Breeding lucerne for tolerance to acid soils

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The low productivity associated with acid soils is a problem of increasing magnitude in the pasture areas of southern Australia. Given the high cost and uncertainty of liming, an alternative approach is the use of pasture species that will tolerate the factors associated with high soil acidity; particularly the toxic levels of aluminium and/or manganese. Lucerne, one of Australia's major pasture legumes, is particularly sensitive to these factors. As part of a breeding programme aimed at developing a lucerne germplasm with improved tolerance to acid soils, an experiment was set up to screen a range of lucerne lines for variation in tolerance to toxic levels of Mn, both within and among lines.

Methods

Two hundred seedlings (ten pots of 20) of each of 11 lines were grown in a gravel bed system which was flushed with nutrient solution once per hour. The nutrient solution was at pH 4.0 and contained 25 ppm Mn. After six weeks of treatment, each seedling was evaluated and rated on a 1-10 scale, particularly with respect to its ability to continue growth under the toxic conditions and also the degree of toxicity symptoms shown. The higher the rating, the more tolerant the plant.

Results and Discussion

Variation in tolerance was found within and among lines, with mean line ratings varying from 2.79 to 4.36 (see Table 1).

Table 1. Variation among lucerne lines in tolerance to toxic Mn levels

Line	Mean rating	% plants with rating 5-9	% plants with rating 7-9
B13AL4	3.47	11.3	1.2
CUF 101	3.05	7.3	3.1
DK 185	3.37	12.6	0.7
HUNTER RIVER	2.94	9.3	0.0
MYERS COMPOSITE	3.41	18.6	3.7
NOVA	2.79	1.9	0.0
P545	3.07	6.3	0.7
RERE	2.94	8.9	0.0
SIRIVER	4.02	28.5	4.8
SIROTASMAN	4.36	41.6	8.3
WL 318	2.99	6.5	1.3

The cultivar Sirotasman exhibited a higher degree of tolerance and contained a higher proportion of highly-rated plants than the other lines. Most of the lines evaluated had a very small proportion of highly-rated plants, although no plants were found that were completely free of symptoms of Mn toxicity. The results suggest that sufficient variation exists to allow progress in a breeding programme. However, one unresolved issue is the possible pH specificity of such selections. Preliminary results from a field trial comparing selections from Mn-toxic sites, ranging in pH from 5.3 to 4.5, suggested that only plants selected from the lowest pH were significantly better than the parental material under the conditions prevailing in the gravel bed. Similar problems may exist an attempting to use gravel bed-selected material in the field. In addition to Mn tolerance, tolerance to toxic levels of Al and a Rhizobium strain effective at low pH are further requirements of this programme.