# Screening wheat genotypes in alkaline sodic subsoil

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## Key findings

- Genotypic variability observed in response to wheat grain yield in alkaline sodic subsoil.
- Mace⌽, Corack⌽, Scepter⌽ and Emu Rock⌽ were the top performing cultivars over three consecutive years.
- Higher grain yield was attributed to greater subsoil water extraction and capacity to maintain higher harvest index under drought conditions.

## Introduction

Among different soil constraints, sodicity is associated with the largest yield gaps across most of the wheat-cropping areas of Australia, with an estimated yield loss of $A1,300 million per annum (Orton et al., 2018). Sodic soils exhibit a range of physicochemical properties including high subsoil exchangeable sodium (Na) concentrations, which cause soil dispersion leading to poor subsoil structure, impeded drainage, waterlogging, denitrification and high soil strength. Genetic improvement is frequently advocated as an avenue for improving crop productivity and adaptation under different hostile soil conditions (Nuttall et al., 2010; McDonald et al., 2012). This paper presents results from a genotype screening experiment conducted in 2019 at Grogan in southern NSW for identifying wheat genotypes and traits linked to sodicity tolerance under field conditions with subsoil sodicity.

## Site details

| | |
|---|---|
| **Location** | Grogan, southern NSW |
| **Soil type** | Sodosol |
| **Previous crop** | Canola |
| **Sowing** | Direct drilled with DBS tynes spaced at 250 mm using a GPS auto–steer system (17 May 2019). |
| **Target plant density** | 130 plants/m$^2$ |
| **Fertiliser** | • 90 kg/ha mono-ammonium phosphate (MAP) (at sowing).<br>• Urea 163 kg/ha (top dressed on 11 July 2019). |
| **Rainfall** | • Fallow (December 2018–April 2019): 200 mm<br>• Fallow long-term average: 223 mm<br>• In-crop (May 2019–November 2019): 124 mm<br>• In-crop long-term average: 356 mm |
| **Harvest date** | 19 November 2019 |

## Treatment

| | |
|---|---|
| **Genotype** | Bremer⌽, Condo⌽, Corack⌽, Emu Rock⌽, Gladius⌽, EGA Gregory⌽, Hartog; Janz; LPB10-2555; Mace⌽; Magenta; Scepter⌽, LongReach Scout⌽, Sunco, Suntop⌽, LongReach Trojan⌽, Wallup⌽ |

This research paper is an extract from the publication *Southern NSW Research Results 2020*, available at https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/southern-nsw-research-results

## Results

### Growing conditions

The soil profile was slightly acidic in the top 10 cm ($pH_{1:5\ water}$ 5.9) and pH dramatically increased with depth (Table 1). The changes in soil sodicity (exchangeable sodium percentage, ESP) followed a similar trend to soil pH with ESP at 10.5% in the topsoil and increasing to 40% in the subsoil (Table 1). The site received slightly less summer rainfall (200 mm, December 2018–April 2019) compared with the long-term average (223 mm). However, during the crop growing season (May–November 2019) the site received 124 mm, which is only 34.8% of the long-term average rainfall (356 mm).

Table 1 Chemical properties at different depths of the soil profile at the Grogan experiment site.

| Soil depth (cm) | $pH_{1:5\ water}$ | EC (µs/cm) | ESP (%) |
|---|---|---|---|
| 0–10 | 5.9 | 309.4 | 10.5 |
| 10–20 | 7.7 | 133.0 | 11.9 |
| 20–30 | 8.8 | 136.9 | 15.9 |
| 30–40 | 9.1 | 207.7 | 20.1 |
| 40–60 | 9.6 | 338.9 | 26.3 |
| 60–80 | 9.5 | 530.4 | 36.7 |
| 80–100 | 9.4 | 897.2 | 40.3 |
| 100–120 | 9.4 | 1148.2 | 40.4 |

Values are means (n = 5). EC, electrical conductivity; ESP, exchangeable sodium percentage.

### Grain yield

Significant (*P*<0.001) genotypic variation occurred in grain yield among the studied genotypes. Grain yield ranged from only 0.57 t/ha (EGA Gregory⁽ᶲ⁾) to 2.0 t/ha (Scepter⁽ᶲ⁾, Emu Rock⁽ᶲ⁾ and Mace⁽ᶲ⁾: Figure 1). Biomass at final harvest did not significantly differ among the genotypes (data not shown; *P* = 0.11) and there was no significant (*P* = 0.09) correlation between grain yield and biomass at the final harvest (Figure 2a).

Significant variation was observed in harvest index (data not shown; *P*<0.001), which ranged from 0.08 (EGA Gregory⁽ᶲ⁾) to 0.26 (Scepter⁽ᶲ⁾). A significant (*P*<0.001) and positive correlation between harvest index and grain yield was observed among the studied genotypes (Figure 2b).

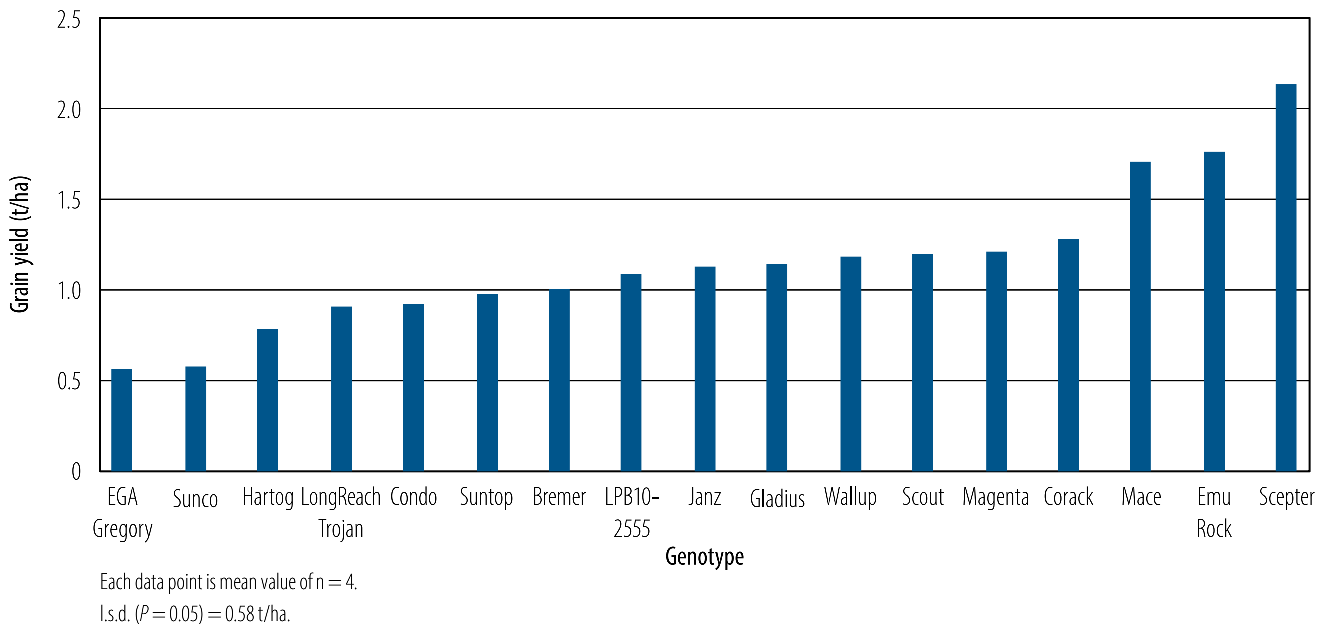


Figure 1 Variations in grain yield (t/ha) of 17 wheat genotypes grown in alkaline sodic dispersive subsoil at Grogan, southern NSW in 2019.

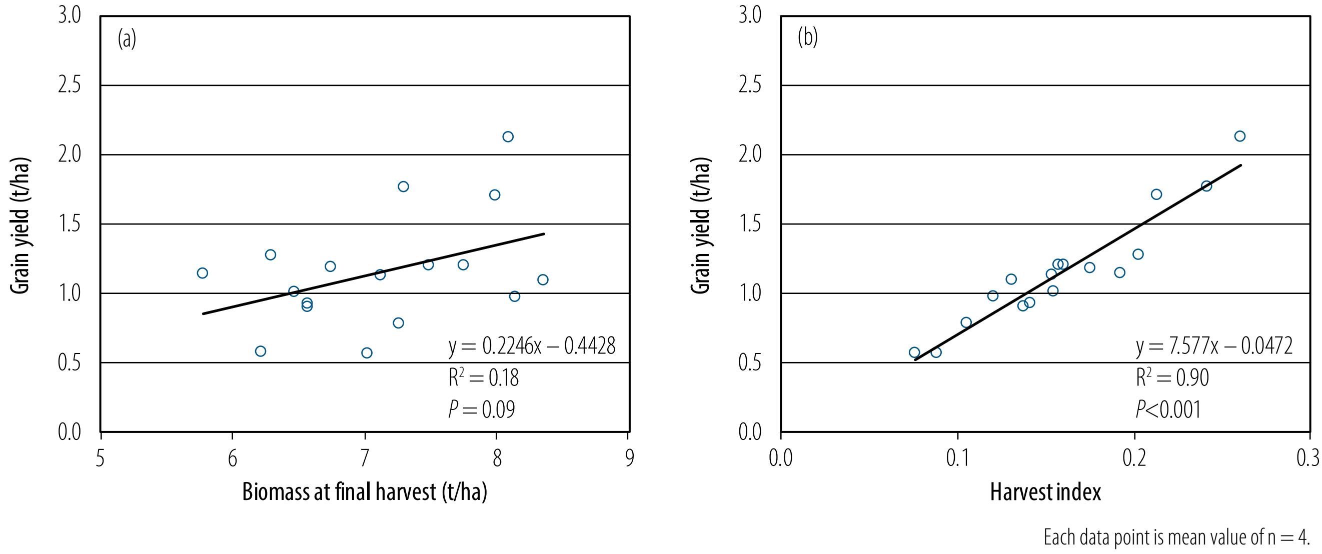


Figure 2 Linear regressions between grain yield and biomass at final harvest (a: left) and harvest index (b: right) of 17 wheat genotypes grown in alkaline sodic dispersive subsoil in Grogan, southern NSW in 2019.

## Conclusion

Identifying traits associated with superior tolerance to different soil constraints could be a low-cost technique to tackle subsoil constraints (McDonald et al., 2012). The intense drought conditions in the experiment year revealed considerable genotypic variation, with some genotypes having a more than three-fold higher grain yield than other genotypes.

Based on controlled-environment studies, the high yielding varieties, Mace⦵ and Emu Rock⦵, are moderately tolerant to tolerant to high pH and have roots that can grow relatively well through soils with high bulk density, whereas low yielding varieties such as EGA Gregory⦵, Hartog and Sunco are sensitive to one or both of these stresses. The very low harvest index in the experiment suggests that there was severe stress around flowering, which reduced grain set as well as during grain filling. The results suggest that the ability to maintain root growth could have helped to alleviate the stress in varieties such as Emu Rock⦵ and Mace⦵. The different traits associated with this greater yield performance from wheat genotypes should prove to be crucial in future breeding programs. We might have overlooked the optimum sowing window for the studied genotypes, which is an important factor for grain yield variability under dryland conditions and needs to be considered in any future screening experiment for sodicity tolerance.

## References


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## Acknowledgements


This experiment was part of the 'Improving wheat yields on sodic, magnesic, and dispersive soils', UA00159, 2015–20. The project is a collaborative partnership between GRDC, NSW DPI, The University of Adelaide (UA), The University of Queensland (UQ) and the Department of Agriculture and Food Western Australia (DAFWA).