A Study of Correlation Between Rapid Soil Tests and Response of Legume Hay to Phosphorus and Potassium Fertilization on Some Michigan Soils

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The reliability and usefulness of any rapid soil testing system used to determine the chemical status of soils from a fertility standpoint and to diagnose plant requirements can best be evaluated by calibration with actual crop growth under field conditions. Studies of this nature must necessarily include the response of a number of crops to fertilizers on widely varying soils and under different seasonal conditions to be of greatest value.

A number of rapid soil testing systems (1, 2, 6, 8, 9, 10, 11, 12), employing different extracting solutions and chemical techniques, have been developed by investigators in various parts of the United States. It is apparent that no single test or group of tests is regarded as best adapted for the soils and crops in all parts of the country. Differences in the form in which an element may be present in the soil and its availability to a given crop determine in large measure the nature of the rapid soil test to be used. The selection of tests for any given area entails the comparison of correlation data between plant nutrients extracted from soils and fertilizer response for one or more crops.

In this investigation, a study was made of the relation between crop response of legume hays in Michigan and soil tests for phosphorus and potassium, using four widely accepted rapid soil testing systems. The general objectives were to evaluate soil testing with respect to experimental field data, to determine if any test is superior to others, and to estimate the critical nutrient levels in soils at which crop response may or may not occur.

PLAN OF INVESTIGATION

Sixty-six fertilizer experiments were laid out in the early spring of 1946 in 36 counties in the southern half of the lower peninsula of Michigan. Sites for field plots were healthy, established stands of legume hays, primarily alfalfa, alfalfa and brome grass, or alfalfa and clover mixtures. Selection of the areas was made at random to cover a wide range of representative soils on farms where farmer cooperation for a 2-year period was assured. No data were obtained of the phosphorus or potassium status of the soils previous to the establishment of plots, but in all cases fields were chosen which had been recently limed. Approximately 80% of the soils had reaction values between pH 6.0 to 7.5, while the remainder fell slightly above or below these limits. The soils in this study include 21 series ranging from loamy sands to clay loams and in drainage from imperfectly to well-drained conditions.

Six experimental plots, 12 feet wide by 36 feet long, were laid out at each location. The treatments on an acre basis included check, 750 pounds of 0-20-0 (superphosphate), 300 pounds of 0-20-20 plus 150 pounds of magnesium, and Phosphate + Potash (PK). For the purpose of this investigation only the first treatments will be considered. There was no replication; and to facilitate ease of sampling and handling, the same experimental design was used at all locations.

Composite surface soil samples, 0 to 6 inches, consisting of 18 auger borings, were taken from individual plots at each location. A single, composite subsoil sample was obtained from the check plot. Fertilizers were then topdressed by hand and all plots were visited at least once before harvest to determine growth and deficiency symptoms. The relation between tissue tests and plant starvation signs from these experiments were reported elsewhere.

Yields of first cutting hay were obtained from 66 locations in 1946 and 55 sites in 1947, and second cutting yields were obtained on about 90% of the locations in 1946. All farms were harvested from one-half of each plot. Yields of the hay were weighed in the field and a composite moisture sample was taken at each location to calculate dry matter yields. The composition of the hay was estimated as a percentage of the amount of legume to grass and weeds.

Soil samples were prepared for analysis by air drying and sieving through a 2-mm screen. “Available” phosphorus was determined by the methods of Bray (2), Peech and English (10), and Spurway (11). The reagents and procedures for the Bray and Spurway tests as used were somewhat different from the methods cited.

RESULTS AND DISCUSSION

CROP RESPONSE TO FERTILIZER APPLICATION

The average yields for first cutting hay in 1946 for treatments from all locations are given in Table 1. It is apparent that phosphorus was the nutrient most needed on the soils studied. The response of legume hay to potash alone was small; but when it was applied in combination with phosphate, the average yield increase in 1946 was more than 55% per acre. The following year hay yields from the check and treated plots were similar to those obtained in 1946.

A more valid picture of the yield results and the crop response to either phosphorus or potash, or a combination of the two elements can be seen in Table 2. In 56 to 58 out of 66 experiments the results of the yield data are given in Table 2. In 56 to 58 out of 66 experiments the results of the yield data are given in Table 2.

Table 1.—Average yield of first cutting hay for fertilizer treatments over a 2-year period.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1946* Dry matter yield in tons</th>
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<tbody>
<tr>
<td>Check (Ck)</td>
<td>1.75</td>
</tr>
<tr>
<td>Phosphate (P)</td>
<td>2.33</td>
</tr>
<tr>
<td>Potash (K)</td>
<td>1.86</td>
</tr>
<tr>
<td>Phosphate+potash (PK)</td>
<td>2.65</td>
</tr>
</tbody>
</table>

*1946 yield data is given for all locations.