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# A Fertilizer Study On the Brown Soil of the Red Prairies

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# A FERTILIZER STUDY

## ON THE BROWN SOIL OF THE RED PRAIRIES

This experiment is located on the Experiment Station farm at Stillwater. It consists of a four-year rotation of cotton, oats, cowpeas, and darso. Each of these crops is treated with various fertilizers anually or as otherwise noted. The early history of this experiment is recorded in Oklahoma Station Bulletin 155. The year 1928 was the end of the third round of the rotation proper, thus twelve years results have been secured. The soil on which this experiment is located is classified as Kirkland loam to silt loam. It is a rather heavy brown soil with a hardpan subsoil. A water table occurs at a depth of 16½ to 18 feet. The subsoil is so impervious to moisture movement, however, that crops suffer during dry seasons for lack of moisture. This soil series is common in the Red Prairies of Oklahoma which comprises essentially the western half of the state exclusive of the Panhandle. The rate of fertilization or fertilizer plan as has been used since 1921 is as follows:

(a) Manured plots receive manure every four years equivalent to that which would be produced if the feed crops were fed to livestock.

(b) Nitrate of soda where used is applied at the rate of 200 pounds per acre annually.

(c) Superphosphate where used is applied at the rate of 125 pounds per acre annually.

(d) Rock phosphate where used is applied at the rate of 1000 pounds per acre every four years.

(e) Kainit where used is applied at the rate of 100 pounds per acre annually.

(f) Limestone where used is applied at the rate of two tons per acre every four years.

(g) Gypsum where used is applied at the rate of 400 pounds per acre annually.

(h) Crop residues consist of the straw, stalks and cowpea vines. Cotton stalks are left on all the plots when this crop is grown. The residues are generally plowed under but has been used as top dressings in a few instances.

Previous to 1921 the rates of fertilization for nitrate of soda and kainit differed slightly from the amounts used since that time. The kainit was applied at the rate of 200 pounds per acre. The nitrate of soda was applied according to the removal of nitrogen in the crops (other than cotton) produced for the years 1919 and 1920. No nitrate of soda was applied in 1918 due to failure to arrive due to war conditions. In 1917, nitrate of soda was applied at the rate of 200 pounds per acre. In calculating the cost of the fertilizers (Tables 2 and 3) these variations were considered. During recent years, the nitrate of soda, kainit and superphosphate have been applied below the seed for the cotton, darso and cowpea crops. All of the fertilizers have been broadcasted in other instances. One outstanding thing noticed in the growth of the crops is that where phosphorus has been applied to the soil, the crop has reached maturity from a week to ten days earlier than the other plots. This is particularly the case where superphosphate has been used but even with rock phosphate, there is some difference in maturity. The average yields for the various treatments are given in Table 1 which follows:

**TABIE 1.—Showing 12 years average results on the use of fertilizers in rotation. Yields per acre.**

| Plot No. | Treatment | Oats*** Grain (bu.) | Oats*** Straw (lbs.) | Cowpeas (lbs.) | Darso Grain (bu.) | Darso Straw (lbs.) | Seed Cotton (lbs.) |
|---|---|---|---|---|---|---|---|
| 1 | Check | 32.90 | 1318 | 2028* | 29.59* | 2695* | 593 |
| 2 | Manure | 38.06 | 1373 | 2198 | 30.02* | 2689* | 705 |
| 3 | Manure, Lime | 37.81 | 1380 | 2336 | 31.54 | 2641 | 701 |
| 4 | Check | 32.25 | 1137 | 2074 | 27.38 | 2370 | 650 |
| 5 | Manure, Lime, Rock Phosphate | 38.75 | 1493 | 2409 | 30.50 | 2629 | 747 |
| 6 | Manure, Lime, Superphosphate | 41.62 | 1731 | 2368 | 29.82 | 2548 | 805 |
| 7 | Check | 32.28 | 1272 | 2071 | 25.14 | 2249 | 647 |
| 8 | Residues | 36.12 | 1388 | 2158** | 27.52 | 2326 | 702 |
| 9 | Residues, Lime | 36.50 | 1378 | 2206** | 28.43 | 2464 | 739 |
| 10 | Check | 32.91 | 1212 | 1989 | 26.64 | 2210 | 724 |
| 11 | Residues, Lime, Rock Phosphate | 34.69 | 1425 | 2121** | 26.73 | 2272 | 755 |
| 12 | Residues, Lime, Superphosphate | 41.19 | 1617 | 2269** | 29.00 | 2235 | 829 |
| 13 | Check | 33.66 | 1274 | 2060 | 28.98 | 2252 | 681 |
| 14 | Nitrate of Soda | 33.12 | 1269 | 2066 | 25.39 | 1997 | 684 |
| 15 | Nitrate of Soda, Lime | 35.31 | 1379 | 2075 | 25.27 | 2241 | 719 |
| 16 | Check | 36.66 | 1330 | 2095 | 26.54 | 2318 | 760 |
| 17 | Nitrate of Soda, Lime, Rock Phosphate | 37.03 | 1380 | 2111 | 24.09 | 2113 | 776 |
| 18 | Nitrate of Soda, Lime, Superphosphate | 42.50 | 1615 | 2149 | 25.86 | 2188 | 801 |
| 19 | Check | 33.50 | 1355 | 2083 | 24.95 | 2172 | 762 |
| 20 | Nitrate of Soda, Lime, Kainit | 38.78 | 1340 | 2226 | 24.43 | 2143 | 755 |
| 21 | Nitrate of Soda, Lime, Kainit, Rock Phosphate | 38.00 | 1282 | 2011 | 26.14 | 2398 | 741 |
| 22 | Check | 35.65 | 1339 | 2072 | 26.61 | 2385 | 755 |
| 23 | Lime | 35.44 | 1301 | 2019 | 27.64 | 2392 | 707 |
| 24 | Gypsum | 35.00 | 1201 | 2076 | 26.28 | 2220 | 746 |
| 25 | Check | 36.41 | 1387 | 2071 | 28.34 | 2407 | 755 |
| 26 | Gypsum, Manure | 42.00 | 1557 | 2294 | 27.98 | 2328 | 864 |
| 27 | Gypsum, Manure, Rock Phosphate | 42.94 | 1629 | 2369 | 30.61 | 2567 | 866 |
| 28 | Check | 34.94 | 1268 | 2217 | 26.53* | 2409* | 841 |
| Ave. | All checks | 34.06 | 1289 | 2076 | 27.07 | 2347 | 717 |

*Eleven year average results on this plot.
**Yields were calculated on these plots for the years 1917 and 1923 as the plots were turned under by mistake before weights were secured.
***1923 was a total failure on account of late freeze.

At first glance it would appear that some of the treatments caused a considerable increase in yields while it can readily be observed that some of the treatments were applied at a loss. To get a better idea of the actual returns, Tables 2 and 3 were constructed.

**Table 2.—Showing the results in gain or loss during one rotation due to fertilization.**

| Treatment | Bushels Oat Grain | Pounds Oat Straw | Cowpea Hay | Bushels Darso Grain | Pounds Darso Forage | Seed Cotton | Value of Gain*** | Cost of* Fertilizers | Net Returns |
|---|---|---|---|---|---|---|---|---|---|
| Manure**** | 5.38 | 115 | 155 | 1.17 | 102 | 93 | $ 9.20 | | $ 9.20 |
| Manure, Limestone | 5.34 | 183 | 277 | 3.42 | 163 | 70 | 10.64 | 3.50 | 7.14 |
| M. L. Rock Phosphate | 6.49 | 311 | 336 | 3.87 | 299 | 98 | 13.87 | 11.00 | 2.87 |
| M. L. Superphosphate | 9.35 | 504 | 296 | 3.93 | 259 | 157 | 18.08 | 11.00 | 7.08 |
| Residue** | 3.63 | 136 | 114 | 1.88 | 90 | 29 | 4.03 | | 4.03 |
| Residues, Limestone | 3.80 | 146 | 190 | 2.29 | 241 | 41 | 4.94 | 3.50 | 1.44 |
| R. L. Rock Phosphate | 1.53 | 192 | 108 | —0.69 | 48 | 45 | 2.45 | 11.00 | —8.55 |
| R. L. Superphosphate | 7.78 | 364 | 233 | 0.80 | —3 | 134 | 10.29 | 11.00 | —0.71 |
| Nitrate of Soda | —1.54 | —24 | —6 | —2.78 | —277 | —23 | —4.24 | 25.00 | —29.24 |
| Nitrate of Soda, Lime | —0.35 | 68 | —8 | —2.08 | —55 | —15 | —2.17 | 28.50 | —30.67 |
| N. L. Rock Phosphate | 1.42 | 42 | 20 | —1.92 | —156 | 15 | 0.03 | 36.00 | —35.97 |
| N. L. Superphosphate | 7.95 | 268 | 62 | 0.38 | —33 | 40 | 6.46 | 36.00 | —29.54 |
| N. L. Kainit | 4.56 | —10 | 147 | —1.07 | —100 | —5 | 1.76 | 34.90 | —33.14 |
| N. L. K. Rock Phosphate | 3.07 | —62 | —65 | —0.08 | 84 | —16 | —0.05 | 42.40 | —42.45 |
| Limestone | —0.46 | —54 | —53 | 0.45 | 0 | —48 | —2.83 | 3.50 | —6.33 |
| Gypsum | —1.16 | —170 | 5 | —1.48 | —180 | —9 | —2.63 | 3.87 | —6.50 |
| Gypsum, Manure | 6.08 | 210 | 174 | 0.24 | —80 | 80 | 8.19 | 3.87 | 4.32 |
| G. M. Rock Phosphate | 7.51 | 321 | 201 | 3.48 | 159 | 54 | 10.50 | 11.37 | —0.87 |

*Actual cost of ingredients, labor not included. These are approximate figures using the following prices: Limestone, $2.10 per ton; Nitrate of Soda, $75.00 per ton; Kainit, $24.00 per ton; Superphosphate, $30.00 per ton; Rock Phosphate, $15.00 per ton, and Gypsum, $5.00 per ton.

**For all plots where residues were returned, the value of the straw, stover, and cowpea hay is not included.

***In making the calculations, the following prices for products were used:

Oat grain, 40c per bushel
Oat straw, $5.00 per ton
Cowpea hay, $15.00 per ton
Darso grain, 60c per bushel
Darso stover, $5.00 per ton
Seed cotton, 5c per pound

****Manure was applied at the rate of approximately 9.39 tons per acre every four years.

**Table 3.---Showing the results of fertilizer treatment for individual crops.**

| Treatment | Cost of Fertilizer for 1 Year | OAT CROP Value of Gain | OAT CROP Net Returns | COWPEAS Value of Gain | COWPEAS Net Returns | DARSO CROP Value of Gain | DARSO CROP Net Returns | COTTON CROP Value of Gain | COTTON CROP Net Returns |
|---|---|---|---|---|---|---|---|---|---|
| Manure* | $ | $2.44 | $2.44 | $1.16 | $ 1.16 | $0.95 | $ 0.95 | $4.65 | $ 4.65 |
| Manure, Limestone | 0.83 | 2.60 | 1.72 | 2.08 | 1.20 | 2.46 | 1.58 | 3.50 | 2.62 |
| M. L. Rock Phosphate | 2.76 | 3.38 | 0.62 | 2.52 | —0.24 | 3.07 | 0.31 | 4.90 | 2.14 |
| M. L. Superphosphate | 2.76 | 5.00 | 2.24 | 2.22 | —0.54 | 3.01 | 0.25 | 7.85 | 5.09 |
| Residues | | 1.45 | 1.45 | | | 1.13 | 1.13 | 1.45 | 1.45 |
| Residues, Limestone | 0.83 | 1.52 | 0.64 | | | 1.37 | 0.49 | 2.05 | 1.19 |
| R. L. Rock Phosphate | 2.76 | 0.61 | —2.15 | | | —0.41 | —3.17 | 2.25 | —0.51 |
| R. L. Superphosphate | 2.76 | 3.11 | 0.35 | | | 0.48 | —2.28 | 6.70 | 3.94 |
| Nitrate of Soda | 6.25 | —0.63 | —6.93 | —0.05 | —6.30 | —2.36 | —8.61 | —1.15 | —7.40 |
| Nitrate of Soda, Limestone | 7.13 | 0.03 | —7.10 | —0.06 | —7.18 | —1.39 | —8.52 | —0.75 | —7.88 |
| N. L. Rock Phosphate | 9.01 | 0.67 | —8.34 | 0.15 | —6.86 | —1.54 | —10.55 | 0.75 | —8.26 |
| N. L. Superphosphate | 9.01 | 3.85 | —5.16 | 0.47 | —8.54 | 0.15 | —8.86 | 2.00 | —7.01 |
| N. L. Kainit | 8.73 | 1.80 | —6.93 | 1.10 | —7.63 | —0.89 | —9.62 | —0.25 | —8.98 |
| N. L. K. Rock Phosphate | 10.61 | 1.08 | —9.53 | —0.49 | —11.10 | 0.16 | —10.45 | —0.80 | —11.41 |
| Limestone | 0.83 | —0.31 | —1.19 | —0.40 | —1.28 | 0.27 | —0.61 | —2.40 | —3.28 |
| Gypsum | 0.97 | —0.88 | —1.85 | 0.04 | —0.93 | —1.34 | —2.31 | —0.45 | —1.42 |
| Gypsum, Manure | 0.97 | 2.95 | 1.98 | 1.30 | 0.33 | —0.06 | —1.03 | 4.00 | 3.03 |
| Gypsum, M. Rock Phosphate | 2.95 | 3.80 | 0.95 | 1.51 | —1.34 | 2.49 | —0.36 | 2.70 | —0.15 |

*Manure was applied in all cases at the rate of approximately 9.39 tons per acre every four years which is equivalent to approximately 2.35 tons per acre per year.

Manure used in this rotation had a value of approximately $1.00 per ton. Considering the rotation as a whole and the net returns secured from the use of the various fertilizers other than manure, none of the fertilizers paid. The nearest any fertilizer used for all of the crops came to paying for itself was superphosphate used with manure and limetsone. Limestone has not paid in the rotation either where used by itself or in combination. Nitrate of soda by itself or in combination was applied at the greatest loss. Landplaster (gypsum) was applied at a loss. Through deduction, it is possible to get an idea of the effect superphosphate has had in the rotation. With manure, considering the rotation as a whole, superphosphate about broke even. The extra cost of the fertilizers above the influence of manure or crop residues has more than offset the increase in yield. It is rather unfortunate that no plot was included that received superphosphate alone. The indications are that such a treatment might have paid. Also a plot receiving manure and superphosphate without limestone might pay.

In considering Table 3, a glance will indicate immediately that fertilizers other than residues and manure were applied at a loss for the individual oat, cowpea and darso crops. Cotton is the only crop that shows any indication of paying for any of the fertilizers and leaving a profit. Superphosphate used in connection with manure and limestone showed some profit when used on the cotton crop. Limestone was applied at a loss. Through deduction, $1.88 spent for superphosphate produced a gain in cotton worth $4.35 (acre basis.) This would indicate that the use of superphosphate, and superphosphate and manure would increase the yield of cotton on this common soil type sufficient to warrant consideration. It would appear from the crops studied that cotton is the only one for which fertilizers could be applied at a profit and that if a rotation is followed, the fertilizers should be applied for this crop and left out for the other crops, the other crops receiving only the residue of any fertilizer not utilized by the cotton crop.