Ratio of kernel $\Delta^{13}C/\delta^{18}O$ improves the selection potential of bread wheat for increased grain yield under different water regimes: A physiological perspective for direct application in wheat breeding

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Background

- Carbon isotope discrimination ($\Delta^{13}C$) and stable oxygen isotope analysis ($\delta^{18}O$) are important determinants of photosynthetic efficiency and water relations in plants. [1]
- Water stress affects grain yield in wheat (Triticum aestivum L.) due to reduced photosynthesis, nutrient uptake and metabolic activities. [2]
- Understanding physiological responses in wheat germplasm under drought stress could help to develop cultivars for low moisture regions.
- A doubled haploid (DH) bread wheat population, B0767, derived from Carberry/AC Cadillac was tested under irrigated and dryland (rainted) environments.
- Results based on the ratio of $\Delta^{13}C/\delta^{18}O$ of mature kernels for selecting wheat germplasm with higher grain yield are presented.

Schematic Diagram: Materials and Methods Used for this Study

Results and Discussion

- Agronomic and quality traits of all DH lines showed variations under irrigated and dryland conditions (Table 1).
- Principal component analysis (PCA) explained over 50% of variation in grain yield due to growing environments, a major contribution was shown by irrigated environments (Figure 1).
- DH lines B0767&AG075 (registered as AAC Goodwin), B0767&AX125 and B0767&BF109, consistently showed higher grain yield whereas the lines B0767&AD028, B0767&AG034 and B0767&AH156 were low yielding (Table 1).

![Figure 1](image1.png)
Figure 1: (a) Average growth environment coordination view of GGE (genotype main effect $G$), and genotype by environment interaction (GE) biplot ranking genotypes relative to an ideal genotype for varieties under different growth environments (IRRI= Irrigated; DRY= Dryland) during 2014 interaction and genotype by environment coordination view of GGE (DH) bread wheat lines under different growth environments (IRRI= irrigated; DRY= Dryland) during 2014-2015. (b) Percent variation accounted by each principle component (Figure 1).

<table>
<thead>
<tr>
<th>Line</th>
<th>Grain yield (kg/ha)</th>
<th>Plant height (cm)</th>
<th>TKN 625</th>
<th>PC1 54.03</th>
<th>PC2 47.81</th>
<th>PC3 17.37</th>
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<tr>
<td>Carberry</td>
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<td>80</td>
<td>14.9</td>
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<td>B0767&amp;AD028</td>
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<tr>
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<td>3700</td>
<td>94</td>
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<td>15.4</td>
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<td>75</td>
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<td>35.3</td>
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</table>

**Table 1**: Mean grain yield, plant height, grain protein, thousand kernel weight (TKN), and stress tolerance index (STI) of selected DH lines under different growth environments (IRRI= irrigated; DRY= Dryland) during 2014-2015.

- Grain yield, both under dryland and irrigated environments, showed a positive relationship with $\Delta^{13}C$, whereas it was negatively correlated with kernel $\delta^{18}O$ (Figure 2).
- Kernel $\Delta^{13}C/\delta^{18}O$ ratio improved the prediction of grain yield in dryland and irrigated conditions.
- DH lines with cooler canopies also showed higher $\Delta^{13}C/\delta^{18}O$ ratio and more grain yield.

- Strong correlation of grain yield with kernel $\Delta^{13}C/\delta^{18}O$ ratio suggests the possibility to integrate these physiological parameters in wheat breeding for selecting germplasm under different moisture regimes.
- Physiological understanding of $\Delta^{13}C$ and $\delta^{18}O$ in wheat yield improvement should be a focus of studies under irrigated and dryland environments.

References


Acknowledgements

Financial support provided by Agriculture & Agri-Food Canada, Western Grain Research Foundation, The Canadian Wheat Alliance and National Research Council Canada. Technical assistance by members of wheat working group at Swift Current Research and Development Centre is greatly appreciated.