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

CASE STUDY

## Strategies to increase wheat crop ground cover on sandy soils

Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

mallee catchment management authority

BCG SHARED SOLUTIONS

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

# **Title:** Strategies to increase wheat crop ground cover on sandy soils

**Location:** Torrita & Underbool

## At a Glance

- Paddock demonstrations were conducted in Torrita and Underbool in the Victorian Mallee to investigate whether current-practice agronomic strategies increased biomass production in wheat.
- At the Torrita site, the mid-slopes produced significantly lower biomass throughout the season regardless of nitrogen (N) rate, these areas of the paddock may be particularly susceptible to wind erosion due to the low ground cover during the cropping season.
- The swale areas of the Torrita paddock produced the highest biomass throughout the season compared to the mid-slopes and dunes, regardless of N treatment. The starting soil moisture in the swale was higher than the mid-slopes and dunes, suggesting that these areas may be more drought resilient.

**Figure 1.** Wheat crops nearing maturity at a demonstration paddock in Torrita, Victoria. Photo: BCG

- The application of a wetting agent to wheat seed at the time of sowing at the Underbool demonstration site did not affect early wheat biomass production compared to untreated wheat, however this may be due to the season's dry start.

Paddock-scale demonstrations were established by Birchip Cropping Group (BCG) on grower paddocks in Torrita and Underbool, Victoria. The demonstrations investigated strategies to increase biomass production of in-season wheat which could be easily integrated into standard farm management activities, without affecting productivity. This project is supported by Mallee Catchment Management Authority, through funding from the Australian Government's Future Drought Fund.

## Background

The Victorian Mallee faces mounting challenges due to the increasing frequency and severity of droughts[1]. Amid this climatic uncertainty, this region, particularly agriculture land, struggles with the complex issue of high wind erosion susceptibility, leaving its soils in a vulnerable state[2,3]. Soil erosion is a main driver behind loss of soil nutrition and farm productivity[4]. As climate patterns change, the necessity to strengthen the Victorian Mallee's resilience against the dual threats of drought and soil degradation becomes increasingly urgent. Developing agronomic solutions that can be easily integrated into farm operations in areas with high wind erosion susceptibility is essential for helping growers protect vulnerable soils and enhance drought resilience.

### Does increased wheat biomass lead to better ground coverage and less soil erosion?

Wheat is a key rainfed crop grown in the Mallee, making up approximately 50% of cropped area[5]. Given its prominence, identifying agronomic strategies relating to the management of wheat is fundamental to the ongoing management of soil erosion in the region.

Wheat and its associated stubble after harvest is a valuable source of ground cover, particularly in high wind erosion susceptible environments[3]. Two important factors for adequate wheat biomass production are water and nitrogen (N) fertiliser[6].

Using nitrogen as urea fertiliser may be a strategic tool to increase ground cover and potentially mitigate soil erosion.

Irrigation is generally not implemented in this region. As such, most growers rely on rainfall for crop production. Given the Victorian Mallee falls within a low rainfall zone, increasing the availability of water to wheat crops is important for its successful establishment and vigour. Increasing water capture for wheat crops can be achieved through agronomic interventions, for example, in-furrow application of wetting agents[7]. The purpose of wetting agents is to enhance vigour and biomass production of seedlings, and are particularly effective in soils with non-wetting characteristics[7]. Therefore, it is possible that increased biomass production through the use of wetting agents in dryland wheat cropping may lead to better ground cover and less risk of soil erosion.

**Figure 2.** Bare ground between rows of maturing wheat at the demonstration paddock in Torrita, Victoria. Photo: BCG.

This case study investigated whether differences in wheat biomass production were detected under varying rates of urea applied to wheat growing in sandy soil. Furthermore, the study assessed whether a wetting agent improved wheat seedling emergence and vigour for better plant establishment and cover.

## Aims

- Assess if varying rates of nitrogen in wheat result in differences in above ground biomass, and better coverage of bare ground during the cropping season.
- Investigate if wheat crops show better establishment and increased vigour with the application of a wetting agent.

## Method

### Site establishment

The Urea Rate (UR) demonstration paddock was sown to wheat (Scepter) on 16 May, 2023. The stubble present in the paddock was vetch grown in 2022. The Wetting Agent (WA) paddock was sown to wheat (Tomahawk) on 28 May, 2024. The previous year's stubble, brown manure legume, was still present at sowing, as was stubble from the barley crop grown in 2022. The grower advised that this paddock experiences non-wetting challenges in the upper profile of the soil. The wind erosion susceptibility in both paddocks is classified as high. Both paddocks were sampled with a hydraulic soil corer for soil chemistry and moisture at the beginning of each season.

### Treatments

### Urea Rate paddock

Nine strips were treated with three urea rates, outlined in Table 1. Each urea rate was applied in three randomised replicated strips that spanned from the eastern side of the paddock to the western side. The strips were approximately 30 m wide and 500 m long.

Three rates of in-season urea were chosen; a paddock-average (61 kg/ha), which was representative of the average of urea applied across the dune, mid-slopes, and swale systems, and two rates that were based on Yield Prophet® modelling according to received rainfall in a decile 5 (90 kg/ha) or decile 10 (264 kg/ha) year. Urea was spread on 20 July, 2023, immediately preceding a rainfall event.

**Table 1.** Urea fertiliser treatments used in this paddock scale demonstration.

| Treatment | In-season urea rate | In-season urea rate |
|---|---|---|
| PS | 61 kg/ha | "Paddock standard" - match paddock average |
| D5 | 90 kg/ha | Decile 5 Yield Prophet® |
| D10 | 264 kg/ha | Decile 10 Yield Prophet® |

### Wetting Agent paddock

A wetting agent was applied in one large demonstration patch at the maximum label rate, 3 L/ha with a total brew of 50 L/ha. The wetter was applied directly in-furrow at sowing. Approximately 58 ha of the paddock was treated with the product, the remaining area of the paddock was untreated.

### Assessments Urea Rate paddock

Three biomass cuts were taken from each treatment strip (9) and landform (dune, mid-slope, swale) at flowering (Z65). The biomass cuts were taken from a quadrat of approximately 50 cm by 50 cm. Harvest cuts were collected in the same manner at maturity, just prior to harvest. Biomass cuts were dried at 70 °C for 3 days, and then weighed. Harvest cuts were threshed to separate grain from biomass, and both components were then weighed.

### Wetting Agent paddock

Crop establishment for the treated and untreated patches was assessed on 24 June 2024 by NDVI measurements collected via drone. Paddock NDVI data was collected with a DJI Mavic 3 Enterprise Multispectral drone and analysed using Quantum Geographic Information System (QGIS) software. NDVI provides data which can be used to infer crop seedling development[8].

**Figure 3.** The wetting agent paddock demonstration at the time of sowing and wetter product application. Topsoil dust is displaced as a consequence of sowing, a typical occurrence in the Mallee region. Photo: BCG.

## Findings

### Urea Rate paddock biomass production

The paddock received 228 mm of rainfall (Decile 6) during the growing season. Soil sampling results indicated that the swale areas of the paddock contained the highest gravimetric soil moisture, followed by the dunes. The mid-slopes showed the lowest gravimetric soil moisture.

**Table 2.** Gravimetric soil moisture results for the Urea Rate paddock.

| Paddock area | Gravimetric soil moisture |
|---|---|
| Dune | 19.9% |
| Mid-slope | 17.9% |
| Swale | 39.2% |

**Table 3.** Starting soil N (kg/ha) results for the Urea Rate paddock.

| Paddock area | Soil N (kg/ha) |
|---|---|
| Dune | 66 |
| Mid-slope | 23 |
| Swale | 85 |

At both growth stages of biomass sampling (flowering and maturity), and across all treatments, the mid-slopes produced the lowest biomass and grain compared to the dunes and swales (Figures 5-6). As shown in Tables 2 and 3, the starting soil moisture and N was lower in the mid-slopes compared to the swales and dunes, which is a possible explanation for why the mid-slopes were less productive across all treatment strips.

Between urea rate treatments, there was no significant difference in biomass production at either growth stage for the mid-slopes ($p > 0.05$). The rainfall received was in line with a decile 6 year, so little difference between the D5 and D10 urea treatment would be expected. However, the lack of difference between the paddock standard treatment and the higher urea treatments suggests that mid-slopes in this environment may have limited productivity potential, which may make them more susceptible to higher in-season erosion due to lower available ground cover.

The same effect was observed between urea rate treatments in the dunes and swales ($p > 0.05$ for both), indicating that applying higher rates of urea did not lead to significantly higher in-season biomass.

**Figure 4.** View from the top of a dune looking down toward a swale. Photo taken 9 October 2023 from the urea rate paddock demonstration. Phone: BCG.

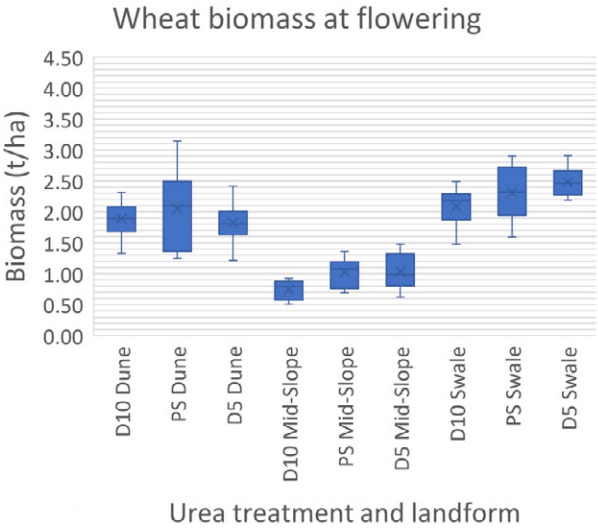

**Figure 5**

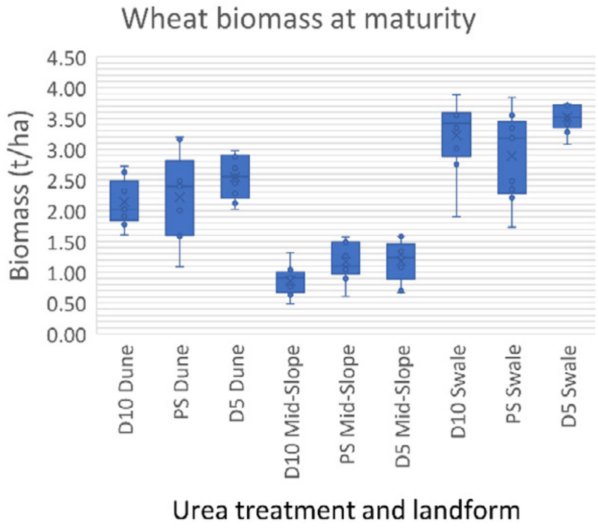

**Figure 6**

**Figures 5 and 6.** Above ground biomass data for each urea treatment and landform. Data was generated from wheat biomass cuts taken at flowering (Z65) (Fig 4, top) and maturity (Fig 5, bottom). Horizontal lines within each box represent the median of all sample for that treatment, and the mean is represented within each box as an 'x'.

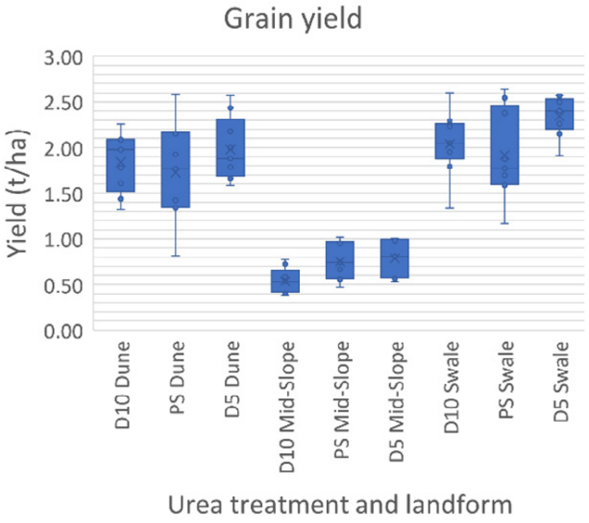

**Figure 7.** Grain yield in t/ha for each urea treatment and landform. Data was generated from harvest cuts taken at maturity. Horizontal lines within each box represent the median of all sample for that treatment, and the mean is represented within each box as an 'x'.

Statistical analysis of grain yield data from the harvest biomass (Figure 7) indicates that there was no significant difference in grain yield between urea treatments for any of the landforms across all treatment strips ($p > 0.05$), with one exception; wheat that received the D10 urea rate yielded significantly lower grain than the PS and D5 wheat ($p=0.021$).

## WA paddock wheat establishment

Crop emergence and development was slow due to the dry start to the season; the closest weather station reports that the region received 26 mm of rain since the paddock was sown. This dry start is reflective of a typical challenge for growers in the Mallee; slow starts can lead to slowed biomass growth and thus soil can stay unprotected for extended periods of time.

Figure 8 shows the overall NDVI map of the Underbool paddock. NDVI data analysis showed that both the treated and untreated sections of the paddock reported an average NVDI value of 0.5, suggesting there was no difference in biomass production between the two sections approximately one month after sowing.

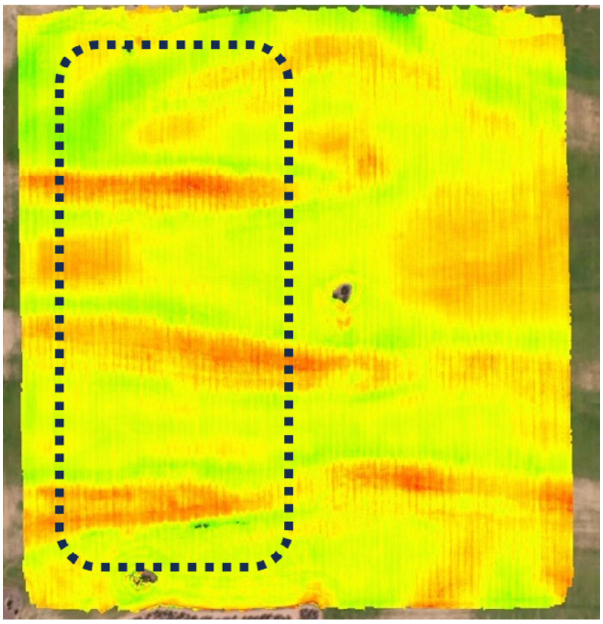

**Figure 8**. Drone image taken on 24 June 2024. Black dotted line indicates the area of paddock treated with wetting agent during sowing.

It is important to remember that conclusions made in this report are based on biomass cut data and early-stage NDVI data, which may provide limited insight into paddock dynamics.

## Implications

Findings from these demonstrations suggest that neither the application of extra nitrogen, nor wetting agent, provided extra ground cover through biomass production. The mid-slope systems produced the lowest above ground biomass throughout the season regardless of N treatment, indicating that these areas are likely to be more prone to wind soil erosion. Further, there was no benefit to grain yield by applying higher rates of urea.

To address the challenges identified in this case study, future work should focus on optimising management practices specifically tailored to the unique conditions of the mid-slope systems in this region, perhaps using cover crops or mulches, to prevent wind erosion in these vulnerable areas.

Additionally, exploring alternative nutrition strategies beyond conventional nitrogen applications may deliver better results in both biomass production and grain yield.

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