Yield And Protein Variation Within A Controlled Traffic System

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ABSTRACT

Controlled Traffic systems aim to minimise wheel traffic impact on the cropping system. In this study, on-farm research was employed to investigate the impact of several wheel tracks on grain yield and protein in a planter width within a 7-year-old Controlled Traffic Farming (CTF) system. This was achieved by using a plot harvester. Results from the study of grain sorghum *(Sorghum bicolor)* and maize *(Zea mays)* showed lower establishment rates adjacent to wheel tracks, resulting in lower yield and higher protein. Further studies investigating a change to a system with fewer wheel tracks show that reducing the number of wheel tracks appears to have led to increased grain yield.

KEY WORDS

Controlled Traffic, compaction, yield reduction, protein.

INTRODUCTION

Although farmer co-operators had implemented a Controlled Traffic Farming system longer than seven years ago, the harvester wheeltracks did not match those used for other farm operations. The configuration consisted of three separate sets of wheel tracks as shown in Figure 1. Wheel tracks for the boom spray, were 60 inch (1520 mm) apart (centre to centre), matching the tractor used for planting. The inside dual of header and the wheels of the chaser bin were 120 inch (3050 mm) apart and the outside dual wheels of the header were 180 inch (4570 mm) apart.

This unconventional configuration was of interest to researchers on the GRDC funded project DAQ402, *"Speeding the adoption of controlled traffic by on-farm research and development*", who investigated the system. Objectives of this project were to identify areas within the system that could be refined and also to determine whether use of multiple wheel tracks over the long-term influenced plant growth, yield and quality.

The objective of another GRDC funded project DAQ434, "*Strategies to apply yield maps to identify and correct yield-limiting factors for northern cereal crops*." was to coincidently map yield and protein on a paddock-scale. Within areas of CTF it was thought that determining grain yield and protein by harvesting row by row may provide insights about the impact of CTF that may go unnoticed when 10 or more rows are harvested together.

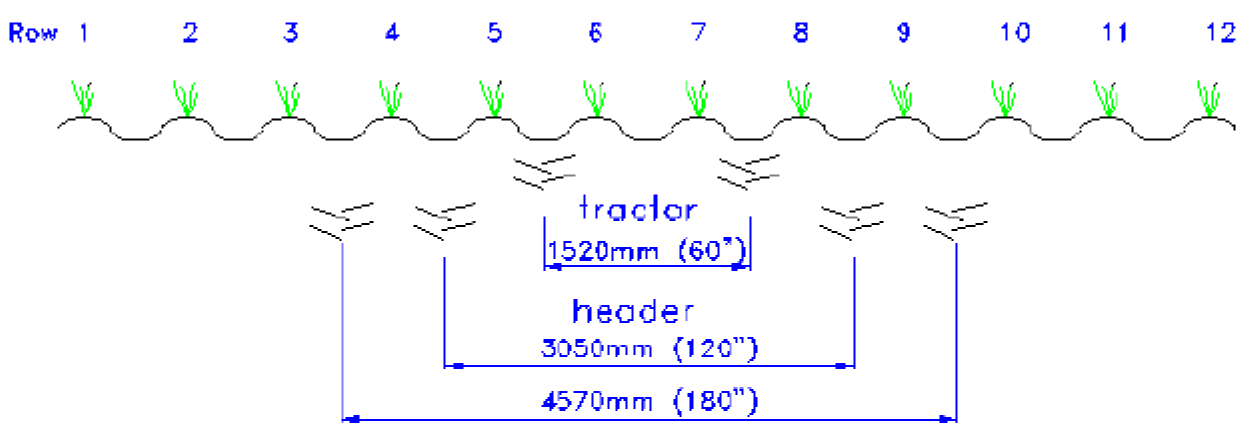

Figure 1. Schematic Representation of Controlled Traffic Layout

Scope of the research

Row-by-row variation in crop yield and protein was measured coincidently at Jimbour, Queensland, 200km west of Brisbane. A plot harvester was used to collect yield samples from each row. Protein was measured on sub samples from the plot harvester using near infrared (NIR) technology.

Trials were conducted on two crops of grain sorghum *(Sorghum bicolor)* and a crop of maize *(Zea mays)*. This paper reports on only the sorghum harvest for which a full analysis was conducted.

Initial investigations showed that the yield was dependent on plant population that was in turn dependant on establishment. In Queensland environments, plant population and spacing within the row are crucial in achieving consistent yields in sorghum fields, due to the low compensating characteristics of this crop. Assuming that the seeding rate across the planting unit was within acceptable tolerances, the lower plant numbers in rows adjacent to wheel tracks was probably due to poor establishment associated with compaction created by wheel traffic. By examining the yield reduction within the crop on rows adjacent to wheel tracks, an analysis could be undertaken to determine a loss of income due to multiple wheel tracks and the associated compaction.

RESULTS

Due to inaccurate wheel tracking of equipment during preceding years crop yield and protein of outside rows (ie rows 1 and 12), were excluded from measurement

Data was imported into Microsoft Excel and the contour plot capacity was utilised to produce the yield and protein maps presented in Figures 2 and 3 respectively. It should be noted that graphs were produced with no smoothing or processing of the data captured. The graphs show the results from one of two areas of sorghum where measurements were obtained. A map of another area of sorghum showed similar patterns in relation to wheel tracks.

As can be seen from Figure 1, tractor wheel tracks occur between rows 5-6 and 7-8, and the dual header wheel tracks occur between 3-4, 4-5, 8-9 and 9-10. The rows in immediate proximity to wheel tracks appear to correspond to the lower yielding areas (< 3t/ha) indicated by the lighter colours in Figure 2. The higher yielding areas (> 3t/ha) are represented by the darker colours and appear to predominantly occur in the outside two rows on each side, where there has been no adjacent wheel traffic. The highest yielding area was the area in the top left corner of the map, away from any wheel traffic.

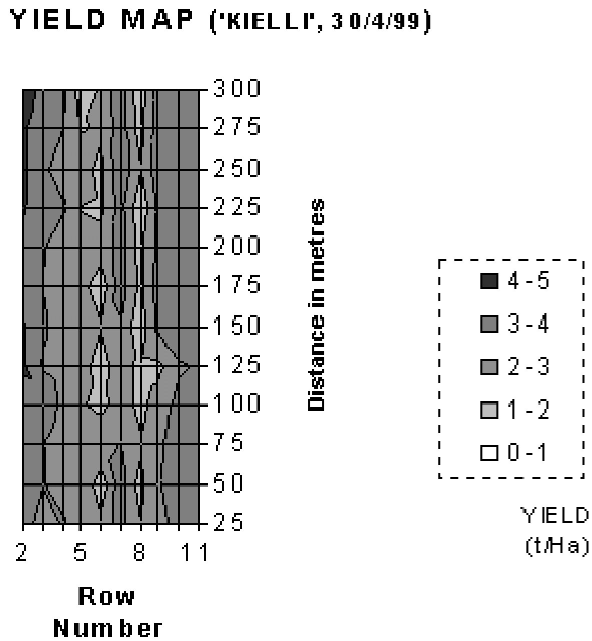

Figure 2: Yield map of sorghum trial area – unsmoothed

The protein map does not have the clear and distinct zones as displayed in the yield map. Generally, the lower yielding areas (lighter colours) in Figure 2 correspond to the higher protein areas (darker colours) in Figure 3 as would be expected due to the compensation that occurs between grain yield and protein.

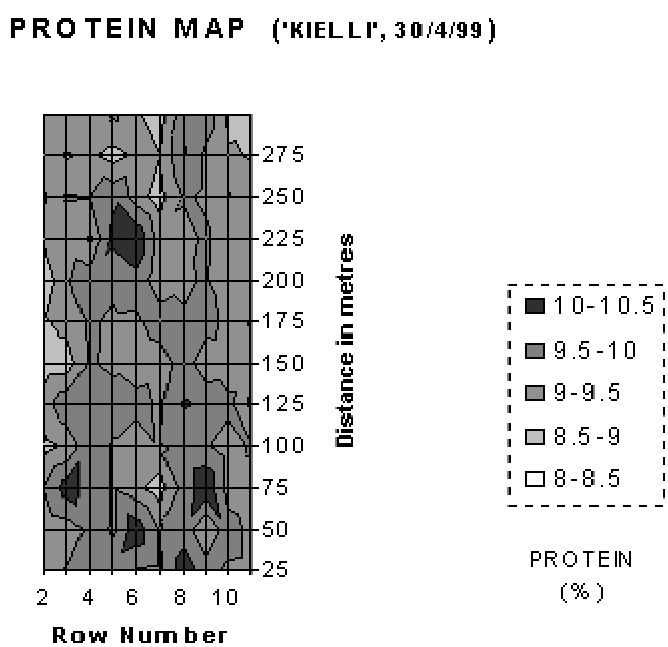

Figure 3: Protein map of sorghum trial area - unsmoothed

A statistical analysis was performed on the trial data and the results presented as Table 1. The results for yield were approaching statistical significance with a P value of 0.07. This indicates there was a 7% chance of a random result occurring, which when considering agricultural trials, is low and indicates a real difference. There is no statistical difference when comparing the average yields between 0-1 and 1-2 wheels per row, but there was a difference when comparing 0-2 wheels per row.

The protein results were highly significant and there was a statistical difference between all treatments.

	Yield (t/Ha)	**Protein (%)**
P	0.07	< 0.01**
Av LSD (5%)	1.16	0.26
0 wheels adjacent to row	3.59 [a]	9.14 [a]
1 wheels adjacent to row	2.99[ab]	9.32 [b]
2 wheels adjacent to row	2.40 [b]	9.60 [c]

Table 1. Statistical analysis results for trial data (indicates highly significant).**

DISCUSSION

For annual cereal crops, where yield varies spatially, there is usually compensation between grain yield and grain protein; in areas where yield is high, protein is low and visa versa. In this study, compaction in specific areas of the paddock has limited the plant's capacity to access available water, resulting in reduced grain yield. Where yield is reduced, plant available nitrogen is transferred to a smaller grain sink (yield), resulting in higher protein levels than in those areas of the paddock where uncompacted soil has produced higher yields.

Further studies have been completed on a system that reduces the number of wheel tracks from six to two, and although not yet fully analysed, results appear to show that reducing the number of wheel tracks reduced the impact on yield.

CONCLUSIONS:

When carrying out controlled traffic farming operations, there is a yield benefit in matching all wheel tracks of the farming system. Although the harvester is difficult to integrate into the system, it can be done as shown in this situation. There is a direct benefit in minimising the number of sets of wheel tracks in the paddock and this is to maximise the yield potential.

Coincident measures of grain yield and protein provides increased confidence that the impact of multiple wheel tracks in CTF is to reduce production of cereal crops in adjacent rows.

ACKNOWLEDGMENTS:

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