Chapter 2
Objectives

Abstract Salinity affects soil, water and crop plants. The severity of soil salinity needs to be determined in order to make informed decisions on best cropping practices. Likewise, the tolerance of crop cultivars needs to be matched to the growing conditions. Protocols are therefore required to monitor field salinity and to evaluate crop tolerance to salt.

2.1 Monitoring Field Salinity

Soil salinity affects both, water availability and plant growth processes. Salinity refers to the presence of one or more of a number of dissolved inorganic ions (Na^+, Mg^{2+}, Ca^{2+}, K^+, $SO_4{}^{2-}$, HCO^{3-}, NO^{3-} and $CO_3{}^{2-}$) in the soil. Monitoring of soil salinity and the preparation of soil salinity maps are essential objectives for good management of salt-affected lands and the productive agriculture of salt-tolerant crop cultivars.

2.2 Screening for Salt Tolerance

The aims are to provide a screen in which salt-tolerant rice, wheat and barley lines can be selected for use in plant breeding. The screen may also be used to compare and classify salt tolerance in a range of germplasm. Extensive tests have been carried out at the IAEA's Plant Breeding and Genetics Laboratory (PBGL) using rice genotypes with known susceptibility/tolerance to saline field conditions. Correlations have been established between seedling hydroponics responses and field salinity tolerance. Thus, the seedling screen described here can be used to select plants that may be expected to perform well in saline field conditions.

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2.3 Benefits and Drawbacks of Seedling Screening

The protocols described in this book use seedlings as the test materials. Tolerance to salt at the seedling stage has been correlated with field performance (Zeng et al. 2003) and in the test cases given in Chap. 4 (Tables 4.6, 4.7 and 4.8), and selection on the basis of plant survival at high salt concentrations has been proposed as a selection criterion for several crop species (Rush and Epstein 1976; Epstein and Norlyn 1977). However, seedling screening should be regarded as a prescreen, and candidate lines should always be validated by performance in saline field conditions. Flowering time is often considered as a salt-susceptible stage and is not considered in these protocols. However, the hydroponic system may be adapted to test plants throughout their life cycling including flowering and maturity stages. The benefits and drawbacks of hydroponics screening for salt tolerance are listed in Table 2.1.

Seedling tests are best performed on M_3 or advanced populations. Tests may be done on M_2 populations which have the advantage of having relatively small population sizes, but there is a risk that the rare mutant line possessing salt tolerance is lost because of other factors, e.g. accidental miss-handling. M_3 populations and above provide more rigour as there is a degree of replication for genotypes carrying the same mutant trait.

The salt tolerance tests described in this booklet are simple and monitor seedling responses; they do not involve deep physiological understanding of the physiological mechanisms involved. Physiological aspects of salt tolerance are covered in the following references:

- Ashraf and Waheed (1990), Dewy (1962), Flowers (2004), Shannon (1985)—plant growth responses over the plant life cycle (germination to maturity)
- Shannon (1985), Neumann (1997), Epstein et al. (1980)—criteria for measuring salt stress
- Parida and Das (2005), Munns and Tester (2008)—effects on plants and mechanisms of salinity tolerance

Table 2.1 Benefits and drawbacks

Advantages	Drawbacks
• Cheap, fast and simple • Clear classification into susceptible, moderate and tolerant types • Tolerant seedlings may be recovered • High-throughput screen • Preselection technique for putative mutants • Equipment is reusable • Greater uniformity compared to soil-based salt tolerance screening	• Requires continual vigilance and maintenance (replenishment of test solution every 2 days) • Solutions need to be changed; therefore, adequate stocks of chemicals are required • Requires good-quality growing conditions • Homogenous, good seed quality required

References

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