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Research On The Technological And Genetic Potential Of Durum Wheat In Algeria (Triticum Durum Desf)

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Abstract :

The present research was concerned with the evaluation of the genetic potential of 20 durum wheat varieties in Algeria by certain biochemical and technological aspects. The aim of this study is therefore to identify and select wheat varieties which are potentially productive in agriculture and which are also characterised by good adaptation, yield stability and production of cereals of good technological and nutritional quality. The different varieties studied indicate the presence of a great variability due to the agro-climatic conditions of the environment; Nevertheless not all genotypes react in the same way some of them are particularly advantaged or on the contrary disadvantaged by certain cultural conditions. The results obtained show the presence of inter-genotype variability for all parameters of technological quality. The protein content at 11% humidity varies from 18.4% in TP/GD/SW which is however a cross, up to 20.1% in the two local varieties Bidi 17 and Hedba 03, Although the germplasm used is quite diversified, between local varieties, improved and introduced, significant variability in protein levels has been recorded within the genotypes studied. In fact, protein content is a low heritability trait and strongly influenced by environmental conditions and cropping practices.Our data for local varieties showed excellent results that have emerged for protein content with little mitadinage in grains, high grain weight and appreciable yields (Exemple : Gemghoum R'ekham and Hedba 3) The introduced varieties show very appreciable results for yield, specific weight With very low speckle and mitadinage levels and average protein levels.(Example: Montepellier variety and Capetit variety 8). Good yields and high grain weights characterising the Simeto, Vitron and Cirta varieties as well as the Daki variety which is well expressed and shows a good yield . we also know that the best qualities are found in local varieties.

Keywords: Durum wheat, technological quality, germoplasm, genetic.

INTRODUCTION

Wheat (triticum sp.) is the main cereal produced ,consumed and processed in Algeria .Since the 1960 s, breeders have focused their efforts on improving traits associated with grain yield such as water stress tolerance ,frost and disease resistance ,and yield components (Benbelkacem A ,2013) National

production hs gradually increased to meet the reuirements of the demographic growth of the local population ,rising to 3.98 Mt in 2018 morethan 0.68 in 1961 .(FAO,STAT,2020).This remarkable progress achieved in terms of performance has not were also effective in improving technological quality.The quality of wheat is determined by several physical ,chemical and rheological properties.the reserve protein content and composition (about 80%) of total protein of wheat grains are the main factors determining the quality of wheat processed into food products (Shewry et al.,2002) .The introduction of high-yielding varieties has caused the disappearance of many local Algerian varieties caracterized by their adaptation to the environment (Bouzerzour et al., 2003) .The main objective of wheat breeders remains the development of wheat varieties characterized by yield, adaptation to contrasting environments, resistance to different stresses and acceptable seed quality. The improvement of the yield and quality of durum wheat requires the creation of varieties and the identification of traits that are linked to the mechanisms of adaptation to environmental constraints. The trait most used in breeding is yield itself, this direct selection has proven to be, most often ineffective in identifying adapted genotypes (Adjabi et al., 2014).In this context, our study aimed to evaluate the variability of a collection of durum wheat varieties grown in Algeria and to analyze the genetic relationship between them, based on technological and biochemical characteristics. The conclusions drawn through this study allow us to select performing genotypes and to identify their potentialities in yield and technological quality.

METHODS AND MATERIALS

Study area: In this study, the plant material evaluated consists of 20 varieties of durum wheat (Triticum) local and improved .The name; pedigree and origin of varieties are shown in Table 1. The field trial was conducted during the 2015-2016 crop season at the experiment station of the technical institute of the field crop (ITGC) in Guelma, Algeria (Altitude: 272 m, latitude :36°05 00N ,Longitude :007° 04 E). the region has a sub humid bioclimatic characterized by mild and rainy winter, has not dry summers and low annual rainfall (400-600 mm); during this campaign, large amount of the order of 186 mm fell between November and January which allows a good start of the vegetation .During the tillering –heaving stage, a unit of the order of 88 mm was recorded during the heading stage, judged to be very significant. However a fraction of the order of 12 mm was marked during the other vegetative stages including the critical stage of durum wheat .The trial was conducted in a complete random block with 3 repetitions .each variety is sown in six rows 1 m long spaced 20 cm, either an elementary plot 1.2 m^2.

Table 1: List of experienced durum wheat varieties (Abdelguerfi and Laouar, 2000; Yekhlef and Djekoun, 2000).

Variety	Origin	Region
V1 Guemgoum R'khem	Local selection	ITGC /Tiaret
V2 Chen's'	ICARDA	ITGC
V3 Hedba 03	Local selection	ITGC / El khroub
V4 Haurani	ICARDA	-
V5 Bidi17 /Syrica	(1995-1996),Algeria	ITGC / El khroub
V6 Capetit 8	Italy	ITGC
V7 TP//Gd/Sw	(1993-1994),Algeria	ITGC
V8 Mrb17	Syria, ICARDA	ITGC/ Sidi Bel Abbes

V9 Bidi 17	Spain	ITGC
V10 OZ / MRB SH	Algeria	ITGC
V11 Gta dur	Mexico, CIMMYTE	ITGC/ Guelma
V12 Montpellier	France	ITGC
V13 Chen's' /Auk	Syria, ICARDA	ITGC
V15Mohammed Ben Bachir	(1931) Local selection	ITGC/ Sétif
V16 Daki	Syria ,ICARDA	ITGC
V17 Waha	Syria,ICARDA	ITGC /Sétif
V18 Cirta	Algeria	ITGC / El khroub
V19 Vitron	(Spain)Semillas Batlle SA	ITGC/Tiaret
V20, Simeto	Italy - Caltagirone Station	ITGC /Tiaret

2. Parameters studied

2.1. Thousand grain weight: The thousand grain weight (GW,gr) was counted by the grain counter and weighing of 1000 seeds for each variety ,after elimination of impurities and broken grains .Three repetition for each variety .

2.2. Grain moisture: The moisture content of the grains was determined according to the method described by the Algerian standard 1333/1990-ISO 712, by drying in an oven at atmospheric pressure, set at 130 C° with a test sample of 5 gr for 1 hour and a half .The mass loss is the amount of water present in the sample. The moisture content expressed as a percentage (H %) by mass of the product as given by the following formula: H (%) = (m – m1) X 100 / m. where: m is the mass of 5 gr of the grains, and m1 is the mass of the grains after parboiling.

2.3.Mitadinage rate : Insert the grain cutter plate ,pour a handful of whole grains on the grid then shake so that a grain is placed vertically in each cell and close the lid to keep the grains sliced .we proceed to select it slowly from all the grains. Remove the plate carefully and then count the number of mitadine grains.each grain is given a degree according to the mitadine (0.25, 0.50, 0.75, 1) and the some of the degrees is calculated and expressed as a percentage in relation to 150 (Afnor, 1982) .The scattering rate according to standard NF V03 -705 ,is expressed according to the formula : **M = Σ D x 100 /150.** Where : D : the degree of ratting for each trial.

2.4. Protein content: The protein level was determined using the Perten type Inframatic . The principale of the analysis method (Algerian standard ISO/5529-1992) is based on the use of infrared radiation .It is then sufficient to 50 to 100 gr of the crushed raw product ,one minute later ,the results are displayed on the screen of the device .

2.5. Wet and dry gluten content : Gluten is a main component of the protein fraction of wheat, insoluble in saline solutions, it is a plastoelastic substance. It is considered as a means of estimating the quality of the paste (Algerian standard NA735/1991/ISO5531). The gluten content was determined according to the protocol of Mauze et al.The principle consists in grinding 10g of wheat, to which we add 5 ml of salted water and using a spatula a dough is formed. Gluten extraction is then carried out by manual leaching under a thin stream of water. The resulting wet gluten is drained, and then reweighed and then weighed. Wet gluten (GH, %) expressed as a percentage by mass according to the formula: where: m represents the weight of gluten and the 10 is the test intake. After drying the wet gluten and using the Glutock, for 3 to 5 minutes, we obtain the weight of the dry gluten (Algerian standard NA735/1991-ISO6645). The dry gluten (GS, %) is expressed as a percentage of the masses

relative to the dry matter and is given as follows: , where: m is the weight of dry gluten and the 10 is the test intake.

2.6. Grain yield (qx/ha) : After the harvest, the yield is calculated for each elementary plot (length 1 m and width 1.2 $m^{2)}$ and converted into qx/ha.

2.7. Specific weight (Kg /hl) : the specific weight is the mass per hectolitre ,it corresponds to the mass of wheat contained in a hectolitre filled with grains ,impurties and interstitial air (NA,1513/1990 . this uick –to- implement commercial criterion is considered to be an indicator of the semolina value in relation to the shell to kermel ratio and the heigher the semolina yield. The minimum value for intervention is 78 kg/hl.

3. Statistical analysis of data : the data obtained were processed by an analysis of variance,with a studied factor.the comparqison of the means of the treatmrnts is made on the basis of the calculation of the smallest significant difference at the threshold 5%(Ppds5%), Morphological diversity was performed by principal component analysis (PCA).

These parameters were calculated using the stat box version 6.4 data analysis and statistical processing software.

RESULTS

1. Weight of a thousand grains: The average value of GW is 31.91 gr very appreciable values. The Vitron variety rises to the top of the classification with a weight of thousand grains of 44 gr Concerning the weight of a thousand grains and according to our results figure1, the varietal means allow us to disting three groups of varieties:

- Hardy varieties, whose yield is higher than or close to the mean of the test under difficult conditions, but much lower than the mean under favourable conditions. These are local varieties such as V2, V5, V8, V11, V14 and V16.
- Varieties with so-called intermediate behaviour, whose yields are close to the average PMG of the test, we find in this group varieties such as V4, V8 and V13.
- Productive varieties with wide adaptation, characterised by above average PMG values and by a very good response to the optimisation of environmental conditions, the varieties corresponding to this behaviour are V3, V11, V18, V19 and V20.

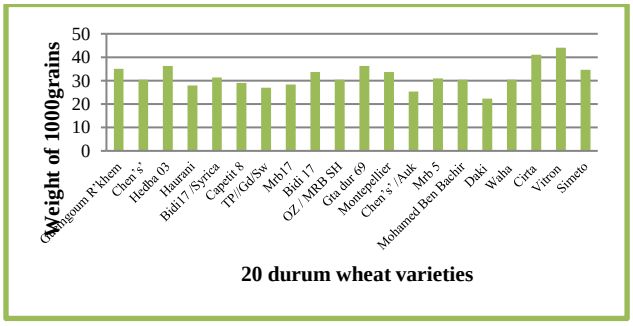

Figure 1: Weight of 1000 grains (gr) of the 20 durum wheat varieties

2.2. Grain moisture: the different humidity values recorded are almost similar; the varieties have a moisture percentage between 11 and 13.2 %. The lowest value 11 % recorded in the TP//Gd/Sw and

Bidi 17 varieties ,repectively .While the highest humidity rte is marked in the Cirta variety and the simeto variety with 13.2%.

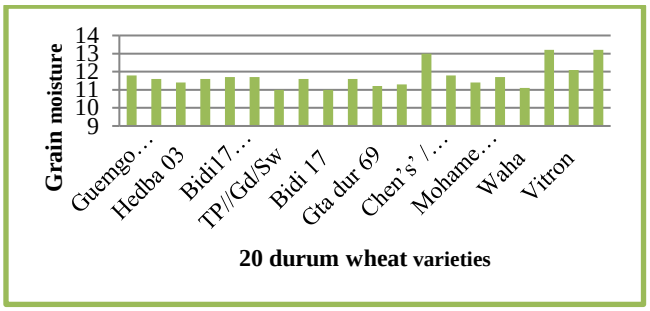

Figure 2 : Grain moisture (%) des 20 variétés de blé dur

2.3.Mitadinage rate : The results of the mitadinage rate for all the varieties studied are given in Figure 3:The lowest rate is represented by the Cirta variety with an average rate of 0.08%, followed by the TP//GD//SW variety. On the other hand for the highest rates are those of Capetit with 8.83% and Chen's with a rate of 8%.

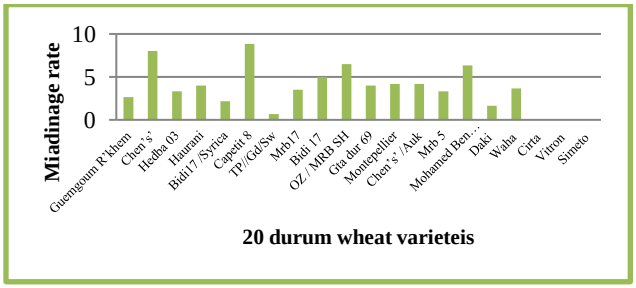

Figure 3 : Mitadinage rate (%) of the 20 durum wheat varieties

2.4. Protein content: The results show values between 15% (the Cirta variety) and 20.1%(the Hedba 03 variety and the Bidi 17 variety). With the exeption of the Hedba 03 variety and the Bidi 17 variety which are characterized by a very high protein value (20.1%, the other varieties have contents consistent with those cited in the standards (Benbelkacem et al ,1995).

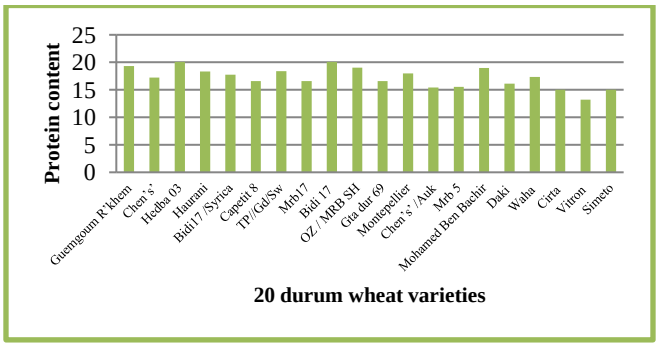

Figure 4 : Protein content (%) of the 20 durum wheat varieties

2.5. Wet and dry gluten content : The wet gluten content is given in the following figure 5. Values ranged from 2.99% to 7.13% for Chen's/Auk and Bidi 17 respectively. Quantitatively, the wet gluten content of all varieties is well below the Delachaux standard of 27.85% in 1983.

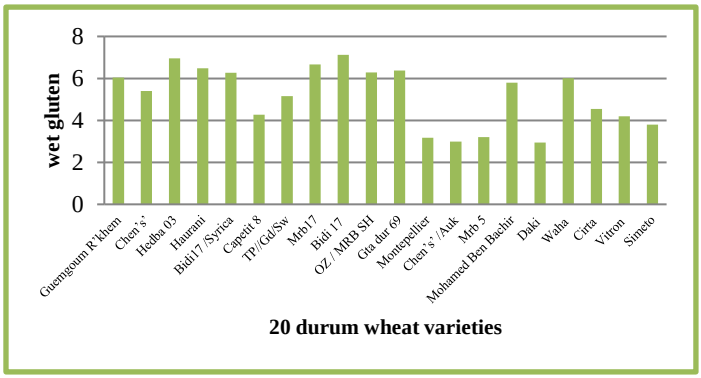

Figure 5 : Wet gluten content of 20 durum wheat varieteis

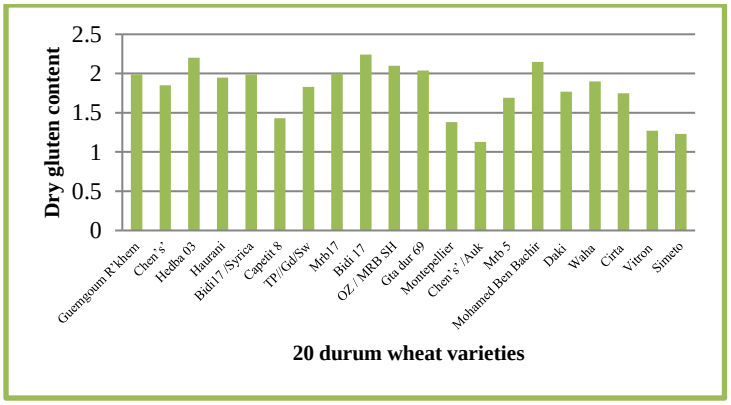

Figure 6 : Dry gluten content of 20 durum wheat varieteis

The results obtained in Figure 6 show that dry gluten levels range from 1.13% (Chen's' /Auk) to 2.24% (Bidi 17). These values are significantly lower than the standards cited by Lecoq (1965) and which place dry gluten between 8% and 12%.

4.1.6. Grain Yield (qx/ha) : The average yield of the lines evaluated varies from 28.66 qx/ha value noted in the local variety Guemgoum R'khem with 28.66 qx/ha, the Simeto variety has the hignest yield. Mong the parental lines used in crossing Oz /mrb Sh records a low grain yield with a value of 11 qx/ha.

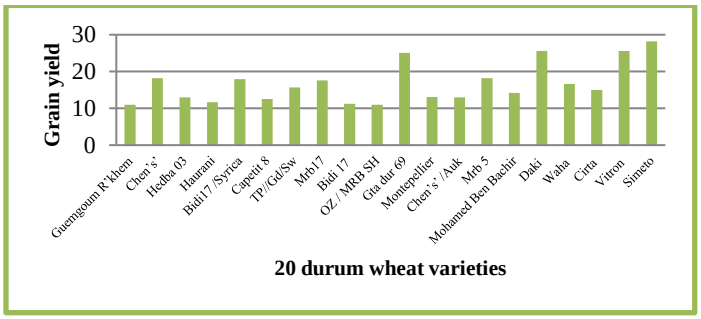

Figure 7 : Grain yield (qx/ha) of 20 durum wheat varieteis

4.1.7. Specific weight : Specific weight values vary between 85.34 and 55.05 kg /hl. This gives great variability for semolina quality. The highest value is marked in the Hedba 03 vriety with 85.34 kg/hl. On the other hand, the lowest rates are those the V9 variety and the V13 variety with a rate of 66 and

55.05 kg/hl. According to thestandrd established for specific weight control wheats are classifed as first quality (80-83 kg/hl) or second quality (77-79.7 kg/hl) .Thus ,our studied varieteis present first quality durum wheats such as Guemgoum R'Khem ,Hedba 03 and Vitron. On the other hand, the varieteis which have lower .Specific weight of (79.08 kg/hl) are second quality wheats such as Chen's' /Auk ,Capetit and Hourani .According to the classification of ERIAD (1984a),these varieties are classified like heavy wheat.

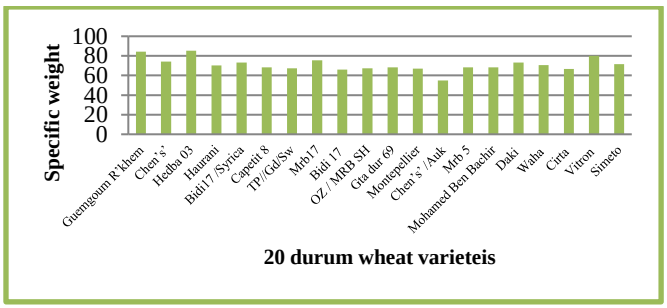

Figure 8 : Specific weight (kg/hl) of 20 durum wheat varieteis

DISSCUSSIONS

1. Phenotypic variability: The analysis of variance (ANOVA) revealed a significant ($p< 0.05$) and very highly significant ($p<0.001$) 'genotype ' effect for all the variables measured (Table .These results indicate the presence of a fairly sighnificant varibility between the genotypes studied .The value taken by the coefficient of variation are low, varying from 3.14% for the weight of 1000 grains to 22.02 for the grain yield (Table 2)

Table 2 : Mean squares of the analysis of variance of the variables studied

SV	ddl	GW	Hum	Mit	Prot	WG	DG	SP	Yield
Repetition	2	0.04	0.03	0	0.07	0.16	0.33	0.01	0.007
Variety	19	0***	0***	0***	0***	0***	0***	0***	0***
Error	38	1.00	0.05	0.69	0.06	0.33	0.17	0.22	45.36
CV(%		3.14	0.46	69.6	0.37	6.30	9.70	0.32	22.02

SV: Source of variation, ddl: degree of freedom, GW: Weight of 1000 grains, Hum: Grain moisture Mit:Mitadinage ,Pro: Protein content, WG: Wet gluten, GS: Dry gluten, Ps:Specific weight, Y: Yield (x/ha , CV: Coefficient of Variation, * and ***: Significant and very highly significant differences at the 5% and 0.1% thresholds, respectively.

1.1.Weight of a thousand grains : the thousand grain weight is generally diffuclt to control.because it is strongly linked to the effects of environment at the time of grain formation and filling a lack of water after flowering combined with high temperatures (frequent conditions in Algeria),leads to decrease in the weight of thousand grains by altering the speed and or the duration filling .,which results in the scalding of the grains (Zouaoui,1993 : Chaker ,2003). The analysis of varince showed a very highly significant effect.the size of the seed is an essentially varietal characteristic (Gegas VC et al ,2010).

1.2. Grain moisture: These water contents are substantially idential to and lower than the maximum value required by Codex STAND 178-1991 (14.5%), so all the varieties are within the standard for the

percentage of humidity. This content also tells us about the amount of water to add to bring the grain moisture to 16.5 % in order to have a good extraction rate during milling (Delwiche SR, 2000).The slight differences observed may be due to several parameters including ,varietal differences ,soil types ,seasonal humidity ,harvesting conditions and sample storage .

1.3. Rate mitadinage : the vitreousness is an importnt factor both in terms of grinding and approval .Starchy kernels are those that are badly damaged ,broken ,or from wheats of other classes.Fractionating is closely related to late nitrogen nutrition (pre and post –flowering) and the resulting protein composition of grains.

1.4.Protein content : The protein content of the grain of durum wheat is the most important criterion for the appreciation of the quality, this content is conditioned according to (Feillet, 2000). On the hand by the genotype factor and on the other hand by the cultural conditions.

1.5. Gluten content : Gluten content gives an overall indication of protein quantity and quality.It is composed mainly of two storage groups : gliadins and glutenins(Bushuk,1986. Perten (1989 generally considers that the elsticity of the dough is due to the gliadins and that the tenacity depends rather on the glutenins . Quantitatively, the wet gluten content of all varieties is well below the Delachaux standard of 27.85% in 1983. The high wet gluten content could be due to high water absorption. The more water the gluten absorbs, the greater the difference between wet and dry gluten and the higher the quality of the gluten.

1.6.Yield (qx/ha) : yield is an indicator of the productivity specific to each variety,it is the final objective of the selection process.It is a complex trait under polyenic control (Mc Neil et al.,1978).It is highly variable under the influence of environmental factors,hence its inffectiveness as a selection criterion (Moragues et al .,2006 ; Belhacene et al .,2006).It is determined directly by the product of the number of grains /m^2 and the weight of 1000 grains (Chennafi et al .,2006). The average yield of the lines evaluated varies from 28.66 qx/ha value noted in the local variety Simeto , to 10.94qx/ha for the variety Guemgoum R'khem. Mong the parental lines used in crossing Oz /mrb Sh records a low grain yield with a value of 11 qx/ha.

1.7. Specific weight :density ,known as mass per hectolitre, commonly known as specific weight ,is an old measure that dates back to the time when the uantity of grains ws mesured by volume. It presents a certain commercial interest :the density is always taken into account in the transactions although its technical interest is very limited .Specific gravity is widely recognized as a grading factor of primary importnce ,it remains useful as an index of semolina potential (Dexter and Edwards ,1998). Specific weight values vary between 85.34 and 55.05 kg /hl. This gives great variability for semolina quality. The highest value is marked in the Hedba 03 vriety with 85.34 kg/hl. On the other hand , the lowest rates are those the V9 variety and the V13 variety with a rate of 66 and 55.05 kg/hl. According to thestandrd established for specific weight control wheats are classifed as first quality (80-83 kg/hl) or second quality (77-79.7 kg/hl) .Thus ,our studied varieteis present first quality durum wheats such as Guemgoum R'Khem ,Hedba 03 and Vitron . On the other hand, the varieteis which have lower Specific weight of (79.08 kg/hl are second quality wheats such as Chen's' /Auk ,Capetit and Hourani .According to the classification of ERIAD (1984a),these varieties are classified like heavy wheat.

2.Analysis of inter character links : The phenotypic and genotypic correlation coefficients are important parameters in wheat breeding ,they are used to determine the degree of association

between pairs of measured traits .Whene the value taken by the correlation efficient is close to unity ;it is indicative of the dependence of the characters .in this case ,if we know the values of one of the two charcters ,we can predict the values of the other character , (Acquaah G. 2007). A correlation coefficient of Zero indicates, on the other hand,that the traits taken into consideration are independant of each other in the point of variation ,sot hey can be considered to be under the genetic control of independent genes (Garcia del et al.,2005).The correlation coefficients between the measured characters are givenin the table 4. More ever, Trentesaux (1995) deduces that if durum wheat semolina is rich in protein ,the better the culinary quality will be with appreciable values of the components of the yellow color . Also, the protein rate shows a negative correlation with the humidity rate and the yield,with a correlation coefficient and probability of (r= -0.65; p<0.01), (r= -0.68; p<0.01) ,so the portion rate acts positively on the quality parameters of durum wheat and increases the gluten content (Table 4) and decreases the rate of browning . the protein content appears to be the cornerstone of the technological variety of durum wheat.Indeed ,many criteria are highly dependent on it (mitadin,...) and itself very dependent on the nitrogen that can be used by the plant.It is therefor necessary to better understand the mode of development of the protein level and the environmental determinats that influence its stability (Hernandez et al .,2004). The rate of mitadin shows a negative correlation with a grain yield and a probability of (r= -0.49; p<0.05) respectively (Table 4) .A negative correlation was noted between wet gluten and humidity with a coefficiet and a pobability of ((r= -0.51; p<0.05) respectively (Table 4).

We alsoe find the thousand grain weight has a fairly strong inversely proportional relationship with the rate of scattering .this is also expected since these traits are both heavily influenced by the environment. At the level of the other parameters, there is no need to report any correlation since the rates are quiet low.

Table 4: phenotypic and genotypic correlation coefficient between the variales studied .

	GW	Y	MIT	PS	HUM	PROT	GH	GS
GW	1.00	0.18	-0.35	0.38	0.23	-0.22	0.14	-0.15
Y		1.00	-0.49*	0.16	0.26	-0.68**	-0.35	-0.12
MIT			1.00	-0.22	-0.39	0.41	0.22	-0.08
PS				1.00	-0.20	0.17	0.36	0.04
HUM					1.00	-0.65**	-0.51*	-0.05
PROT						1.00	0.66**	0.15
GH							1.00	0.29
GS								1.00

Statistical significance threshold *, p < 0.05; **, p < 0.01; ***, p < 0.001

Gw: Weight of 1000 grains, Y: Yield, MIT:Mitadinge, SW: Specific weight, Hum: Grain moisture, Pro: Protein content, WG: Wet gluten, DG: Dry gluten, Fat values differ significantly from 0 to 5% threshold.

CONCLUSION

The results indicate highly significant differences between the genotypes tested for all the characters measured. No genotype has the best values for all characters in the desired selection direction. The traits measured are highly hereditary, as indicated by the degree of genotypic determination in the broad sense and the index of variation, with the exception of grain moisture that remains under environmental influence. Although the genetic material used is very diverse, between the advanced local line and the introduced varieties, significant variability in protein content has been recorded in the genotypes studied. In fact, the protein content is a character with low heritability and strongly influenced by environmental conditions and cultural practices. The protein content at 11% humidity varies from 18.4% in TP//Gd/Sw which is however a cross, up to 20.1% in the two local varieties Bidi 17 and Hedba03.

Despite the significant differences in the resemblances and divergences in the behavior of the twenty genotypes with regard to the parameters studied, which make it possible to distinguish the local varieties and to classify them together in two groups, and the other varieties introduced in another group. These three groups diverge mainly by their yield, their protein content and their gluten rate (wet and dry). So mainly by their production potential and their technological quality.

The hierarchical classification has shown that despite the introduction of new varieties of wheat, with "high yield", the local genotypes (not very productive) remain the best adapted to the climatic conditions of our lands, and that agro-climatic factors have an influence very important on the color, the rate of speckling and the mitadinage of the grains of durum Wheat. Our data for the local varieties showed excellent results which appeared for the high protein content with a high weight of thousand grains and appreciable yields (Example; the variety Guem goum R'khem and Hedba 3)

The introduced varieties stand out very appreciable results for the yield, specific weight with very low speckling and and mitigation rates and average protein content (Example: the Montepellier variety and the Capetit 8 variety).
Good yields and high thousand grain weights characterizing the Simeto, Vitron and Cirta varieties as well as the Daki variety which expresses itself well and marks a good yield. We note that it is the local varieties that have the best qualities.
Genetic variability is important in the genotypes studied, which constitute an important sample of our genetic heritage of durum wheat. On the one hand, this study could help us better use distant relatives in our future crosses in order to broaden our genetic base.
On the other hand it makes possible to assess the behavior of these genotypes, compared to yield and technological quality parameters, to highlight the variety or lineage, which presents an ideal behavior both for production and for quality.

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