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Evaluation of Genetic Progress in New Selections of Durum Wheat (*Triticum durum* Desf.) Under Semi-Arid Conditions (Algeria).

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ABSTRACT

The present contribution, control at the station of the agronomic research of El Khroub (Constantine), was fixed for objective, the selection for the tolerance with the abiotic stress at durum wheat (*Triticum durum* Desf.). It related to the follow-up of the physiological and biochemical behavior of 15 selections, which were evaluated in an experimental device in blocks completely randomized with four repetitions and elementary plot of 12 m². The preliminary results highlight a great genotypic variability, the tolerant genotypes with the stress present in the area; minimize the fall of the yield thanks to important accumulations of soluble sugars and proline. The values of the cellular integrity are strongly correlated with the concentrations of osmoticums, whereas the tolerance with the hydrous stress is rather related at the speed of water epicuticular loss and to the wax deposit on the foliage. Taking account of the information brought by these connections, it is possible to select tolerant and productive genotypes.
Keywords: Durum Wheat, Abiotic Stress, Adaptation, Grain Yield, Selection.

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INTRODUCTION

The climatic characteristics of the cereal zones are such as the durum wheat culture is exposed to various stresses which reduce discountable output and generate the variability of the production from one year to another and of one area to the other. The improvement of the production on the level of these zones or at least its stability in the immediate future can be conceived through the search for new more adapted varieties, which react positively to the assessment of the climatic variations to give an acceptable yield to each harvest.

The introduction of the high-yield varieties to give a new rise to the national production, ace not led to the anticipated results. These varieties being selected for more favorable and more regular mediums, appeared little adapted to the variable strong conditions, of the zones of setting in culture. The selection of durum wheat (*Triticum durum* Desf.) is done currently at the Technical Institute of the Field crops starting from the introductions coming primarily from the European countries like Italy, France, Greece, and Spain.

The selection aims at varieties to the acceptable potential of production and which are characterized by a broad adaptation, to minimize the production decreases at the time of the difficult years.

The varietal selection is practiced on the basis of yield in grain. The results of several studies agree to show that the yield in grain is a very variable character, subjected to high interactions genotype X place and presents a coefficient of rather weak heritability [1].

It is necessary however to determine those which seem most dominating on the level of each environment where the selection is practiced. The hierarchization of the characters interest is desirable, to take into account only those which have major effects. Considering the existence of a multiplicity of characters candidates to the realization of a better stability of the yield in grain, it is necessary also to check the effectiveness of the variables retained like characters really able to play an effective part in the stability of the production [2].

The present contribution proposes as objective to evaluate the behavior of the new durum wheat selections (*Triticum durum* Desf.) made by the Station of the Agronomic research of El Khroub, compared to the witness of reference, to identify the changes obtained in the physiology, biochemistry and agronomy of the plant, following act of selection and to determine the most important characters, that it is necessary to cumulate for the selection of productive and stable genotypes.

MATERIAL AND METHODS

Localization of the experimentation

The study was led to the Station of the Agronomic research of El Khroub, located at the contact 36° 38 N and 4° 17 E at an altitude of 640 m. The zone is characterized by a cold climate in winter, dryness and heat in summer, representing the interior plains telliennes. Average annual pluviometry borders the 500 mm.

Characteristics of the soil

The soil of the station calci-magnesic is carbonated, brown surfaces some and brown in-depth ochre. Granulometry is a little finer, limestone rich person, the rate of clay varies from 32 to 42% along the profile from 0 to 120 cm of depth. Dominant texture is silty clay. The average of the holding capacity for water is of 30%. It is a soil deep, of a slope from 3 to 5%, difficult to work when it is wet. The cation capacity of exchange is average with strong through the profile. The rate of saturation reaches the 75% including more than 50% occupied only by the ion calcium.

Installation of the experimentation

The experimentation set up consists of 15 genotypes (Table 1) of durum wheat (*Triticum durum* Desf.). These varieties result from a local selection multi made within the framework of the project Wanadin (West Asia and North Africa Durum International Network) led in Algeria, jointly by the Stations of El Khroub, Setif, Sidi Bel Abbes and Tiaret. Vegetable material is sown on elementary plot of 12 m²; the experimental protocol consists of blocks completely randomized with 4 repetitions. The experimentation was installed on a plot whose farming precedent is a fallow.

Table 1: List of genotypes evaluated on the experimental site.

Order	Pedigree	Origin	Randomization			
1	Ada/Dui//Simeto	Italy	1	13	8	3
2	Ada/Dui//Fotore	Italy	2	14	7	10
3	Mbb/Lahn's 1	Local	3	12	6	15
4	Mbb/Lahn's 2	Local	4	15	10	7
5	Cirta	Local	5	9	5	2
6	Fen//Ada/Duilo	Italy	6	1	14	4
7	Hedba//Awl2/Bit	Local	7	3	11	14
8	M1084	Local	8	2	12	6
9	Derraa	Syria	9	4	1	13
10	Waha	Local	10	5	2	12
11	Msbl2	Syria	11	7	4	12
12	Quadelete	Italy	12	6	3	1
13	Camadi abou1	Syria	13	11	9	9
14	Ada/Pr//Ofanto	Italy	14	8	5	5
15	Mrf3	Syria	15	10	13	11

Work on this plot were deep plowing followed by two passages, the first with the cover crop and the second with a farmer to take over plowing and prepare the seedbed. The plot has received basic fertilizer (P_20_5) right before sowing at a rate of 1 q/ha. The contribution of the nitrate fertilizer, ammonium sulfates at 1.5 q / ha and chemical weed control were carried out at the stage tillering.

Parameters analyzed

To characterize the studied genotypes, of measurements were made on the physiological, biochemical and agronomical characters all the way along development cycle of the plant.

- Foliar turgescence (TF, %) was given at the heading stage by the formula of [3].
- The leaf aera (SF, cm ²) is determined by the formula of [4].
- The speed of loss of the water of the sheet per minute (VDE, mg/mn/cm ²) is calculated by the method of [5].
- The rate of wax (TC, µg/cm ²) was given on a sample of 4 sheets taken by elementary plot; at the heading stage [6].
- The cellular integrity (IC, %) was given on a sample of 3 sheets per elementary plot, by the formula due to [7].
- The proportioning of the proline (Pro, fresh weight mg/100mg) was given according to the method allotted to [8], modified by [9].
- Soluble sugars (Suc, fresh weight mg/100mg) are proportioned according to the method of [10], based on the anthrone diluted in sulphuric acid like reagent.
- The yield in machine grains (RDT g/m²) was given following the harvest of the experimentation with the reaping machine threshing-machine.

Data statistical analysis

The data collected for the various measured parameters were processed by an analysis of variance with one classification criterion, according to the additive model [11]. The coefficient of the heritability in the broad sense (H ² sl) of the analyzed characters was estimated by the formula from [12] and the genetic profit expected (GGA) in selection, on the basis of a given nature, was calculated by the formula allotted to [13].

Climatic characterization of the year of study

The study campaign recorded a total rainfall of 288.8 mm, for the period September to June, corresponding to the cycle of the plant. Analysis of the distribution of the rain, according to the seasons of winter and spring, can provide information on the differential behavior of the studied varieties.

Taking the monthly office plurality of 40 mm as being an acceptable threshold, allowing on the soil to store sufficiently water; year of experimentation is characterized by a dry autumn, one rainy winter and a spring of which March was marked by an almost total absence of rain. Year of experimentation was slightly colder during the winter. The number of days of hoarfrosts was 52 days; it became hotter as from May. The vegetation of this year thus was doubly penalized by the hydrous deficit and the rise in the temperature at the end of the cycle.

RESULTS AND DISCUSSION

The analysis of the variance of the variables measured on the experimentation carried out reveals significant genotypes effects for the unit of the characters subjected to analysis (Table 2). The dimension of the squares average associates with genotype effect indicates a strong phenotypical variability. Part of this variability, of genetic cause, is available for the selection inside evaluated vegetable material (Table 2).

Table 2: Mean square deviations of the analysis of variance of the measured characteristics among 15 genotypes evaluated at the experimental site.

	Sources of variation			
	Total	**Genotype**	**Block**	**Residual**
Characters/ddl	59	14	3	42
TF	12.49	27.60*	3.32	8.11
SF	3.62	12.11*	2.28	0.89
VDE	5.97	15.21*	2.25	3.16
TC	1.13	4.64*	0.01	0.05
IC	71.18	219.59*	71.57	21.69
Pro	0.03	0.016*	0.00	0.00
Suc	5.07	20.89*	0.27	0.15
RDT	3230.79	10128.24*	647.37	1116.17

* Significant genotype effect at the 5%

Table 3: Differences of averages compared to those of Waha control for traits measured in the 15 varieties studied on the experimental site.

N°	Genotypes	TF	IC	TC	VDE	Pro	Suc	SF	RDT
1	Ada/Dui//Simeto	-0.17	-9.08	-0.97	+1.4	+0.58	+6.12	-0.08	+156
2	Ada/Dui//Fotore	-4.3	+8.25	-2.5	+2.3	+2.3	+0.1	+5.4	+5
3	Mbb/Lahn's 1	-3.7	-11.33	-2.6	+2.6	+0.5	+5.3	+1.6	+133
4	Mbb/Lahn's 2	+0.4	+3.75	-1.4	+0.5	+0.4	+3.8	+0.5	+88
5	Cirta	+1.4	-2.85	-0.7	-1.2	+0.5	+2.1	+1.0	+6
6	Fen//Ada/Duilo	-3.4	-2.39	-2.5	+1.8	+0.3	+2.2	+1.8	+66
7	Hedba//Awl2/Bit	+2.6	+8.68	-0.8	-2.8	+0.1	-0.8	+1.4	+48
8	M1084	-0.8	-14.83	-2.1	+1.2	+0.2	+5.7	+2.9	+158
9	Derraa	-1.1	+0.40	- 2.3	+1.1	+0.2	+3.8	+2.4	+158
10	*Waha (control)*	*80.3*	*37.60*	*4.11*	*11.4*	*0.36*	*4.41*	*11.2*	*228*
11	Msbl2	+3.3	+3.21	-1.2	-2.4	+0.5	+3.7	-1.2	*228*
12	Quadelete	+0.3	+9.21	-2.3	+0.4	+0.3	+0.7	+2.0	+52
13	Camadi abou	+2.7	+4.15	+0.5	-2.7	+0.2	-0.4	-0.2	+36
14	Ada/Pr//Ofanto	-0.6	+3.59	-2.7	-0.7	+0.3	+1.6	+0.5	+63
15	Mrf3	+4.7	-6.66	-0.2	-2.9	+0.5	+3.0	-1.3	+93
Average experimentation		80.3	37.15	2.63	11.3	0.73	6.89	12.3	300
Lsd5%		3.36	5.50	0.26	2.1	0.00	0.45	1.12	44.9

The general average of each one of the analyzed characters, that taken by the characters of the cultivar Waha, the control of reference, as well as the differences between the averages of the studied varieties and the average of Waha are given to table 3.

Studying the cycle of development of the typical varieties of durum wheat, [14] found that the variety Waha is as a variety of reciprocating type, very sensitive to accumulated degree-days, especially during the early stages of its development. Such behavior indicates that as soon as he makes quite warm, the plant shortens its development stages, including the vegetative phase, to quickly complete its cycle. This variety can therefore serve as a control for the adaptation strategy based on dodging.

The selections Ada/Dui//Simeto and M1084 accumulate high quantities of proline and soluble sugars, with respectively 0.94 and 0.95 for the amino-acid, 10.53 and 10.17 for glucids. The weakest accumulation of these osmoticums was announced at Ada/Dui //Fortore for the first variable and Hedba3 /Awl2//Bit for the second, with respectively 0.35 and 3.56 mg /100 Mg fresh weight. Various authors, [15], [16], [17], [9], [18] consider that the accumulation of proline is a character with sufficient heritable variations to allow its use in selection for the tolerance the drought at most cereals.

The relations between the capacity of accumulation of proline and the yield are however complex. Whereas more the share of the authors conclude that a strong accumulation of proline is frequently the fact of tolerant cereal genotypes to the drought [19].

Phenotypical variability is also measured by the coefficient of variation, in % of the average of each variable; the character which has less variation is the foliar turgescence (Table 4). The coefficients of the genotypic variations are slightly lower than the phenotypical coefficients of variation, highlighting the weak action of the medium on the expression of the genotype.

Table 4: Values of genotypic coefficients of variation (CVg) and phenotypic (CVp), heritability (h^2) and expected genetic gain selection (GGA) characters measured in 15 genotypes evaluated on the experimental site.

Characters	Cv_G (X)	Cv_P (%)	h^2 (%)	GGA (%)
TF	2.74	3.26	70.68	4.74
SF	13.56	14.08	92.71	26.90
VDE	15.28	17.17	79.21	28.01
TC	40.60	40.77	99.13	83.25
IC	18.93	19.94	90.12	37.01
Pro	27.40	27.40	100	56.44
Suc	33.03	33.12	99.42	67.83
RDT	15.8	16.76	88.9	30.7

Moreover the heritability in the broad sense is high and higher of 70% for the whole of the analyzed characters, confirming the little of influence of the medium of production for this countryside on the expression of the potential.

The heritability of a character indicates its answer to the selection; it is dependent on the genetic variability and the importance of the effects of the sudden environment by the measured character [20]. The coefficient of heritability is calculated by the report of the genetic variance on the genetic variance on the phenotypical variance. The genetic variance and the sum of the variances of genetic cause and interaction genotype X environment. [21] show that the component of very high interaction often in value, reach sometimes more than 70% of the total genetic variance. A variance of high interaction is indicating little of resemblance between environments so that a given character, measure to two environments, behaves like two different characters.

Only the characters rate of wax, content of proline and soluble sugar rates have a high heritability associate with high genetic profits higher than 56%. This fact these characters can be the object of attempts at early selection to make evaluate their phenotypical averages. A strong heritability associated with a high genetic profit is mainly due for purposes of the additive types [22].

The selection is more effective if it is made on the basis of character which has raised an enough coefficient of heritability, therefore undergoing the action of the medium less. It is also more effective, if it is carried out on vegetative material which is fixed essentially genes controlling the characters under selection. Thus the effectiveness of the selection is dependent on the genetic variability which is put at the disposal of sport selector, the more important the latter is, and the more the selection is likely to be effective. It is dependent also on the selected characters and the environment of selection.

Foliar turgescence is positively related to the content of wax (R^2=0.74**) and negatively correlated with the speed of loss water epicuticular (-0.92**); the latter is negatively related to the content of wax (R^2= -0.70**) (Table 5). Concentrations of the proline and soluble sugars, positively dependent between them (R^2=0.79**), are correlated negatively with the median values of cellular integrity, and positively correlated with the yield (Table 5).

Table 5: Coefficient matrix of phenotypic correlations between pairs of traits measured.

	TF	IC	VDE	TC	PRO	SUC	HT	SF	VEG	RDT
TF	1									
IC	0.15	1								
VDE	-0.92	-0.32	1							
TC	0.74	0.04	-0.70	1						
PRO	0.18	-0.64	0.02	-0.13	1					
SUC	-0.17	-0.79	0.42	-0.31	0.79	1				
HT	-0.06	-0.23	-0.05	-0.02	-0.48	-0.11	1			
SF	-0.75	0.12	0.66	-0.64	-0.34	-0.10	0.28	1		
VEG	-0.71	-0.19	0.58	-0.53	-0.23	0.09	0.30	0.75	1	
RDT	-0.16	-0.78	0.38	-0.26	0.71	0.82	0.29	0.02	0.16	1

The present one of wax increases turgescence and reduced losses water epicuticular, accumulation of the proline, soluble sugars and the reduction of the damage caused with the cellular membrane by the heating constraint are associated with a better expression of the yield in grains and its components. [23] report that the osmoregulation is an important component of the tolerance to the hydrous deficit whose consequences are water content relative more important and a speed of loss of rather weak water. According to [24], the genotypic capacity of production of wax is conditioned by two loci (Bm_1, Bm_2) with recessive state.

These results are in conformity with those reported by [25] and by [26] which find a correlation negative between the yield in grain and the values of the test of the cellular integrity. They diverge however from those of [27, 28] which do not find relations consistent between the values of the test of the cellular integrity and the productivity of the plant. The absence of significant correlation between the cellular integrity and foliar turgescence joined the results of [26] which mention that the genes which control the tolerance with the thermal stress are different from those which control the hydrous stress. According to [29], high relationship between soluble sugar content and the damage cell membranes, show that maintaining a relatively high accumulation of the glucidic reserves can constitute a warranty for the maintenance of a high cellular integrity.

The productivity at the studied genotypes is associated with the tolerance; this tolerance is especially assured by a strong accumulation of proline and soluble sugars. A capacity of accumulation and transfer of the glucidic reserves is associated with the tolerance with the hydrous constraint [30].

CONCLUSION

The study of the physiological, biochemical and agricultural variability of a collection of 15 durum wheat genotypes (*Triticum durum* Desf.) led over one year, highlight the existence of a great phenotypical variability within the vegetable material evaluated for the unit of the analyzed characters; what explains the behaviors very different from the lines opposite to the stress present. The coefficients of heritability and the genetic profit expected in selection are very consequent, stating, that appreciable progress can be made in selection of the measured characters.

The advantage of the output in grain at the new selections compared to the local control Waha is done following complex combinations between the determining characters. The selection is easy, if one has information concerning the latter, while controlling the variations and to maintain the averages on acceptable levels to improve the output in grain indirectly.

The results of the tests carried out, indicate existing genotypic answers with respect to the stress. The tolerant genotypes are dissociated by strong accumulations of proline and soluble sugars. New obtainings bring important change as regards tolerance and productivity. The profit is more consequent with the adoption of the M1084 genotypes, Ada/Dui// Simeto, Derraa and Mbb/lahn's'1, what shows that there is a possibility of selecting tolerant and productive lines, for little information concerning the behavior with respect to the stress is taken into account during selection process.

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