Raised-bed cropping leading the way in high rainfall southern Australia

R. Peries[1], T. Johnston[1, 2,] C. Bluett[1] and B. Wightman[1]

[1]Department of Natural Resources and Environment and Southern Farming Systems, PO Box 103, Geelong, Victoria.
[2]Joint Centre for Crop Improvement, The University of Melbourne, Parkville, Victoria.

Abstract

Using a farming systems approach, two drainage systems: narrow (1.7m) and wide (20m) raised beds are being developed by Southern Farming Systems (SFS) to minimise stress damage to crops due to waterlogging. In the first three years since introduction, narrow raised beds have produced up to 4-fold increases in crop yields on growers' properties, compared to district practice. The long-term sustainability of raised beds across different farming systems and the potential environmental impacts associated with the quantity and quality of any run-off water and deep drainage are currently being investigated.

Key words

Crops, drainage, raised beds, soil structure, waterlogging.

Introduction

In south-west Victoria, many traditional sheep farmers are expanding their cropping enterprise because of the poor returns from wool. However, their attempt to grow profitable crops is frequently unsuccessful in the 500+ mm-rainfall region due to winter waterlogging during the long cool growing season. The expectation of better crop performance on raised beds is primarily based on farmer experience of improved drainage and better root growth (1) under average rainfall conditions. The reduction in waterlogging and the minimum tillage and controlled traffic associated with these new systems, appear to be contributing to improvements in soil structure, both in the short and long term. This paper summarises the current investigations and preliminary results of two of the main raised bed research trials being undertaken in south-west Victoria.

Materials and Methods

The development and long-term sustainability of raised beds are being investigated at the SFS trial site at Gnarwarre (249730E; 5774070N, 510mm mean annual rainfall), 25 km west of Geelong. The environmental impacts of possible surface run-off and deep drainage from raised bed crops are compared with crops on the flat at the SFS 'Concept Farm' (241860E; 5769810N), Gnarwarre, 30 km west of Geelong in south west Victoria.

SFS systems trial

The experimental area consists of 14ha, with 36 plots each measuring 0.4ha each. Four different sub-soil types have been identified in the trial area (D. Adcock and R. MacEwan, pers. comm.) which are expected to behave differently in response to bedding and waterlogging. Three different rotations are being evaluated using four grain crops [Canola (C), Wheat (W) and Field Pea (Pe), Barley (B)] and two pastures [Perennial (Pp) and Annual (Pa)]. The drainage treatments, ie. narrow raised beds (1.7m) and wide raised beds (20m) are superimposed on the rotations and were installed in March 1999. The rotation treatments are; (a) continuous cropping (eg. CWPeB), (b) short 2 x 2 rotation (eg. CWP_aP_a) and (c) long 4 x 4 rotation (eg. $CWPeBP_pP_pP_pP_p$}.

SFS environmental impacts trial

The trial to investigate water and nutrient losses from raised beds was installed in mid 1999. The trial site is a randomised block design, with 3 cropped treatments (0.2 ha /plot) replicated 3 times, and 1 unreplicated pasture plot (1.5 ha). Surface run-off and deep drainage (to 1.5m) is being measured on all treatments. The soil type is a grey sodosol (2) and the site is managed by the grower. The crop and pasture treatments are: (i) crop without beds (shallow cultivation: 75 mm) (ii) crop without beds (deep cult.: 150-200mm), (iii) crop with narrow raised beds (deep cult.: 150-200mm and 2.0m beds), and (iv) a pasture plot on a similar soil type & gradient (1%) to the cropped plots.

Results and discussion

Preliminary soil results from the initial 'SFS drainage site' (R. McEwan, pers. comm.) indicated that in less than two years after installation of raised beds in 1998, the bulk density of the top 7.5cm of soil dropped from 1.6 to 1.2 g/cm^3, accompanied by an increase in total porosity compared to the flat. Consequently the gravimetric water content on beds was also higher. The higher porosity of the soil in the bed is considered a result of the increased depth of aggregates generated by self-mulching of the soil surface and the absence of traffic. More frequent wetting-drying cycles are also expected in the beds than on the flat, which is likely to be the major contributor towards the generation of a deeper surface mulch of aggregates (R. MacEwan, pers. comm.).

In 1999, the growing season rainfall (May-Nov) for the Gnarwarre District was 248mm, 93mm below the 100-year mean and was the third year in succession to experience below average rainfall. Consequently, at both sites, the soil profile down to 1m depth was near or below wilting point at the end of season as a result of thorough extraction of soil water by crops. At 125 days after sowing (25 October), the total dry matter production at the centre of wide raised beds exceeded those of the narrow raised beds and the edges of the wide raised beds, by as much as 40%. While the greater volume of top soil at the centre of wide raised beds appeared to favour this phenomenon, the greater soil surface exposure on the narrow raised beds appeared to enhance unproductive loss of water from them under below average rainfall, thus limiting plant available water for crop growth. Final yield of crops did not differ significantly between treatments and were considerably higher than the district average for the same year.

Soil organic matter accumulation and water retention down the depth of profile are being monitored at regular intervals which should provide an explanation of the beneficial improvements to soil structure that favour improved crop performance on raised beds. A greater understanding of the temporal release of air-filled pore space during waterlogging events will also advance our understanding of optimum bed widths for different subsoil types. The effect of sheep treading on soil physical properties is also investigated during the grazing phase of systems.

The dry seasonal conditions in 1999 and 2000 have restricted the collation of data from the environmental trial site. No surface run-off water samples have been collected as yet, and there has been no significant soil water fluxes occurring down to a depth of 1.5m. Surface run-off samples will be analysed for nitrogen (nitrate and total N), phosphorus (dissolved reactive P and total P), pH, EC and turbidity. It is anticipated that raised bed cropping will not significantly increase the volume and quality of water being lost from raised bed cropping paddocks on an annual basis, compared to conventional flat cropped country.

Conclusion

The drainage of excess water and the apparent soil structure improvements associated with minimum tillage and controlled traffic operations imposed by the drainage treatments (raised beds) are contributing to breaking regional yield barriers and consequently bringing about significant agricultural change in the region.

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