Spatial analysis of nitrogen strip trials in sugarcane

A method to match nitrogen rates to crop demand at the within-block scale to reduce nitrogen losses

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Issue

Elevated levels of nitrogen originating from agricultural runoff have been detected in rivers draining to the Great Barrier Reef lagoon, where excess nitrogen is potentially leading to a degraded reef ecosystem (De'arth and Fabricius 2010). Nitrogen loss reduction targets over ten years to 2018 are not being met.

Sugarcane is the dominant cropping system in Great Barrier Reef catchments (~380,000 ha), and is an intensive user of nitrogen fertiliser. There is a pressing need to reduce nitrogen losses from sugarcane farms to help protect the Great Barrier Reef.

N loss target by 2018

Current N losses in excess of target to Great Barrier Reef

N loss reductions to Great Barrier Reef since 2009

Rationale

Yield of sugarcane within a management unit (or 'block') can be highly variable (Bramley 2009). Under uniform management, lower yielding areas of a block of sugarcane are likely to be nitrogen loss 'hot spots' (Webster et al 2016).

Strategies such as variable rate application (VRA) could reduce nitrogen application to inherently low yielding areas and reduce nitrogen losses without compromising yield.

To implement VRA, farmers need a basis for determining what rates to apply where. Various techniques exist to support VRA, one of these being the spatial analysis of strip trials via a moving *t*-test to identify areas where variable management will achieve a significant change in yield (Lawes and Bramley 2012).

Method

The site was on a dark grey vertisol in the Burdekin sugarcane farming district (close to 19°40' south, 147°20' east) with annual average rainfall of 954 mm.

Sugarcane variety Q183 was planted in May 2012 and strips nine rows wide received 170, 37 or 132 kg N/ha, with the rest of the block receiving the farmers standard application of 153 kg N/ha. The site was irrigated to be water non-limiting.

The site was harvested in August 2013 with a harvester fitted with a yield monitor calculating yield on a three second interval. Yield values from the resultant yield map were extracted every three metres from the centreline of each treatment strip, and along a strip adjacent to each treatment where 153 kg N/ha was applied (approximately 14 m away).

Moving east to west rolling extracted yield values for ten points of the treatment strip and the 'standard' strip were compared via a paired two tail *t*-test. *P*-values less than 0.01 were considered areas of significantly different yield.

Findings

The overall yield of the block averaged 186 fresh tonnes per hectare, ranging from less than 75 t/ha to greater than 200 t/ha. Along the entire eastern boundary is a zone of low yielding area, an artefact of the harvesting event. This area was excluded from the analysis.

The yield map is presented below, with the centreline of each analysed strip marked.

Areas of the 170 strip are significantly higher than the adjacent 153 strip, however from the yield map this area appears to be part of a broad high yielding area (a). A large area of reduced yield along the 37 strip can be seen (b), along with areas in the west of the block that do not have significantly reduced yield (c). Large areas of the 132 strip are not significantly different yielding to the adjacent 153 strip, although some areas are.

Practical uses of this research

The moving *t*-test was initially implemented for use with an 'N-rich' strip in grains to identify areas where response to additional N can be expected. In this instance reduced nitrogen treatments are used as 'N limiting' strips to identify areas where there is no response to additional nitrogen and thus where nitrogen rates could be reduced.

When the moving *t*-test results are considered in conjunction with the yield map, observations that are a consequence of some aspect of underlying variation in the block can be accounted for. This analysis identifies spatially where 37, 132 and 153 kg N/ha is the optimal strategy, and these results can be implemented via variable rate application, matching nitrogen rates to spatial crop demand.

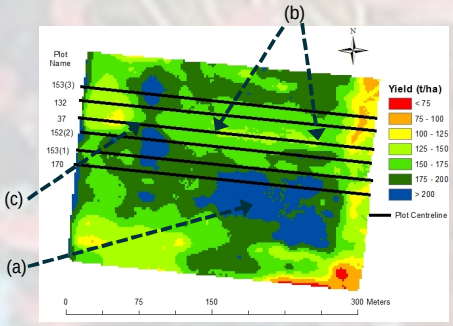

Figure 1: Yield map of whole block with treatment centrelines marked. (a) area of inherently high yield; (b) low yield as a result of treatment; (c) non significantly different yield.

Implications

Given the long history of nitrogen application in the sugarcane industry targeted at yield maximization, it appears the addition of a nitrogen limiting strip and analysis of yield differences between that and 'normal' application may have more potential utility than an 'N rich' strip.

While yield maps are instructive, the simple tool of analyzing nitrogen rich (or nitrogen limiting) strips using a moving *t*-test can add value to the interpretation. Here, we show that short-range variation in sugarcane yield can be marked, as is illustrated by the yield map. We also identify areas where rates of 37, 132 and 153 kg N/ha is the optimal strategy.

The farmer could use this information to apply nitrogen differentially at the within-block scale at rates that match crop demand in this block. This action would lead to reduced nitrogen losses to the Great Barrier Reef.

FOR FURTHER INFORMATION

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ACKNOWLEDGEMENTS

We thank the landholder Denis Pozzebon for assistance in conducting this trial.
We acknowledge Sugar Research Australia and CSIRO for funding this work through project CSE022.
We credit Pixar Animation Studios and Walt Disney Pictures for the cartoons.