A STUDY OF THE AVAILABLE PHOSPHORUS
STATUS OF SOILS BY PHOSPHORUS-DEFICIENT
TOMATO SEEDLINGS

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Certain plants manifest characteristic phosphorus deficiency symptoms when grown in media low in available phosphorus and the symptoms disappear when supply of available P is restored. Little effort has been made to utilize this fact to assess quantitatively the phosphorus fertility status of soils.

Anthocyanin pigments are known to be formed in many plants when the supply of phosphorus is reduced; they disappear as adequate amounts of phosphorus are present in the soil. The biochemical steps leading to the formation of anthocyanin in phosphorus deficient plants are not clearly understood, but it is known that anthocyanin formation results from metabolic changes in the cell. In the present investigation the change in concentration of anthocyanin pigments during recovery from phosphorus starvation was taken as a measure to predict the phosphorus status of soils. In addition to the measurements of anthocyanin concentration, analyses for chlorophyll and total phosphorus were also undertaken.

TECHNIQUE

The tomato plant (Lycopersicum esculentum Mill.) which shows characteristic phosphorus deficiency symptoms and can be easily grown in the greenhouse was selected as indicator plant. Two early varieties were used in the present study and no difference due to variety was observed.

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The seeds were germinated in sand using distilled water to supply moisture. After emergence of the cotyledonary leaves, a 1 : 1 dilute Hoagland nutrient solution devoid of phosphorus was used to irrigate the medium (KH$_2$PO$_4$ was replaced by KCl). After proliferation of the first leaves, minus-phosphorus Hoagland solution of normal concentration was used to supply elements other than phosphorus.

Depending upon the season of year, the time required for the appearance of phosphorus deficiency symptoms varied considerably. Therefore, by selecting seedlings of the same stage of development or physiological age for transplanting to soils, the data from several experiments could be compared. The first symptoms of phosphorus deficiency were the appearance of purple (anthocyanin) colour in the leaves and stems plus a marked retardation in growth rate. It was followed by deepening of the anthocyanin colour and arresting of the growth processes. As the phosphorus deficiency progressed the leaves appeared pale green or yellowish-green, and the pair of cotyledonary leaves turned yellow and dropped off. In the present study, this physiological period has been termed the critical stage of phosphorus deficiency, at which time the tomato seedlings were transplanted to soils. It took from 3 to 7 weeks for the appearance of the symptoms associated with the critical phosphorus deficiency.

Soils used in the present study were collected from the plow layer of various field experiments conducted by the Agronomy Department. The soil samples were dried and mixed, screened through a 4-mm sieve, and stored until ready for use.

Glazed pots containing 800 grams of the mineral soils or 500 grams of the organic soils were used for growing the test plants. Nutrients other than phosphorus were added to all soils at the rates indicated in Table I. Four levels of phosphorus were added — 0, 75, 150, and

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\text{TABLE I}
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<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Chemicals used</th>
<th>Pounds per acre *)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NH$_4$NO$_3$</td>
<td>200</td>
</tr>
<tr>
<td>Mg</td>
<td>MgSO$_4$.7H$_2$O</td>
<td>23</td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>K</td>
<td>KCl and/or KH$_2$PO$_4$</td>
<td>165</td>
</tr>
</tbody>
</table>

*) Based on 2,000,000 lbs. of soil.