Durum – mechanisms of yield and grain protein improvements

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Introduction

In recent years, Canadian researchers successfully registered Canadian Western Amber Durum (CWAD) (*Triticum turgidum* L., var *durum*) wheat cultivars which improved both grain yield and quality relative to earlier cultivars. An understanding of the physiological basis for these genetic improvements would facilitate further breeding efforts and assist agronomists and producers in designing soil and crop management practices that will permit full expression of these improved traits

The objective of this study was to compare four CWAD cultivars released at different times in terms of yield components, dry matter production and redistribution, and N uptake and remobilization.

Materials and Methods

Some details of this experiment have been reported earlier (Wang et al. 2002; 2007). From 1998 to 2000, four CWAD cultivars (Hercules, Kyle, AC Avonlea, and AC Navigator) were grown on an Orthic Brown Chernozem near Swift Current, Saskatchewan. Fertilizer was broadcast before seeding to meet a target of 112 kg ha-1 available N and 67 kg ha-1 available P. The plots were irrigated once on 16 July 1998 with 48 mm of water.

Plants from a random 50-cm row from each plot were sampled at physiological maturity and plants were separated into leaf, stem plus sheath, peduncle, glume, rachis, awns and kernel. Vegetative samples were oven dried at 60 ^{o}C for a minimum of 72 h, weighed and ground to a 2mm diameter. Grain samples were ground to a 1mm diameter. Total nitrogen was determined by the Kjeldahl method. Grain protein concentration (13.5% moisture basis) was determined by near-infrared spectroscopy.

Results and Discussion

AC Navigator, a semi-dwarf cultivar, had the highest yield, but a slightly lower protein concentration when compared with other cultivars (Figure 1). However, it would have received the protein premium in each study year. AC Navigator achieved high yield via increases in both kernel weight (Figure 2) and kernel number per unit area. The latter increase was mainly through the increase of number of spikes per plant (Figure 3). AC Avonlea out-yielded Hercules by 13% (P=0.04) and Kyle by 9% (P=0.12). AC Avonlea significantly increased spike size (Figure 3) through increasing both kernel weight and kernels per spike (Figure 2) compared with Hercules and Kyle. Both new cultivars had longer grain filling stages, resulting in a maturity 2 days later than Hercules. The new cultivars had higher total above-ground dry matter than Hercules, but not Kyle. AC Navigator had a significantly higher harvest index than Kyle.

AC Avonlea, AC Navigator and Kyle had higher total N uptake than Hercules (Figure 4). At maturity, AC Avonlea had lower N remaining in the non-grain parts than AC Navigator (P=0.06) and Kyle (P=0.003) resulting in higher grain N and a higher N harvest index for AC Avonlea. Kyle had the lowest N harvest index. At maturity, AC Navigator had higher N concentrations compared with other cultivars in all non-grain plant parts except the glume and rachis, indicating a relatively poor N remobilization efficiency. This is surprising because grain N is commonly thought to be source limited (Richards et al. 2001).

Conclusion

In conclusion, the two new CWAD cultivars had different approaches to increase yield while maintaining grain protein concentration when compared to older cultivars. AC Navigator, a semi-dwarf cultivar, increased kernel weight and spikes per plant. AC Avonlea, a conventional height cultivar, reduced height and increased spike size via both increased kernel weight and kernels per spike. Although both new cultivars and Kyle had similar N uptake, AC Avonlea had the highest N use efficiency which could be related to its large spike size. Further research on N use efficiency should be undertaken to facilitate selection for this trait in breeding of high yield, high protein wheat cultivars.

References

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Figure 1. Grain yield and protein content of four Durum varieties

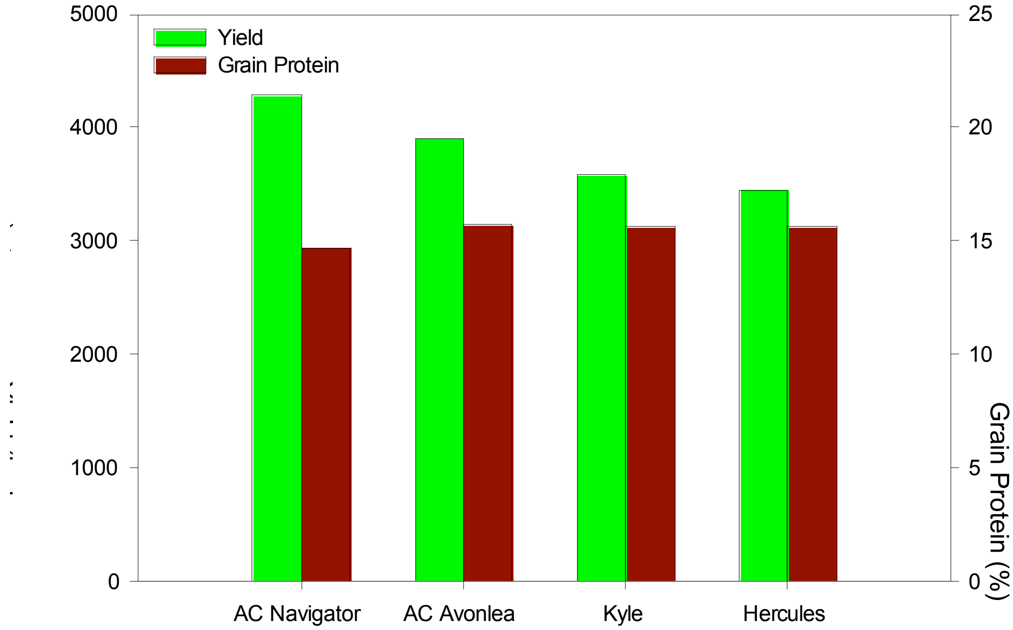

Figure 2. Kernel weight and plant height of four Durum varieties

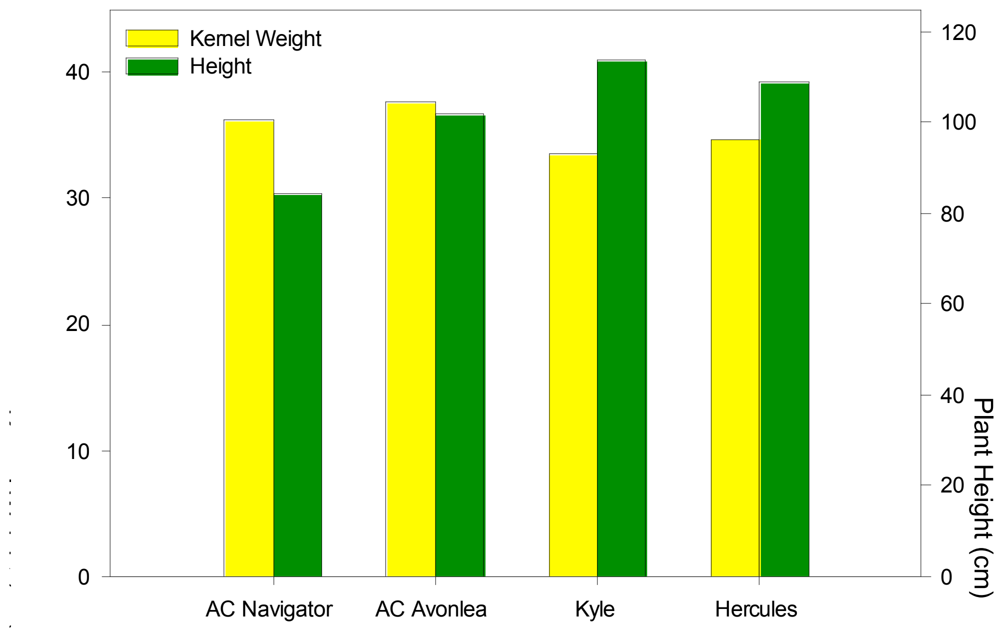

Figure 3. Spike size and spikes per plant of four Durum varieties

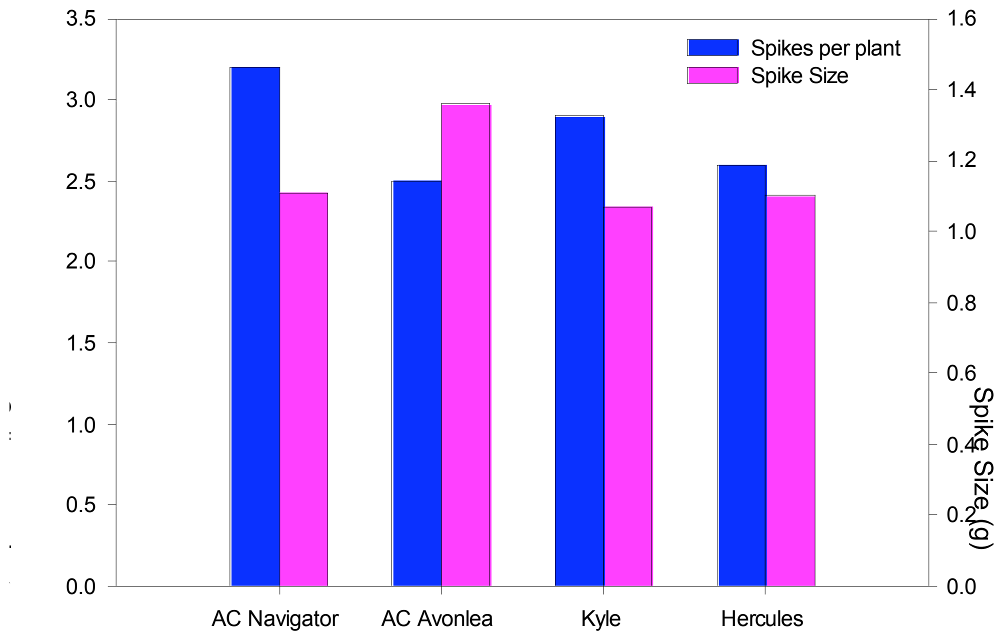

Figure 4. Nitrogen and plant harvest index of four Durum varieties