Carbon Isotope Discrimination as a tool of durum wheat selection and its stability value in eastern High Plateau of Algeria

HAFSI Miloud ; HADJI Abbas; SEMCHEDDINE Nadjim; ROUABHI Amar; MAAMRI Khelifa
Départment d'Agronomie
Faculté des Sciences de la Nature et de la Vie
Université Ferhat ABBAS
Sétif 19000
hafsimiloud@yahoo.com

Introduction

The last study in north eastern Algeria on the potential use of carbon isotope discrimination (CID) in wheat selection conducted between 2003-2008 in collaboration with the IAEA showed several facets. Indeed, the results of seven trials in rainfed conditions characterized by a rainfall fluctuating between 250 and 500 mm and by additional abiotic stresses such as winter-spring cold (due to altitude) and terminal heat (because of close proximity of the Saharan desert).
In this type of area, several genotypes of diverse origin were evaluated in order to measure the stability of CID values in relation to grain yield.

Materiel and Methods

Plant samples were analyzed for $\delta^{13}C$ to identify lines presenting a large variation for Δ. Based on Δ analysis, six advanced lines from the CIMMYT / ICARDA durum wheat breeding program (Sooty9 / Rascon39, Dukem12 / 2*Rascon, Kucuk, Mexicali, Waha) and two old Algerian cultivars (Polonicum, Oued Zenati) were selected (Table 1) evaluated from 2002-03 to 2006-07 at the Sétif experimental station. Trials in the 2003-04 seasons were conducted under two contrasting rain-fed conditions in north-eastern Algeria.

Table 1. Brief description of eight genotypes grown in season 2003-04 at Setif and Khroub stations

Cultivar No.	Name	Origin
1	Mexicali	CIMMYT cultivar, released in 1975
2	Sooty9 / Rascon57	CIMMYT advanced line
3	Waha	CIMMYT/ICARDA line (Sham 1) released in Algeria in 1986
4	Oued Zenati	Local variety
5	Altar	CIMMYT cultivar, released in 1984
6	Dukem12 / Rascon21	CIMMYT advanced line
7	Kucuk	CIMMYT cultivar, released in 1984
8	Polonicum	Local variety

The stability regression coefficient (b-value) was calculated for each genotype according to Finlay and Wilkinson (1963) **[1]** to determine the stability of grain yield and CID across different environments. In general, genotypes with b-values (i) <0.70 were considered unresponsive to different environments or had above average stability; (ii) between 0.70 and 1.30 had average stability; and (iii) >1.30 were considered responsive to good environments or had below average stability (Lin and Binns, 1985) **[2]**.

Results

2003-04

1. Grain yield

Mean GY in Khroub station was significantly higher than in Sétif station. Overall GY was affected significantly by genotypes. Grain yield was also affected significantly with location and location x genotype interactions.

2004-05 and 2005-06

Significant differences among genotypes were observed for grain yield. The mean grain yield for all genotypes was about 1.3 times higher in 2004-05 trial than the first trial in 2006. ΔGrain for the three trials carried out from 2004 to 2006 were respectively 15.11; 16.45 and 17.26 ‰.The greatest difference between extreme genotypes for ΔGrain was observed in the 2005 season (1.39 ‰). The smallest range for ΔG was observed in the second trial of 2006 (0.98 ‰). The effect of environment, understood as the combination of region and total rainfall, on grain yield and grain-Δ was much higher than that of genotypic variability. For CID, the interaction between genotypes and trials was not significant.

An attempt was made to classify genotypes by level of stability using grain yield and the corresponding value of Δ for each genotype (Table 2) according to Finlay and Wilkinson (1963) **[1]**. The relationship between the mean grain yield and the mean Δ across the six trials was significant.

Table 2. Stability parameters range and mean of grain yield and Δ from 7 trials

Genotypes	Grain yield (slope ± SD)†	Grain yield range (t ha^{-1})	Mean yield (t ha^{-1})	Δ (slope ± SD)†	Δ range (‰)	Mean Δ (‰)
Altar	0.766 ± 0.099	1.67 – 5.05	3.15	1.242 ± 0.168	15.22 – 18.03	16.55
Dukem	0.915 ± 0.203	2.16 – 5.51	3.49	1.090 ± 0.124	15.36 – 18.05	17.16
Kucuk	1.309 ± 0.033	2.09 – 7.22	3.69	0.829 ± 0.260	15.26 – 17.77	16.71
Mexicali	1.038 ± 0.110	2.24 – 6.34	3.55	0.881 ± 0.150	15.57 – 17.59	16.69
Oued Zenati	0.610 ± 0.121	1.71 – 4.44	2.82	1.316 ± 0.243	14.18 – 17.57	16.04
Polonicum	0.609 ± 0.036	1.86 – 4.28	2.73	1.013 ± 0.265	14.62 – 17.21	15.80
Sooty	1.317 ± 0.204	2.53 – 7.82	3.78	1.206 ± 0.260	15.24 – 17.91	16.83
Waha	1.437 ± 0.137	2.06 – 7.87	3.74	0.952 ± 0.081	15.44 – 17.40	16.76

†SD = standard deviation

It appears that the subset of modern cultivars obtained from the CIMMYT / ICARDA durum wheat breeding program had on average, a higher Δ value (16.78 ‰) than the subset of local cultivars (15.82 ‰). This result is in good agreement with previous results obtained in the same type of environments. It can be explained by a lower stomatal conductance, or more likely, by less effective re-mobilization efficiency, reflected in their lower harvest index (Monneveux et al., 2005) **[3]**. The local cultivars, and particularly Oued Zenati, yielded well under the adverse environmental conditions of the high plateau, mainly because of a better phenological adaptation. The results of the present experiments, as well as those of previous studies (Hafsi et al., 2001 and 2007) **[4, 5]** suggest that Δ has a limited application as a yield predictor in this type of environment.

Acknowledgements

We would like to thank the international Atomic Agency and Comena (Algeria) for their financial support and Dr. W.Pfeiffer (CIMMYT) for providing the seed used in the experiments.

References

[1] FINLAY, K.W., WILKINSON, G.N., The analysis of adaptation in a plant-breeding programme, Aust. J. Agric. Res. **14** (1963) 742–754.

[2] LIN, C.S., BINNS, M.R., Procedural approach for assessing cultivar-location data: Pairwise genotype-environment interactions of test cultivars with checks, Can. J. Plant Sci. **65** (1985) 1065–1071.

[3] MONNEVEUX, P., et al., Relationship between grain yield and carbon isotope discrimination in bread wheat under four water regimes. European Journal of Agronomy, (2005) 22, 231-242.

[4] HAFSI, M., et al., “Carbon isotope discrimination and yield in durum wheat grown in the high plains of Sétif (Algeria). Contribution of different organs to grain filling”, Durum Wheat Improvement in the Mediterranean Region: New Challenges, Options Méditerranéennes **40** (2001) 145–147.

[5] HAFSI, M., AKHTER, J., MONNEVEUX,P., Leaf senescence and carbon isotope discrimination in durum wheat (*Triticum durum* Desf.) under severe drought conditions, Cereal Res. Comm. **35** (2007) 71–80.