



## Salinity and the Growth of Forage Species

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*Salinity, predominantly caused by excess sodium chloride (NaCl) in the soil, is a serious problem throughout Australia restricting agricultural productivity and degrading the natural environment. The purpose of this Agriculture Note is to briefly outline some of the effects of salinity on plant growth, predominantly forage species. Further information can be obtained from the author.*

### Measurement of salinity

Salinity is the total concentration of water soluble salts in water and soil. Soil salinity can be measured as a concentration, but in most agricultural situations it is measured as the electrical conductivity of a saturated soil paste ( $EC_e$ ) or a 1:5 ( $EC_{1:5}$ ) water extract in units of deci Siemens per metre (dS/m) at 25°C. In the past salinity has been expressed as

EC units (micro ( $\mu$ ) Siemens per centimetre) or parts per million (1 dS/m = 1000 EC units = 640 ppm).

The measurement of electrical conductivity does not indicate the types of salts present. Therefore measurements are also made of specific salts such as chloride.

### Plant growth and salinity

#### Effect of salinity

Salinity can affect plants in three ways. Initially, salt makes it more difficult for plants to withdraw water from the soil, even if the soil appears quite moist. In effect, the plant suffers from a form of drought which can result in retarded growth and reduced yield.

Secondly, some salts, such as Na and Cl can be directly toxic to plants. Plants take up salts with the water that they use, and often these salts can damage the plant internally, affecting the plant's physiological processes and often resulting in reduced growth, leaf burn and even plant death. This effect is the most serious for plants.

Thirdly, high amounts of ions such as Na and Cl may affect the availability of other ions e.g. K, Mg, N or P which are extremely important for plant growth.

### Responses of plants

Generally, a reduction in plant growth - evident by a reduction in plant height or in the number of leaves or shoots - is the plant's first response to salinity. As the plant becomes more affected, it may appear wilted, despite a moist soil, and the leaves may show leaf burn. Under these more severe circumstances, the plant may die. Shoots are generally more inhibited in growth than roots and at low salinity levels root growth may not decrease at all.

### Salt tolerance of plant species

Differences exist between plant species in their tolerance of salinity. These differences can be related to the salt content of the soil and/or water which causes an initial decline in growth (yield), and also to the rate of yield decline that occurs with increasing salinity.

Table 1 indicates general differences in salt tolerance between several plant species. However, the salt tolerance values presented are not fixed and plant salt tolerance varies with

- water management practice (eg irrigation method, frequency, intensity, waterlogging);
- stage of plant growth;
- climatic conditions (eg temperature, humidity and light); and,
- soil type.

Salt tolerance can also differ between cultivars of a species, such as for subterranean clover and white clover. However, these differences are usually much smaller than differences between species.

The table should be used as a general guide and further information obtained, when required, from **DPI, Tatura**.

Sensitivity of plants to salinity can vary from one stage of growth to another. Germination and particularly seedling emergence and early seedling growth are frequently the most sensitive stages. Tolerance is normally highest when plants are established, but may decrease at flowering or grain filling.

For established perennials, such as lucerne, regrowth following cutting may also be more sensitive than later growth.

### Crop management with saline water

The growth of plants in saline conditions requires special management.

Soil salinity should be minimised before sowing and until plants are established. In general the EC of a soil-water suspension should not exceed 0.6 dS/m at this time. This may require initial irrigations with water of low salinity to leach salt from the surface.

During the growth of the crop, the plants should be checked for any signs of wilting or leaf burn. In pastures, particular attention should be paid to the growth of clovers as they are generally less salt tolerant than grasses. When clover plants are salt affected and the clover content in pasture decreases, the pasture quantity and quality can be reduced.

If plants appear stressed or clover growth declines, irrigation with water of a lower salinity, obtained by mixing saline drainage or ground water with channel water, is advisable. Under saline conditions more frequent irrigation may be needed to reduce salt concentration in the root zone.

Ponding of water should be prevented during irrigation because waterlogging in conjunction with salinity is severely detrimental to plant growth and causes greater growth depression than would occur with either salinity or flooding alone. In addition, some species eg. lucerne, are more sensitive to waterlogging than to salinity. Localised waterlogging can also lead to an increase in soil salinity.

Where saline water is used for irrigation it should not be applied with overhead sprinklers, as evaporation of saline water on plant leaves can lead to high concentrations of salts causing leaf burn.

With increasing soil salinity soils may become sodic and dispersed, with a resulting reduction in water infiltration. The addition of calcium (as gypsum) to the soil or irrigation water can aid in maintaining adequate soil structure (for more information contact **DPI, Tatura**).

**Table 1. Salt tolerance of several forage species**

Salinity of irrigation water	Comments
0 to 0.75 dS/m	Suitable for use with all crops. Above 0.75 dS/m sensitive plants will suffer some yield loss as soil salinity increases.  <i>Sensitive plants:</i> Many clovers; white, red, cluster, suckling, subterranean
0.75 to 1.5 dS/m	Sensitive plants have increasingly reduced growth. Moderately-sensitive plants should suffer little or no yield decline.  <i>Moderately-sensitive plants:</i> Balansa clover, persian clover, strawberry clover, Berseem clover, lucerne
1.5 to 3.00 dS/m	Moderately-sensitive plants will suffer increasing yield loss. Moderately-tolerant plants should suffer little yield loss with good management at the lower end of this range. At the upper end, some yield loss will occur.  <i>Moderately-tolerant plants:</i> sorghum, tall fescue, phalaris, perennial ryegrass, cocksfoot, Wimmera ryegrass, crested wheatgrass, barley(hay), wheat, reed canary grass, paspalum.
3.00 to 5.00 dS/m	Moderately-tolerant plants will suffer increasing yield decline. Only tolerant plants should be grown with very good irrigation/soil management. Toward the top of this range some yield decline will occur for some of the tolerant plants.  <i>Tolerant plants:</i> Tall wheatgrass, puccinellia, bermuda grass, barley(grain), saltwater couch, salt bush

#### Notes

Plants within each group are not arranged in any order of salt tolerance.

Salt tolerance values presented here are general guidelines and assume free drainage with at least 10% of the water applied (irrigation plus rainfall) passing through to the soil below the root-zone and the absence of a saline watertable

*This Information Note was previously published in December 1997.*

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