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Wheat Fertilization Studies in Western Oklahoma
Progress Report, 1953-54

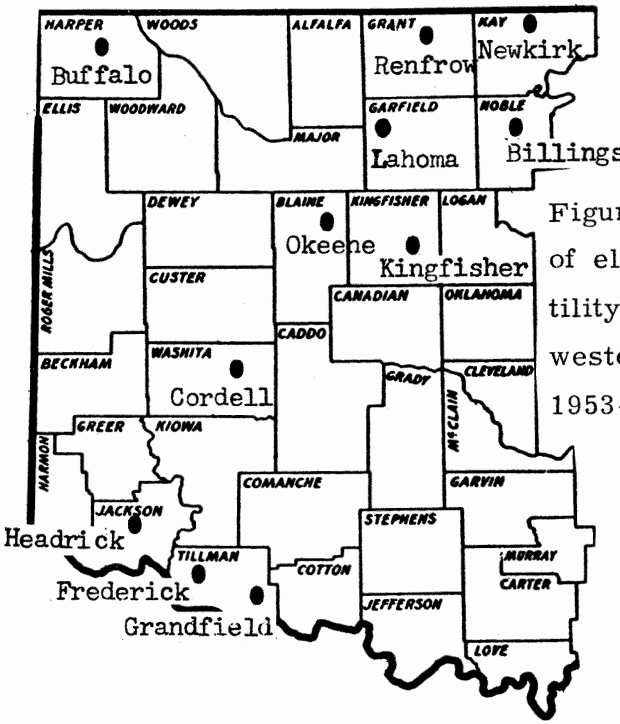

Figure 1. Locations of eleven wheat fertility experiments in western Oklahoma, 1953-54 season.

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
1953-54

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This publication reports 1953-54 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 only be expected after phosphorus needs are fulfilled.

(2) It may be advisable, especially in the drier areas, to delay nitrogen fertilization of wheat until late winter or early spring. The added yield increase from spring over fall application of nitrogen will at least pay for the cost of application and also, by spring, 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 initiated in 1952, 1953, and 1954, 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 1953-54 is the second of a series of progress reports which are published annually. The first report, Oklahoma Agricultural Experiment Station Bulletin B-432, contains results for 1951-52 and 1952-53. 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, both this report and the preceding one should be consulted.

Experimental Sites

Experimental sites are shown in Figure 1. The sites are listed below, with associated information given in the following order: Location; soil type; variety of wheat grown; average annual rainfall; and percent of the annual average received during the crop year (July 1 through June 30). Previous soil management in all cases was continuous wheat.

Newkirk, Kay County: Bethany silt loam; Wichita; 33.76; 61.3
Renfrow, Grant County: Tabler silt loam; Triumph; 28.62; 82.2
Billings, Noble County: Kirkland silt loam; Triumph; 29.26; 83.8
Lahoma, Garfield County: Grant very fine sandy loam; Triumph; 29.82; 85.3
Kingfisher, Kingfisher County: Renfrow silty clay loam: Triumph; 30.26; 98.0
Okeene, Blaine County: Ponca; 27.52; 93.4
Buffalo, Harper County: St. Paul silt loam; Wichita; 22.20; 88.4
Cordell, Washita County: Tillman silt loam; Triumph; 27.48; 95.9
Headrick, Jackson County: Foard silt loam; Triumph; 25.49; 103.7
Frederick, Tillman County: Tillman clay loam; Westar; 27.37; 98.4
Grandfield, Tillman County: Foard silt, clay loam; Triumph; 30.08; 114.0

Climatic Conditions

The 1953-54 season was one of near average total rainfall but eratic rainfall distribution. Average monthly rainfall for the 11 locations in relation to long-time average monthly rainfall is shown in Figure 2. Rainfall during the 3 month period of July through September, the fallow and seedbed preparation period, was near average. In general, conditions for establishing stands of wheat were good. At most locations, the wheat entered the winter dormancy period in good condition. Rainfall during the first three months of 1954 was markedly below average. The drought period extended through the first two weeks of April at most of the locations. Temperatures were favorable for rapid growth after about March 1. The available soil moisture became exhausted and the wheat plants suffered severe drought injury. The crop was revived by the rains in April and May. The average yield of wheat in Oklahoma was 15.0 bushels per acre compared to 12.0 bushels per acre in 1953 and 13.3 bushels per acre for the period 1943-52.

Experimental Design, Methods, and Materials

Fertilizer treatments are listed in Table I. 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

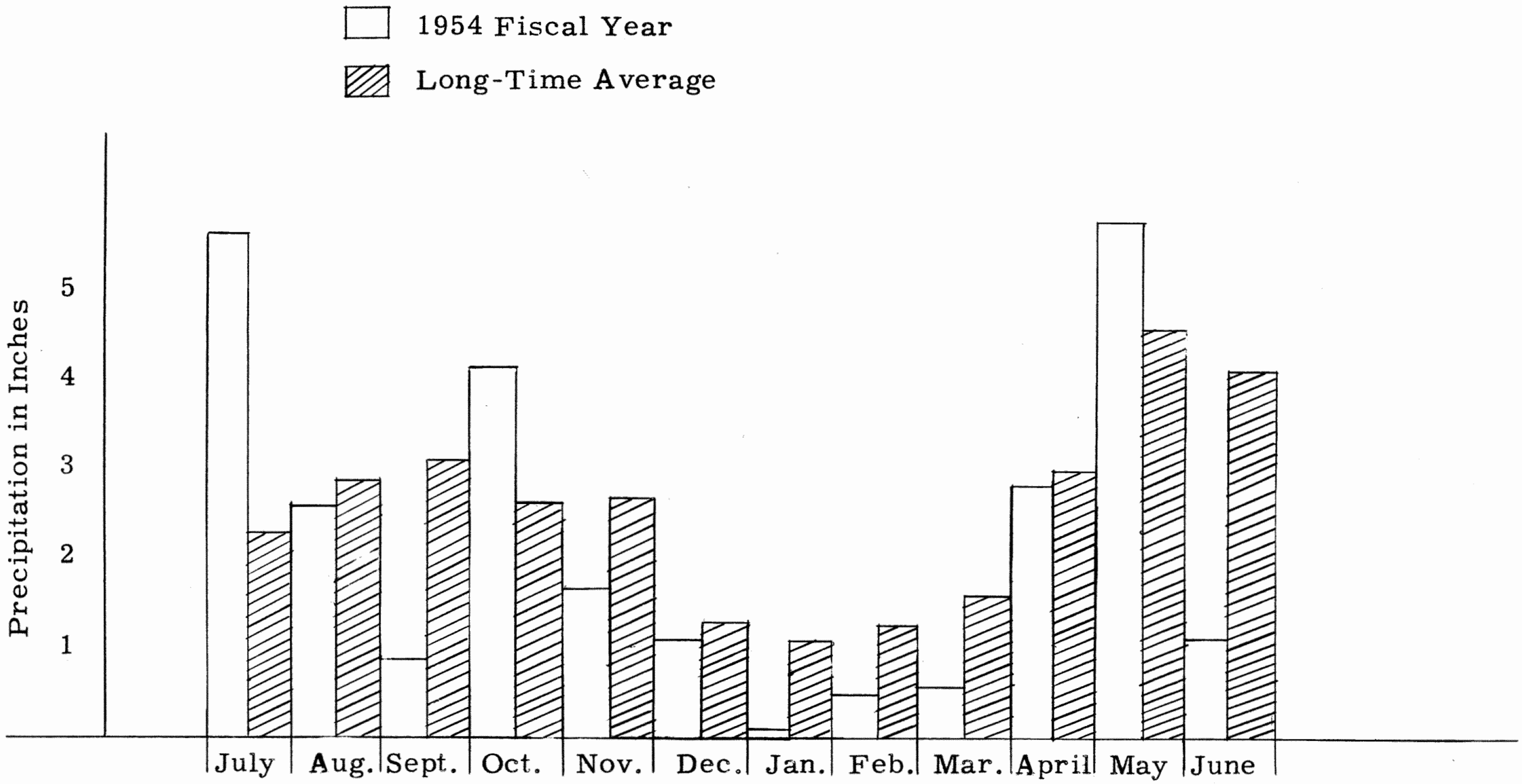

Figure 2. Average monthly rainfall (July 1, 1953 to June 30, 1954) and long-time average monthly rainfall at eleven locations in western Oklahoma.

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 analysis 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 I, II and III, 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 I, are considered in that order. Yield increases due to nitrogen applications were obtained at 4 of the 11 locations, namely, Renfrow, Billings, Kingfisher, and Grandfield. At these 4 locations where nitrogen response was obtained, yields increased with successive increments of nitrogen through 80 pounds per acre. The 20 pound rate was the most efficient one in increasing yield with 4.7 pounds of nitrogen required for each additional bushel of wheat. In the case of the 40, 80 and 160 pound rates, the nitrogen supplied for each bushel increase was 7.1, 7.9, and 17.4 pounds; respectively. The 160 pound application of nitrogen affected yield in about the same manner as the 80 pound rate at these responding locations. The only instance of nitrogen reducing yield was at Okeene where the 160 pound rate brought about a significant decrease in yield.

Under the prevailing climatic conditions, the soil at 7 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 II, are considered here. The protein content of the grain increased with increasing nitrogen through

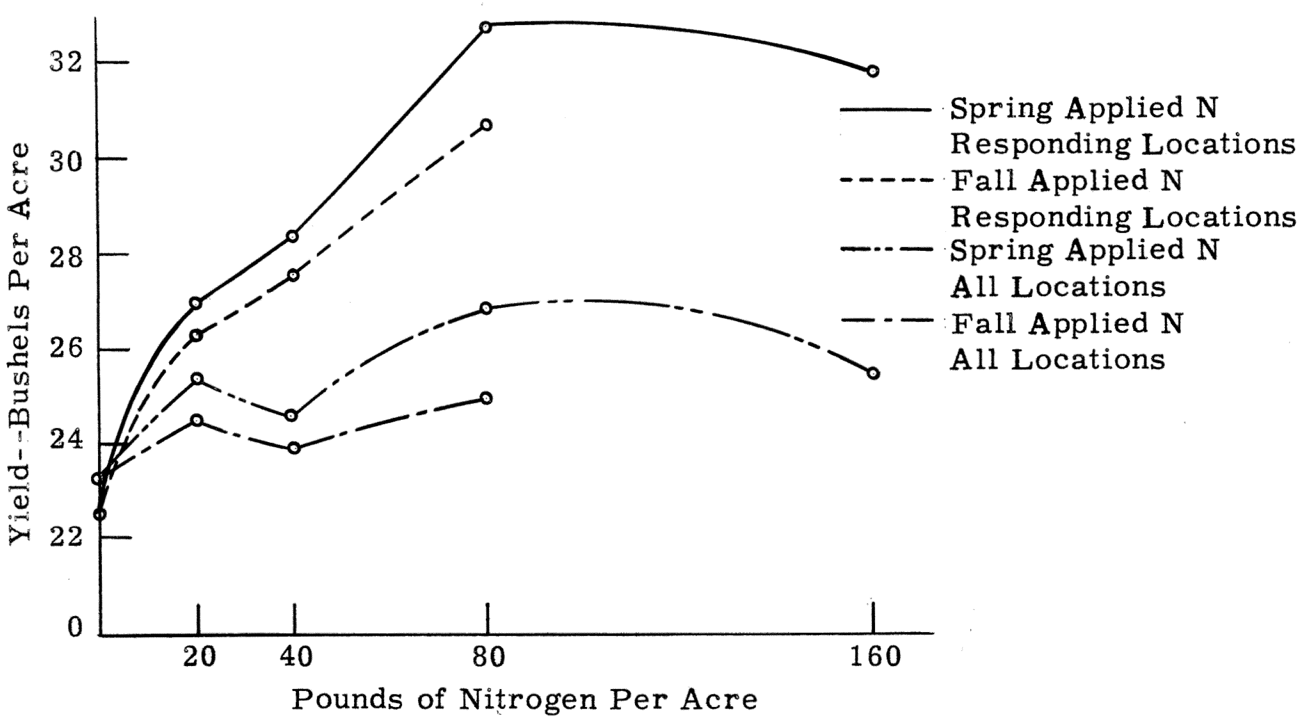

Figure 3. Yields on wheat fertility trials as affected by rate and time of nitrogen fertilization, 1953-54.

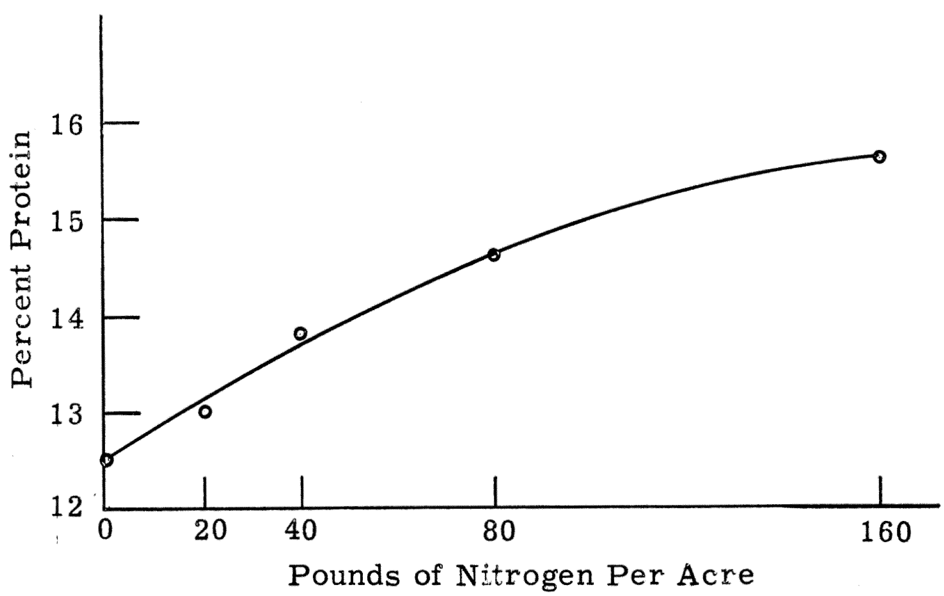

Figure 4. Protein in wheat grain as affected by rate of nitrogen fertilization, 1953-54.

160 pounds per acre at all locations except Buffalo, Headrick and Frederick. At Buffalo and Headrick, maximum protein content was reached at 40 pounds of nitrogen per acre and at Frederick, the maximum was reached at 80 pounds of nitrogen. 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 applied than the higher rates did. At locations where there was little increase in grain protein between the 80 and 160 pound rates, one may conclude that sufficient nitrogen was applied to give maximum protein increases while at those where successive equal increments gave near equal protein increases through 160 pounds per acre, the conclusion is that sufficient nitrogen for maximum protein increase probably was not supplied.

At locations where yield increases were obtained, smaller protein increases were realized for the low rates of nitrogen than at locations where no yield increases were obtained. This is due to the fact that some of the added nitrogen was utilized in producing the increased grain yields.

<u>On Test Weight of Grain</u>

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 III. Treatments 3, 8, 10, 12, and 6 are considered. The effect of the nitrogen applications on test weight was very slight though the average for the 160 pound rate of nitrogen was a little lower than that for the other nitrogen rates.

Fall vs. Spring Application 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 I, II, and III. Spring applied nitrogen gave significant yield increases over fall applied nitrogen at 5 of the 11 locations. The average yield advantage for spring over fall application was 1.2 bushels per acre. The advantage is the same whether all or only the responding locations are considered. Time of nitrogen application had little effect on protein content and test weight of grain. The effect of date of nitrogen application on yield of grain is shown graphically in Figure 3.

Though there was only a slight advantage for spring over fall application of nitrogen in this season, no difference in the previous season, and relatively small advantage in the 1951-52 season (2.5 bushels per acre), it may be advisable, especially in the drier areas, to delay nitrogen application until late winter or early spring. The added yield increase from spring over fall application of nitrogen will at least pay for the cost of application and also, by spring, 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.

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 I, are considered in that order. There were significant increases in yield from phosphorus at Renfrow, Billings, and Grandfield. Phosphorus had much less effect on yield in the 1953-54 season than it had during the two previous seasons. The effect of phosphorus on fall growth was obvious at Newkirk, Cordell, Headrick, and Frederick as well as at the responding locations. Phosphorus response had been obtained in previous seasons at Newkirk, Lahoma, Kingfisher, and Frederick. Previous results suggest that the use of phosphate fertilizer on wheat is profitable throughout most of western Oklahoma. It appears that the results in this one season are an exception to what can usually be expected. (See Figure 6 for 1951-52 and 1952-53 results.)

Data from the past 3 years indicate that phosphorus is the first limiting chemical element in wheat growth on many soils in western Oklahoma and maximum response from nitrogen fertilizer cannot be expected unless phosphorus fertilizer is applied.

On Protein Content of Grain

Phosphorus fertilization had no significant effect on the protein content of the grain at any location. (See treatments 2, 4, 10, and 5, Table II.)

On Test Weight of Grain

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

Summary and Conclusions

The 1953-54 results of wheat fertility experiments at 11 locations in western Oklahoma furnished information for the following conclusions:

(1) Nitrogen fertilization brought about significant increases in yield at 4 of the 11 locations.

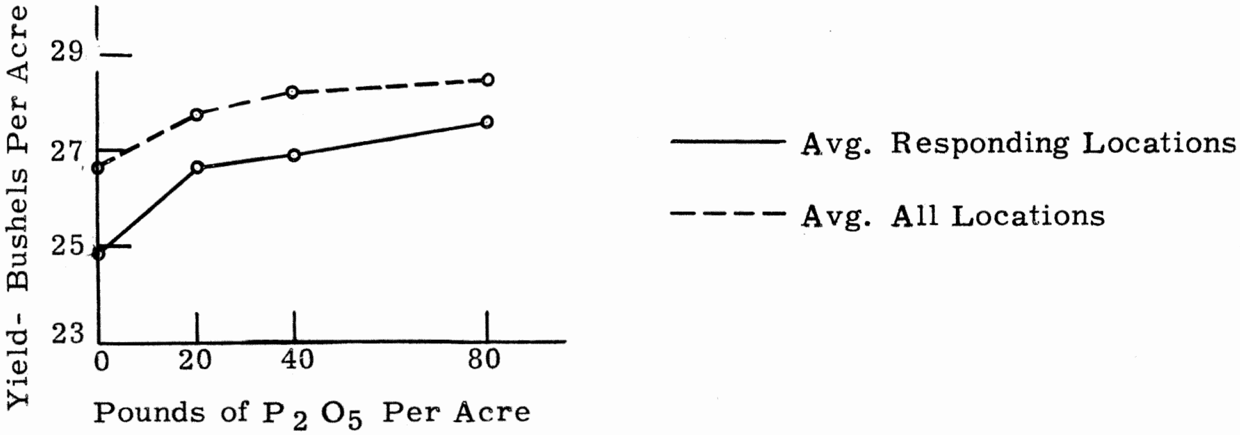

Figure 5. Yields on wheat fertility trials as affected by rate of P_2O_5 fertilization.

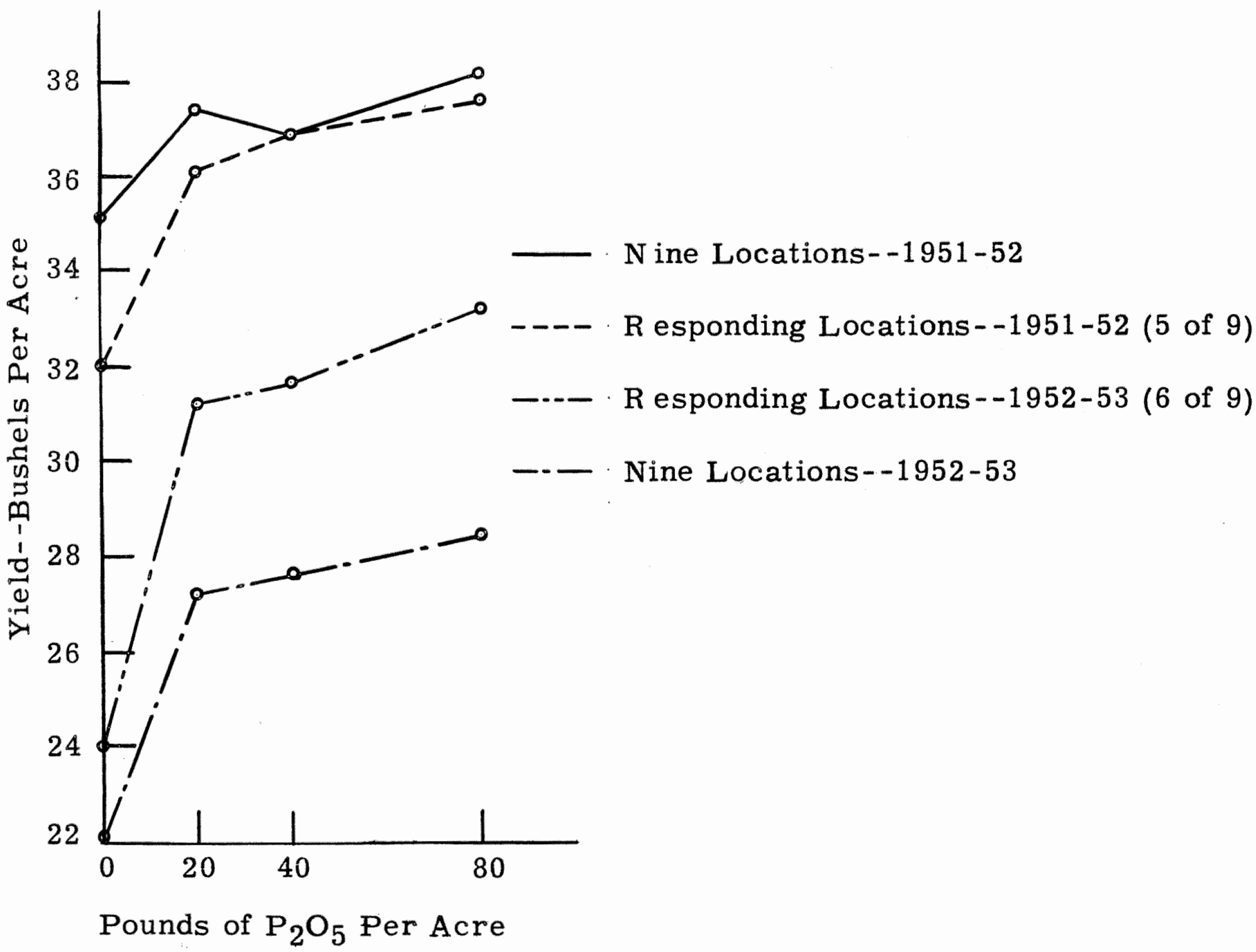

Figure 6. Yields of wheat on fertility trials as affected by rate of P_2O_5 fertilization, 1951-52 and 1952-53.

(2) At the 4 locations where nitrogen response was obtained, yield increased with increasing nitrogen through 80 pounds per acre. The most efficient rate was 20 pounds per acre where 4.7 pounds of nitrogen was required to produce each bushel of increase.

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

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

(5) Spring applied nitrogen produced slightly higher yields than fall applied nitrogen, however time of nitrogen application had no effect on grain protein or test weight.

(6) Phosphorus fertilization brought about significant increases in yield at 3 of the 11 locations.

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

(8) Phosphorus fertilization increased initial growth, tillering, and top growth at 7 of the 11 locations.

(9) Even though there was little yield response to phosphorus in the 1953-54 season, results from 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 I. Yields on wheat fertility trials at eleven locations in western Oklahoma, 1953-54*

(Bushels per acre)

	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
Newkirk	25.5	27.9	28.8	27.4	30.2	28.5	28.6	29.7	28.2	30.2	27.4	29.9
Renfrow	23.0	27.4	22.6	29.6	29.4	34.1	26.1	26.9	28.1	29.4	32.7	34.1
Billings	20.2	23.4	19.6	24.1	25.1	28.7	22.6	24.0	25.2	25.3	26.7	28.4
Lahoma	35.7	35.6	33.7	35.2	33.3	32.5	33.8	34.4	32.4	35.5	33.2	34.4
Kingfisher	25.6	31.9	23.9	30.8	31.0	37.3	29.0	30.1	29.7	32.2	35.7	39.8
Okeene	26.6	25.3	26.6	24.8	25.9	18.6	24.7	27.5	23.6	25.7	19.3	23.6
Buffalo	13.2	14.0	12.4	14.4	11.0	13.9	12.0	13.7	10.7	13.2	10.8	13.3
Cordell	18.8	19.4	20.3	20.4	19.5	18.9	19.2	20.5	18.9	20.9	18.7	21.5
Headrick	21.9	28.9	20.9	26.2	22.3	20.2	26.2	22.7	19.1	21.2	21.5	20.5
Frederick	20.7	19.1	21.8	21.2	19.7	21.2	20.2	22.0	20.6	19.8	20.7	21.5
Grandfield	23.3	24.0	24.1	26.4	28.2	26.9	27.3	26.5	26.9	26.0	27.3	28.4
Average	23.3	25.2	23.2	25.5	25.1	25.5	24.5	25.3	23.9	24.6	24.9	26.9
Av. at N Res. Loc.**	23.0	26.7	22.6	27.7	28.4	31.8	26.3	26.9	27.5	28.2	30.6	32.7
Av. at P_2O_5 Res. Loc /	22.2	24.9	22.1	26.7	27.6					26.9		

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. ** Averages at locations where nitrogen response was obtained. Includes Renfrow, Billings, Kingfisher, and Grandfield. /Averages at locations where phosphorus response was obtained. Includes only Renfrow, Billings, and Grandfield.

Table II. Protein in wheat grain on fertility trials at eleven locations in western Oklahoma, 1953-54*

(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 -	40 P	40 N -	40 P	80 N -	40 P
							Fall	Spring	Fall	Spring	Fall	Spring
Newkirk	12.68	12.76	11.68	13.75	12.47	14.84	12.45	12.19	12.59	12.78	13.90	13.34
Renfrow	10.99	11.17	10.59	11.06	10.93	14.27	10.39	10.48	10.14	10.67	12.01	11.77
Billings	10.93	12.58	10.89	12.60	11.98	15.19	10.97	11.68	11.63	12.19	13.40	13.49
Lahoma	11.46	13.24	10.72	12.20	13.14	15.49	11.90	13.09	12.75	13.18	14.93	14.38
Kingfisher	10.34	11.34	10.26	11.21	10.96	13.63	10.18	10.17	9.96	10.83	11.20	11.44
Okeene	12.64	15.12	12.25	15.16	14.28	16.92	13.92	12.93	14.95	14.69	16.60	16.10
Buffalo	15.72	17.56	16.60	17.73	17.43	17.88	16.55	17.14	17.48	17.87	17.42	17.96
Cordell	16.19	15.75	15.48	16.66	16.68	17.24	16.71	15.64	16.83	16.11	16.54	16.84
Headrick	13.08	14.83	13.98	14.93	15.11	16.22	13.96	13.90	15.42	16.51	14.64	16.42
Frederick	13.45	14.03	13.45	14.06	13.94	14.67	13.05	14.00	14.67	13.78	15.39	14.62
Grandfield*	11.88	14.05	11.79	13.03	12.77	15.08	12.90	11.94	14.22	13.07	14.37	14.19
Average	12.67	13.86	12.52	13.85	13.61	15.58	13.00	13.01	13.69	13.79	14.58	14.60

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.

Table III. Test weight of wheat grain on fertility trials at eleven locations in western Oklahoma, 1953-54*

(Pounds per measured bushel)

	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 - 40 P		40 N - 40 P		80 N - 40 P	
							Fall	Spring	Fall	Spring	Fall	Spring
Newkirk	60.0	60.1	59.8	60.1	59.7	59.6	59.9	59.9	59.8	60.1	59.7	59.9
Renfrow	62.6	62.6	62.4	62.8	62.8	61.7	62.4	62.6	62.6	62.7	62.6	62.7
Billings	63.3	63.2	63.1	63.2	63.1	62.0	63.3	63.5	63.3	63.2	62.5	63.2
Lahoma	61.2	61.0	60.9	61.0	60.8	60.4	61.0	60.8	60.9	61.0	60.4	61.0
Kingfisher	62.0	62.6	62.0	62.5	62.5	62.8	62.5	62.4	62.4	62.8	62.6	63.0
Okeene	59.0	59.0	58.8	59.0	59.2	58.7	59.2	59.1	59.1	59.2	59.0	58.8
Buffalo	58.6	57.6	57.8	57.6	56.7	56.4	58.0	57.7	57.8	57.1	56.8	57.1
Cordell	58.6	58.5	58.9	58.2	57.9	58.0	58.2	58.6	58.0	58.4	58.4	58.6
Headrick	60.1	60.5	60.3	60.3	60.1	59.4	60.0	59.9	59.8	60.0	60.2	59.6
Frederick	59.0	59.2	59.5	59.4	59.3	59.1	59.4	59.4	59.2	59.4	59.2	58.9
Grandfield	58.4	58.9	58.4	59.2	58.7	59.1	58.9	58.5	58.9	58.9	59.0	59.1
Average	60.3	60.3	60.2	60.3	60.1	59.7	60.3	60.2	60.2	60.3	60.0	60.2

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

* Three replicates composited previous to determination of test weight.