# Top-dressing Durum with Nitrogen to Manage Protein

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## A. Summary

Grain protein is an important factor in determining the quality of durum wheat (*Triticum turidum* L.). Durum markets pay a premium for protein content of 13% or higher. During the 1990s, the average protein content of durum produced on the Canadian prairies has been 12.5% or less, leaving a sizable proportion of the durum crop unsuitable for the premium market. The overall objective of this project is to determine the effect and relative efficiency of top-dressed N on grain protein, quality, yield, and economic return of durum wheat. Nitrogen at three rates (20,40 and 60 kg N $ha^{-1}$) was top-dressed on durum at 4 growth stages: before germination (during seeding), five leaf, flag leaf and flowering. The study was done over three years at two locations (Indian Head and Swift Current, SK). Four cultivars were used. Increasing the rate of top-dressed nitrogen increased the protein content of the durum. Applying all the nitrogen at seeding provided the most consistent increases in protein. However, when the yield potential increased during the growing season due to above normal spring and summer precipitation, protein levels in the durum seed increased when nitrogen was top-dressed during the growing season

## B. Background and Objectives of Study

Durum wheat markets demand assurance of minimum quality standards. Grain protein is one of the most important factors determining durum wheat quality. Durum markets consistently pay a premium for protein content of 13% or higher. Since the early 1990s, the average protein content of CWAD has been 12.5% or less, leaving a sizeable proportion of the durum crop unsuitable for the premium market. As a result, other durum producing countries, mainly the United States and Australia, have increased their share of the international market at our expense.

The reduction in protein content of the durum crop has been attributed to higher levels of precipitation in the Brown and Dark Brown soils zones concomitant with a decline in soil available nitrogen. In the Thin Black soil zone inadequate nitrogen supplies have made kernel quality a major degrading factor, with the corresponding decline in returns to the farmer. Crop management techniques that allow durum producers to maximize the probability of obtaining a significant protein premium and minimize the probability of downgrading will have a significant effect on their net return.
The overall objective is to develop knowledge that will permit durum producers to implement crop and soil fertility management strategies to improve grain quality, protein,

and yield to achieve a higher return.

## C. Study Description

**STUDY #1** Effect and relative efficiency of top-dressed N on yield, grain protein, quality and economic return of durum wheat.

Cultivars of CWAD wheat will be grown with a base N application at seeding that will provide the crop with 75% of the available N (soil $NO_3$-N plus fertilizer N) required to achieve maximum yield and protein. Top-dressed N treatments will be superimposed on this base N application and will consist of a full factorial combination of the following factors:
I) Nitrogen application rates: 20, 40, and 60 kg N $ha^{-1}$.
II) Time of topdressing: five-leaf, flag-leaf, and flowering growth stages
III) CWAD cultivars: AC Avonlea, AC Morse, AC Navigator, Kyle.
As control for each cultivar, a set of plots will be fertilized at seeding with the base N application plus 0, 20, 40, and 60 kg N $ha^{-1}$.
Locations: Indian Head and Swift Current, SK

All plots will receive a blanket application of P, K, and S to ensure these nutrients will not limit crop growth. The experiment will be replicated four times. This design will allow us to determine the direct effect of top-dressed N on grain yield, protein and quality parameters, and to assess the efficiency of top-dressed N relative to a similar amount of N applied at seeding.

*Measurements:* soil nutrient status to 60 cm before seeding, plant density, heads $m^{-2}$, plant height, lodging, days to heading, disease, grain yield, Hard Vitreous Kernels (HVK), protein content, test weight, moisture content, kernel weight, visual down grading factors (ergot, black point, red smudge, midge damage, and fusarium). An economic analysis will be conducted once the data has been collected.

## E. Results

### Study 1

Residual nitrate is presented in Table 1 and available moisture is presented in Table 2. Very little increase occurred in yield after the first 20 kg was added above the 75% check (Fig. 1). Since this trial was focussed on protein not yield, that is the response that we hoped to achieve. Protein consistently increased as the nitrogen rate increased (Fig. 2). The rate of increase in protein level varied among years and locations. Some further analysis will be required to determine if a protein response can be estimated from this data to provide farmers with an economic analysis of the returns to topdressing durum.

Timing of nitrogen application had no effect on yield at Indian Head in 2001 and 2002, and Swift Current in 2001 (Fig. 3). At Indian Head in 2003, adding the nitrogen at seeding increased yield compared to adding nitrogen at the 5 leaf, flag leaf and flowering stages of development. At Swift Current in 2002, the best time to add nitrogen to increase yield was at seeding, although there was some variation among the cultivars (Fig. 4). At Swift Current in 2003, the 60 kg $ha^{-1}$ at seeding decreased yield compared to all the treatments (Fig. 5). This is a phenomenon that can occur in the dryer parts of the province and is some times called "haying off". There was excellent moisture conditions at seeding which allowed the extra nitrogen to stimulate so much growth that the consumption of water occurs faster than precipitation can replace it and not enough water is left to finish the filling of seed. This is a risk durum producer's face in the dryer parts of the durum growing region. However, at Swift Current in 2002 in the presence of good moisture during the entire growing season the opposite response occurred with increasing rates of nitrogen increasing yield at seeding and 5 leaf (Fig. 6).

The response of protein to the timing of nitrogen application varied. At Swift Current in 2002 when moisture conditions were good throughout the growing season, the addition of nitrogen increased protein at all four stages, seeding, 5 leaf, flag leaf and flowering (Fig. 7). In Swift Current in 2003 where moisture levels decreased as the growing season proceeded, protein levels were increased with the addition of nitrogen at seeding and 5 leaf, with the largest increases occurring when nitrogen was applied at seeding (Fig. 8). At Indian Head in 2003 when the soil profile had excellent moisture reserves but very little precipitation occurred during the growing season, all the cultivars except AC Navigator had a significant increase in protein levels with increased amounts of nitrogen (Fig 9.). Applying nitrogen at seeding provided the highest protein level at Swift Current in 2001 and Indian Head in 2001 and 2002 (Fig. 10).

The yield (Fig. 11) and the protein (Fig. 12) achieved by the four cultivars did not differ in any consistent ranking. This indicates that nitrogen management will have a much larger effect on protein level than the cultivar grown.

If you want to increase the protein level of durum, applying the nitrogen at seeding is the most reliable method of doing so. If your yield potential increases from increased available water during the growing season, then topdressing of nitrogen can be used to protect the protein level in the durum crop. The full results of this study will be published by September 30, 2004.

**Table 1. Residual nitrate levels in the soil at each location from 2001 to 2003**

| | Soil Residual $NO_{-3}$ (0-60 cm depth) | | |
|---|---|---|---|
| | 2001 | 2002 | 2003 |
| Location | | Kg $ha^{-1}$ | |
| Indian Head | 56 | 42 | 27 |
| Swift Current | 11 | 21 | 19 |

**Table 2. Available moisture from soil and precipitation from 2001 to 2003 at Indian Head and Swift Current Saskatchewan**

| | 2001 | 2002 | 2003 |
|---|---|---|---|
| | | mm of available water in 0 to 122 cm | |
| Indian Head | 307 | 170 | 250 |
| Swift Current | 38 | 57 | 125 |
| | | Precipitation (mm) | |
| Indian Head | 85 | 280 | 76 |
| Swift Current | 121 | 337 | 112 |

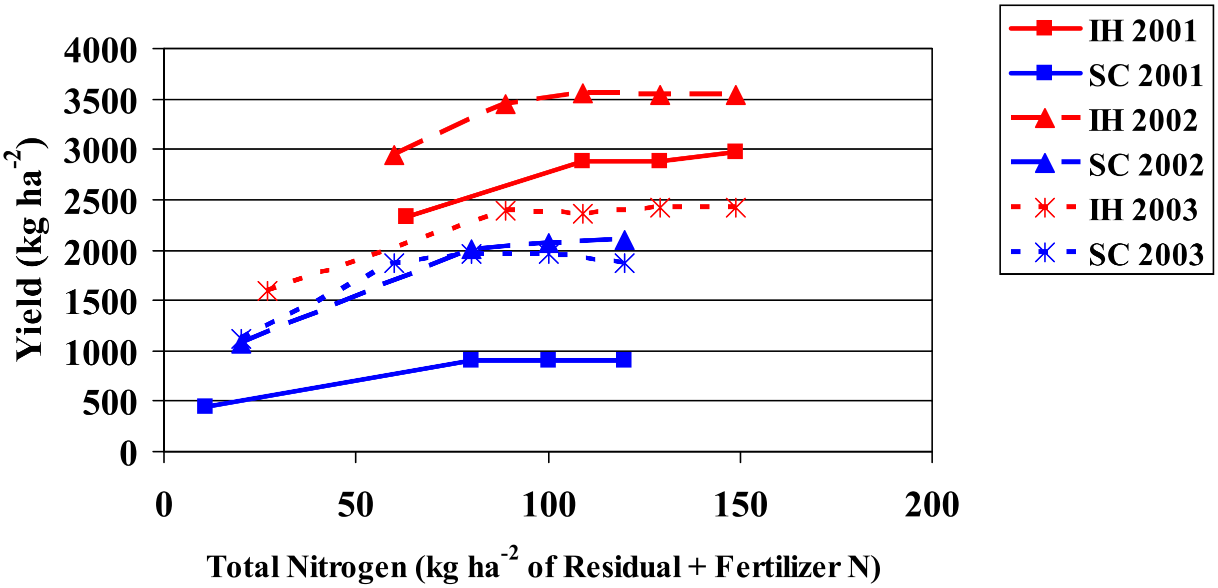


Figure 1. The effect of nitrogen on seed yield

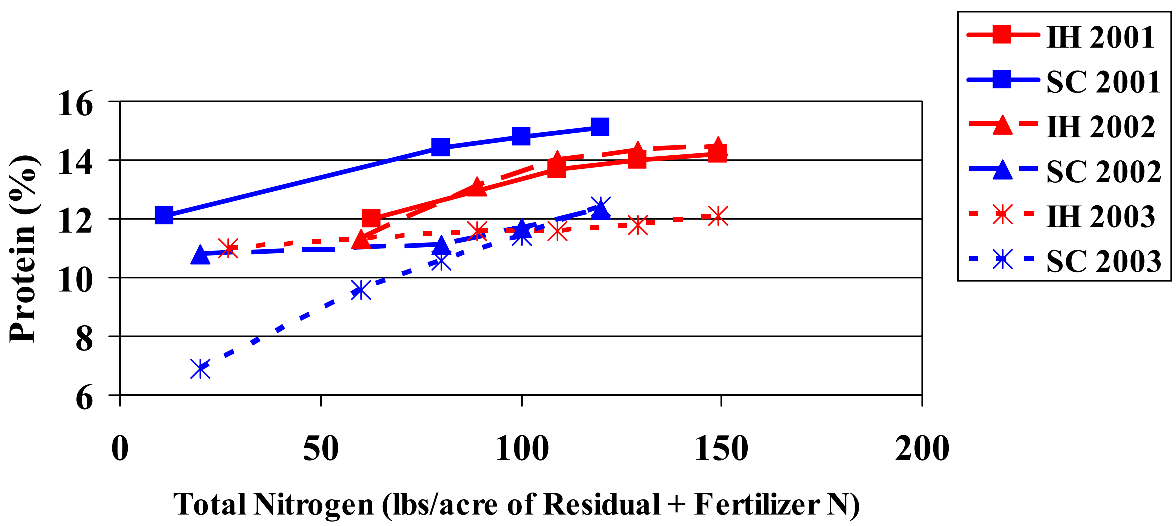


Figure 2. The effect of nitrogen on protein in durum

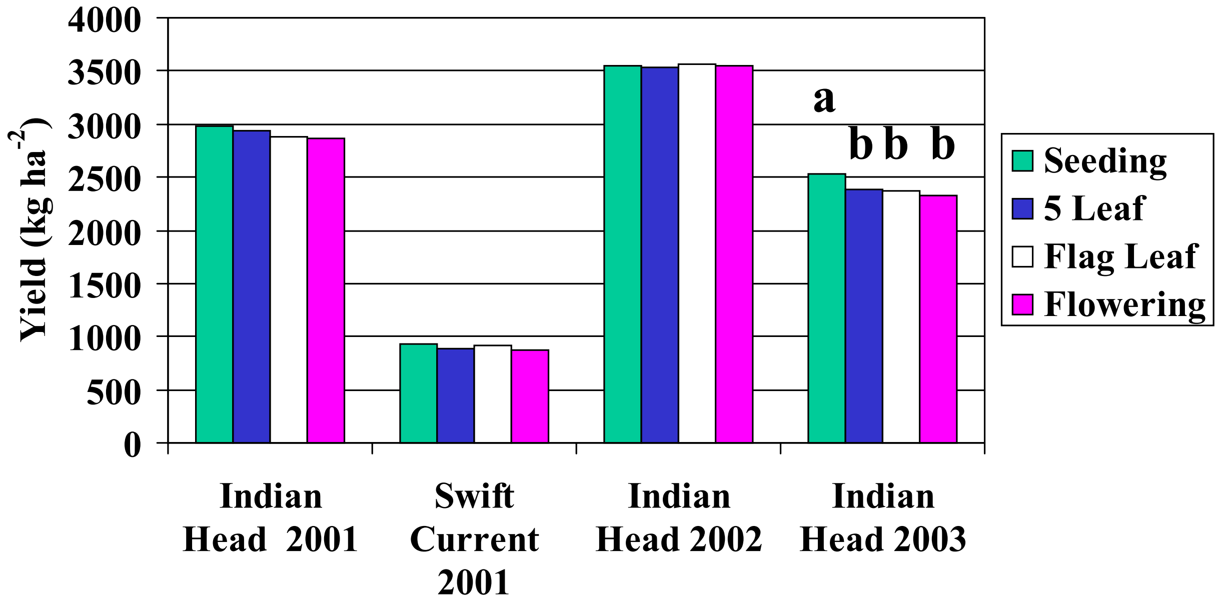


**Figure 3. The effect of the timing of nitrogen application on yield**

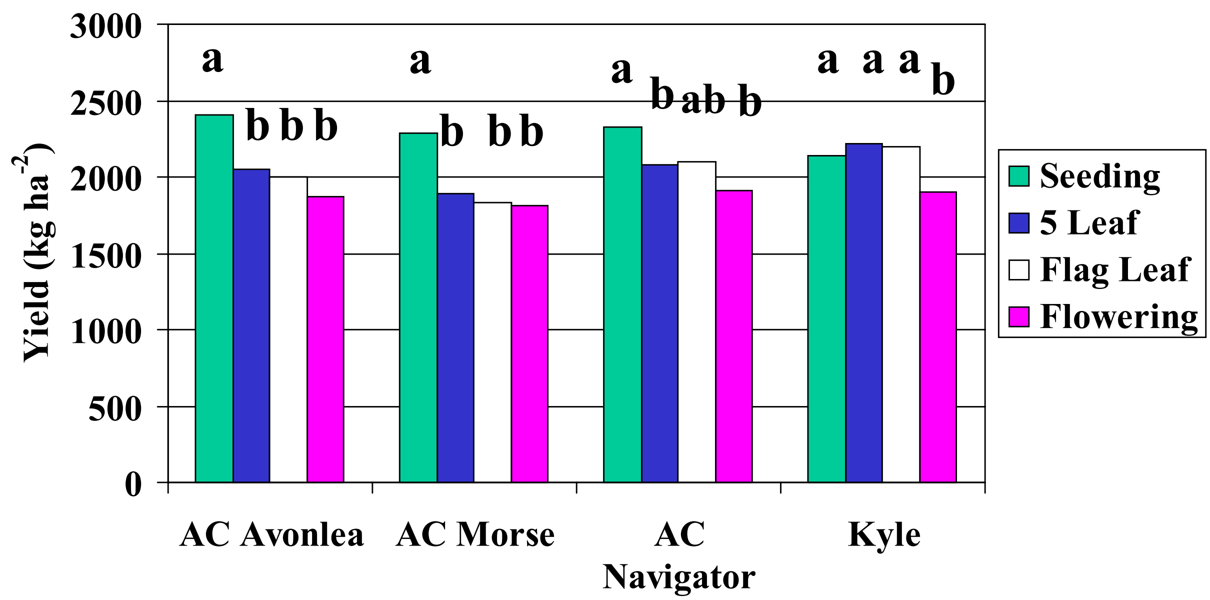


**Figure 4. The effect of timing of nitrogen application and cultivar on seed yield at Swift Current in 2002**

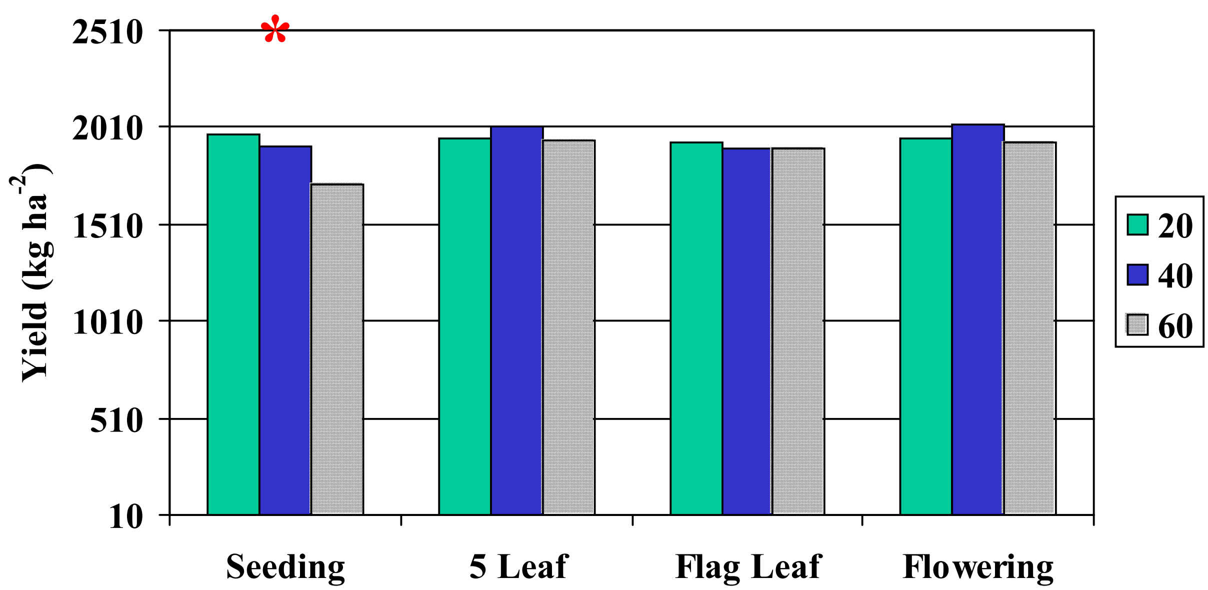


**Figure 5. The effect of nitrogen timing and rate on yield at Swift Current in 2003**

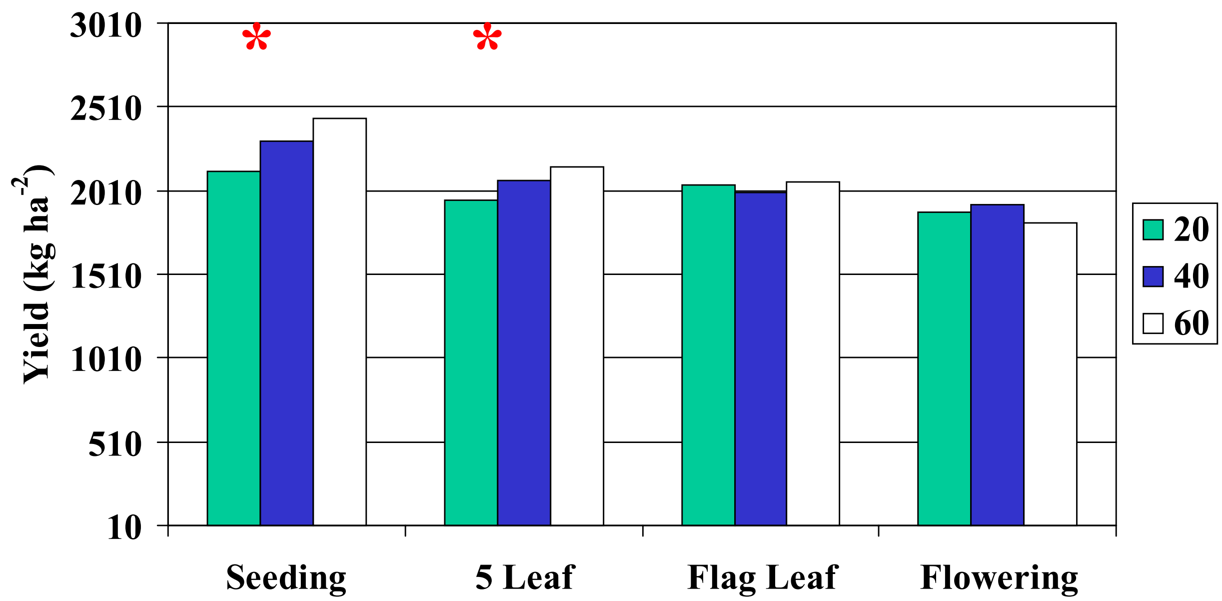


**Figure 6. The effect of Nitrogen timing and rate on yield at Swift Current in 2002**

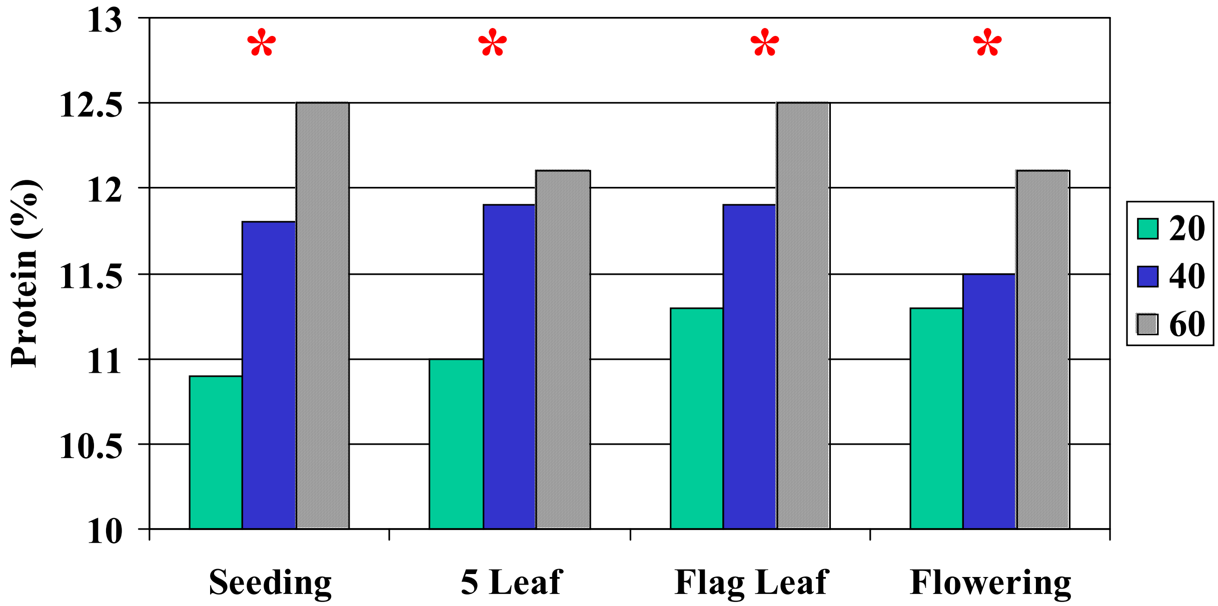


**Figure 7. The effect of nitrogen timing and rate on protein at Swift Current in 2002**

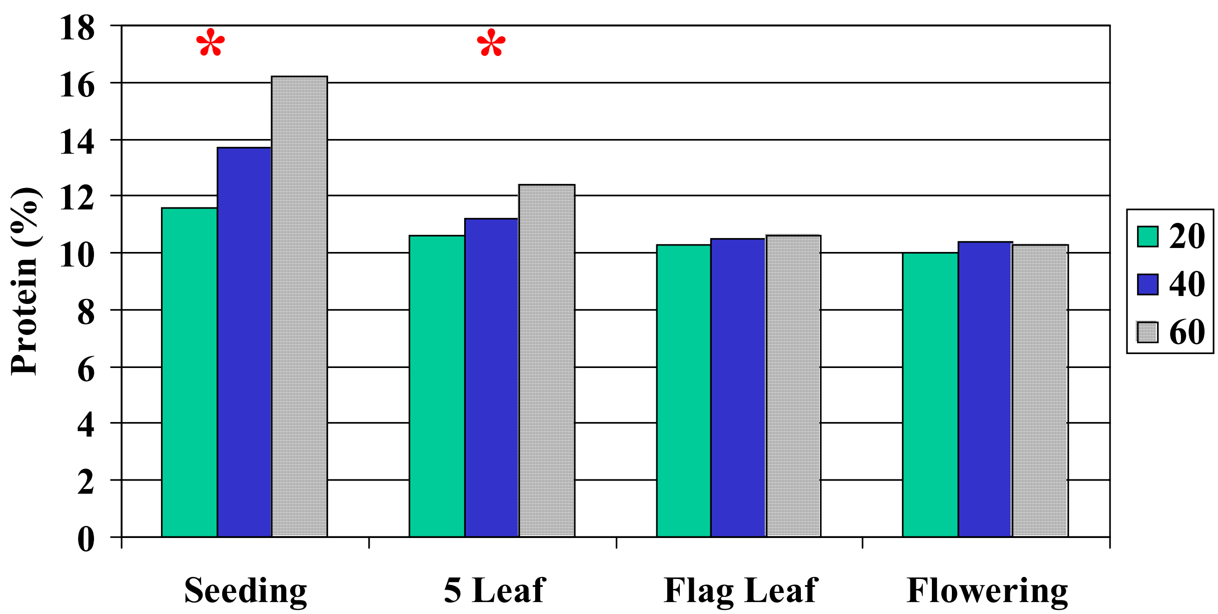


**Figure 8. The effect of nitrogen timing and rate on protein at Swift Current in 2003**

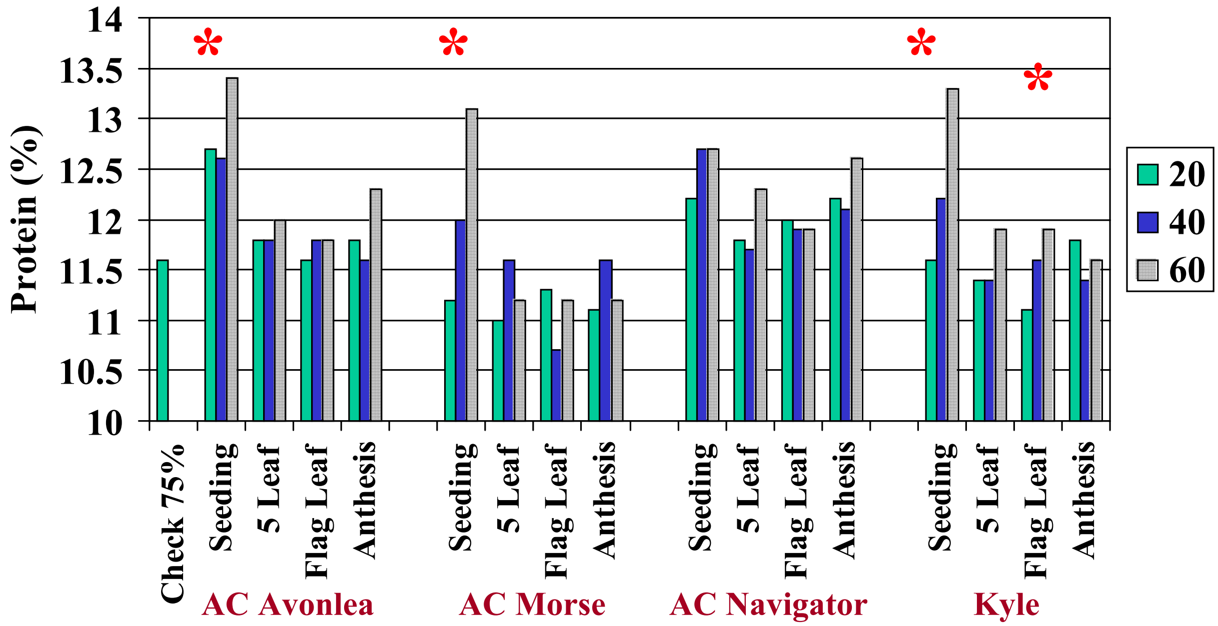


**Figure 9. The effect of cultivar, nitrogen timing and rate on protein at Indian Head in 2003**

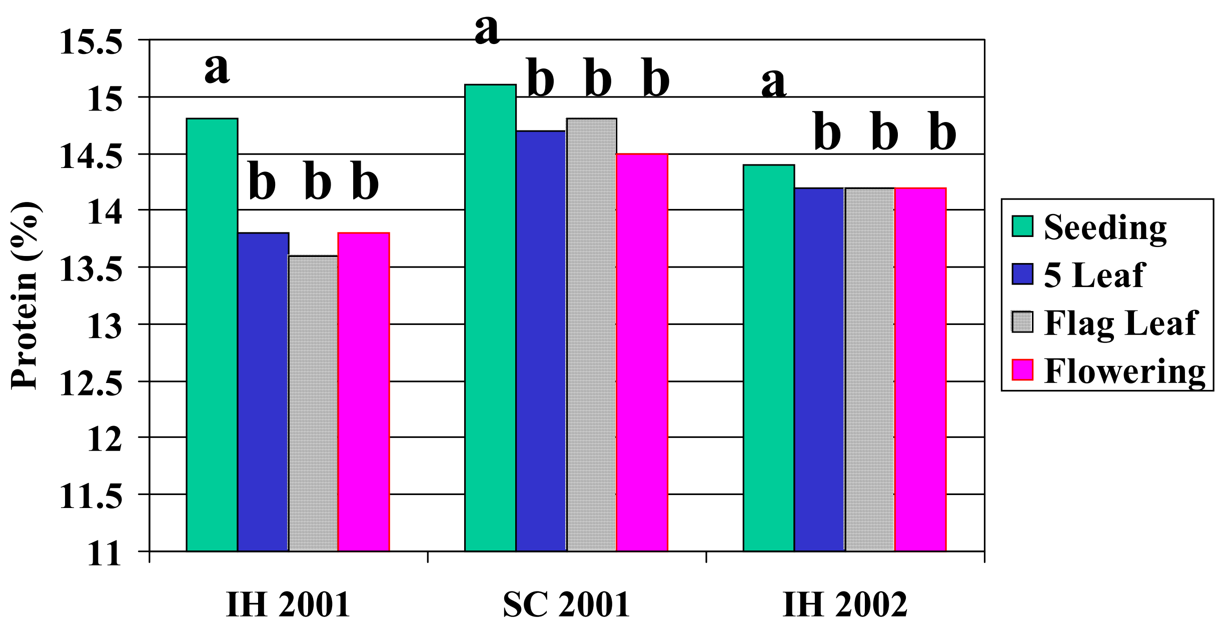


**Figure 10. The effect of nitrogen timing on protein in 2001 at Indian Head in 2002**

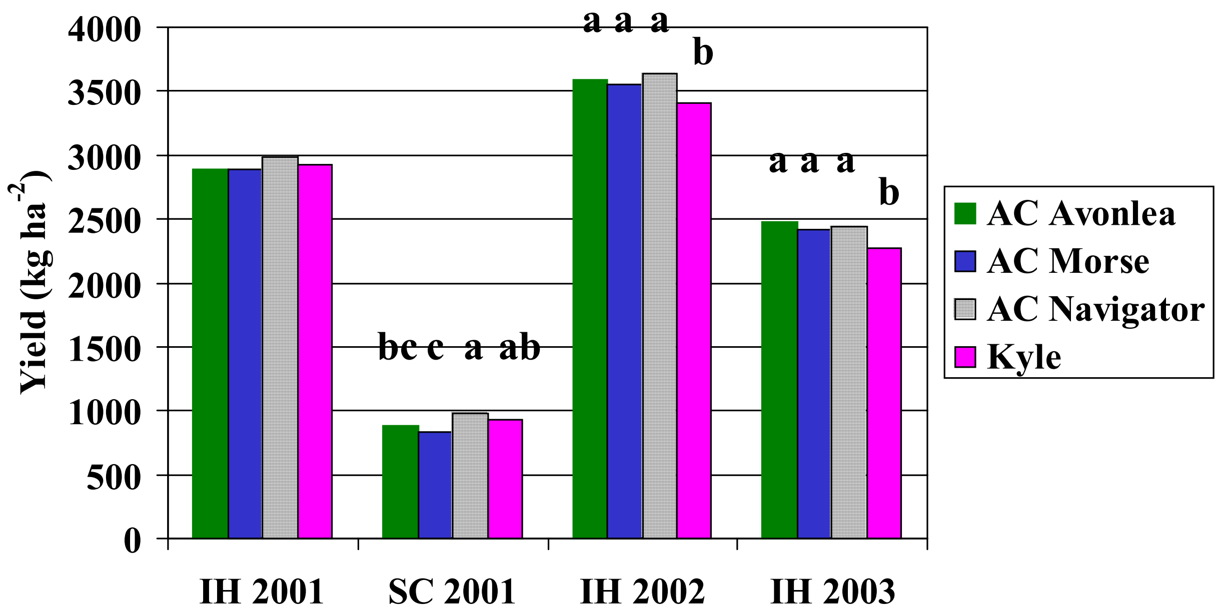


**Figure 11. The effect of cultivars on yield at Indian Head in 2001, 2002 and 2003 and Swift Current in 2001**

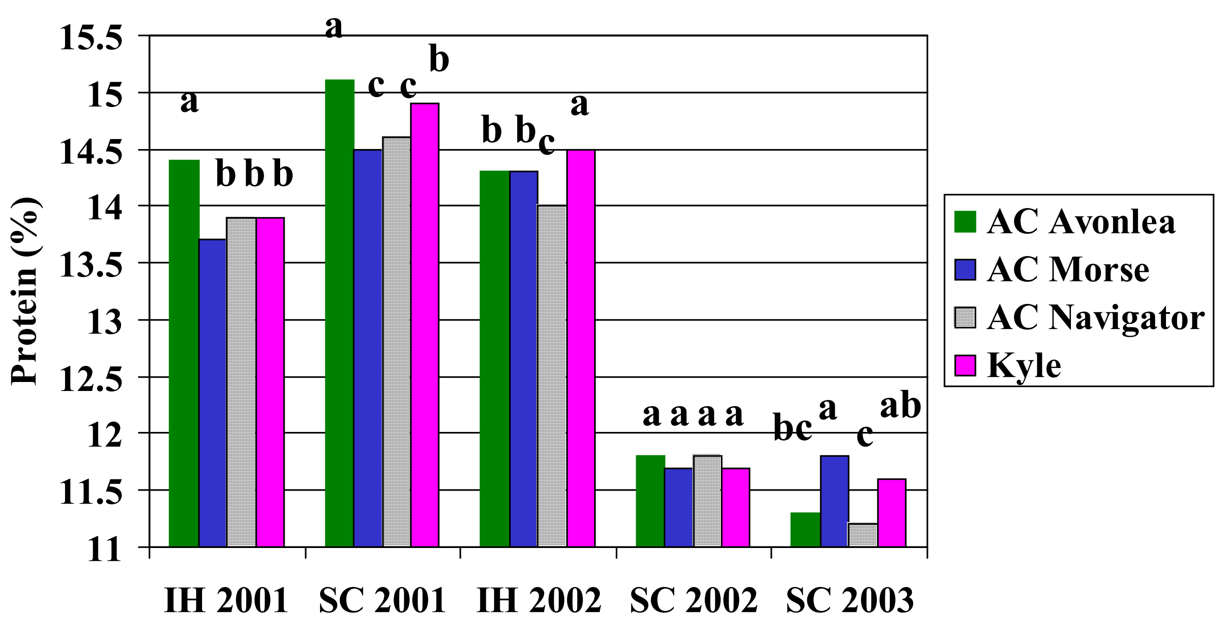


**Figure 12. The effect of cultivars on protein in durum**

**Conclusions**
**Protein Management**

- Adding nitrogen at seeding was more effective in increasing protein levels than at 5-leaf, flag leaf or flowering

- In a dry year no advantage to adding nitrogen later

- When spring soil moisture levels are very good there is some risk of decreased yield from high levels of nitrogen fertilization, however, this risk is lower than the risk assumed by growers who apply very low levels of nitrogen fertilizer

- Under wet conditions protein can be protected with the application of nitrogen fertilizer

- Increasing the rate of applied nitrogen increased protein

- Economic analysis is required