Initial findings show benefits of controlled traffic for intensive vegetable production

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Introduction

Controlled traffic farming (CTF) keeps all paddock traffic in the same wheel tracks, thereby separating compacted traffic zones from soil used for growing crops, and providing a wide range of benefits for crop production. Benefits observed in research and commercial practice in the grain and sugar industries include reduced soil erosion, more efficient energy, water and fertiliser use, improved soil structure, organic matter and timeliness, and increased productivity (Bowman 2008; Lamers et al. 1986; McPhee et al. 1995; Stewart et al. 1997; Vermeulen et al. 2007).

Use of CTF in the Australian grain and sugar industries has increased in recent years as the benefits have become more widely recognized. The uptake of CTF in the intensive vegetable industry is almost non-existent for a number of reasons, including diversity and incompatibility of current equipment, and often, a diversity of ownership arrangements (e.g. private, contractor and company-based machines) requiring industry-wide involvement for effective change.

Recent research in vegetables in Tasmania has provided evidence of improved soil conditions through the use of controlled traffic, while on-farm demonstrations have identified a number of factors that need to be addressed for practical adoption of the technique. Issues to be resolved for successful adoption of CTF in vegetable production include tracking stability on compacted wheel tracks, and implement working and track width compatibility.

Materials and Methods

A 2 ha experimental site near Devonport, Tasmania, has red ferrosol soils, and is representative of the prime vegetable production areas in Tasmania. The site has undulating topography and a winter dominant rainfall of 1000 mm/y. Irrigated summer vegetable cropping is the main enterprise of the region, although rain-fed winter crops are also grown.

The site has two treatments – controlled traffic based on a 2 m wheel track, and conventional practices using random traffic. Both treatments are cultivated as required, although the type, number and intensity of tillage operations varies with the treatment and seedbed requirements. Measurements taken at various times each season include soil bulk density, and related derived parameters, and soil resistance. Bulk density cores are taken at depths 0 – 50, 125 – 175 and 275 – 325 mm and provide data on bulk density, porosity, gravimetric and volumetric water content, water filled pore space and the ratio of soil:water:air in the sample. Soil resistance data are collected at 100 mm intervals across a 3 m transect, to a depth of 600 mm at 15 mm intervals.
Demonstration sites have been established on two farms with similar soil types, and on a third site with duplex soils. Less intensive monitoring occurs on these sites, which are used for testing and demonstrating controlled traffic within the constraints of existing farming operations.

**Results and Discussion**

Results are presented for porosity, water filled pore space, infiltration and tillage operations on the main research site. Although soil cores were taken at three depths, only data from 150 mm is presented. This is often the approximate depth of final seedbed tillage operations. Data for other depths reflect similar trends, although the magnitude of differences varies.

*Porosity*

Porosity is derived from bulk density samples. Figure 1 shows porosity under controlled traffic is consistently higher than under conventional management. The increase in porosity under controlled traffic has implications for water holding capacity, drainage, aeration and root growth, all of which can be beneficial for plant growth.

![Figure 1. Soil porosity at 150 mm depth from areas managed with conventional tillage and controlled traffic. Error bars indicate S.E. of means. All differences between treatments are significant (p<0.05) with the exception of the data for Jul 10.](image)

*Soil-water-air ratio*

Figure 2 shows that, as well as higher porosity, soil under controlled traffic also has a more balanced ratio of water:air in the pore spaces. Very high percentages of water filled pore space indicate conditions approaching anaerobic, which can significantly influence the incidence of root disease and the generation of nitrous oxide emissions from nitrogenous fertilisers. Nitrous oxide is a high impact greenhouse gas, and the soil conditions under controlled traffic have the potential to reduce the level of emissions.
Infiltration

Only one set of infiltration tests has been conducted so far on the trial site. A Cornell Infiltrometer was used and the data showed a substantial difference in infiltration capacity between the two treatments (Table 1). This change will reduce run off and erosion from the crop beds, and has implications for capture and storage of rainfall and irrigation water.

Table 1. Infiltration test data from conventional and controlled traffic treatments (July 2010).

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Controlled traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of test (min)</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Average time to run-off (min)</td>
<td>4</td>
<td>Not reached</td>
</tr>
<tr>
<td>Average run-off rate (mm/h)</td>
<td>202</td>
<td>0</td>
</tr>
</tbody>
</table>

Tillage operations

Controlled traffic eliminates compaction removal as a primary reason for tillage in vegetable production. Consequently, tillage operations under controlled traffic are largely directed towards residue management and seedbed preparation. This reduces the number and energy intensity of tillage operations required (Table 2).

Table 2. Number of tillage operations to transition between crops managed under conventional and controlled traffic systems.

<table>
<thead>
<tr>
<th>Crop transition</th>
<th>Conventional</th>
<th>CTF</th>
</tr>
</thead>
<tbody>
<tr>
<td>potato - onion</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>onion - broccoli</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>broccoli - beans</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

The changes in soil condition that occur through the use of controlled traffic will have impacts across all aspects of vegetable production. Soil that is not impacted by traffic compaction provides a more robust growing environment under variable climatic conditions and requires significantly less effort for seedbed preparation. The initial findings show clear benefits from controlled traffic for soil management in intensive vegetable cropping. These benefits will be further monitored over the remainder of the project, and findings used to assist development and uptake of controlled traffic in the vegetable industry.
References


