Soil Fertility Studies for WINTER OAT PRODUCTION In Eastern Oklahoma

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Oat forage and grain production in eastern and central Oklahoma is usually limited by low soil fertility. Climatic conditions are favorable most years for much higher pasture and grain yields than are generally produced. Oats have a high plant nutrient requirement, particularly nitrogen; but response to nitrogen may be disappointing when other nutrients are inadequate.

Experiments reported here were undertaken to determine the soil fertility requirements of oats. Nutrient levels of the soils, kinds of fertilizer materials, and combinations and times of fertilizer application were studied in field experiments from 1956-1961.

PROCEDURE

Field experiments were established on Wilson silt loam, Bryan County; on Choteau silt loam, Muskogee County; on Dougherty sandy loam, Garvin County; and on Norge sandy loam, Payne County.

Randomized block experiments were used at all locations. Fertilizer materials included ammonium nitrate (33.5 percent nitrogen), 20 percent superphosphate (8.7 percent phosphorus), 46 percent triple superphosphate (20.1 percent phosphorus), 60 percent muriate of potash (49.8 percent potassium), and various ammonium phosphate formulations. Details of treatments are presented in the tables of yield data (Tables I-IV).

EXPERIMENTS

Wilson Silt Loam — Bryan County

Experiments on Wilson silt loam were completed in 1956, 1957 and 1958 on the H. Robinson farm near Bokchito. This soil type was

Research reported herein was done under Station Project 898.

located on nearly level upland, slowly permeable with heavy clay subsoil. The field had been farmed intensively for many years with very little lime or fertilizer added. The soil tested strongly acid, low in organic matter, very low in available phosphorus and medium in potassium.

Three levels of phosphorus (P)—0, 17.5 and 35 pounds P per acre as superphosphate (20 percent P_2O_5)—and two levels of potassium (K)—0 and 50 pounds K per acre as muriate of potash (60 percent K_2O)—were applied at planting. Rates of nitrogen (N) applied as ammonium nitrate (33.5 percent N) were 0, 20, 40 and 80 pounds N per acre. Nitrogen was applied two different times, in the fall at planting and topdressed on the established stand in early spring. Details of the fertilizer treatments and time of nitrogen application are presented with oat yields in Table I.

Average yield responses to nitrogen, phosphorus and potassium in various combinations are shown in Figure 1. The response to phosphorus

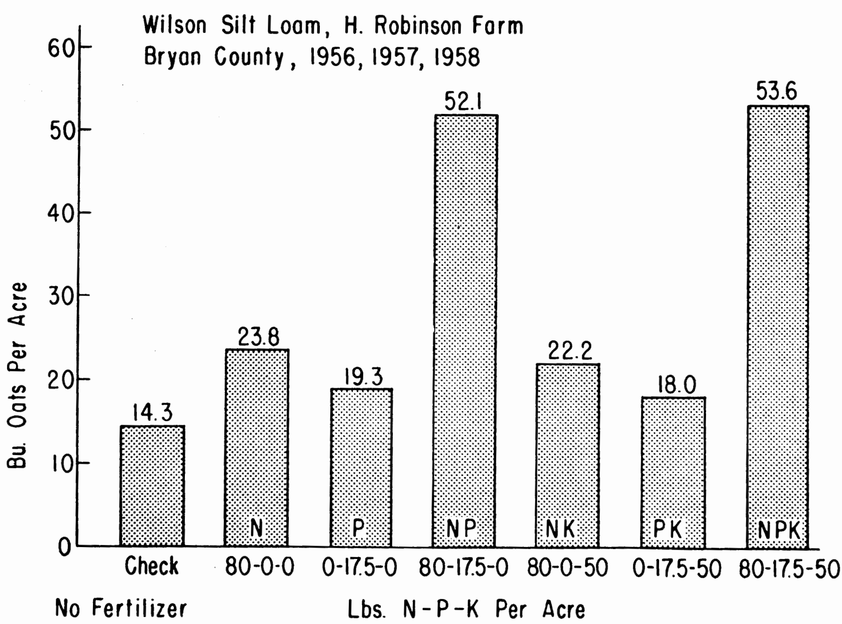

Figure 1. Adequate available soil phosphorus and nitrogen together increased oat yields. Neither of these plant nutrient elements used alone was as effective as in combination.

and nitrogen in combination is very marked. Neither element applied singly or in any combination that did not include the other was effective in improving yields.

The quadratic type of yield response to levels of phosphorus when nitrogen and potassium were not limiting is shown in Figure 2. Yields were more than doubled with the first 8.7 pounds P, increasing from 22.2 to 50.7 bushels per acre. Average yields were increased to 53.6 bushels with 17.5 pounds P and to 60.0 bushels with 35 pounds P.

The large yield increases from nitrogen application when phosphorus and potassium were not limiting (17.5 pounds P plus 50 pounds K per acre) are shown in Figure 3. Yields were doubled by 20 pounds N topdressed in the spring—amounting to 37 bushels, compared to 18 bushels when no N was used. Average yields of 44.9 and 53.6 bushels per acre were obtained when nitrogen was topdressed at the rate of 40 and 80 pounds per acre, respectively.

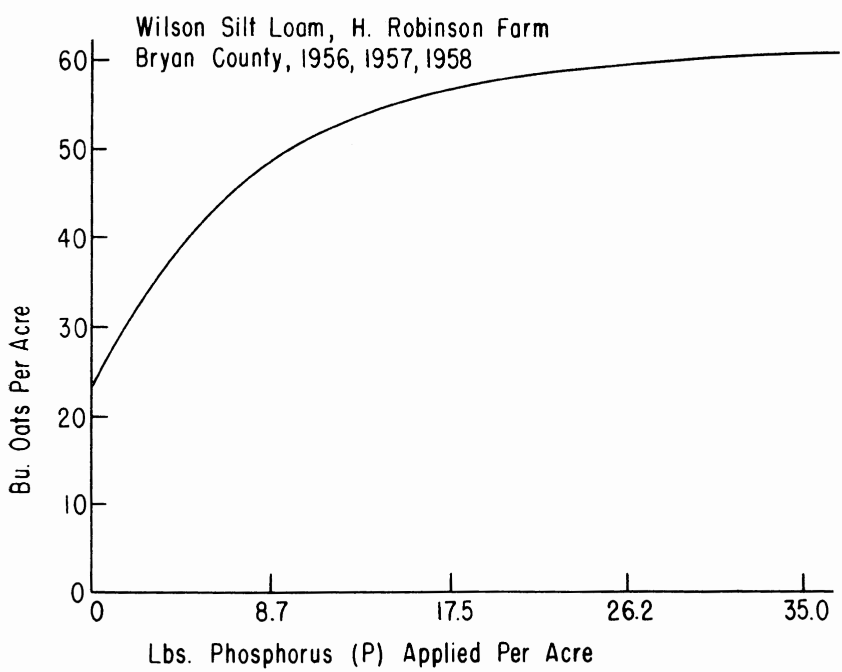

Figure 2. Oat yields were increased by additional phosphorus fertilizer when adequate nitrogen and potassium were supplied to this soil. Average yields for three years were from plots receiving 80 pounds N as early spring topdressing and 50 pounds K at planting.

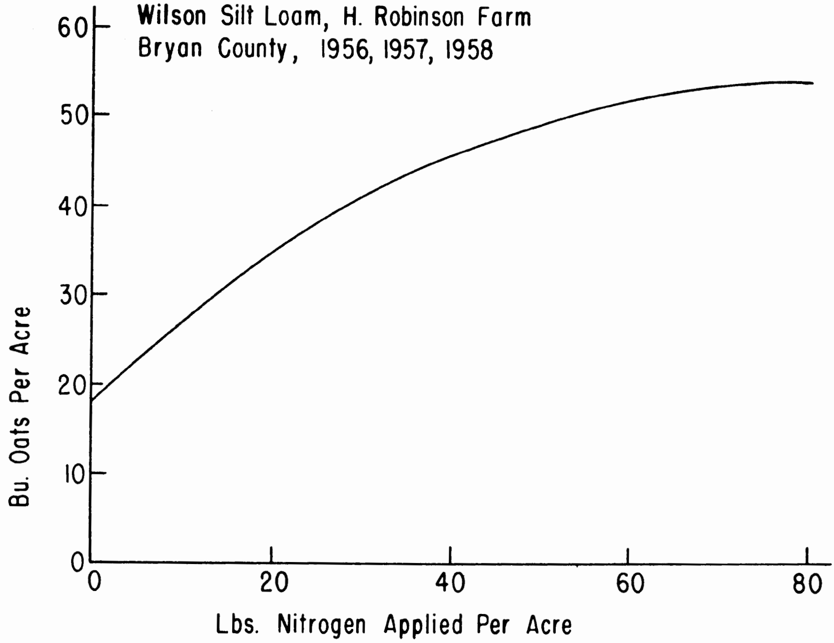

Figure 3. Oat yields were increased with each additional increment of nitrogen when adequate levels of phosphorus and potassium were supplied. Three-year average yields shown here were from plots receiving 17.5 pounds P and 50 pounds K per acre at planting. Nitrogen was topdressed on the established stand in early spring. An increase of 1 bushel of oats for approximately 2½ pounds nitrogen fertilizer was obtained on this soil.

Neither fall nor spring application gave any consistent advantage in yields when the same nitrogen levels were used. Results from three years at this location are shown in Figure 4.

Factors that determine time of nitrogen application on oats may depend on soil moisture at planting and prospects for fall and winter pasture from the crop.

Choteau Silt Loam—Muskogee County

Effects of various soil fertility treatments topdressed on established oat stands were studied in 1958 and 1959 at Connors Agricultural College, Warner. This soil type is located on nearly level topography, normally has a low fertility level and is easily eroded if runoff occurs. The field had been cropped extensively for many years with moderate fertilization. Soil tests showed low organic matter, very low available phosphorus, low potassium and a moderately strong acid reaction.

Oat crops were established with a complete fertilizer, 200 pounds per acre of 10-20-10 analysis. The topdress fertilizer treatments were applied on the established stands in early March. Yield results are given in Table II.

The check (no treatment) average yield of 52.7 bushels per acre was increased to 82.8 and 70.3 bushels, respectively, with nitrogen alone applied at 20 and 60 pounds N per acre as ammonium nitrate. Phosphorus alone applied as superphosphate (20 percent $P_2 0_5$) at rates of 26 and 52 pounds P per acre gave average yields of 59.1 and 62.4 bushels per

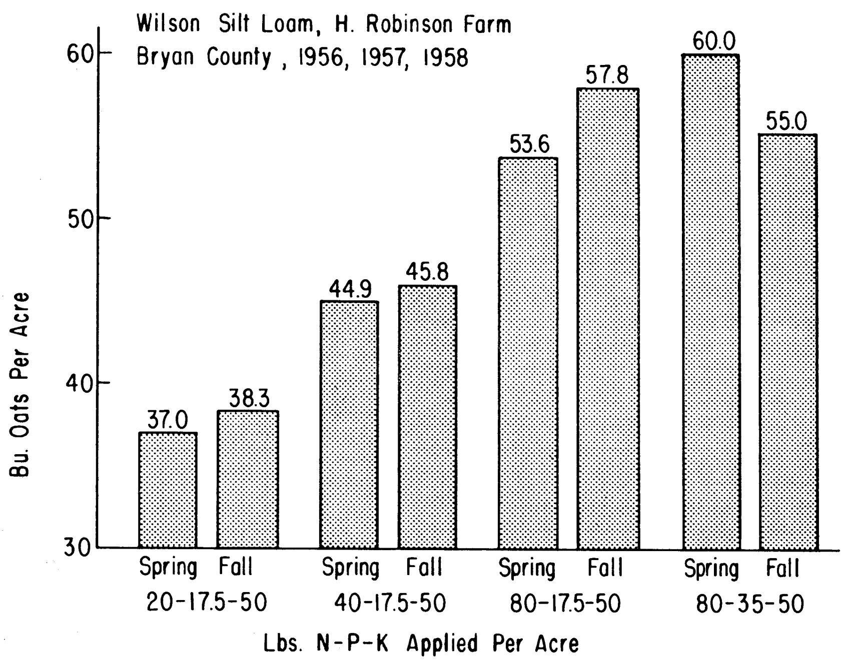

Figure 4. There was no consistent or significant difference in oat yields as a result of different times of nitrogen application when adequate phosphorus and potassium were used. Fall-applied nitrogen was included in the starter fertilizer treatment at planting. Spring-applied nitrogen was topdressed on the established stand in late February or early March.

acre, respectively. However, highest yields were obtained both years from combinations of these two fertilizer materials.

Oat yields showed increases of 20 to 36 bushels with various N and P combinations applied as completely water-soluble ammonium phosphate fertilizers. However, combinations of ammonium nitrate and superphosphate gave higher yields than corresponding treatments supplied as ammonium phosphates.

Yields generally were increased with the addition of 50 pounds K in the fertilizer treatments. The increases with potassium fertilization were apparent both with the ammonium phosphate fertilizers and the ammonium nitrate-superphosphate combinations.

Dougherty Sandy Loam—Garvin County

Field experiments at the Peanut Experiment Station, near Stratford, were used to determine influence of various nitrogen, phosphorus and potassium starter fertilizer treatments with nitrogen applied as topdressing on oats. This soil type is located on gently rolling topography; fertility levels are generally low; and the area is subject to severe wind and water erosion. The field used in this study was slightly acid in reaction, low in available phosphorus, low in organic matter and medium in potassium. Yield results from these experiments are presented in Table III.

Phosphorus and nitrogen fertilization, alone or in combination, resulted in large yield increases over the check (unfertilized) treatment. However, 17.5 pounds P per acre at planting was apparently adequate on this soil type with small yield increases obtained when that level was doubled to 35 pounds P per acre.

Consistent yield increases were obtained with increased rates of nitrogen application. Oat yield response to nitrogen levels is illustrated in Figure 5. An average increase of about 1 bushel of oats was obtained from each 3 pounds of N up to 100 pounds N per acre. Response to 20 pounds N per acre was essentially the same whether applied at planting or topdressed.

Yields were generally increased slightly with addition of 33 pounds K per acre when combined with phosphorus and nitrogen treatments.

Norge Sandy Loam—Payne County

Effects of nitrogen, spring and fall applied, combined with various phosphorus and potassium combinations were determined at the Para-

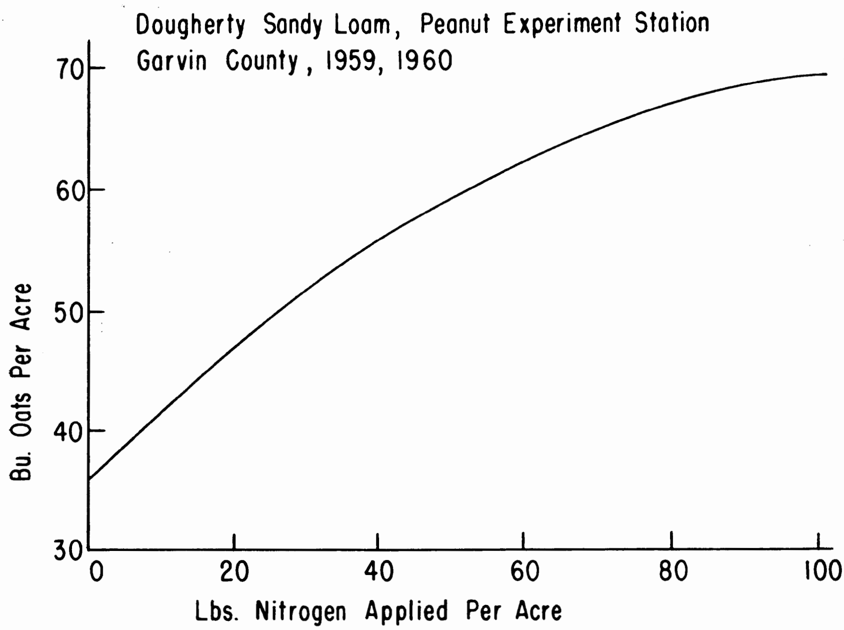

Figure 5. Average oat yields from all phosphorus and potassium treatments increased with increasing rates of nitrogen on this soil. Significant and profitable yields were obtained with nitrogen fertilization, ranging from 36.1 bushels with no nitrogen to 67.4 bushels with 100 pounds N per acre.

dise Farm, Payne County. The field was nearly level with good internal and surface drainage. This soil is subject to severe erosion with cultivated crops and normally is medium to low in fertility depending on previous soil management treatments. Results from soil tests indicate that this soil was slightly acid, low in organic matter, medium in potassium and low in available phosphorus.

Results of these experiments for 1959, 1960 and 1961 are shown in Table IV. Consistent yield increases were obtained only in 1960 from phosphorus and potassium fertilization, alone and in combination when applied without nitrogen.

Time of nitrogen application, whether in the fall at planting or topdressed in the spring, did not greatly influence yield at corresponding rates of nitrogen fertilization.

Increased yields with rates of nitrogen ranging from 0 to 80 pounds N per acre when combined with 17.5 pounds P and 33 pounds K are shown in Figure 6. An average increase of about 1 bushel of oats for 2 pounds of nitrogen applied was obtained at this location.

SUMMARY AND CONCLUSIONS

This publication reports results from field experiments conducted from 1956-1961 to determine oat yield response to various fertilizer treatments in eastern Oklahoma.

Four soil types were studied: Wilson silt loam, Choteau silt loam, Dougherty sandy loam and Norge sandy loam. Treatment variations included kinds and levels of fertilizers—applied alone and in different combinations—and times of fertilizer application.

Results from these studies indicate that proper nutrient balance, particularly with adequate available soil phosphorus and nitrogen, is required for high oat yields.

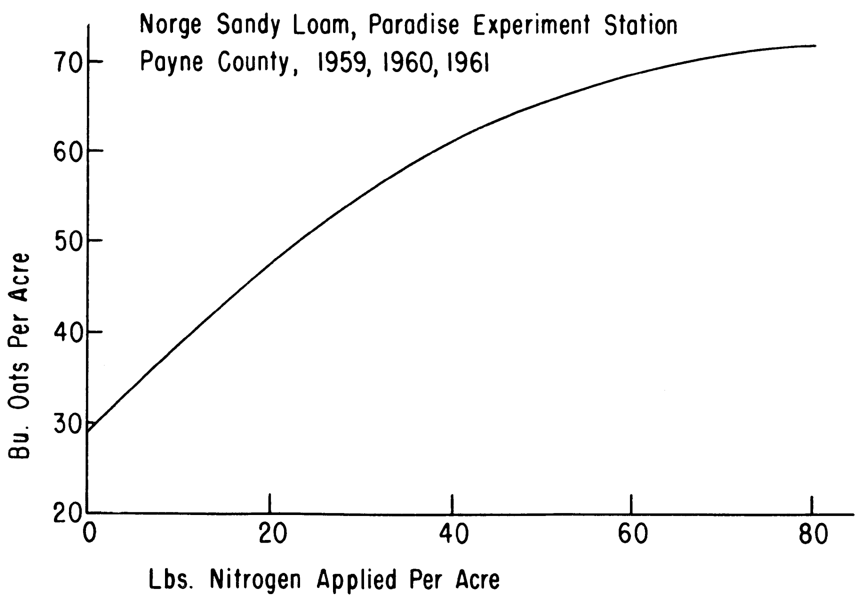

Figure 6. The three-year average of all phosphorus and potassium treatments in this field experiment showed an increase of about 1 bushel of oats for each 2 pounds of nitrogen applied. There was little difference in time of nitrogen application, and both fall and spring nitrogen treatments are included in this figure.

Yield response to increased nitrogen fertilization is highly profitable when adequate soil phosphorus is available to the crop. Nitrogen rates up to 80 and 100 pounds N gave highly significant and profitable yield increases when soil phosphorus and potassium were not limiting.

There was little difference in response to time of nitrogen application. Spring-topdressed nitrogen was as effective as fall-applied nitrogen at all rates of application.

Improved oat forage and grain yields are dependent on adequate nutrient levels of the soil, supplied by proper fertilization. High nitrogen levels with adequate available soil phosphorus are necessary for maximum yields of oats.

Table I. Effects of various soil fertility treatments on oat yields, Wilson silt loam, H. Robinson farm, Bryan County—1956, 1957, 1958

Treatment	Time of N	Acre Yield			
N – P – K	Application	Arkwin 1956	Arlington 1957	De Soto 1958	Average
lbs./acre		bushels			
Check	----	14.0	10.8	18.2	14.3
80-0-0	Spring	16.5	9.9	42.0	23.8
0-17.5-0	----	19.6	15.2	23.0	19.3
0-17.5-50	----	22.5	10.2	21.2	18.0
80-0-50	Spring	14.4	10.6	41.5	22.2
80-17.5-0	Spring	36.5	28.6	91.1	52.1
20-8.7-50	Spring	28.9	23.4	54.2	35.5
40-8.7-50	Spring	37.9	26.3	66.2	43.5
80-8.7-50	Spring	33.5	25.9	92.7	50.7
20-17.5-50	Spring	34.9	25.9	50.3	37.0
20-17.5-50	Fall	36.4	20.7	57.9	38.3
40-17.5-50	Spring	35.5	25.7	73.5	44.9
40-17.5-50	Fall	37.5	25.7	74.3	45.8
80-17.5-50	Spring	38.2	25.7	97.0	53.6
80-17.5-50	Fall	40.7	27.2	105.5	57.8
80-35-50	Spring	47.5	30.3	102.2	60.0
80-35-50	Fall	51.2	28.3	85.5	55.0

Yield figures are mean of three replications. Treatment F: 1956=51.79** 1957=9.44** 1958=27.01**

Table II. Effect of various soil fertility treatments topdressed on Arkwin oat yields, Choteau silt loam, Muskogee County—1958, 1959

Treatment[1] N – P – K	Materials Used[2]	Acre Yield 1958	1959	Average
lbs./acre			bushels	
Check	0	53.2	52.1	52.7
20-0-0	N	55.8	109.8	82.8
60-0-0	N	44.5	96.0	70.3
0-26-0	Super	57.0	61.2	59.1
0-52-0	Super	56.1	68.6	62.4
0-0-50	KCl	44.8	67.5	56.2
30-26-0	N + Super	72.1	114.3	93.2
60-52-0	N + Super	86.0	93.7	89.8
30-26-0	Am phos	73.1	83.5	78.3
60-52-0	Am phos	46.3	98.3	72.3
30-26-25	Am phos	52.9	110.9	81.9
60-52-50	Am phos	81.9	86.3	84.1
20-26-0	Am phos	70.4	85.2	77.8
40-52-0	Am phos	84.6	92.6	88.6
20-26-17	Am phos	62.1	94.9	78.5
40-52-33	Am phos	74.5	95.5	85.0
30-26-25	N + Super + KCl	79.9	102.3	91.1
60-52-50	N + Super + KCl	79.1	106.3	92.7

Yield figures are mean of three replications.

Treatment F: 1958=3.78** 1959=3 97**

[1] 200 lbs. 10-20-10 fertilizer per acre applied at planting each year; topdressed fertilizer treatments applied in early March.

[2] N=Ammonium nitrate (33.5%), Super=Superphosphate (20%), KCl=Muriate of potash (60%), Am phos=Ammonium phosphate combination.

Table III. Effect of various soil fertility treatments on Forkedeer oat yields, Dougherty sandy loam, Peanut Experiment Station, Garvin County—1959, 1960.

Starter Fertilizer	Acre Yield				
	Lbs. N Topdressed Per Acre				
N – P – K	0	20	40	80	Average
lbs./acre	bushels				
			1959		
0-0-0	27.1	42.5	47.5	53.3	42.8
0-17.5-0	30.8	44.6	40.4	52.5	42.1
0-17.5-33	46.7	45.8	52.9	53.3	49.7
0-35-33	28.8	39.6	46.3	62.1	44.2
20-17.5-0	42.9	43.3	45.8	55.0	46.8
20-35-0	42.5	44.6	48.8	53.3	47.3
20-17.5-33	49.2	41.7	52.5	52.9	49.1
20-35-33	35.0	43.3	58.3	55.0	47.9
Average	37.9	43.2	49.1	54.7	46.2
			1960		
0-0-0	29.5	35.0	52.2	64.1	45.2
0-17.5-0	38.9	43.3	55.2	80.5	54.5
0-17.5-33	46.5	65.5	72.4	61.4	61.5
0-35-33	40.5	59.3	68.4	63.4	57.9
20-17.5-0	52.5	49.2	73.6	86.1	65.4
20-35-0	53.0	61.6	78.5	83.2	69.1
20-17.5-33	46.0	76.3	66.7	75.0	66.0
20-35-33	49.7	68.6	78.5	78.9	68.9
Average	44.6	57.3	68.2	74.1	61.0

Yield figures are mean of three replications.

Treatment F: 1959=1.03* 1960=3.52**

Table IV. Effect of various soil fertility treatments and time of application on Forkedeer oat yields, Norge sandy loam, Paradise Farm, Payne County—1959, 1960, 1961.

Starter-Fertilizer P — K	Acre Yield, Lbs. N Per Acre: Spring 0	Spring 20	Spring 40	Spring 80	Fall 20	Fall 40	Fall 80	Average
lbs /acre	bushels							
				1959				
0-0	28.3	54.2	56.3	70.0	66.3	57.9	76.3	58.5
17.5-0	29.2	55.8	71.3	90.8	59.2	69.6	95.4	67.3
0-33	31.7	55.0	60.0	72.1	57.9	63.8	77.1	59.7
17.5-33	23.8	59.2	70.0	102.9	57.1	67.9	89.2	67.2
Average	28.3	56.1	64.4	83.7	60.1	84.8	84.5	63.2
				1960				
0-0	29.9	67.6	63.4	74.8	66.7	56.5	59.2	59.7
17.5-0	32.8	55.0	83.0	94.9	72.6	63.3	101.0	71.8
0-33	50.0	61.1	62.3	83.4	62.6	57.1	80.4	65.3
17.5-33	37.0	76.5	81.3	101.0	71.2	75.5	106.1	78.4
Average	37.4	65.1	72.5	88.5	68.3	63.1	86.7	68.8
				1961				
0-0	23.5	31.2	32.9	38.7	22.4	21.7	30.4	28.7
17.5-0	19.3	31.8	37.6	40.7	28.8	22.7	34.4	30.7
0-33	23.8	33.6	30.0	38.2	26.9	24.9	29.4	29.5
17.5-33	18.3	33.9	38.3	39.0	25.3	25.8	27.7	29.7
Average	21.2	32.6	34.7	39.2	25.9	23.8	30.5	29.7

Yield figures are mean of three replications.

Treatment F: 1959=12.22** 1960=6.64** 1961=6.29**

Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than $700,000,000 annually. The value added by manufacture of farm products adds another $130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.

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