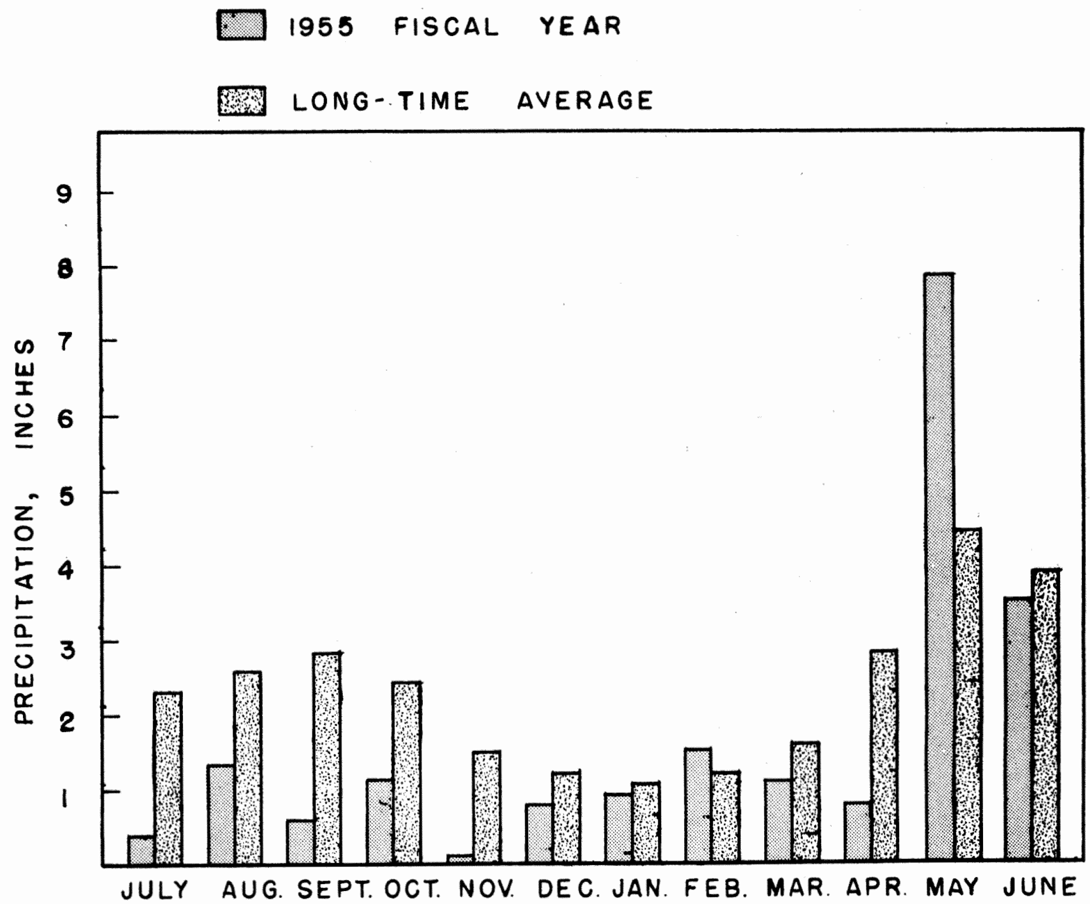

Figure 2. - - - Average monthly rainfall (July 1, 1954 to July 30, 1955) and long-time average monthly rainfall at 11 locations in western Oklahoma.

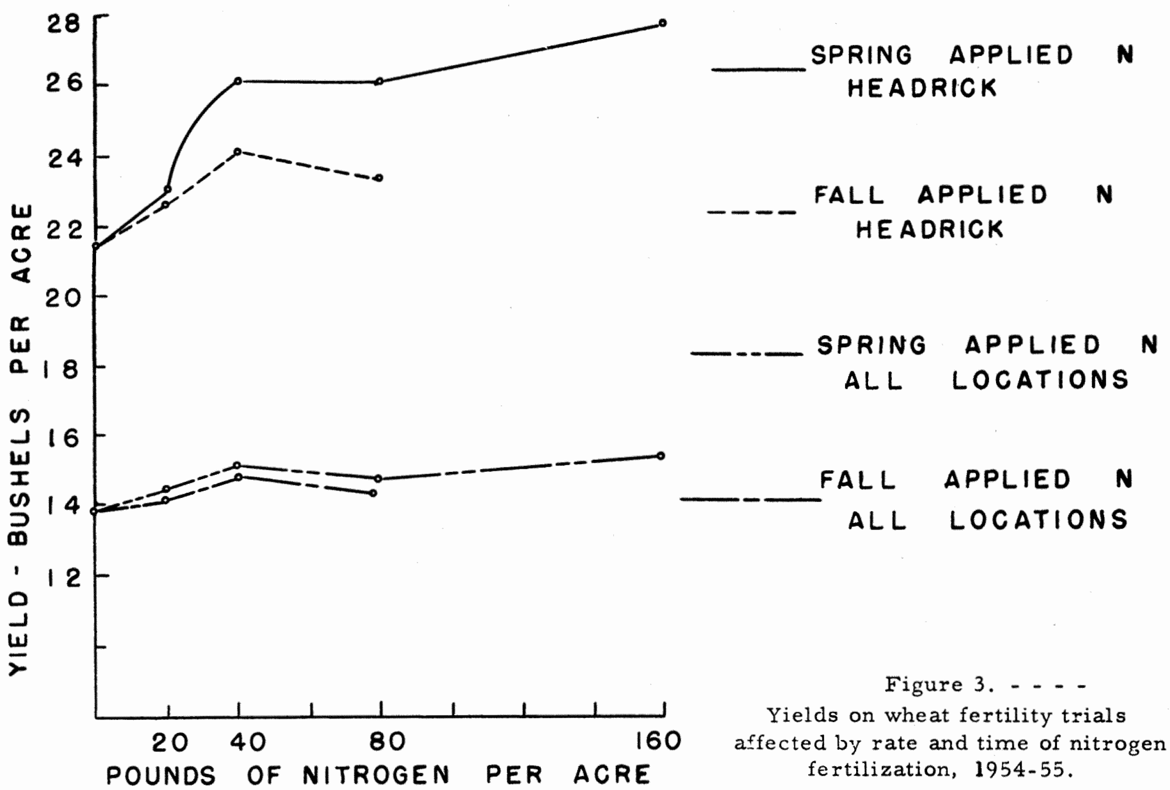

Figure 3. - - - - Yields on wheat fertility trials affected by rate and time of nitrogen fertilization, 1954-55.

Effects of Nitrogen Fertilizer

On Yield of Grain

The effect of nitrogen on yield of grain is shown graphically in Figure 3. Treatments 3, 8, 10, 12, and 6, Table II are considered in that order. Yield increases due to nitrogen applications were obtained only at Headrick. There, the 40 pound nitrogen rate increased grain yield from 21.4 to 26.1 bushels per acre. Nitrogen required per bushel increase was 8.5 pounds. There were no instances of applied nitrogen causing yield reductions even under the severe drouth conditions encountered in this season

Under the prevailing climatic conditions, the soil at 10 of the 11 locations contained sufficient nitrogen for maximum wheat yields.

On Protein Content of Grain

The effect of nitrogen on protein content of grain is shown graphically in Figure 4. Treatments 3, 8, 10, 12, and 6, Table III are considered here. Nitrogen applications did not affect grain protein at Kingfisher, Buffalo, and Lahoma. Grain protein increased with increasing rates of nitrogen through 160 pounds per acre at Headrick, Grandfield, Renfrow, and Billings; through 80 pounds per acre at Frederick and Cordell; through 40 pounds per acre at Newkirk and through 20 pounds per acre at Okarche. At locations where the protein content of the grain was relatively low, the increases in grain protein were about the same from successive equal increments of nitrogen. At locations where the grain protein was relatively high, the low rates of nitrogen gave greater protein increases per pound of nitrogen than the higher rates did. At locations where there was no increase in grain protein with applied nitrogen, one may conclude that the soil contained sufficient nitrogen to give maximum grain protein under existing enviromental conditions. At Headrick grain protein was increased from 10.52 percent on the no nitrogen treatment to 15.09 percent at the 160 pounds per acre rate. This is a 42.5 percent increase in grain protein. At Kingfisher, with the same variety of wheat (Triumph), applied nitrogen did not affect grain protein. Grain protein there, though, without added nitrogen, was 16.65 percent which probably approaches the genetic capacity of Triumph so far as grain protein is concerned. Grain protein, of course, fluctuates considerably from location to location and from season to season since such things as plumpness of grain, starch content, and other factors affect it.

On Test Weight of Grain

Test weights (weight per measured bushel) were determined on composites of replicates rather than on the grain from individual plots. The values are presented in Table IV. Treatments 3, 8, 10, 12 and 6 are considered. Nitrogen applications had little or no effect on test weight.

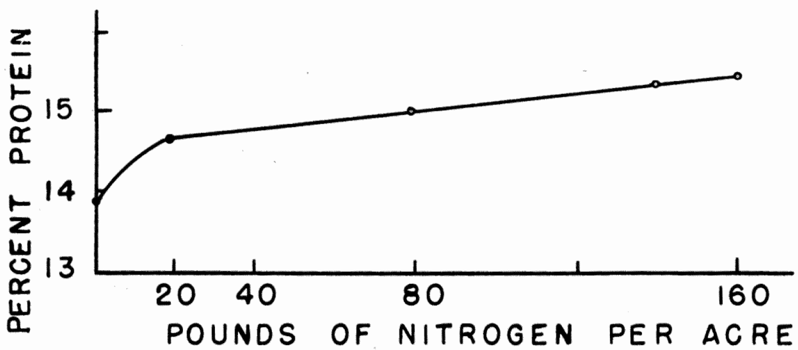

Figure 4. - - -
Protein in wheat grain as affected by rate of nitrogen fertilization, 1954-55.

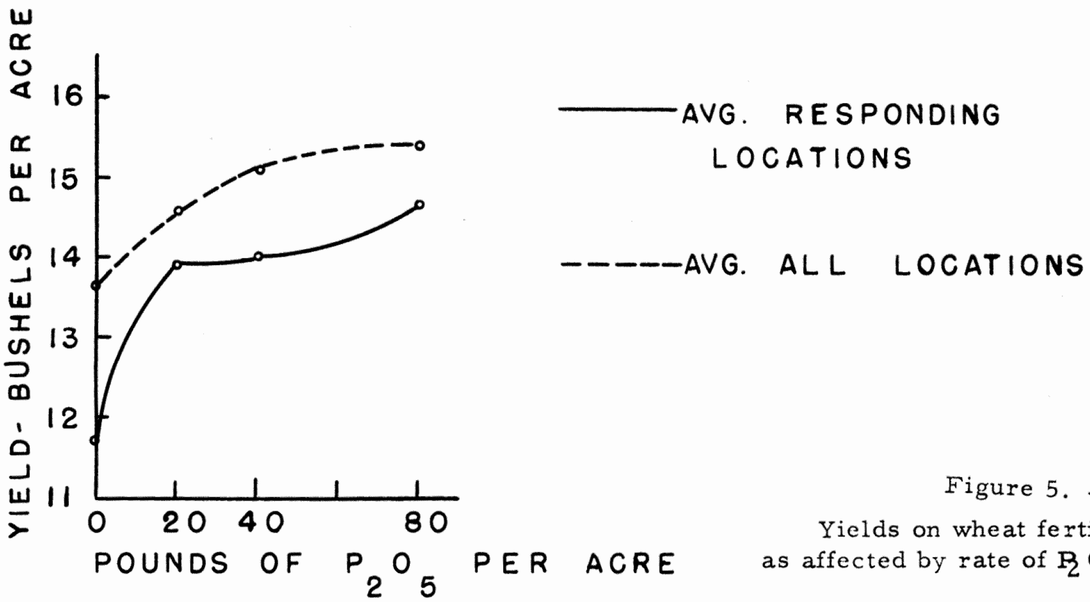

Figure 5. - - -
Yields on wheat fertility trials as affected by rate of P_2O_5 fertilization.

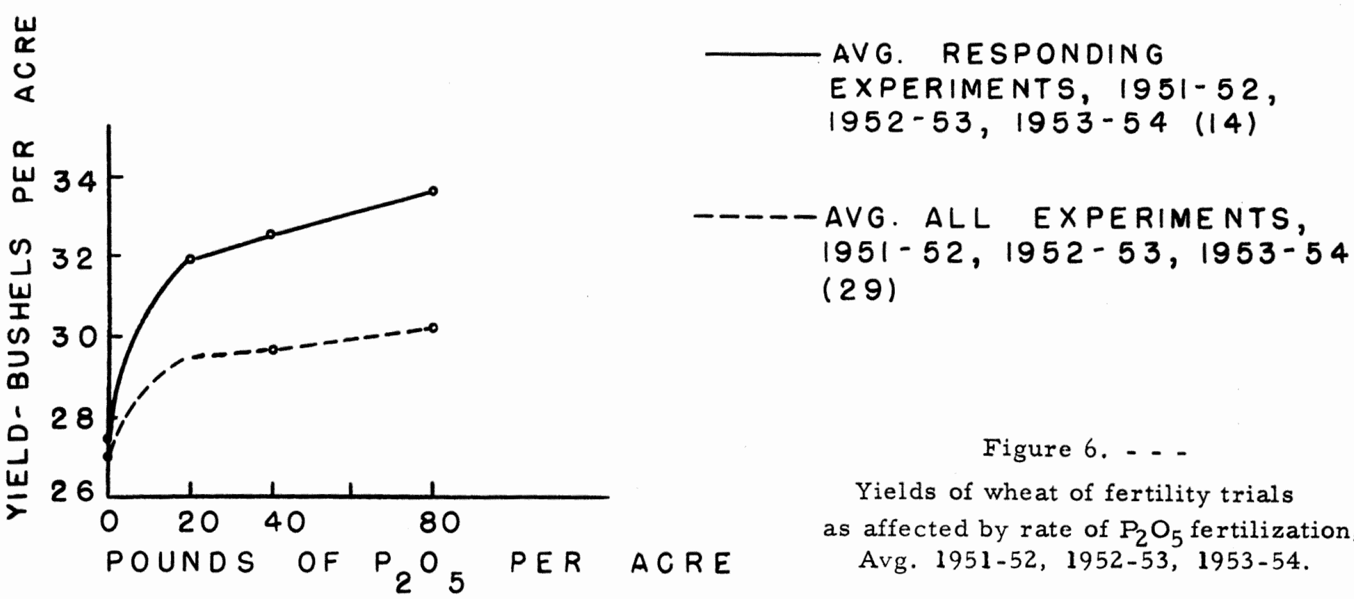

Figure 6. - - -
Yields of wheat of fertility trials as affected by rate of P_2O_5 fertilization, Avg. 1951-52, 1952-53, 1953-54.

Fall vs. Spring Applications of Nitrogen

A comparison of the effects of fall and spring application of nitrogen may be made by comparing treatments 7, 9, and 11 with treatments 8, 10, and 12, Tables II, III, and IV. Spring applied nitrogen gave a significant yield increase over fall applied nitrogen only at Headrick, the only location where nitrogen response was realized. At the other locations, time of nitrogen application had no effect on yield. Whether nitrogen was applied in the fall or in the spring had little effect on grain protein or on test weight. The effect of date of nitrogen application on yield of grain is shown graphically in Figure 3.

In four seasons of experimentation, there have been two seasons when there were no differences between fall and spring application of nitrogen and two seasons when there were relatively small advantages for spring over fall nitrogen application. It seems advisable, however, to delay nitrogen application until late winter or early spring. By that time, a farmer is in a better position to know the possibilities of raising a crop and the possibilities of obtaining nitrogen response than he is in the fall. Since fall application is no better than spring, he does not risk decreasing yields by waiting until spring to apply nitrogen fertilizer.

Effect of Phosphorus Fertilizer

On Yield Grain

The effect of phosphorus fertilizer on wheat yields is shown graphically in Figure 5. Treatments 2, 4, 10, and 5, Table II, are considered in that order. There were significant increases in yields from phosphorus at Lahoma, Frederick, Newkirk, and Billings. Yield averages for these responding locations show that 20 pounds of P_2O_5 per acre increased yields an average of 2.2 bushels per acre. In previous seasons, significant increases in yield from phosphorus have been obtained at Kingfisher, Renfrow, and Grandfield, as well as at the locations which show response this season. At Kingfisher and Renfrow, phosphorus increased initial growth and tillering even though it did not affect yield.

In 29 trials conducted in three previous seasons (1951-52, 52-53, and 53-54) phosphorus response was obrained in 14. In the 29 trials, the average response to 20 pounds of P_2O_5 per acre was 2.4 bushels per acre and in 14 trials in which phosphorus response was obtained, the average response to 20 pounds of P O per acre was 4.9 bushels per acre. These data are illustrated graphically in Figure 6.

Phosphorus appears to be the first limiting element in wheat growth on most wheatland soils in western Oklahoma and maximum response from nitrogen fertilizer cannot be expected unless phosphorus fertilizer is applied. Even when it does not affect yields, it stimulates early growth and tillering which is quite important from standpoints of reducing the danger of wind erosion, establishing stands, and providing winter pasture.

On Protein Content of Grain

Phosphorus fertilization had little effect on the protein content of the grain (see treatments 2, 4, 10, and 5, Table IV).

On Test Weight of Grain

Phosphorus fertilizer had no effect on the test weight of the grain (treatments 2, 4, 10, and 5, Table IV).

Summary and Conclusions

The 1954-55 results of wheat fertility experiments at 11 locations in western Oklahoma furnished information for the following conclusions:

(1) Nitrogen fertilization brought about a significant increase in yield at only one of twelve locations.

(2) Applications of nitrogen as high as 160 pounds per acre did not decrease yields under very severe drouth conditions.

(3) Protein content of the grain increased with increasing rates of nitrogen application.

(4) Time of nitrogen application (fall or spring) had no effect on yield at four of eleven locations.

(5) Phosphorus fertilization brought about significant increases in yield at four of eleven locations.

(6) Where phosphorus gave yield increases, 20 pounds of P_2O_5 per acre was sufficient to give maximum increases.

(7) Results from current and previous work and observations point to the conclusion that the first limiting nutrient element in wheat production in western Oklahoma is Phosphorus. When the required phosphorus is supplied and suitable climatic conditions prevail, nitrogen fertilization is profitable.

Table II. Yields on Wheat Fertility Trials at Eleven Locations in Western Oklahoma, 1954-55*

(Bushels Per Acre)

	1	2	3	4	5	6	7	8	9	10	11	12
	No treat-	40 N	40 P	40 N 20 P	40 N 80 P	160 N 40 P	20 N - 40 P		40 N - 40 P		80 N 40 P	
							Fall	Spring	Fall	Spring	Fall	Spring
Newkirk	13.7	13.6	18.4	17.1	19.0	17.3	17.0	16.9	18.4	16.3	16.8	17.6
Renfrow	12.2	12.1	12.1	11.6	13.5	12.0	12.3	12.3	12.5	12.1	12.1	12.1
Billings	8.4	9.2	9.1	9.4	10.3	9.6	9.3	9.8	9.9	9.9	9.9	9.8
Lahoma	3.7	3.6	3.7	4.5	4.6	4.7	4.5	4.2	4.7	3.7	4.4	3.4
Kingfisher	9.5	8.7	9.4	9.4	10.3	10.5	8.5	10.6	10.2	9.5	9.7	9.2
Buffalo	4.0	4.8	4.0	4.5	4.6	5.0	4.5	4.1	3.9	4.8	3.6	4.7
Cordell	12.7	12.2	13.7	13.6	13.5	16.4	13.8	12.5	12.9	15.8	12.6	15.0
Headrick	21.0	26.2	21.4	22.9	24.2	27.7	22.6	23.0	24.1	26.1	23.4	26.0
Frederick	22.3	20.3	22.5	24.5	24.7	26.5	23.0	25.3	25.7	26.0	25.1	23.2
Grandfield	27.4	27.8	26.5	30.8	31.8	28.4	28.9	29.5	30.3	31.2	30.1	28.5
Okarche	11.1	10.9	11.8	11.9	12.4	11.3	11.8	10.7	11.5	10.5	11.3	10.6
Average	13.3	13.6	13.9	14.6	15.4	15.4	14.2	14.4	14.9	15.1	14.5	14.6
Av. at P_2O_5 Res. Loc.**	12.0	11.7	13.4	13.9	14.7					14.0		

Treatments: Treatments are shown in pounds per acre of nitrogen (N) or P_2O_5 (P). All notrogen was applied broadcast in early spring except in treatments 7, 9, and 11. All phosphorus was applied with the seed at planting.

* Averages of three replicates.

** Averages at locations where phosphorus response was obtained. Includes Lahoma, Frederick, Newkirk, and Billings.

Table III. Protein in wheat grain on fertility trials at eleven locations in western Oklahoma, 1954-55*

(Percent)

	1	2	3	4	5	6	7	8	9	10	11	12
	No treatment	40 N	40 P	40 N 20 P	40 N 80 P	160 N 40 P	20 N Fall	40 P Spring	40 N Fall	40 P Spring	80 N Fall	40 P Spring
Newkirk	13.44	13.62	12.88	13.64	13.56	14.52	13.88	13.73	14.24	14.23	14.50	13.66
Renfrow	13.75	14.13	13.71	14.82	14.50	16.13	14.62	14.52	14.80	14.89	15.65	14.85
Billings	13.77	13.92	13.20	14.31	13.90	15.08	14.05	13.93	14.54	14.20	14.91	14.59
Lahoma	16.48	17.03	16.56	17.09	16.57	17.01	16.48	15.88	15.42	17.18	16.19	17.54
Kingfisher	16.76	16.54	16.65	16.26	16.43	16.29	16.65	16.25	16.67	16.54	17.08	16.66
Buffalo	15.96	15.80	15.75	15.96	16.07	16.21	15.65	15.90	15.98	16.20	16.01	15.95
Cordell	14.73	15.30	14.46	15.15	15.14	15.70	15.11	15.00	15.01	14.99	15.36	15.47
Headrick	10.75	11.89	10.52	11.39	11.35	15.09	11.31	10.47	11.44	11.40	12.61	13.23
Fredrick	11.74	13.40	11.19	11.92	12.75	13.55	11.81	11.42	11.85	12.48	12.67	13.46
Grandfield	12.68	13.44	12.36	13.17	13.23	14.73	12.37	12.95	12.69	12.97	13.87	13.59
Okarche	14.11	14.30	14.97	14.95	15.14	15.29	14.70	15.38	15.32	15.31	14.95	15.40
Average	14.02	14.49	13.84	14.42	14.42	15.42	14.24	14.13	14.36	14.58	14.89	14.95

Treatments: Treatments are shown in pounds per acre of nitrogen (N) or P_2O_5 (P). All nitrogen was applied broadcast in early spring except in treatments 7, 9, and 11. All phosphorus was applied with the seed at planting.

* Averages of three replicates.

TableIV.. Test weight of wheat grain on fertility trials at eleven locations in western Oklahoma, 1954-55*

	1	2	3	4	5	6	7	8	9	10	11	12
	No treat-ment	40 N	40 P	40 N 20 P	40 N 80 P	160 N 40 P	20 N Fall	40 P Spring	40 N Fall	40 P Spring	80 N Fall	40 P Spring
						(Pounds per measured bushel)						
Newkirk	61	60	62	61	61	61	61	60	61	61	60	61
Renfrow	60	62	60	61	61	61	61	61	61	61	61	61
Billings	61	62	61	60	61	60	61	61	60	60	61	61
Lahoma	54	54	56	55	55	54	55	54	55	55	56	54
Kingfisher	55	56	56	56	57	56	56	55	56	53	54	56
Okarche	57	56	57	56	56	56	57	56	56	57	56	55
Buffalo	53	53	50	54	53	52	54	53	54	53	52	53
Cordell	58	57	57	58	58	58	57	58	58	58	57	57
Headrick	59	58	58	59	58	58	59	58	59	58	57	57
Frederick	59	59	59	59	60	57	59	58	59	59	59	59
Grandfield	62	60	61	60	62	60	61	61	61	61	61	61
Average	58.1	57.9	57.9	58.1	58.4	57.5	58.3	57.7	58.2	57.6	57.6	57.7

Treatments: Treatments are shown in pounds per acre of nitrogen (N) or P_2O_5 (P). All nitrogen was applied broadcast in early spring except in 7, 9, and 11. All phosphorus was applied with the seed at planting.

* Three replicates composited previous to determination of test weight.