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Can You Trust Phosphorus Soil Tests?

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MORE PHOSPHATE FERTILIZER will go onto the farms of Iowa this spring than ever before. Iowa farmers want to produce abundantly for their nation and her allies to help win the war.

Farmers are asking, “Where shall I apply phosphate fertilizer? Can I get my soil tested by a chemical means and know where to put the fertilizer to get the most returns from it?”

Those are important questions. We have done some work here at the Iowa Station to find some of the answers. We have been “testing the soil tests” to see how accurate they are. So far we have not found a chemical test that can be depended on as the only measure of whether a soil needs phosphorus fertilizer. But we think some of the tests, in the hands of the right man, who has the right knowledge, are of some value. To use these tests best a man must be familiar with the soil types, weather conditions, general cropping practices of the locality and past management of the soil.

Knowing all of this, a skilled operator may use a test to help him make recommendations about the use of fertilizer on a certain field, but even then this information should supplement knowledge gained from actual experience under similar conditions.

And so we feel that chemical tests today for phosphorus needs are not a very acceptable sole guide. We have hope that some day a more accurate and dependable test will be found.

We have been comparing the results obtained from applying fertilizer on fields that showed by the chemical test “high,” “medium” and “low” phosphorus content. These comparisons have been made in many parts of the state on a good many soil types. The comparisons have been a part of our field tests carried on in cooperation with Iowa farmers, the Iowa Station and the Iowa Agricultural Extension Service.

In these cooperative tests various plots are treated with fertilizers and other plots alongside
In this quick test, soil is mixed with acid, a tin rod is placed in the filtered solution. The depth of the blue color indicates the amount of phosphorus in the soil.

them receive no fertilizer. The field is seeded and cultivated along with the remainder of the field by the farmer who is cooperating. Some of these experiments are conducted on all of the major crops grown in Iowa.

At harvest time a representative of the college harvests and weighs the crop produced on each plot. We are trying in these tests to find out whether the chemical tests are accurate indicators of fertilizer needs, whether phosphate or other fertilizers will give profitable increases in crop yields and under what conditions they are likely to prove profitable.

Before the fertilizer is applied samples of soil are taken from various spots in the field and thoroughly mixed. These are tested by different chemical tests. When the crop is harvested we can then determine whether the actual increases, if any, are in accord with the indicated

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Comparison of Various Tests for Available Phosphorus With Response of Corn to Phosphorus Fertilization in the Field

<table>
<thead>
<tr>
<th>Soil types</th>
<th>Yield of check plots Bu. per A.</th>
<th>Response to 0-20-0 Bu. per A.</th>
<th>Lab. method Phos per A.</th>
<th>Quick Test No. 1</th>
<th>Quick Test No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckner fine sand</td>
<td>63.0</td>
<td>0</td>
<td>50</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Putnam silt loam</td>
<td>55.0</td>
<td>0</td>
<td>22</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Floyd silt loam</td>
<td>71.4</td>
<td>0</td>
<td>25</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Carrington loam</td>
<td>76.5</td>
<td>0</td>
<td>32</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Carrington loam</td>
<td>88.3</td>
<td>0</td>
<td>24</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Grundy silt loam</td>
<td>72.5</td>
<td>0</td>
<td>32</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Marion silt loam</td>
<td>66.1</td>
<td>6</td>
<td>40</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Grundy silt loam</td>
<td>63.1</td>
<td>4</td>
<td>34</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Grundy silt loam</td>
<td>69.6</td>
<td>6</td>
<td>15</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Grundy silt loam</td>
<td>70.3</td>
<td>8</td>
<td>20</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Floyd silt loam</td>
<td>57.2</td>
<td>12</td>
<td>22</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Clyde silt loam</td>
<td>58.2</td>
<td>8</td>
<td>36</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Average of six non-responding fields</td>
<td>36.4</td>
<td>Med.</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of six responding fields</td>
<td>28.4</td>
<td>Med.</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

100 lbs. per acre of 0-20-0 applied in the hill
tions of the soil needs as shown by the tests. And that is how we are “testing the soil tests.”

In 1940 about 25 of these tests were conducted in which plots of corn receiving 100 pounds of 20 percent superphosphate per acre, applied with a planter attachment, were compared with plots receiving no fertilizer. The comparison of the results of three chemical methods with the increases in corn yield are shown in the accompanying table. The laboratory method used takes considerable time and requires equipment which is not ordinarily available for routine soil testing.

The quick tests used here are more nearly comparable to the types of tests used in routine soil testing such as is done by fertilizer companies and other organizations which sometimes test soil for farmers. Quick test No. 1 makes use of a strong acid for extracting the phosphate from the soil, and quick test No. 2 uses a weak acid to dissolve the phosphate. In this table are the results from six fields which gave the greatest response to phosphate fertilizer in comparison with six fields that gave no response.

This table shows that quick test No. 1 indicated a low or medium amount of phosphorus in three fields which gave no response to phosphate. On the other hand, two fields which showed a high amount of phosphorus according to this test gave increases in yield which would have returned a nice profit over the fertilizer cost.

If the farmers who owned these 12 fields had used the soil test as the only guide in deciding whether or not to use phosphate, three men would have used phosphate without getting any return from it, and two other men would have planted their corn without phosphate when they really could have used some to advantage. This means that 5 of the 12 farmers would have received the wrong information from the soil test.

Quick test No. 2 showed all of these fields to be low in available phosphorus. It would obviously be of no value in determining fertilizer requirements on the fields studied, since it does not indicate any difference between the six fields which responded to phosphate and the six fields where phosphate did not increase the yield.

The laboratory method was evidently a little better than either of the quick tests, but it is still far from perfect. According to this test the soils which responded to phosphorus were lower, on the average, in available phosphorus than the soils which showed no response. There are several inconsistent fields in each group, however, which indicates that this method, like the quick tests, would not be entirely reliable as a guide in determining fertilizer use.

The comparison of chemical tests with field response shows that these tests alone are not a very good indication of whether or not a field needs phosphorus. However, when we stop to consider the various things that affect the yield of crops, it is not...
surprising that the tests do not give us all the information that is needed. The chemical tests may fail for one or more of the following reasons:

**Why Tests Fail**

1. The roots of the crop plants penetrate the soil to considerable depth and may feed on phosphorus in the subsoil. We have evidence indicating that the subsoil of some soil types contains much more available phosphorus than do others. Moreover, the amount in the subsoil is sometimes greater than in the surface soil. A test of samples taken from the surface of the field cannot measure, therefore, the amount of phosphorus that the plants may obtain from the subsoil.

2. Soils high in organic matter contain large amounts of phosphorus in the form of partially decomposed plant residues. None of the quick tests now used measure this phosphorus; yet when the plant residues are decomposed the phosphorus in them will become available to plants.

3. The past management of the field influences the general fertility of the soil and also the amount of phosphorus in plant residues. For instance, if a field has been manured regularly for some time, it will probably contain much phosphorus in this form. The results given in the table show that the fields which did not respond to phosphate fertilizers were generally higher yielding than those which did respond. It would seem logical from this evidence that farmers who have been practicing good soil management for some time and are now getting good yields of corn are not as likely to need phosphate fertilizers badly as are farmers who are operating low-yielding, worn-out land.

4. Different plants vary in their ability to feed on the phosphorus in the soil. Just as some animals are “easy keepers” and maintain good flesh and healthy appearance on rough feed while other animals require some grain to stay in good condition, some plants may thrive and others starve on the same soil. In the last issue of the Farm Science Reporter, A. J. Englehorn discussed experiments comparing the response to phosphorus of different plants growing on the same soil. This article emphasizes the fact that certain plants grow almost as well on unfertilized soil as on that fertilized with phosphate, while the yield of other plants growing on the same soil could be greatly increased by the use of phosphate. Therefore a knowledge of the feeding power for phosphorus of the crop to be grown is essential to properly interpret soil tests.

5. Some factor such as moisture and not the plant food content of the soil may limit the growth of the crop. In a dry season applying fertilizers is not likely to be of benefit because lack of soil moisture limits the plant growth. Also, some other nutrient in the soil may be so deficient that plants do not make enough growth to utilize even a low supply of phosphorus. Fields which have not grown legumes for a long time may be low in nitrogen and also in phosphorus. In order to get good returns from phosphate fertilizers, legumes should be grown to increase the available nitrogen and thus enable plants to make enough growth to utilize the added phosphorus. A condition of this kind, however, would not be revealed in a chemical test for phosphorus. In order to use soil tests intelligently we must first determine whether the growth of the plants is limited by factors which cannot be measured by the tests.

**Need Better Tests**

We know most soils contain much more phosphorus than is removed by one crop, and yet phosphate fertilizers very often give increased yields. Evidently only a small part of the total phosphorus in the soil is available to plants.

The problem of soil testing, then, rests on separating the small amount of phosphorus that the plant can use from the large amount of unavailable phosphorus. We must devise tests which imitate the plant root in extracting phosphorus from the soil. In order to do this we must have laboratory experiments designed to separate the phosphorus of the soil into different types of phosphorus compounds, and field and greenhouse experiments designed to measure the availability of each type to different plants.

Laboratory research of this nature may seem to be far removed from practical farm problems, yet the discovery of some new method of separating one type of phosphorus compound from others would have immense practical value in improving our methods of soil testing.

**Crops Best Single Test**

When arguments for and against soil tests are summed up, it seems that although these tests may have a limited value when used to supplement other information, they are not very reliable if used alone for determining fertilizer needs for the soil and cropping conditions of Iowa. Further research on the problems of soil testing should result in new and more reliable types of tests. As of this date we feel that fertilizer recommendations based entirely on chemical soil tests should be accepted with a “grain of salt.” The most accurate guide we know of now is to try phosphate on a small, average area of a field and compare the results carefully with the same crop on untreated soil alongside it.

In general, the greatest response to phosphate fertilizer will be obtained when they are applied to legume seedings. Soils that have been poorly managed or have lost some of their productivity through erosion or heavy cropping are more likely to need phosphorus than well managed productive soils.