# Grain protein concentration of several commercial wheat varieties

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**Abstract**

EGA Gregory has been a widely grown wheat variety in NSW over recent seasons. Despite all of its advantages, EGA Gregory has regularly been reported by producers and agronomists as having low grain protein concentration for a given yield level. In 2011, a series of experiments were conducted across the grain growing regions of NSW as a component of the GRDC and NSW DPI funded Variety Specific Agronomy Packages (VSAP) project to investigate nitrogen (N) management responses of different wheat varieties. Results showed that EGA Gregory was either the highest, or among the highest yielding varieties at all sites. In addition, it was also observed that EGA Gregory had the lowest or close to the lowest grain protein concentration at each site. The field trials showed that grain protein concentration and grain yield were generally negatively correlated for the milling wheat varieties entered in these trials. However, the research did highlight that one variety, Spitfire maintains a relatively high grain protein concentration even at relatively high yield levels. An exploratory regression analysis of 103 main season NVT trials indicated that for a given yield level, Spitfire had a grain protein concentration 1.4 % higher ($P$<0.001) than EGA Gregory.

**Introduction**

Grain protein concentration has been an especially important issue for wheat producers in the past two seasons. From 2000 to 2009, the average price premium for Australian Prime Hard grade above Australian Hard grade (based on AWB Pool Returns) was $19/tonne, however in 2010 this increased to $64/tonne and increased further to $67/tonne in 2011 (source: awb.com.au). This has led growers to target wheat varieties with perceived higher grain protein concentration, even where there may be a resultant small yield penalty from growing such varieties.

Grain protein is determined by the balance between the nitrogen requirement of a crop and the supply of nitrogen to that crop, as well as by environmental conditions during grain filling (Stoddard and Marshall 1990). The nitrogen requirement of a crop is set by the water-limited yield (stored moisture plus in-crop rainfall), the crop species (e.g. wheat, barley, canola), the desired grain protein concentration and crop management (disease, phosphorus supply, weed control and sowing time). The nitrogen (N) supply for crops in the lower rainfall areas comes mainly from decomposing organic matter and this is controlled by the amount of organic matter, the quality of the organic matter (carbon to nitrogen ratio, particle size, age), soil type and suitable conditions of temperature and moisture for mineralisation. Fertiliser N usually accounts for a small proportion of total N supply but can still be crucial for achieving desired yield and protein targets (Anderson and Hoyle 1999).

EGA Gregory has been a popular variety across NSW in recent seasons due to its high relative yields (Matthews *et al.* 2012), Australian Prime Hard Classification in northern NSW, high relative tolerance of the root lesion nematode *Pratylenchus thornei* (Simpfendorfer *et al.* 2010) and flexibility with regard to sowing date (Brill 2012). A negative correlation generally exists between grain yield and grain protein concentration of wheat (McNeal *et al.* 1972), hence it is generally anticipated that high yielding cultivars such as EGA Gregory will be low in grain protein. However, there have been suggestions from growers and agronomists that relative to other varieties, EGA Gregory has a lower grain protein concentration, even where varietal yields are similar.

This paper reports on a series of N management trials that were conducted throughout the NSW grains belt to determine whether wheat varieties vary in their response to N nutrition.

**Methods**

Seven trials were conducted in 2011 across NSW to investigate the response of several wheat varieties to nitrogen rate (Table 1). The nitrogen trials included both randomised complete block designs as well as randomised split plot designs (nitrogen rate as main plot), depending on machinery capabilities. In all trials N was applied as urea (46 % N) at or near sowing.

**Table 1: Location, nitrogen rates and number of varieties sown in seven agronomy trials across NSW in 2011.**

| Location | Nitrogen rates (kg/ha) | No. of varieties |
|---|---|---|
| Condobolin | 0, 30, 60, 90 & 120 | 9 |
| Coonamble | 0, 30, 60 & 120 | 6 |
| Merriwagga | 0, 30 & 60 | 10 |
| Parkes | 0, 30, 60, 90 & 120 | 9 |
| Spring Ridge | 0, 40, 80 & 160 | 6 |
| Trangie | 0, 30, 60 & 90 kg | 9 |
| Wagga Wagga | 0, 23 & 46 | 10 |

For each site, an ANOVA was conducted to determine the effects of variety, nitrogen rate and variety by nitrogen rate interactions using Genstat (v13). Differences between means were tested using LSD. This paper specifically focuses on the variety component of these trials and grain yield and grain protein concentration results (across all nitrogen rates) only from popular varieties EGA Gregory, Spitfire, Sunvale and Lincoln. The results report absolute grain yield and grain protein concentration values, as well as the ranking of EGA Gregory, Spitfire, Sunvale and Lincoln for grain yield and grain protein concentration relative to all other varieties entered in a particular trial. The trials had an inconsistent list of variety entries as entries were determined by regional suitability rather than the requirement for cross-sites analysis.

Further to the trials outlined above, there was an exploratory regression analysis undertaken of 103 main season NVTs (National Variety Trials) from 2008 to 2011 using GenStat (v13) to examine the link between grain yield and grain protein concentration for three varieties, EGA Gregory, Spitfire and Sunvale. This analysis was based on predicted grain yield data from trials with at least three replicates, while the data for grain protein concentration was from one composite sample only from each trial. The trial at Benerembah in 2008 with yields > 8 t/ha was excluded from the regression analysis due to its high leverage on the regression.

**Results**

*2011 agronomy trials*

EGA Gregory was either the highest yielding variety or close to the highest yielding at each site (Table 2). The yield of Spitfire was more variable, ranging from being relatively high yielding at Condobolin, Coonamble and Parkes; to relatively low yielding at Merriwagga, Trangie and Wagga. There were fewer data sets for Sunvale and Lincoln, however the yield of Sunvale was relatively low and the yield of Lincoln was variable.

**Table 2: Grain yield and rank of four wheat varieties from seven variety by nitrogen trials in NSW in 2011. The '*' indicates that the variety was not entered into that particular trial.**

| | *Grain yield (t/ha) and rank within trial* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Trial* | *EGA Gregory* | | *Spitfire* | | *Sunvale* | | *Lincoln* | | l.s.d. (*P*=0.05) |
| Condobolin | 1.5 | 3/9 | 1.6 | 2/9 | * | | 1.3 | 8/9 | 0.11 |
| Coonamble | 2.0 | 2/6 | 2.2 | 1/6 | 1.9 | 4/6 | * | | 0.22 |
| Merriwagga | 4.2 | 3/10 | 4.0 | 8/10 | * | | 4.7 | 1/10 | 0.22 |
| Parkes | 4.1 | 2/9 | 4.2 | 1/9 | * | | 4.1 | 3/9 | 0.24 |
| Spring Ridge | 5.1 | 1/6 | 4.8 | 4/6 | 4.5 | 6/6 | * | | 0.15 |
| Trangie | 4.2 | 1/9 | 3.3 | 9/9 | 3.5 | 8/9 | 3.9 | 3/9 | 0.17 |
| Wagga | 4.6 | 1/10 | 3.0 | 10/10 | * | | 3.2 | 5/10 | 0.20 |

The grain protein concentration of EGA Gregory was relatively low in all trials (Table 3). Spitfire had a relatively high grain protein concentration in all trials, regardless of grain yield. Sunvale had relatively high grain protein concentration in the three trials in which it was included, while Lincoln had relatively low grain protein concentration in most trials.

At several sites (Coonamble, Parkes and Condobolin) Spitfire displayed a relatively high grain protein concentration even where it achieved a relatively high grain yield.

**Table 3: Grain protein concentration and rank of four wheat varieties from seven variety by nitrogen trials in NSW in 2011. The '*' indicates that the variety was not entered into that particular trial.**

| | *Grain protein concentration (%) and rank within trial* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Trial* | *EGA Gregory* | | *Spitfire* | | *Sunvale* | | *Lincoln* | | l.s.d. (p = 0.05) |
| Condobolin | 12.2 | 8/9 | 13.5 | 2/9 | * | | 12.8 | 6/9 | 0.11 |
| Coonamble | 11.4 | 6/6 | 13.5 | 1/6 | 12.5 | 3/6 | * | | 0.22 |
| Merriwagga | 8.0 | 9/10 | 9.4 | 2/10 | * | | 8.0 | 9/10 | 0.22 |
| Parkes | 9.6 | 9/9 | 11.1 | 4/9 | * | | 10.2 | 7/9 | 0.24 |
| Spring Ridge | 11.6 | 6/6 | 12.7 | 2/6 | 12.5 | 3/6 | * | | 0.15 |
| Trangie | 12.7 | 9/9 | 15.3 | 1/9 | 14.5 | 2/9 | 13.6 | 6/9 | 0.17 |
| Wagga | 9.7 | 10/10 | 10.9 | 1/10 | * | | 10.1 | 7/10 | 0.20 |

*Analysis of NVT*

The regression analysis of NVT trials ($R^2 = 36.1$, $P < 0.001$) firstly showed that for each of the three varieties EGA Gregory, Sunvale and Spitfire, grain yield and grain protein concentration were negatively correlated (Figures 1 a, b and c). Further to this, variety had a significant effect ($P < 0.001$) on the intercept of the regression, with Spitfire being 0.6 % higher than Sunvale, and Sunvale 0.8 % higher than EGA Gregory. There was no significant difference ($P = 0.25$) in the slope of the regression of each variety, which indicates that the difference in grain protein concentration of the varieties was maintained at all yield levels. In effect this analysis indicated that based on the trials included and the composite protein samples, Spitfire was able to achieve a protein level 1.4 % greater than EGA Gregory for a given yield level.

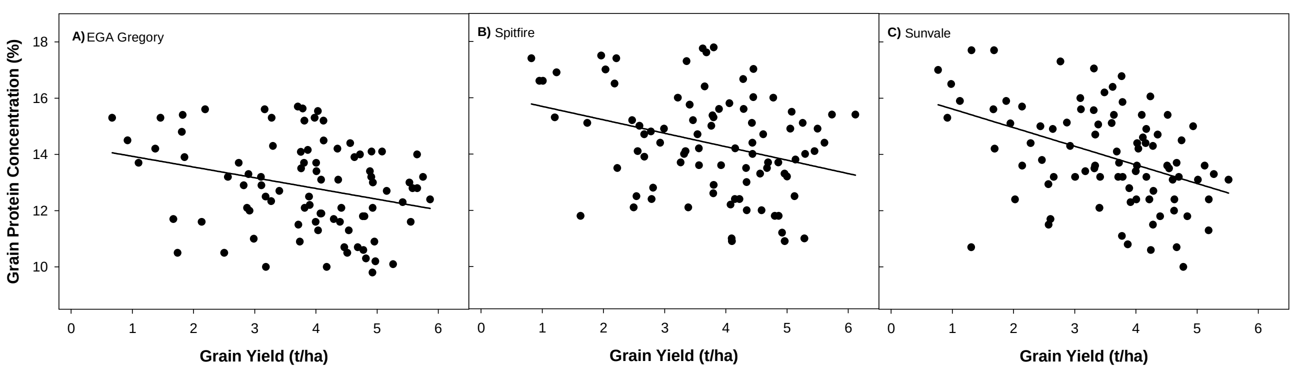


**Figure 1: Relationship between grain yield and grain protein concentration of A) EGA Gregory, B) Spitfire and C) Sunvale based on an analysis of 103 main season NVT trials from 2008 to 2011. Protein equations for EGA Gregory, Spitfire and Sunvale are 15.536-0.6061*yield, 16.914-0.6061*yield and 16.301-0.6061*yield, respectively.**

## Conclusion

The N trials conducted in 2011 showed that EGA Gregory is a consistently high yielding variety across several regions in NSW, but that it also accumulates a relatively low grain protein concentration. Grain yield for Spitfire was more variable than EGA Gregory, ranging from being highest yielding or among the highest yielding varieties at three sites, and lowest yielding or among the lowest yielding varieties at three sites. Being a relatively new variety, the reasons behind the yield variability of Spitfire are not well understood. However the grain protein concentration achieved by Spitfire was relatively high in most of the trials, being either the highest or close to the highest in six of seven trials. Of particular interest though is that where Spitfire achieved a relatively high grain yield (Condobolin, Parkes and Coonamble), it was also able to achieve a relatively high grain protein concentration. The yield of Spitfire was similar to EGA Gregory at each of these sites; however grain protein concentration was at least 1.3 % higher.

In the agronomy trials, the variety Lincoln also exhibited relatively low grain protein concentration, indicating that EGA Gregory does not accumulate less grain protein than all other popular commercial varieties. The consistently higher yields of EGA Gregory in respect to N use indicates that it is a yield efficient variety. Anderson and Hoyle (1999) found yield efficient lines that had inherently low grain protein concentration, however the low grain protein concentration was due to the ability of the variety to produce high yields rather than a reduced ability to convert N into grain protein *per se.*

The analysis of NVT trials from 2008 to 2011 also indicates that Spitfire was able to accumulate a relatively high grain protein concentration for a given yield level. NVT trials are generally managed with above average levels of plant nutrition relative to commercial paddocks, so further work is required to determine the differences between varieties over a range of fertiliser regimes, soil N levels and soil types.

EGA Gregory remains a consistently high yielding variety, and should still comprise a major part of wheat plantings in NSW. For situations where soil N status is low, yield response to applied N is likely to be greater for EGA Gregory than for other varieties mentioned in this paper.

There may be a commercial advantage of planting Spitfire, especially where premiums for grain protein concentration are high (as was the case in 2010 and 2011), and where soil N status is moderate to high and only small yield responses from applied N are expected. In such cases, small increases in grain protein concentration from applied N may be profitable if the grain achieves a higher receival grade as a result.

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