A STUDY OF TECHNIQUES FOR PREDICTING POTASSIUM AND BORON REQUIREMENTS FOR ALFALFA: II. INFLUENCE OF BORAX ON DEFICIENCY SYMPTOMS AND THE BORON CONTENT OF THE PLANT AND SOIL

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SYMPTOMS of boron deficiency have been observed on alfalfa in New York in some seasons and on some fields by Colwell (2) and by Gustafson (5). Since many fields are not deficient in boron for alfalfa production, the question arises how this deficiency can be predicted in a particular field, or how the extent of deficiency in a large area can be economically determined. In this investigation chemical determination of the boron content of soils and alfalfa, biological determination of the boron content of soils, and symptoms of boron deficiency were studied for these purposes.

PLAN OF THE INVESTIGATION

The plan of the investigation was to determine by means of field experiments whether accurate predictions of boron deficiency could be made by the methods selected. These experiments were established on soils ranging in texture from sandy and gravelly loams to clays and in pH from 5.3 to 7.7. Additional information about these experiments has been presented by Chandler, Peech, and Bradfield (1).

Alfalfa yields were determined on most of these experiments in the spring and fall of 1943, 1944, and 1945. The percentage of stems showing symptoms of boron deficiency was determined on each of these experiments in the fall of 1943 and in the spring and fall of 1944 and 1945.

Soil samples were taken in the fall of 1942 before any fertilizer was applied. Additional samples were taken in the spring of 1943 and at the time of the second cutting of the alfalfa in 1943, 1944, and 1945. Water-soluble boron was determined by the Naftel (6) method on all of these samples. Biologically available boron was determined by the Colwell method (2, 3) on the samples taken in the fall of 1942.

Samples of alfalfa hay were taken from the second cutting in 1943 and from both cuttings in 1944 and 1945. Total boron was determined on all of these samples by the Naftel (6) method.

RESULTS

ALFALFA YIELDS AND SYMPTOMS OF BORON DEFICIENCY

The data on yields of alfalfa presented by Chandler, Peech, and Bradfield (1) and by Dawson (4) show that significant yield responses were seldom obtained from applications of borax to the surface of soils that supported good stands of alfalfa. Symptoms of boron deficiency were observed in some seasons on some soils, and their appearance was prevented in every case by the application of borax. Fig. 1 shows the fields on which more than 1% of the stems showed symptoms of boron deficiency as a percentage of the total number of fields observed. The data presented in Fig. 1, combined with the yield data, indicate that symptoms of boron deficiency appeared for feed, deficiency symptoms should be used as the criterion of insufficient boron. Recognition of this criterion should enable farmers to maintain a boron supply in the soil at such a level that boron would not seriously limit plant growth. For this reason symptoms of boron deficiency, rather than yield responses, are used as the field criterion for inadequate supply of boron.

BORON CONTENT OF ALFALFA AND OF SOILS

Water-soluble boron in the surface 6 inches and total boron in alfalfa were increased in every case by the application of borax. Water-soluble boron had not increased as much as it would have been if all of the boron in the applied borax had remained in the water-soluble form in the surface 6 inches of soil. The observed increases from applications of 40 pounds of borax per acre varied between 0.1 and 2.0 grams of boron per gram of soil and increased approximately linearly with pH in the range of 5.3 to pH 7.7.

A quadrant frequency distribution of total boron in alfalfa as a function of water-soluble boron is presented in Fig. 2. The tetrachoric correlation (7) ± the probable error (8) from these data with dichotomic lines at 20 micrograms of boron per gram of oven-dry alfalfa and 0.35 microgram of water-soluble boron per gram of air-dry soil is 0.84 ± 0.03.

The distribution of points within the two

<table>
<thead>
<tr>
<th>Time (Months)</th>
<th>Boron deficient fields (per cent of total number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>24</td>
<td>30</td>
</tr>
</tbody>
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Fig. 1.—Fields on which alfalfa showed symptoms of boron deficiency as function of time after borax application.