The application of precision agriculture techniques to assess the effectiveness of raised beds on saline land in WA.

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Abstract

The application of raised beds to reduce waterlogging in broad-acre farming on non-saline soils has been widely adopted in some areas of the states of Victoria and Western Australia (WA) in Australia. The application has now been extended to saline waterlogged land with the aim to eliminate waterlogging and reduce the salt levels and to improve the productivity in those areas.

Three large experimental sites (60 – 80 ha) were installed in 2002 in WA with a range of salinities and various degrees of waterlogging. Two forms of raised beds were implemented: with and without deep cultivation prior to bed forming. A control was used to assess the impact of these treatments. During the last four years the spatial distribution of soil conductivity, biomass and yield data was collected at different times using an electromagnetic induction (EM38), multi-spectral digital images and a yield monitor, respectively. Soil conductivity, biomass and yield relationships were developed for each treatment using a relative yield approach to accommodate the large spatial variations in the yield.

The results to date indicate a significant effect of the bedding treatments on the yield due to the elimination of waterlogging but as yet little effect on the salt balance. From the spatial assessment it is clear that, in the absence of salinity, significant increases in yield should be possible.

Key Words

Waterlogging, salinity, yield maps, EC, EM38

Introduction

Significant areas of the Western Australian Wheat Belt experience elevated levels of soil salinity and are prone to waterlogging particularly in lower lying areas. Research into the application of raised beds to alleviate waterlogging has shown that yield increases can be obtained with that farming system. The impact of raised beds on waterlogged **and** saline land has not been clear and has been the subject of a research project. Due to the spatial extent of salinity and waterlogging the effectiveness of the raised beds was assessed using spatial techniques familiar to precision agriculture. Some results will be presented in this paper.

Methods

Three (only one site reported here?) large (about 60 ha) experimental areas located in the South Western part of WA and were selected on the basis of the range of salinities, the susceptibility to waterlogging, and their representation of significant portions of the landscape. The initial salinity across the areas was established through an electromagnetic (EM38) and topographic survey. The electrical conductivity (ECa) obtained with the EM38 is a very good predictor of salinity to a depth of 60-70cm. Based on this information the experimental layout was determined (what was the experimental layout?), shallow surface drains and the treatments installed in 2002. Subsequent salinity surveys were carried out each year during the winter after seeding and after each harvest (through EM38 or soil tests?). The treatments consisted of a cropping and a pasture area with raised beds (RB) which are beds made following a deep soil cultivation and an annual soil loosening, no-till beds (NT) which are beds made without any prior soil cultivation or annual soil loosening and a control (C) flat land no tillage?. The choice of crop and pasture

pasture not measured or reported? composition varied from site to site and was determined by the growers.

A yield (grain?) map was generated at each harvest. Because the salinity and the yield were not obtained in exactly the same position (if yield and salinity were determined from maps of the area, why could the same position not be located?) , an interpolated yield was obtained at each point where the salinity was measured how was this done?. In order to extract the salinity effect on the yield other factors such as, for example, waterlogging, soil nutrition and weeds had to be excluded. This was done using the approach of relative yield. With the relative yield the yield at each point within a plot (plot arrangement and characteristics are not explained) is calculated relative to the yield at a level of salinity (i.e. 50 -100 mS/m) in that plot that should not have affected the yield, hence excluding the confounding effects such as weeds, waterlogging and soil nutrition. With this approach it is assumed that those effects are uniform across the plots. This doesn't adequately explain how relative yield was determined (ie yield at a level of salinity). Were weeds, waterlogging and nutrition uniform across the plots and were they measured?

Results and Discussion

The results presented are limited to Woodanilling. The yield (what was the crop?) in 2004 as well as the relative yield as a function of salinity (EC_a) is presented in Figure 1.

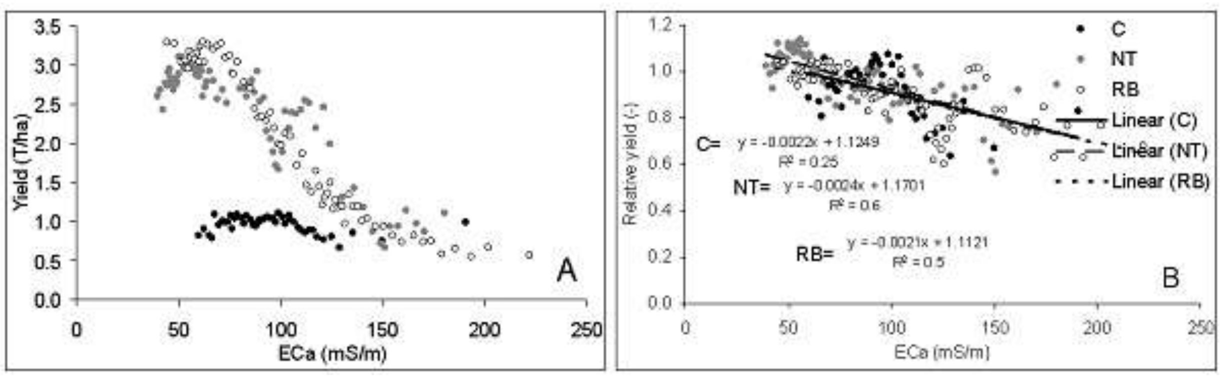

Figure 1 Yield as a function of salinity for the control (C), raised beds (RB) and the no-till beds (NT) (A) and the relative yield (B). Each data point is the average of 50 data points.

From Figure 1A it is clear that introducing raised bed (NT & RB) to this landscape can significantly improve the yield. From the same yield vs. salinity relationship for the NT and RB treatment, a strong salinity effects appear to be present. The yield in the beds remained constant until a level of about 80 mS/m after which the yield declined rapidly. The yield was converted to a relative yield and presented in Figure 1B. With that approach the apparent salinity effect has been reduced with little difference between the treatments in the salinity effect on relative yields (Fig. 1B) because the slope of the three regression lines is identical. What appeared to be a salinity effect in Figure 1A was confounded by other factors as presented in the next section.

There were large differences in yield in the various plots for a given salinity as presented in Figure 2.

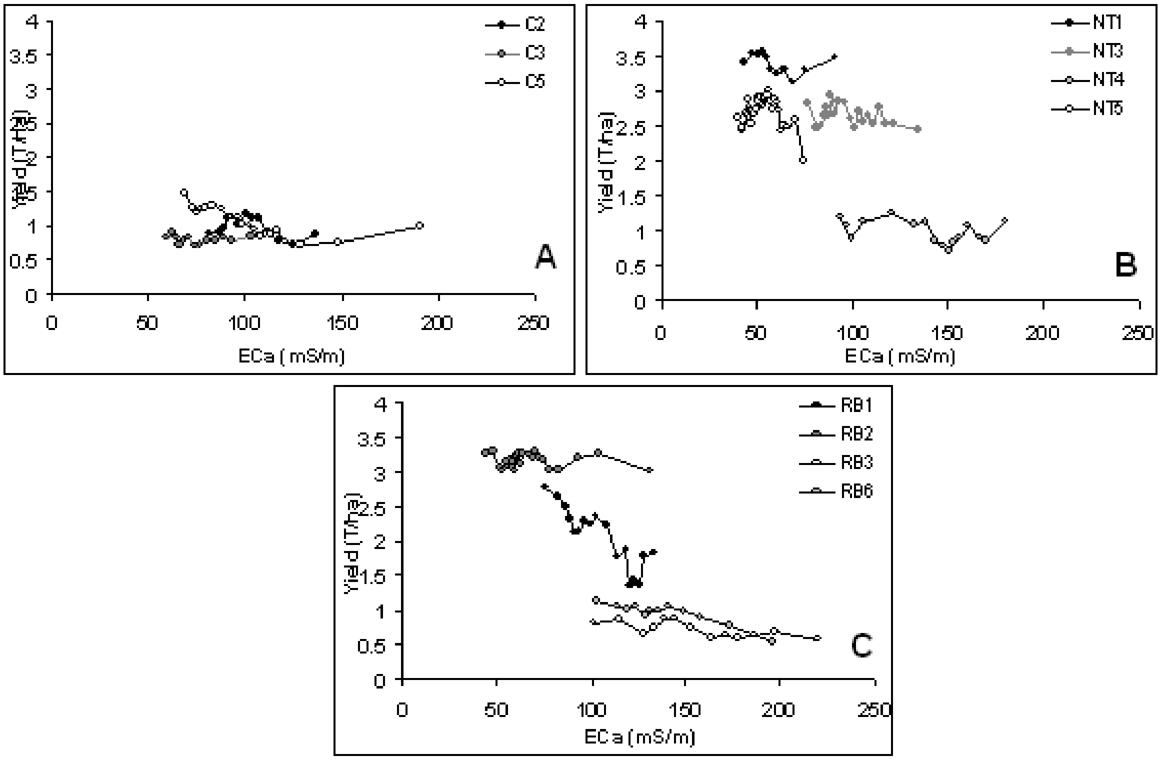

Figure 2. Yield as a function of salinity for the various plots for the control (A), the no-till beds (B) and the raised beds (C).

Little difference was found between the plots in the control (Fig. 2a). All were affected by waterlogging and weeds to a level that salinity did not affect the productivity. For the NT treatment NT1 was the most productive plot. Plot NT1 has the largest depth to the ground water, the best nutrition, the least exposed to waterlogging and very few weeds. The productivity of the raised beds also varies greatly. Good yields were achieved in RB2 which is also well drained, a good fertiliser history, few weeds despite some moderately salinities i.e. up to 130 mS/m, again illustrating the yield potential for such salinities. RB3 is poorly drained as well as poor weed control, fertiliser history and very high salinities resulting in an overall poor productivity. RB6 is very well drained but has high levels of salinity, a poor fertiliser history and has a big weed problem which upsets the yield potential. At an EC_a of 120 mS/m the yield ranged from 3 to 0.9 t/ha. It is difficult to understand this section, as there has been no explanation of plot or the measurements taken. As the paper is only a poster presentation and should be limited to 2 pages, I suggest that the author concentrates on clarifying how yield and relative yield calculations were determined to demonstrate that productivity on saline land can be improved by controlling waterlogging, weeds and nutrition.

Assuming a threshold of 120 mS/m the potential to improve yields by better drainage, fertiliser application and weed management is considerable (i.e. 2 t/ha). From this approach it is clear that large gains in the yield here at Woodanilling can be expected to be made when salinity is the only limiting factor and when weed control, fertiliser and surface water management are improved.

Conclusions

The application of raised beds to waterlogged and saline land would significantly improve the productivity from such landscape. The alleviation of waterlogging greatly improved the yield, but pockets of high salinity still limited the yield in areas. Using a spatial assessment of salinity and yield no differences between treatments were found in the manner salinity was affected. However it was clear that in the absence of waterlogging and salinity other factors such as soil fertility and weed burden also limited the yield. These can be managed which would allow a further improvement in productivity.

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