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EFFECT OF SOIL pH ON EMERGENCE AND SURVIVAL OF *AUSTRODANTHONIA* SPP.

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Abstract

We evaluated the effects of soil acidity on seedling emergence and seedling persistence of several ecotypes of *Austrodanthonia* spp. collected from the Central, Southern and Monaro Tablelands of New South Wales (NSW) in southern temperate Australia. A pot experiment was conducted outdoors to identify the most promising material tolerant to soil acidity for domestication. In the experiment, 183 ecotypes and two commercial cultivars of *Austrodanthonia* were grown in pots at three levels of pH_{Ca} (3.9, 4.4 and 5.3). The pH treatments were achieved by adding either aluminium sulphate or lime to an acid earthy sandy loam soil collected from a grazing farm. Seedling emergence and persistence were recorded for 170 days after sowing (DAS). Establishment of all lines was severely reduced by soil acidity. At pH 3.9, average seedling emergence over all lines was 11%, whereas, at higher pH (pH 4.4

and 5.3) emergence was about 72%. Of the seeds sown, survival at 170 DAS was, on average, less than 1% at pH 3.9, compared with 25% at pH 4.4 and 5.3. Further investigations on species/ecotypes, particularly those favoured at low soil pH, should provide a useful basis for selection programmes.

Keywords: Soil pH, Al & Mn, emergence, persistence, *Austrodanthonia*, ecotypes, pasture, grasses

Introduction

The soils of the tablelands of NSW are generally shallow and of relatively low fertility, and pasture production is often limited by soil acidity (Simpson and Langford, 1996). Farmers have tried to improve the level of productivity by using introduced pasture species. Many of these species fail to persist because of poor adaptation to the unfavourable soil conditions. Although liming is an effective method of correcting soil pH, the cost and other factors such as sub-soil acidity, difficult topography and low nutrient availability may limit the benefit. Therefore, there is a need to find alternative ways of dealing with acid soils as part of an integrated approach to the problem. The *Austrodanthonia* genus (~20 species) is highly regarded as a source of forage by Australian landholders and is generally considered to be acid tolerant, however, preliminary empirical data indicate that there is a wide range of responses to pH, varying from tolerant to sensitive (Dowling *et al.*, 1996; Rubzen *et al.*, 1996). This study was undertaken to evaluate the influence of soil pH on seedling emergence and seedling persistence of a range of *Austrodanthonia* species and ecotypes under low fertility conditions.

Material and Methods

183 ecotypes of 15 *Austrodanthonia* species were collected from 126 sites on the Central, Southern and Monaro tablelands of NSW during 1991/92 (Garden *et al.*, 1993). We

grew these ecotypes and two commercial cultivars of *Austrodanthonia* (cvs. Taranna and Bunderra) in pots. Topsoil for the experiment (pH_{Ca} 4.35, Al 14 mg/kg, Mn <5 mg/kg) was collected from a grazing property in the central west of NSW. Soil from the same location was used in experiments by Helyar and Conyers (1994) to rank a wide range of pasture species for tolerance to soil acidity. The treatments (pH_{Ca} 3.9, 4.4 and 5.3) were achieved by adding aluminium sulphate ($Al_2SO_4.18H_2O$), using unamended soil or adding lime ($CaCO_3$) (Islam *et al*., 2000). Basal fertilisers were added (Helyar and Conyers, 1994). Soil pH was measured in a 1:5 soil:0.01M $CaCl_2$ suspension and electrical conductivity was determined in a 1:5 soil:water extract (Rayment and Higginson, 1992). Ten seeds of each ecotype/species were sown in each pot. The experiment was laid out in a randomised complete block design with three replications. The pots were regularly watered and monitored for seedling emergence and persistence until 170 DAS. Data were analysed using ASReml (Gilmour *et al.*, 1998) and Genstat 5- Release 4.1.

Results and Discussion

pH had a great influence on seedling emergence of *Austrodanthonia* species and their ecotypes. Emergence was reduced at low pH (~11% emergence at pH 3.9), and many of the ecotypes failed totally to emerge. This was a similar result to that found by Rubzen (1996) for *Austrodanthonia linkii* cv. Bunderra, one of the commercial cultivars included in our experiment. Most of the ecotypes emerged well at pH_{Ca} 4.4 and 5.3 (average 72%), and there was a significant difference ($p<0.001$) between emergence at these two pH's and that at pH 3.9 (Figure 1).

A significant difference was also observed in seedling survival of all lines across the treatments (Figure 2); less than 1% of plants survived at pH 3.9 at the time of final harvest (170 days after sowing), whereas about 25% survived at pH 4.4 and 5.3 ($p<0.001$). These findings show that, as with other species of grasses (e.g. Foy *et al*., 1988; Helyar and Conyers, 1994), *Austrodanthonia* ecotypes differ in tolerance to soil acidity and that this variability may be exploitable in breeding and selection of improved cultivars.

It is well known that genetic variation exists in the ability of plants to tolerate soil acidity (e.g. Foy *et al*., 1988; Scott and Fisher, 1989). The responses of plants to soil acidity in different soils depends on changes in the solubility of Al and Mn with soil pH and the differences between plants in tolerance to Al, Mn and H^+. Plant tolerance to Al, Mn and H^+, appears to be independently inherited and varies between species and ecotypes (Foy *et al*., 1988; Scott and Fisher, 1989; Edmeades *et al*., 1991; Howeler, 1991). The variable responses to soil pH could be caused by genetic differences between species, and the mechanisms that plants have developed to tolerate and survive could include exclusion of the toxic ions and detoxification of the ions once they have been absorbed (Foy, 1984; Foy *et al*., 1988; Scott and Fisher, 1989; De la Fuente-Martinez and Herrera-Estrella, 1999). Further studies in nutrient culture are planned.

The emergence and persistence results are in close agreement with the spatial distribution of the ecotypes in relation to soil properties in the field survey (Garden *et al*., 1993). However, further studies should provide information on how the various ecotypes, particularly those which differ in their sensitivity to acid soils, perform in competition with other species.

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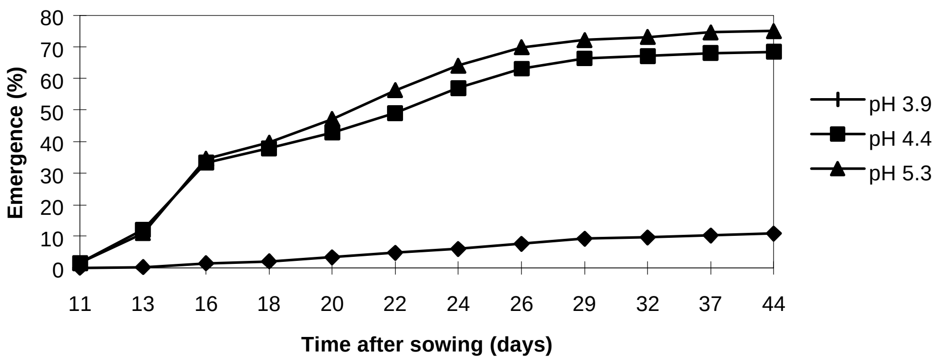

Figure 1 - Seedling emergence of *Austrodanthonia* ecotypes at 3 levels of soil pH. Data points are the means for 183 ecotypes.

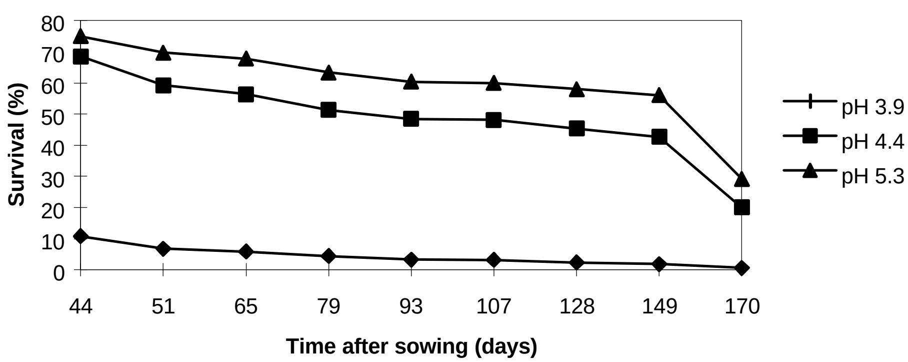

Figure 2 - Effect of soil pH on survival of *Austrodanthonia* ecotypes from 44 to 170 days after sowing. Data points are the means for 183 ecotypes. Percent survival is based on number of seeds sown.