Agronomic Evaluation of Somaclonal Variants from Durum Wheat Cultivars

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INTRODUCTION

The main objective of many plant breeding programs is the selection and development of high yielding cultivars with adequate resistance or tolerance to biotic and abiotic stresses and good end-use quality characteristics. Hybridization has been the primary source of variability for selection in conventional breeding programs. However, in the past decade, somaclonal variation or variation among tissue culture-derived lines (TCDLs) has been recognized as a novel source of variation with potential to contribute agronomically useful types (Ahloowahlia and Sherington, 1985; and Larkin et al., 1984). Somaclonal variation has been attributed to chromosomal aberrations, single and multigene mutations as well as cytoplasmic mutations (Ahloowahlia, 1982; Evans and Sharp, 1983; Karp and Maddock, 1984; Larkin et al., 1984; and Lee and Philips, 1988).

Both bread wheat (*Triticum aestivum* L.) and durum wheat (*Triticum durum* Desf.) have been shown to be amenable to the tissue culture process and the major

details for cell culture and regeneration have been described (Bartok and Sagi, 1990; Bennici and Damato, 1978, and Carman et al., 1988). In bread wheat extensive somaclonal variation has been reported in a number of quality, morphological and agronomic traits, including yield and yield components (Chen et al., 1987; Hanson et al., 1994; Ryan et al., 1987; and Villareal et al., 1993). However, most of these studies focused on comparing the performance of TCDLs with their respective original cultivars and no attempt has been made to compare them with leading cultivars at their target production areas to estimate tissue culture direct worth in breeding new cultivars. In comparison to bread wheat (BW), field studied to assess the agronomic performance of TCDLs from durum wheat (DW) are limited.

Objectives

To evaluate yield performance of TCDLs from four DW cultivars and compair them to their respective original cultivars and leading DW varieties in North-west Mexico.

Materials and Methods

Durum Wheat TCDLs were evaluated in sixteen-entry yield trials in Yaqui Valley, North-west Mexico during 1992/93 and 1993/94 wheat cycles. The entries were composed of: TCDLs (6), their respective original cultivars (4), in addition to one sister line of each original cultivar (4) and check varieties (2) that were adapted to irrigated optimum environments. The six TCDLs were the resultant lines after 3 cycles of field evaluation and selection of about 60 somaclonal variants from each original cultivar. In each visual selection cycle the variants were compared with their respective cultivars and the best lines were retained as normally done in

breeding programs. The original DW cultivars sources of the somaclonal variants, were lines adapted to optimum environments. Table 1 lists the original cultivars, the number of TCDLs selected from each, and check varities used in this study.

The yield trials were conducted under optimum crop management. Randomized complete block design with 3 replications was used. Seed rate was 120 kg ha^{-1}. Plot size used was 8 rows x 5 m long and harvested area was 5 m^2.

Yield data were analyzed by analysis of variance (ANOVA). Treatment means were compared by LSD and contrasts were carried out using the general linear model (GLM) procedure of the Statistical Analysis System (SAS Institute, 1985). Entries were grouped into three groups (G1 =original cultivars; G2=tissue culture-derived lines, and G3=check varieties) and contrasts were carried out between groups as well as within common entries from a cultivar.

Results and Discussion

Growing conditions were fairly typical in 1993/94 wheat cycle, but not so in 1992/93 season, when above normal precipitation and cloudiness were experienced. Table 2 shows the range and mean yields obtained as well as coefficient of variation (CV%) for the trials in the two test seasons. On testing for the homogenity of the error variance, no evidence to the contrary was observed and thus combined ANOVA across the seasons was carried out. ANOVA results indicated highly significant yield differences between the years and significant differences within test lines (Table 3). On comparing yield performance of TCDLs with their respective original cultivars, no significant differences were observed. In contrast, the check

varieties significantly out-yielded both the TCDLs and their original cultivars (Table 4 and 5). On average TCDLs were 2.6% and 12.2% lower-yielding than the original DW cultivars and check varieties, respectively.

Yield components and agronomic traits (flowering, maturity days and grainfilling period) were measured in each entry and ANOVA was performed. Results of groups comparisons for these traits are summarized in Table 6. TCDLs were significantly superior to original cultivars only in spikes m^{-2}. For other yield components and agronomic traits no significant differences were observed between TCDLs and original cultivars. Comparison of check varieties with TCDLs revealed the superiority of check varieties in grain yield, and test weight. TCDLs flowered significantly later than the check varieties.

Thus considerable variation was observed for yield, biomass, harvest index, spikes number, grains per spike, thousand-grain weight, test weight, days to heading, days to maturity and grainfilling. However, TCDLs were generally inferior in yield and yield components to their respective original cultivars and much so to optimum environment check varieties. These results are in line with findings of Chen et al., (1987), Hanson et al., (1993), Ryan et al., (1987), and Villareal et al., (1993), in TCDLs from BW.

SUMMARY

Field screening revealed considerable variation in morphological and agronomic traits in DW somaclonal variants. However, on regiours testing of selected TCDLs in replicated yield trials, with the exception of spikes m-2, somaclonal variants did not differ significantly in yield nor yield components from

their respective original cultivars. When compared to optimum environment varieties, TCDLs were generally inferior in yield and yield components. Thus these results show that somaclonal variation would not benefit wheat breeders if used directly to develop varieties.

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Table 1. Original DW cultivars sources for somaclonal variants, number of selected TCDLs* from each cultivar, and check varieties used in the study.

A) Original cultivars	Cultivar Cross Number	No. of Selected TCDLs*
1. Arlequin	CD26132	2
2. Duergand	CD37734	1
3. Laru	CD28220	2
4. Crocethia	CD20626	1
B) Check varieties		
1. Altar 84	CD22344	
2. Aconchi 89	CD67124	

*TCDLs = Tissue Culture-Derived Lines.

Table 2. Observed range, mean yield and trials coefficient of variation (% CV) for 1992-93 and 1993-94 wheat cycles.

A)	Wheat cycle Y92-93:	
	Range:	5787-4227 kg ha^{-1}
	Mean:	4968 kg ha^{-1} A*
	CV:	7.46%
B)	Wheat cycle Y93-94:	
	Range:	8446-6898 kg ha^{-1}
	Mean:	7557 kg ha^{-1} B*
	CV:	3.39%%

* Means that have different letters are significantly different at the 0.05 probability level.

Table 3. Combined ANOVA for yield over seasons

Source	DF	Mean Square	F value
Year	1	160844215	1103.07**
Block (Year)	4	145816	0.35 NS
Entry	15	646020	1.54*
Year* Entry	15	419003	

*, ** Significant at the 0.05 and 0.01 probability levels, respectively.
NS = Not significant

Table 4. Comparison of tissue culture-derived lines (TCDLs) with their respective original cultivars and check varieties

Contrast	DF	Mean Square	Pr > F
Arlequin vs TC_1 (=Arlequin TCDLs)	1	828.38	0.9651 NS
Duergand vs TC_2 (=Duergand TCDLs)	1	1000.00	0.8793 NS
Laru vs TC_3 (=Laru TCDLs)	1	56357.04	0.7189 NS
Crocethia vs TC_4 (=Crocethia TCDLs)	1	1242481.78	0.1056 NS
Check varieties vs ($TC_1+TC_2+TC_3+TC_4$)	1	6438483.34	0.0014**

** Significant at 0.01 probability level.
NS = Not significant.

Table 5. Comparison of, over the years, groups mean yields.

Group	Mean yield (Kg ha^{-1})
G3	6920.0 A*
G1	6238.6 B*
G2	6074.2 B*

G1 = Original DW cultivars
G2 = Tissue culture-derived lines
G3 = Check varieties
* Means that have similar letters are not significantly different.

Table 6. Groups comparisons for yield, yield components and agronomic traits.

Plant characteristic	Differences between Means G1-G2			G3-G2		
Grain yield (kg ha^{-1})	+	164.40	NS	+	845.80	*
Biomass (kg ha^{-1})	-	1369.00	NS	+	1350.00	NS
Harvest index (%)	+	0.03	NS	+	0.01	NS
Spikes/m^2	-	61.00	*	-	8.00	NS
Grains/m^2	-	343.00	NS	+	187.00	NS
Grains/spike	+	4.00	NS	-	0.06	NS
1000-grain weight (g)	+	1.10	NS	+	3.60	NS
Test weight (kg hl^{-1})	+	0.35	NS	+	3.59	*
Days to flowering	-	2.00	NS	-	3.00	*
Physiol. maturity (day)	-	2.00	NS	-	4.00	NS
Grainfill period (day)	-	0.10	NS	-	1.00	NS

GI=Original DW cultivars; G2=Tissue Culture-derived lines; G3=Check varieties
NS=Not significantly different.
* Significantly different at the 0.05 probability level.
(+/-) Means difference sign. If sign is (-) G2 is superior, if (+) G1 or G3 is superior.