3

Electrical conductivity, related attributes and redox potential

The soil solution plays a major role in the supply of nutrients to plants. It also contributes to the cycling, transformation and transport of nutrients and pollutants in soils and ecosystems (Agbenin 2003). Its key components are soil water and dissolved electrolytes, gases, and water-soluble compounds (Adams 1974). While it is possible to measure all constituents, this is usually impractical. Moreover, the composition of the soil solution is affected by plant nutrient uptake, root exudates, microbiological activity, fertilisation, leaching and other soil properties that vary in space and time.

An indication of the nature and ionic strength of the soil solution can be obtained from the EC of a soil/water suspension. This soil test provides a quick estimate of the concentration of electrically-charged water soluble salts able to enter and persist in the soil solution. These consist predominantly of the cations Ca^{2+}, Mg^{2+} and Na^{+} and the anions Cl^{-}, SO_4^{2-} and HCO_3^{-}. Fertilisers and animal manures often contribute other inorganic ions such as K^{+}, NH_4^{+} and NO_3^{-}. Soil EC values are unaffected by non-ionic solutes such as sugars, and ions that combine to form neutral ion pairs. The predominant mechanisms causing the accumulation of soluble salts in farmlands are heavy use of fertiliser, and (more commonly) the loss of water through evaporation and evapotranspiration, leaving ever-increasing concentrations of Cl salts in the remaining soil-water.

Visible effects of elevated levels of soluble salts include loss of stand, reduced plant growth, reduced yields, and in severe cases, crop failure and salt crystallization on the soil surface. High soil salinity may also cause specific-ion toxicities or upset the nutritional balance of plants. In addition, the salt composition of the soil-water influences the composition of cations on the exchange complex of soil particles that in turn affect soil permeability and tilth (Corwin and Lesch 2005).

There is no internationally agreed method for measuring EC for routine soil testing purposes, the main variant being the soil/water ratio. Common ratios include 1:1, 1:2.5 and 1:5, in addition to saturation extracts. A 1:5 soil/water ratio ($EC_{1:5}$) has wide acceptance in Australia, as other determinations such as pH, water-soluble Cl and water-soluble NO_3 can be made in the same aqueous extract. The 1:5 soil/water extract represents a dilution above field water content of from five to >40 times, which typically results in an overestimation of salinity when soils are light textured and/or when they contain sparingly soluble salts such as gypsum (Shaw 1988; Tolmie and Biggs 2000).

Based on the interpretative criteria of Bruce and Rayment (1982), most horticultural species, field crops and pastures prefer soils with very low (<0.15 dS/m) to low (0.15–0.45 dS/m) values of $EC_{1:5}$. In contrast, high (0.90–2.0 dS/m) to very high (>2.0 dS/m) values of $EC_{1:5}$, which correspond to high concentrations of soluble salt in the soil, reflect soil conditions