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# Identifying the causes of unreliable N fixation by medic based pastures

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## Key Messages

- Applying Phosphorus (P) to a soil with low P reserves, when establishing a medic pasture, boosts shoot and root dry matter, improves root health and improves nitrogen (N) fixation.
- The addition of urea at seeding can reduce nodulation in medic pastures.
- Applying a full label rate of Agritone 750 (late) decreases pasture production and N fixation in actively growing medic pastures.
- Residues of the herbicide Logran can severely stunt medic growth.

## Background

The broad aim of this three year SAGIT funded project was to investigate if current management tools for medic based pastures, such as herbicides, fertilisers and rhizobial inoculants, are affecting N fixation by medic pastures under field conditions typical of the upper Eyre Peninsula. These results should also be relevant to other low rainfall Mallee systems.

This article mostly reports on the third and final year of these trials. For a detailed summary of the results of the first year, please refer to the Eyre Peninsula Farming Systems Summary 2015 p209-213. The second year's results are available in the Eyre Peninsula Farming Systems Summary 2016 p142-146.

## About the trial

In 2017, the third and final year of the trial, two replicated field trials were established on the Eyre Peninsula. One on red sandy loam, representative of typical Mallee environments in SE Australia (Minnipa Agricultural Centre) and the other on a grey highly calcareous sandy soil (Brent Cronin's property at Piednippie). The trials were dry sown with inoculated Herald strand medic at 10 kg/ha on 6 June (Minnipa) and 7 June (Piednippie).

All nutrition treatments (Table 1) were applied at sowing. Treatments to simulate herbicide residues were imposed immediately after sowing. Plots were sampled to determine the number of viable root nodules, root health and root weight. $N_2$ fixation was measured using the $^{15}N$ natural abundance technique. Soil mineral N will be measured in autumn 2018.

***Table 1.*** *2017 Treatment Details*

| Treatment | Active Ingredient | Chemical Group | Application Rate (units/ha) |
|---|---|---|---|
| **Nutrition** | | | |
| **Phosphorus** | Phosphoric acid | | 10 kg P |
| **Phosphorus + Tigrex** | Phosphoric acid<br>250g/L MCPA as the ethylhexyl ester;<br>25g/L Diflufenican | F<br>I | 10kg P<br>100ml +200ml *wetter |
| **Phosphorus + LVE Agritone** | Phosphoric acid<br>570g/L MCPA as the 2-ethylhexyl ester | I | 10kg<br>250ml + 200ml *wetter |
| **Phosphorus + Late Agritone 750** | Phosphoric acid<br>750g/L MCPA (as dimethylamine salt) | I | 10kg<br>200ml |
| **Zinc** | Zinc Sulphate | | 2kg |
| **Herbicide Residues** | | | |
| **Intervix** | 33g/L Imazamox; 15g/L Imazapyr | B | 45ml |
| **Logran** | 750g/kg Triasulfuron | B | 1.75g |
| **Lontrel** | 300g/L Clopyralid (as triisopropanolamine salt) | I | 7.5ml |
| **Post Emergent Herbicides** | | | |
| **Tigrex Early** | 250g/L MCPA as the ethyhexyl ester;<br>25g/L Diflufenican | F<br>I | 100ml + 200ml *wetter |
| **Tigrex Late** | 250g/L MCPA as the 2-ethylhexyl ester;<br>25g/L Diflufenican | F<br>I | 100ml +200ml *wetter |
| **LVE Agritone Early** | 570g/L MCPA as the 2-ethylhexyl ester | I | 250ml + 200ml *wetter |
| **LVE Agritone Late** | 570g/L MCPA as the 2-ethylhexyl ester | I | 250ml + 200ml *wetter |
| **Agritone 750 Early** | 750g/L MCPA (as dimethylamine salt) | I | 200ml |
| **Agritone 750 Late** | 750g/L MCPA (as dimethylamine salt) | I | 200ml |
| **Control** | Inoculated | | |

*Wetter = BS1000

## Results & Discussion

Due to the dry start, the medic was sown nearly a month later than in the 2 previous years, and took nearly another month to establish. Growth continued to be slow. At Minnipa Airport the mean site plant density was 223 plants/$m^2$. At Piednippie the mean site plant density was 218 plants/$m^2$. Plant density was not affected by herbicide residues, nor nutrition. However, once plants reached the 1-2 trifoliate leaf stage, it became apparent that Logran, applied after sowing to simulate herbicide residues in the soil, was causing stunted growth, with the effect more pronounced at Minnipa, where most plants failed to develop beyond the first leaf stage. For other treatments, once plants had progressed to the 2-3 trifoliate leaf stage, phosphorus and zinc were observed to have a positive early growth effect, with the effect more visible at Piednippie; but this was not consistent across all treatment replicates. The other residual herbicide treatments of Intervix and Lontrel, did not appear to have had any early effect on medic growth.

At Minnipa, shoot biomass (DM) prior to flowering, in the Control was 446 kg/ha. Biomass was decreased by the residual Logran treatment to only 34 kg/ha, with the stunted plants never recovering. All other treatments produced biomass similar to the control at this site.

At Piednippie shoot biomass (DM) prior to flowering, in the Control was 134 kg/ha. No treatments reduced biomass compared to the control. In sharp contrast to Minnipa, the plants initially stunted by the residual Logran treatment, recovered to be similar to the control by the time of sampling. Biomass was increased by phosphorus to 283 kg/ha compared to the control. P + Late Agritone 750 also increased the shoot biomass to 305 kg/ha.

At Minnipa the total number of nodules per plant averaged 6.3. Nodulation and root weights were not affected by any treatment. Levels of root disease (based on a visual score) were reasonably low (4.5 out of 15) and did not differ between treatments.

At Piednippie the total number of nodules per plant averaged 4.2. Although treatments had no effect on total nodule number per plant, there were treatment differences in the effectiveness and distribution of nodules on the roots. Generally, LVE Agritone Early and LVE Agritone Late decreased the proportion of effective nodules. Similar to Minnipa, the levels of root disease at Piednippie were reasonably low with a score of 5.6 out of 15 & did not differ between treatments.

*Plant Nitrogen (2016 Results)*

In 2016 the amount of N in medic shoots derived from fixation was estimated using the $^{15}N$ natural abundance method. At Pinbong, Agritone 750 Late & urea both decreased the amount of fixed N. The two controls averaged 23 kg of fixed N/ha, but the late application of Agritone 750 reduced this to 13 kg of fixed N/ha. Applying urea to the medic reduced the amount of N fixed to only 7 kg/ha. Urea also decreased the amount of N fixed per tonne of DM.

At Piednippie Agritone 750 Late and urea also decreased the amount of fixed N. The two controls averaged 25 kg of fixed N/ha, but the application of Agritone 750 Late reduced this to 17 kg of fixed N/ha. Urea reduced the amount of fixed N to 15 kg/ha. At Piednippie the addition of 10 kg/ha of P increased the amount of fixed N to 39 kg/ha.

The percentage of N in medic tops which had been fixed was 92% at Pinbong and 83% at Piednippie. At Pinbong the amount of N fixed in tops was 20 kg N/ha; similar to the amount measured in 2015, whereas at Piednippie, the average amount of fixed N (kg/ha) more than doubled in 2016, from 11 kg/ha to 25 kg/ha.

The 2017 results are not yet available.

*Soil Mineral Nitrogen*

The 2016 trials were sampled for mineral N in the root zone in March 2017. Soil mineral N was not affected by treatments in the 0-10 cm or the 10-60 cm nor the combined 0-60 cm soil zone, at both sites. Similarly, there were no treatment effects on soil mineral N in 2016, after the 2015 medic trials. The average total mineral N (0–60 cm) was 32 kg N/ha at Pinbong and 50 kg N/ha at Piednippie in March 2017. These totals are substantially lower than those measured in autumn 2016 following the 2015 trials. In 2016 Pinbong had 101 kg N/ha and Piednippie had 89 kg N/ha.

The 2017 results are not yet available.

*Wheat*

This year the 2016 medic trial sites were sown with Scepter wheat on 18 May (Pinbong) and 7 June (Piednippie) at a rate of 60 kg/ha. At Pinbong the average yield was 1.36 t/ha, average protein was 10.8% and the average screenings were 7.4%. At Piednippie the average yield was 0.79 t/ha, average protein was 10.8% and the average screenings were 7.4%. The previous year's medic treatments had no effect on plant emergence, late dry matter, yield or grain protein. At Pinbong the previous year's applications of LVE Agritone + Verdict and Agritone 750 (2) decreased the yield of wheat, even though these treatments had not affected the amount of N fixed by the medic in 2016, nor the amount of soil N present in March 2017.

In 2016, the wheat sown onto the 2015 medic trial sites also had no differences in yield, protein and screenings.

## Implications for commercial practice

The dry start this year meant that the medic was sown late, was slow to emerge and produced less than 500 kg/ha shoot dry matter. Continuing low rainfall and high spring temperatures meant that the medic was stressed at the time of the nodulation assessment which may have increased the numbers of ineffective nodules recorded.

At Minnipa the plants were podding, and their nodules were generally senescent, so very few nodules were recorded as effective, making it difficult to discern herbicide effects. At Piednippie plants were less mature with some treatment effects on nodulation measured.

As shown in the previous years' trials, phosphorus increased medic growth. While the increased biomass would have been beneficial to grazing, this year it did not appear to provide any benefit to N fixation in terms of nodulation, although we are yet to receive the N Fixation results.

At Minnipa residual Logran severely stunted early medic growth, with the plants never recovering. In contrast to previous results, the post emergent herbicides had no effect on medic productivity, almost certainly due to the dry conditions and the plants not actively growing. Piednippie received extra early rainfall which would have increased the activity of soil microbes, allowing them to break down the Logran residue. This extra rain may have washed the residues down through the sandy soil. Hence the Logran affected medic seedlings were able to recover. LVE Agritone early and late, decreased the percentage of effective nodules at Piednippie, but this percentage was already very low on the controls. Therefore, we can conclude that in a dry growing season, when medic plants are already moisture stressed, herbicides will have little impact on medic productivity and N fixation.

Regardless of seasonal conditions, the management of medic pasture with respect to herbicides and fertilisers, appears to have no influence on the yield and protein level of the wheat crop in the following year.

In general, biomass production and total N contribution from the medic pastures has been low in the establishment year, and likely explains why no significant differences in soil mineral N were able to be measured in the years following the medic pasture. In regenerating medic pasture the treatment impacts on medic growth and N fixation would be greater due to the increased biomass, and therefore likely to have greater impacts on the following cereal crop.

These trials have shown that applying P when establishing medic pastures can substantially increase their productivity, whereas using certain herbicides can significantly damage them, by reducing their ability to grow, maintain effective nodules and fix nitrogen. Herbicides are an essential part of weed management, but their negative effects on medic pasture growth for N production and livestock feed, must be considered from a whole farming systems perspective in relation to the value of the weed control they provide.

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