SHORT COMMUNICATION

The Influence of Boron and Copper Deficiency upon Infection by *Erysiphe graminis* D.C., the Powdery Mildew, in wheat var. Kenya

Introduction

While the influence of micronutrients upon the susceptibility or resistance of a host plant to fungal infections has not been studied extensively, plant pathology texts do draw attention to these relationships, as do more specialised works on micronutrients. Forsyth's work clearly shows that rust resistance can be very complex and that even non-nutrients such as DDT can increase the susceptibility of resistant varieties. As long ago as 1930, Eaton reported upon the influence of boron deficiency upon the resistance of barley to the obligate parasite *Erysiphe graminis*. In the absence of boron, infection was extremely severe. No information regarding the action of copper appears to exist, although the addition of manganese to the soil significantly reduces the rate of infection. In South Africa, *E. graminis* has been reported extensively, but it is not of common occurrence, being mainly found infecting wheat and barley on irrigated lands.

Experimental

An unheated glasshouse filled with sand-culture experiments involving wheat var. Kenya became infected with *E. graminis* D. C. The source of the infection could not be traced, but it is presumed that the spores were air borne, and all the wheat plants became infected eventually, the fungus being readily identifiable by its vegetative characteristics, especially its large oidiospores.

The infection was associated with very changeable weather, warm days alternating with periods of sudden severe cold. The fungus spread rapidly over all the boron-deficient plants, less rapidly over copper, molybdenum and manganese-deficient ones and slowly over the controls which received full-balanced mineral nutrition.

One group of plants was strictly comparable. These were plants of wheat grown in sand culture at the rate of three per 14-cm. pot. They were irrigated with a modified Robbins solution, the deficient cultures lacking only this specific element. The plants were allowed to grow to full ear, which took a period of 14 weeks in the case of the control.
This group of strictly comparable plants contained controls, boron-deficient and copper-deficient plants, which became infected at 12 weeks of age. The difference in the severity of the infection is clearly demonstrated in Table 1 where the degree of fungal infection is subjectively assessed by three independent observers.

**TABLE 1**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Subjective rating</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Observer I</td>
<td>Observer II</td>
<td>Observer III</td>
<td>Av.</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Copper deficient</td>
<td>9</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Boron deficient</td>
<td>19</td>
<td>16</td>
<td>20</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

Subjective-rating scale — 0 (no visible infection) to 20 (very heavy general infection). Using the $\chi^2$ test, these results are found to be highly significant. The difference between the control and — B plants is significant at the 0.001% level, while between the control and — Cu at the 0.01% level.

As well as a marked difference in the degree of infection, there is also a pronounced difference in its manner. Boron-deficient plants showed severe infection of the stem, leaf sheath and the leaf blade; the lesions on copper-deficient plants were mainly situated upon the leaf blades and to a slight extent on the leaf sheath. In the controls, the stems showed the first lesions. No reason can be deduced for this.

**Discussion**

In this small scale investigation, it could be clearly shown that in wheat var. Kenya, the micronutrient status of the host plant is a very important factor in determining its response to mildew infection. Wolfe in a comprehensive investigation into the physiological specialization of *Erysiphe graminis* in Britain notes that in some species of wheat, such as Halle Stamm 14/44, the degree of infection by mildew is increased in conditions unfavourable to the development of the host and so did not make it a very satisfactory test plant for his researches, but he found Kenya so variable in this respect, that he disregarded all his data obtained from this variety in his survey.

The degree of infection of Kenya may be a good indication of soil conditions. Resistance to infection may be nutritionally as well as genetically determined. *Erysiphe cockerelliae* var. D.C.² growing on sunflower is used as an indicator of boron deficiency in soils in parts of America.