Staggered N Rate Economics: 2018-20 Case Study

Mackay grower: John 'Mac' Muscat

Growers participating in Project Catalyst trials worked with economists from the Department of Agriculture and Fisheries (DAF) to identify costs and benefits of the trials. In this study, John Muscat and DAF (assisted by Farmacist) trialed the application of varied Nitrogen (N) rates.

The trial objective was to determine the impact on yield, CCS and economic performance of applying varied N rates against the recommended "Six-Easy-Steps" (6ES) rates to manage early lodging. Trial results were analysed for the full ratoon cycle (2017 to 2020) but due to Severe Tropical Cyclone Debbie, 2017 results (1st ratoon) are excluded from the case study as cane damage had a significant effect on overall yield and CCS.

Trial design

John Muscat (and DAF) conducted the trial between 2016 and 2020 on his farm, located west of Mackay, using variety Q242. Nitrogen was applied on each ratoon at one of five rates, 180kg/ha (180N), 150kg/ha (150N, 6ES rate), 110kg/ha (110N), 0kg/ha (0N, control), and an 'alternating rate'. The 'alternating rate' (110N/150N) applied 150kg/ha of N to the 2017 and 2019 crops, and 110kg/ha to the 2018 and 2020 crops.

The trial was randomised and replicated with 10 plots in two blocks (north and south of the tow path), with two plots within each block randomly allocated to one of the five N rate treatments. Hence, there were four replications for all five treatments on a uniform soil (see Figure 1). The control (0N) plots were 20 metres at the row end of two randomly selected treatments from each block, thus minimising the impact on overall paddock yield.

Key findings

- There was no economic benefit in applying a higher rate of N (above "Six-Easy-Steps" rates).
- Despite a significantly higher yield in 2020, the gross margin was significantly lower due to the CCS impact relative to previous years.
- Applying 0N had consistently lower yields and sugar (t/ha).

The products used to apply different N levels included: Liquid One Shot® (LOS) for 180 kg/ha, Econo LOS for 150 kg/ha and Liquid 50/50 for 110 kg/ha. Sulphate of Potash (SOP) was added for the 0N treatment to ensure a consistent application of other macro-nutrients. Yield data were obtained from both weigh trailer measurements and mill records for all treatments except the 0N rate (i.e. not enough bins allowing for a mill sample). Economic analyses were, however, only applied to mill results as they are the most reliable source of data relating to grower payment calculations.

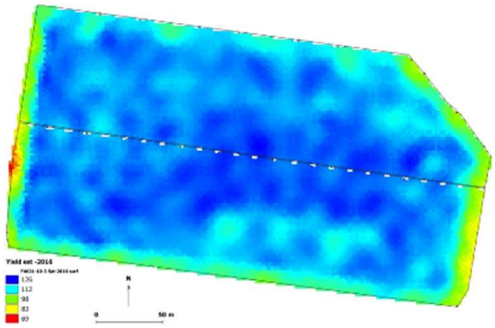

Figure 1: Processed satellite yield map (2016)
(source: Farmacist)

Agronomics

Figure 2 presents mill yield data for 2018, 2019, 2020 and all three years combined. Neither annual, nor combined data, differed significantly between treatments, with combined average yields ranging from 85 t/ha for the 180N treatment, to 88 t/ha for the alternating treatment. Similarly, there was no difference in either CCS (figure 3) or sugar yield (figure 4) among treatments.

Average yield (for all treatments) was greater in 2020 than in 2018 and 2019 (101 vs 78 and 80 t/ha; p<0.001) while CCS decreased from 14.0% in 2018 to 13.5% in 2019 and to 10.1% in 2020 (p<0.001). This resulted in sugar yield being less in 2020 than in 2018 or 2019 (10.2 vs 10.9 and 10.8 t/ha; p=0.002).

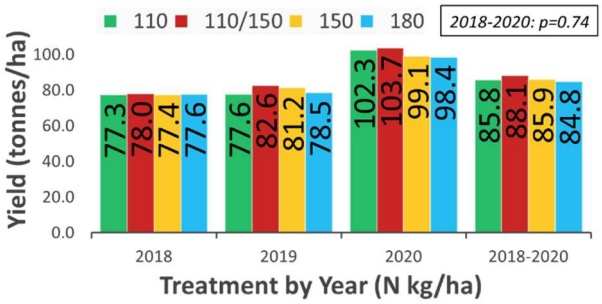

Figure 2: Average mill yield results (t/ha)

Note: Care should be taken when interpreting average CCS results as mill average CCS was used in 2019. However, given there was no significant difference in mill CCS for 2018 and 2020 (figure 3), the average CCS for 2019 was included for the final economic analysis.

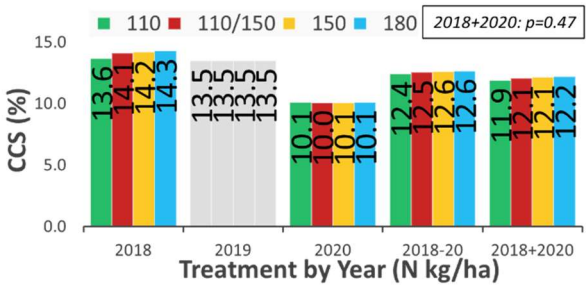

Figure 3: Average mill CCS results (t/ha)

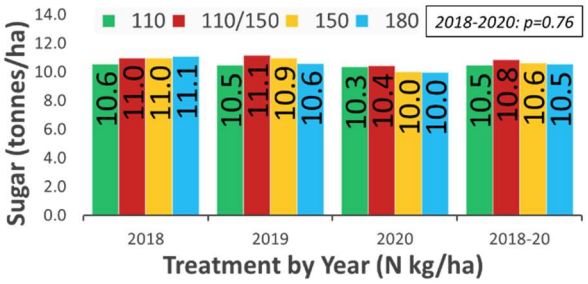

Figure 4: Average mill sugar results (t/ha)

Due to the small plot size of the 0N treatment, mill data was not available. To enable comparison of the N treatments with the 0N treatment, an analysis was done to combine the mill and the weigh trailer data. Yields were significantly greater for the N treatments compared with the 0N treatment (p=0.002; figure 5). This difference was clearly visible in the aerial photograph (figure 6; lighter colour for 0N treatments).

It should be noted that this may have been due to the other nutrients and organic carbon contribution of the BioDunder applied. Similarly, sugar yield was significantly lower for the 0N treatment when compared with the others (figure 7; p=0.011).

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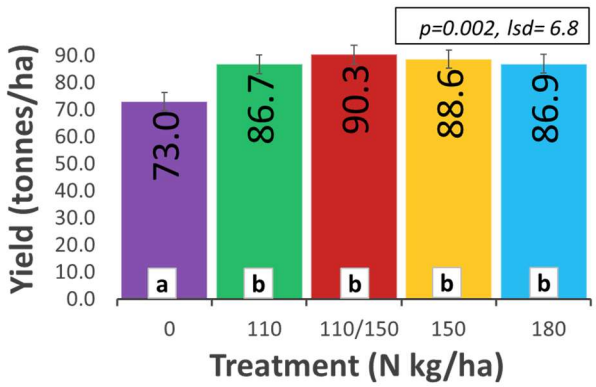

Figure 5: Combined average mill and weigh trailer yield results for years 2018-2020 (t/ha)

Error bars indicate 95% least significant difference and different letters indicate statistically significant differences. Note: same applies to figure 7.

Figure 6: Visible lower 0N treatment yields

(Source: DAF 2018)

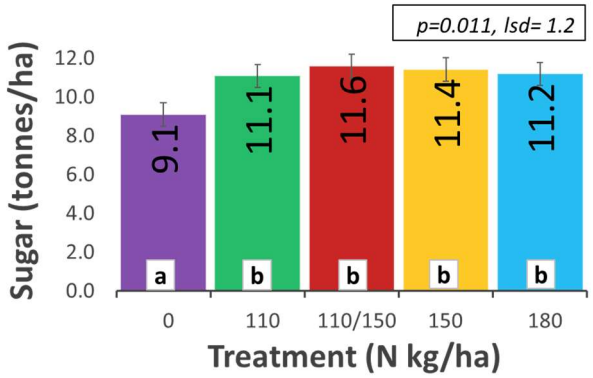

Figure 7: Combined average mill and weigh trailer sugar results for years 2018-2020 (t/ha)

Costs

Figure 8 presents the combined average annual variable costs for 2018, 2019 and 2020 seasons. Similar cost line items were included for 2018 and 2019, with additional irrigation and insect control costs added for 2020 (0.5ML of irrigation water and 1.2L of Confidor).

The difference in treatment variable costs were largely due to fertiliser costs and costs that varied with changes in yield (i.e. harvesting costs and levies). The 180N treatment had variable costs that were $58/ha and $112/ha higher than the 150N (6ES) and 110N treatments respectively.

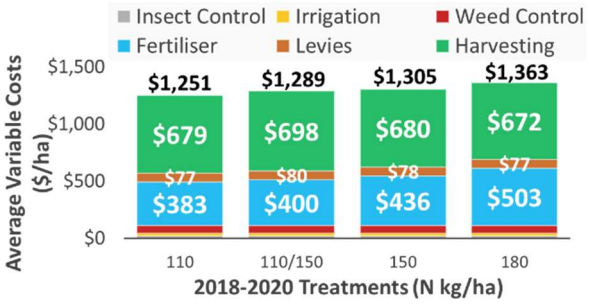

Figure 8: 2018 Average annual variable costs per treatment ($/ha)

Gross Margins

Gross margin results (revenue less variable costs) are presented in Figure 9 based on a 5-year average sugar price ($417/t). Although the alternating treatment showed a $149/ha higher average annual gross margin than the 180N treatment, the difference was not statistically significant so differences among treatments cannot confidently be attributed to the N rates.

Average annual gross margins decreased from $1,898/ha in 2018 to $1,741/ha in 2019 and to $890/ha in 2020 ($p<0.001$). This was likely due to significantly lower CCS results for 2020 compared to 2018 ($p<0.001$), despite 2020 having a significantly higher yield ($p<0.001$).

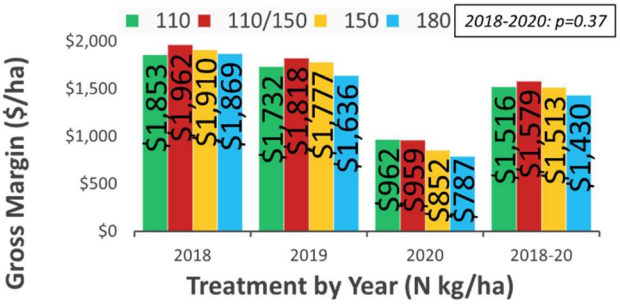

Figure 9: Average gross margin ($/ha)

Conclusion

Although gross margins did not differ significantly among the applied N treatments, further exploration of alternating nitrogen rates between 6ES (150N) and marginally lower N rates may be worthwhile given the potential environmental benefits (i.e. lower N runoff with no material change in profitability). Over the full crop cycle there remains no indication that it would be beneficial to apply N rates (e.g. 180N) above the 6ES guidelines given the savings in fertiliser costs at the lower rates.

The control (0N) treatment consistently produced lower yields and sugar (t/ha). These results suggest that the under-application (further reducing rates below 110N) may result in a negative gross margin (based on previous economic analyses). Further trials providing mill data on lower rates would be useful to explore minimum rate applications.

Interestingly, there was a significantly higher average yield in 2020 (late season harvest) compared to 2018 and 2019. However, due to significantly lower CCS and higher costs (relating to higher yields), the gross margin for 2020 was significantly lower. This highlights the importance of considering sugar production and economic outcomes over yield improvement alone.

Previous research trials (that explored variable N rates, e.g. RP20 Project taken over 5-years for 23 replicated/randomised trials) have shown that CCS reduces with higher N application rates. Using an average CCS value in the absence of individual treatment mill CCS data may have impacted gross margin results. However, 2018 and 2020 CCS results did not show significant differences and thus the mill average CCS for 2019 was the most suitable given trial specific conditions.

Note: the trial results are specific to this grower, paddock and prevailing conditions.

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