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RESEARCH ARTICLE

AGRO MORPHOLOGICAL CHARACTERIZATION AND STUDY OF GRAIN YIELD OF ALGERIAN DURUM WHEAT (*TRITICUM DURUM*.DESF.

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Abstract

Improvement and rehabilitation passes necessarily by a characterization step and a performance evaluation in view of future use. In this context, a collection of 26 accessions of durum wheat (*Triticum durum*.desf) was studied based on an assortment of agro morphological and physiological traits. This study took place during the campaign of 2011/2012 on the ITGC site of el khroub station. This site represents the highest Algerian eastern plains. The results showed highly significant varietal differences for all measured parameters. Highly positive significant links have been found between grain yield and the number of grains produced per unit area, and the number of grain per spike. The principal component analysis, described a total variation of 77.36 %, and the hierarchical classification has divided the genotypes according to their phenotypic variation into three distinct groups. The first one includes old varieties showing adaptability to climatic conditions to the studied area. They are late and large. In contrast, the two groups left are formed by improved genotypes and other newly introduced ones. They are characterized by a small, early maturity at heading, and show higher values for all performance components.

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Introduction:-

In Algeria, cereal products occupy a strategic place in food system and national economy (Djermoun, 2009). Among them, durum wheat (*Triticum durum* .Desf) is one of the most cultivated species, and takes a big part in our diet. However, the current cereal production can only cover partially the population need's (Chennafi et al; 2011). Unfortunately, the area occupied by this crop has not evolved for a long time (Smadhi et al; 2009). They are also subjected to high climatic variability (Hanifi et al; 2008). The rainfall is low, erratic and unpredictable, which is the main limiting factor (Makhlouf et al; 2012). In order to face this situation, various improvement strategies can be applied. As a first step of any strategy the germoplasm needs to be well known, to be able to use its potentials. To do so, the study and the characterization of genetic resources is critical and can be useful to create new varieties with good quality, high efficiency, highly adapted to climatic variations and resistant to diseases (Amallah et al ; 2016). Several collecting missions have been conducted to characterize the diversity and genetic structure of local populations of durum wheat in the Mediterranean countries and North Africa since 1925 (Vavilov; 1992). For this purpose, a set of agro- morphological parameters have been used (Sahri et al; 2014, Belhadj et al; 2015 Zarkti et al;

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2012). The characterization and the evaluation of crop varieties allow us to protect and restore this genetic heritage .To be used at the end in breeding programs (Chentoufi et al; 2014). Cereal improvement has long been and still is strongly oriented towards increasing productivity (Boubaker et al ; 1999). The Knowledge of any existent link between the grain yield and its component can be useful to identify interesting traits for selection. This information is used to guide the selection process to promote the features able of generating improved performance (Mekhlouf and Bouzerzour; 2000).

In this context our study aimed to evaluate Twenty Six accessions of durum wheat grown in Algeria, based on agromorphological characters. Also to analyze and compare the grain yield and its component to be able to improve our knowledge and so to identify the most relevant characteristics for choosing the more efficient and adapted genotypes.

Material and methods:-

Plant material used for our study consists of 26 durum wheat varieties (*Triticum durum*.Desf). With various origins (Table 1). The assay was conducted during the 2011-2012 season at the experimental station of the Crops Technical Institute (ITGC) of El Khroub , located at 14Km south east of Constantine, with an altitude of 640m , a latitude of 6.67 East and longitude 36.67 North . According to an experimental randomized block with 5 repetitions. The plant material is sown by hand on a basic plot in a line of 1m long by spacing each line 20 cm. sowing was carried out on 22/12/2012 in approximately 2 to 3cm depth.

Measured parameters:-

Phonological observations were held throughout the vegetative cycle of the wheat (seedling to maturity). The heading stage (DHE) : number of days from emergence to the release date of 50% of ears per variety ; the plant height (PH in cm), is made at maturity, ground level at the top of the ears, not included beards; flag leaf area is derived by the formula: $SF (cm^2) = 0.606 (L \times I)$ where L= total length of 5 sheets, I = average width of 5 leaves and 0.606 = regression coefficient between the surface of photocopied sheets of paper weight on that deduced by the product (I x L) (Spagnoletti Zeuli and Qualset, 1990) ; the spike length (SL in cm) measured from the base of the ear to the tip, not included beards; the length of beards (LB in cm); the relative water content is determined at heading stage on a sample of three leaves, according to the protocol of Barrs (1968). It is calculated by the following formula (RWC %) = (fresh weight- dry weight)/ (rehydrated weight- dry weight) x100. The physiological status of plants was monitored by RWC.

The number of grass tillers: is determined by direct counting of the number of grass tillers (except main shoot) of all plants / genotype, from the 4-leaf stage until end of tillering. The number of fertile tillers: is the direct counting the number of fertile tillers (except main shoot) of all plants / genotype, maturity stage and then deducted the report tillering ear / tillering grass (NTF/NTG).

The temperature of crop canopy (TC) is measured by a hand-held infrared thermometer. The measurements were carried out during the heading stage of good weather around solar noon, back to the sun. the data for each varieties is the mean of four or five readings .The measures also focused on the thousand kernel weight in grams (TKW) , the number of spike per square meter (spike / m²) and the average number of grains / spike , grain yield (g / m²) .

Data analysis:-

An analysis of variance (ANOVA) is performed for each variable at the P<0.05 significance level .And a principal component analysis (PCA). A correlation matrix is calculated to study the different expressions between variables.

The hierarchical cluster CAH, is performed to study the structure of our collection on different quantitative traits. All statistical analyzes were performed with XLSTAT 2014 software.

Table 1:- Name and pedigree, origin of the genotypes used in the study.

N° Accession	Varieties or Lines	Pedigree	Origin
2	Mexicali75		CIMMYT (Mexico)
8	Aribs (ex Capeiti)		Algeria (Italy)
9	Waha	Plc/Ruff//Gta/3/ Rtte	Algeria
23	Chen "S"		CIMMYT (Mexico)
33	Hoggar	Vitron	Algeria
38	Tell76		Algeria
39	Tassili		Algeria
54	Righa	Cocorit71	CIMMYT (Mexico)
79	T.PolonicumxZ.Bouteille	Var.Population	Algeria
82	Mohamed Ben Bachir	Var.Population	Algeria
83	Montpellier	Var.Population	Algeria
84	Hedba3	Var.Population	Algeria
85	Bidi17	Var.Population	Algeria
86	O.Zenati 368	Var.Population	Algeria
88	Djennah Khetifa	Var.Population	Algeria/Tunisia
89	Guemgoum Rkhem	Var.Population	Algeria
90	Rahouia 80 (ex Gloire de Montgolfier)	Var.Population	Algeria
91	Beliouni	Var.Population	Algeria
92	Gta/Dur69...		Algeria
93	Simeto		Algeria (Italy)
99	Sooty-3/Rascon-37		Mexico
107	Boussellem		Algeria
115	Ofonto		Algeria (Italy)
123	Mrf1/Stj2//Gdr2/Mgnl1		ICARDA (Syria)
129	Sigus	Ter-1/3/Stj3// Bcr /Lks4	Algeria (ICARDA)
139	Beni Mestina	Lahn/Ch1.2003	Algeria (ICARDA)

Results:-**Table 2:-** Means values of thirteen traits agro morpho-physiological of the genotypes tested.

variety	DHE	DM	NTF/NT	RW	SL	BL	PH	SF	TC	Spike/ m ²	TK W	Grs /spike	GY
2	135,67	161,00	0,50	0,67	8,70	8,87	88,00	32,00	26,87	140,00	40,03	45,00	255,23
8	135,67	162,00	0,56	0,94	6,67	5,60	85,33	25,33	26,13	168,67	41,93	38,33	270,61
9	139,67	161,00	0,47	0,89	7,50	9,80	74,00	26,00	26,44	95,33	30,70	52,67	154,88
23	140,33	162,00	0,51	0,80	8,23	7,60	65,00	26,67	29,46	96,00	38,00	43,33	156,80
33	140,33	161,00	0,48	0,74	7,23	7,40	77,33	22,00	26,78	182,00	34,03	48,33	299,85
38	140,67	162,00	0,36	0,86	8,07	10,90	76,50	28,67	28,66	121,33	36,07	48,00	209,23
39	140,33	161,00	0,61	0,76	8,33	11,33	81,00	23,67	28,48	161,33	39,03	52,33	331,90
54	141,67	163,00	0,44	0,81	7,00	10,93	85,00	29,33	28,18	203,33	32,67	32,67	216,27
79	147,33	174,33	0,50	0,86	6,90	11,00	112,00	29,33	29,15	140,00	42,00	47,33	282,54
82	147,00	173,00	0,41	0,93	6,00	11,70	104,60	21,00	30,90	116,67	38,90	35,67	165,30

	0	0			0	7	7	0	2		7		5
83	147,0 0	176,0 0	0,36	0,87	6,0 0	7,47	79,00	28,6 7	29,7 4	109,33	40,0 0	34,00	149,5 1
84	148,0 0	174,3 3	0,19	0,84	8,6 7	11,6 0	118,0 0	31,6 7	30,9 4	91,33	40,0 0	51,33	186,5 5
85	147,0 0	175,0 0	0,23	0,92	6,1 0	11,6 7	103,0 0	30,3 3	29,5 3	74,67	44,0 0	33,67	110,2 8
86	147,3 3	176,3 3	0,25	0,95	6,1 3	10,4 3	105,6 7	37,6 7	28,1 8	100,00	47,3 3	38,00	176,5 8
88	149,0 0	177,0 0	0,44	0,93	7,6 7	9,83	109,6 7	29,6 7	29,0 8	92,00	37,0 0	36,00	120,1 8
89	147,0 0	176,6 7	0,36	0,88	8,8 3	9,53	112,3 3	30,3 3	30,8 0	88,67	56,0 0	33,67	163,1 5
90	147,3 3	178,0 0	0,22	0,65	7,2 3	12,6 7	111,6 7	36,0 0	30,6 5	138,67	40,0 0	40,67	224,6 9
91	147,0 0	178,0 0	0,39	0,74	6,4 3	11,3 0	104,1 7	29,6 7	33,0 2	137,33	43,6 7	42,33	262,1 0
92	144,6 7	174,0 0	0,47	0,76	7,4 3	8,50	72,00	33,6 7	34,0 0	122,00	37,0 3	62,33	280,6 2
93	139,0 0	169,0 0	0,28	0,80	7,1 7	8,50	71,33	27,6 7	32,5 3	116,67	39,9 0	40,33	190,8 9
99	141,0 0	166,0 0	0,37	0,80	6,9 7	9,37	69,00	36,3 3	32,7 0	110,00	38,0 7	33,33	138,3 7
107	145,0 0	171,0 0	0,46	0,89	6,7 0	11,9 7	80,50	34,3 3	34,7 5	122,67	40,0 0	55,33	272,8 2
115	140,3 3	178,0 0	0,56	0,81	6,7 0	11,7 0	71,00	35,3 3	32,9 7	96,00	54,0 0	39,67	214,0 1
123	142,6 7	168,0 0	0,31	0,74	6,6 0	10,8 7	79,33	30,0 0	34,3 7	113,33	42,0 0	40,00	189,2 1
129	139,6 7	168,0 0	0,28	0,82	7,0 3	9,37	82,80	22,0 0	32,4 0	152,00	41,9 0	40,00	250,6 5
139	144,0 0	171,0 0	0,36	0,75	7,6 7	7,23	67,53	32,3 3	32,7 3	123,33	40,0 3	49,00	247,8 5

Descriptive statistical analysis:-**Table 3:-** Means values, maximum and minimum and statistical significance of the measured characters.

Variable	Minimum	Maximum	Means	Standard deviation	Significance (Pr > F)
Number of days to heading	135,667	149,000	143,256	3,944	< 0,0001
Number of days to maturity	161,000	178,000	169,872	6,452	< 0,0001
NTF/NTG	0,193	0,613	0,398	0,113	< 0,0001
RWC	0,650	0,953	0,824	0,082	0,005
SL	6,000	8,833	7,229	0,846	< 0,0001
BL	5,600	12,667	9,892	1,810	< 0,0001
PH	65,000	118,000	87,917	16,795	< 0,0001
SF	21,000	37,667	29,603	4,526	0,106
TC	26,133	34,750	30,364	2,550	< 0,0001
Spike/m ²	74,667	203,333	123,564	31,058	0,01
TKW	30,700	56,000	40,553	5,519	< 0,0001
Grs /spike	32,667	62,333	42,821	7,835	< 0,0001
GY	110,277	331,897	212,312	59,364	0,01

The means values of quantitative characteristics measured on the 26 genotypes are listed in Table 2. The variety Mexicali presents the shortest development cycle to 161 days and a heading period of 135.66 days. The genotypes formed by old varieties are considered as late and have a quite significant delay in relation to the variety Mexicali, with a period of heading of 149 days, a difference of 17 days to the end of the cycle. Boussalem has the best ability the transformation into tillers ears (0.61%). The stubble height is in the advantage of Hedba3 (118 cm), Chen "S" is the shortest (65cm). At the heading stage, O.Zenati 368 develops a large area of flag leaf with an average of 37.667 cm², while Mohamed Ben Bachir with 21 cm² has a low surface sheet. The differences between genotypes are too marked for the number of spike per unit area with an average of 123.56 spike / m². The highest value was noted in Righa. The best TKW is presented by the variety Guengoum Rkhem 65.00 g unlike the variety Waha which had a weight of 30.7 g. The variety with the most fertile spike is Gta / Dur69 (Grs /spike = 62.33). The grain yield shows values varies between 331.9 and 110.3 g/m²; it is the varieties Hoggar and Tassili that shown the best performance. The genotype Bidi 17 showed the lowest grain yield.

The analysis of correlations between the measured parameters shows that there are positive and negative relations between these parameters ranging from a low to a high correlation (Table 4).

Table 4:- Correlation coefficients between yield and other traits in durum wheat.

Variables	DHE	DMA	NTF/NTH G	RWC	SL	BL	PH	SF	TC	spike/m ²	TKW	Grs/spike
DMA	0,81***											
NTF/NT G	-0,459*	-0,436										
RWC	0,263	0,165	-0,021									
SL	-0,234	-0,340	0,159	-0,328								
BL	0,267	0,390	-0,262	-0,008	-	0,119						
PH	0,682** *	0,570	-0,379	0,255	-	0,010	0,488* *					
SF	0,475*	0,304	-0,281	-0,129	-	0,031	0,271	0,103				
TC	0,290	0,284	-0,294	-0,227	-	0,198	0,272	-	0,150	0,357		
Spike/m ²	-0,481*	-0,426	0,361	-0,358	-	0,031	-0,179	-	0,156	0,364	0,278	
TKW	0,227	0,582* *	-0,132	0,132	-	0,068	0,166	0,317	0,339	0,304	-0,378	
Grs/spike	-0,120	-0,224	0,280	-0,268	0,371	-0,003	0,255	0,006	0,115	0,094	0,339	-
GY	-0,424*	-0,274	0,459*	0,446*	0,145	-0,080	0,157	0,174	0,003	0,721** *	-	0,597** *

* (P<0.05); ** (P<0.01); *** (P<0.0001)

Principal component analysis:-

Table 5:- Projection of the different traits studied on the five axes of the principal components analysis.

Traits	F1	F2	F3	F4	F5
DHE	0,813	-0,113	0,330	0,080	-0,155
DMA	0,883	-0,235	0,084	-0,155	0,138
NTF/NTG	-0,633	0,011	0,076	-0,092	0,462
RWC	0,344	0,674	0,083	0,005	0,125
SL	-0,331	-0,240	-0,032	0,807	0,244
BL	0,511	-0,337	0,399	0,060	-0,196
PH	0,621	0,061	0,689	0,219	0,133
SF	0,497	-0,442	-0,324	0,081	0,094

TC	0,403	-0,603	-0,400	-0,319	-0,152
SPIKE/m ²	-0,668	-0,113	0,477	-0,417	-0,051
TKW	0,550	-0,132	-0,127	-0,164	0,740
Grs/Spike	-0,413	-0,606	0,060	0,328	-0,125
GY	-0,589	-0,507	0,392	-0,251	0,215

A principal component analysis was performed from 13 variables. We notice the first axis alone explains 33.772% of the information, the first two axes develop 49, 048%, the three axes explain 60.042%, and the first four axes have 69.435% and the first five axes explain 77 363% of the total variation. Therefore, these five axes had better summarize information provided by all the initial variables. On the positive side, the first components (axis) integrate information relating to the variation of the variables: duration of heading and maturity, SF, the BL. On the negative side, the ratio NTF/NTG, Spike/m² and grain yield. Along this axis 1 oppose phenology and morphological characteristics to production capacities. The RWC is positively correlated with the axis 2 on the positive side, and canopy temperature and the number of grains per spike on the negative side. As for axis 3, is formed by the plant height on the positive side. Axis 4 and 5 are positively correlated with spike length and thousand kernel weight respectively (Table 5). Considering the significance of axes, we analyzed the distribution of varieties. Along axis 1 oppose the genotype Hedba3, Bidi17, O.Zenati 368, DjennahKhetifa to Mexicali, Aribis, Waha, Chen "S", Hoggar, Tell, Tassili, Righa. On the negative side of the axis 2, the varieties Rahouia 80, Beliouni, Gta / Dur69, Boussellem characterized by high grains number per spike also a canopy temperature. The same axis but on the positive side, varieties Mohamed Ben Bachir, Montpellier, characterized by high RWC (Fig.). In the plane 1- 3 (Fig.), the dispersion of individuals shows that varieties Simeto, Sooty-3/37-Rascon, Mrf1 / Stj2 // GDR2 / Mgn1, Beni Mestina characterized by low plant height. On the positive side of the axis 05; varieties Guemgoum Rkhem, Ofonto ,O.Zenati 368, T.PolonicumxZ.Bouteille, is distinguished by a very high TKW (Fig.).

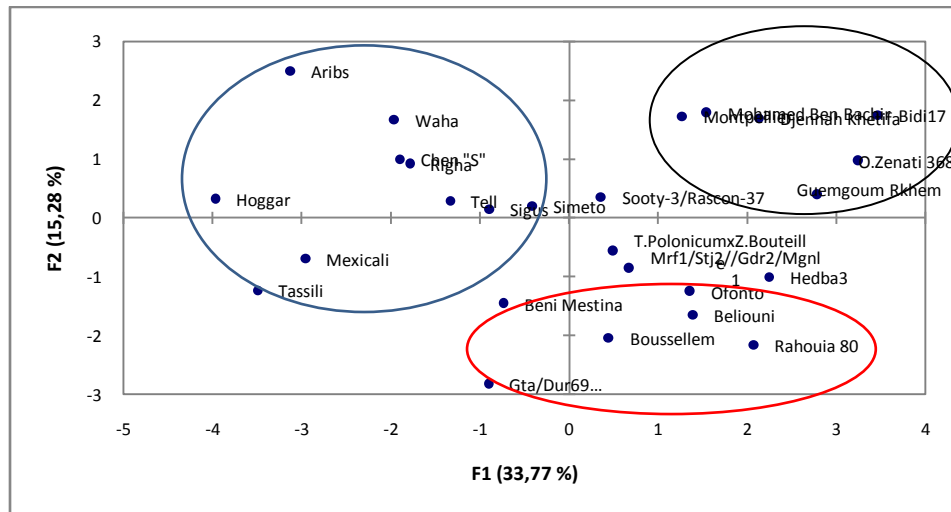


Fig 1:- Distribution of the 26 durum wheat accessions for the agro morphological and physiological traits in the plan of axes 1 and 2.

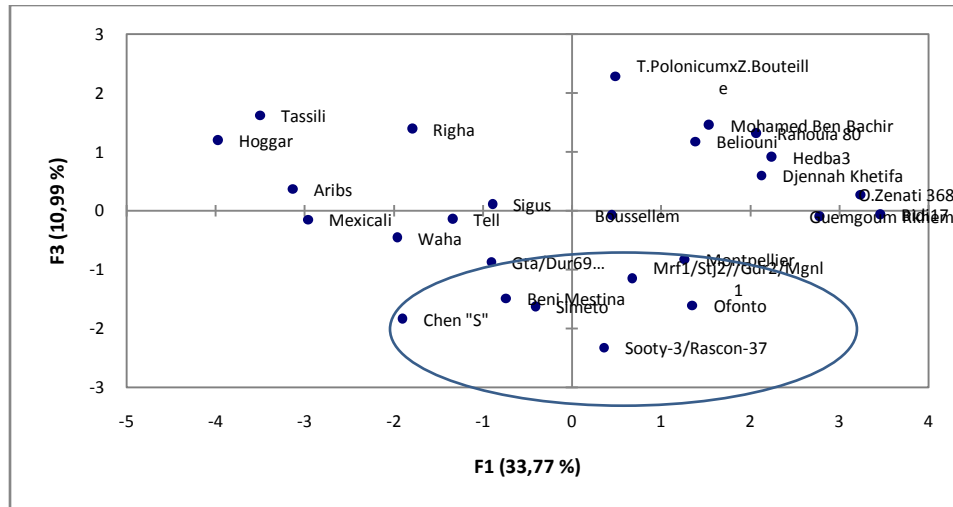


Fig 2:- Distribution of the 26 durum wheat accessions for the agro morphological and physiological traits in the plan of axes 1 and 3.

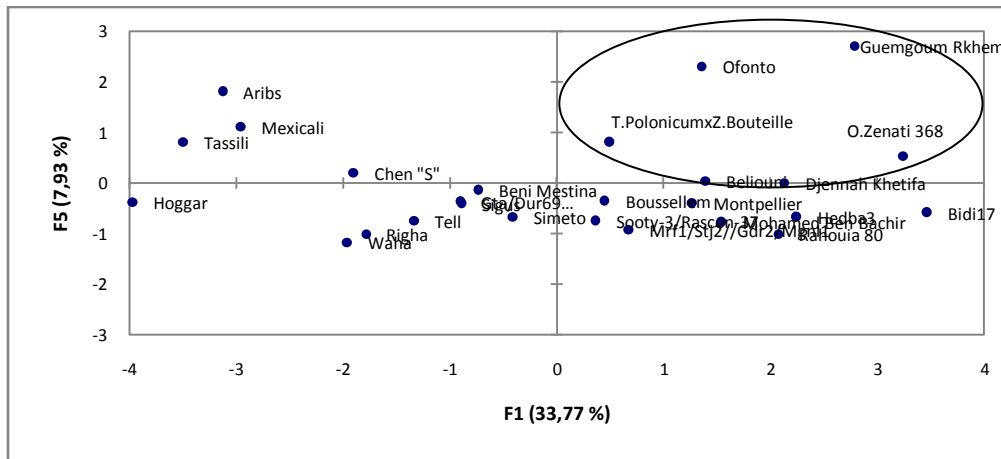


Fig 3:- Distribution of the 26 durum wheat accessions for the agro morphological and physiological traits in the plan of axes 1 and 5.

The hierarchical classification:-

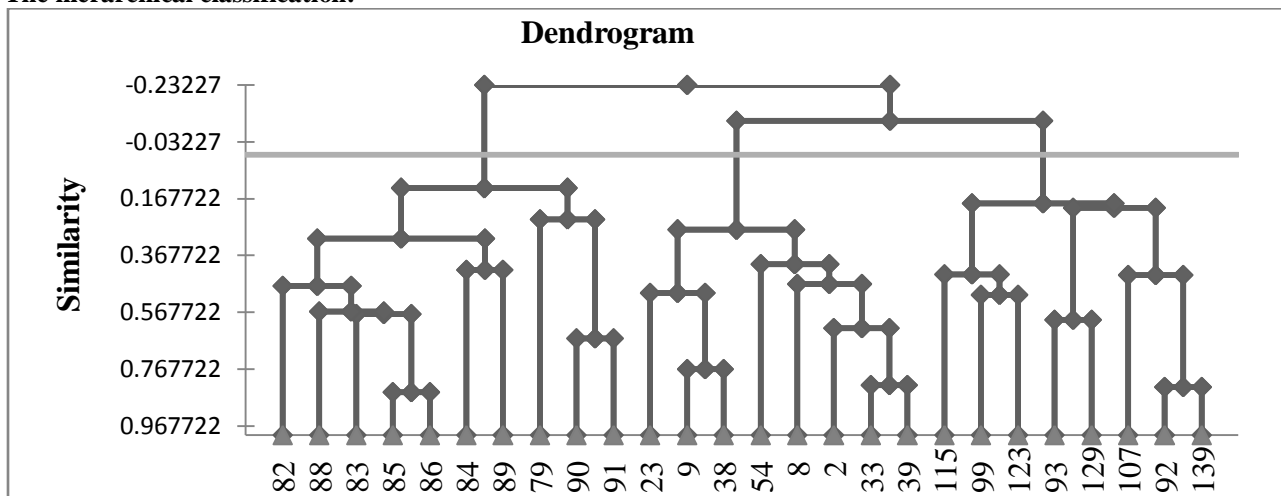


Fig 4:- hierarchical clustering based on phenotypic and agro physiological variables considered in our study.

The results of the hierarchical cluster analysis are presented in Fig. 04. The grouping according to the degree of resemblance between the different genotypes on the basis of the measured variables reveals three distinct groups. Group I consists of T.PolonicumxZ.Bouteille Mohamed Ben Bachir, Montpellier, Hedba3, Bidi17, O.Zenati 368, Djennah Khetifa, Guemgoum Rkhem, Rahouia 80, Beliouni. Group II consists of the genotypes Mexicali, Aribis, Chen "S", Viton, Tell, Tassili, Righa, Waha. And group III is represented by Gta / Dur69, Simeto, Sooty-3/37-Rascon, Bousellem, Ofonto, Mrfl / Stj2 // GDR2 / Mgn11, Sigus, Beni Mestina. Analysis of this dendrogram shows that the old varieties are located in the same group I and constitute a separate cluster of improved varieties.

Discussion:-

Our study aimed to characterize an Algerian durum wheat collection by using thirteen physiological and agromorphological traits. The analysis of variance ANOVA revealed highly significant differences between varieties (Table 03). The existence of variability between accessions is probably due to both genetic differences and the environment in which they have been cultivated. It has been observed that, as well as for the lowest and the highest values of quantitative characters, the latest varieties to heading are the latest ones to maturity. Nevertheless, late varieties, such as local populations, are more adapted to cold spring (Amallah *et al*; 2016). Understanding the existent relationship between different traits can be really valuable to identify the most interesting criteria's for selection. In the other hand, correlation study, showed a significant and negative relation between the number of days to heading, spikes number per square meter ($r=-0.481$) and grain yield ($r=-0.424$). Those results suggest that precocity may improve durum wheat yield. Improved varieties and those from CIMMYT and ICARDA (with short development cycle) have the ability to use more properly, nutritive resources at the end of the cycle. Precocity insures a better efficiency of water use by producing a higher amount of biomass. They are also less exposed to environmental stress than late ones (Slama *et al*; 2005). The parameter, number of days to heading, presents a highly significant correlation with plant height ($r=0.682$), and a significant one with leaf temperature ($r= 0.475$). Under changing environment, morphological characters can play an important role. According to Blum (1988), the existence of a relationship between plant height and drought tolerance can be explained by the ability of large genotype to grain filling under terminal drought stress, using the amount of assimilate stocked within the stem and their ability to remobilize their supplies. The surface of flag leaf is also an important trait. In fact it represents the last active organ that remains, in addition to spikes and beards, in order to produce assimilate needed for grain filling. Flag leaf with large dimensions is highly recommended in favorable environment (Slama *et al*; 2005). Maturation date appears to be significantly correlated to the thousand kernel weight in grams, such relationship can be explained by an important accumulation of supplies, in consequence of which, grains are highly fulfilled (Sayar *et al*, 2007). According to Benbelkacem and Kellou (2000), the TKW, is not quiet controllable, because this trait is highly affected by environment during grain filling. The lack of water after flowering, combined at elevated temperature (usually observed in Algeria) results in a decrease of TKW by alteration of the rate of grain filling and / or the filling time. During this phase, the lack of water results in a reduction of the grain size (scalding) thus is reducing the yield (Megherbi *et al*; 2014). That diminution is due to an alteration in grain filling rate and/or duration. Grain yield showed a highly significant correlation with the following variables: spikes number per square meter ($r=0.721$), grains number per spike ($r=0.597$), and a significant one with the ratio NTF/NTG ($r=0.459$). Our results are in agreement with several researches, which indicate that yield is formed by different component that take place in successive or in a simultaneous way during developmental stages (Masse, 1981). Yield improvement is necessarily connected to grains number per spike, which can explain 75% of yield variability. Our results are also in agreement with those mentioned by Blum and Pnuel (1990) and by Erchidi *et al*, (2000), in fact wheat yield is more related to spike fertility than to the average grain weight (Belkharchouche *et al*, 2009). Grain yield is negatively correlated to the RWC this indicates that local tolerant genotypes are less productive. According to Fellah *et al*, (2002); the most tolerant genotypes to water stress minimize a decrease in grain yield under constraining conditions. In the opposite, sensitive ones show a good expression and a high amount of grain yield under favorable conditions. The multifarious analysis highlighted an important variability within this durum wheat collection. Among those varieties some of them seemed to be more vigorous for phenological and morph physiological parameters as well as for yield component. In fact the studied varieties appeared to react in the same way toward climatic conditions during 2011/2012. Those conditions were relatively favorable to a good agriculture (sufficient precipitation unfortunately with freeze and high temperature). The principal component analysis led us to group them according to the chosen parameters. Number of grain per spike, number of spike per square meter, grain yield, thousand kernel weight, heading date and plant height, are the most discriminate characters. In addition, the hierarchical classification is in agreement with the emerged conclusion from the CPA analysis, and divides the accession in tree groups. The first one includes ancient varieties (late ones) with low yield; they exhibit the highest RWC, SF, PH values, characterized by a lower canopy temperature. This group includes the most tolerant varieties to abiotic

stresses. Our results are supported by those mentioned by Fellah *et al.*, (2002); indicating that tolerant genotypes are less productive. They are large and late to heading. They lose less leaf water per time unit too. Renolds *et al.*, (1994) also suggested that leaf temperature can be a good tool to select adapted genotypes to thermal stress (Benmahamed, 2005). The physiological aspect of those genotypes needs to be studied in a deeper way in order to be used as parents. The second group contains improved varieties and those introduced by international centers; they are characterized by: a good grain yield, an early heading and maturity, an important number of spikes per square meter and a high NTF/NTG ratio. Those genotypes can be used as parents in durum wheat breeding programs. Hazmoune (2000) suggested that even after introducing new durum wheat varieties with high yield, the less productive local genotypes (Hedba 3, Bidi 17, O.Zenati 368, Mouhamed Ben Bachir) still remain more adapted to water stress affecting our regions. The introduced ones are instable under constraining conditions. The last group appears to be closer to the second one and is characterized by: a high number of grains per spike, a high level of grain yield, an intermediate TKW, Spikes / m², and NTF/NTG ratio. As well as an average cycle to heading, a height stubble and relative water content.

Conclusion:-

The measured parameters enabled us to highlight the existence of diversity between varieties. This study revealed that the grain yield is positively correlated with the ratio NTF/NTG and the grains number per spike, spike/m², it suggests putting more emphasis on these elements to increase productivity. The variety Mexicali has the shorter development cycle which should be exploited in breeding programs. Multivariate analyzes allowed us to identify and regroup the varieties in three divergent groups, it would be interesting to combine the advantageous adaptive traits of local and traditional populations, combined with production of the introduced varieties for the development of efficient and tolerant varieties.

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