Soil Fertility Studies;
St. Clair County, Illinois

Agriculture
B. S.
1903
SOIL FERTILITY STUDIES
WITH SPECIAL REFERENCE TO
TO CERTAIN SOILS OF
ST. CLAIR COUNTY
ILLINOIS

BY

GUSTAVE HERMAN EIDMANN

THESIS
FOR THE DEGREE OF BACHELOR OF
SCIENCE IN THE COLLEGE OF
AGRICULTURE

UNIVERSITY OF ILLINOIS
1903
THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Gustave Herman Eidmann

ENTITLED: "Soil Fertility Studies, with Special Reference to

Certain Soils of St. Clair County, Illinois"

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

of Bachelor of Science in Agriculture

Cyril G. Hopkins

HEAD OF DEPARTMENT OF Agronomy

66650
X Places where samples of soil were taken for pot cultures.
INTRODUCTION.

Two series of pot cultures were conducted with each of two types of St. Clair County soils taken from the farm of L. P. Eidmann located in sections seventeen and eighteen of Englemann Township, (Tp. 1 S. R. 6 W. of the third principal meridian).

The object of these investigations was to determine the value of adding lime, nitrogen, phosphorus and potassium to each of these types of soils, for the growing of wheat. The object was later extended and a crop of millet grown after the wheat had been harvested. The first series of pot cultures, which was called the A series was prepared to determine whether or not these elements of fertility when added slightly in excess are of any value to the soils under consideration for the production of the above mentioned crops, while the second or B series was intended to indicate in what amounts it is profitable to add the elements which prove to be of value in series A.

The two soils investigated are so different in physical properties that they were considered as two distinct types. The one type is truly representative of an area of some fifteen to eighteen square miles of level prairie land. The second type lies some ten or fifteen feet lower than the first, lies nearer to the creek, and covers probably no more than two square miles of land. The former is referred to as brown silt loam or upland, and the latter as black clay loam or lowland. Both series A and B of the pot cultures were prepared with each of these types of soil, and the series designated A-U, A-L, B-U or B-L according to the type under consideration,
Series 4-7, wheat; grown alike, showing no marked differences between.

the growth of wheat receiving applications of different elements of fertility.

Photographed April 17.
U representing upland and L lowland.

The soils are both prairie soils of the middle Illinoisan glaciation, but have both been considerably modified by a deposit of what seems to be loess, which was probably wind-blown from the bluffs along the Mississippi river, while the lowland type has also been affected by alluvial deposits from surrounding higher lands. In texture these soils are very fine and to a depth of several feet are thought to be loess because they are entirely free from gravel. The upland soil also has a velvety feel which is characteristic of loess, and under ordinary conditions pulverizes very easily.

In color it is considerably lighter than the black prairie silt soils of Central Illinois, but in mechanical composition it is very similar, being also a silt loam and is therefore called a brown silt loam. The color of the surface soil does not change materially until a depth of eighteen to twenty inches is reached.

In general appearance the lowland type resembles very closely the low, sticky black clay soils of Central Illinois and is therefore called a black clay loam. It is very black in color and begins to grow lighter only at a depth of thirty-four to thirty-six inches. Freezing and thawing pulverizes the exposed surface into cubical granules similar to those of Yazoo clay. This soil is very sticky when wet, and very hard and rough when dry. It is very greatly influenced by its moisture contents. When it contains a certain amount of moisture which does not have a very wide range, it pulverizes very nicely, forming its characteristic cubical granules. Water permeates it very readily. Until about fifty years ago this soil was covered by water the greater part of the time, and only since eight or ten years has surface drainage been affected which removes
the surface water fairly well. Even now, since there is no under

drainage, water sometimes stands on the field in places until it

evaporates. In the immediate vicinity tile drainage has not been

attempted on either of these two types of soils.

A short distance to the south, about one third of a mile from

where samples of the brown silt loam were taken, is a small moraine

about forty five feet higher than section seventeen. The soil on

this moraine is coarser in texture, being a fine sandy loam. The

rain which falls on a part of this moraine and that which falls on

the brown silt loam collects and flows in the direction of the black

clay loam to Silver Creek two miles to the west. Water washing

over a soil carries with it the fine material leaving the coarser

particles behind. Since at one time this water which washed the

higher lands stood for days and even weeks upon the lower lying

lands, this fine material carried in suspension by the water was

deposited by sedimentation and on evaporation of the water, on the

lowland, and hence increased the contents of fine material in the

lowland soil.

The thickness of the drift in this locality can be estimated

from borings made in neighboring towns. To the northwest of this

area, at Belleville twelve miles away the bed rock is reached at

from 80 to 87 feet; at Renchler six and one half miles away at

about 40 feet; to the west six miles, at Freeburg, at from 25 to

30 feet; to the southwest about eight miles at Lementon at 51 feet;

to the south about nine miles, at New Athens one boring at 37 feet,

while another in the same town at *75 feet; to the northeast about

ten and a half miles near New Baden at 27 feet; to the north about

* The latter boring is probably in an old abandoned bed of the

Kaskaskee river.
eleven miles at Summerfield at from 35 to 50 feet; at Lebanon about nine miles to the north on the drift ridge at over 86 feet. The wells in the vicinity where the samples were taken are from 30 to 40 feet deep, and do not reach the bed rock.

Both soils have been cropped for some fifty years. The following shows approximately the system of rotation which has been followed:

<table>
<thead>
<tr>
<th>Brown Silt Loam</th>
<th>Black Clay Loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1893 ... ... clover</td>
<td></td>
</tr>
<tr>
<td>1894 ... ... corn</td>
<td></td>
</tr>
<tr>
<td>1895 ... ... corn</td>
<td>1895 ... ... wheat</td>
</tr>
<tr>
<td>1896 ... ... oats</td>
<td>1896 ... ... wheat</td>
</tr>
<tr>
<td>1897 ... ... wheat</td>
<td>1897 ... ... corn</td>
</tr>
<tr>
<td>1898 ... ... wheat</td>
<td>1898 ... ... corn</td>
</tr>
<tr>
<td>1899 ... wheat &amp; clover</td>
<td>1899 ... ... corn</td>
</tr>
<tr>
<td>1900 ... ... clover</td>
<td>1900 ... ... corn</td>
</tr>
<tr>
<td>1901 ... ... corn</td>
<td>1901 ... ... oats</td>
</tr>
<tr>
<td>1902 ... ... corn</td>
<td>1902 ... ... timothy</td>
</tr>
</tbody>
</table>

Following is the average yield in bushels per acre of crops grown on the brown silt loam since 1897:

<table>
<thead>
<tr>
<th>Crops</th>
<th>1897</th>
<th>1898</th>
<th>1899</th>
<th>1900</th>
<th>1901</th>
<th>1902</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>8</td>
<td>18</td>
<td>9</td>
<td>15</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>Corn</td>
<td>40</td>
<td>37</td>
<td>40</td>
<td>45</td>
<td>3</td>
<td>55</td>
</tr>
<tr>
<td>Oats</td>
<td>24</td>
<td>22.5</td>
<td>20</td>
<td>30</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>Timothy</td>
<td>1 T.*</td>
<td>1.5 T.</td>
<td>1 T.</td>
<td>2 T.</td>
<td>1.5 T.</td>
<td>1 T.</td>
</tr>
</tbody>
</table>

* A load of hay from the field was estimated to weigh a ton when cured. T. stands for tons.
The yields of the black clay loam are similar to the above. In wheat and oats they are probably somewhat lower, while in corn and hay they are somewhat higher. Corn usually suffers considerably from excessive moisture in the spring. Wheat makes a rank growth producing a large amount of straw, but comparatively little grain. Clover has not been grown upon this soil for eleven years, but when it was grown there, it usually produced a good crop. The writer remembers well when six acres adjoining the nine acre field from which the samples were taken, and which are very similar in type produced an average of three and one third bushels of clover seed per acre after having produced a large crop of hay in the early summer.
Plate 4-1, taken on July 11th, showing no marked difference between the effect of small preceding applications of different amounts of fertility, except where lime was added with 100 per cent wood ash. Test 1, pots 1, 2, and 10. Photographed April 14.
POT CULTURES.

For the pot cultures the sample of upland soil was taken about 15 rods north of the center of the southwest quarter of the southwest quarter of section seventeen. The sample of the lowland soil was taken from the northwest ten acres of the northwest quarter of the southeast quarter of section eighteen. See page 1. The samples were taken one foot deep. In both soils the surface six inches were kept separate from the subsurface. In the upland soil there was also a division of the subsurface at ten inches. This division of the upland subsurface was made because the soil below ten inches was somewhat lighter in color.

In filling the pots the soil was arranged as it lay in the field, that is, the subsurface was put in before the surface. When all the soil had been pulverized and passed through a sieve of one half inch mesh, it was put into the pots as the fertilizer was mixed with it. The fertilizers weighed out for any particular pot were mixed together, and one half of the mixture added to the subsurface and the remaining one half to the surface soil. The lime was added after the pots had been filled with soil, so it was added to the surface four inches.

The lime was added to the pots in the form of ground limestone (Ca CO₃), the nitrogen, phosphorus and potassium fertilizers in the forms of dried blood, acidulated bone meal and sulfate of potash (K₂ SO₄) respectively. In series A when a fertilizer was added it was always added in the same quantity, a quantity sufficiently large to insure an excessive amount of plant food required for one maximum crop. In series B five* pots constitute a subseries. The

*Pots 8, 7, and 6 are later also compared with the subseries making six pots in each subseries.
Series B-3 - nitrogen superseding, test on glass clay loam. All pots received
like amounts of lime, phosphorus and potassium, but the nitrogen in the form of blood
blood was varied as indicated on the pots. Photographed April 12.
lime and two of the three fertilizers are always constant in amounts and always added in excessive quantities, while the third fertilizer is varied from the smallest quantity, which it is practical to add, to one which is quite likely to prove to be too large to be profitable.

In the tables indicating the amounts of fertilizer added to each pot, L in the second column stands for lime, N for nitrogen, P for phosphorus and K for potassium. In the last three columns g. for grams, d. b. for dried blood, and b. m. for bone meal. In the top line printed on the pots the abbreviations U and L stand for upland and lowland respectively.

For the chemical composition of the fertilizers added see appendix, page 50.

The following tables indicate what fertilizers were added, and in what amounts they were added to each pot in the series:
Series 3-5. One control series, wheat on black clay loam. All pots received like amounts of lime, nitrochalk and potash, but the phosphorus in the form of bone meal was varied as indicated on the pots. Photographed April 15.
elements of Fertility added in the form of Commercial Fertilizers

<table>
<thead>
<tr>
<th>No. of pot</th>
<th>Elements added</th>
<th>Lime in grams</th>
<th>Dried blood in grams</th>
<th>Acidulated bone meal in grams</th>
<th>K₂SO₄ in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>L</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>LN</td>
<td>10</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>LP</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>LK</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>LNP</td>
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</tr>
<tr>
<td>7</td>
<td>LNK</td>
<td>10</td>
<td>15</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>LPA</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>LNPK</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>None</td>
<td>0</td>
<td>15</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Series B-L: potassium subseries, wheat on black clay loam. All pots received
like amounts of lime, nitrogen and phosphorus, but the potassium in the form of
potassium nitrate was varied as indicated on the pots. Photographed April 13.
Elements of Fertility added in the form of Commercial Fertilizers

<table>
<thead>
<tr>
<th>No. of pots</th>
<th>Elements added</th>
<th>Lime in grams</th>
<th>Dried blood in grams</th>
<th>Acidulated bone meal in grams</th>
<th>$\text{K}_2\text{SO}_4$ in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen subseries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>LNPK</td>
<td>10</td>
<td>n-10g.d.b.</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>LNPK</td>
<td>10</td>
<td>N-2.0g.d.b.</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>LNPK</td>
<td>10</td>
<td>N-6g.d.b.</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>LNPK</td>
<td>10</td>
<td>N-10g.d.b.</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>LNPK</td>
<td>10</td>
<td>n-10g.d.b.</td>
<td>P-6g.b.m.</td>
<td>K-6g.2KSO4</td>
</tr>
<tr>
<td>Phosphorus subseries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>LNPK</td>
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<td>10</td>
<td>P-4g.b.m.</td>
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</tr>
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<td>2</td>
<td>LNPK</td>
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<td>15</td>
<td>P-1g.b.m.</td>
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</tr>
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<td>15</td>
<td>P-2g.b.m.</td>
<td>3</td>
</tr>
<tr>
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<td>15</td>
<td>P-4g.b.m.</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>LNPK</td>
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<td>N-15g.d.b.</td>
<td>P-6g.b.m.</td>
<td>K-6g.2KSO4</td>
</tr>
<tr>
<td>Potassium subseries</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>LNPK</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>K-2g.2KSO4</td>
</tr>
<tr>
<td>2</td>
<td>LNPK</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>K-5g.2KSO4</td>
</tr>
<tr>
<td>3</td>
<td>LNPK</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>K-1g.2KSO4</td>
</tr>
<tr>
<td>4</td>
<td>LNPK</td>
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<td>15</td>
<td>6</td>
<td>K-2g.2KSO4</td>
</tr>
<tr>
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<td>LNPK</td>
<td>10</td>
<td>n-10g.d.b.</td>
<td>P 6g.b.m.</td>
<td>K-6g.2KSO4</td>
</tr>
</tbody>
</table>

*Where an element was added in irregular amounts, it is written in this table in a form identical with that painted on the pots.*
Elements of fertility added in the form of Commercial Fertilizers

<table>
<thead>
<tr>
<th>No. of pot</th>
<th>Elements added</th>
<th>Lime in grams</th>
<th>Dried blood in grams</th>
<th>Acidulated bone meal in grams</th>
<th>( \text{NH}_4 \text{SO}_4 ) in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
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<td>0</td>
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</tr>
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<td>L</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>LN</td>
<td>6</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>LP</td>
<td>0</td>
<td>0</td>
<td>6</td>
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<td>0</td>
</tr>
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<td>3</td>
</tr>
<tr>
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<td>15</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>NPK看望</td>
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<td>15</td>
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<td>None</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Stakes 3-9, nitrogen subseris. Wheat in brown silt loam. All pots received two amounts of lime, manganese and molybdenum, but the nitrogen in the form of liquid blood was varied as indicated on the list. Photographed June 20.
Elements of Fertility added in the form of Commercial Fertilizers

<table>
<thead>
<tr>
<th>No. of pot</th>
<th>Elements added</th>
<th>Lime in grams</th>
<th>Dried blood in grams</th>
<th>Acidulated bone meal in grams</th>
<th>K₂SO₄ in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen subseries</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>LNPK</td>
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<td>N-1g.d.b.</td>
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<td>3</td>
</tr>
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<td>LNPA</td>
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<td>N-2.5g.d.b.</td>
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</tr>
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<td>N-5g.d.b.</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
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<td>N-10g.d.b.</td>
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<td>3</td>
</tr>
<tr>
<td>5</td>
<td>LNPA</td>
<td>6</td>
<td>N-15g.d.b.</td>
<td>*</td>
<td>K-3g.K₂SO₄</td>
</tr>
</tbody>
</table>

Phosphorus subseries

| 1          | LNPA           | 6             | 15                   | P-4g.b.m.                     | 3              |
| 2          | LNPA           | 6             | 15                   | P-1g.b.m.                     | 3              |
| 3          | LNPA           | 6             | 15                   | P-2g.b.m.                     | 3              |
| 4          | LNPA           | 6             | 15                   | P-4g.b.m.                     | 3              |
| 5          | LNPA           | 6             | N-15g.d.b.           | P-6g.b.m.                     | K-3g.K₂SO₄     |

Potassium subseries

| 1          | LNPA           | 6             | 15                   | 6                             | K-2g.K₂SO₄     |
| 2          | LNPA           | 6             | 15                   | 6                             | K-5g.K₂SO₄     |
| 3          | LNPA           | 6             | 15                   | 6                             | K-1g.K₂SO₄     |
| 4          | LNPA           | 6             | 15                   | 6                             | K-2g.K₂SO₄     |
| 5          | LNPA           | 6             | N-15g.d.b.           | P-6g.b.m.                     | K-3g.K₂SO₄     |

*Where an element was added in irregular amounts, it is written in this table in a form identical with that painted on the pots.*
Series 3-7, 1. Unsprayed samples, 2. 12% sprays 4 times. All data received like amounts of lime, nitrogen and potassium, but the amounts in the form of bone meal were varied as indicated on the pots. Photographed June 6.
All pots were first seeded, February 2, 1903, to spring wheat, Fife No. 149 from Minnesota Experiment Station. Twenty-five kernels of wheat were planted at equal distances apart in each pot, and on February 26 each pot was thinned to contain ten plants. This crop was harvested on June 23, and the same pots reseeded to millet on July 16. To prepare the pots for the seeding of the millet, no additional lime or fertilizer was added, but the soil was all removed from each pot, keeping the surface from the subsurface and thoroughly pulverized before it was returned to the pots. Each pot was seeded to 25 grains of millet, and later thinned to 15 plants.

At different intervals of the growth of the plants, careful notes were taken on the effect of each kind and quantity of fertilizer used. Photographs were taken of all the pots while growing wheat on April 18 and June 20, and while growing millet on November 4, 1903.

Following are the tables showing the yields which were obtained from both crops:
Series B-11. Potassium subseries, wheat on brown sill loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the vials. Photographed June 27.
SERIES A-U

Yield of Wheat, Grain and Straw, and of Millet Hay

<table>
<thead>
<tr>
<th>No. of pot</th>
<th>Elements added</th>
<th>No. of heads harvested</th>
<th>No. of heads lost</th>
<th>Weight of straw in grams</th>
<th>Weight of grain in grams</th>
<th>Wt. of grain computed in grams</th>
<th>Wt. of hay* minus heads in grams</th>
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<td>29.4</td>
<td>13.5</td>
<td>13.5</td>
<td>0.3</td>
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</tbody>
</table>

* More than twenty percent of the full number of heads lost.
* The heads of the millet were badly mutilated by sparrows, so they were removed and not weighed.
## Comparative Value of the Elements of Fertility

<table>
<thead>
<tr>
<th></th>
<th>Wheat (grain) in grams</th>
<th>Millet (hay) in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L &amp;N gain for nitrogen</td>
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<td>15.7</td>
</tr>
<tr>
<td>LP &amp;N-gain for nitrogen</td>
<td>9.9</td>
<td>15.8</td>
</tr>
<tr>
<td>LK &amp;N-gain for nitrogen</td>
<td>3.7</td>
<td>10.6</td>
</tr>
<tr>
<td>LPK&amp;N gain for nitrogen</td>
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<td>17.5</td>
</tr>
<tr>
<td>Total gain for nitrogen</td>
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<tr>
<td>Average gain for nitrogen</td>
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</tr>
<tr>
<td><strong>Phosphorus</strong></td>
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</table>
Series B-L - Nitrogen supplement only. All were received
line weights of live, phosphorus and potassium, but the nitrogen in the form of N-P-K
blood was varied as indicated on the pots. Photographs were the.

30
## SERIES B-U YIELDS

<table>
<thead>
<tr>
<th>No. of pot</th>
<th>Elements added</th>
<th>No. of heads harvested</th>
<th>No. of heads lost</th>
<th>Weight of straw in grams</th>
<th>Weight of grain in grams</th>
<th>Wt. of grain computed in grams</th>
<th>Wt. of hay minus heads in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>5(A-U)</td>
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### Nitrogen subseries

### Phosphorus subseries

### Potassium subseries

X More than twenty percent of the full number of heads lost.

* Pots 8, 7&6 of series A-U are also employed here because they received the same treatment except in the fertilizers added.
Yield of Wheat, Grain and Straw, and of Millet Hay

<table>
<thead>
<tr>
<th>No. of pot</th>
<th>Elements added</th>
<th>No. of heads harvested</th>
<th>No. of heads lost</th>
<th>Weight of straw in grams</th>
<th>Weight of grain in grams</th>
<th>Wt. of grain computed in grams</th>
<th>Wt. of hay* minus heads in grams</th>
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<tr>
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<td>10.7</td>
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<tr>
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<tr>
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<td>LNK</td>
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<td>56.6</td>
<td>17.1</td>
<td>17.1</td>
<td>9.9</td>
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* The heads of the millet were badly mutilated by sparrows, so they were removed and not weighed.
SERIES A-L

Comparitive Value of the Elements of Fertility

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<th></th>
<th>Wheat (grain)</th>
<th>Millet (grain)</th>
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<td></td>
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<td>in grams</td>
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<tr>
<td><strong>Nitrogen</strong></td>
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<tr>
<td>L &amp;N-gain for nitrogen</td>
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<tr>
<td>LP &amp;N-gain for nitrogen</td>
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<td>19.9</td>
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<tr>
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<td>LPA &amp;N-gain for nitrogen</td>
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### SERIES B-L YIELDS

<table>
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<th>No. of pot</th>
<th>Elements added</th>
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<th>No. of heads lost</th>
<th>Weight of straw in grams</th>
<th>Weight of grain in grams</th>
<th>Wet of grain computed in grams</th>
<th>Wet of hay minus heads in grams</th>
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</thead>
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<tr>
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<td>LNK</td>
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<td>24.3</td>
<td>24.8</td>
<td>31.7</td>
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</table>

**Nitrogen subseries**

**Phosphorus subseries**

**Potassium subseries**

*More than twenty percent of the full number of heads lost.*

*Pots 6, 7 & 8 of series A-L are also employed here because they received the same treatment except in the fertilizers added.*
Series F-II—nitrogen compounds. All pots received the same amount of all elements except nitrogen in the form of dried blood, which was varied as indicated on the pots. Both the first row of pots with the inclusion of nitrogen. Photographed November 1.
GENERAL CONCLUSIONS.

It should be understood that definite and satisfactory conclusions can not be drawn from the insufficient data which were obtained in these investigations. During the early part of May, the wheat crop became infected with green flies, which could not be kept under absolute control. From the time the wheat began to ripen until it was harvested it was preyed upon by ravenous mice, which infected the pot culture green house. In the absence of the writer, it seemed impossible to control these pests because the pots had to stand very close together, for lack of sufficient green house room. It is very much to the regret of the writer that these obstacles seriously affected the value of the results of the work. It is thought, however, that the suggestions offered by these results can be taken to apply at least in a general way.

There is no means by which the harm done by the fly can be determined. The disastrous work of the mice could be easily seen, but not so readily estimated. In cases where less than twenty percent of the number of heads of wheat were destroyed, the yield can probably be computed with some degree of accuracy, but where the loss was greater than twenty percent, no importance can be attached to the yields of grain which were obtained. It is thought that the mice selected the largest and plumpest rather than the smallest heads and therefore the computed yields are probably too low rather than too high.

When in interpreting the results of the pot cultures, it was found that the difference in yield between two pots, which were to be compared, was less than two grams, this difference was not
attributed to the different treatment of the pots. It was considered to be due to unknown causes, and the difference was too small to be noted. Two grams, however, was considered to be the limit, and differences greater than two grams were credited to the additional element of plant food which had been added.

From the notes on the growth of the plants, the photographs taken and the yields obtained, the following conclusions have been drawn:

BROWN SILT LOAM.

Wheat Grain

LIME seems to be of some benefit.

NITROGEN produced the largest increase of any of the three elements of plant food added, producing an average increase per pot of 7.5 grams. It produced the largest yield when added at the rate of 800 pounds of dried blood to an acre - 5 grams per pot. This rate produced even more than did heavier applications.

PHOSPHOROUS produced an average increase of 3.85 grams per pot. When added at the rate of 320 pounds of acidulated bone meal to an acre - 2 grams per pot - it produced its largest yield. Pot 4 was badly injured by the mice.

POTASSIUM decreased the yield of grain in wheat at the average rate of 2.35 grams per pot. Applied at the rate of 160 pounds of potassium sulfate to an acre - 1 gram per pot - it produced its largest yield. This yield, however, was but 3.5 grams larger than that of pot 7 in A U series which received no potassium fertilizer at all.
Millet Hay Without The Heads.

LIME seems to have produced slightly beneficial results. NITROGEN as in the case of wheat produced the largest increase of any element added, an average increase of 14.3 grams per pot. Added in the largest quantity in which it was added to any pot at the rate of 2400 pounds of dried blood to an acre - 15 grams per pot - it produced its largest yield. When added with all the other fertilizers it more than tripled the yield, while in other cases it considerably more than doubled the yield. See photograph page 35.

PHOSPHORUS was probably of some value, having produced an average increase of .9 grams per pot, although it showed no definite results. At the rate of 640 pounds of acidulated bone meal to an acre - 4 grams per pot - it produced its largest yield. This, however, was but two grams more than the yield produced by pot 2 where the bone meal was added at the rate of but 160 pounds to the acre.

POTASSIUM gave no regularly increasing results, but on the other hand frequently decreased the yield. The average showed a loss of 1.2 grams per pot. The pot receiving no potassium fertilizer whatever produced practically as large a yield as the one receiving the heaviest application. It is true that in series B-U potassium subseries pot 4 produced the largest yield of any pot in the subseries, but this yield - 34 grams - is so out of proportion that the increase is not attributed to the action of the potassium sulfate which had been added.

The heads of the millet were badly mutilated by sparrows so that they were removed and not weighed.
BLACK CLAY LOAM.

Wheat Grain

LIME is of no benefit. When added with acidulated bone meal it decreased the yield. This, however, is supposed to be due to the reversion of soluble phosphates into insoluble compounds caused by the action of the lime.

In this soil the elements of plant food ranked in the same order of importance as they did in the brown silt loam, namely, nitrogen, phosphorus and potassium.

NITROGEN produced an average increase of 6.1 grams per pot. Applied at the rate of 1600 pounds of dried blood to an acre - 10 grams per pot - it produced the largest yield.

PHOSPHORUS, according to the data at hand, produced its largest yield when applied at the rate of 640 pounds of acidulated bone meal to an acre - 4 grams per pot. The data, however, is rather incomplete because pot 5 is not considered as being reliable. In the regular A-L series it produced an average increase of 1.5 grams per pot.

POTASSIUM can not be said to be of any value, because the pot which received no potassium fertilizer whatever yielded very nearly as heavily as those that did, and in this case even more than the one which received the heaviest application of potassium sulfate.

Millet Hay Without The Heads.

LIME seems to be of some value particularly when added with fertilizers.

NITROGEN as in the foregoing cases produces the largest in-
increase of any element, an average of 19 grams per pot. When added with all the other fertilizers, it more than tripled the yield, while in other cases it produced differences almost equally as great. Added at the rate of 2400 pounds of dried blood to an acre - 15 grams per pot - it produced its largest yield. See photograph, page 43.

PHOSPHORUS produced an average increase of 2.4 grams per pot. This increase was produced chiefly after nitrogen had been added. Pot 3 produced practically as much as any pot in the subseries. In pot 3 phosphorus was added at the rate of 320 pounds of acidulated bone meal to an acre - 2 grams per pot.

POTASSIUM is of no known benefit. Pot 1, which received potassium sulfate at the rate of 32 pounds to an acre, produced the largest yield. In the regular (A-L) series, potassium produced an average decrease of .3 grams per pot.

FINAL CONCLUSIONS.

For the growing of general farm crops it is indeed questionable whether lime would prove profitable; nitrogen is doubtless of great value, particularly in the growing of millet, for which crop is required about twice the application of dried blood that is required for wheat; phosphorus is of some value in almost all cases, but probably profitable only when the deficiency of nitrogen has been supplied, for in such cases the increase due to phosphorus was always greater than where no nitrogen had been added; potassium can not be said to be of any particular value to either wheat or millet, and to add it to the soils investigated in this work would certainly be an economic loss.

The above results also indicate that the black clay loam, which
The plants were grown under controlled conditions. All pots received equal amounts of light, moisture, and nutrients in the form of various mineral concentrations. The plants were observed regularly for growth and development.
has a very black surface soil three feet deep, is increased in productive capacity by the addition of nitrogen, as much as the brown silt loam.

In rational farming the best method of treating these soils would probably be that of adding nitrogen and organic matter by pasturing leguminous crops or by turning them under green, and by making liberal use of farm manures, to which may have been added some ground phosphate rock or ground steamed bone meal. Whether the elements, lime, phosphorus, and potassium may profitably be added, should be determined by plot experiments. Until it has been proved that any of these elements can be added with profit, it would be considered unwise to add them to the entire area comprising the soils investigated.
APPENDIX.

Acidity of Pot Culture Soils.

An acidity test of the soils used for pot cultures was made by the method recently adopted by the Illinois Experiment Station. This test showed that the soils were but slightly acid. The upland requires but 222.18 pounds and the lowland but 96.6 pounds of ground lime stone (CaCO₃), to an acre, to entirely correct the acidity.

Chemical Composition of Fertilizers used in Pot Cultures.

Nitrogen in dried blood 13.33 percent.
Phosphorus in acidulated bone meal 10 percent.
Potassium in potassium sulfate 42.6 percent.