# SCREENING RYEGRASS CULTIVARS FOR ALUMINIUM SENSITIVITY IN NUTRIENT SOLUTION

F. O. Gallardo[1], S. Benavides[1], R. Demanet[2] and F. Borie[1]

[1]Departmento de Ciencias Quimicas

[2] Depto. de Producción Agropecuaria. Universidad de La Frontera. Casilla 54-D. E-mail: gallardo(werken.ufro.cl. Temuco. Chile

**ABSTRACT**

The objective of this study was to evaluate Al and H+ tolerance of nine ryegrass (*Lolium perenne* and *L. multiflorum*) cultivars by growing plants in a mineral solution (pH 4.8 and 6.0 and 0-200 (M Al). Results showed that Yatsyn-1, with a relative root length of 91 was the cultivar least affected by acidity ($H^+$), and Concord ( RRLpH = 58) was the cultivar with the highest $H^+$ sensitivity. In connection with Al-tolerance, Yatsyn-1 and Concord, were the most tolerant cultivars with 88 and 87 RRLAl, respectively whereas Nui and Marathon, were the most sensitive ones, reaching only a 66, 60 RRLAl, respectively.

**KEYWORDS**

*Lolium perenne, Lolium multiflorum*, mineral solution, aluminum toxicity, root elongation

**INTRODUCTION**

Acidification and Al-toxicity are considered as the most important factors in plant growth and development in high acidity soils (Baligar et al., 1992). Al and $H^+$, in a lower degree, affect root development negatively, especially highly absorbent rootlets, which strongly influence water availability and mineral nutrition of plants growing in such conditions (Fageira et al., 1988; Gallardo et al., 1996).

Andisols and ultisols from Southern Chile are normally acidic, but in the last few years soil acidification has increased mainly from an excessive use of acidic fertilizers especially ammoniacal ones. For overcoming such a problem, farmers need to apply heavy amounts of lime and/or use Al-tolerant species. The objective of this study was to evaluate Al-tolerance of nine ryegrass (*Lolium perenne* and *L. multiflorum*) cultivars by growing plants in a mineral solution (pH 4.8 and 6.0 and 0-200 (M Al).

**METHODS**

Three ryegrass cultivars (Lolium multiflorum) and six perennial ryegrass cultivars (*Lolium perenne*) were used. Seedlings were pregerminated in sand and were grown in 1 L pots (12 seedlings/ pot) containing a nutritient solution. The nutrient solution (Taylor and Foy, 1985) had the following composition in mM: N-NO3 - 3.71; N-NH4+ 0.31; Ca++ 1.27; K+ 0.75; S-SO4= 0.12; P-HPO4= 0.10; in (M: Fe-EDTA 17.9; B 6.6; Mn 2.4; Zn 0.6; Cu 0.2 and Mo 0.1. Treatments in the nutrient solution were 4 Al- (0, 50, 100 and 200 (M) and two pH-levels (4.8 and 6.0). The experiment was made in a growth chamber for 15 days at 25°C with a 14 hour-photoperiod. At the end of the experiment, root lengths were measured. The treatments were expressed as relative root length (RRL). Root length of the plants grown in mineral solution containing 0 (M of Al and pH 4.8 was considered as 100% (RRLAl) and RRLpH was compared with root length of the plants grown at pH 6.0 with no Al on a percentage basis.

All experiments were made with four replications and data was statistically analyzed by the Tuckey means comparison procedure.

**RESULTS AND DISCUSSION**

One of the most important advantages of screening for acid tolerance in a mineral solution is to analyze pH effect alone or the combined effects of pH plus Al. In the treatment with no Al and pH 6.0, Yatsyn-1 (RRLpH = 91) was the least affected by acidity (H+), and Concord ( RRLpH = 58) showed the highest H+ sensitivity (Tables 1 and 2).

The most striking results were found in the presence of 200 (M Al at pH 4.8 (RRLAl). Under these conditions several phytotoxic Al-species are found (Mackay et al., 1991; Bona et al., 1993) which was confirmed in this research by the decrease in root length, especially of Nui and Marathon. On the contrary, although Yatsyn-1 and Concord were adversely affected, the decrease was not as sharp as that of the others. The negative effect of Al in root growth is better visualized in Table 1 and 2, where results are expressed as relative root length (RRLpH, RRLAl).

In conclusion, Yatsyn-1 was the least affected cultivar by acidity and Concord showed the highest H+ sensitivity. On the other hand, Yatsyn-1 and Concord, were the most Al-tolerant cultivars, whereas Nui and Marathon were, the most sensitive ones.

**ACKNOWLEDGEMENTS**

The authors thank the financial support given by the National Fund Science and Technology (FONDECYT) through 1940840 and 2-88 FONDEF projects.

**REFERENCES**

**Baligar, V.C., R.J. Wright and K.D. Ritchey**. 1992. Soil acidity effects on wheat seedling root growth. J. Plant Nutr. **15**: 845-856.

**Bona, L., R.J. Wrigth, V.C. Baligar and J. Matuz**. 1993. Screening wheat and other small grains for acid soil tolerance. Landscape and Urban Planning. **27**: 175-178.

**Fageria, N.K., V.C. Baligar and R.J. Wright**. 1988. Aluminium toxicity in crop plants. J. Plant Nutr. **11**: 303-319.

**Gallardo, F.O., M.E. Pino, S. Benavides and F. Borie**. 1996. Different Ca/Mg in Al-phytotoxicity of wheat growing in mineral solution. Proc. IV th International Symposium on Plant and Soil Interactions al Low pH. Brasil.

**Mackay, A.D., J.R. Caradus and S. Wewala**. 1991. Aluminum tolerance of forage species.In Plant- Soil Interactions at Low pH. De. R.J. Wright, V.C. Baligar and R.P. Murrmann. pp 925-930, Kluwer Academic Publishers, Dordrecht.

**Taylor, G.J. and C.D. Foy**. 1985. Mechanisms of aluminum tolerance in Triticum aestivum L. (Wheat). I. Differential pH induced by winter cultivars in nutrient solution. Amer. J. Bot. **72**: 695-701.

**Table 1**
Aluminium tolerance of six *Lolium perenne* cultivars grown in mineral solution.

| µM Al | Yatsyn-1 | | Nui | | Ellet | | PG-14 | | Embassy | | Marathon | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / % | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ |
| 0 | 91 | 100 | 89 | 100 | 88 | 100 | 80 | 100 | 90 | 100 | 72 | 100 |
| 50 | 89 | 98 | 84 | 94 | 76 | 86 | 79 | 99 | 78 | 87 | 63 | 88 |
| 100 | 80 | 88 | 76 | 85 | 72 | 82 | 61 | 76 | 59 | 66 | 53 | 74 |
| 200 | 81 | 88 | 59 | 66 | 70 | 79 | 60 | 75 | 55 | 61 | 43 | 60 |

Root length of the plants grown in mineral solution containing 0 mM of Al and pH 4.8 was considered as 100 % ($RRL_{Al}$) and $RRL_{pH}$ was compared with root length of the plants grown at pH 6.0 with no Al on a percentage base.

**Table 2**
Aluminium tolerance of three *Lolium multiflorum* cultivars grown in mineral solution.

| mM Al | Tama | | Tetrone | | Concord | |
|---|---|---|---|---|---|---|
| / % | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ | $RRL_{pH}$ | $RRL_{Al}$ |
| 0 | 90 | 100 | 80 | 100 | 58 | 100 |
| 50 | 85 | 97 | 75 | 94 | 54 | 93 |
| 100 | 77 | 84 | 67 | 84 | 54 | 93 |
| 200 | 73 | 83 | 72 | 80 | 51 | 87 |

Root length of the plants grown in mineral solution containing 0 mM of Al and pH 4.8 was considered as 100 % (RRLAl) and RRLpH was compared with root length of the plants grown at pH 6.0 with no Al on a percentage base.