Contribution of Kernel Size to Grain Yield Potential and Sample Uniformity of Winter Wheat

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Abstract

Improvements in agronomic practices and cultivars have permitted the successful production of winter wheat on the Canadian prairies. In this study, the seed size of eleven winter wheat varieties grown under dry land and irrigation in each of two years was measured to determine if kernel size and position in the spikelet were important restrictions to cultivar grain yield potential and sample uniformity. Varietal differences in the weight of kernels in the A and B positions in the spikelet varied by more than 20 percent indicating that there is considerable genetic variation available in the wheat gene pool for this character. Kernel size of the C and D positions decreased to approximately 75 and 50 percent, respectively, of the average A and B positions in both dry land and irrigation environments. Artificially reducing floret numbers by 25 and 50 percent to increase assimilate supply to the remaining seeds did not influence seed size under irrigation. In contrast, kernel weight increased as the number of spikelets spike^{-1} decreased indicating that assimilate supply during grain filling and not restrictions imposed by kernel size determine grain yield of winter wheat grown on dry land in western Canada.

Introduction

The increased grain yield of modern day wheat cultivars has been achieved by increasing kernel number rather than kernel weight. Kernel weight has usually remained unchanged or even decreased over time (Siddique *et al.*, 1989; Slafer and Andrade, 1989), which is likely due to the increased contribution to yield by the more distal (i.e., C and D) kernels in the spikelet (Fig. 1). Unpublished data (Duggan and Fowler) suggests that C and D kernels of western Canadian winter wheat cultivars can contribute up to 22 and 5 percent of the grain yield respectively. These kernels are typically smaller and lighter than the more portal (A and B) kernels and make a disproportional contribution to 'clean-out' during harvest and subsequent dockage. The objectives of this study were to determine 1) the extent that kernel size and position in the spikelet influence sample 'clean-out' and limit the grain yield potential of current cultivars and 2) to identify sources of genetic variability that could be exploited to increase the yield potential and sample uniformity of winter wheat produced in western Canada.

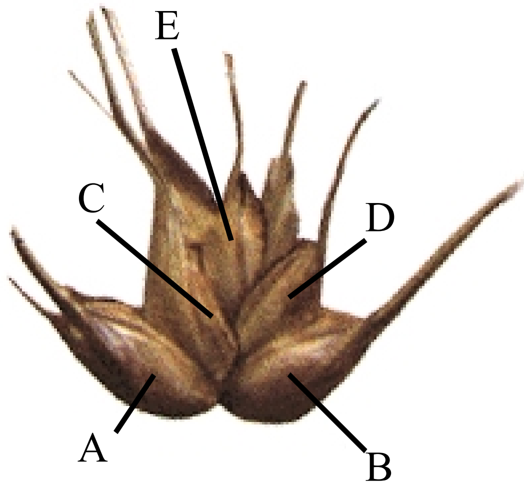

Figure 1. Wheat spikelet displaying the location of the various floret/kernel positions

Materials and Methods

Winter wheat cultivars AC Tempest, CDC Falcon, Norstar and Norwin were grown on irrigation and dry land at Saskatoon in 1999 and on irrigation at Saskatoon and dry land at Yorkton in 2000. Borden, Sundance, CDC Osprey, TW96516, CDC Ptarmigan, S96-74 and Oro Blanco were also included in the 2000 trials. Three spikelet reduction treatments (a check and 25 and 50 percent spikelet removal) were imposed on each winter wheat variety at anthesis to vary assimilate availability to the developing kernels. Each treatment consisted of 10 spikes sampled from each of two to three replicates in yield trials arranged in a randomized complete block experimental design. Spikes from each treatment were harvested and dried at maturity. Kernels were then hand-sorted into A, B, C and D kernel position in the spikelet, counted and weighed.

Results and Discussion

Varietal differences in the weight of kernels in the A and B positions in the spikelet ranged from 35.2 to 45.5 mg indicating that there is considerable genetic variation available in the wheat gene pool for this character (Fig. 2). Varieties such as TW96516, Borden, and Sundance consistently produced heavier kernels than other winter wheat genotypes regardless of the availability of assimilate. Kernel size of the C and D positions decreased to approximately 75 and 50 percent, respectively, of the average A and B positions in both dry land and irrigation environments. A significant ($P<0.0001$) variety x kernel position interaction indicated that there was considerable variability among varieties in the degree of kernel uniformity, but this source of variation was minor compared to decrease in size associated with the C and D kernel positions in the spikelet.

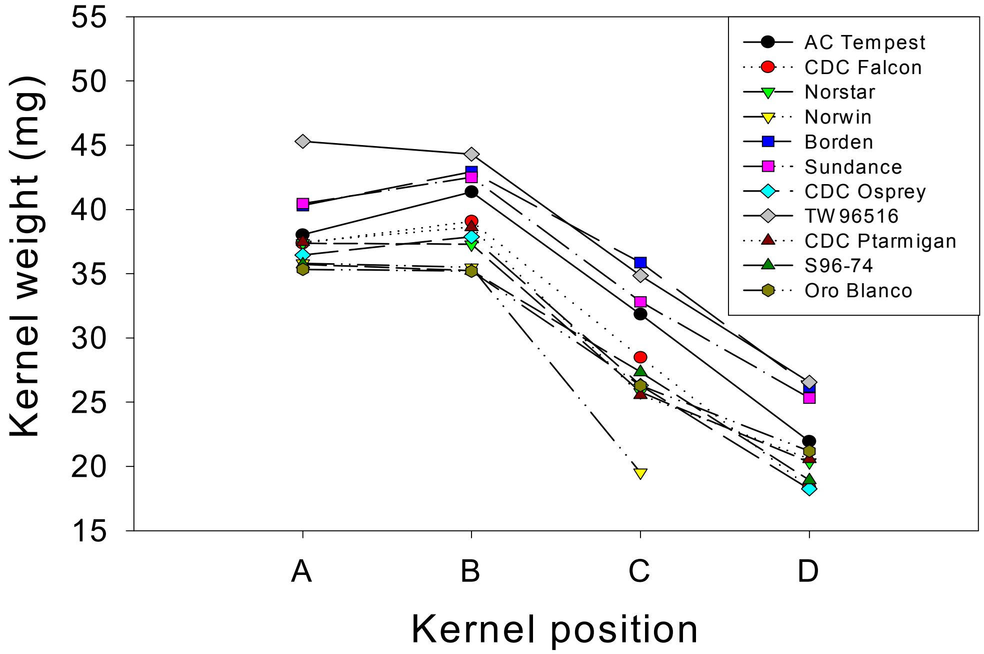

Figure 2. Average kernel weight for each position in the spikelet of eleven winter wheat cultivars (S.E. = 0.120)

Artificially reducing floret numbers by 25 and 50 percent to increase assimilate supply to the remaining seeds did not influence seed size in high moisture environments indicating that restrictions imposed by seed size may limit grain yield when growing conditions are favourable (Fig. 3). In contrast, kernel weight increased as the number of spikelets spike^{-1} decreased indicating that assimilate supply during grain filling and not restrictions imposed by kernel size determined grain yield of winter wheat grown on dry land in western Canada. The results of this study suggest that a winter wheat plant architecture that has increased spikelets spike $^{-1}$, larger seeds, and fewer seeds in the C and D spikelet positions would increase grain yield potential while producing a more uniform grain sample in variable semi-arid environments like western Canada.

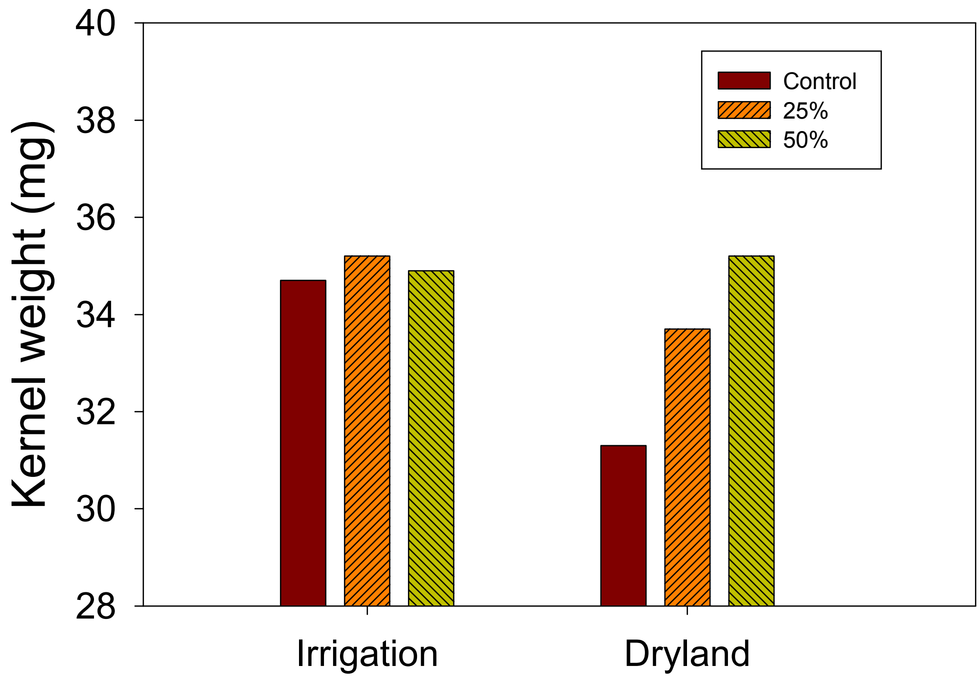

Figure 3. Average kernel weights of winter wheat cultivars grown under irrigation and dryland conditions when 0, 25 and 50% of spikelets were removed at anthesis (S.E. = 0.097)

References

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