

**Responses of accessions of *Austrodanthonia* spp. to factors  
associated with soil acidity**

by

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## **Certificate of Originality**

The work presented in this thesis is my own, except where otherwise acknowledged. No other person's work has been used without due acknowledgment in the main text of the thesis. The investigations presented here have not been submitted for the award of any degree or diploma within the University of Sydney or elsewhere.

Mohammed Anowarul Islam

August 7, 2002

## Dedication

*I proudly dedicate this work to my beloved wife, Jesmin Banu and my lovely daughter Alhena Islam, whose strength and love sustain me; and to the memory of my parents, Abed and Anowara, who sacrificed their lives raising and educating their children, but did not have the chance to see the completion of the long desired work described in this thesis.*

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## Abstract

Pasture plants already adapted to acidic soil conditions are required as part of an integrated approach (with lime amelioration) to managing acid soils on the Tablelands of New South Wales, Australia. The objective of this thesis is to evaluate the usefulness of *Austrodanthonia* species for this purpose. The material evaluated in this study was collected during a previous survey of the distribution of *Austrodanthonia* on the Central, Southern and Monaro Tablelands of New South Wales. It was hypothesised that the genus *Austrodanthonia* has a wide range of tolerance to acid soils.

A series of experiments that provided information on the growth and physiology of *Austrodanthonia* in relation to soil acidity, with a view to the identification and eventual domestication of the most promising plant material have been conducted through pot, hydroponics and field investigations.

Firstly, soils were acidified or limed to obtain a range of soil pH and Al concentrations. This experiment showed that adding aluminium sulfate and calcium carbonate followed by washing excess salts with water is a simple, rapid and convenient method for adjusting soil pH for pot experiments. The pH of the amended soils remained relatively unchanged eight months after treatment. The experimental set-up also resulted in a wide range of soluble Al (2-52 mg/kg) across the soils.

The relative Al-tolerance of 183 accessions from 15 *Austrodanthonia* species was tested in a pot experiment using a range of soil pH. Emergence, survival and growth of all accessions were drastically reduced by high soil acidity (pH 3.9,  $P < 0.001$ ). About 11% of plants emerged at pH 3.9, whereas at pH 4.4 and 5.3, ~72% of plants emerged.

Accessions exhibited large variation within and between species in their tolerance to soil acidity. From the species/accessions tested, 49 accessions from eight species were selected for further study (on the basis of being more acid tolerant).

Hydroponic experiments conducted in the glasshouse evaluated: (i) formulation of nutrient solution with a stable pH, (ii) effectiveness of the formulation using tap water and deionised water and (iii) estimation of free ion activities of Al and Mn in the nutrient solution and their effects on *Austrodanthonia* growth. These experiments showed that a  $\text{NO}_3\text{-N}/\text{NH}_4\text{-N}$  ratio of 9:4 is the most appropriate ratio to obtain a stable pH 4.0 without affecting plant growth; that there was little difference between tap water and deionised water on the ionic effects of Al and Mn, and plant-size did not play a role on accession survival and that accessions of *Austrodanthonia* could grow well within a wide range of pH (3.5-5.5), Al (50-250  $\mu\text{M}$ ) and Mn (100-2000  $\mu\text{M}$ ). Growth of *Austrodanthonia* accessions declined under high acidity (pH < 3.5) and Al (300  $\mu\text{M}$ ), but tolerated high concentrations of Mn (2000  $\mu\text{M}$ ).

Root-tips stained with hematoxylin grouped accessions in a similar way to the pot and hydroponic experiments for most of the accessions tested. The intensity of root staining with hematoxylin and the differential distribution of Al in the shoots and roots provided an indication that different tolerance mechanisms may be involved with *Austrodanthonia* accessions. It appears that both exclusion and internal mechanisms may operate for Al- and Mn-tolerance.

A field experiment was conducted at Carcoar (33<sup>o</sup>37'S, 149<sup>o</sup>13'E, elevation 800 m) using gradients in soil pH and Al available on-site to grow selected accessions of *Austrodanthonia*. The accessions exhibited a range of responses to soil acidity. The

accession responses to acidity from the pot and hydroponic experiments were similar to those obtained in the field, especially where Al was present as a low Al-challenge.

Overall, this study shows that *Austrodanthonia* exhibits a wide range of acid tolerance between species and accessions within species. Among the species tested, *A. duttoniana* and *A. fulva* appeared to have the greatest commercial potential, because of their productivity and acid tolerance. The variability that exists in the accessions may be exploitable in breeding and selection programs for improved cultivars.

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