POTASSIUM

WHEN TO USE IT
WHERE TO USE IT
HOW TO USE IT

ON ILLINOIS SOILS

CIRCULAR 765, UNIVERSITY OF ILLINOIS, COLLEGE OF AGRICULTURE, EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS
Potassium — An Important Member of the Soil-Fertility Team

Potassium is one member of the soil-fertility team that has not been getting the attention it deserves. One reason is that methods of testing large acreages for available potassium were not developed until a few years ago. Then, too, it is only recently that high-analysis potash fertilizers, such as muriate of potash, have been widely available. Until a few years ago most of the potassium used was in mixed fertilizers carrying a low percentage of potassium so that often the amount of this plant food applied was far short of what the soil needed.

The purpose of this circular is to point out the value of potassium on soils that are lacking in this plant food and to offer you suggestions for using it efficiently.

It must be remembered, however, that applying potassium is only one part of a balanced soil-fertility program. Taking care of the potassium needs of the soil will not do much good if something else is short. Besides potassium, the soil must have plenty of lime, phosphate, nitrogen, and other plant foods; it must have a supply of active organic matter; and it must have good tilth. Good soil management also calls for a suitable crop rotation, including plenty of legumes; necessary erosion-control measures; and adequate drainage.

The Role of Potassium in Crop Production

Why do plants need potassium? Potassium, like nitrogen, phosphorus, and other plant foods, has an essential part to play in the growth of plants. Exactly how potassium works in the plant, however, is not well known. It seems to be needed for the production of starches and protein and for changing these materials to a form that can be moved within the plant. Potassium is considered important in the functioning of the cells and in maintaining a favorable acid-base balance; and it is believed to be essential in the development of chlorophyll, the green coloring matter in plants.

Potassium apparently does not combine permanently with other plant foods as part of the plant tissue. After the crop is mature, some of the potassium may be lost from the plant by leaching from the leaves and stems and by moving down into the roots and out into the soil.

How much potassium do plants use? From the illustration at the bottom of this page you can see how much potassium is used for given yields of different crops, as well as the distribution of potassium between the grain and the straw or stalks. Except for soybeans, about one-fourth of the potassium is found in the grain and three-fourths in the stalks or straw. Where the stalks are left on the field, most of the potassium is there to be used again. With soybeans, however, most of the potassium is in the grain, and it is sold from the farm when the beans are sold.

Legumes, such as alfalfa, clovers, and lespedezas, feed heavily on potassium. A 3-ton crop uses about 90 pounds of potassium or 108 pounds of potassium oxide. This is as much as is contained in 180 pounds of muriate of potash (60 percent). If the legumes are fed on the farm and good care

Amounts of Potassium in Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Potassium in Grain</th>
<th>Potassium in Stalks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (60-bushel crop)</td>
<td>16 lb.</td>
<td>46 lb.</td>
<td>62 lb.</td>
</tr>
<tr>
<td>Soybeans (30-bushel crop)</td>
<td>29 lb.</td>
<td>18 lb.</td>
<td>47 lb.</td>
</tr>
<tr>
<td>Oats (60-bushel crop)</td>
<td>9 lb.</td>
<td>26 lb.</td>
<td>35 lb.</td>
</tr>
<tr>
<td>Clover (3-ton crop)</td>
<td>88 lb.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
is taken of the manure to avoid losses, much of this potassium can be returned to the soil. This is not so, however, if the legume crop is sold.

Weeds crowd out legumes where potassium is low. Although legumes take up more potassium than most other crops, grass and weeds will take up twice as much as the legumes, according to experiments at the New Jersey Experiment Station. Furthermore, weeds and grass are stronger feeders than the legumes—that is, they are able to get enough potassium to survive on soils where alfalfa and other legumes would starve for potassium. So weeds and grass can soon crowd out the legume crop on soils low in potassium.

Crop needs not basis for applying potassium. Although the figures on page 2 show the amounts of potassium required by different crops, they should not be used as the basis for applying potassium fertilizers. Potassium should be applied according to the results of soil tests rather than to the requirements of a particular crop.

What Is the Difference Between Potassium and Potash?

Much confusion exists between these two terms. Actually potassium is the element that the test measures, the plants use, and the farmer pays for. However, the fertilizer industry gives the potassium content of fertilizers in terms of potassium oxide, commonly called "potash," although this compound itself is not actually present in potash fertilizers.

Potassium oxide is a compound made up of two parts of potassium (K) and one part of oxygen (O). The chemical symbol is K₂O. Potassium makes up 83 percent of potassium oxide, so to convert potassium oxide (potash) to the element potassium, you multiply the pounds or percentage of potassium oxide in the fertilizer by 83 percent. For example, to find the potassium content of 0-0-60 you would multiply 60 percent by 83 percent, which gives approximately 50 percent.

A good deal of the existing confusion could be avoided if the potassium content of fertilizers were given as potassium instead of potassium oxide.
Many Illinois Soils Need Potassium

At present about 9 million acres in Illinois, or 37 percent of the land, needs potassium. It would take about 1¼ million tons of muriate of potash (0-0-60) to supply enough potassium for a four-year rotation on these soils.

The shortage of potassium is often so severe that crops show definite symptoms of starvation. These signs are likely to show up first on corn, as it is one of the crops most sensitive to a shortage of potassium.

But don't wait about applying potassium until the starvation symptoms show up in your crops. If you do, you will be waiting 10 or 15 years too long. Starvation symptoms do not appear until a shortage of potassium has become severe enough to sharply reduce crop yields. By then losses have been occurring for many years. Soil tests will show you the need for potassium before symptoms appear and serious losses occur.

Southern Illinois soils are especially likely to be low in available potassium. Many of them cannot supply enough potassium for more than half a crop even though an otherwise good management program has been followed.

While the need for potassium is not so widespread in central and northern Illinois as in southern Illinois, lack of potassium is seriously reducing crop yields on many farms. Peat, alkali, and "shelly" soils, in particular, usually need potassium.

Farms that need potassium may be found next to farms that are high in potassium. Even on the same farm, one or more fields may be low while the other fields are high. The only way to make sure of the potassium situation on your farm is to test all fields systematically.

Soil Tests Show Potassium Needs

Don't depend on guesswork when applying potassium. Have your soil tested; then take time to study the results and recommendations so that you will know where potassium is needed and how much is needed to the acre. That way you can go out and buy what your soil needs instead of spending your money on fertilizers that may not do the job.

A soil-testing service is conveniently available to every farmer in the state. There are more than 80 county and regional Extension laboratories under the supervision of the county farm advisers. In addition, there are a number of commercial laboratories. All these laboratories test for lime and phosphorus as well as for potassium.

What the Potassium Test Tells About Your Soil

<table>
<thead>
<tr>
<th>Very Low Test</th>
<th>Low Test</th>
<th>Slight Test</th>
<th>Medium Test</th>
<th>High Test</th>
<th>Very High Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>400</td>
<td>300</td>
<td>200</td>
<td>125</td>
<td>0</td>
</tr>
</tbody>
</table>

Pounds of 0-0-60 needed per acre
Potassium Made This Difference on a Soil Testing Very Low in Available Potassium

<table>
<thead>
<tr>
<th>LIME, ROCK PHOSPHATE</th>
<th>LIME, ROCK PHOSPHATE, PLUS POTASH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALFALFA-CLOVER</td>
<td>3000 lb.</td>
</tr>
<tr>
<td>CORN</td>
<td>36 bu.</td>
</tr>
<tr>
<td>SOYBEANS</td>
<td>15 bu.</td>
</tr>
<tr>
<td>WHEAT</td>
<td>29 bu.</td>
</tr>
</tbody>
</table>

What Does the Potassium Test Mean?

The potassium test measures the amount of potassium that is available to crops in an acre of surface soil. Laboratories vary in the method they use for reporting the results. Some give the actual pounds of available potassium per acre. Others report the test as very low (VL), low (L), slight (S), medium (M), medium plus (M+), high (H), or very high (VH).

Soils testing very low (VL) and low (L). A test reading of very low indicates that the soil contains 40 to 60 pounds of available potassium per acre of surface soil. Soils testing low contain from 61 to 90 pounds of potassium.

Alfalfa and clover will usually fail even if the soil is well supplied with lime and phosphorus; or if they do survive, yields will be low and quality poor. Corn will usually show symptoms of severe potassium starvation and will produce only a low yield of poor-quality grain. Cornstalks are weak and will often break over. Even soybeans and small grains suffer severely. The losses in crop yields on soils testing very low in available potassium are shown by the results on the Toledo Soil Experiment Field (above).

Soils testing very low require 500 pounds of 60-percent muriate of potash for a four-year rotation, and soils testing low need 400 pounds.

Soils testing slight (S) contain from 91 to 120 pounds of available potassium per acre. Such soils will, of course, produce better crops than low-testing soils, but potash fertilizer is necessary for good yields. These soils need 300 pounds of muriate of potash for a four-year rotation.

Soils testing medium (M) have from 121 to 150 pounds of available potassium per acre. They need 200 pounds of muriate of potash for a four-year rotation.

Soils testing medium plus (M+) or high (H). Soils testing medium plus contain 151 to 180 pounds of available potassium and need 150 pounds of muriate of potash per acre for a four-year rotation. A high-testing soil contains 181 to 200 pounds of available potassium and needs 125 pounds of muriate of potash.

Where extra high yields are expected on soils testing medium plus to high, additional potash may be needed. The amounts recommended for the rotation can be increased by 100 to 150 pounds.

Soils testing very high (VH) contain more than 200 pounds of available potassium per acre. They supply enough potassium for good crop yields. For extra high yields of corn or legumes, 100 pounds of 0-0-60 may be needed.
How to Use Your Soil Test Report

Very often soil samples from different parts of a field will show wide variations in potassium content. Suppose, for example, that you have a 40-acre field which has been tested for potassium with the following results:

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Results of test</th>
<th>Pounds of muriate of potash (0-0-60) needed for 4-year rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medium (M)</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>Slight (S)</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>Medium (M)</td>
<td>200</td>
</tr>
<tr>
<td>4</td>
<td>Low (L)</td>
<td>400</td>
</tr>
<tr>
<td>5</td>
<td>Very low (VL)</td>
<td>500</td>
</tr>
<tr>
<td>6</td>
<td>Very Low (VL)</td>
<td>500</td>
</tr>
<tr>
<td>7</td>
<td>Low (L)</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>Very High (VH)</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>Slight (S)</td>
<td>300</td>
</tr>
<tr>
<td>10</td>
<td>Very Low (VL)</td>
<td>500</td>
</tr>
<tr>
<td>11</td>
<td>Low (L)</td>
<td>400</td>
</tr>
</tbody>
</table>

While the potassium tests do not vary as much for this field as for many others, there is considerable difference between samples. So you have the problem of deciding how much potassium to apply to different parts of the field, so that you can meet the potassium needs of the soil and still keep the method of applying practical. Can you average the recommended amounts and apply this average over the entire field? To do this wouldn’t be very efficient. The average amount of 336 pounds would be considerably more than needed on some parts of the field, and too little for other parts.

Here is where a map of the field showing the location of the various soil samples comes in. With such a map you can get a better understanding of the potassium needs of the field and how much to apply to each part. On the map shown at the top of this page, the test results are given at the right of the sample numbers.

The area represented by sample 8 does not need any potassium. Previous experience and observation will tell whether this area is only a few square rods or several acres in size. If it is very small, then the most practical thing would be to treat it like the surrounding areas. However, if it is several acres, it could be skipped. This could mean a saving of $40 or $50 in your potassium bill for one rotation.

Samples 4, 5, 6, 7, 10, and 11 all test low or very low, showing a need for 400 to 500 pounds of muriate of potash for a four-year rotation. These amounts are close enough that the average amount of 450 pounds could be applied to the whole area represented by these samples.

The area represented by sample 9 needs only 300 pounds, but if changing the rate of application does not seem practical, the area can be included with that getting 450 pounds.

Samples 1, 2, and 3 test somewhat higher than most of the rest of the field. The need is for 200 to 300 pounds of muriate of potash per acre. An average amount of 250 pounds could be applied to this entire area.
Where and When to Apply Potassium

The soil test tells you how much muriate of potash you need to build up the potassium supply of the soil, not how much to apply to each crop. But you will get the most efficient use of this fertilizer — at least until the potassium level of the soil is built up — if you apply it ahead of the crops which suffer most from a shortage of potassium. Since corn and legumes are most sensitive to a potassium shortage, it is a good plan to apply most (or even all) of the potash fertilizer ahead of one or both of these crops.

If a field needs less than 200 pounds of muriate of potash, the entire amount can be applied ahead of either the corn or legumes. However, if your spreader will handle as little as 100 pounds, you can divide the application between these two crops.

If a field needs more than 200 pounds of muriate of potash, the total amount should be divided into two or more applications. There are two reasons for splitting the heavier amounts. In the first place, crops will use more potassium than they need if a surplus is available. This is called "luxury" feeding. Secondly, potassium loses some of its availability after it is mixed with the soil. This is because some of the potassium moves into the "storehouse" inside the clay particles (page 12). So if 300 pounds of muriate of potash is applied ahead of the legume, this crop will use more than it actually needs, leaving less for the other crops, and that which is left will be less available.

There is no hard-and-fast rule for dividing the muriate of potash during a four-year rotation. Sometimes as many as four applications may be advisable. However, any added effectiveness from the smaller, more frequent applications must be balanced against the extra time and cost of making them.

At any rate, if much more than 200 pounds and less than 400 pounds of muriate of potash is required, you should divide it into at least two applications — one for corn and one for the legume.

Where 400 to 500 pounds is needed for a four-year rotation, you may find it worthwhile to divide this amount into three applications. One part might be applied ahead of corn, another ahead of small grain, and the rest top-dressed on the legume.

Of course, if potassium is deficient on all fields included in the rotation, and if a potassium fertilizer has not been used previously, some should be applied to every field to start with.

Don't Short-Change the Soil on Potassium

These three plots during a 17-year period received lime and —

- No potassium
- 4250 lb. 3-12-12 carrying 423 lb. potassium
- Phosphate and 1400 lb. 0-0-60 carrying 700 lb. potassium

If you apply a mixed fertilizer, be sure you use enough to supply the amount of 0-0-60 called for by the soil test. One plot at the Toledo Soil Experiment Field received 250 pounds of 3-12-12 a year (the equivalent in potassium of 50 pounds of 0-0-60). After 17 years (and 4,250 pounds of fertilizer), the soil tested very low in available potassium — the same as a plot receiving no potassium at all. The plot that received 82.4 pounds of 0-0-60 a year (1,400 pounds during the 17 years) tested medium plus. See pages 10 and 11 for information on the amounts of 0-0-60 in different mixed fertilizers.
How to Apply Muriate of Potash

Muriate of potash can either be broadcast or applied through a fertilizer attachment on a grain drill or corn planter. On “peat” or “alkali” spots hill dropping or drilling will probably give better results than broadcasting.

Any equipment used to apply a potassium fertilizer should be thoroughly washed out to prevent rusting.

Hill dropping or drilling requires caution. Too much muriate of potash applied with a grain drill or corn planter at planting time may injure the germinating seed. Not more than 80 pounds per acre of muriate of potash should be drilled in the row with small grain, and not more than 60 pounds hill-dropped with corn. About 125 pounds of muriate of potash can be drilled along the row with corn. (Be sure, when you apply these amounts, that the planter is not dropping fertilizer on top of the seed.) Muriate of potash should not be drilled in contact with soybean seed.

Broadcasting is a safe, convenient method. The easiest and safest way of applying muriate of potash is to broadcast it. The coarse, granular grade can be broadcast quickly and easily through an endgate oat seeder or fan type lime spreader. A regular fertilizer spreader can, of course, be used to broadcast either the granular or the standard grade of muriate of potash.

Even with heavy applications, broadcasting will not retard or damage germination. Also, muriate of potash can be broadcast on growing wheat, legumes, and other crops without damage if the leaves are dry. If the leaves are wet with rain or dew, some of the potash salt will stick to them and may cause burning. However, the principal danger from potash comes when too much is applied near the seed.

If you cannot conveniently apply potash ahead of wheat where legumes are to be seeded, you can broadcast it on the growing wheat any time during the fall, winter, or early spring. Potash can also be spread on alfalfa or clover. It is better applied ahead of the seeding, however, since the potash may save the loss of the seeding or at least give a better stand.

Planning a Long-Time Program for Potassium Treatment

The plan to be followed in a long-time treatment program will, of course, vary with different conditions. As we have seen, one field on a farm may test high while others test low, and even the same field may show wide variations in the amount of potassium needed. We have also seen that you can divide your applications during the rotation in a number of different ways.
POTASSIUM-TREATMENT PLAN
FOR FIELD TESTING LOW
1st year — Oats with alfalfa seeding
Broadcast 200 pounds of 0-0-60
2nd year — Alfalfa
3rd year — Corn
Broadcast 200 pounds of 0-0-60
4th year — Soybeans
5th year — Oats with alfalfa seeding
Broadcast 200 pounds of 0-0-60
6th year — Alfalfa
7th year — Corn
Broadcast 200 pounds of 0-0-60
8th year — Soybeans
After two rounds of the rotation (8 years) have soil
tested again and apply the amounts of 0-0-60 called
for by the new tests. Continue these amounts for
two more rotations; then have another soil test.

The important thing is to follow through on a
program that will give your soil all the potassium
it needs. After you have your soil tested, you
should apply the required amounts for two rota­
tions; then test the soil again.

A variety of plans is possible. Some of the
possible variations in time and method of applying
potassium have already been discussed. For the
sake of further example, let us assume that you
have a field which has tested uniformly low in
potassium and needs 400 pounds of 0-0-60 for a
four-year rotation. We will assume that the soil
already contains plenty of limestone and phos­
phorus. The rotation is corn — soybeans — oats —
alfalfa.

Assuming that the potash treatment will start
the year that the field is to be sown to oats with
an alfalfa seeding, you could broadcast half the
total amount, or 200 pounds, ahead of the oats.
This would also take care of the alfalfa crop
during the second year. The other 200 pounds
could be broadcast ahead of the corn, and would
take care of the soybean requirements as well as
the corn. The same plan would be followed for
the next four years.

A number of other plans would work as well.
The 400-pound requirement could be divided into
four applications of 100 pounds a year, or into
three applications, with 200 pounds applied ahead
of oats and alfalfa, 100 pounds top-dressed on
alfalfa, and 100 pounds applied ahead of corn.
(If a second corn crop were substituted for the
soybeans, 200 pounds could be applied ahead of
the oats and alfalfa seeding, 100 pounds applied
ahead of first-year corn, and 100 pounds applied
ahead of second-year corn.)

Another possibility for the corn-soybeans-oats­
alfalfa rotation would be to apply part of the
potash fertilizer with the corn planter. About 60
pounds of 0-0-60 could be hill-dropped or about
125 pounds drilled along the row. Also, the potash
could be applied in 0-10-30 at the rate of about
100 pounds hill-dropped or about 200 pounds
drilled along the row. However, if the potash for
corn is applied in the hill or row another broad­
cast application would be needed for soybeans,
and a third application for the alfalfa seeding.

Two hundred pounds of 0-10-30 drilled along
the row with corn would be equivalent to 100
pounds of muriate of potash. This would leave
300 pounds of 0-0-60 to be applied for the rest of
the rotation. Of this, 100 pounds might be applied
broadcast for the soybeans and 200 pounds for the
alfalfa seeding.

Test soil every six or eight years. Applying a
potassium fertilizer for one or even two rotations
will not necessarily bring the potassium supply in
your soil to a satisfactory level. You may need to
apply the recommended amounts for several rota­
tions before the soil tests will show that the
amount can be reduced. So test your soil for
potassium every six to eight years. The tests will
tell whether you should continue to apply the
same amounts as in previous years, or whether
you can cut down your applications. Even after
you build up the potassium supply in your soil, you
will need to continue applying some potassium
in order to maintain a good supply.
Kinds of Potassium Fertilizers

You can buy potassium either in a straight fertilizer such as muriate of potash, or in a mixed fertilizer. Since the percent of potassium varies with different fertilizers, it is important to know how much each contains and how much the potassium costs. It is not the number of bags of fertilizer you apply or even how many dollars you spend that counts. The important thing is the actual pounds of potassium and other plant foods that you apply to the acre.

Muriate of potash. Most of the potassium used in Illinois is in the form of muriate of potash, which is the common name for potassium chloride. Not only does it supply almost all the potassium in mixed fertilizers, but it is also the most common straight potash fertilizer sold.

There are two grades of muriate of potash, one carrying 50 percent of potash, and the other 60 percent. Most of that now on the market is 60 percent. Two grades of fineness are also available. The finer material is known as the regular grade. The coarser is called the granular grade. This grade is especially convenient for handling and spreading with a fan type spreader.

The rapid increase in demand for muriate of potash is no doubt due to the fact that it carries a high analysis of potash (potassium oxide) at a relatively low cost. Muriate of potash is now selling below prewar prices. Another advantage of muriate of potash is that you can apply the amount of potassium your soil tests call for without also having to apply phosphorus and nitrogen — which the soil may not need at all or may need in different amounts than those supplied by a mixed fertilizer.

In many localities you can buy muriate of potash in bulk and hire it trucked and spread at a reasonable charge. This saves the hard labor of lifting and carrying the 80- or 100-pound bags.

Mixed fertilizers. Most mixed fertilizers contain some potassium, although the amounts in the different mixtures vary widely. The third figure in the analysis or “name” of a fertilizer indicates the percentage of potassium oxide or potash guaranteed by the manufacturer. (The first figure indicates the percentage of nitrogen and the second the percentage of phosphoric acid.)

A 10-10-10 fertilizer contains 10 percent of potassium oxide, and a 0-20-20 contains 20 percent, or twice as much as the 10-10-10. Sixty-percent muriate of potash (0-0-60) contains 60 percent potassium oxide or three times as much as 0-20-20 and six times as much as 10-10-10. Thus it takes 300 pounds of 0-20-20 or 600 pounds of 10-10-10 to equal the potassium in 100 pounds of 0-0-60.

As we have already seen, muriate of potash is used to supply the potassium in mixed fertilizers. For example, 20 pounds of muriate of potash (0-0-60) is put into each 100 pounds of 3-12-12 to supply the 12 pounds of potassium oxide (potash). So for each 100 pounds of 3-12-12 you apply, you add 20 pounds of muriate of potash.
A soil testing low in potassium needs for a 4-year rotation —

400 lb. of 0-0-60

or 1200 lb. of 0-20-20

or 2400 lb. of 10-10-10

To find out how many pounds of a mixed fertilizer you need to supply a given amount of 0-0-60, divide the 60 by the last number in the analysis of the mixed fertilizer. Then multiply this answer by the number of pounds of 0-0-60 needed. For example, if you need 400 pounds of 0-0-60, and you want to use 4-16-16, divide 60 by 16. Your answer is 3⅔. Multiplying 400 by 3⅔, you will need to apply 1,500 pounds of 4-16-16.

Manure contains potassium. About nine-tenths of the potassium in crops fed to animals is found in the fresh manure. A ton of cattle manure (liquid and solid), including bedding, contains about 8 pounds of potassium. Much of this potassium can be returned to the soil if the manure is handled carefully. Naturally, the more potassium you can return in manure, the less potassium you will have to buy.

It takes careful handling to save the potassium as well as the organic matter and other plant foods in manure. As a matter of fact, livestock and dairy farms may lose potassium faster than grain farms. This is largely because the liquid portion of the manure contains about 60 percent of the potassium, and this is easily lost unless floors are watertight and plenty of bedding is used to soak up the liquid. Then, of course, some of the manure is dropped along the lanes and in other places from which it does not get back to the fields. If manure is piled outside the barn for two or three months, rain will carry away much of the potassium as well as the other plant foods.

Availability of Potassium in Fertilizers

The potassium both in muriate of potash and in mixed fertilizers is water-soluble and therefore highly available to plants when first added to the soil. On all but sandy soils, however, the potassium soon changes from the water-soluble to the exchangeable form (page 12). In this form it is held on the surfaces of clay particles and soil humus. Much of the exchangeable potassium is held rather lightly, and so is still available to plants. If the soil is quite low in available potassium, some of the added potassium may be absorbed into the "storehouse" inside the clay particles (page 12) and thus become temporarily unavailable.

The change from the water-soluble form has its advantages, because it prevents loss by leaching. Only on sandy soils is there danger of much potassium being carried away by drainage water. This is because sandy soils have very little clay and humus which can grab onto and hold the potassium added in fertilizer. Large amounts of potassium should therefore not be added to sandy soils at one time.

Forms of Potassium in the Soil

In most Illinois soils the total amount of potassium will range from 20,000 to 40,000 pounds per acre of surface soil. Even so, many of our soils cannot supply enough available potassium to crops. That is because more than 95 percent of the potassium may be locked up so tightly in the soil minerals that only a few pounds become available each year.

Certain kinds of clay are the main sources of available potassium. Soils which have large amounts of these clays still have large supplies of reserve potassium from which the supply of available potassium is continually renewed. Many of these soils can supply crops with plenty of available potassium for years to come. The clays in other soils have a smaller storage capacity and much of the reserve potassium has been used up. Such soils test low in available potassium and need additions of potassium fertilizer.
There are three forms of potassium in the soil which are available to plants or can become available. These are (1) the "storehouse" (non-exchangeable) form, (2) the exchangeable form, and (3) the water-soluble form.

The storehouse form is called nonexchangeable or fixed potassium. It is held between the layers or plates that make up the clay particles. Anywhere from about 200 pounds to 1,500 pounds per acre of storehouse potassium is found in Illinois soils. The potassium stored near the outside of the clay particles can easily move out to become available either as exchangeable potassium or as water-soluble potassium.

The exchangeable form is lightly attached to the surfaces of the clay and humus in the soil. It is readily available to crops and makes up most of the soil potassium measured by the potassium test. (The other form measured by the test is in the soil solution.) The amount of exchangeable potassium in Illinois soils varies from less than 40 pounds to more than 300 pounds per acre of surface soil.

As crops remove the potassium in the soil solution, exchangeable potassium leaves the clay and moves in to renew the supply of water-soluble potassium. Plant roots may, to some extent, feed directly on the potassium held on the clay. However, they probably get most of their potassium after it moves into the soil solution.

Water-soluble potassium is found dissolved in the soil solution and is of course easily available to the crop roots. Only a few pounds of potassium is present in the soil solution at any one time. However, the supply is quickly renewed from the exchangeable potassium held on the outside of the clay.

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**Potassium Alone Is Not Enough**

When you have your soil tested for potassium, it is, of course, equally important to have tests made for lime and phosphorus. For good crop yields, all three must be added if all three are needed; and an otherwise good program of soil management must also be followed. Further information may be found in Circular 721, "Limestone, How, When, and Where to Use It," and Circular 724, "Soil Treatment Recommendations Based on Soil Tests," as well as other publications from the University of Illinois College of Agriculture.