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WHEAT FERTILIZATION STUDIES IN WESTERN OKLAHOMA - - - - - Progress Report, 1955 - 1956

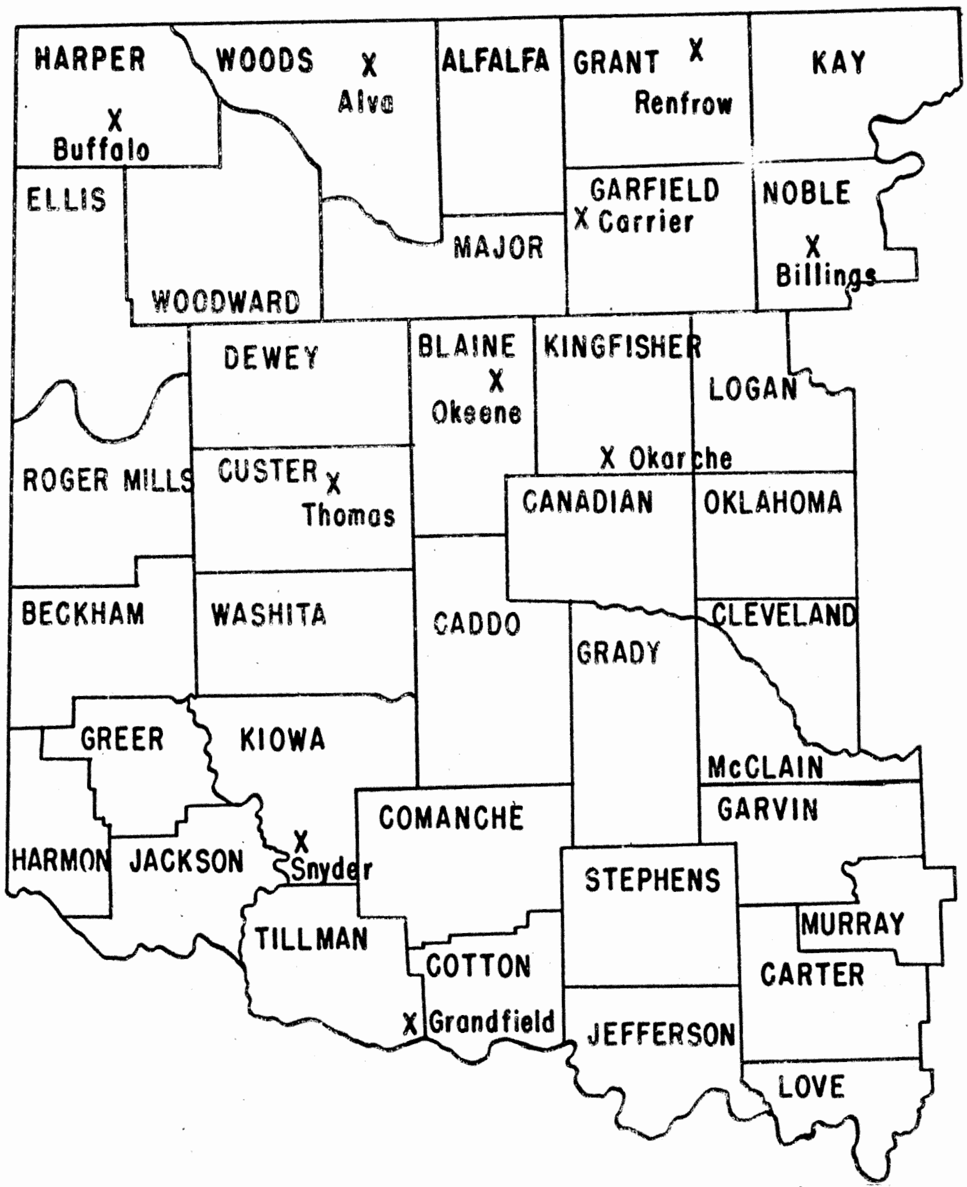

Figure 1. Locations of 10 wheat fertility experiments in western Oklahoma, 1955-56 season.

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DIVISION OF AGRICULTURE
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and

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

PROGRESS REPORT

WHEAT FERTILIZATION STUDIES IN WESTERN OKLAHOMA 1955-1956

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This publication reports 1955-56 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 phosphorus does not affect grain yields, it stimulates early growth and tillering. This 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 five seasons, there were no differences between fall and spring applications of nitrogen; in two seasons, there were relatively small yield advantages for spring over fall application; and in one season, there was a small advantage for fall over spring application of nitrogen. There has not been enough difference between fall and spring application of nitrogen to conclude that one is better than the other; however, spring application has the advantage of allowing the farmer to assess his crop prospects in the early spring before buying nitrogen fertilizer. This is especially important in an area where yields, as well as nitrogen response, are often controlled by moisture.

Uniform wheat fertility experiments were initiated in western Oklahoma in the fall of 1951. Additional experiments were initiated in 1952, 1953, 1954, 1955, and 1956. 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 1955-56, is the fourth of a series of progress reports published annually. Previous reports are Oklahoma Agricultural Experiment Station Bulletin B-432 and Mimeographed Circulars M-270 and M-281. Conclusions drawn in these reports are only tentative, but should be good indicators 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.

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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 crop in all cases was continuous wheat.

Table I - Locations of wheat fertility trials, 1955-56

Town	County	Soil Type	Wheat Variety	Long time avg. rainfall	Percent of long time rainfall rec'd 7/1/54 - 6/30/55
Alva	Alfalfa	Pond Creek silt loam	Comanche	27.87	51.5
Billings	Noble	Kirkland silt loam	Concho	26.26	60.2
Buffalo	Harper	Carey silt loam	Triumph	22.20	47.7
Carrier	Garfield	Pond Creek silt loam	Triumph	29.82	67.1
Custer City	Custer	Carey silt loam	Wichita	29.24	77.9
Grandfield	Tillman	Foard silty clay loam	Triumph	28.68	70.2
Okarche	Kingfisher	Bethany loam	Wichita	30.26	77.2
Okeene	Blaine	Grant silt loam	Concho	27.52	66.4
Renfrow	Grant	Tabler silt loam	Triumph	28.62	55.2
Snyder	Kiowa	Lawton silt loam	Triumph	27.37	65.5

Climatic Conditions

The 1955-56 season was one of below average rainfall. Average monthly rainfall for the 10 locations in relation to long-time average monthly rainfall is shown in Figure 2. Precipitation was below normal in all months except September and October. The average of the 10 locations was 17.91 inches, 9.88 inches below normal. General rains in the latter part of September and early in October provided moisture for favorable stands of wheat in most sections of Oklahoma. Surface and subsoil moisture was good to excellent in most localities at planting time. The below average rainfall from October through June (37.5 percent of normal) definitely decreased wheat yields. The crop was made from moisture stored in the soil from the September and October precipitation. The state average yield per harvested acre was 16.0 bushels compared to 8.0 bushels in 1955 and 13.4 bushels, the 1945-54 average.

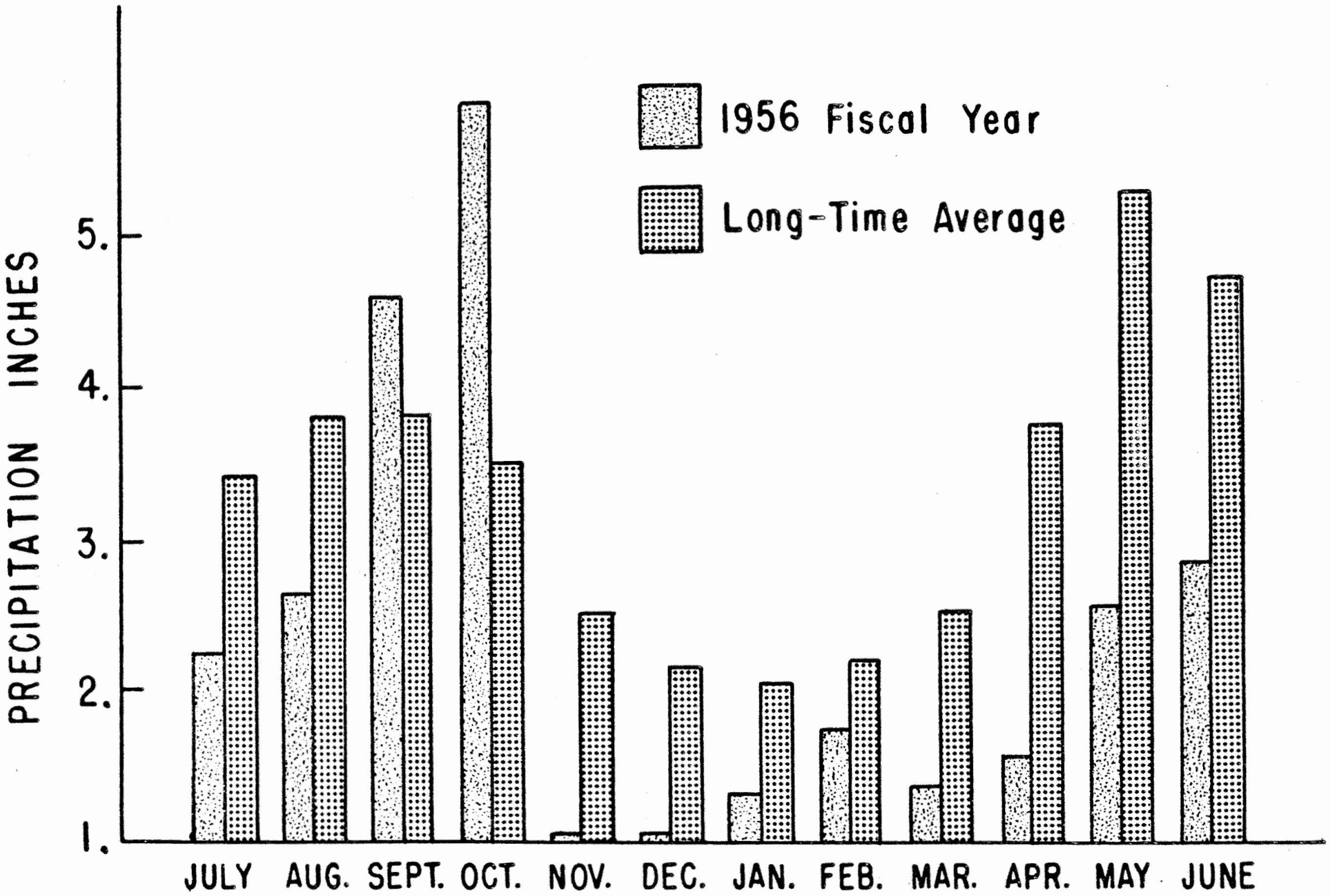

Figure 2. Average monthly rainfall (July 1, 1955 to June 30, 1956) and long-time average monthly rainfall at 10 locations in western Oklahoma.

Table II Yields on wheat fertility trials at ten locations in western Oklahoma, 1955-56*

	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 - 40 P		40 N 40 P		80 N 40 P	
							Fall	Spring	Fall	Spring	Fall	Spring
	Bushels Per Acre											
Alva	12.3	13.0	15.0	11.6	14.5	12.9	14.1	13.2	15.6	13.1	14.9	15.4
Billings	23.7	24.1	25.2	24.9	25.8	25.0	24.9	24.9	24.6	24.9	25.8	25.5
Buffalo	8.4	7.9	11.4	9.3	10.6	10.2	8.8	10.4	11.1	10.0	9.0	8.6
Carrier	22.8	24.7	22.8	23.5	23.8	22.4	22.3	22.3	21.5	21.7	22.4	21.4
Custer City	21.9	21.2	22.1	22.4	22.1	21.7	21.1	22.1	21.5	22.2	21.9	21.5
Grandfield	29.7	32.1	33.4	33.2	31.7	33.7	34.1	30.7	32.3	31.9	32.1	33.1
Okarche	25.1	25.1	26.9	26.9	26.1	26.9	24.8	25.2	30.6	27.2	30.1	25.9
Okeene	13.5	14.2	15.8	14.6	16.5	15.9	15.6	15.5	14.6	15.0	14.4	15.4
Renfrow	20.4	20.7	22.6	23.0	25.3	25.1	23.1	24.3	24.0	24.3	23.8	24.3
Snyder	27.8	29.1	31.5	31.2	31.2	32.1	31.1	30.3	30.7	29.3	34.9	28.1
Average	20.6	21.2	22.7	22.1	22.8	22.6	22.0	21.9	22.7	22.0	22.9	21.9
Av. at P_2O_5 Res. Loc.**	17.5	17.6	19.7	19.1	20.6	---	---	---	---	19.7	---	---

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 treatments 7, 9, and 11. All phosphorus was applied with the seed at planting.

* Averages of three replicates.

** Average at locations where phosphorus response was obtained. Includes Renfrow, Billings, and Buffalo.

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 feet 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 spreader. Fall applications of nitrogen were made immediately following the planting operation. The spring nitrogen applications were made in Februrary 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 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.

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 Renfrow. There, the 20-pound nitrogen rate gave maximum yield increases. The higher nitrogen rates did not give yields significantly different from the 20-pound rate. 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 9 of the 10 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. Grain protein increased with increasing rates of nitrogen application. Grain protein was comparatively high in 1956. The average in the unfertilized plots for the 10 locations was 15.2 percent. The highest nitrogen rate gave an average protein percentage of 16.6 percent, thus the increase in grain protein from applied nitrogen was comparatively small. In seasons when grain protein is low, greater increases in protein can be expected from applied nitrogen. (In 1953, for instance, unfertilized plots averaged 12.5 percent while the

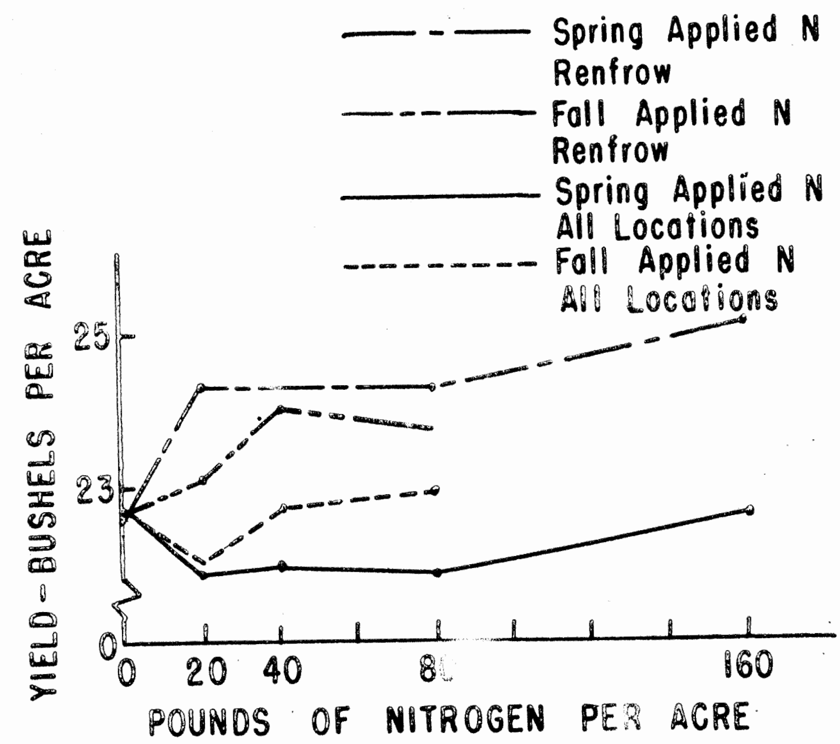

Figure 3. Yields on wheat fertility trials as affected by rate and time of nitrogen fertilization, 1955-56.

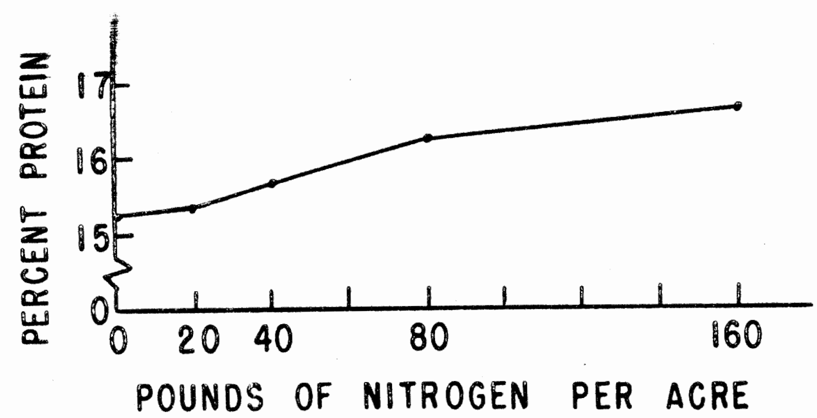

Figure 4. Protein in wheat grain as affected by rate of nitrogen fertilization, 1955-56.

Table III Protein in wheat grain on fertility trials at ten locations in western Oklahoma, 1955-56*

	1	2	3	4	5	6	7	8	9	10	11	12
	No treat-ment	40 N	40 P	40 N 20P	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
						Percent						
Alva	18.4	18.0	17.8	18.6	18.1	19.1	18.4	18.8	18.0	18.4	18.0	18.3
Billings	14.3	15.1	14.4	15.2	15.2	15.7	14.5	14.8	14.8	14.8	15.6	15.8
Buffalo	16.1	16.1	16.5	16.1	16.2	16.4	16.3	16.0	16.3	16.4	16.3	16.3
Carrier	15.1	15.0	15.4	15.6	15.0	17.0	17.0	15.4	14.9	15.7	15.6	16.2
Custer City	16.8	16.7	16.3	16.3	16.7	17.2	16.4	16.3	15.9	16.6	17.0	16.7
Grandfield	13.4	13.7	14.0	15.4	15.1	14.6	14.7	12.5	14.9	12.9	16.2	14.3
Okarche	13.9	15.7	14.9	15.4	16.1	16.7	14.9	15.5	15.5	15.2	16.1	15.4
Okeene	16.0	18.1	15.5	17.0	16.9	17.9	16.8	16.1	16.6	17.2	18.3	17.9
Renfrow	13.9	14.7	13.5	14.5	13.7	15.7	14.4	14.0	14.4	14.5	15.2	15.2
Snyder	14.2	14.7	14.5	15.0	14.2	15.2	14.5	15.0	14.7	14.9	14.5	15.3
Average	15.2	15.8	15.3	16.0	15.7	16.6	15.8	15.4	15.6	15.7	16.3	16.2

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.

highest nitrogen rate gave an average grain protein content of 15.6 percent.) At locations where grain protein was relatively low on the unfertilized plots, larger increases were realized than at locations where grain protein was relatively high on the unfertilized plots.

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.

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. At Renfrow, the only location where response to nitrogen was obtained, spring applied nitrogen gave higher yields than fall applied nitrogen. At Snyder, fall applied nitrogen gave higher yields than spring applied nitrogen. The average advantage for spring application at Renfrow was 0.7 bushels per acre while that for fall application at Snyder was 3.0 bushels per acre. At the other locations, time of nitrogen application did not have significant effects on grain yields. When all locations are considered, fall applied nitrogen outyielded spring applied nitrogen an average of 0.9 bushels per acre. Whether nitrogen was applied in the fall or in the spring had little effect on grain protein or on test weight. The effect of time of nitrogen application on yield of grain is shown graphically in Figure 3.

In five seasons of experimentation, there have been two seasons when there were no differences between fall and spring application of nitrogen, two seasons when there were relatively small advantages for spring over fall nitrogen application, and one season when there was a small advantage for fall over spring nitrogen application. There has not been enough difference between fall and spring application of nitrogen to conclude that one is better than the other; however, spring application has the advantage of allowing the farmer to assess his crop prospects in the early spring before buying nitrogen fertilizer. This is especially important in an area where yields, as well as nitrogen response are often controlled by moisture.

Effect of Phosphorus Fertilizer

On Yield of 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 Renfrow, Billings, and Buffalo. Twenty pounds of P_2O_5 per acre was sufficient to give maximum yields at Billings and Buffalo; however, at Renfrow, yields increased with increasing rates of P_2O_5 through 80 pounds

Table IV Test weight of wheat grain on fertility trials at ten locations in western Oklahoma, 1955-56*

	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						
Alva	57.7	56.0	55.4	55.9	55.1	55.6	55.9	55.5	56.1	56.0	56.0	55.5
Billings	60.0	59.6	59.6	59.0	60.0	59.1	59.2	59.9	59.8	59.5	58.9	59.1
Buffalo	58.0	58.0	57.8	57.8	56.9	58.1	58.0	57.9	56.3	57.7	58.0	57.2
Carrier	60.0	60.5	60.2	60.0	60.0	59.5	59.9	60.0	60.2	59.6	60.4	59.8
Custer City	59.3	58.8	58.1	59.3	58.4	57.8	58.8	57.6	59.0	59.0	58.7	58.5
Grandfield	63.5	63.3	63.2	63.0	63.2	63.3	63.1	63.6	63.4	63.1	62.9	63.2
Okarche	59.0	58.0	58.5	58.5	58.1	58.4	58.6	58.4	58.5	58.7	58.3	58.3
Okeene	56.3	55.4	56.4	55.1	56.4	55.5	56.0	55.9	56.0	55.7	55.9	56.1
Renfrow	59.9	59.5	60.0	59.9	59.4	59.2	59.9	60.0	59.7	59.8	60.0	59.4
Snyder	60.0	59.8	59.5	59.6	59.8	59.2	59.8	59.4	59.8	59.4	59.7	59.1
Average	59.4	58.9	58.9	58.8	58.7	58.6	58.9	58.8	58.9	58.9	58.9	58.6

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.

per acre. At the three locations where significant responses were obtained, 20 pounds of P_2O_5 per acre increased yields by an average of 1.5 bushels per acre. In previous seasons, significant increases in yield from phosphorus have been obtained at Grandfield, as well as at the locations which show response this season. At Snyder, Carrier, Custer City and Okarche, phosphorus increased initial growth and tillering even though it did not affect yield.

In 40 trials conducted in four previous seasons (1951-52, 52-53, 53-54, and 54-55) phosphorus response was obtained in 18. In the 40 trials, the average response to 20 pounds of P_2O_5 per acre was 2.1 bushels per acre and in the 18 trials in which phosphorus response was obtained, the average response to 20 pounds of P_2O_5 per ac was 4.4 bushels per acre. These data are illustrated graphically in Figure 6.

Results of five seasons of experimentation indicate that phosphorus is the first limiting element in wheat growth on most wheatland soils in western Oklahoma. 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 are 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 III.)

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 1955-56 results of wheat fertility experiments at 10 locations in western Oklahoma furnished information for the following conclusions:

(1) Nitrogen fertilization brought about a significant increase in yield at only one of ten 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 little effect on grain yields.

(5) Phosphorus fertilization brought about significant increases in yield at three of ten locations.

(6) Twenty pounds of P_2O_5 per acre was sufficient to give maximum yield increases

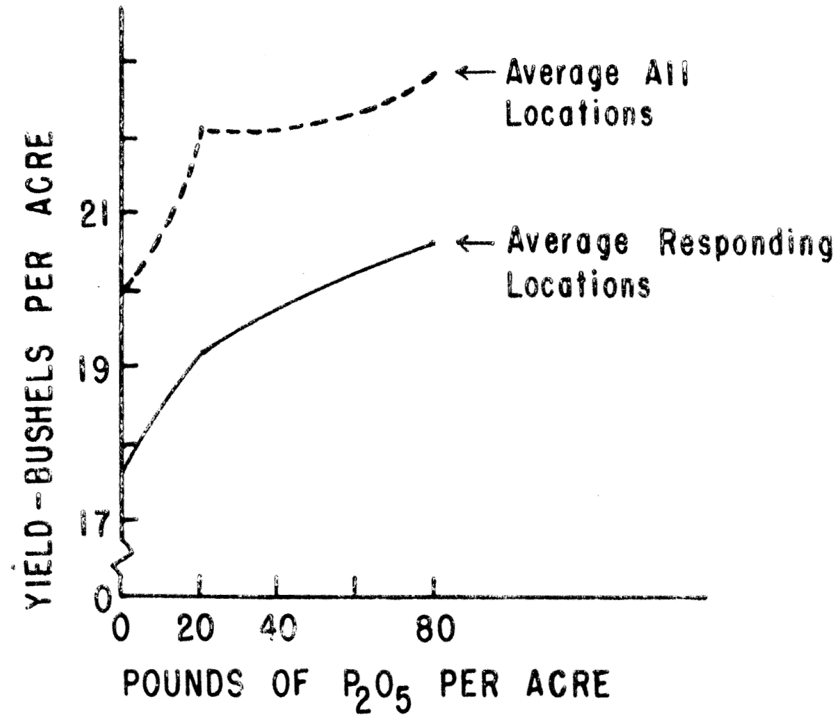

Figure 5. Yields on wheat fertility trials as affected by rate of P_2O_5 fertilization.

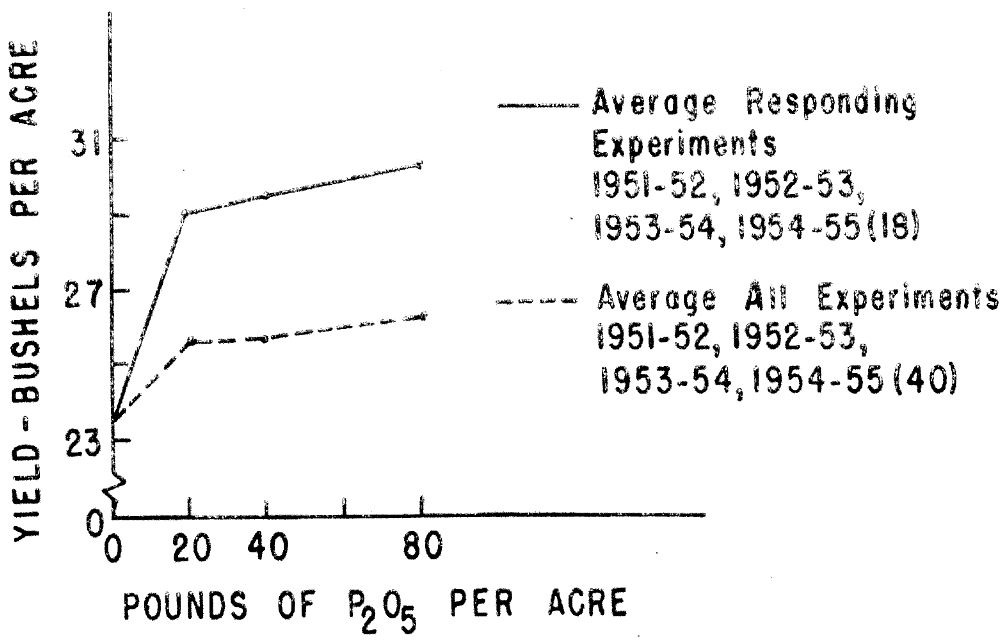

Figure 6. Yields of wheat on fertility trials as affected by rate of P_2O_5 fertilization, Avg. 1951-52, 1952-53, 1953-54, 1954-55.

at two of the three locations where phosphorus gave yield increases. At Renfrow, yields increased with increasing rates of P_2O_5 through 80 pounds per acre.

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