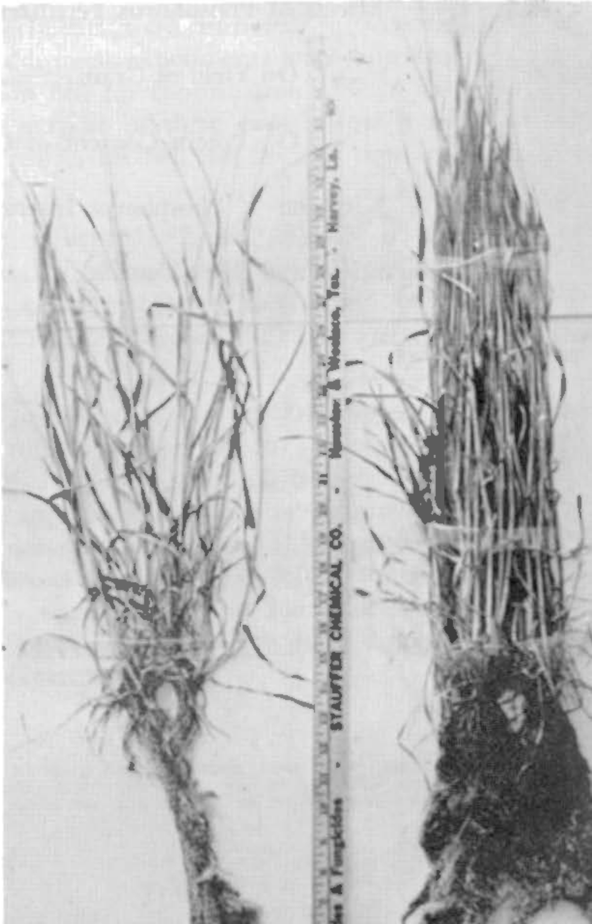
Bulletin B-432 July, 1954

# Wheat Fertilization Studies In Western Oklahoma;

## Progress Report, 1951-52 and 1952-53

Right, phosphate fertilizers; left, no phosphate.

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## PROGRESS REPORT

# Wheat Fertilization Studies In Western Oklahoma 1951-52 and 1952-53

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

This publication, giving results for 1951-52 and 1952-53, is the first of a series of progress reports to be published annually. 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 in western Oklahoma.

Earlier work on fertilization of wheat in western Oklahoma includes 30 experiments conducted during the period 1945-50. In the six years, wheat yields were increased an average of 4.0 bushels, from 13.1 to 17.1 bushels per acre, by the application of 32 pounds of nitrogen per acre. Most of this work was done on sandy soils. Little, though some, regard was given to phosphorus level in these soils. In later work, some phosphorus treatments were included at some locations. The results indicate that phosphorus deficiency may have limited nitrogen response in some of the experiments.

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## Experimental Sites

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

**1951-52**

Billings, Noble County: Renfrow silt loam; continuous wheat; Triumph; 32.00 in. and 87.0%.

Carmen

Alfalfa County: Pond Creek silt loam; continuous wheat; Pawnee;24.41 in. and 84.9%.

Alfalafa County: Pratt loamy fine sand; continuous wheat; Pawnee: 24.41 in. and 84.9%.

Cherokee, Alfalfa County: Reinach very fine sandy loam; continuous wheat; Comanche; 24.41 in. and 84.9%.

Dacoma, Alfalfa County: Pond Creek silt loam; continuous wheat; Pawnee; 27.87 in. and 79.4%.

Davidson, Tillman Coonuty: Pratt loamy fine sand; cotton; Triumph; 26.37 in. and 98.4%.

El Reno, Canadian County: Canadian sandy loam; continuous wheat; Pawnee; 28.69 in. and 86.2%.

Frederick, Tillman County: Tillman silt loam; continuous wheat; Westar; 26.37 in. and 98.4%.

Lahoma, Garfield County: Grant very fine sandy loam; continuous wheat; Triumph; 29.82 in. and 72.5%.

Newkirk, Kay County: Kirkland silt loam; continuous wheat; Wichita; 33.76 in. and 85.4%.

**1952-53**

Billings, Noble County: Kirkland silt loam; continuous wheat; Triumph; 29.40 in. and 67.4%.

Frederick, Tillman County: Tillman silt loam; continuous wheat; Westar; 27.37 in. and 60.4%.

Grandfield, Tillman County: Foard silt loam; continuous wheat; Triumph; 30.26 in. and 59.02%.

Kingfisher, Kingfisher County: Kirkland clay loam; continuous wheat; Triumph; 30.26 in. and 60.1%.

Lahoma, Garfield County: Grant very fine sandy loam; continuous wheat; Triumph; 29.82 in. and 64.1%.

Loyal, Kingfisher County: Soil unidentified; continuous wheat; Comanche; 28.33 in. and 53.9%.

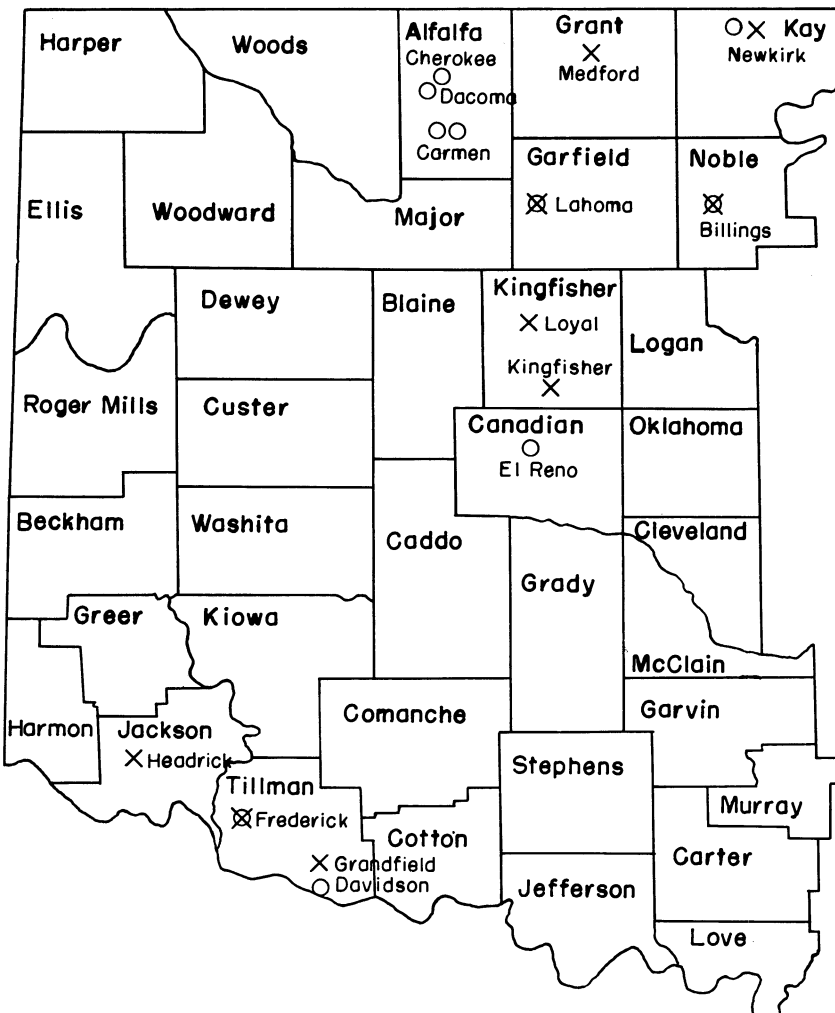


**Fig. 1.—Location of Uniform Wheat Fertility Experiments in Western Oklahoma, 1951-52 and 1952-53 seasons.**

Medford, Grant County: Tabler silt loam; continuous wheat; Triumph; 28.62 in. and 63.4%.

Newkirk, Kay County: Tabler silt loam; continuous wheat; Triumph; 33.76 in. and 60.2%.

Experiments were completed at ten locations in 1951-52 and at nine locations in 1952-53. In the 1951-52 season, both nitrogen and phosphorus variables were studied at seven of the sites. Only nitrogen was studied at one, and phosphorus alone was studied at two of the locations. In the 1952-53 season, both nitrogen and phosphorus were studied at all locations. The sites were picked to typify the important wheat soils of western Oklahoma. Three sites, at Carmen, El Reno, and Davidson, were located on sandy soil; the others were on the "hardlands."

## Climatic Conditions

Moisture conditions in the fall of 1951 were excellent for the establishment of good stands of wheat in all areas except the Panhandle. Favorable moisture conditions prevailed through April but precipitation dropped sharply below normal in May and June. There was sufficient soil moisture to mature the wheat and the crop was the largest in Oklahoma's history.

The 1952-53 season was exceedingly dry in western Oklahoma. On the average, the nine locations received only 59.2 percent of their long-time average rainfall. The driest location was at Headrick, which received only 41.5 percent of its long-time average. The least dry location was Billings, which received 67.4 percent of normal. Total precipitation, of course, is not so important as distribution of precipitation. This is borne out by the fact that a record yield of wheat was produced at Grandfield, which received only 17.86 inches or 59 percent of the long-time average.

At planting time, there was insufficient surface moisture to germinate the seed wheat. The seed was "dusted in" and remained in dry soil until late November when sufficient rain fell to germinate it. Cool December and January temperatures retarded growth. At most locations, little or no tillering had taken place by February 15, and the plants were only 1 to 1½ inches tall.

Rainfall during the spring months was below normal, and at some locations severe symptoms of drought were apparent during dry intervals. Temperatures were high and hot winds came during the ripening period. Generally, the early varieties of wheat were mature enough to escape the ravages of the hot winds, but the later varieties ripened prematurely and the grain was shriveled. The late germination, thus short growing period of the wheat crop, was probably responsible for its yielding as much as it did under the drought conditions.

## Experimental Design, Methods, and Materials

The treatments used in the 1951-52 season are listed in Tables I and II. Those used in the 1952-53 season are given in Table III.

In the 1951-52 season, nitrogen and phosphorus were studied in separate randomized block experiments which were placed adjacent to each other at the experimental site. Each treatment was replicated four times. The design was modified in the 1952-53 season so that all treatments were in a common randomized block and each treatment was replicated three times. Two treatments, a check, and a high nitrogen treatment were added.

The phosphate source used was superphosphate (20% $P_2O_5$) and the nitrogen source was ammonium nitrate (33.5 % N). The phosphorus was applied with the seed at planting. The fall nitrogen treatments were broadcast on the surface of the soil either immediately preceding or following the planting operation. The spring nitrogen applications were made in February or early March. All nitrogen applications, except those made in the fall of 1951, were made with a hand-drawn "Gandy" spreader. The nitrogen applications in the fall of 1951 were made with combination grain and fertilizer drill.

The wheat was planted with a drill and harvested with a 7-foot self-propelled combine. Individual plots were one drill width wide (8′9″ in 1951-52, and 7′7″ in 1952-53) by 100 or more feet in length. In most cases, the harvested area was 7 x 100 ft.

Soil samples were collected at each site. The results of soil analysis will not be presented here. Data were taken on yield and on protein and phosphorus content of the grain. Rainfall and soil moisture records were kept.

## Results

Grain yields for the 1951-52 experiments are presented in Tables I and II. Grain protein percentages from five 1951-52 nitrogen experiments are reported in Table IV. Grain yields and grain protein percent-

**TABLE I.—Yields of Wheat at Eight Locations in Western Oklahoma as Affected by Four Rates and Two Dates of Nitrogen Fertilization, 1951-52.***

*(Bushels per acre)*

| Location | No Nitrogen | 20 lbs. N per A. | | 40 lbs. N per A. | | 80 lbs. N per A. | |
|---|---|---|---|---|---|---|---|
| | | Fall | Spring | Fall | Spring | Fall | Spring |
| Newkirk | 29.3 | 35.7 | 38.9 | 40.1 | 43.3 | 45.0 | 46.7 |
| Billings | 24.7 | 29.6 | 30.8 | 33.0 | 34.3 | 35.9 | 36.4 |
| Dacoma | 36.5 | 40.4 | 41.6 | 43.2 | 49.6 | 45.8 | 53.4 |
| Carmen | 32.6 | 37.3 | 40.9 | 40.9 | 46.4 | --- | --- |
| Carmen (Sand) | 27.1 | 30.8 | 29.3 | 35.4 | 37.3 | 38.9 | 39.4 |
| Cherokee | 37.2 | 38.2 | 42.0 | 41.3 | 44.2 | 40.7 | 44.9 |
| Frederick | 52.2 | 51.7 | 51.2 | 50.2 | 54.3 | 52.0 | 49.3 |
| Davidson | 10.6 | 13.0 | 13.7 | 13.0 | 16.1 | 11.5 | 16.0 |
| Avg. (All Locations) | 31.2 | 34.6 | 36.1 | 37.1 | 40.7 | 38.5 | 40.9 |
| Avg. (Responding locations)** | 28.3 | 32.1 | 33.9 | 35.3 | 38.7 | 36.3 | 39.5 |

All plots received 40 lbs. of $P_2O_5$ per acre applied with the seed at planting.

* Average of four replicates.

** All locations except Frederick.

**TABLE II.—Yield of Wheat at Nine Locations in Western Oklahoma as Affected by Four Rates of Phosphorus Fertilization, 1951-52.***

*(Bushels per acre)*

| Location | No Phosphate | 20 lbs. P per A. | 40 lbs. P per A. | 80 lbs. P per A. |
|---|---|---|---|---|
| Newkirk | 28.4 | 36.4 | 37.6 | 36.9 |
| Billings | 28.0 | 30.3 | 32.7 | 34.7 |
| Dacoma | 35.7 | 35.7 | 34.5 | 36.8 |
| Carmen | 41.3 | 40.8 | 41.2 | 42.3 |
| Carmen (Sand) | 29.4 | 32.8 | 30.6 | 31.4 |
| Lahoma | 47.8 | 51.4 | 51.0 | 51.9 |
| Frederick | 45.2 | 51.6 | 51.9 | 52.8 |
| Davidson | 10.4 | 11.0 | 11.3 | 11.5 |
| El Reno | 50.0 | 47.0 | 41.0 | 45.3 |
| Avg. (All Locations) | 35.1 | 37.4 | 36.9 | 38.2 |
| Avg. (Responding locations)** | 32.0 | 36.1 | 36.9 | 37.6 |

All plots received 40 lbs. of nitrogen per acre broadcast at planting.

* Averages of four replicates.

** Newkirk, Billings, Lahoma, Frederick, and Davidson.

**TABLE III.—Yields on Wheat Fertility Trials at Nine Locations in Western Oklahoma, 1952-53.***

*(Bushels per acre)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No treat-ment | 40N | 40P | 40N 20P | 40N 80P | 160N 40P | 20N-40P | | 40N-40P | | 80N-40P | |
| | | | | | | | Fall | Spring | Fall | Spring | Fall | Spring |
| Newkirk | 26.0 | 25.9 | 35.7 | 34.0 | 38.9 | 37.5 | 37.8 | 37.9 | 38.1 | 37.6 | 39.3 | 36.7 |
| Loyal | 15.7 | 15.1 | 14.9 | 18.0 | 14.9 | 16.4 | 19.1 | 22.0 | 14.4 | 15.6 | 20.2 | 20.1 |
| Grandfield | 36.7 | 34.9 | 41.7 | 44.5 | 48.0 | 43.4 | 44.8 | 44.8 | 45.3 | 43.8 | 44.4 | 45.1 |
| Kingfisher | 22.6 | 23.5 | 29.3 | 30.7 | 33.5 | 34.5 | 30.7 | 30.5 | 32.9 | 32.4 | 32.9 | 33.7 |
| Medford | 19.9 | 21.4 | 22.2 | 22.0 | 22.4 | 22.3 | 22.2 | 22.5 | 22.1 | 23.6 | 20.7 | 21.1 |
| Frederick | 21.9 | 20.7 | 27.8 | 27.3 | 28.2 | 22.5 | 27.6 | 26.8 | 28.6 | 27.7 | 25.8 | 25.5 |
| Headrick | 18.0 | 18.1 | 19.6 | 17.9 | 19.1 | 18.4 | 19.1 | 19.9 | 19.9 | 18.9 | 19.0 | 18.0 |
| Billings | 19.3 | 19.7 | 24.8 | 24.9 | 25.7 | 26.6 | 24.9 | 25.1 | 25.6 | 25.4 | 24.0 | 27.7 |
| Lahoma | 21.6 | 19.4 | 22.5 | 25.6 | 25.0 | 22.9 | 24.3 | 22.1 | 26.7 | 22.8 | 25.3 | 23.1 |
| Average | 22.4 | 22.1 | 26.5 | 27.2 | 28.4 | 27.2 | 27.8 | 28.0 | 28.2 | 27.5 | 28.0 | 27.9 |
| Avg. at Res. Loc.** | 24.7 | 24.0 | 30.3 | 31.2 | 33.2 | --- | --- | --- | --- | 31.6 | --- | --- |

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

* Averages of three replicates.

** Averages for locations at which phosphorus response was obtained; excludes Loyal, Medford, and Headrick.

ages for the 1952-53 experiments are presented in Tables III and V, respectively.

## EFFECTS OF NITROGEN FERTILIZER

### On Yield of Grain

Table I is considered for the 1951-52 yields; and treatments 3, 8, 10, 12, and 6, Table III, are considered in that order for the 1952-53 yields.

Statistical analyses of the 1951-52 individual location yield data show that the yield increases from nitrogen fertilization were significant at all locations except Frederick, where nitrogen had no effect on yield. The soil there was virtually summer fallowed during the season preceding the experiment. It was planted to wheat in the fall of 1950 and plowed in the spring of 1951 after a green bug infestation ruined the wheat crop. The fallow condition may have been responsible for more available nitrogen in the soil, thus the lack of response to nitrogen. The low yields at Davidson were caused by drought conditions. The wheat was planted in cotton stalks and the soil was very dry at planting time. Precipitation during the growing season was insufficient to produce higher wheat yields.

Figure 2 is a graphic presentation of the yield data from the eight locations combined. When applied in the spring, 40 pounds of nitrogen was sufficient to give nearly maximum yields. In the case of fall ap-

**TABLE IV.—Protein* in Wheat Grain at Five Locations in Western Oklahoma as Affected by Four Rates and Two Dates of Nitrogen Fertilization, 1951-52.****

*(Percent)*

| Location | Nitrogen | 20 lbs. N per A. | | 40 lbs. N per A. | | 80 lbs. N per A. | |
|---|---|---|---|---|---|---|---|
| | | Fall | Spring | Fall | Spring | Fall | Spring |
| Newkirk | 9.12 | 8.63 | 8.84 | 8.72 | 9.17 | 9.30 | 10.11 |
| Billings | 10.53 | 10.74 | 10.70 | 10.86 | 11.22 | 11.45 | 11.96 |
| Carmen | 9.38 | 9.23 | 9.12 | 9.32 | 9.19 | ---- | ---- |
| Carmen (sand) | 9.37 | 9.87 | 9.80 | 10.23 | 10.44 | 11.12 | 11.81 |
| Cherokee | 9.32 | 9.69 | 9.67 | 10.52 | 9.84 | 9.37 | 11.76 |
| Avg. (All Locations) | 9.54 | 9.63 | 9.63 | 9.93 | 9.97 | 10.31 | 11.41 |

* Protein analysis based on 14% moisture in grain. Protein =5.7 X nitrogen.
** Average of four replicates. All plots received 40 pounds per acre of $P_2O_5$.

## TABLE V.—Protein in wheat grain on fertility trials at nine locations in western Oklahoma, 1952-53.*

*(Percent)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No treatment | 40N | 40P | 40N 20P | 40N 80P | 160N 40P | 20N-40P | | 40N-40P | | 80N-40P | |
| | | | | | | | Fall | Spring | Fall | Spring | Fall | Spring |
| Newkirk | 13.76 | 12.94 | 12.06 | 13.22 | 11.91 | 15.48 | 12.21 | 12.60 | 12.88 | 12.22 | 14.53 | 14.35 |
| Loyal | 14.00 | 15.23 | 13.52 | 13.75 | 14.54 | 16.78 | 13.52 | 12.59 | 15.28 | 14.11 | 14.47 | 15.46 |
| Grandfield | 11.56 | 11.97 | 10.66 | 11.90 | 11.89 | 13.87 | 11.09 | 11.11 | 11.20 | 11.52 | 13.41 | 13.11 |
| Kingfisher | 12.32 | 13.48 | 11.39 | 12.86 | 12.27 | 14.97 | 11.84 | 12.03 | 12.90 | 11.96 | 13.04 | 13.77 |
| Medford | 15.37 | 15.67 | 14.43 | 15.10 | 14.90 | 16.47 | 14.80 | 14.07 | 15.13 | 14.63 | 15.77 | 15.77 |
| Frederick | 14.07 | 14.05 | 12.31 | 13.52 | 13.86 | 16.34 | 13.56 | 12.68 | 13.84 | 13.60 | 15.35 | 16.11 |
| Headrick | 15.78 | 15.96 | 16.59 | 16.62 | 16.46 | 17.17 | 16.01 | 16.22 | 16.97 | 17.12 | 17.02 | 17.24 |
| Billings | 11.77 | 13.00 | 10.23 | 11.53 | 12.90 | 14.13 | 12.43 | 11.17 | 12.50 | 12.20 | 13.23 | 13.77 |
| Lahoma | 11.53 | 13.00 | 11.60 | 11.50 | 11.87 | 15.43 | 12.37 | 13.20 | 11.83 | 12.30 | 14.27 | 13.63 |
| Average | 11.82 | 13.92 | 12.53 | 13.33 | 13.40 | 15.63 | 13.09 | 12.85 | 13.61 | 13.30 | 14.57 | 14.80 |

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.

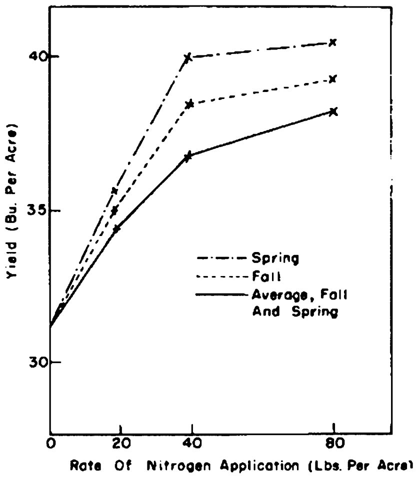


**Fig. 2.—Effect of Nitrogen Fertilizer on Wheat Yields. Average of Eight Locations in Western Oklahoma, 1951-52.**

plication, there was some yield increase above the 40-pound application rate.

At seven of the eight locations in 1951-52, a spring application of 40 pounds of nitrogen gave a yield increase of approximately 10 bushels of wheat. Without nitrogen, the average yield at the seven locations was 28.3 bushels per acre.

In the 1952-53 season, yield increases due to nitrogen treatments were statistically significant only at Kingfisher. This lack of yield response to nitrogen as compared to 1951-52 is no doubt due to the differences in the prevailing climatic conditions. Under the climatic conditions of the 1952-53 season, soil nitrogen was not a limiting factor in wheat production.

## On Protein Content of Grain

Table IV is considered for the 1951-52 experiments; and treatments 3, 8, 10, 12, and 6, Table V, are considered for the 1952-53 experiments.

Generally, the protein content of the grain increased with successive increments of nitrogen. The 1951-52 data indicate that at Newkirk and Carmen the yield increases from the lower rates of application were sufficient to utilize the applied nitrogen (or the utilizable portion thereof) and in addition to slightly lower the protein content in relation to the check plots. The higher rates of application increased protein content as well as yields.

Statistical analyses of the 1952-53 data show that nitrogen applications increased protein content at all locations except Headrick. Protein content increased with each increment of nitrogen through the 160 pounds per acre application, but did not rise as rapidly above the 80 pound rate as it did below it.

## FALL VS. SPRING APPLICATION OF NITROGEN

The 1951-52 yield and protein data (Tables I and IV) show that spring application of nitrogen was significantly superior to fall application. More of the spring-applied than the fall-applied nitrogen went into grain formation. More of the fall-applied nitrogen must have been lost through leaching, denitrification, or in some other manner. In 1952-53, on the contrary, time of nitrogen application had no effect on yield or protein content of the grain (Compare treatment 8 with 7, 10 with 9, and 12 with 11, Tables III and V). In another season when wheat makes fall growth, differences in yield and protein content might be expected.

## EFFECTS OF PHOSPHORUS FERTILIZER

### On Yield of Grain

Yield data for the 1951-52 experiments are reported in Table II, and yields for the 1952-53 experiments are given in Table III (treatments 2, 4, 10, and 5, in that order).

In the 1951-52 season, significant increases in yields were obtained at Newkirk, Billings, Davidson, Frederick, and Lahoma. There was no significant difference within the 20-, 40-, and 80-pound rates at any location except Billings. At Billings, yields were increased with each increment of phosphate. Thus, 20 pounds of $P_2O_5$ gave maximum yields at four of the five locations where a yield response was realized.

In 1952-53, significant yield increases were obtained at all locations except Loyal, Medford, and Headrick. Twenty pounds per acre of $P_2O_5$ was sufficient to give maximum yield increases at all locations except Newkirk, where yield increased with phosphate rate through 80 pounds per acre. Visual differences due to phosphate fertilizer were apparent at Loyal, Medford and Headrick through most of the season. It is felt that unusual circumstances, rather than sufficient soil phosphorus, were responsible for the lack of yield response to phosphorus at these locations.

The average increases in yield from 20 pounds of $P_2O_5$ per acre (2.3 bushels per acre in 1951-52 and 5.1 bushels per acre in 1952-53) are ample to warrant the recommendation of phosphorus fertilization of wheat in western Oklahoma. If only locations where yield increases were obtained are considered, the increase for 1951-52 was 4.2 bushels and that for 1952-53 was 7.2 bushels per acre.

**On Protein Content of Grain**

Grain samples from the 1951-52 phosphorus experiments were not analyzed for protein so only the 1952-53 data are available. Treatments 2, 4, 10, and 5, Table V, are considered here. The indication is that where phosphorus was applied at any rate, the protein content of the grain was decreased. This is probably a "dilution" effect. The increase in yield due to phosphorus application is responsible for the decrease in protein content. Where the yield was increased, the same amount of nitrogen was simply spread over more grain.

### NITROGEN X PHOSPHORUS INTERACTION

Design of the 1951-52 experiments did not permit ready study of interaction. The yield and protein data for 1952-53 show no N x P interaction (Treatments 1, 2, 3, and 10; Tables III and V). In a more normal season when nitrogen response is realized, one would expect an interaction in the yield data.

Phosphorus appears to be the first limiting chemical element in wheat growth, and maximum response from nitrogen fertilizer could not be expected without the application of phosphorus fertilizer. Though no true check plots were included in the 1951-52 experiments, yield data from locations where both nitrogen and phosphorus response was obtained indicate that the yield increases obtained from a combination of nitrogen and phosphorus were probably greater than the total of increases from either nitrogen alone or phosphorus alone.

## Observations and Discussion

There were no visible differences in top growth in the fall of 1951 that could be attributed to nitrogen application except at Davidson. There, the plots were established on a sandy soil and planted in cotton stalks. At other locations, differences first became apparent when rapid spring growth began. This indicates that most of the soils contained sufficient available nitrogen for maximum fall growth. However, nitrogen became limiting in the spring, as shown by yield response.

In the 1952-53 season, visual differences due to nitrogen treatments became apparent in the late spring and were observed from April until harvest time. The plots which received nitrogen fertilizer were deeper green in color and made more vegetative growth than the ones which received no nitrogen. These differences, however, were not reflected in yield. With added vegetative growth and delayed maturity, the nitrogen treated plots apparently required more moisture than the other plots and this moisture was not present, plus potential increases in yield were not realized.

It is interesting to note that the extreme high rate of nitrogen, 160 pounds per acre, did not decrease yields even though moisture was deficient. It is a rather common belief among farmers that if they apply fertilizer and receive insufficient rainfall they will "burn their crops up." The data show that the high rate of nitrogen in combination with phosphorus, under very severe drought conditions, did not bring about the feared effect.

In the spring of 1954, nitrogen response was quite apparent on the plots which received 80- and 160-pound applications of nitrogen in the 1952-53 season. This indicates that nitrogen applied in a season in which no response is obtained is not lost and may be used by a succeeding crop.

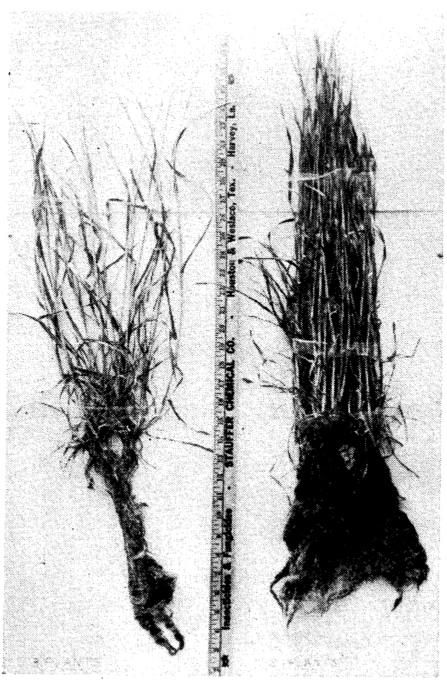

**Fig. 3.—Differences Due to Phosphate Fertilizer**

At the left, three plants with 15 tillers, from an unphosphated plot at Frederick in 1952. At the right, two plants with 31 tillers from an adjacent plot treated with 80 pounds of $P_2O_5$ per acre.

In both seasons, differences due to phosphate treatments became apparent shortly after the plants emerged. The phosphated plots made considerably more initial growth and tillered more than the unphosphated ones. These differences carried through to harvest time and are reflected in the yield data (Tables II and III).

Figure 3 illustrates differences in root growth, top growth, and tillering due to phosphate fertilizer.

Observations of initial growth of the wheat plants indicated that, on most of the soils used for these tests, phosphorus fertilization is more important than nitrogen fertilization for early growth. In addition to increasing grain yields, phosphorus fertilizer increased forage production. The short supply of phosphorus limits fall growth on many soils which contain sufficient available nitrogen for more growth. This is important to those who depend on wheat pasture for livestock feed.

## Summary and Conclusions

The results of these wheat fertility experiments conducted over two crop seasons in western Oklahoma furnished information for the following conclusions.

1. Nitrogen fertilization brought about significant increases in yield at seven of eight locations in the 1951-52 season. In 1952-53, nitrogen response was realized at only one location.

2. Yields increased with the amount of nitrogen applied through 80 pounds per acre in the 1951-52 season. The most economical rate, 40 pounds per acre, gave an average yield increase of 10 bushels per acre at seven of eight locations.

3. Yield and protein increases from spring applications of nitrogen were superior to those from fall applications in the 1951-52 season. There were no differences in response between fall and spring applications of nitrogen in the 1952-53 season.

4. High applications of nitrogen did not decrease yields even under severe drought conditions.

5. Nitrogen fertilization increased the protein content of the grain.

6. Phosphorus fertilization brought about significant increases in yields at five of nine locations in 1951-52 and at six of nine locations in the 1952-53 season.

7. Twenty pounds of $P_2O_5$ per acre is sufficient to bring about maximum wheat increases in most areas of western Oklahoma. Average yield increases at locations where phosphorus response was obtained were 4.2 bushels per acre in 1951-52 and 7.2 bushels in 1952-53.

8. Phosphorus fertilization increased initial growth and tillering as well as yield. This is important to farmers who depend on wheat pasture for livestock feed.

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