Wheat Fertilization On Claypan Soils In Northeastern Oklahoma

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Hard Red Winter wheat is dependably a good cash crop on claypan soils in eastern Oklahoma providing adequate plant nutrients are applied by means of proper fertilization. Claypan soils in this area are usually low in natural fertility and characterized by poor internal drainage. Warm season crops are normally subject to greater drouth hazard on these claypan soils than on soils with more permeable subsoils.

This study was undertaken to determine the kinds, rates and time of fertilizer application required for profitable winter wheat yields on a claypan soil, Parsons silt loam, near Welch, Craig County, Oklahoma.

Procedure

Winter wheat was planted in a prepared seedbed on Parsons silt loam following early summer plowing in each of the four years, 1953, 1954, 1955 and 1956.

Pawnee wheat variety was used in this experiment the first two years, 1953 and 1954. Ponca was used the last two years, 1955 and 1956.

Fertilization treatments included four rates of phosphorus equivalent to 0, 20, 40 and 80 pounds P_2O_5 per acre, two rates of potassium equivalent to 0 and 60 pounds K_20 per acre, and four rates of nitrogen 0, 20, 40 and 80 pounds N per acre. Ordinary superphosphate (20%), muriate of potash (60%) and ammonium nitrate (33.5%) were used as the sources of phosphorus, potassium and nitrogen, respectively. The phosphorus, potassium and fall nitrogen fertilizer treatments were all applied at planting. The spring nitrogen treatments were applied in February or early March. A detailed summary of fertilizer treatments and corresponding wheat yields for the years 1953, 1954, 1955 and 1956 is presented in Table 1. Statistical analyses of these data are presented in Table 2.

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Table 1.—Wheat Yields as Affected by Various Soil Fertility Treatments, Parsons Silt Loam Soil, Welch, Oklahoma, 1953-1956.*

Treatment	1953	1954	1955	1956	Average
Check (no fertilizer)	15.4	19.1	16.3	26.9	19.4
0-40-0	19.0	26.6	21.3	42.3	27.3
0-0-60	16.5	22.3	17.3	27.6	20.9
0-40-60	19.9	28.6	22.8	44.3	28.9
20-40-60 (Spring N)	26.1	31.5	21.9	44.5	31.0
20-40-60 (Fall N)	25.9	30.2	20.9	44.6	30.4
40-40-60 (Spring N)	30.9	36.2	21.7	42.7	32.9
40-40-60 (Fall N)	30.6	35.9	19.3	44.3	32.5
80-20-60 (Spring N)	28.0	33.3	18.5	37.8	29.4
80-40-0 (Spring N)	33.3	33.9	20.2	43.9	32.8
80-40-60 (Spring N)	31.8	39.4	21.2	44.6	34.2
80-40-60 (Fall N)	32.3	37.9	22.6	43.7	34.1
0-20-0	17.8	25.0			21.4
80-20-60 (Fall N)	29.3	31.8			30.6
80-40-0 (Fall N)	29.9	30.9			30.4
80-0-0 (Spring N)			14.0	24.8	19.4
80-0-60 (Spring N)			16.5	28.9	22.7
80-80-60 (Spring N)			23.5	48.6	36.0
20-20-60 (Spring N)			18.9	36.5	27.7
40-20-60 (Spring N)			20.7	39.2	29.9
80-80-60 (Fall N)				47.6	47.6
Standard Error	1.95	4.08	1.61	1.87	
F Value	30.87**	5.97**	8.08**	48.45**	

*Each yield figure represents the mean of three replications. Phosphorus and potassium fertilizers were applied at planting. Time of nitrogen fertilizer application is indicated for the indivdual treatments.

**Yield differences between soil fertility treatments were statistically significant at the 1% probability level.

The non-fertilized Parsons silt loam in this area is characterized by a strongly acid reaction, pH 4.8 to 5.2; a low content of available phosphorus, 10 to 20 pounds per acre; a medium content of exchangable potassium, 75 to 130 pounds per acre; and low organic matter content.

Table 2.—Multiple Range Test for Significance at One Percent Level Between Mean Yields of Wheat as Affected by Various Soil Fertility Treatments, Parsons Silt Loam, Welch, Oklahoma.*

Treatment	1953	Av. Yield
Check		15.4
0-0-60		16.5
0-20-0		17.8
0-40-0		19.0
0-40-60		19.9
20-40-60		
Fall N		25.9
Spring N		26.1
80-20-60		
Spring N		28
Fall N		29.3
80-40-0		
Fall N		29.9
40-40-60		
Fall N		30.6
Spring N		30.9
80-40-60		
Spring N		31.8
Fall N		32.3
80-40-0		
Spring N		33.3

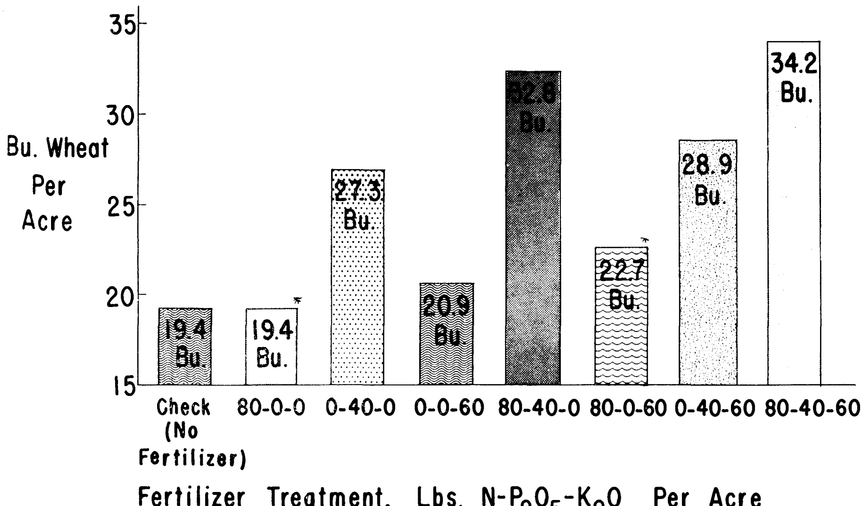
Treatment	1954	Av. Yield
Check		19.1
0-0-60		22.3
0-20-0		25.0
0-40-0		26.6
0-40-60		28.6
20-40-60		
Fall N		30.2
80-40-0		
Fall N		30.9
20-40-60		
Spring N		31.5
80-20-60		
Fall N		31.8
Spring N		33.3
80-40-0		
Spring N		33.9
40-40-60		
Fall N		35.9
Spring N		36.2
80-40-60		
Fall N		37.9
Spring N		39.4

Treatment	1955	Av. Yield
80-0-0		
Spring N		14
Check		16.3
80-0-60		
Spring N		16.5
0-0-60		17.3
80-20-60		
Spring N		18.5
20-20-60		
Spring N		18.9
40-40-60		
Fall N		19.3
80-40-0		
Spring N		20.2
40-20-60		
Spring N		20.7
20-40-60		
Fall N		20.9
80-40-60		
Spring N		21.2
0-40-0		21.3
40-40-60		
Spring N		21.7
20-40-60		
Spring N		21.9
80-40-60		
Fall N		22.6
0-40-60		22.8
80-80-60		
Spring N		23.5

Treatment	1956	Av. Yield
80-0-0		
Spring N		24.8
Check		26.9
0-0-60		27.6
80-0-60		
Spring N		28.9
20-20-60		
Spring N		36.5
80-20-60		
Spring N		37.8
40-20-60		
Spring N		39.2
0-40-0		42.3
40-40-60		
Spring N		42.7
80-40-60		
Fall N		43.7
80-40-0		
Spring N		43.9
0-80-60		44.3
40-40-60		
Fall N		44.3
20-40-60		
Spring N		44.5
80-40-60		
Spring N		44.6
20-40-60		
Fall N		44.6
80-80-60		
Fall N		47.6
Spring N		48.6

1953 F =30.87 SM =1.135**
1954 F = 5.97 SM =2.351**
1955 F = 8.08 SM = .927**
1956 F =48.45 SM =1.083**

*Treatment yields not bracketed by the same line are significantly different at the one percent probability level.



*Average yields for 1955 and 1956. All other yields are averages from the four years 1953, '54, '55 and '56. All nitrogen treatments shown were spring applied.

Fig. 1—Proper balance of plant nutrients applied as fertilizers is of great importance for increasing wheat yields on a claypan soil, Parsons silt loam, Craig County Oklahoma. Adequate phosphorus must be applied before yields can be increased by nitrogen and potassium fertilization on this soil.

Results

Plant Nutrient Balance

The need for proper balance in the kind and amounts of plant nutrients supplied as commercial fertilizers is shown in a graphic presentation of data from these experiments in Figure 1. Phosphorus is obviously the first limiting factor for wheat production on this soil. The absence of phosphorus from nitrogen and potassium fertilizer treatments resulted in non-significant increases in wheat yield. Nitrogen may be termed as the second limiting factor, with the treatment combining nitrogen and phosphorus giving substantially higher yields than only phosphorus or combined phosphorus and potassium fertilizer treatments. Highest yields were obtained consistently from the complete fertilizer treatments containing nitrogen, phosphorus and potassium all supplied in adequate amounts.

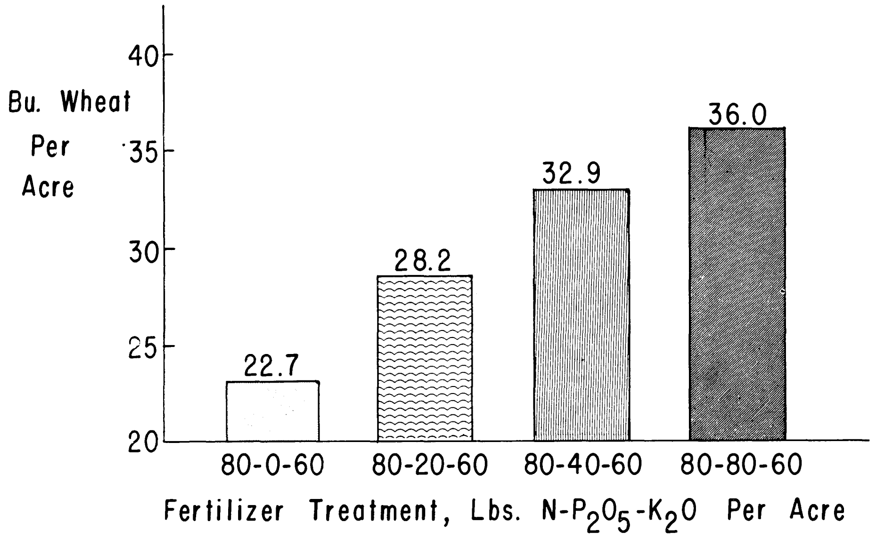


Fig. 2—Increased wheat yields were obtained with increased phosphate application when adequate nitrogen and potassium were applied to this soil. These yields are the two-year averages for 1955-56. The four-year averages for the 80-20-60 and 80-40-60 treatment were 29.4 and 34.2 respectively. All nitrogen treatments were applied in the spring.

Phosphorus Response:

Adequate phosphate fertilization should be considered as basic treatment on this soil type for increased wheat yields (See Figure 2.) An increased yield was obtained with each additional increment of available phosphorus applied at rates equivalent to 20, 40 and 80 pounds P_2O_5 per acre. The highest yield increase for a single plant nutrient addition was obtained from the addition of 40 pounds P_2O_5 averaging 7.9 bushels increase over the mean non-fertilized (check) yields of 19.4 bushels per acre during the four-year period. The application of 20 pounds P_2O_5 with 80 pounds N and 60 pounds K_2O gave a four-year average increase of 10 bushels per acre over the check yields. The 80-40-60 treatment gave an increase of 4.8 bushels over the 80-20-60 yields for the same period.

Nitrogen Response:

Significant increases in wheat yield were obtained with each additional increment of nitrogen fertilizer when combined with the phosphorus fertilizer treatments. Figure 3 illustrates the mean yields from the four years results from nitrogen applications with adequate phosphorus and potassium. The application of 20, 40 and 80 pounds nitrogen per acre with 40 pounds P_2O_5 and 60 pounds K_2O gave a four-year average yield increase of 2.1, 4.0 and 5.3 bushels of wheat per acre respectively. The largest increases per pound of nitrogen applied were obtained at the 20- and 40-pound rates.

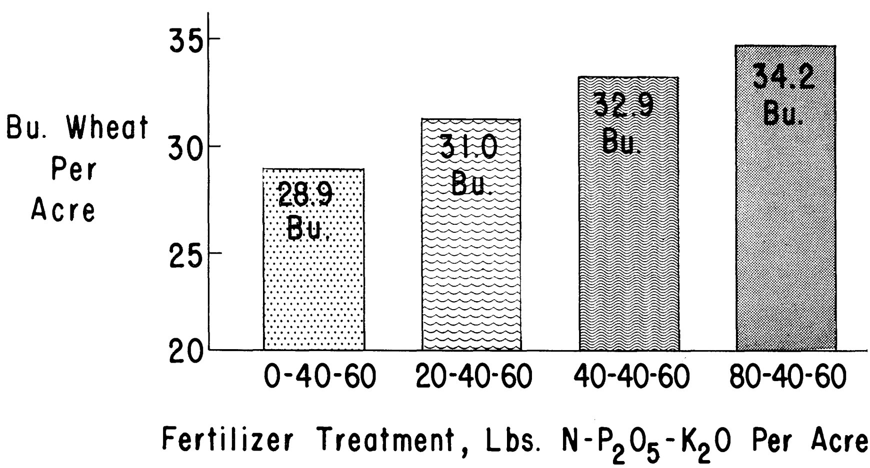


Fig. 3—Each additional increment of nitrogen applied resulted in increased wheat yield on Parsons silt loam when adequate phosphorus and potassium were applied. These yield figures are the average of four years 1953-56. The nitrogen was applied in the spring.

Time of Nitrogen Application:

Fall and spring applications of nitrogen were compared at all rates of nitrogen fertilization used and with various combinations of phosphorus and potassium. No differences in wheat yield were obtained. Figure 4 shows the relation of time of nitrogen application to average wheat yields for the four-year period, when adequate phosphorus and potassium were applied. Mean yields were essentially the same for all comparable fertilizer treatments when time of nitrogen application was the only variable, during all four years of this experiment.

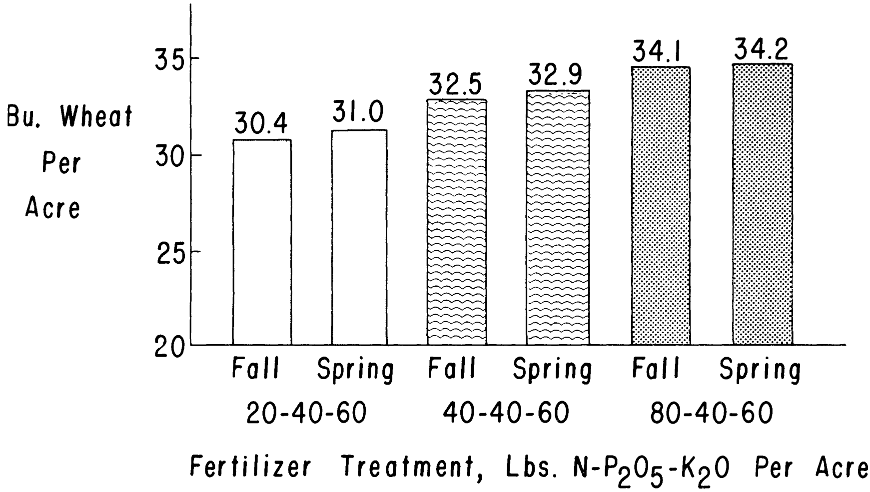


Fig. 4—No significant diffference in average wheat yields was obtained at any rate of nitrogen fertilization whether the nitrogen was applied in the fall at planting, or topdressed in the early spring months for the four-year period 1953-56. The same phosphorus and potassium fertilization rates were applied to these different nitrogen treatments.

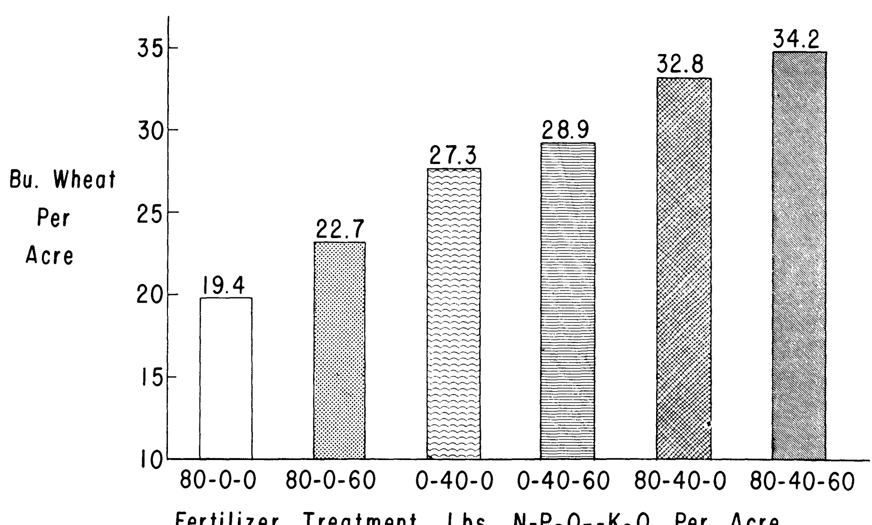


Fig. 5—Wheat yield increased with the addition of potassium fertilizer to all nitrogen and phosphorus treatments on Parsons silt loam. The 80-0-0 and 80-0-60 yields shown are the average of two years results 1955-56. All other treatments shown are the four-year averages 1953-56. Nitrogen was applied in the spring for all treatments.

Potassium Response:

Wheat yields increased with potassium fertilization in the treatments and combination studies through the four-year period (Figure 5). The four-year average yield for the 0-40-60 treatment was 1.6 bushels higher than the 0-40-0 mean yield for that period. The 80-40-60 treatment averaged 1.4 bushels higher than the 80-40-0 for the four-year period in both treatments. The nitrogen was applied in the spring.

The 80-0-60 averaged 3.3 bushels higher than the 80-0-0 treatment for the two years, 1955 and 1956, that these treatments were in the experiment. In both treatments the nitrogen was applied in the spring.

Summary

Four years' data from comprehensive soil fertility experiments with hard red winter wheat on a claypan soil, Parsons silt loam, Craig County, Oklahoma, gave the following results:

1. Highly significant and profitable increases in wheat yields resulted from proper rates and combinations of nitrogen, phosphorus and potassium fertilization for each of the four years, 1953-1956.

2. The first limiting plant nutrient for wheat yields on this soil type was phosphorus. Highest yield increases were obtained only with adequate phosphorus application. Superphosphate applied at rates equivalent to 40 pounds P_2O_5 per acre gave the highest yield increase for a single plant nutrient addition.

3. Yield increased with additions of 20, 40 and 80 pounds nitrogen applied per acre when phosphorus and potassium were supplied in adequate amounts. The largest increases per pound of nitrogen applied were obtained at the 20- and 40-pound nitrogen rates when combined with 40 pounds P_2O_5 and 60 pounds K_2O.

4. No significant differences in yield were obtained as a result of difference in the time of nitrogen application, spring or fall.

5. Increases in yield with application of 60 pounds K_2O per acre were obtained at all rates and combinations with nitrogen and phosphorus fertilizer treatments used in this experiment.

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