SALINITY EFFECTS ON IRRIGATED LUCERNE

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Abstract

The effect of saline irrigation on the growth of six cultivars of lucerne was assessed over four irrigation seasons at Tatura, Victoria. Measurements made in the study included shoot dry matter production, shoot ion concentrations, flowering incidence, root distribution and soil salinity levels. After the first season, cultivars differed significantly in salt tolerance as defined by the rate of decline in dry matter production and the ability to exclude Na and Cl from the shoots. The cultivars CUF 101 and Validor were consistently the most salt tolerant cultivars although cv. Southern Special produced the greatest amount of dry matter over all salinity treatments. Root densities at depths from 0 to 60 cm were greater under saline (2.5 and 7.6 dS/m) than under non-saline conditions. Flower production was increased by salinity.

Key words: lucerne, Medicago sativa, NaCl, salinity, salt tolerance

Introduction

In the irrigation regions of northern Victoria and southern New South Wales, saline groundwater is pumped from aquifers at shallow depths below the soil surface to control surface soil salinisation. The pumped groundwater, when diluted with channel water is used for irrigation on farms to minimise the volume of salt disposed into the river system. Lucerne (*Medicago sativa* L.) is an important crop in the region and is recognised as being moderately salt sensitive (1) although this response varies according to genetic and climatic factors. A previous study (3), examined the effect of low to moderate levels of saline irrigation water on local soil characteristics and the growth of one cultivar of lucerne. The present study continues this research and examines the degree of intraspecific variation for salt tolerance that is present within lucerne by describing the vegetative and reproductive growth of six cultivars that were irrigated with low to high concentrations of saline water over four irrigation seasons.

Materials and methods

Field plots (10 m^2) of five commercial cultivars of lucerne (*viz*. Validor, WL Southern Special - both semi-dormant types: Aurora and Trifecta - both winter active types: and CUF101- a highly winter active type) and one line that was still in the developmental stage (*viz*. Sirosal which was bred from the highly winter active cultivar Siriver) were established on a lemnos loam soil (Dr 2.33) at Tatura, Victoria under rainfed conditions in October, 1990. Saline irrigation water (EC_w) of 0.1, 0.8, 2.5, 4.5, and 7.6 dS/m was applied in October, 1991, and continued throughout the 1991/2, 1992/3, 1993/4 and 1994/5 irrigation seasons.

Over each irrigation season, the plots were harvested when 10 to 20% of the plants were flowering (usually every 5 to 6 weeks). Measurements made on this material included shoot fresh and dry matter production and tissue ion (Cl, Na, K, Mg and Ca) concentrations. At the first and final harvest of each season, the plots were soil sampled to a depth of 120 cm. The electrical conductivity of the soil samples was measured using a 1:5 water extract that was later converted to EC saturation extract (EC_e). Soil samples were also analysed for Cl, Na, K, Mg and Ca. Root distribution was measured in February 1995 from soil samples taken from the 0.1, 2.5 and 7.6 dS/m treatments. Flowering incidence was determined in December 1994 and February 1995 by counting the number of flowers (both mature and immature) present in a quadrat sample (area = 0.1 m^2) in cultivars Trifecta and Validor at the lowest (0.1 dS/m) and highest (7.6 dS/m) salinity treatments. This data was then expressed as a total number flowers per plot and as total number flowers per unit dry weight.

All data was analysed by ANOVA with a randomised block design and salinity levels fitted as orthogonal polynomials (Genstat 5.0)

Results and discussion

At the end of each irrigation season (1991-1995), there were significant differences in soil salinity levels between irrigation salinity treatments ($P<0.001$) and between soil depths ($P<0.001$). Soil salinities were highest between 15 to 60 cm depth and peaked at 7.0 dS/m for the highest salinity treatment (7.6 dS/m) in April 1993.

In the first irrigation season (1991/1992), there were no differences in dry matter production between cultivars or between salinity treatments although there was a downward trend in production from the lowest to the highest irrigation salinity treatment (*viz*. mean drymatter production across all cultivars = 15.3 t/ha at 0.1 dS/m compared with 13.9 dS/m at 7.6 dS/m). In subsequent seasons (1992-1995) the cultivars could be divided into separate groups based on their salinity response with cultivars CUF 101 and Validor showing a slower rate of decline in dry matter production (and therefore greater salt tolerance) with increasing soil NaCl levels than cultivars Southern Special or Trifecta ($P<0.05$). The performances of cultivars Aurora and Sirosal were intermediate between these two groups. Southern Special consistently produced the greatest amount of dry matter over each season and Sirosal the least ($P<0.05$).

Cultivars differed significantly ($P<0.05$) in shoot concentrations of Na and Cl with cv. Trifecta having the greatest concentrations of these ions over all irrigation seasons ($P<0.05$) and Cuf 101 the lowest ($P<0.05$). This information relates well with the salt tolerance rankings obtained for dry matter production since ion (Na and Cl) exclusion is generally associated with salt tolerance in forage legume species such as lucerne (2) and white clover (4).

Root densities were greatest over the 0-15 cm depth and were significantly higher ($P<0.001$) in the 2.5 dS/m and the 7.6 dS/m treatment compared with the non saline treatment at this depth and at the 15-30 and 30-60 cm depths.

While there were no differences in the total number of flowers per plot between salinity treatments or between cultivars, the total number of flowers per unit of dry weight was significantly greater ($P<0.05$) in the high salinity plots (7.6 dS/m) compared with the non-saline plots (*e.g.* 12.0 flowers/g dwt in plots at 0.1 dS/m compared with 16.1 flowers/g dwt in plots at 7.6 dS/m for Trifecta in December 1994). This suggests that salinity stress may affect the partitioning of biomass between vegetative and reproductive growth increasing flowering incidence and bringing flowering time forward.

Conclusions

This study has shown that lucerne growth is reduced by saline water applied at levels greater than 2.5 dS/m and also that there is a degree of variation in salt tolerance within the species which seemed unrelated to seasonal growth activity. Although there was some variation across seasons, the cultivars CUF 101 and Validor consistently appeared to be the most salt tolerant in terms of a slower rate of decline in dry matter production with increasing levels of soil salinity and the ability to exclude Na and Cl from the shoots.

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