June 2024

Building drought resilience of vulnerable soils in low rainfall cropping and grazing systems

CASE STUDY

Sowing rate and nitrogen management in cereals for increasing ground cover on sandy soils

Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

mallee
catchment management authority

BCG
SHARED SOLUTIONS

Title: Sowing rate and nitrogen management in cereals for increasing ground cover on sandy soils

Location: Kooloonong, VIC

At a Glance

- Field demonstrations were conducted in Kooloonong in the Victorian Mallee to investigate the effect of variable sowing and nitrogen rates to improve in-season ground cover.
- The findings of this case study show that in this paddock, neither sowing rate nor nitrogen rate impacted biomass production, and thus in-season ground cover for mitigating soil erosion.
- Findings from these demonstrations suggest that landform had the largest influence on ground cover; cereal production was generally lowest on the dunes, and highest in the swales, with little effect from sowing rate or nitrogen application.
- Future research should be conducted to target landforms and areas of Mallee agricultural land that are particularly susceptible to soil erosion from wind.

Figure 1. View of a Kooloonong demonstration site, immediately after sowing. Photo: BCG

Two paddock-scale demonstrations were established by Birchip Cropping Group (BCG) in Kooloonong, Victoria. The demonstrations investigated the impact of two sowing rates in wheat and barley on in-season ground cover, and whether nitrogen management was an influencing factor on wheat biomass production.

This project is supported by Mallee Catchment Management Authority, through funding from the Australian Government's Future Drought Fund.

Background

The Victorian Mallee is increasingly challenged by more frequent and severe droughts[1]. This climatic uncertainty heightens the region's high susceptibility to wind erosion, leaving its soils vulnerable[2]. As weather patterns shift, it becomes crucial to enhance the resilience of the Victorian Mallee to withstand both drought and soil degradation.

Tailoring agronomic solutions, such as sowing rate and in-season management of key crops, to farms located in the high wind erosion susceptibility zones is necessary for understanding how growers in this region can protect vulnerable soils for increased drought resilience.

Cereals play a vital role in Mallee farming rotations due to their suitability to the semi-arid climate, and thus are critical for ensuring profitability[3]. Cereals offer an answer to consistent market demand, ensuring reliable income for Mallee farmers. However, the impact of cereals in the rotation reaches further than just end-of-season profitability; these crops and associated stubble residues can reduce soil erosion and improve soil health.

In the Mallee, soil erosion can occur throughout the cropping season, and can impact all parts of the paddock[4]. The management of cereals during this time can have a large impact on soil erosion. Maximising ground cover of cereals and associated stubble residues reduces the risk of wind and water erosion by protecting the soil surface[5]. Thus, it is important to explore what easily deployed methods can be utilised to achieve this, such as optimising plant density and stimulating biomass production through input such as nitrogen (N) fertiliser.

Figure 2. Wheat growing at the top of a dune in a Kooloonong demonstration paddock. Photo: BCG.

This case study investigated the impact of sowing rate in two key cereals, wheat and barley, to understand how different densities influence crop performance and soil protection through ground cover. The demonstrations also included an evaluation of nitrogen (N) application rates for wheat, following recommendations from Yield Prophet® modelling, which is based on rainfall deciles. This approach allowed for an assessment of optimal N rates under theoretical variable seasonal conditions.

Wheat was sown at different rates and treated with two N levels to observe the interaction between plant density and nutrient availability. Barley was also sown at varying rates but without additional N treatments. The study aimed to determine the ideal sowing rates for maximising yield while minimising soil erosion via better ground cover.

By supporting sowing and fertilisation practices, the demonstrations sought to optimise resource use and improve sustainability in cereal production in the Mallee region.

Aims

- Assess the impact of sowing rate and in-season nitrogen management on wheat and barley on in-season ground cover.

Method

Wheat paddock - Site establishment

Two demonstration sites were established on legume stubbles; the first ("wheat paddock") was sown to wheat (Razor) on 9 May 2023. In 2022 the western side of the paddock was sown to chickpea, and the eastern side was sown to lupin.

In the wheat paddock, there were four demonstration strips as shown in Table 1. All four strips spanned from the eastern to western sides of the paddock, covering both stubble types (Figure 3). Yield Prophet® was used to determine the amount of nitrogen (N) to be applied in line with decile 5 (medium N) and decile 10 (high N) rainfall finishes to the season.

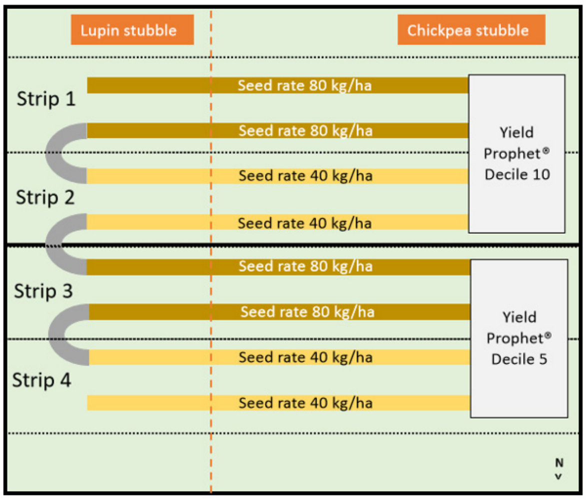

Figure 3. Wheat paddock demonstration strip set up.

Table 1. Treatment strips in the wheat paddock

Treatment strip	Sowing rate	Nitrogen
High rate/high N	80 kg/ha	YP® Decile 10
Low rate/high N	40 kg/ha	YP® Decile 10
High rate/low N	80 kg/ha	YP® Decile 5
Low rate/low N	40 kg/ha	YP® Decile 5

Barley paddock - Site establishment

The second paddock ("barley paddock") was sown to barley (Commodus) on 14 May 2023. In 2022, most of the paddock was sown to lupin, however the western-most side of the paddock was sown to vetch. There were two experimental demonstration strips, as shown in Table 2.

Both strips spanned from the eastern to western sides of the paddock, covering both stubble types (Figure 4).

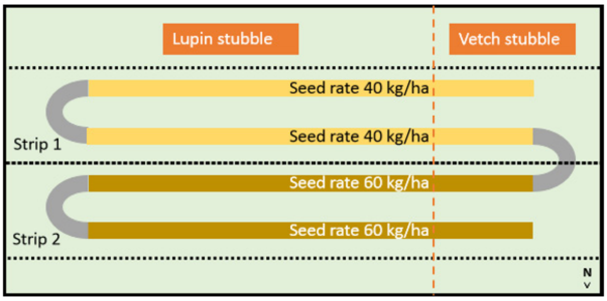

Figure 4. Barley paddock demonstration strip set up.

Table 2. Treatment strips in the barley paddock

	Treatment strip	Sowing rate
1	Low rate	40 kg/ha
2	High rate	60 kg/ha

Assessments

Multiple biomass cuts were taken from each landform across all strips. Each biomass cut consisted of total above ground biomass and was dried at 70 °C for 3 days, and then weighed. Biomass cuts were taken twice throughout the season; flowering and prior to harvest. The reader is advised to remember that data presented in this case study is non-replicated, thus statistical analysis is limited and should be interpreted with caution.

Yield data for each strip was collected from the grower and is presented as an average yield per hectare (ha) for each demonstration strip.

Results/findings

Wheat paddock

No treatment effect was detected in biomass data at both flowering and maturity. Figures 5-6 show the average data for each demonstration strip. Analysis on demonstration strip data is limited; the graphs show overlapping standard error bars for each strip, indicating that there is unlikely to be differences between the treatments. However, the data have not been tested for statistical significance.

Figures 7 and 8 demonstrate variation in biomass production across landforms and stubble types, showing wheat growing in the swales generally produced more biomass, regardless of most treatments, suggesting that soil in the swales may be the least vulnerable areas of this paddock to wind erosion.

Yield data was collected from the grower's harvest records and represent an average yield across entire strips (covering both stubble types and all landforms). The higher sowing rate did not appear to result in a higher grain yield, as shown in Table 3. The data show little difference in grain yield between demonstration strips; however the highest rate of 3.5 t/ha was achieved by the low sowing rate/ low N treatment strip.

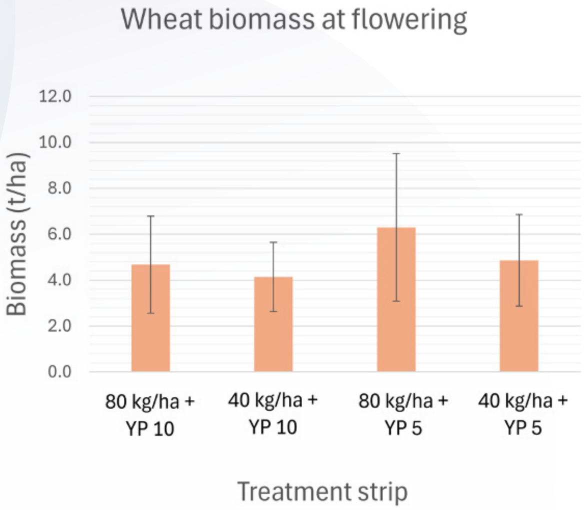

Figure 5. Wheat biomass for each treatment strip at flowering (Z65). Data is presented as sowing rate (e.g., 80 kg/ha) with N strategy (e.g., YP 10). Data reported in this graph represents the mean of all strip data aggregated across landforms and stubble types and should be interpreted with caution due to the potential for spatial confounding. Error bars represent the standard error across all data points for each strip.

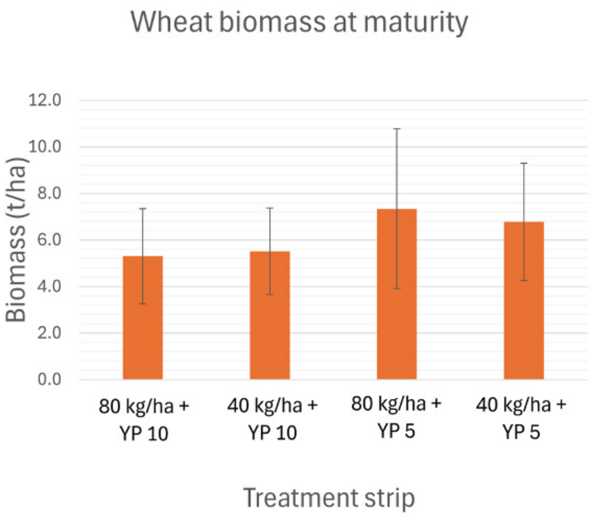

Figure 6. Wheat biomass for each treatment strip at maturity. Data is presented as sowing rate (e.g., 80 kg/ha) with N strategy (e.g., YP 10). Data reported in this graph represents the mean of all strip data aggregated across landforms and stubble types and should be interpreted with caution due to the potential for spatial confounding. Error bars represent the standard error across all data points for each strip.

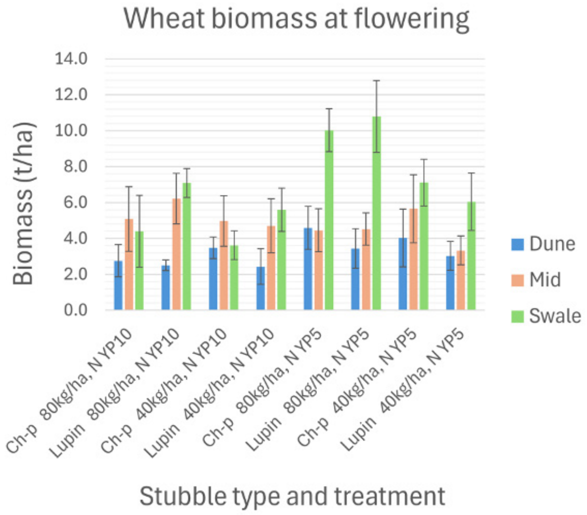

Figure 7. Wheat biomass at flowering displayed by stubble type and landform. Data is presented as stubble type (chickpea or lupin), sowing rate (e.g., 80 kg/ha), and N strategy (e.g., YP 10). Data represents the mean of three replicates and should be interpreted with caution, as treatments were for demonstration only and not replicated. Error bars represent the standard error across the three replicates across each area.

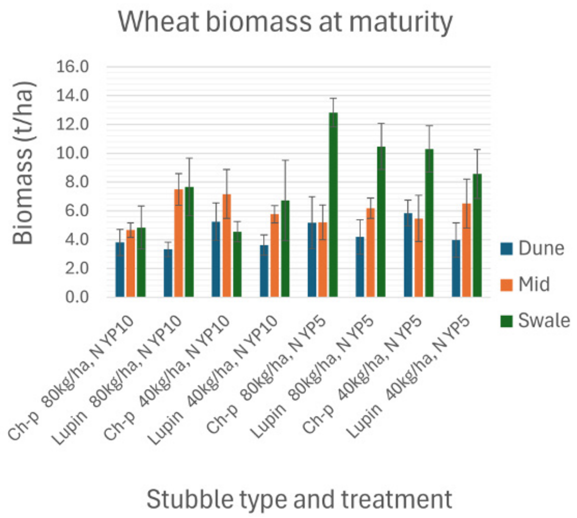

Figure 8. Wheat biomass at maturity displayed by stubble type and landform. Data is presented as stubble type (chickpea or lupin), sowing rate (e.g., 80 kg/ha), and N strategy (e.g., YP 10). Data represents the mean of three replicates and should be interpreted with caution, as treatments were for demonstration only and not replicated. Error bars represent the standard error across the three replicates across each area.

Table 3. Average wheat grain yield data for each demonstration strip. Data provided by the host grower.

	Treatment strip	Sowing rate	Nitrogen	Average yield (t/ha)
1	High rate/ high N	80 kg/ha	YP® Decile 10	3.0
2	Low rate/ high N	40 kg/ha	YP® Decile 10	3.1
3	High rate/ low N	80 kg/ha	YP® Decile 5	2.7
4	Low rate/ low N	40 kg/ha	YP® Decile 5	3.5

Barley paddock

Similarly to the wheat paddock, no treatment effect was observed in biomass data at both flowering and maturity, shown in Figures 9 and 10.

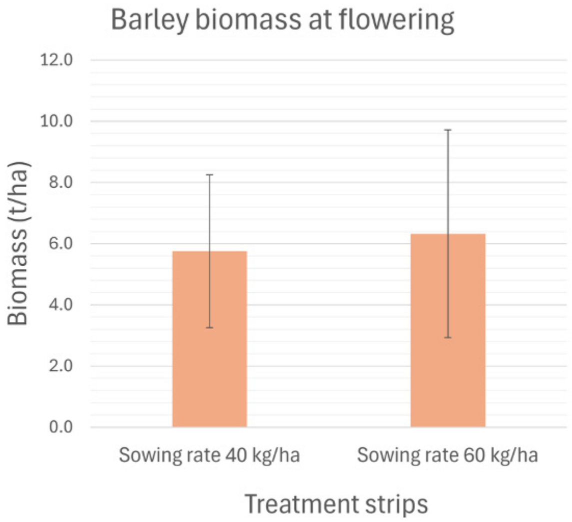

Figure 9. Barley biomass for both treatment strips at flowering (Z65). Data reported in this graph represents the mean of all strip data aggregated across landforms and stubble types and should be interpreted with caution due to the potential for spatial confounding. Error bars represent the standard error across all data points for each strip.

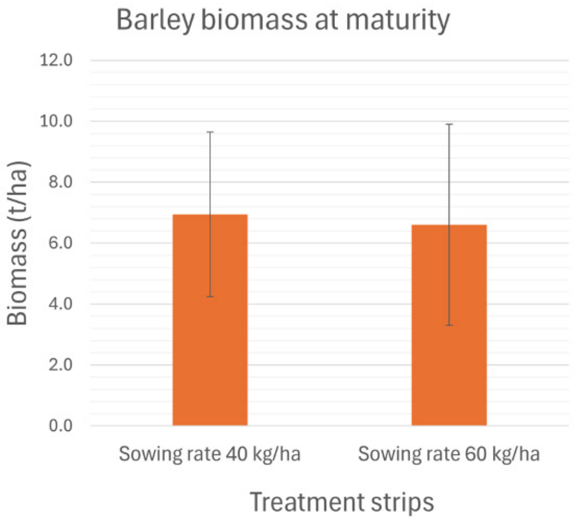

Figure 10. Barley biomass for both treatment strips at maturity. Data reported in this graph represents the mean of all strip data aggregated across landforms and stubble types and should be interpreted with caution due to the potential for spatial confounding. Error bars represent the standard error across all data points for each strip.

As with the wheat paddock, barley growing in the swales generally produced more biomass, regardless of most treatments, suggesting that soil in the swales may be the least vulnerable areas of this paddock to wind erosion (Figures 11 and 12). The highest biomass was recorded for the vetch stubble swales, regardless of sowing rate. For the lupin stubble, the strip sown to the lower barley sowing rate of 40 kg/ha showed higher biomass production across all landforms.

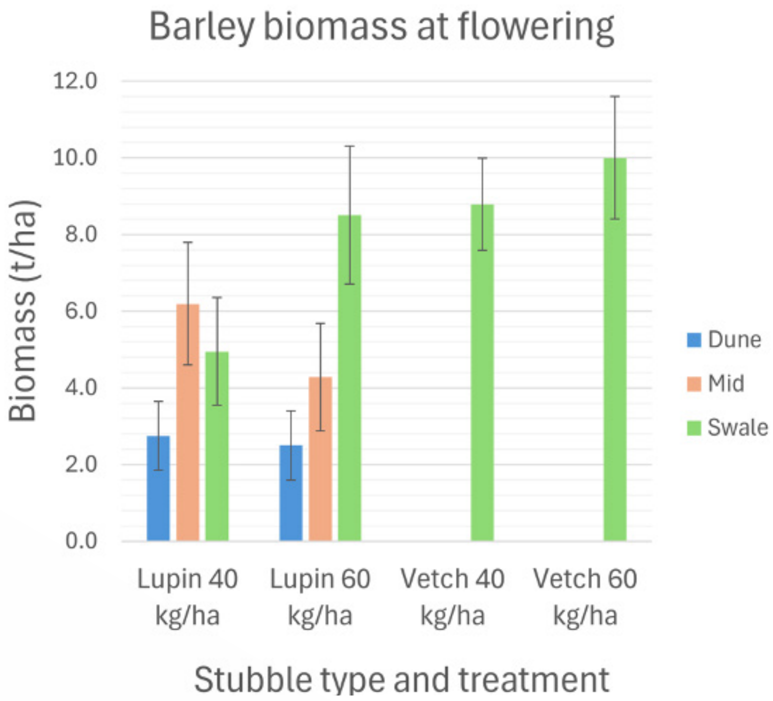

Figure 11. Barley biomass at flowering separated by stubble type and landform. Data is presented as stubble type (lupin or vetch) and sowing rate (e.g., 80 kg/ha). Data represents the mean of three replicates and should be interpreted with caution, as treatments were for demonstration only and not replicated. Error bars represent the standard error across the three replicates across each area.

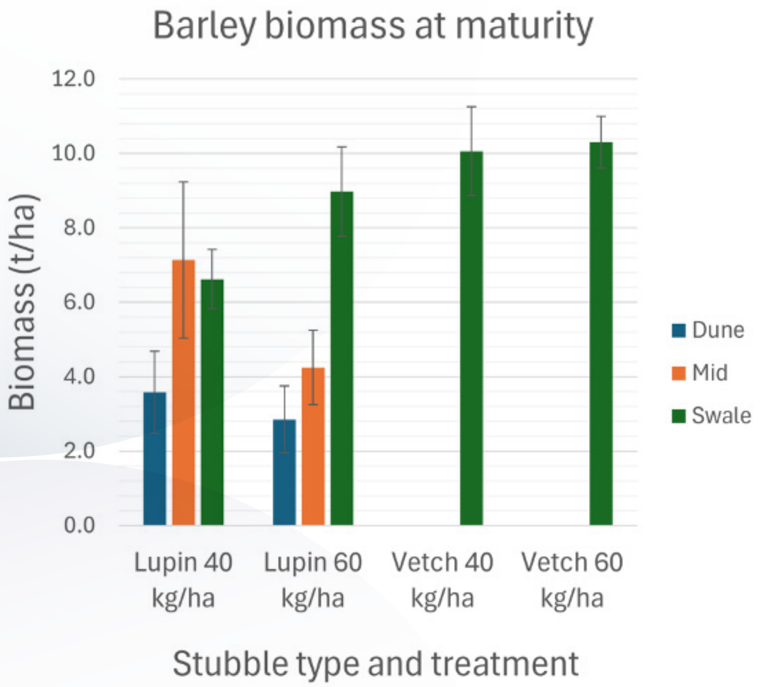

Figure 12. Barley biomass at maturity separated by stubble type and landform. Data is presented as stubble type (lupin or vetch) and sowing rate (e.g., 80 kg/ha). Data represents the mean of three replicates and should be interpreted with caution, as treatments were for demonstration only and not replicated. Error bars represent the standard error across the three replicates across each area.

Grain yield was recorded per run for each strip (Table 4). There was little difference in observed in grain yield between strips, however when both runs for each strip are averaged, the lower sowing rate yielded slightly more grain.

Table 4. Average barley grain yield data for each demonstration strip. Data provided by the host grower.

	Treatment strip	Sowing rate	Average yield (t/ha)
1A	Low rate – run 1	40 kg/ha	1.8
1B	Low rate – run 2	40 kg/ha	2.1
2A	High rate – run 1	60 kg/ha	1.8
2B	High rate – run 2	60 kg/ha	1.7

Implications

The findings of this demonstration suggest that sowing rate and N management had little effect on cereal biomass production, and therefore ground cover.

The factor that appears to be more critical is the vulnerability of certain zones throughout the paddock. For example, both wheat and barley paddock results showed that the dunes produced the lowest biomass compared to the mid-slopes and swales across all stubble types and treatments, with a small number of exceptions.

This highlights the influence of landform variation on crop performance and soil erosion, suggesting that site-specific management practices might be more beneficial.

Targeting crop performance and soil health on dunes in Mallee paddocks could be crucial for improving overall productivity. Consequently, future research should focus on tailored strategies to mitigate the adverse effects of landform variation, focussing on enhancing crop productivity in these important areas of agricultural activity in the Mallee.

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