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Full Length Research Paper

The validity of using juvenile stages for evaluation of salt stress tolerance of *Triticum durum* genotypes

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The aim of this work was to evaluate eight North African wheat genotypes (*Triticum durum*) on the basis of their salt stress tolerance. The effect of this abiotic constraint was investigated at tillering stage using hydroponic culture. Some growth and development parameters were measured between three and six leaves stages and also at harvest. Data were submitted to a comparative canonic analysis followed by a hierarchical cluster analysis within both aforementioned stages. Some old Tunisian varieties, such as Mahmoudi who was almost completely abandoned in cereal culture, showed more tolerance to stressful conditions than the new and standard productive varieties. This aptitude to tolerate salt was observed as well in the beginning and at the end of plant development cycle. We concluded that some measures at juvenile stage may be used as valid genetic discrimination tool, leading to time and space gain in breeding programs.

Key words: Triticum durum, salt stress tolerance, juvenile stage, evaluation.

INTRODUCTION

Characterized by irregular rainfall in time and space, the climate is one of the primary factors limiting yields and is the main constraint which generates not only differences between the average annual yields but also between potential of different cereal varieties each season (Sorrells et al., 2000). The random nature of rainfall affects crops, particularly if we consider that the agronomy is still for most part carried out without irrigation for 60% of them (Slama et al., 2005). The use of irrigated crops, although is more expensive and require heavy equipment, can skirt the edges. This is dependent on rainfall factor, but the expansion of irrigated agriculture and intensive use of water resources, combined with high evaporation in arid and semi-arid, raises another problem and inevitably leads to soil and ground water salinisation (Radhouane, 2008). The scarcity of viable water resources in Tunisia aggravates this situation. Indeed, 50% of groundwater in southern Tunisia, for example, is considered as salted waters containing between 2 and 6 g/l of salt. Similarly, in irrigated agricultural area, water from dams has a load salt from 2 to 3 g/l, while wells have of 4 to 7 g/l (Hachicha and Braudeau, 1998). There is, then, in semi arid to arid areas, an alternation between water stress and salt stress; very frequently (Yuncai and Schmidhalter, 2005). The salt tolerance of crops and in a second level of the cultivated varieties would allow and enhance these waters in agriculture (Maas and Poss, 1986). The alternative approach is, therefore, to seek plants that have some tolerance to salt to give good production face high salinity water and soil (Radhouane, 2008).

The stability of cereal production is currently a priority for the Tunisian strategy for improving cereals especially as climate forecasts (Koutsoyiannis, 2003) herald little

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Abbreviations: HFL, Height up to flag leaf; **HS,** height to the base of the spike; **LS,** length of spike; **STI,** stress tolerance index; **TW,** total dry weight; **TH,** height growth; **TNS,** total number of spikelets.

possible progress mainly because of greenhouse gas emissions and also because of the looming problem of water shortage especially in Africa. Thus, the selection of new genotypes providing resistance to drought or salinity (Ben et al., 1997; Rezgui et al., 2000) could be an answer to the instability in the country. A better knowledge of the involvement of key stages of plant development in developing grain yield could facilitate successful upgrades (Slama, 2002) by guiding and simplifying the search for varieties adapted to drought and salinity. Then, understanding the impact of juvenile stages (often subject to rainfall constraints) on performance is one of our objectives. Indeed, among the successive stages of development through which a cereal passes, the early stages have a major importance in the outcome of the culture and the establishment of different yield components (Rassaa et al., 2008). Thus, the number of spikelets per spike and thus the potential number of grains per spike are determined before stage five to six leaf (tillering stage) (Kirby and Appleyard, 1987). To differentiate between certain genotypes of durum wheat variety on the basis of their tolerance to salt stress, different salt treatments have been advocated. This work aims therefore, to identify the effect of salt stress on the differentiation of the apex in durum wheat and its effect on the performance of the plant; this differentiation occurring in a relatively early stage of the cycle plant (three to six leaves). Previously, we attempted to identify some early tests that can predict the final performance of the plant either in yield components or eco physiological quality. We therefore, conducted a comparative study of the behaviour of different wheat genotypes (*T. durum*), faced with NaCl at the early stages and its repercussion on harvest.

MATERIALS AND METHODS

The study was conducted on four improved varieties: Karim, Razzek, Om Rabii, INRAT 69; three autochthon varieties: Mahmoudi, Biskri, Chili and a cultivar namely "Alia" (referring to its origin).

Experiment installation

For better control of salinity plant rhizospheres, a apparatus consisting of hydroponic boxes with perforated lids (2.5 l of nutrient solution), air pump (Haile Aco-2201, Q-max 90l / h) and a ceiling light (about 120 µmol/m^2 / s) was used. 24 seedlings (from 96 h of germination in a Petri dish) were placed on each one. Three boxes were used per treatment and variety. The photoperiodic regime was maintained for 16 h of daily radiation with a light intensity of around 120 µmol/ m^2/s. The temperature and relative humidity were respectively 24°C and 80% on average daily.

Driving experiment

The nutrient solution Haogland was slightly modified and used in this experiment. The nutrient solution was changed every 72 h. The plants, from a set of germination in Petri dishes, were carried out to three leaf stage (stage approximately at the beginning of flower initiation) without saline treatment. From this stage, treatments assumed to induce plant physiological responses were applied: T1: control; T2: NaCl = 5g/l , T3: NaCl = 10 g/l.

Observations and measurements

Various parameters were monitored to identify the plant response to salt stress. The approach pursued in this work was based on a further interest in the juvenile stages characterized by qualitative and quantitative descriptors. Tracking the number of leaves and dry matter production was achieved, the stage of apex development (the stage of differentiation on a scale inspired from the description of the cereal development by Kirby (Kirby and Perry, 1987) and the number of spikelets differentiated observed after dissection under binocular microscope were noted at each sampling at a rate of about ten days (each appearance of a new leaf). These actions are destructive; limited to five samples per variety. The water content of seedlings was also calculated using the formula: Water content = (Dry weight - fresh weight) * 100 / Fresh weight. Beyond the six-leaf stage, at which point treatment was stopped, the plants were transplanted into pots and transferred into a greenhouse and they continued their development until the end of the cycle. Other parameters on yield were measured at harvest, even after the removal of treatments.

Statistical analysis

Data on developmental parameters and plant growth were analyzed using statistical software “GenStat” (Payne et al., 2003). ANOVA and the comparison tests such as least significant differences (LSD) were calculated similarly for the parameters measured at harvest. A canonical analysis of variables measured at tillering stage and another canonical analysis of those measured at harvest were performed through the software “GenStat”. A dendrogram deduced from the matrix of Mahalanobis distances was performed using the software "Phylip" according to Kitch method (Felsentein, 2008).

RESULTS

The effect of varieties, the effect of salt treatments and the interaction between these two effects were highly significant on leaf growth ($p < 0.001$) according to Fisher Snedecor test (Table 1). The number of tillers was also measured, but although the effect of varieties was significant for this parameter ($p < 0.001$), the readings were low for most varieties. Autochthon variety Biskri, Chili and CV Alia had the best indentations (average 0.75 tillers) and Om Rabii and Razzek had the lowest tillering. The effect of varieties and the effect of salt treatments on the weight gain, were, respectively, highly significant ($p < 0.001$) and significant ($p = 0.002$). The water content in leaves (Figure 1) responded to salt stress under different varieties, and some varieties gradually decreased the water content of their leaves according to the intensity of stress; for example cv Alia. Others absorbed more water when stress was mild and did not decrease their water

Table 1. ANOVA analysis: fisher test signification for variables measured at tiller stage and at harvest for some wheat genotypes (*Triticum durum*).

Stage	Variable	Salt treatment	Genotype	Treatment*Genotype
Tillering stage	LN	*P = 0.001****	*P = 0.001****	*P = 0.001****
	TN	*P = 0.001****	*P =0.002***	*P = 0.757*NS
	DM(g)	*P = 0.001****	*P =0.006***	*P = 0.001****
	DSN	*P = 0.001****	*P = 0.001****	*P = 0.001****
	DS	*P = 0.001****	*P =0.021***	*P = 0.001****
	WC(%)	*P = 0.001****	*P = 0.002***	*P = 0.001*****
Harvest stage	TH (cm)	*P* = 0.025**	P = *0.001****	*P* = 0.012**
	HS (cm)	*P* = 0.004**	*P = 0.001****	*P* = 0.057NS
	HFL (cm)	*P = 0.002***	*P = 0.001****	*P = 0.005***
	SL (cm)	*P* = 0.382NS	P = 0.016**	*P* = 0.620NS
	TW (g)	*P* = 0.080NS	*P = 0.001****	*P = 0.001****
	WTH (g)	*P* = 0.442NS	*P = 0.001****	*P* = 0.201NS
	WS (g)	*P* = 0.011**	*P = 0.001****	*P =□ 0.001****
	GNS	*P* = 0.353NS	*P = 0.001****	*P =□ 0.001****
	FSN	*P* = 0.218NS	*P = 0.001****	*P =□ 0.001****
	SSN	*P* = 0.304NS	*P = 0.001****	*P =0.001****
	SST	*P* = 0.903NS	*P = 0.001****	*P* = 0.034**
	SSB	*P* = 0.034**	*P = 0.001****	*P = 0.001****
	TNS	*P = 0.001****	*P = 0.001****	*P = 0.018***

LN, Leaf number ; TN, Tiller number ; DM, dry matter ; DSN, Differenciated spiklet number ; DS, development stage ; WC, water content ; TH, total height ; HS, height of spike; HFL, height up to flag leaf; SL, spike length ; TW total weight ; WTH, Thatch weight WS, weight of spike; GNS, grain number spike ; FSN, fertile spike number ; SSN, sterile spike number ; SST, sterile spiike at top ; SSB, sterile spike at base; TNS, total number of spike; NS, non significant effect; **, significant by Fischer test; ***, highly significant by Fischer test.

absorption when the stress became more severe as was the case for Om Rabii and Biskri. Finally, several varieties gradually increased their water absorption according to stress intensity as was the case of varieties Mahmoudi and INRAT 69. The effect of varieties and interaction between the effects of salinity and variety were the same; highly significant ($p < 0.001$) for the water content of the aerial part.

The apical differentiation (Figure 2) starts just after the completion of leaf primordia development that occur appreciatively and in non-stressful conditions at three leaves stage. Then, we can observe a double ridge stage which continues to glume and lemma primordia differentiation until stage six to seven leaves depending on the environmental conditions when terminal spikelet stage is started. It was noticed that the floral development was very significantly different ($p < 0.001$) depending on variety. Also, salinity had a significant effect ($p = 0.002$) on the apical differentiation. Among the genotypes studied, Chili was characterized by the fact that there was already 15 at T_2 (moderate stress) and 12 at T3 (severe stress) differentiated spikelets at tillering stage but was not yet at the stage where we could identify floral primordium sites in the control apex (Figure 3). The other genotypes tended to decrease the number of differentiated spikelets except for Om Rabii and Karim (this could be due to the delay in floral development). The total number of spikelets per spike (Figure 3) appeared unaffected by a moderate stress for all genotypes studied except for Chili and Razzek. There is, however, a downward trend during severe salt stress. The same trend was observed in both stages. Concerning height growth, Chili and Biskri were distinguished by the height (TH) most importantly; their average heights were, respectively 76.33 and 89.73 cm.

The variety Razzek was shorter (46.47 cm) (Table 2). The difference between them by Fisher test was indeed highly significant for this parameter. This parameter was grouped into three components that could explain the mechanism of growth in height: height up to flag leaf (HFL), height to the base of the spike (HS) and length of spike (LS). The HFL was the largest ever held by the variety Biskri (775.08 cm) followed by Chili (64.04 cm) and similarly by the HS (respectively 83.75 and 69.33 cm). The variety Biskri, differed consequently in its leaf growth and tillering and its development in height. The

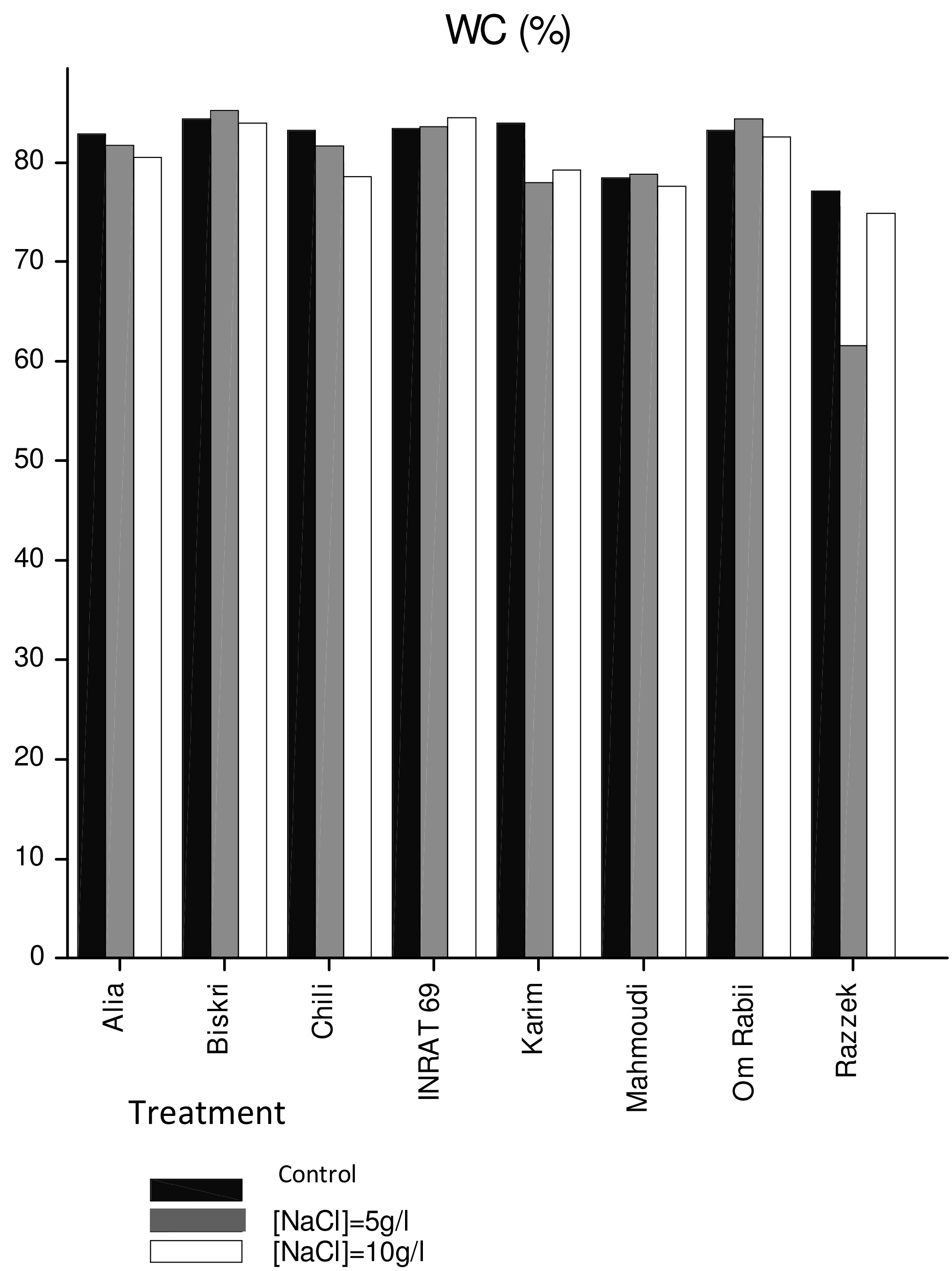

Figure 1. Plant water content (%) under 3 salt treatments (■ Witness, ■ [NaCl]=5g/l, □ [NaCl]=10g/l) for some tunisian wheat genotypes (*Triticum durum*).

difference in total dry weight between the studied varieties was indeed highly significant (*P<0001*) (Table 1). The effect of treatment was not apparent for some varieties such Om Rabii and INRAT 69. However, ANOVA revealed a highly significant difference for interaction treatment x variety. The recorded production of biomass was still maintained by the variety Biskri (Table 2). The number of grain per spike (Y) was little or was almost not affected by salt stress when it was moderate (Ys2) except for Razzek, Chili and Om Rabii (Table 3). In more severe stress, varieties the number of grains per spike (Ys2) was reduced except for Chili where the number of grain was similar to that of the control.

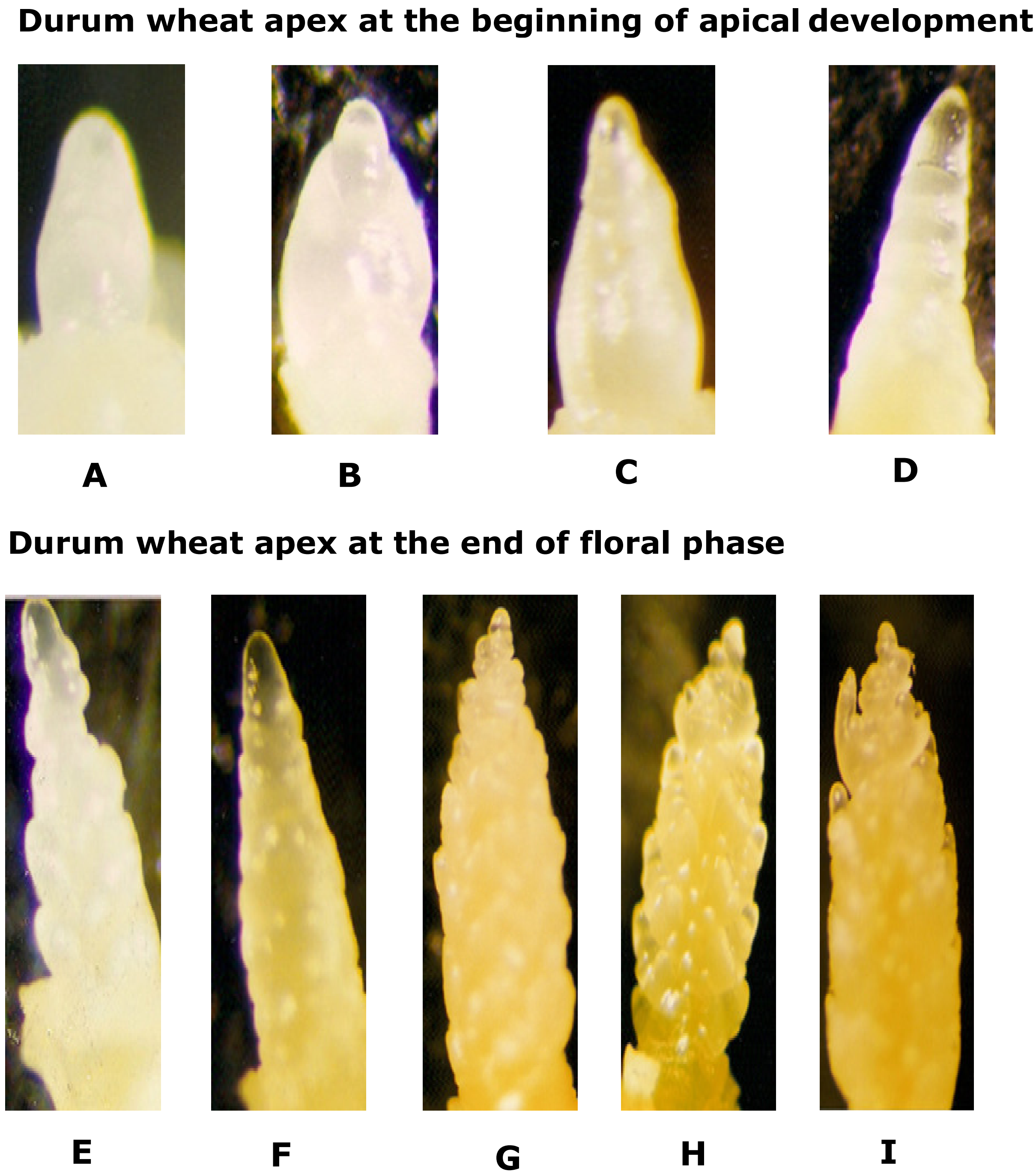

Figure 2. Apical stage development of triticum durum. A, vegetative phase; B, floral phase beginning; C, dome elongation; D, double ridge stage; E, glume primordium; F, lemma primordium; G, multi-floret nature; H, terminal spiklet; J, floral phase complete.

Salt stress tolerance

To assess the effect on grain yield by salinity for the different genotypes studied, stress tolerance index (STI) was calculated for each variety by the following formula suggested by Fernandez (1992) and cited by

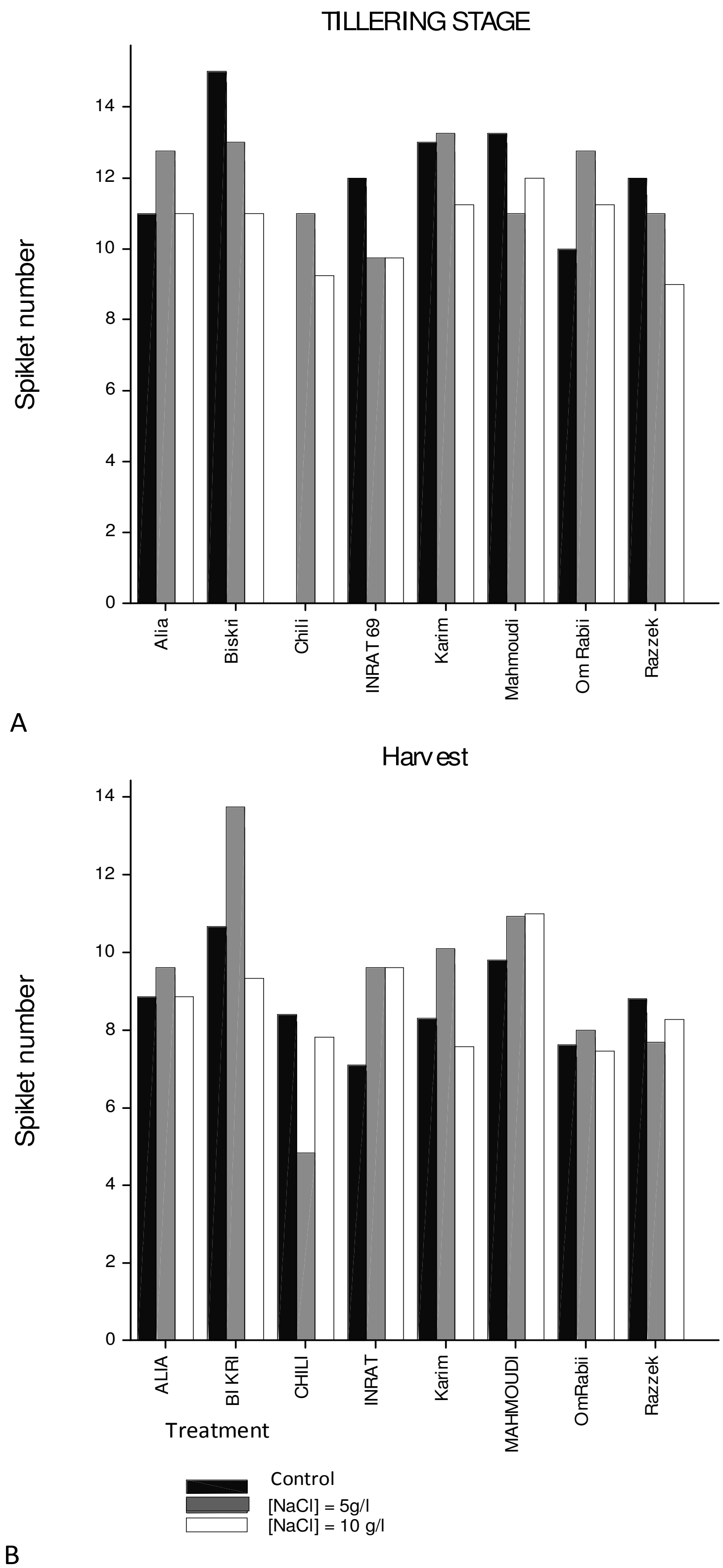

Figure 3. Number of spikelets differentiated at tillering stage (A) and at harvest (B) under three salt treatments (■, control; ■, NaCl=5g/l; □, [NaCl]=10g/l).

Table 2. Measured parameters means and their least significant difference LSD (5%) for each durum wheat genotypes considered at tillering stage and at harvest.

Stage	Variable	Om Rabii	Alia	Karim	Razzek	INRAT 69	Biskri	Chili	Mah-moudi	LSD (5% level)
Tillering stage	WC (%)	83.37	81.71	80.38	71.21	83.83	84.51	81.14	78.28	2.41
	DS	6.33	7.13	7.00	8.00	6.33	6.67	4.58	7.71	0.34
	DSN	11.33	11.59	12.50	10.67	10.50	13.00	10.45	12.08	0.70
	LN	4.59	4.43	4.45	4.54	4.15	4.77	4.01	4.77	0.11
	TN	0.17	0.75	0.25	0.00	0.50	0.83	0.33	0.17	0.40
	FM (g)	1.46	1.48	1.38	0.92	1.54	3.03	1.46	1.23	0.25
	DM (g)	0.24	0.27	0.25	0.26	0.24	0.45	0.27	0.27	0.04
Harvest	TH (cm)	52.07	51.41	48.17	46.47	68.82	89.73	76.33	52.93	2.50
	HS (cm)	48.77	45.62	44.12	41.92	62.52	83.75	69.33	47.19	4.58
	HFL (cm)	38.09	35.32	36.24	31.17	49.33	75.08	64.04	35.51	3.53
	SL (cm)	3.30	5.80	4.05	4.55	6.30	5.98	7.01	5.75	0.77
	TW (g)	1.13	1.63	1.31	1.38	1.45	2.82	1.64	1.60	0.27
	WTH (g)	0.49	0.68	0.64	0.53	0.74	1.91	1.33	0.67	0.15
	WS (g)	0.63	1.01	0.72	0.84	0.67	0.74	0.39	1.00	0.20
	GNS	10.14	14.95	10.69	12.84	11.02	16.38	8.75	19.71	2.80
	FSN	7.69	9.10	8.52	8.29	8.83	11.27	6.95	10.57	1.00
	SSN	4.73	4.05	4.83	3.61	6.21	6.26	8.23	3.10	0.79
	SST	0.54	0.34	0.57	0.09	0.88	0.21	0.80	0.31	0.37
	SSB	4.22	3.87	4.13	3.26	5.45	6.29	7.40	3.04	0.68
	TNS	12.42	13.15	12.95	10.94	15.03	16.92	14.41	13.24	1.21

Farshadadfar (2008): $STI=(Yp)*(Ys)/(Yp)^2$; Yp is the grain production in non-stressful conditions, and Ys is the production of grain in stressful conditions. The highest grain productivity by ear (Y) was found in the variety Mahmoudi (Yp = 20.90; YS1 = 21.33; Ys2 = 21.45). From Table 3, the variety Mahmoudi had the best stress tolerance index to salt in the case of moderate or severe stresses (respectively 1.11 and 1.04). Among the improved varieties, variety Razzek had also a good tolerance index (1.08 for severe stress and 0.96 for a mild stressor). The variety Om Rabii was the most sensitive to salinity; it displayed an index of stress tolerance of 0.81 even at slight stress. The index of tolerance of the variety Karim was relatively high for a mild stress, but was much diminished at severe stress (STI = 0.51).

Canonical analysis

The canonical analysis of variables measured at tillering (Figure 4) showed that local varieties Chili and Biskri were detached from the rest of the genotypes studied in both groups separately. Razzek and Mahmoudi, though unrelated, were distinct into two overlapping groups. Axis 1 (represented mainly by the leaf and apical development) and axis 2 (represented mainly by the accumulation of dry matter) accounted for 65.77 and 17.75% of total variation, respectively. For both axes, the adjustment terms were 11.466 and 2.826 for axis 1 and 2, respectively. The dendrogram representing the Mahalanobis distances between the genotypes studied (Figure 5) shows the distinction of the variety Mahmoudi into one group. The old varieties Mahmoudi, Chili and Biskri ranked in the top three levels of hierarchy. The cultivar Alia seemed close to the variety Om Rabii from this analysis. At harvest, if variables were eliminated by keeping only those that are representative of what has been measured at tillering stage, canonical analysis (Figure 6) shows then a distribution of the genotypes studied very similar to that revealed by the analysis based on the variables measured at tillering stage; the analysis was limited to variables describing height growth (TH) reflecting the number of leaves measured at tillering stage, the total dry weight (TW), reflecting the growing weight at stage tillering, the total number of spikelets per spike (TNS) reflecting the number of spikelets differentiated at juvenile stage and the weight of the ear (SW) and the number of grains per ear (GNS) reflecting both, but in part, the rate of apical development during the tillering stage. The canonical analysis of variables measured at harvest revealed then, as at the cycle beginning, the detachment of two ancient varieties (Chili

Table 3. Average grain productivity in non-stressful conditions (Yp), in slightly stressful condition (YS2) and severely stressful conditions (YS1) and index of tolerance to moderate (STI2) and to high (STI1) salt stress.

Variety	Yp	YS1	YS2	STI1	STI2
Karim	14.13	14.25	7.86	0.98	0.57
Razzek	14.92	13.46	13.40	0.96	1.08
OmRabii	13.23	11.00	10.23	0.81	0.70
Inrat 69	13.33	11.08	10.94	0.90	0.76
Mahmoudi	20.90	21.33	21.45	1.04	1.11
Alia	17.67	16.46	13.40	0.93	0.80
Biskri	18.29	15.38	11.18	0.91	0.57
Chili	14.17	11.00	7.50	0.85	0.49

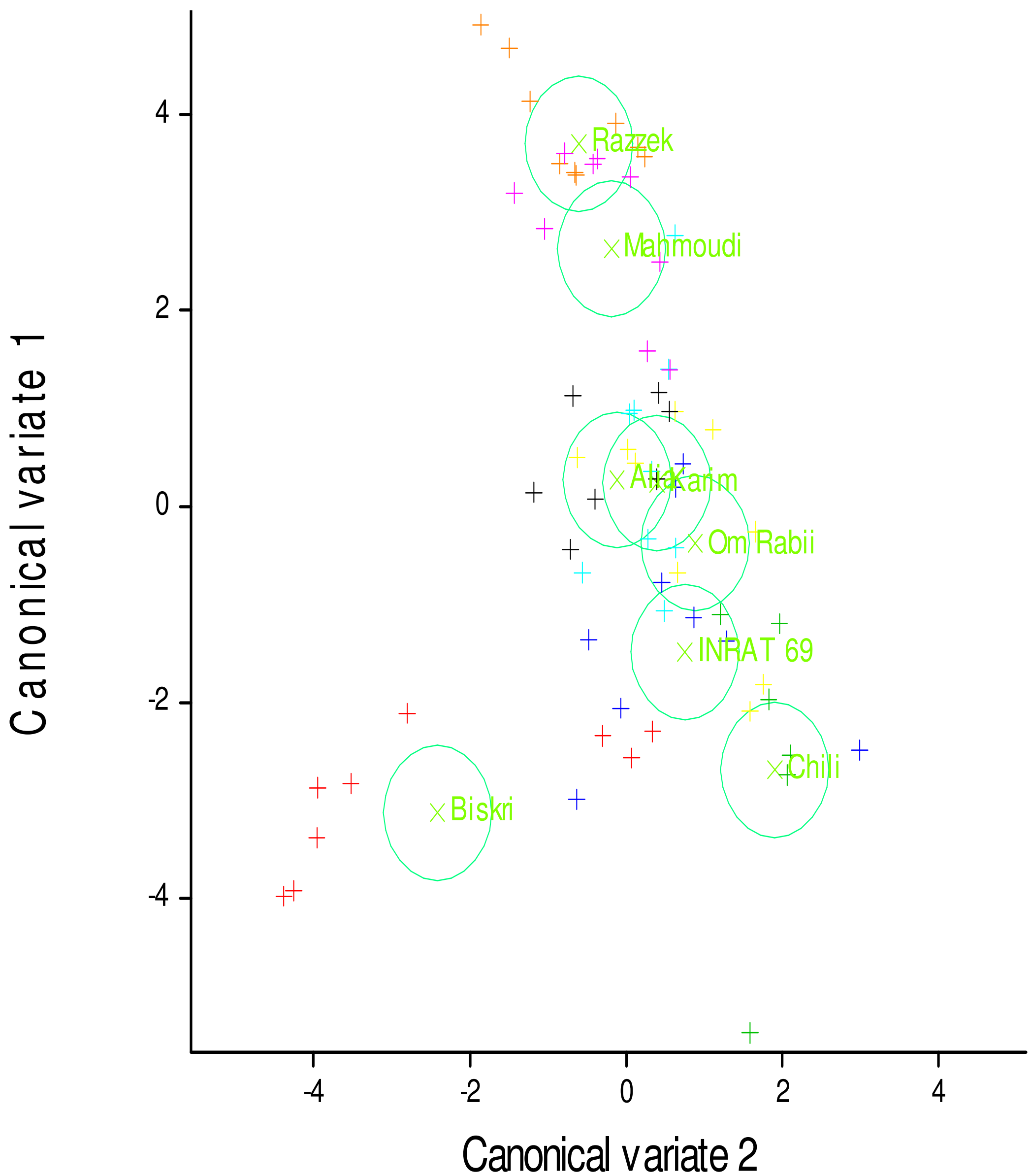

Figure 4. Canonical analysis of variables measured at tiller stage.

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                                       +-----------  Karim
                    +------------------7
                    !                  +-----------  Om Rabii
                    !
                    !                        +----  INRAT 69
          +---------5                     +--4
          !         !                 +---6  +----  Alia
          !         !                 !    !
          !         !        +-------2    +--------  Razzek
        --1         !        !        !
          !         +--------3        +-------------  Biskri
          !                  !
          !                  +---------------------  Chili
          !
          +----------------------------------------  Mahmoudi
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Figure 5. Hierarchical cluster deduced from Mahalanobis distance calculated on variables measured at tiller stage.

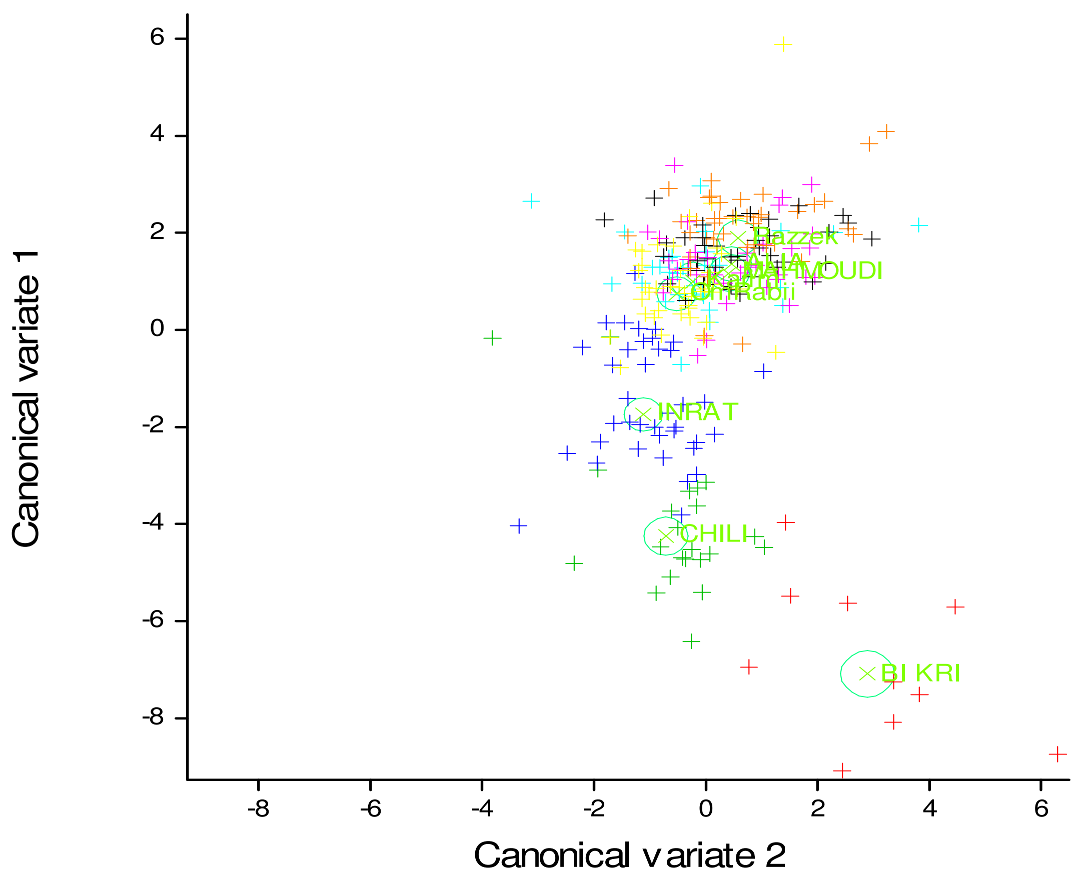

Figure 6. Canonical analysis of variables measured at harvest.

and Biskri); very distinct from the other genotypes studied. Axis 1 accounted for 82.78% of the variation, which is represented mainly by the weight of the ear, while the axis 2, which absorbed 11.37% of the variation was accounted for mainly by the production of biomass; terms of adjustment was -7. 666 to -2.398 for 1 axis and

```
                                                    +  Om Rabii
                                                 +--5
                                               +-7  +  Alia
                                               ! !
                               +---------------4 +---- Karim
                               !               !
                               !               !   +-- Razzek
                        +------1               +---6
                        !      !                   +-- INRAT 69
  +---------------------3      !
  !                     !      +---------------------- Biskri
--2                     !
  !                     +----------------------------- Chili
  !
  +--------------------------------------------------- Mahmoudi
```

Figure 7. Hierarchical cluster deduced from Mahalanobis distance calculated on variables measured at harvest.

axis 2. The dendrogram representing the Mahalanobis distances between the genotypes studied on the basis of parameters was measured at harvest (Figure 7). The old varieties; Mahmoudi, Chili and Biskri ranked in the top three levels of hierarchy. The cultivar Alia seemed closer to the range of INRAT 69 after analysis made on the basis of the parameters measured at harvest.

DISCUSSION

For most varieties studied, the salt stress involved varying proportions according to the stress intensity range, lower leaf growth and weight studied (interaction treatment x variety was highly significant by test Fisher *Pr <0.001*). This drop in biomass accumulation appears to be a strategy to reduce plant water stress caused by salinity and thus water loss by transpiration. Alem et al. (2002) indeed observed that the decrease in leaf area was the main strategy adopted by different varieties of durum wheat (among them the variety Karim) to get around the effects of limited water availability in conditions of salt stress such as water stress conditions (Brisson and Casals, 2005). Similarly, Bouaouina et al. (2000), showed reduced growth in durum wheat (var. Razzek) at a juvenile stage. This reduced growth was reported by several other authors (Maas and Grieve, 1990; Munns et al., 1995; Raj et al., 2002). Concerning apical development, acceleration in development stage was another strategy to avoid stress and it had repercussions on differentiated spikelets number. This trend in unconformity between growth and development was treated in previous research (Rassaa et al., 2008). Moreover, after this study of plant response variability to salt stress, it appears that the changeability in grain yield is such that the choice of the farmer is largely justified. Indeed, the variety Karim, who remains among the varieties preferred by Tunisian and North African farmers (Deghais, 2007), in addition to its constancy (the lowest standard deviation for all parameters measured) compared to other genotypes in the stress response, had the most important weight of thousand grains parameter providing the greatest benefit to users.

However, with a rather low stress tolerance index (severe STI1 = 0.57), this variety did not tolerate high salt concentration. Being a recommended variety for irrigation (Deghais, 2007), it is important that the salinity of used water is low, to externalize its potentiality. The variety Razzek, with good weight of thousand grains, was very close to the variety Karim in its response of apical development to the salt stress. However, it had a better tolerance to salinity (STI2 = 1.08) in relation to his ascendancy Karim. These results are in contradiction to the previous work by Bouaouina et al. (2000) who concluded that this same variety has physiological characteristics of sensitive plants to salinity during the juvenile phase. This variety, could then, be better recommended to irrigate crops. The variety OmRabii was less productive than the first two and spikelet number appeared sensitive to salinity. It was assigned to low NaCl concentration (T1 corresponding to 5g / l), and had the tolerance index of the lowest among the improved varieties (STI1 = 0.81 and STI2 = 0.70). Ben Naceur et al. (2001) even found that this variety was more tolerant to salt stress compared to Razzek for most parameters they measured. Among the old varieties and local varieties, the genotypes that stand out distinguished by greater biomass production under conditions of stress are the two ancient varieties Biskri and Chili which have also been identified by canonical analysis; two distinct groups.

These varieties are unfortunately almost eliminated from the pool of varieties registered and promoted by the Tunisian government; Chili was in fact abandoned from crops in about 1985 and officially removed from the catalogue in 1993 (Deghais, 2007).

The variety Biskri tolerated low NaCl concentration but was affected by a higher salinity which limited leaf growth and slowed its apical development. The variety Chili, holding a slow leaf and weight growth compared to other varieties, recorded a significant acceleration of floral development in a moderate stress. This acceleration is a lesser percentage for a more severe stress. This plasticity of phenological development to stress has already been mentioned by Brisson et al. (2003) as strategies of plant adaptation to conditions of limited water supply. Moreover, even if this variety had a low yield compared to improved varieties (SML = 24.74), it has the advantage of been least affected by salinity. Indeed, this variety had more of the qualities of resistance to abiotic stress, and other qualities like resistance to yellow berry mentioned by Benedji and El Gazzah (2008). The local variety Mahmoudi held the index of tolerance to stress the most important whatever the intensity of stress was. The slowdown of apical development was observed during severe stress. The maximum tolerance of this variety was fairly high> 5g / l. Similarly, the vital functions of the plant did not seem affected at above 10 g / l. This variety is almost an abandoned crop. The cultivar "Alia," seems to be a genotype with many distinguished agricultural interests over older varieties; was low affected by salinity and whose importance is similar to that of improved varieties (NGE = 14 and PMG = 55 , 55). The development and growth does not seem much affected by salinity; applied to juvenile stages. However, the response of this cultivar was not very homogeneous (standard deviation is, for example, 6 for total height and 6.5 for the number of grains per spike), which could be explained by the heterogeneity of the latter.

A selection study in this cultivar would certainly lead to purification of it and a fixation of its potential.

This work also enabled us to test the validity of juvenile stages (some parameters that are measured) to evaluate the stress tolerance of the genotypes studied. And it appears, from the canonical analysis made primarily on the basis of parameters measured at tillering stage and on the basis of those measured at harvest that it is possible to reliably assess at this early stage, the tolerance of these genotypes to stress. Indeed, the distribution revealed by the analysis in the early development cycle is like that shown at harvest. Similarly, the dendrogram deduced from Mahalanobis distances calculated on the basis of parameters measured at tillering was able to distinguish the variety Mahmoudi in a lot of the varieties studied; distinction was proved similarly, from the dendrogram deduced from Maha-lanobis distances calculated on the basis of the parameters measured at the end of the development cycle. This could consist in an important time and space gain in breeding programs. Some old Tunisian varieties, almost completely abandoned from crops compared to new and standard productive varieties were more resistant to stressful conditions. Their conservation in gen banks will not preserve their dynamic evolutionary adaptation to their environment in those climate changing times. Frankel and Soule (1981) and Ceccarrelli (2007) observed the inadequacy of management exclusively static (ex situ collections, or reserves) to agricultural biodiversity. Genotypes such as Chili and Biskri or Mahmoudi benefit from being promoted to farmers (particularly the poorest among them) to ensure, in addition to *ex situ* conservation in gen banks, dynamic conservation *in situ*. This would either enhance the adaptive capacities of these genotypes or fitness for a mixed productivity and would preserve their dynamic aspect. The use of these genotypes may also, ensure moreover grain production not only for small farmers with low budget (integrated in social actions) but also nationally while valuing marginal land.

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