Barley production and soil acidity

P J. Dolling
W. M. Porter

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One of the causes of reduced plant yields on acid soils is aluminium toxicity. Because barley is extremely sensitive to this mineral, a project started last year to examine the influence of soil acidity on barley production in the main barley growing areas of Western Australia.

This article discusses some background information on the project and its aims.

Barley production

In the 1982-83 season Western Australian farmers grew 715,000 tonnes of barley. Table 1 shows the statistical divisions of the State which produce a significant amount of barley.

The shires with most farm land sown to barley were Gnowangerup, Jerramungup and Kent in the Lower Great Southern, Lake Grace in the Upper Great Southern, Lake Grace in the Upper Great Southern and Esperance and Ravensthorpe in the South-Eastern.

The effect of soil acidity on barley

Crops vary greatly in their tolerance of soil acidity. The reason for this variation is complex because there are many components of soil acidity. They include aluminium and manganese toxicities and nitrogen, phosphorus, molybdenum, calcium and magnesium deficiencies.

The component or components which reduce plant growth vary between soils and areas. The sensitivity of barley relative to other crops is only known for some of them.

One of these components is aluminium toxicity which is caused by very high levels of aluminium dissolved in the soil water. Research overseas and in the Eastern States has shown barley to be very sensitive to aluminium.

Aluminium toxicity is one of the major consequences of soil acidity in the northern and eastern wheatbelt. It is not known whether high levels of aluminium are a problem in the medium rainfall zone where most of the State's barley is grown.

Another possible consequence of soil acidity is manganese toxicity. Evidence from New South Wales indicates that barley is moderately tolerant of manganese.

In Western Australia manganese toxicity has not been a concern in the areas already examined for soil acidity problems. However, the soils in the medium rainfall zone have not been examined for this aspect of soil acidity.

Work in Canada has shown that soil acidity below pH 5.0 to 5.5 (in water) causes yield reductions in barley crops. It is not known whether these pH values apply to soils here.
Problems in the medium rainfall zone

There have been two recent pH surveys in the medium rainfall zone.

York area survey

In January 1983, the area around York, Quairading and Brookton was surveyed. The survey was limited to the light textured soils which make up only a small proportion of the total area, but which are likely to be more acid than the other soils. Fifty-eight surface (0-10 cm deep) and subsoil (30 cm deep) samples were taken. Surface samples were also taken from adjacent virgin sites and the pH compared to the paddock sites.

Most of the topsoils and subsoils were below pH 5.5 (in water). A significant proportion were below pH 5.0 (Table 2).

A comparison of paddock pH with that for bush or virgin country indicates the effect agriculture has had on the pH of these soils. The mean drop in pH was 0.3 of a pH unit (Table 3 and Figure 1) and the lowest drop was 1.8 pH units. Most of the soils were cleared 40 to 60 years ago.

Lower Great Southern survey

In 1982, officers of the Department of Agriculture's Albany Regional Office surveyed the areas of Katanning-Kojonup, Mt Barker-Frankland and Mt Manypeaks-Stirlings. A significant proportion of the soils, especially in the Manypeaks-Stirlings area were below pH 5.3 (in water).

The York and Lower Great Southern pH surveys showed that most of the virgin soils were moderately acid at pH 5.5 to 6.0 (in water). After the introduction of agriculture, soil acidity has increased slightly. Many light textured, cultivated soils are now below or about pH 5.5. The yield potential of barley may already be less on these soils, if not now, most likely in the coming years.

Responses of barley to lime

As a result of the York-Brookton survey, a lime trial was set up on a site at York with a topsoil of pH 5.3 (in water) to determine whether soil acidity was affecting barley production. The barley responded to applied lime.

Field trials carried out by Aglimes agronomist, Dr L. Cargeeg, in 1982 also showed that lime applied to acid soils improved barley yields. The trials, at five sites in the wheatbelt, involved barley and wheat grown with marginal and optimal fertiliser levels and four rates of lime.

Barley responded to applied lime at all sites, although at some sites there was a response in only one of the two fertiliser treatments. At two of the sites there appeared to be an aluminium toxicity problem. The response to added lime resulted from a lowering of the aluminium content and an increase in the nutrient levels of the soil. At the other three sites a nutrient deficiency appeared to be the major problem.

Although these trials were mostly on the fringe of the State’s main barley growing areas, they show that liming marginally acid soils can increase the grain yield of barley. However, the reason for the response varies from site to site and may involve a number of causes.

The project

There are still several gaps in our knowledge about soil acidity in the State’s barley growing areas, about the effects of soil acidity on barley growth and on the response of barley to applied lime and other treatments. These features will be examined in this project.

The first stage during 1984 involved a soil survey to understand the characteristics of the soils in the main barley growing areas.

Liming trials for barley will be set up on 11 sites in 1985. The trials will determine the reasons for any responses to added lime.

Barley cultivars have different tolerances of soil acidity levels, particularly of aluminium toxicity. The more acid-tolerant lines can then be selected for growing and crossbreeding.

Acknowledgement

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Table 3. A comparison of bush and paddock pH values (in water) in three survey areas (from Davies, 1983).

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of samples</th>
<th>Bush pH</th>
<th>Paddock pH</th>
<th>Change in pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>York, northwards</td>
<td>20</td>
<td>5.5</td>
<td>5.4</td>
<td>-0.1</td>
</tr>
<tr>
<td>York to Quairading</td>
<td>20</td>
<td>5.8</td>
<td>5.4</td>
<td>-0.4</td>
</tr>
<tr>
<td>Brookton, westwards</td>
<td>18</td>
<td>6.0</td>
<td>5.5</td>
<td>-0.5</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>5.7</td>
<td>5.4</td>
<td>-0.3</td>
</tr>
</tbody>
</table>

Figure 1. Differences between paddock pH and adjacent bush pH at York, Quairading and Brookton.

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