## Trial 2. Nitrogen Use Efficiency Trial – influence of N rate

**Protocol Objective:**
To evaluate nitrogen use efficiency in grain maize under different rates and of applied N fertiliser applied at sowing and at V6 as urea (46% N).

### Kerang, Victoria

**Sown:** 29 October 2019
**Harvested:** 22 April 2020
**Soil Type:** Neutral self-mulching grey clay
**Previous crop:** Grass dominant pasture (3 years)

**Hybrid:** Pioneer Hybrid 1756
**FAR code:** ICC M19-01-2
**Irrigation Type**: Border check surface irrigation

***Key Points:***

- *The highest grain yield (machine harvested) achieved was 16.36 t/ha with the applied N rate of 240 kg N/ha in a crop producing 30.63 t/ha dry matter at 50.45% harvest index.*
- *N applications above 240kg N/ha were uneconomic in the trial.*
- *The nil control treatment yielded 10.89 t/ha in a crop producing 26t/ha dry matter at 51% harvest index.*
- *Available Soil N prior to sowing and watering up was 34 kg N/ha (0-60cm). The nil control N offtake at harvest was 241 kg N/ha, suggesting in-crop mineralisation resulted in 207 kg N/ha of the N taken up.*
- *At the highest level of N (560kg N/ha) there was no advantage to applying 80 Kg N/ha of the dose very late at tasselling.*

Mineralisation at the trial site may have been higher than usual due to a long history of pasture and little mineralisation of the soil organic matter over the last few dry years and no irrigation. There was a statistically significant yield response as a more N was applied, which peaked at 240 kg N/ha. N applied at 560 kg N/ha resulted in a yield decrease, while not statistically different to the highest yields, was similar to the low rates (80 and 160 kg N/ha) (Table 1).

**Table 1:** SAGI analysis for grain yield (t/ha), test weight (kg/hl), harvest index (%) and harvest dry matter (t/ha).

| | | Yield (t/ha) | | | Test weight kg/hL | | Harvest index (%) | | Total DM (t/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pre-sow N | | PV | | SE | PV | SE | PV | SE | PV | | SE |
| 1 | 0 | 10.89 | d | +/- 0.47 | 82.35 | +/- 0.87 | 51.14 | +/- 1.13 | 26.13 | b | +/- 1.59 |
| 2 | 80 | 12.78 | c | +/- 0.47 | 82.04 | +/- 1.16 | 51.76 | +/- 1.13 | 27.06 | b | +/- 1.58 |
| 3 | 160 | 13.80 | bc | +/- 0.47 | 82.53 | +/- 1.19 | 50.11 | +/- 1.13 | 34.40 | a | +/- 1.59 |
| 4 | 240 | 16.36 | a | +/- 0.50 | 82.44 | +/- 1.17 | 50.45 | +/- 1.17 | 30.63 | ab | +/- 1.63 |
| 5 | 320 | 16.32 | a | +/- 0.48 | 82.09 | +/- 1.17 | 53.49 | +/- 1.13 | 35.08 | a | +/- 1.59 |
| 6 | 400 | 15.48 | ab | +/- 0.47 | 82.5 | +/- 1.18 | 52.48 | +/- 1.13 | 34.26 | a | +/- 1.58 |
| 7 | 480 | 15.56 | a | +/- 0.47 | 81.88 | +/- 1.19 | 50.41 | +/- 1.14 | 33.63 | ab | +/- 1.57 |
| 8 | 560 | 15.62 | a | +/- 0.48 | 82.5 | +/- 1.17 | 49.51 | +/- 1.12 | 32.11 | ab | +/- 1.57 |
| Mean | | 14.6 | | | 82.3 | | 51.2 | | 31.7 | | |
| P val | | 0 | | | 0.231 | | 0.156 | | 0.002 | | |

| | | | | |
|---|---|---|---|---|
| **LSD** | 1 | 0.6 | 2.8 | 4.2 |
| **CV** | 14.4 | 0.5 | 4.9 | 13.9 |

*PV= Predicted value, SE= Standard error*

*Treatment 7 was modified following discussion at the field walk as a result 80 kg N/ha (46% N urea) was applied at tasselling to 480kgN/ha, so both treatment 7 & 8 represent 560kg N/ha.*

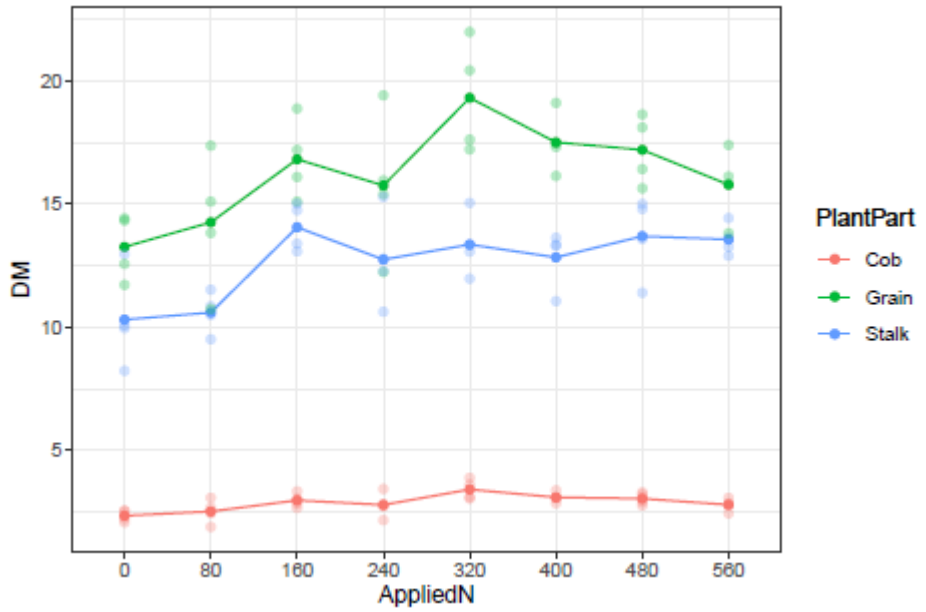



**Figure 1: Total** dry matter content (kg/ha) in maize at maturity, 23 March 2020.

***** *This treatment was modified following discussion at the field walk as a result 80 kg N/ha late applied N (46% N urea) was applied at tasselling.*

*Nitrogen content Figures followed by different letters are considered to be statistically different (p=0.05)*

*^ Nitrogen content of stover (stalks, leaves and cob husk) and grain calculated from dry matter at harvest.*

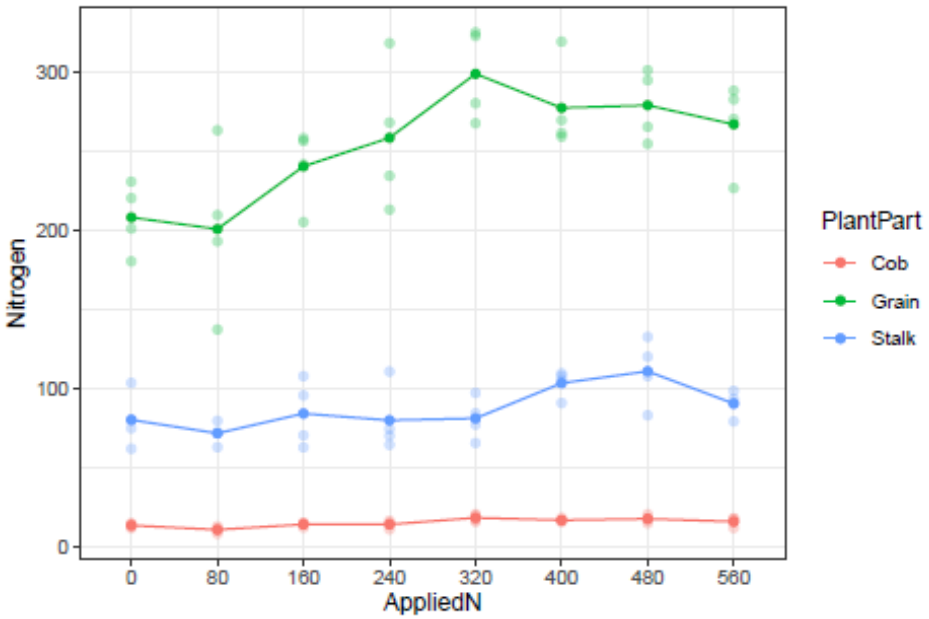



**Figure 2.** Total crop N (kg N/ha) offtake at harvest in the stover (stalks, leaves, husk) and grain (mean of 2 replicates).

*Treatment 7 was modified following discussion at the field walk as a result 80 kg N/ha (46% N urea) was applied at tasselling to 480kgN/ha, so both treatment 7 & 8 represent 560kg N/ha.*
*N content has been calculated using DM weights from the sample cuts taken at the bottom of plots to avoid any drag of N by irrigation.*

There were differences in N content between the different plant parts and a slight interaction of the combined effect of plant part and Nitrogen indicating that more N went into the grain as applied fertiliser N increased (Figure 2).

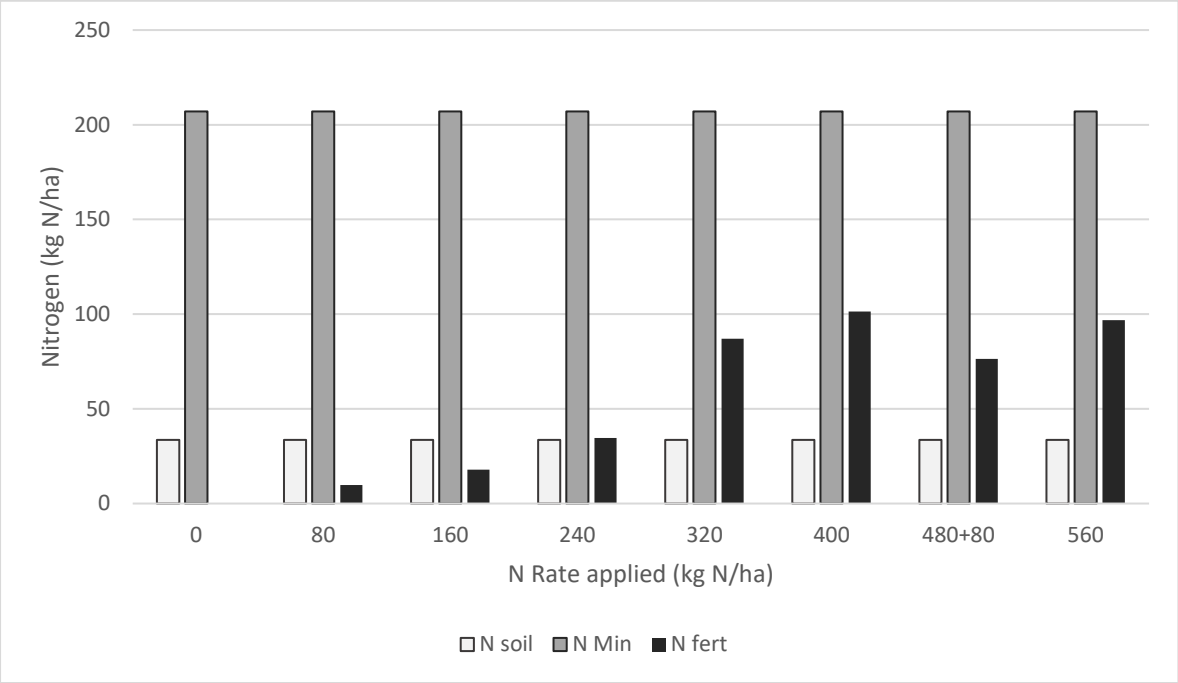



**Figure 2:** Assumed contribution of N fertiliser to total crop N offtake at harvest (if mineralisation was assumed to be the same in all treatments and that preferential N uptake of soil N rather than bag N was the case).
*Note without specific N isotope studies it cannot be accurately calculated what proportion of N uptake by the plant came from the soil or the fertiliser applied).*

This trial suggests that mineralisation can contribute a considerable amount when sowing into a pasture paddock. Soil N prior to sowing and watering up was 34 kg N/ha and total N in the untreated crop was 241 kg N/ha at harvest, leaving a balance of 207 kg N potentially supplied by mineralisation. The highest yielding treatment had an N content of 353 kg N/ha at harvest which was achieved by applying 240 kg N/ha N fertiliser. This is 51 kg N/ha higher offtake than in the untreated suggesting minimal contribution to the total crop N from fertiliser applied. The highest amount of N taken up by the crop at harvest was 408 kg N/ha in the '480 + 80 kg N/ha' treatment which was statistically similar to the '400' and '560" treatments. However, none of these higher N contents were associated with significantly higher yields than that achieved with 240kg N/ha.

Yield plateaued after 240 kg N/ha rate. Assuming (with the provisos already stated) the mineralisation rate was approximately 207 kg N/ha, only 70 kg N/ha of the applied fertiliser ended up in the plant, this would represent a very poor nitrogen use efficiency of 29%.

**Table 2:** Influence of N rate on leaf %N.

| N Rate (kg N/ha) | Leaf N (%) | |
|---|---|---|
| | Tasselling (VT) | VT + 21 days |
| **Nil (Control)** | 1.50 | 1.35 |
| **320** | 2.65 | 2.15 |
| **560** | 2.50 | 2.30 |

Most maize growers would be applying at least 300 kg N/ha to their crops, and do not consider the amount of mineralisation to be a substantial contributor to the N budget. Another comment made at the field days was that applying more N didn't necessarily result in more yield, but high rates are maintained to ensure the crop has too much rather than not enough N. If this surplus N fertiliser is available to the next crop then this might still be an economic approach, however if it is lost from the system as leaching or nitrous oxide emissions then these high N input strategies would be uneconomic. In this trial the margin advantage of 240kg N/ha over 560kg N/ha was almost $500/ha. Both the Peechelba and Kerang trials suggest that mineralisation can contribute a considerable amount of N to the systems and should be considered in the N budget. However, all paddocks will differ in the amount of organic matter available for mineralisation – e.g. a continuously summer cropped paddock is likely to have a lower potential for mineralisation than a long-term clover-based pasture. In both trials in this case optimum N levels of applied fertiliser applied did not exceed 200 - 250kg N/ha.

**Table 3:** Original analysis of grain yield (t/ha @ 14% moisture), dry matter (t/ha @ 0% moisture), test weight (kg/hL) and harvest index (H.I.%), 21 April 2020 presented in the provisional results.

| Treatment | | | Seed Yield and Quality | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yield | | DM | | Test Wt | | H.I | |
| Pre-drill | Post | Total kg N/ha | t/ha | | t/ha | | kg/hL | | % | |
| **1** 0 | 0 | **Nil (Control)** | 10.91 | a | 22.02 | a | 82.4 | - | 43 | ab |
| **2** 40 | 40 | **80** | 12.61 | b | 23.95 | a | 82.0 | - | 45 | abc |
| **3** 80 | 80 | **160** | 14.00 | b | 29.07 | b | 82.6 | - | 42 | a |
| **4** 120 | 120 | **240** | 16.43 | c | 28.92 | b | 82.3 | - | 49 | c |
| **5** 160 | 160 | **320** | 16.16 | c | 30.97 | b | 82.4 | - | 45 | ab |
| **6** 200 | 200 | **400** | 15.78 | c | 29.50 | b | 82.5 | - | 46 | bc |
| **7** 200 | 200 | **480+80*** | 15.38 | bc | 29.95 | b | 81.9 | - | 45 | ab |
| **8** 280 | 280 | **560** | 15.37 | bc | 30.05 | b | 82.4 | - | 44 | ab |
| **LSD** | | | 1.60 | | 2.94 | | NS | | 0.31 | |
| **Mean** | | | 14.58 | | 28.06 | | 82.3 | | 45 | |
| **P Val** | | | <0.001 | | <0.001 | | 0.361 | | 0.040 | |
| **CV** | | | 7.4 | | 7.1 | | 0.5 | | 6.0 | |

*Notes: Treatment 7 was modified following discussion at the field walk, as a result 80 kg N/ha (46% N urea) was applied at tasselling to 480kgN/ha, so both treatment 7 & 8 represent 560kg N/ha.*
*Yield Figures followed by different letters are considered to be statistically different (p=0.05)*

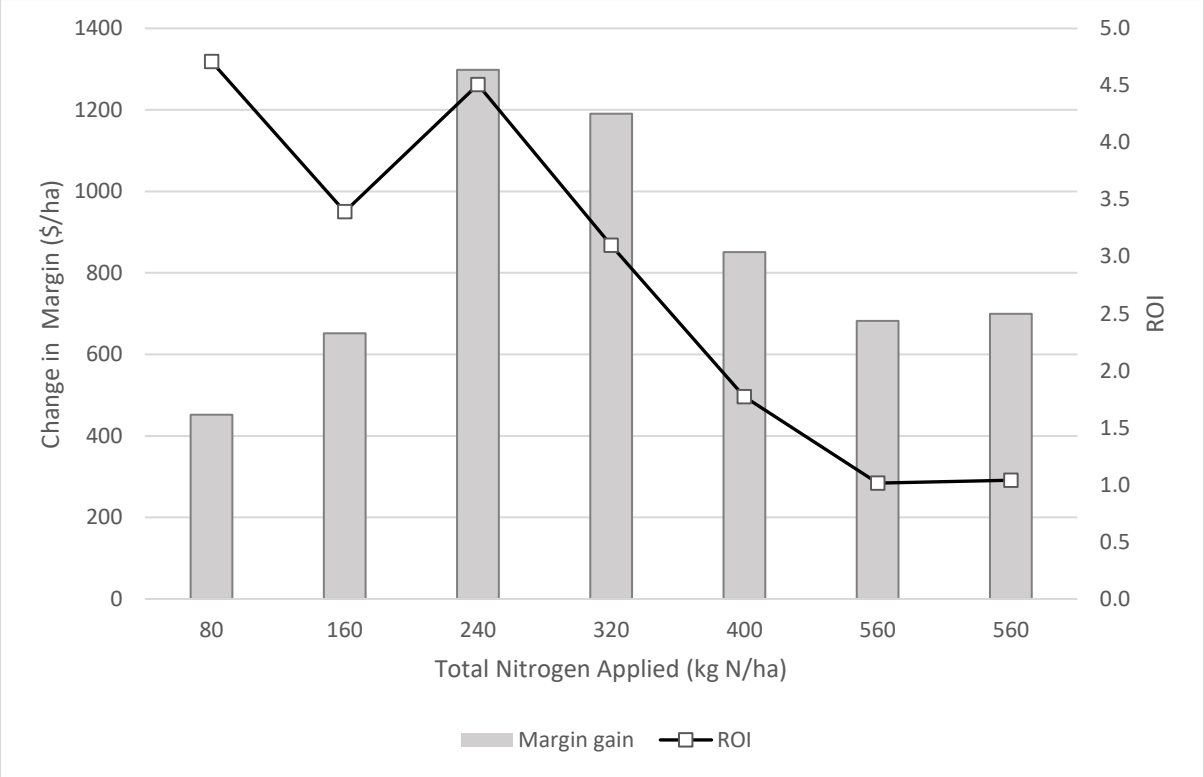



**Figure 3.** Influence of nitrogen rate on margin over input cost compared to control (0 N) ($/ha – value of increased grain production minus cost of inputs) and return on investment (RIO). Based on SAGI predicted yield.

*Input costs based on price of $1.20/kg N, Income based on grain value of $290/t.*