# Increasing productivity and sustainability of mixed farming enterprises through improved pasture management in non-arable hills of the Mid-North

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**Key findings**

- Pasture growth responses were consistent with soil test results. Where low levels of nutrition was measured, the application of phosphorus and nitrogen increased dry matter production by up to 33%.
- The variability of results across four trial sites shows that selective soil sampling from specific soil types or areas of varying pasture production will be important to identify zones within a paddock where nutrient response will occur.
- Weed control varied depending on species. In some cases, significant damage to beneficial plants such as clover species occurred, but despite this, two years of control could be achieved with a single application of herbicide.

**Why do the trial?**

The hills pasture landscape in the Mid-North of South Australia is predominately made up of mixed farmers with a primary focus on grain crop production. Consequently, much of the hills pasture landscape area is set stocked to simplify the stock operation during the cropping season and in some cases, it can be over grazed leaving the hills vulnerable to erosion. The pastures are rarely fertilised to increase production as it is difficult to measure the return on investment in this environment. This method of grazing promotes weedy pastures that are often dominated by stemless thistle *(Onopordum acaulon)*, nutgrass (*Cyperus rotundus)* and storksbill *(Erodium botrys and Erodium cicutarium)*. These weed species offer little feed value or soil protection.

Identifying simple management practices that can be readily adopted, will have a significant positive benefit to increase profitability, increase ground cover, increase water infiltration, and ultimately reduce erosion risk. These practices are also likely to compliment improved grazing management practices, moving away from set stocking to better manage rotational grazing. Without simple tools for mixed farmers to use, it is likely that the hills pasture landscape of the Mid North will continue to be degraded and in drought seasons, put the landscape at significant risk of erosion such as events seen between 2017 and 2019.

The aim of the project is to improve pasture production in the non-arable hills and rangeland pasture landscape of the Mid North, SA, to reduce the risk of erosion, increase water infiltration and ultimately improve production and profitability of South Australian landholders.

**How was it done?**

| | | | |
|---|---|---|---|
| **Plot size** | 2.0 m x 12.0 m | **Site 1** | Matters 1 |
| **Location** | Spalding, SA | **Site 2** | Broughton Park |
| | | **Site 3** | Stephenson |

Two main trial sites, Matters 1 and Broughton Park, were implemented near Spalding in March, 2021. All trials were randomised complete block designs with three replicates. Soil samples were taken for analysis at 0 – 10 cm and 0 – 60 cm.

Due to high nitrogen and phosphorus levels identified at Matters 1, a third site, Stephenson, was established on July 14. A fourth site, Matters 2, with reduced treatments was established on August 11 after observing nitrogen deficiency and poor pasture growth in another area in Matters 1 paddock.

*Fertiliser trials*

Fertiliser treatments at the two sites were implemented June 6 in front of a 27 mm rainfall event that occurred over the following two days.

Stock were removed from the Matters 1 trial on August 11 and the Broughton Park trial was fenced to exclude stock on September 6. The additional Stephenson and Matters 2 sites were not grazed post fertiliser treatment application.

Trial assessments were made using Greenseeker NDVI and biomass cuts were taken at 4 cm from the soil surface between October 11 and October 13. In addition to biomass measurements, grass species scores (0 – 9) were also conducted to assess shifts in species population.

*Herbicide trials*

The two main herbicide trials Matters 1 and Broughton Park were established in March with the first treatments applied on June 28. A third herbicide trial, Stephenson, was established to the east of Spalding on July 20. Treatments for these trials are shown in Table 2.

Weed control assessments were made using scores from 0 (no effect) to 9 (100% control) at 15, 43 and 71 days after the first application (DAA) at Matters 1 and Broughton Park. At the Stephenson site a weed control score was conducted 43 DAA.

*Table 1. Application timings and weed descriptions for herbicide trials 2021.*

| Trial site | Herbicide timing 1 | Herbicide timing 2 | Weed species | Weed size at first herbicide timing | Clover size at first herbicide timing |
|---|---|---|---|---|---|
| Matters 1 | June 28 | September 1 | Common storksbill | 4 cm | NA |
| Broughton Park | June 28 | September 1 | Long-beaked storksbill | 4 cm | 2 – 3 trifoliate leaves |
| Stephenson | July 21 | NA | Stemless thistle | 4 – 15 cm | NA |
| | | | Long-beaked storksbill | 5 cm | NA |

An additional herbicide trial has been included in this report that was established August 18 to investigate control strategies for stemless thistle *(Onopordum acaulon)*. Control scores were conducted 63 DAA and ranged from 1 – 6, where 1 = unaffected and 6 = complete control.

**Results and Discussion**

*Fertiliser trials*

*Matters 1 and Broughton Park*

Matters 1 and Broughton Park fertiliser trials both had high levels of background nutrition with 0 – 10 cm nitrogen (N) at 132 kg N/ha and 68 kg N/ha, respectively. Colwell P at 0 – 10 cm was also 94 mg/kg and 38 mg/kg, for Matters 1 and Broughton Park. This resulted in minimal response to any fertiliser treatment. The high nutrition treatment (500 kg single super + 200 kg urea) showed some visual responses at these sites during the growing season where the height of the pasture was visibly taller and the plants were visibly darker green. However, no significant differences were measured for NDVI or dry matter production in October.

*Additional fertiliser sites*

The additional sites established in July and August were selected based on poor pasture production observed during the season. Soil test results from these sites indicate low nutrition with Colwell P values 26 mg/kg and 11 mg/kg for the Matters 2 and Stephenson trials, respectively. Nitrogen and sulphur levels were also low at these sites.

*Matters 2*

Positive biomass responses to the application of nitrogen were observed at the Matters 2 trial with an average increase of 0.9 t DM/ha (23%) recorded for all urea treatments (Figure 1). The application of P as single superphospate at any rate alone did not have any impact on pasture production and single super plus urea did not further increase biomass production over urea applied alone. This indicates that nitrogen was the main limiting nutrient in this grass dominant pasture.

*Stephenson*

At the Stephenson trial site, only combinations of single super and urea were able to significantly increase dry matter production producing an average of 2.7 t DM/ha compared to 2.1 t DM/ha in the control (nil treatment); a 33% increase in production. Increasing rates of single super and urea to 200 kg and 100 kg/ha, respectively, showed an increase in dry matter production above the lower application rates. These results indicate that this site has more severe P and/or S deficiency compared to the Matters 2 trial, and this is supported by the lower P soil test values (Colwell P – 11 mg/kg).

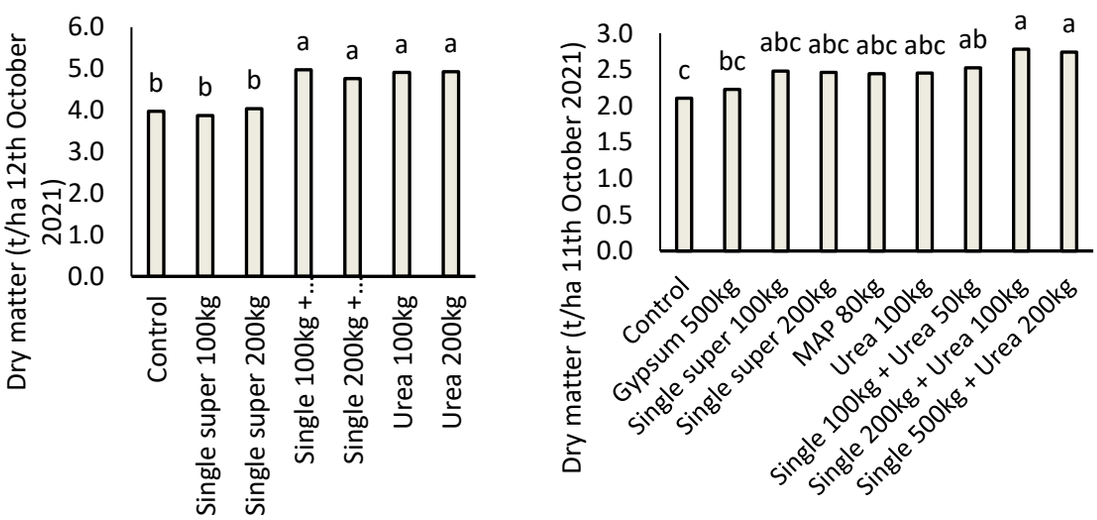


*Figure 1. (L) Dry matter production (t/ha) October 11 (61 days after application) for the Matters 2 fertiliser trial in 2021. (R) Dry matter production (t/ha) October 11 (61 days after application) for the Stephenson fertiliser trial in 2021.*

*Impact of fertiliser application on grass species*

At the Broughton Park and Matters 1 trials, some high input fertiliser treatments appeared to reduce the proportion of wild oats and increase barley grass that was present in the plots. However, a score of the population composition, between wild oat and barley grass was conducted prior to biomass cuts for dry matter yield and scores did not show any differences.

It is expected that after several seasons of fertiliser application, species composition may be altered; however, long-term replicated trials are required to make better assessments of this impact.

*Herbicide trials*

*Matters – Common Storksbill (Erodium cicutarium)*

The Matters herbicide trial was dominated by barley grass *(Hordeum leporinum)* and common storksbill with a low level of wild oats *(Avena fatua)* present. Herbicide treatments Ecopar® + MCPA and Igran® + MCPA provided good early control of common storksbill and had little impact on the grass species present (Table 2). Thistrol Gold® is a slower acting herbicide but still had some significant effect at the early score. At the later assessment, (43 DAA) the best performing treatments were still Ecopar® + MCPA, Igran® + MCPA. The T-rex® + 2,4-D treatment had now provided complete control with a herbicide score of 9 out of 9.

The two Verdict treatments provided excellent control of the erodium and controlled most of the barley grass and wild oats. A low population of silver grass *(Vulpia bromoides)* was present at the site and this became the dominant species in these treatments after the other grass species were removed. These treatments were also left more exposed compared to other treatments and would have been at a higher risk to wind and water erosion.

*Broughton Park – Long-beaked Storksbill (Erodium botrys)*

The early score at the Broughton Park herbicide trial was conducted 15 days after treatment. Similar to the Matters trial, the Ecopar® + MCPA and Igran® + MCPA treatments had the fastest impact on the long-beaked storksbill providing an average score of 8.3, 15 DAA (Table 2).

Broadstrike® + Diuron and Broadstrike® + bromoxynil also performed well on long-beaked storksbill in this trial. Broadstrike® + Buttress® and Broadstrike® + MCPA did not provide any control at this assessment. Therefore, it is presumed that it is the Group 5 herbicide component of diuron or bromoxynil that is providing the control in the Broadstrike® mixtures. This treatment contains a higher loading of bromoxynil (400 g ai/ha) compared to the Thistrol Gold® + bromoxynil treatment (140 g ai/ha) and had a greater impact at this earlier score.

Clover herbicide tolerance was also scored in this trial to assess the effects on the desired broadleaf pasture species. The Broadstrike® + diuron treatment produced a score of 5.7 out of 9 at this assessment timing indicating a high level of damage. However, there was some recovery and by 43 DAA the score for this treatment reduced to 2.7. In contrast the T-Rex® + 2,4D amine treatment was slower to kill the clover but by 43 DAA none remained.

As expected, the Verdict® treatments caused severe damage to the grasses, however as in the Matters trial, silver grass that was not visible in the other treatments now dominated some areas of those plots. Storksbill control of in these treatments was excellent and clover was unaffected. The addition of Broadstrike® did not improve storksbill control but it was noted that grass control appeared slower compared to Verdict applied alone.

This trial became infested with brown pasture looper (Ciampa arietaria) after the first herbicide application and no data on erodium botrys was collected beyond the 15DAA score.

*Stephenson – Stemless thistle (2021 and 2020)*

Stemless thistle was the hardest weed to control in this trial series. In the trial established in 2021 the best herbicide control score achieved was 4.0 out of 9 from the application of Thistrol Gold at 4000 mL/ha although this was statistically similar to Broadstike + Butress, Thistrol Gold at 2000 mL/ha and MCPA Amine + Saracen (these four treatments averaged a score of only 3.7) (Table 3). This level of control is not satisfactory and indicates that getting good control with treatments that do not damage legume-based pasture will be difficult to achieve.

In 2020, a trial was established in a similar location to the 2021 trial. In this trial more treatments were included that were known to be damaging to legume-based pastures.

*Table 2. Herbicide score for grasses including barley grass (Hordeum leporinum) and wild oat Avena fatua), common storksbill (Erodium cicutarium), long beaked storksbill (Erodium botrys) (0 = no effect, 9 = complete control and approximate ground cover of Clover and Wild oat) for the Matters and Broughton Park herbicide trials 2021, refer to Table 3 for herbicide application rates.*

| | Broughton Park Score 0 - 9 | | | | | Broughton Park approx. % cover | | Matters Score 0 - 9 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatment** | **Grass 15 DAA** | **Long beaked storksbill 15DAA** | **Grass 43 DAA** | **Long beaked storksbill 43 DAA** | **Clover 43 DAA** | **Clover 71 DAA** | **Wild oat 71 DAA** | **Grass 16 DAA** | **Clover 15DAA** | **Common storksbill 15DAA** | **Grass score 43 DAA** | **Common Storksbill score 43 DAA** |
| Nil | 0.0 | 0.0 | 0.0 | 4.0 | 0.0 | 25 | 90 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tigrex 750mL | 0.3 | 2.3 | 0.0 | 9.0 | 0.3 | 12 | 77 | 0.0 | 0.3 | 1.0 | 0.0 | 6.7 |
| Jaguar 750ml | 0.0 | 2.7 | 0.3 | 9.0 | 0.3 | 23 | 77 | 0.0 | 0.3 | 1.3 | 0.0 | 2.0 |
| Broadstrike 25g + Butress 2L + Banjo | 0.3 | 1.7 | 0.0 | 9.0 | 0.3 | 12 | 83 | 0.3 | 1.3 | 1.7 | 0.0 | 5.3 |
| Broadstrike 25g+ MCPA Amine 330mL + Banjo | 0.3 | 2.7 | 0.3 | 9.0 | 0.0 | 13 | 80 | 0.3 | 1.3 | 3.0 | 0.0 | 6.7 |
| Broadstrike 25g + Diuron 600g + Banjo | 3.0 | 8.3 | 2.0 | 9.0 | 2.7 | 3 | 70 | 3.3 | 5.7 | 5.3 | 3.0 | 8.7 |
| Broadstrike 25g + Bromoxynil 2L + Banjo | 0.7 | 7.3 | 0.0 | 9.0 | 0.7 | 18 | 90 | 1.7 | 2.0 | 1.7 | 0.3 | 7.0 |
| Verdict 100mL + Uptake | 6.7 | 8.0 | 8.3 | 9.0 | 0.0 | 67 | 0 | 7.0 | 0.0 | 7.7 | 8.0 | 8.0 |
| Broadstrike 25g + Verdict 100mL + Uptake | 6.7 | 6.0 | 8.3 | 9.0 | 0.0 | 53 | 0 | 6.3 | 1.0 | 5.7 | 8.0 | 7.7 |
| Brodal Options 200mL | 0.0 | 0.7 | 0.3 | 9.0 | 0.7 | 8 | 83 | 1.0 | 0.3 | 1.0 | 0.0 | 2.7 |
| Igran 500mL + MCPA Amine 330mL | 1.3 | 8.0 | 0.0 | 9.0 | 1.3 | 10 | 83 | 1.7 | 3.3 | 7.0 | 0.3 | 9.0 |
| Ecopar 500mL + MCPA Amine 330mL | 0.3 | 8.7 | 0.0 | 9.0 | 1.3 | 7 | 83 | 0.3 | 2.0 | 8.3 | 0.0 | 9.0 |
| Tigrex 750mL + 2,4DAmine625 750mL | 1.0 | 4.7 | 0.0 | 9.0 | 9.0 | 0 | 47 | 0.0 | 2.7 | 3.3 | 0.0 | 9.0 |
| Thistrol Gold 2L + Banjo | 0.3 | 2.7 | 0.0 | 9.0 | 0.0 | 8 | 80 | 0.7 | 1.0 | 6.0 | 0.0 | 7.0 |
| Thistrol Gold 4L + Banjo | 1.0 | 3.7 | 0.0 | 9.0 | 0.3 | 18 | 87 | 1.3 | 1.3 | 5.3 | 0.0 | 7.0 |
| Thistrol Gold + Banjo + Bromoxynil | 1.0 | 2.3 | 0.0 | 9.0 | 1.3 | 13 | 87 | 1.0 | 1.3 | 4.7 | 0.0 | 7.7 |
| T2_Broadstrike 25g + Butress 2L + Banjo | 0.0 | 0.0 | 0.0 | 4.7 | 0.0 | 18 | 87 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| T2_Thistrol Gold 2L + Banjo | 0.0 | 0.0 | 0.0 | 5.0 | 0.0 | 18 | 90 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| T2_Tigrex 1L | 0.0 | 1.0 | 0.0 | 6.3 | 0.0 | 17 | 77 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | 0.7 | 2.2 | 0.5 | 1.5 | 1.1 | 13 | 16 | 0.9 | 1.0 | 2.5 | 0.9 | 2.3 |

These treatments included the herbicides dicamba, clopyralid and metsulfuron-methyl. The clopyralid treatment provided almost 100% control with an average score of 4.7 out of 5 (data not presented). Dicamba + 2,4D amine provided control with a score of 3.7 out of 5 on the same scale. Treatments that were similar in both trials produced equivalent levels of control in both years.

The site established in 2020 was revisited in 2021 and a score of population was conducted. Results were variable due to the scattered population, but it was reasonably clear that the two best treatments in 2020, dicamba and clopyralid had the lowest population of stemless thistle almost a year after application. This indicates that although damaging to the pasture species, if good control is achieved in year one, benefits remain in the following season. If a non-residual herbicide treatment such as dicamba + 2,4D amine is used it is likely that clover or medic pasture species would be able to regenerate in the following season, providing there is an adequate seed bank remaining in the soil.

*Table 3. Herbicide score for stemless thistle (Onopordum acaulon) and common storksbill (Erodium botrys) (0 = no effect, 9 = complete control) 43 days after application for the Stephenson herbicide trial 2021, refer to Table 3 for herbicide application rates.*

| Product(s) | Stemless thistle | Common storksbill |
|---|---|---|
| Nil | 1.0 | 1.0 |
| Tigrex 750mL | 2.7 | 4.0 |
| Broadstrike 25g + Butress 2L + Banjo | 3.3 | 4.0 |
| Broadstrike 25g + MCPA Amine 330mL + Banjo | 3.0 | 3.3 |
| Igran 500mL + MCPA Amine 330mL | 2.7 | 6.7 |
| Ecopar 500mL + MCPA Amine 330mL | 2.7 | 8.3 |
| Tigrex 750mL+ 2,4DAmine625 750mL | 2.2 | 6.7 |
| Thistrol Gold 2L + Banjo | 3.7 | 2.5 |
| Thistrol Gold 4L + Banjo | 4.0 | 5.0 |
| MCPA Amine 1L + Saracen 100mL + Banjo | 3.7 | 8.3 |
| **LSD (P≤0.05)** | **0.9** | **2.6** |

Pasture growth responses are consistent with soil test results and variable within the same paddock. Where low levels of nutrition were measured, the application of phosphorus and nitrogen increased dry matter production by up to 33% in this trial series. This increase in production also generates greater ground cover resulting in reduced risks to wind and water erosion and opportunity for increased meat and wool production in the area. The variability of results across the four trial sites shows that selective soil sampling from specific soil types or areas of varying pasture production will be important to identify zones within a paddock where nutrient response will occur and which nutrients are likely to be most responsive.

Weed control in these trials varied depending on species. Both long beaked storksbill and common storksbill were effectively controlled where desired pasture species were able to be retained. However, this was not the case for the more difficult to control stemless thistle. For this species, it was necessary to use herbicides that caused significant damage to beneficial plants such as clover species. Despite this, it was noted that two years of control could be achieved with a single application of herbicide.

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