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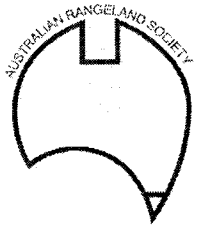

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SALINITY TOLERANCE OF *ATRIPLEX NUMMULARIA* IN RELATION TO ITS USE FOR REHABILITATING SALT-DEGRADED AREAS

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ABSTRACT

Glasshouse experiments were used to determine the salinity tolerance of *Atriplex nummularia* (old man saltbush) either growing under free-draining or waterlogged conditions. Plants were grown over a 17 week period in either a sandy-clay or a sand and watered with saline solutions ranging from 0-1000 mmol/L NaCl. All plants in free-draining pots survived the experimental period over the entire salinity range. Growth was slightly stimulated at the lower end of the range (100-200 mmol/L) relative to that of the control where as growth was significantly reduced when salt concentrations exceeded 600 mmol/L. Growth at 1000 mmol/L was reduced to 54% of the control. Waterlogging significantly affected both growth and survival for all salinity levels other than the control. Growth was reduced to 50% at 100 mmol/L and to 22% from 400 mmol/L onwards. The lethal dose of salt that produced a 50% mortality (LD50) was 100 and 270 mmol/L for the waterlogged sandy-clay and sand respectively. Laboratory germination experiments showed that seed germination occurred under moderately saline conditions and that the level of salt tolerance increased significantly when the seeds were extracted from the bracts.

INTRODUCTION

Atriplex nummularia is a potentially valuable plant for use in rehabilitating scalded and secondary salinised areas because it is an halophyte. The species may be used in reclamation work by either planting seedlings or by directly sowing seed onto affected areas when conditions are suitable for germination and early survival. The objectives of this study were (i) to determine the level of salinity tolerance of *A. nummularia* juvenile plants growing under free-draining or waterlogged conditions in sandy-clay or clay soils and (ii) to determine the effects of salinity on seed germination.

MATERIALS AND METHODS

The salinity screening experiment was conducted under glasshouse conditions using seven-month old seedlings provided by a commercial supplier (Narromine Transplants). The soils used were a red clay (collected from a scalded area near Nyngan, NSW) and a sandy-clay (prepared by mixing equal volumes of the red clay with river sand). Plants were grown either under free-draining or waterlogged conditions. Salinity concentrations used were 0, 100, 200, 400, 600, 800 and 1000 mmol/L NaCl. The solutions were applied as a daily irrigation in the free-draining treatment or as a water bath in the waterlogged treatment (with the solution being maintained to about 1.5-2.0 cm from the soil surface and then replaced weekly with fresh solution). The experiment ran for about 17 weeks (121 days). Height and mortality were recorded fortnightly and a growth index was calculated as the area under the natural log height/age curve for each plant.

Seed germination was undertaken on seeds pretreated by leaching for 48 h under fresh running water, by removing the bracts (naked seed) or as a control. Salinity concentrations used ranged from 0-600 mmol/L NaCl. Seeds were incubated on a 12 h light-dark cycle at 20°C for 29 days.

RESULTS AND DISCUSSION

No plant deaths were recorded over the experimental period (121 days) in the free-draining treatment for the entire salinity range while in the waterlogged treatment all plants in the 400 mmol/L treatment and above died. Survival was not significantly different for all those salinity levels with the average survival period being 55 days. Mean survival periods for the waterlogged treatments at 100 and 200 mmol/L were 92 and 82 days respectively. All plants in the waterlogged control treatment survived. Survival was better in sand

than sandy-clay soils with the LD50 (the concentration of salt that results in 50% mortality) being 270 and 100 mmol/L respectively.

All plants in the free-draining treatment grew in height over the experimental period with the control treatment increasing by 141% while the height increase in the 1000 mmol/L treatment was 33%. Height growth in the waterlogged control treatment was 110% while for the 1000 mmol/L treatment dieback occurred and the height decreased 16% over the period for which they survived. Growth index (**Fig. 1**) showed that there was a slight stimulation in growth when plants were irrigated with low concentration salt solutions (100 and 200 mmol/L) over that of the control in the free-draining treatment although the difference between the control and all salinity levels up to and including 400 mmol/L were not significantly different. The combination of waterlogging and increasing salinity significantly decreased the growth index compared with the zero salinity, waterlogged treatment. Growth was not significantly reduced any further when salinity levels were increased beyond 400 mmol/L.

Seed germination was significantly improved with the removal of the bracts surrounding the seed (naked seeds) over all salinity levels used (**Fig. 2a**). Germination increased from 13.0% for the untreated, control (0 mmol/L NaCl) seeds to 71.5% for naked, control seeds. Germination was significantly improved for naked seeds at all salinity levels used in the experiment. The leaching pretreatment only improved germination in the absence of salt whereas there was no difference in germination under saline conditions. Germination rate (as measured by the number of days to reach 50% of maximum germination) was significantly improved (**Fig. 2b**) with the removal of the bracts and leaching when the seeds were germinated under control conditions. Germination rate for intact seeds was 7.9 days compared with 2.3 and 2.9 days for leached and naked seeds respectively. Increasing salt concentrations significantly reduced germination rates for the control and leaching pretreatment. The change in germination rates also decreased for naked seeds although the rates were significantly less than for the other pretreatments. The difference between germination rates for naked seeds was only significantly different at the 600 mmol/L salinity level from the control and all other salinity levels.

The results from these experiments show that *A. nummularia* seedlings may be potentially used in rehabilitating salt-affected land, provided that in highly saline soils they are not constantly waterlogged. Waterlogging significantly reduces growth and survival even in the presence of low concentrations of salt. Direct sowing of seeds onto saline areas is likely to be more successful if the seeds are removed from the bracts as this increases both the germination capacity and rate.

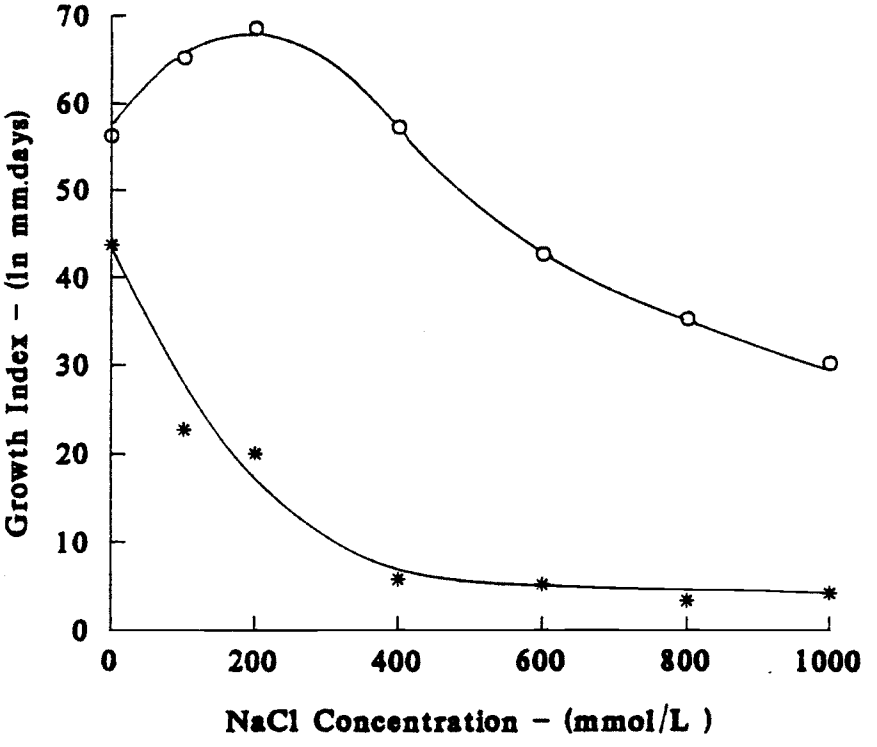

Figure 1. Growth index for *Atriplex nummularia* growing under either free-draining (o) or waterlogged (*) conditions over a range of saline conditions. $LSD_{(0.05)}$= 12.9.

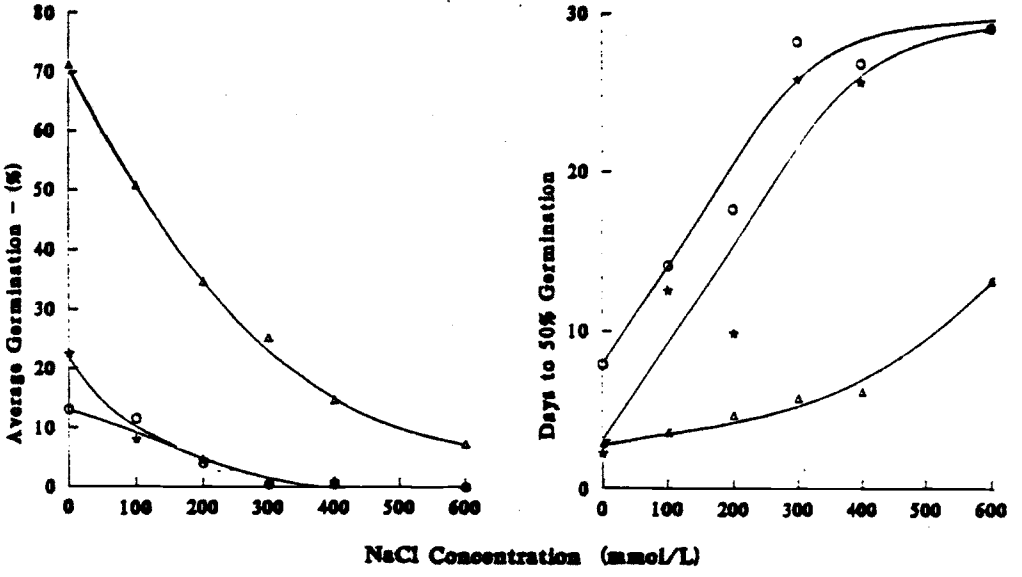

Figure 2. Germination capacity (a) and germination rate (b) for *Atriplex nummularia* under a range of saline conditions when seeds were removed from the bracts (naked seeds ▵), leached with running tap water for 48 h (*) or as a control (o). $LSD_{(0.05)}$= 9.0 for germination % and $LSD_{(0.05)}$= 7.1 for germination rate.