Tolerance of wheat genotypes to subsoil constraints in southwest Queensland

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Abstract

We evaluated tolerance of wheat genotypes in two sets of trials, each at 3 locations to various levels and combinations of subsoil constraints, particularly acidity and phytotoxic levels of chloride (Cl). In experiment 1 the crop lower limit (CLL) at the low constraints site was significantly lower compared to other 2 sites and all 10 genotypes were able to extract water down to 1.30-1.40 m depths. Maximum depth of water extraction decreased with increasing constraints to 1.10-1.20 m depth at site 3 and 0.80-1.0 m at site 2. High subsoil Cl and acidity appears to have restricted water extraction in the subsoil. Preliminary results suggest that drought tolerant genotypes showed less reduction in maximum depth of water extraction than others. In the second experiment, increasing levels of subsoil Cl increased CLL and decreased maximum depth of water extraction significantly for both *Baxter* and *Sunco* wheat cultivars. *Sunco* was more seriously affected than *Baxter*. At two sites with similar concentrations of subsoil Cl there was a difference in the maximum depth of water extraction by wheat from 0.80 m at one site to 1.0 m at the other. Increased subsoil acidity (pH=4.7) at 0.70-0.90 m soil depth is a likely cause of the reduced depth of water extraction.

Key words

Acidity, chloride, crop lower limit, maximum depth of water extraction

Introduction

Subsoil constraints, particularly salinity, sodicity, acidity, phytotoxic levels of sodium (Na) and chloride (Cl) occur commonly in many soils of southwest Queensland (Dang *et al.* 2006). The primary effect of complex and variable combinations of subsoil constraints is to reduce the plant available water capacity and this effect is evident from increased crop lower limit (CLL) of available water (Sadras *et al.* 2003). Knowledge of the effect of subsoil constraints on increasing CLL will assist in identifying cultivars tolerant to the causal factors of subsoil constraints. The objective of this study was to quantify the relative tolerance of wheat cultivars to subsoil constraints for their use in breeding program.

Materials and Methods

Two sets of trials were conducted in Vertosols, each at 3 locations in southwest Queensland with various levels and combinations of subsoil constraints during 2005. In the first experiment, 10 wheat genotypes were evaluated in a complete randomised design replicated twice. In the second experiment, 2 wheat cultivars *Baxter* and *Sunco* were evaluated in a complete randomised design replicated thrice. Soil water was measured at sowing and at physiological maturity at 0.10 m and 0.20 m intervals thereafter throughout the 0.10-1.10 m soil profile. The topsoil layer (0-0.10 m) was excluded to obtain CLL to avoid confounding effects of soil evaporation and plant water uptake on minimum soil water content (Sadras *et al.* 2003). At crop maturity, plant samples from quadrats (2 m by 1.0 m) were taken randomly from 3 places to determine grain yield. Soils at each site were analysed for pH, and Cl in 1:5 soil water extracts (Fig. 1).

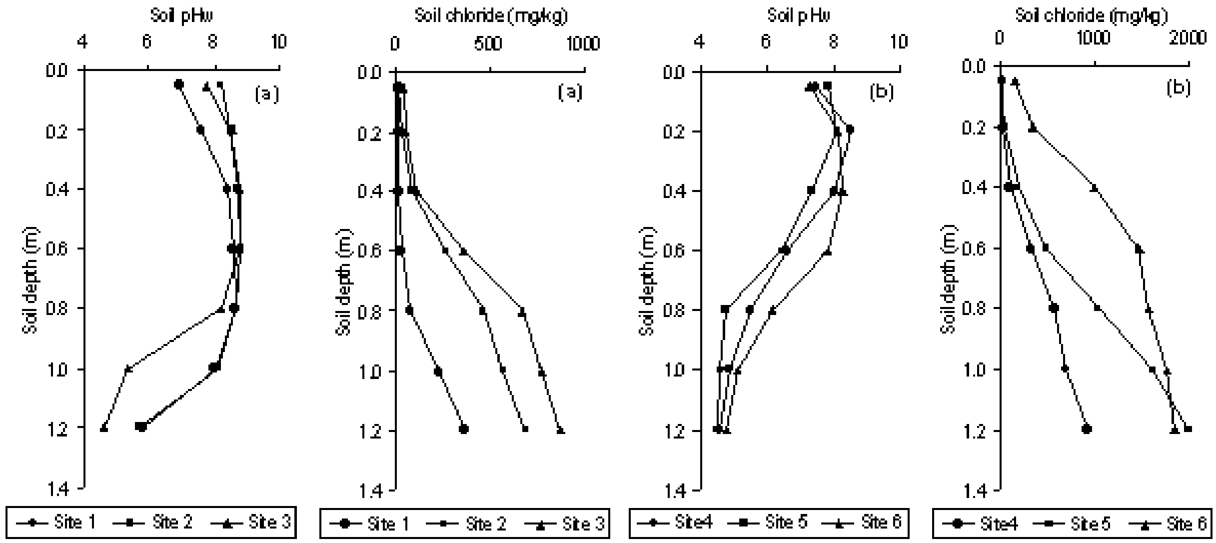

Fig. 1. Soil pH_w (water) and chloride profiles for 3 sites in (a) experiment 1 and (b) experiment 2.

Results and Discussion

In experiment 1 crop lower limit (CLL) at site 1 was, on average, considerably lower than for site 2 or 3 (Fig. 2) indicating that all genotypes had extracted more moisture at the site with the least subsoil constraints. All 10 genotypes were able to extract water down to 1.3-1.4 m depths at site 1. Maximum depth of water extraction was lower at site 3, 1.1-1.2 m and at site 2, 0.80-1.0 m (data not shown). Subsoil acidity at site 2 and high subsoil Cl concentration at site 3 were the likely causes of a higher CLL and reduced rooting depth compared to site 1. Preliminary results suggest that drought tolerant genotypes such as *Dhawar* and *Seri* exhibited a smaller increase in CLL with increase in constraints at site 2 and 3 and less reduction in maximum depth of water extraction than the standard genotype *Hartog*.

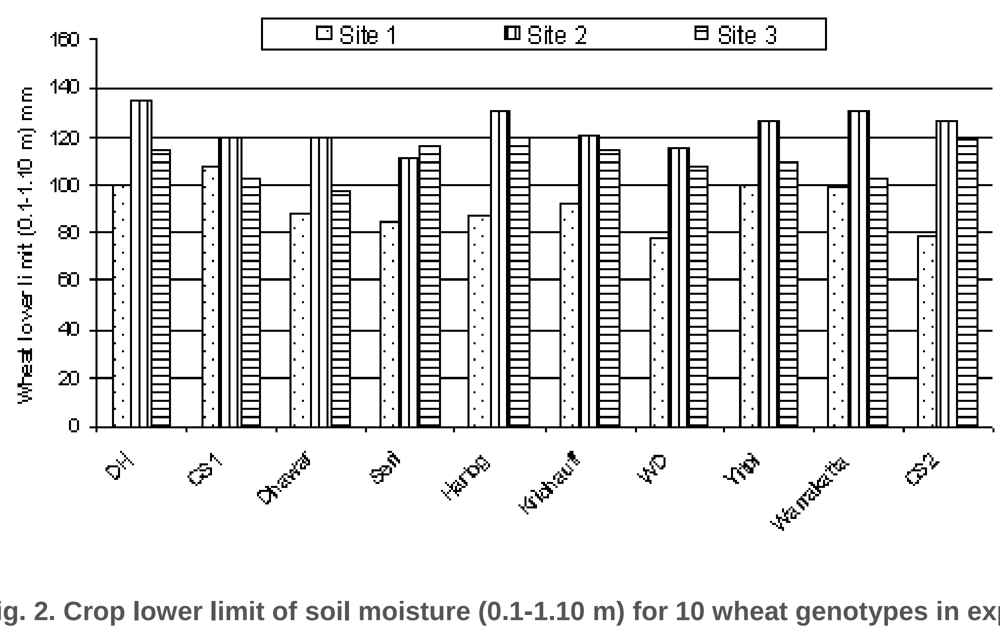

Fig. 2. Crop lower limit of soil moisture (0.1-1.10 m) for 10 wheat genotypes in experiment 1 including 6 named cultivars along with "DH" a doubled haploid from a cross between *Seri* and *Hartog*, "*CS1*" and "*CS2*" two CIMMYT synthetic hexaploids and durum line "WD".

In experiment 2, sites with higher levels of subsoil Cl had significantly higher CLL and lower maximum depths of water extraction (Fig. 3), and grain yield (data not shown) for both *Baxter* and *Sunco* cultivars. *Sunco* was more seriously affected than *Baxter*. Sites 5 and 6 with similar concentrations of subsoil Cl at 1.0 m, exhibited a difference in maximum depth of extraction from 0.8 m at site 5 to 1.0 m at site 6. Lower pH at 0.70-0.90 m soil depth at site 5 is a likely cause of the reduced depth of water extraction.

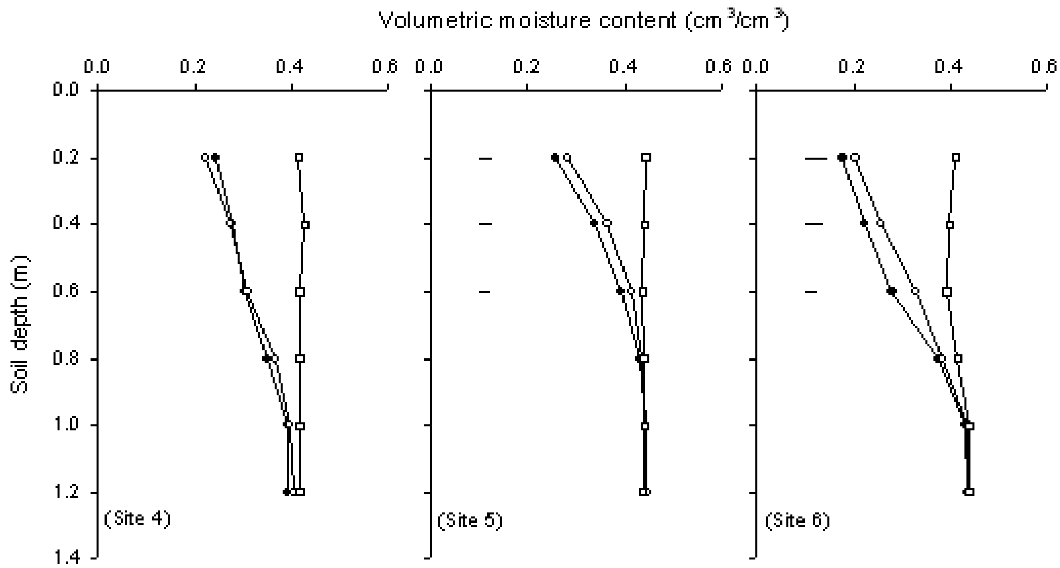

Fig. 3. Pattern of soil water extraction by *Baxter* (●) and *Sunco* (○) cultivars of wheat in experiment 2.

Acknowledgements

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