Alternative bed shapes to improve potato yields and water use

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Adequate water supply is a key requirement for achieving high yields in potato crops. However, in a farming situation, there are irrigation management factors outside of the grower's control that can cause water stress for the crop, for example: pressure to irrigate other crops, water restrictions and drought.

A trial was conducted by the Plant & Food Research Field Crops team on an experimental block at Lincoln to look at the possibility of using a flatbed architecture (as opposed to the conventional ridge/furrow) to try to improve root access in the soil profile and therefore water use efficiency. The soil at the site was a deep Templeton silt loam with an available water-holding capacity of approximately 190 mm/m of depth. It was also characterised by a 400mm thick hard subsoil layer, starting at approximately 250 mm depth.

The treatments consisted of:

- Two bed architecture types
    - ridge/furrow (2 rows per bed)
    - flatbed (4 rows per bed)
- Two contrasting irrigation regimes
    - high: irrigation to field capacity once a week from emergence, then twice a week from full canopy onwards (no water stress)
    - low: irrigation to field capacity once the soil moisture in top 400 mm of soil was close to wilting point (severe water stress)
- Two sub-soil tillage techniques
    - sub-soiling as deep as possible to shatter the dense subsoil layer (370 mm)
    - no sub-soiling

Methods

The cultivar used was 'Bondi'. Plots were arranged as a split-plot design replicated four times; the main plots were the two irrigation regimes, and the split plots consisted of the two bed architectures and the sub-soil tillage treatments (Figure 1). Each split-plot was 12 rows (0.8 m row spacing) by 10 m. Irrigation was applied using a single span lateral irrigator. There was a 12 m buffer of fallow soil between each main plot.

Figure 1. Bed architecture trial in early January when the crop was at full canopy. Each group of four split-plots makes up a main plot under one of the irrigation regimes.

Several implements were tested for the sub-soil tillage treatment to try to shatter some of the dense sub-soil layer. No equipment would penetrate further than 370 mm from the surface. The sub-soiler implement used to apply the treatment can be seen in Figure 2.

Figure 2. Sub-soiler used to apply a sub-soil tillage down to 370 mm on half of the plots.

The ridge/furrow plots were planted with a two-row planter. Seed spacing was 280 mm and planting depth was 200 mm. The flatbed plots were hand planted in furrows created using a modified spring tine implement attached to a power harrow. Seed spacing was also 280 mm with a planting depth of 200 mm (Figure 3). To achieve a flat surface, the flatbed plots were hand-raked after planting. All plots were planted using whole seed.

Figure 3. Planting of a flatbed plot (left), leveling the flatbed plots after planting (right).

Soil water content down to 1000 mm depth was measured using automated reflectometers (TDR) in the top 200 mm and a neutron probe for the remaining depths. The neutron probe access tube and TDR were installed within the row and between two plants.

Tuber yield was measured after canopy senescence, 180 days after planting, by hand digging 8 m of four rows (25.6 m^2 area). Tubers were graded based on reject (less than 65 mm in length) and marketable (65 mm or more in length). Tuber dry matter was measured from a subsample of tubers dried for 48h at 60°C.

Results

At 85.1 t/ha, yield was consistently greater from the flatbed configuration under the high irrigation regime compared to ridge/furrow bed shape (79 t/ha) (Figure 4). The yield difference was less significant between flatbed and ridge/furrow bed architecture under the low irrigation regime (63.5 and 61.2 t/ha respectively). Not surprisingly, marketable yield was greater for both bed architectures under the high irrigation regime than under the low irrigation regime (Figure 4).

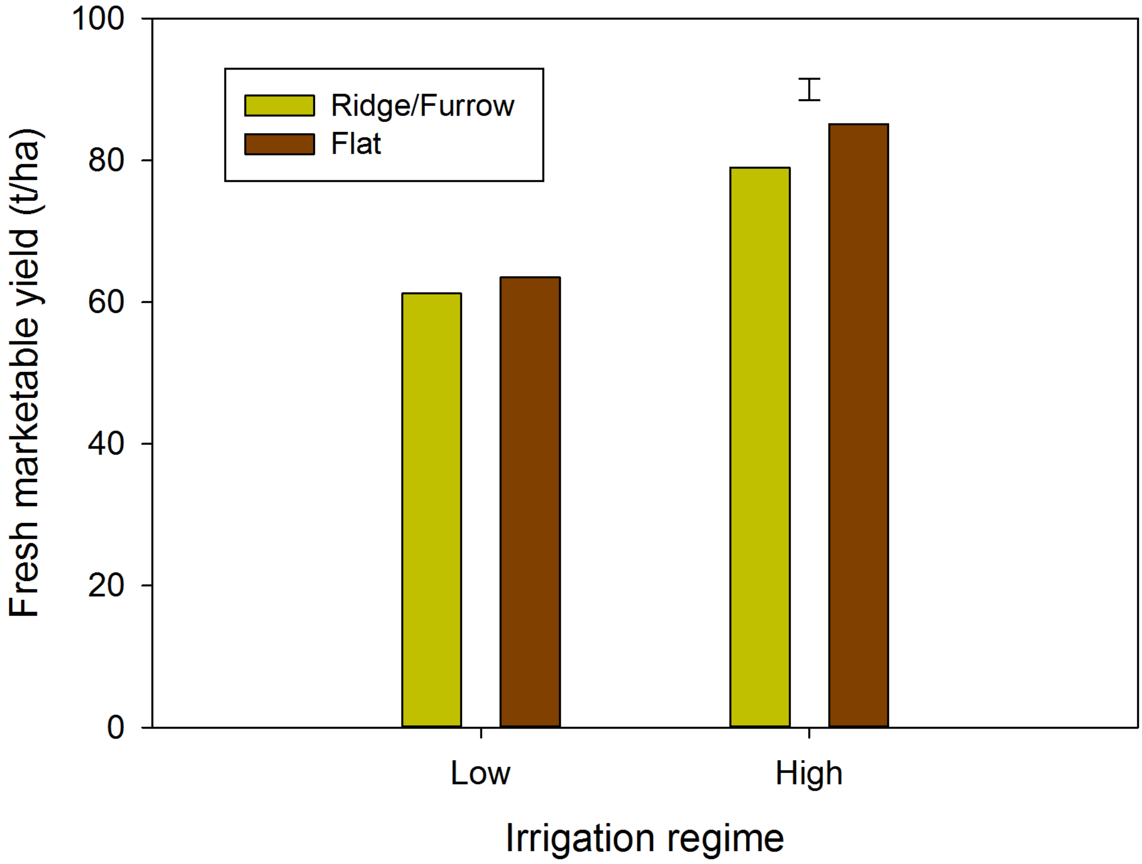

Figure 4. Average fresh marketable tuber yield from potatoes grown in ridge/furrow or flatbed and under a low or high irrigation regime. The bar represents LSD (5%).

The difference in yield between a ridge/furrow and a flatbed architecture could be explained by the fact that the potato roots had more space to develop and explore horizontally in flatbed plots. At full canopy (January), pits were dug down to the subsoil in one of the replicates to visually assess root development. In the ridge/furrow plots, root development in the top soil layer (top 400 mm) was good in the ridge area but was poorer in the furrow and wheel track (Figure 5). In the flatbed plots, root development in the top soil layer was good across the whole bed (Figure 6).

The subsoil tillage treatment did influence yield and this was attributed to the fact that it only partially loosened a further 120 mm of the dense layer.

Figure 5. A root development assessment pit in a ridge/furrow plot. Root development is good in the top 400 mm of the ridge (centre) where plenty of roots of different thicknesses can be observed.

Root development is poorer in the bed furrow (right) and almost non-existent in the wheel track (left) where few to no roots can be observed.

Figure 6. A root development assessment pit in a flatbed plot. Root development in the top soil layer (top 400 mm) is good across the whole bed: numerous roots can be seen from left to right.

The Field Crops team at Plant and Food Research have plans to modify conventional planting equipment in order to further investigate alternative bed shapes: a two-row planter modified to plant in different bed configuration from ridge/furrow to flatbed, including modified ridge profiles. The team hope to have it ready for next season (2017/18) and already have a plan to test alternative bed shapes and see if those can help improve yields and/or water use efficiency of potato crops.

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