MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Quantifying the tolerance of cereal cultivars to soil acidity

Prepared by Drs S. Moroni (smoroni@csu.edu.au), A. Zander, J. Condon and G. Li
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Wheat had a wider range of tolerance to soil acidity with 1/3 of cultivars evaluated more tolerant than the experimental line ET8. There is a need increase the range of tolerance of barley cultivars. Sources for tolerance from old cultivars or from exotic germplasm could be transferred to cultivars suitable to Australian conditions.

Introduction

The utilisation of crops with tolerance to acidic soils *i.e.* primarily to aluminium (Al) and manganese (Mn) toxicity is an important complementary strategy to lime application for cropping on acidic soils. In NSW only wheat cultivars have been evaluated for tolerance to acidic soils and this information is available in the NSW DPI Winter Crop Variety Sowing Guide. There is, however, no current systematic evaluation for tolerance to acidic soils for the other crops and thus little is known of their tolerance levels.

There are known differences among crop species, but not necessarily among the cultivars within the species. A pot screening experiment was conducted to evaluate the level of tolerance to soil acidity among a selection of current wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.) and oat (*Avena sativa* L.) cultivars in an acidic soil, with and without addition of lime.

Materials and methods

Soil was collected from the 10-20 cm layer at the long-term field site at Dirnaseer, west of Cootamundra, NSW (34°38'S, 147°49'E). The bulk soil had a pH 4.3 in $CaCl_2$ and Al comprised about 20% of the exchangeable cation capacity.

Soil samples (1.4 kg) were weighed in plastic bags and separated into two groups with one half of the bags being thoroughly mixed with lime to a target pH of 5.3. A full nutrient solution (5 ml) was added to each individual bag, fully mixed with soil and air-dried. The soil from the each bag was then dispensed into a PVC pot (18cm in height and 9cm in diameter) lined with a plastic bag to prevent drainage. The soil in pots was incubated for 8 weeks in a glasshouse with wet/dry cycles. All pots were watered to 100% field capacity (FC) by weight initially, dried to about 70% FC and then re-watered by weight to about 80% FC over the incubation period. The purpose of the 8-week incubation was to allow lime and soil to react and reach the target pH, and to lessen the risk of Mn toxicity on plant growth.

A collection of 33 wheat, 16 barley and 3 oat cultivars was included in this screening experiment with the wheat experimental lines ET8 (Al tolerant) and ES8 (Al sensitive) as checks.

Six to eight seeds were sown per pot at about 1cm depth in pre-drilled holes, then thinned to 4 plants per pot 5-7 days after sowing. Pots were placed in a control environment glasshouse and watered to 80% FC on a regular basis.

The experiment was set up as a split-plot design with cultivars as the main plot and the soil treatments as the sub-plot, replicated 4 times.

The plants were harvested 21 days after sowing on a replicate basis over 4 consecutive days. Shoots were cut at the soil surface, bagged and dried at 60°C and weighed. The roots were extracted after thorough washing off of the soil and manual gathering by the flotation method.

The relative root weight (RRW) was used to evaluate differential response among genotypes. RRW (%) = root weight from the unlimed soil treatments divided by the root weight from the limed soil multiplied by 100%. The analysis of variance was performed using the REML procedure in Genstat Release 18.1.

Results

The soil assay readily distinguished between acidic soil tolerant and sensitive cultivars (Figure 1). A significant range of differential responses to the acidic soil was shown among the cereals (Figure 2). As is already known, on average, oat was more tolerant than wheat, which in turn was more tolerant than barley. Among wheat, there was a wider range of responses (32 to 100%) than barley (27 to 60%).

There were no visual toxicity symptoms in the foliage in any of the cultivars growing in either unlimed or limed soil. It appeared that the 8-week incubation with wet/dry cycles in a cooler temperature environment encouraged the oxidation of Mn in the soil solution, and thus minimised the risk of Mn toxicity.

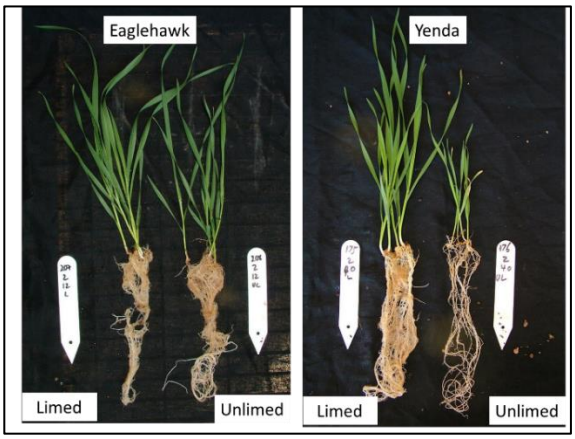

Figure 1. Eaglehawk (Al tolerant) and Yenda wheat (Al sensitive) grown in an acid soil with (left) and without lime (right).

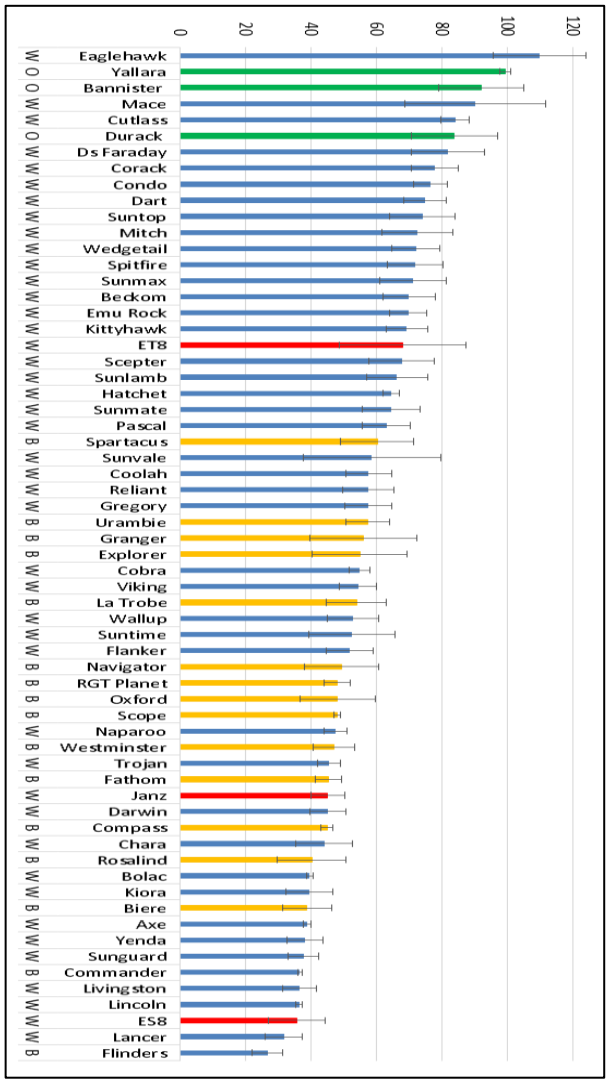

Figure 2. The relative root dry weight (%) among a selection of wheat (W, in blue), barley (B, in yellow) and oats (O, in green) cultivars grown in an acidic soil. Bars represent ±SE.

Conclusions

Wheat had a wider range of tolerance to soil acidity than barley. The relatively poor response range for current barley cultivars indicates a need to increase the level of tolerance in barley, which at present is limited. Some of the commercial barley cultivars, such as Brindabella, that were known to be acidic soil tolerant are no longer available. Thus, sources for tolerance from old cultivars or from exotic germplasm could be transferred to cultivars suitable to Australian conditions. There is still work to be done to determine the critical toxicity levels associated with acidic soil and crop responses.

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Project partners and contacts

Organisation	Key contact	Telephone
NSW Department of Primary Industries	Dr Guangdi Li Dr Ehsan Tavakkoli	02 6938 1930 02 6938 1992
La Trobe University	Prof Caixian Tang	03 9032 7416
Charles Sturt University	Dr Sergio Moroni Dr Jason Condon	02 6933 2914 02 6933 2278
CSIRO Canberra	Dr Peter Ryan	02 6246 5053
FarmLink Research	Cindy Cassidy	02 6980 1333
Holbrook Landcare Network	Dale Stringer	02 6036 3181
Riverine Plains	Dr Cassandra Schefe	03 5744 1713
Southern Farming Systems	Lisa Miller	03 5265 1666