

Wheat variety x nitrogen trial

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Key Points

- Applying nitrogen increased grain yield, grain protein concentration and profitability.
- This site was extremely low in nitrogen. By applying 100 kg/ha N upfront, profit increased by \$327/ha over nil nitrogen applied.
- Nitrogen use efficiency and return on investment was highest when 50 kg N/ha was predrilled prior to sowing.
- There were large differences between varieties for grain yield.
- Increasing seeding rates from 20 to 40 kg/ha increased yield by over 400 kg/ha (16%). This is likely due to timely rain in September.
- Results in this trial may have been different if rainfall in September did not occur. This rain was essential for this trial to reach its potential.

Trial aim

To measure the impact that varying nitrogen rates and seeding rates have on grain yield and quality across a number of varieties of wheat.

Trial details

Soil type: Red Sandy Loam
Soil test: 0 – 10 cm: pH = 5.7, Al% = 1.5
Sulphur = 7 mg/kg;
Colwell P = 39 mg/kg

Nitrate N = 30.7mg/kg

Ammonium N = 1.5 mg/kg

10-30 cm:

Ammonium N = 4.5 mg/kg

Nitrate N = 1.6 mg/kg

30-60 cm:

Ammonium N = 3.7 mg/kg

Nitrate N = 1.1 mg/kg

60-90 cm:

Ammonium N = 4.7 mg/kg

Nitrate N = 1.3 mg/kg

Total 96.6 kg N (0-90cm)

Previous crop: Wheat

Seeder used: Morris Contour drill tines (12mm knife point and press wheel)

<5% Seed Bed Utilisation

Sowing date: 29th April

Herbicide: 1.0L Roundup CT + 118g Sakura + 35g Logran (IBS)

Starter fertiliser: 60 kg Superfect

(8.8% P, 11% S, 19.1% Ca)

Post em herbicide: Nil

Fungicide: Intake on fertiliser

Insecticide: Nil

Harvest date: 7th November

Treatments

Varieties

EGA Gregory, Elmore, Livingston, Spitfire, Suntop and Sunvale.

Nitrogen treatments

All nitrogen predrilled prior to sowing on 2cm guidance directly under the seed row.

0, 50, 100 and 150 kg Nitrogen/ha (in the form of urea).

Seeding rates

All varieties sown at either 20 or 40 kg seed/ha.

Seasonal review

The soil profile was reasonably dry at sowing only holding about 40cm of moisture. This paddock measured reasonable soil nitrogen levels in the soil test, but was expected to be low in nitrogen following two good wheat crops (2.5t/ha in 2011 and 2.5t/ha in 2012).

The trial was sown into marginal moisture but established evenly. Weed control was exceptional, and the trial was very even throughout the season.

Higher than average in crop rainfall before September allowed crop growth to progress well. Conditions became very dry towards the end of August and early September, however rain arrived just in time to allow the crop to fill grain adequately. 2013 also hosted less frosts than average which minimised any frost damage in this trial.

Table 1: Monthly rainfall at Merriwagga 2013.

	Rainfall (mm)
Jan	0
Feb	60
Mar	45
Apr	0
May	15.5
Jun	57
Jul	49
Aug	24.5
Sep	33
Oct	7.5
Nov	-
Dec	-
Total	291.5
In-crop	186.5

Trial results

Normalised Difference Vegetation Index (NDVI)

NDVI is a measure of reflectance which predicts plant biomass and was measured at flowering (5th September).

The average NDVI for this trial was 0.57.

There were significant ($p < 0.001$) differences in NDVI between variety and nitrogen applied.

As you would expect NDVI increased dramatically with increasing nitrogen. This confirms visual observations in the trial.

Table 2: Effect of variety on NDVI.

Variety	NDVI
EGA_Gregory	0.59
Elmore	0.53
Livingston	0.54
Spitfire	0.56
Suntop	0.59
Sunvale	0.58
lsd	0.02

Table 3: Effect of nitrogen rate on NDVI.

Nitrogen Applied	NDVI
0	0.36
50	0.58
100	0.65
150	0.67
lsd	0.02

Tiller number

The average tillers/m² in this trial was 282.

Tiller numbers were influenced by variety ($p < 0.001$), nitrogen rate ($p < 0.001$), seeding rate ($p < 0.001$), and the interaction between variety and nitrogen ($p < 0.001$), variety and seeding rate ($p < 0.001$), and nitrogen and seeding rate ($p = 0.026$).

Table 4: Effect of variety on tiller number.

Variety	Tillers/m ²
EGA_Gregory	270
Elmore	297
Livingston	264
Spitfire	258
Suntop	252
Sunvale	351
lsd	20

Table 5: Effect of nitrogen rate on tiller number.

Nitrogen (kg/ha)	Tillers/m ²
0	203
50	285
100	313
150	327
lsd	16

Table 6: Effect of seeding rate on tiller number.

Seeding Rate (kg/ha)	Tillers/m ²
20	271
40	293
lsd	12

The interactions between the treatments and their effect on tillers are a little more complex to understand and explain.

All varieties except Sunvale showed increasing tiller numbers with increasing nitrogen rates (figure 1). Sunvale reacted differently to other varieties where it gained maximum tiller numbers at 50kg N/ha, and maintained tiller numbers from 50-150 kg N/ha.

Varieties also tillered differently at different seeding rates. Livingston and Spitfire maintained the same tiller numbers at both 20 and 40 kg seed/ha, whilst the other varieties, and most noticeably Sunvale increased tillers with increased seeding rate (figure 2).

The interaction between seeding rate and nitrogen rate also impacted on tiller numbers. Tiller numbers did not vary between seeding rates at 0, 100 and 150 kg N/ha. At 50 kg N/ha however tillers increased from 260/m² at 20 kg seed/ha to 311/m² at 40 kg seed/ha.

The three way interaction between variety, seeding rate and nitrogen rate was significant, however complex to interpret and understand.

Grain Yield

The average yield for this trial was 2362 kg/ha.

There were significant ($p < 0.001$) differences in grain yield between varieties, nitrogen applied and seeding rates.

Suntop, EGA Gregory and Spitfire were the highest yielding varieties in this trial (Figure 4).

Grain yield increased with higher levels of applied nitrogen (Figure 5).

Grain yield at 20 kg/ha seeding rate averaged 2158 kg/ha and at 40 kg/ha seeding rate averaged 2566 kg/ha (LSD = 187 kg/ha).

Protein

The average grain protein in this trial was 10.11%. Grain protein was closely correlated to nitrogen applied and yield (grain protein yield).

Interestingly at nil nitrogen, the grain protein was actually higher than when 50kg nitrogen was applied. This is obviously as a result of over double the yield in this treatment.

Grain protein yield increased with increasing nitrogen applied. This is to be expected and is shown in table 7.

Grain protein yield varied between varieties. Suntop, Spitfire and Gregory accumulated more protein than Sunvale.

Discussion

Variety

The highest yielding variety, Suntop yielded 453 kg/ha more than the lowest yielding variety Sunvale.

This highlights the importance of varietal choice for yield.

Seeding rate

Seeding rate affected tiller number but not NDVI in this trial. For the first time since running these trials yield was higher at 40kg seeding rate than 20kg seeding rate. This is uncommon in this environment and is likely due to the timely rainfall that occurred in September.

Nitrogen

The site was very nitrogen responsive. This was also the case in many cropping paddocks around the local region.

The profit from applying nitrogen in this trial was large and was highest at 100 kg N/ha (Table 8) where an extra \$327/ha was gained over the nil.

The return on investment however was greatest at the lower nitrogen rate of 50 kg N/ha. This is an important outcome when applying nitrogen in marginal environments where yield responses are variable.

The large responses are remarkable given that nitrogen use efficiency was lower than expected (Table 7) and well below the industry benchmark of 50% when nitrogen rates increased above 100 kg/ha.

The remaining fertiliser nitrogen (>70% in the case of this trial) that was unused could be assumed tied up in the soil by microbial activity. Losses by leaching or volatilisation are expected to be low because the urea was predrilled before sowing and there were no rain events post sowing likely to cause leaching below the root zone.

Interestingly there were quite large differences between varieties and protein yield. This is the first trial at Merriwagga where these differences have been measured, and supports industry perceptions that some varieties have higher protein levels at a given yield than others.

Acknowledgement

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GRDC-supported research project in south/central NSW to develop agronomic information for new varieties of wheat, lupins and winter oilseeds.

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File reference: WFZAMER13

Figure 1: Interaction of variety and nitrogen rate on tillers/m² in a trial at Merriwagga 2013.

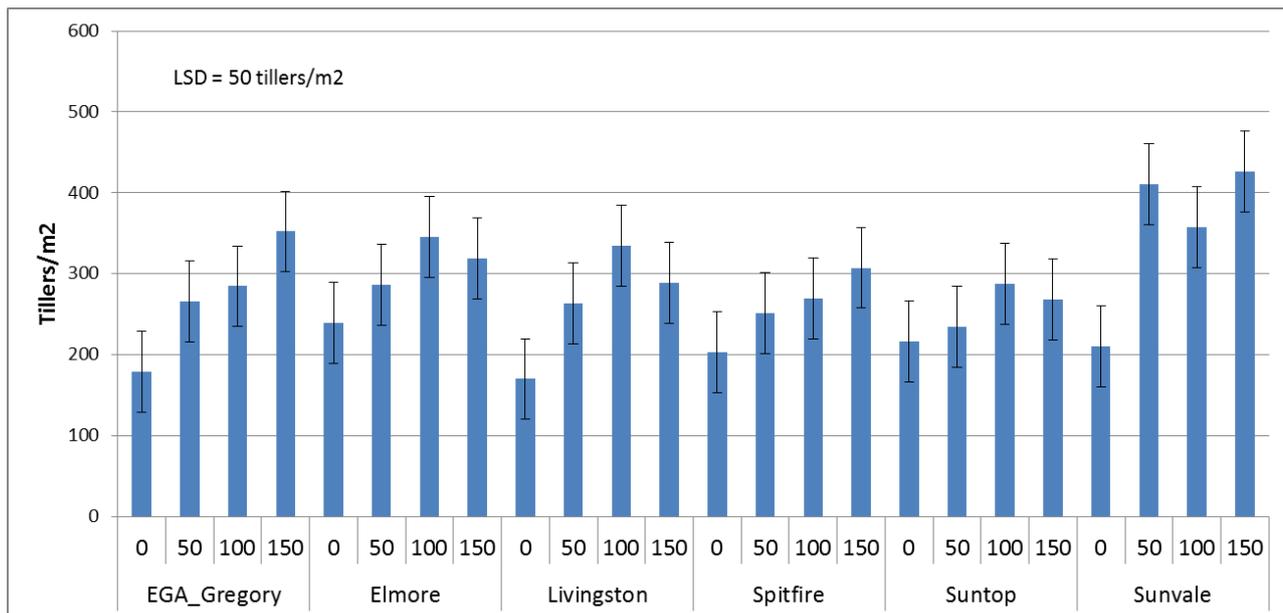


Figure 2:

Figure 2: Interaction of variety and sowing rate on tillers/m² in a trial at Merriwagga 2013.

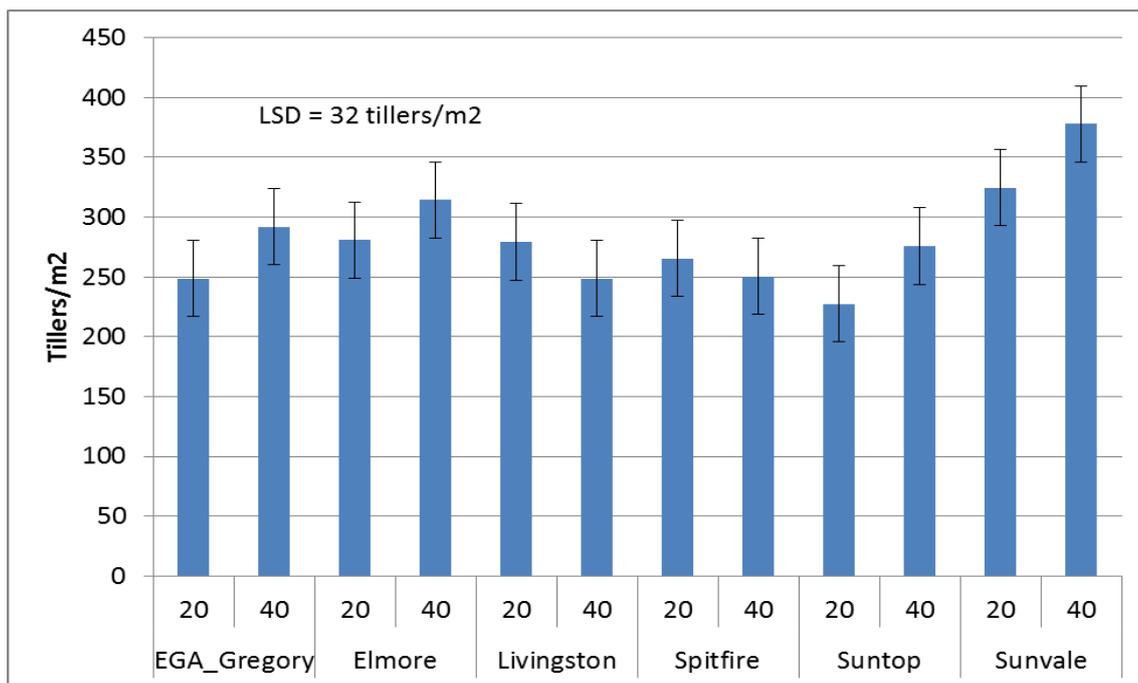


Figure 3: Interaction of sowing rate and nitrogen rate on tillers/m² in a trial at Merriwagga 2013.

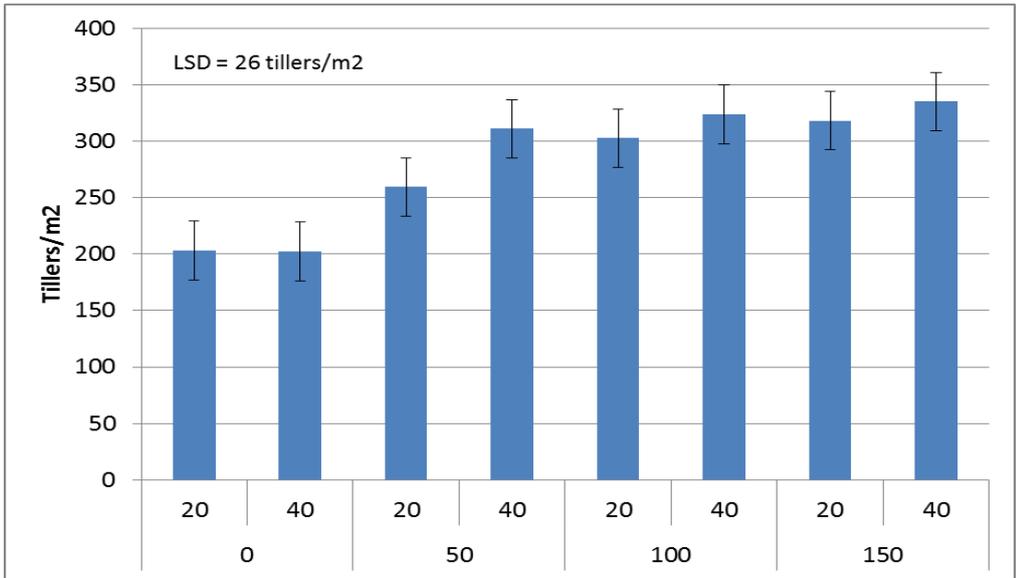


Figure 4: Effect of variety on yield in a trial at Merriwagga 2013.

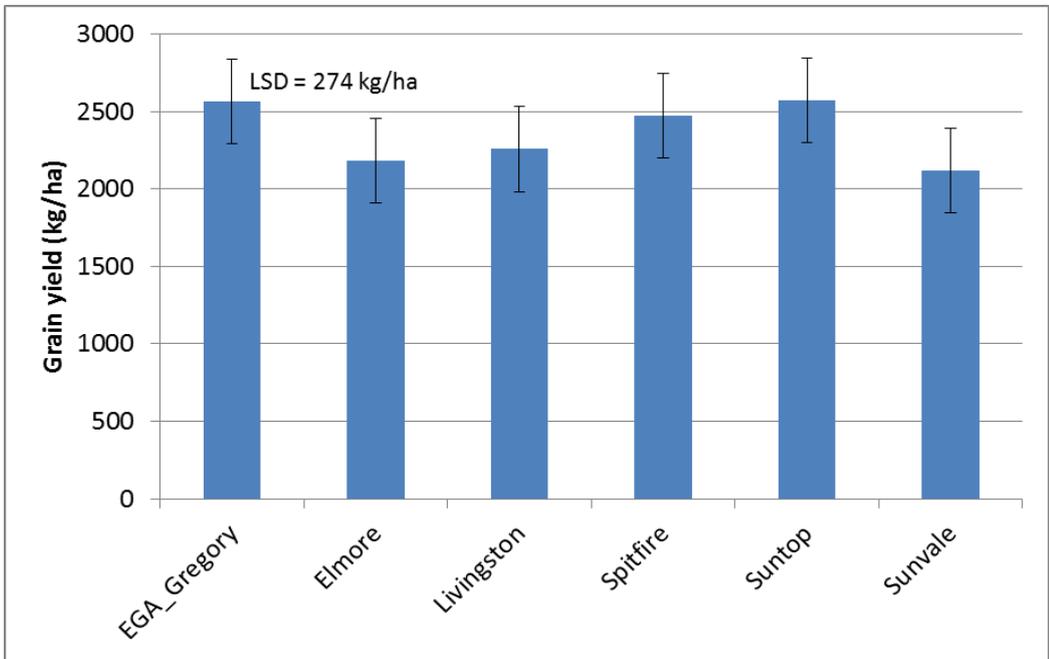


Figure 5: Effect of nitrogen applied on yield in a trial at Merriwagga 2013.

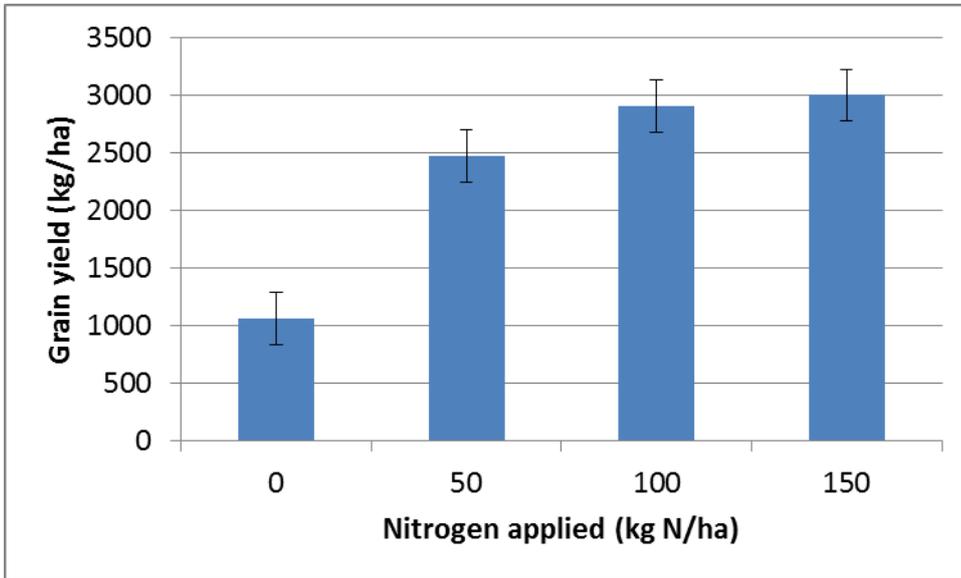


Figure 6: Grain protein yield of individual varieties at a trial at Merriwagga 2013.

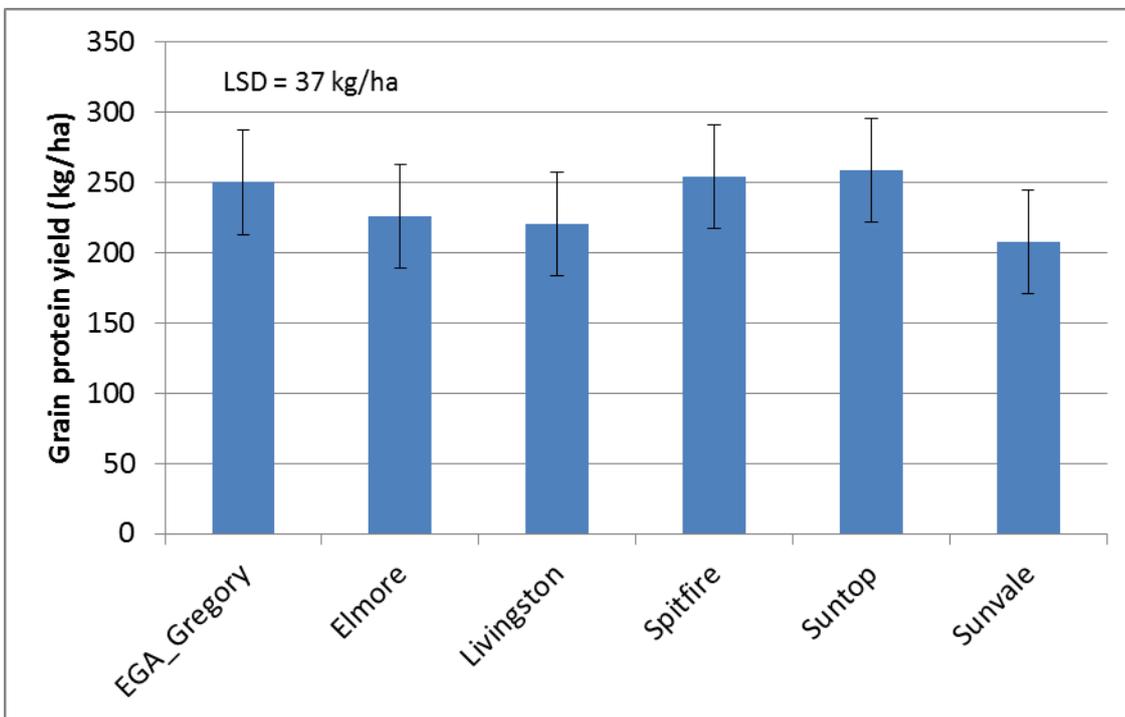


Table 7: The grain protein recorded in a trial at Merriwagga 2013

Nitrogen Applied (kg/ha)	Yield (kg/ha)	Grain Protein (%)	Conversion factor	Grain Protein yield	Amount N extracted (kg/ha)	Nitrogen efficiency (%)
0	1061	10.33 APW	1.75	105	19.18	100
50	2476	9.81 ASW	1.75	231	42.51	47
100	2909	10.11 APW	1.75	297	51.46	32
150	3004	10.17 APW	1.75	311	53.46	23

LSD	225	0.33		31	-	-
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Table 8: The return on investment from nitrogen in a trial at Merriwagga 2013.

<i>Nitrogen Applied (kg/ha)</i>	<i>Yield (kg/ha)</i>	<i>Increased return (\$/ha)</i>	<i>Increased profit (\$/ha)</i>	<i>Return on investment (%)*</i>
0	1061	0	0	0
50	2476	290	231	394
100	2909	444	327	279
150	3004	466	290	165

*Assuming ASW wheat at \$220/t, APW wheat \$240/t on farm and Urea at sowing at \$540/t on farm (\$1.17/kg N).