Tolerance to salinity in some species of trifolium and medicago

I. Kaehne, E.T. Kobelt and B.M. Martin

Department of Agriculture, Northfield Research Laboratories GPO Box 1671, Adelaide SA 5001

Summary. The tolerance to salinity of 26 clover populations from 16 species of *Trifolium,* 32 lucerne and annual medic populations from 12 species of *Medicago* and one representative each of *Hedysarum coronarium, Lotus corniculatus* and *Vicia villosa* was assessed on plants grown from four weeks of age in a saline solution. The saline treatment was applied in intermittently flooded beds. NaCI concentration was increased from 40 to 220 mM/L over four weeks and then maintained. Tolerance was assessed by visual appearance and plant height. *Trifolium* species were generally more tolerant to intermittent hourly flooding and salinity than were *Medicago* species. Possible sources of tolerance to salinity in *Trifolium* and *Medicago* are indicated.

Introduction

Salinity is a significant constraint to dryland and irrigated agriculture in Australia (2). Although salt tolerant grasses are well recognised and commercially used, there are no cultivars of pasture legumes recognised for their high tolerance. This study aimed to evaluate the salt tolerance under simulated poorly drained field conditions of an array of annual and perennial clovers and medics which have agronomic value in Australia.

Methods

Two experiments were conducted to determine the tolerances of populations of *Trifolium* and *Medicago.* Single check entries of *Lotus, I ledysarum* and *Vicia* were also included to give a comparison with the clovers and medics. *Lotus* is regarded as salt tolerant, *Vicia villosa* is not. The populations are listed in Tables 1 and 2. All cultivars tested are indicated. The arrays of *M. polymorpha* (A to H) and *M. sativa* (A to E) were progenies of saline-tolerant selections.

The populations were established in free-draining trays of loam-based and adequately fertilized potting mix approximately 8 cm deep. Each plot was a 25 cm row containing approximately 30 established seedlings. There were three replicates. At four weeks intermittent hourly flooding of the trays to 2 cm above their base was commenced with non-saline (control) and saline water in flooding bays. The NaCI concentration was increased from 40 to 220 mM/L over four weeks in six steps of 30 mM/L each and then maintained. This system of imposing the solution treatments was chosen to cause a partial waterlogging effect by capillary action above free water level in the flooding bays. This simulated the common association between saline conditions and partial or complete waterlogging in the field resulting from discharge of subsoil water or collection of saline runoff. Six weeks after the commencement of the intermittent flooding and saline treatments, tolerance was assessed using a rating for appearance and measuring stem length. The predominant colour of leaves was used for rating. Healthy leaves were rated 9, light-green leaves 7, yellow-green leaves 5, pale leaves with no green tone 3 and dead plants 0. If variation occurred in a plot a mean rating was estimated.

Results and discussion

The appearance ratings and stem lengths after six weeks of saline treatment for each population are presented in Tables 1 and 2 for the *Trifolium* and *Medicago* groups respectively.

Intermittent flooding with non-saline water had a moderate effect on the appearance of most Trifolium populations and Lotus. Only T. alexandrinum and *T. scutatum* were very poorly adapted. In contrast, many *Medicago* species and *Vicia* were severely affected by intermittent flooding only. The effect of flooding on *Hedysarum* was intermediate.

Table 1. The appearance rating and stem length of *Trifolium* populations after six weeks in saline and non-saline conditions.

Species, cultivar or accession	Appearance rating		Stem length (cm)	
	Non-saline	Saline	Non-saline	Saline
T. alexandrinum	6.7	5.0	45	30
T. balansae cv. Balansa	8.3	8.0	33	27
T. balansae A	8.0	7.7	25	20
T. cherleri	6.3	3.0	9	7
T. echinatum	8.7	3.3	9	5
T. fragiferum cv. Palestine	8.3	8.0	23	17
T. hirtum	7.0	4.3	21	11
T. isthmocarpum A	7.7	7.3	31	21
T. isthmocarpum B	8.7	7.7	35	22
T. isthmocarpum C	9.0	8.3	10	7
T. isthmocarpum D	8.3	7.3	38	26
T. isthmocarpum E	8.3	8.0	29	21
T. nigrencens	8.0	8.0	24	18
T. purpureum	7.0	6.0	28	18
T. repens cv. Haifa	8.3	8.3	28	19
T. repens cv. Irrigation	8.0	8.0	20	17
T. resupinatum cv. Kyambro	7.7	7.3	23	15
T. resupinatum cv. Maral	8.0	7.7	31	24
T. resupinatum A	7.7	7.7	39	24
T. resupinatum B	7.7	7.7	24	16
T. scutatum	6.7	6.9	16	12
T. subterraneum ssp. *brachy*. cv. Clare	7.0	5.3	23	17
T. subterraneum ssp. *brachy*. cv. Rosedale	6.3	5.0	19	12
T. subterraneum ssp. *sub*. cv. Junee	9.0	8.0	25	20
T. subterraneum ssp. *sub*. cv. A	8.3	6.0	28	20
T. subterraneum ssp. *yann*. cv. Trikkala	8.7	7.3	26	19
T. subterraneum ssp. *yann*. cv. FS 24	8.3	6.7	21	15
T. versiculosum	7.3	6.3	17	14
Hedysarum coronarium	6.7	6.0	22	17
Lotus corniculatus	8.7	8.7	11	9
Medicago intertexta	7.7	7.3	31	20
Vicia villosa cv. Namoi	5.3	2.7	47	27
Mean	7.7	6.7	25	18
l.s.d. (P=0.05) (treatment x population)	0.4		2	

Table 2. The appearance rating and stem length of annual and perennial *Medicago* populations after six weeks in saline and non-saline conditions.

Species, cultivar or accession	Appearance rating		Stem length (cm)	
	Non-saline	Saline	Non-saline	Saline
M. aculeata	3.7	0.8	15	6
M. arabica	3.3	1.8	10	5
M. intertexta A	5.8	5.3	25	19
M. intertexta B	7.2	7.3	18	17
M. intertexta C	7.8	6.8	15	12
M. littoralis cv. Harbinger	1.2	0.3	7	3
M. minima	2.5	0	5	2
M. murex cv. Zodiac	8.3	8.0	15	12
M. polymorpha cv. Santiago	5.2	1.5	21	7
M. polymorpha cv. Serena	4.8	3.5	32	21
M. polymorpha A	5.5	4.8	29	20
M. polymorpha B	6.2	2.8	20	10
M. polymorpha C	6.8	4.3	22	16
M. polymorpha D	7.0	6.0	16	12
M. polymorpha E	6.2	4.0	20	13
M. polymorpha F	6.2	3.5	19	13
M. polymorpha G	5.0	1.0	28	11
M. polymorpha H	5.0	3.3	24	12
M. tornata cv. Tornafield	3.6	3.2	11	6
M. truncatula cv. Jemalong	1.5	0.7	12	4
M. truncatula A	2.7	0.5	4	2
M. truncatula B	1.7	0	8	0
M. rugosa cv. Paraponto	2.3	0.2	11	0
M. sativa cv. Aurora	4.7	3.3	18	13
M. sativa cv. CUF 101	3.5	3.2	21	14
M. sativa cv. Hunter River	3.5	2.2	21	14
M. sativa A	5.2	3.7	19	12
M. sativa B	4.5	3.8	18	13
M. sativa C	4.5	3.7	18	13
M. sativa D	4.7	3.7	16	13
M. sativa E	4.8	3.2	18	11
M. scutellata cv. Sava	2.2	0.7	20	7
Mean	4.6	3.0	18	10
l.s.d. (P=0.05) (treatment x population)	0.4		4	

The saline treatment imposed with intermittent flooding did not significantly reduce further the appearance rating of *T. balansae, fragiferum,* some *T. isthmocarpum* populations, *T. nigrencens, T. repens, T. resupinatum* or *Lotus corniculatus,* but reduced the stem length of all *Trifolium* populations. Their appearance rating (7) suggests that selection should be possible for both tolerance to salinity and adaptation to poorly drained soil conditions in many *Trifolium* species. *Lotus corniculatus* was tolerant to salinity but *Hedysarum coronarium* and *Vicia villosa* were intolerant.

In the *Medicago* lines, the saline treatment imposed with intermittent flooding further reduced plant appearance and also reduced stem length except in *M. intertexta* (B) and *M. murex* cv. Zodiac. Some individual plants of *M . intertexta, M . murex* and *M. polymorpha* set pods and seed when allowed to grow on in the saline solution beyond evaluation at 10 weeks of age. Polymorphism for tolerance to partially waterlogged saline conditions may occur in many accessions of these species. The progenies of *M.*

polymorpha from saline sites were not tolerant to intermittent flooding and salinity except population D which expressed marginal tolerance.

Although some lucerne, *M. sativa,* genotypes are salt-tolerant in freely drained conditions (1) no tolerant individual plants were identified in this experiment, even in populations A to E which were progenies of field selections from saline sites. The salinity tolerance *per se* of these populations may have been masked by their sensitivity to intermittent flooding. Interspecific hybridization of *M. sativa* with other annual species (3) may be a rewarding path to achieve a perennial medic with adaptation to saline poorly-drained soils. It is unlikely that selection within *M. sativa* will achieve development of a salt tolerant perennial to control rising saline water tables.

Acknowledgments

This experiment was supported by the Wool Research and Development Council. The noncommercial lines of *M. saliva* (A to E) were developed by the South Australian Department of Agriculture and of *M. polymorpha* (D to H), were collected by E.T. Kobelt in saline sites. All other non-commercial entries were supplied by G.C. Auricht from the SA Genetic Resources Unit.

References

1. Noble C.L., Halloran, G.M. and West, D.W. 1984. Aust. J. Agric. Res. 35, 239-252.

2. Standing Committee on Soil Conservation, 1982. Salting of Non-irrigated Land in Australia. (Soil Conservation Authority: Victoria).

3. Thomas, M.R., Johnson, L.B. and White, F.F. 1990. Plant Science 69, 189-198.