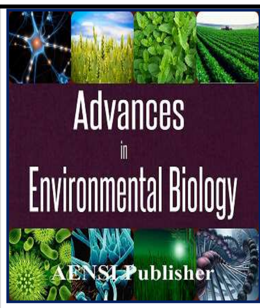
Advances in Environmental Biology, 10(4) April 2016, Pages: 108-119

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/



Morphological and Agricultural Diversity of Durum Wheat Varieties Sown in a Semi-Arid Area

[1]Zoghmar Meriem, [1]Kara Youcef, [1]Farhati Laid, [2]Zeltni Abd Esselem and [1]Bouchareb Radia

[1]Department of Vegetable Biology and Ecology Faculty of Natural Sciences and Life University of Brother Mentouri Constantine , 25000 Algeria
[2]Technical Institute of Great cultures. Elkhroub, Constantine. Algeria

Address For Correspondence:
Zoghmar Meriem, 1Department of Vegetable Biology and Ecology Faculty of Natural Sciences and Life University of Brother Mentouri Constantine , 25000 Algeria

Received 12 February 2016; Accepted 28 April 2016; Available online 15 May 2016

ABSTRACT

our study is focused on the diversity of morphological and agricultural traits of four durum wheat variety for drought tolerance in a semi-arid zone area (Constantine) under two years 2011/2012 and 2012/ 2013. The later accuse drought periods during the plant cycle. These climatically areas factors have disrupted the performance of the local and introduced varieties of durum wheat. These factors influenced especially the grain yield and their components, the number of spike per meter square, the biomass production and the number of grains per spike of the new cultivar (Wahbi compared to elder varieties Waha, Bidi 17 and Sémito) from one year to another. The obtained results show a wide variation in morphological characteristics namely leaf area, plant height, and the spike length in addition to some agricultural characters such as grain yield, the thousand kernel weight between genotypes. This indicate that the year effect and the interaction between genotype×year effect are present more than that the genotype effect .There by providing information on biodiversity and explains a large variability inters-varietal , intra and inter-annual between them . Indeed, Mediterranean climate in semi arid areas is changeable during the year from one month to another and affects directly the durum wheat production according to the type of stress (in our case, draught stress). The relationships between the durum grain yield and the related traits under draught conditions evaluated using several multivariate analyses, including simple correlation, principal component analysis and cluster analysis indicated that these traits are correlated with yield to determine the performance cultivars under stress conditions. Introduced cultivars of durum wheat are more efficient than local cultivars because of their earliness. The time of heading is often used as a selection criterion to drought tolerance of durum wheat yields especially in semi-arid areas. These results suggest that selections should be based on this trait for developing new wheat cultivars.

KEYWORDS: Agricultural characters, Biological Diversity, Durum wheat, Grain yield, Year effect.

INTRODUCTION

Water plays a fundamental role in the life of plants. Its deficiency may develop and perform all aspects of plant growth. It is therefore one of the most important factor limiting crop yields around the word especially in arid and semi arid areas. In fact, drought stress is the most serious constraint for crop production [1]. The problem of drought stresses is acute in the developing countries where about 37% of the wheat growing areas are semi-arid with low moisture as a limiting factor for higher yield [29].

Besides, Algerian cereals are largely dominated by durum wheat crop [23]. Since it occupies large areas of the country. Production improving remains very low and irregularly reports with the needs. As a result, the country remains heavily dependent on imports for commodities [11]. The Algerian market has absorbed an annual average of 60, 36% of durum wheat crop [7]. As a matter of fact, wheat imports are increasing from an average of 3 million tons in the period of 2000-2005 to 5 million tonnes over the period 2006-2012 [9]. In this circumstance, the political ambition in agriculture is to achieve an increase in production and yield of this crop.

The analysis of the behaviour of genotypes according to the characteristics of the environment has been a preoccupation subject of the researchers. Many morph-physiological and phenotypical traits are distinguished from one year to another and from one environment to another for a given genotype. In case of drought, some traits proposed by stress physiologists appear to be associated with crop survival. A comparison of old and new varieties has shown that, under drought, older varieties over-produce many tillers of which fail to set grain, while modern drought tolerant lines produce fewer tillers the majority of which survive [25].

In most circumstances, however, the main effect of drought is to reduce grain yield without killing the plant. These annual variations make a difficult selection based on yield potential as a highly influenced by the environment and low heritability [18]. The combination of high yield stability and high relative yield under drought has been proposed as it is a useful selection criterion for characterising genotypic performance under a varying degree of water stress [28]. Traditional local genotypes appear to make idiotypes in ours conditions culture [3]. Allowing them to be used as a genitors in ameliorate actions. The variation in performance is caused by the sensitivity of the new cultivars to various stresses that characterize the environment of production medium [27,8]. A comparison of genotypic performance under favourable and unfavourable environment to the expression of high grain yields is often used to identify tolerant and productive genotypes. The research should aim at selecting tolerant varieties in stress climate, productive and also more stable in their production. This approach aims to characterize the a-biotic stresses and identify adaptable traits in different types of drought stress. So, we understand the interest in this study which is to identify and analyze the variability of four varieties of durum wheat in water deficit in order to identify performance genotypes and that could be adapted in the region of study and to determine suitable selection criteria for selecting genotypes tolerant to draught stress conditions.

MATERIAL AND METHODS

A. Plant materiel:

Four durum wheat varieties from different origin were used in this experiment field, one local variety Bidi 17 and one introduced Sémito: *Capeiti×Valvona* with two selected genotypes such as Waha: *Waha`S´PLC `S´/RUFF//GTA`S´/3ROLOTE* and Wahbi: *Bidi17/Waha/ Bidi17* for screening durum wheat varieties for draught tolerance (Farm of Demonstration and Seed Protection; Technical Institute of Great Cultures; *I.T.G.C.* Elkhroub, (Constantine).

B. The field experiments:

Our study is intended to connect the performance of genotypes tested in various morphological and agricultural traits of adaptation to drought tolerance and to compare these genotypes behaviour in the middle of the fields. The experiments were conducted at the Driver Farm of Technical Institute of Great Cultures, during the periods 2011/2012 and 2012/2013. This region has a semi arid climate (574, 5 mm to 392, 3 mm, Figure 1). The experimental site is located 14 km south-east Constantine, Algeria. Seeding wheat was 250 seeds. M^{-2}.

The soil has a clay loam texture. Both trials were conducted according to the Fischer device completely randomized design with four replications in total 16 elementary micro-plots of six m^2 (5 m × 1.20 m) consisting of 6 rows with a 20 cm inter-lows space and a 50 cm inter-blocks space, tests have surrounded rye to put all genotypes in the same conditions.

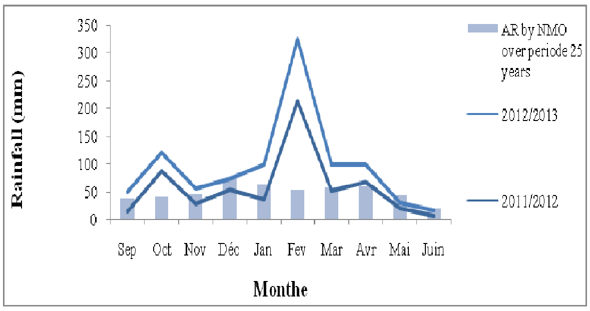
C. Climate data of both 2011/2012 and 2012/2013 agricultural companions:

- *Rainfall:*

The average amount saved by agricultural companions is variable, the cumulative rainfall is recorded (574,5 mm and 392,3 mm respectively), the amount of rain was important in the first year and low the second year regarding to 486,5 mm the normal average established by the services of *National Meteorological Office* (NMO) over the period of 25 years (Figure 1).

The wettest period during two companions was February with 213 mm and 111,9 mm respectively and a minimum of 6 mm in June during the 2011-2012, companions climatic conditions that characterized the two years of the trial were quite variable (Figure 1).

Advances in Environmental Biology, 10(4) April 2016, Pages: 108-119



Source: (T.I.G.C) Constantine

Fig. 1: Monthly distribution of rainfall during two agricultural companions 2011/2012 and 2012/2013.

AR by NMO over period 25 years:

the average rainfall established by the National Meteorological Office (**NMO)** over the period of 25 years.

- *Temperature:*

The temperature is a key and a determinant factor for the development of the plant during both agricultural companions. This parameter influences the production by an important effect in winter where low temperatures on several continuous days (Figure 2; A and B) with many days of frost (53 and 55 days in total, respectively) have slowed or even hindered the growth of plants. The mild temperatures of March and especially April helped a lot plant good development (Figure 2; A and B).

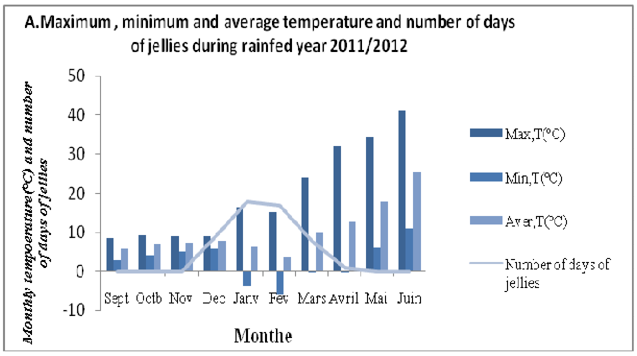
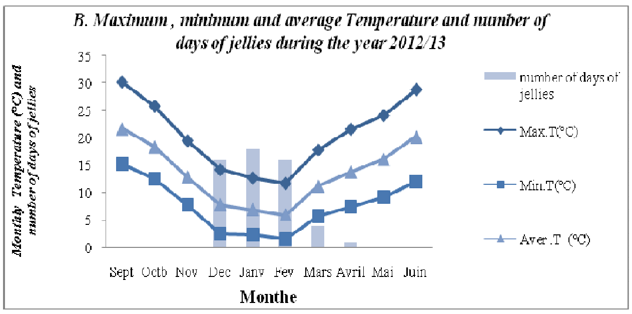


Fig. 2: A. Monthly temperatures and number of days revealed to Constantine during agricultural companion 2011/2012.



Source: (T. I. G.C) Constantine

Fig. 2: B. Monthly temperatures and number of days revealed to Constantine during agricultural companion 2012/2013.

- *Measurements:*

At levee stage, the number of plants per square meter ($NP.m^{-2}$) was counted on 5 lines at a rate of four plants of one meter long on each plot by avoiding border effects. Date of heading was recorded on all micro-plots in each experiment like the date when 50% of shoots had reached treatment and per micro-plots. After the harvest, the thousand kernel weight (TKW) is counted automatically by an electric counter after the hype of all ears by harvester type (Numigral), and then is evaluated by using Grain yields ($qx.ha^{-1}$); all grains harvested per micro-plots weighted, and these traits were measured by four repetitions per treatment and per micro-plots. The biomass production (BIO) is measured by the weighting of the whole plant with its roots of four plants taken randomly per micro-plots were weighted an electric precision balance. The number of grains per spike is counted ($NG.Spike^{-1}$), the spike and the number of spikes per square meter ($NS.m^{-2}$) were counted. Leaf area (LA) is measured in cm^2 by a device type (Area Maters) with four leaves per micro-plots and by repetition. At physiological maturity, the plant high (PH), the peduncle length (PL) and the spike length (SL) were measured by four repetitions per treatment and per micro-plots. After the harvest, the thousand kernel weight (TKW) is counted automatically by an electric counter after the hype of all ears by harvester type (Numigral), and then is evaluated by using an electric precision balance. The number of grains per spike is counted ($NG.\ Spike^{-1}$), the spike is weighted, and these traits were measured by four repetitions per treatment and per micro-plots. The biomass (BIO) is measured by the weighting of the whole plant with its roots of four plants taken randomly per micro-plots. The Grain yields (qx.ha-1), all grains harvested per micro-plots were weighted.

Statistical analysis:

The statistical analysis of the results obtained in different experiments was tested by analysis of variance (ANOVA) and performed using the (STATISTICA 7.0 for windows) software. Each experiment was analysed using randomised competed block design model. Mean comparisons are conducted using Fischer's (least significant difference, LSD). The Duncan test has given the average and ranks with a significance levels (α=5%). Analysis of correlation coefficient between grain yield and the other characteristics was used to determine principal component analysis, relationships analysis and dendrogram of cluster analysis influencing on the final grain yield using (STATISTICA 7.0 software for windows).

Results:

A. Variance analysis of morphological characteristics of yield and their components:

Analyse of variance was conducted to determine the effect of years **Y**, genotypes **G** and the interaction effect among this factors (G×Y). As shown in Table.1, variance analyses of the measured traits indicate that the mean year effect is present with very high significance for all variables studied (Table 2). The genotype effect was very highly significant for $NP.m^{-2}$, NDH, PH and SL and was highly significant for LA, PL, SL, BIO and also for GY. This factor was not significant for $NS.m^{-2}$, $NG.S^{-1}$, WS, and TKW. Moreover, interaction effect between genotype × years was very highly significant for NDH, PH, PL, SL, $NG.S\text{-}^{1}$, BIO, also for $NP.m^{-2}$and GY and the opposite for $NS.m^{-2}$;LA, WS and TKW. However, these results suggest that different characters measured vary depending on the genotype and climatic hazards that characterize both agricultural companies. These results showed that, the combined analysis of variance of yield and its components were drastically affected by years of study. This might be attributed to the considerable rainfall increase in the second year of the experiment, especially from March until April (Fig 1).

B. Morphological characters:

Respecting the morphological variables, Table (1) shows a very high significance variation of genotypes, the year and the interaction between genotype × year effects (*p≥0, 01*) excluding Leaf area , for the interaction between genotype × year effects was not significant (*p= 0,15*^{Ns}) . Leaf area is an evaluation criterion for growth of durum wheat varieties which are grown under climatic conditions of the two wet tests, the results show that this parameter is influenced by these conditions, the average surface of the leaf is from 29, 87 ±4,778 cm^2in rain fed year 2011/2012 to 20, 53±5, 26 cm^2 in rain fed year 2012/2013 which corresponds to a decrease of the company 2011/2012 is considered as a favourable year. Leaf areas of both genotypes Bidi17 and Waha were larger (33, 85±1, 406 and 32, 98±4, 37 cm^2 respectively), than the leaf areas of the two other genotypes which are Wahbi and Sémito (26, 81±3,41cm^2 and 25, 84±3, 63 cm^2 respectively, Table 2). However, in rain fed year 2012/2013, the local variety Bidi17 kept its highest leaf area (24, 62±4, 52 cm^2) followed by Sémito (20, 23±7, 13 cm^2) and Wahbi (19, 63±2, 41 cm^2), and the lowest leaf surface was observed in the Waha variety (17, 64±5, 17cm^2).

During the agricultural companion 2011/2012, Plant height ranged from 82,29±6,58cm for Sémito to 131,75±2,66cm for Bidi17 (Table 2). Otherwise, in season 2012/2013, the Waha variety has the highest straw (87, 32±18, 98 cm) followed by Bidi17 (77, 94±10,91cm) and Sémito (71, 38±7,17cm), while Wahbi showed the lowest size (69, 68±4,82cm). The highest reduction (-40, 93%) due to the climatic condition in 2012/2013 was observed in Bidi17 cultivar (Table 2). The average sizes of genotypes were varied from one year to another. Relatively a lower straw confers to the plant, where severe water stress explains a best tolerance capacity to drought. However, the peduncle length ranged from 13, 75±1,7cm (Waha) to 22±2,082 cm (Bidi17) during 2011/2012 and ranged from 12, 14 ±1,69cm (Bidi17) to 14, 17±3, 38 cm (Waha) during 2012/2013. Bidi 17 and Wahbi produced highest peduncle lengths which were significantly higher for the two other genotypes under both conditions of 2011/12. While under rain fed year 2012/2013, the highest peduncle length was observed in Waha variety (14, 16±1, 78 cm) followed by the rest of variety with a similar values (12, 95±0, 25; Table 2).

Spike length was varied from average value of (9, 48 ±1,08 ;9,5± 0,91 cm) characterised Wahbi and Bidi 17 varieties to 6, 5±0,58 cm in Sémito variety in the 1st year and from 6, 09±0,72cm in Bidi 17 to 5, 42±1,27cm in Sémito in the 2nd year, while the average reduction of this character is -28, 62%.Generally, spike length decreased gradually from the 1st year to the 2nd year especially for selected varieties (in our case, is Wahbi cultivar with the highest reduction value of -40, 44%; Table 2).

C. Agricultural characters:

Comparisons were made between durum wheat genotype were used in term of important agronomical traits in the study, four durum wheat genotypes were significantly different from the traits observed (Table 3). According to the results obtained over years in rain fed conditions ,the mean values of genotypes for number of plant per metre square, the number of days to heading and the number of spike per metre square ranged between 166,65±8,88 and 116,19±5,67; 140,62±0,84 and 146,06±1,63; 366,87±32,75 and 180,25±48,33 respectively (Table 2 and 3). Regarding, the Agricultural characters, the thousand kernel weight is a major character of the yield components, the results of this parameter for the four genotypes are varied according to the changing climate conditions in two agricultural companions (Fig 1,2; Table 2). The similar and the highest values are recorded in both Waha and Wahbi varieties which are 55, 49±2, 62g and 55,93±1,28 g respectively followed by Bidi17 and Sémito with 52,65±7,84g and 52,24±6,83 g respectively (Table 2). During 2012/2013, the tested varieties recorded lower significant values from 45,30±5,40 g of Wahbi variety to 51,12±3,25g of Bidi17 variety, which notice that there is a decrease of -17,89; -19, 02%; -10, 62% and 2, 88% for Waha,Wahbi, Sémito, and Bidi17 respectively, compared to the previous year (Table 2).

Table 1: Variance analysis ANOVA of the morphological characteristics, the grain yield and their components of four durum wheat varieties during two agricultural companions 2011/2012 and 2012/2013.

Variables	Genotype effect			Year effect			Genotype ×Year effect		
	CM	F	Pr> F	CM	F	Pr> F	CM	F	Pr> F
NP. m^{-2}	3832,82	8,298	0,0005***	20368,18	44,098	0,0000***	1359,16	2,943	0,053*
NDH	133,36	64,99	0,0000***	236,53	115,26	0,0000***	121,115	59,02	0,0000***
NS.m^{-2}	2047	1,134	0,356^{Ns}	278631	154,308	0,0000***	553	0,306	0,81^{Ns}
LA	66,364	3,542	0,03**	698,445	37,282	0,00003***	36,407	1,943	0,15^{Ns}
PH	1138,657	14,686	0,000012***	4935,460	63,656	0,0000***	929,446	11,988	0,000054***
PL	13,391	2,704	0,068*	192,080	38,795	0,000002***	35,986	7,268	0,001239***
SL	6,025	6,137	0,003**	43,199	43,999	0,00001***	4,545	4,629	0,010824**
NG.S-^{1}	30,945	0,446	0,723^{Ns}	2978,955	42,897	0,0001***	253,747	3,654	0,027**
SW	0,212	0,261	0,853^{Ns}	7,325	9,014	0,006***	0,141	0,174	0,913^{Ns}
BIO	828,382	5,206	0,007**	9194,358	57,784	0,0000***	593,406	3,729	0,025***
TKW	7,81	0,202	0,894^{Ns}	381,833	9,885	0,004***	35,826	0,927	0,443^{Ns}
GY	53,15	2,402	0,093*	6586,076	297,68	0,0001***	64,404	2,911	0,055*

NP. m^{-2}: number of plants per square meter ; NDH (days) : number of days to heading ; NS.m^{-2}: number of spike per square meter ; LA : leaf area ; PH : plant height in cm ; PL : peduncle length in cm ; SL: spike length in cm ; NG.S^{-1}: the number of grains per spike; WS: weight spike in grams; BIO : ground biomass in grams ; TKW : Thousand kernel weight in grams; GY(qx.ha^{-1}): grain yield (quintals per hectare) ; *p ≤ 0,1, **p ≤ 0,05, ***p ≤ 0,001 : respectively significant, highly significant and very highly significant; NS: not significant .

Table 2: Average values of morphological variables, spike weight and date to heading measured in both agricultural companions (2011/12-2012/13): average year, average genotype and average genotype ×year effect

	LA	PH	PL	SL	SW	NDH
Mean year effect (Mean± Ecart type)						
2011/2012	29,87^{a}±4,778	101,41^{a}±19,38	17,76^{a}±3,65	8,11^{a}±1,67	3,540^{a}±0,826	140,62^{b}±0,84
2012/2013	20,53^{b}±5,26	76,58^{b}±12,72	12,86^{b}±2,10	5,79^{b}±0,94	2,59^{b}±0,82	146,06^{a}±1,63
Mean genotype effect						
Waha	25,3^{b}±9,32	90,40^{b}±12,96	13,95^{b}±1,62	6,5^{b}±1,26	2,83^{a}±1,21	139,87^{c}±1,63
Wahbi	23,22^{c}±4,71	83,90^{bc}±15,65	15,08^{ab}±3,76	7,55^{a}±2,19	3,12^{a}±0,94	149,25^{a}±2,77
Bidi 17	29,23^{a}±5,82	104,84^{a}±29,68	17,07^{a}±5,87	7,79^{a}±1,98	3,08^{a}±0,92	141,87^{b}±0,87
Sémito	23,031^{c}±6,036	76,83^{c}±8,64	15,12^{ab}±2,91	5,95^{b}±1,08	3,21^{a}±0,80	142,37^{b}±0,67
Mean genotype ×year effect						
Waha	32,98^{ab}±4,37	93,5^{bc}±2,5	13,75^{d}±1,70	7,0^{b}±1,22	3,25^{a}±1,08	144^{b}±0,91
Wahbi	26,81^{bc}±3,41	98,12^{b}±3,010	18^{b}±2,581	9,48^{a}±1,08	3,79^{a}±0,52	156,5^{a}±0,64
Bidi 17	33,85^{a} ±1,41	131,75^{a}±2,66	22^{a}±2,082	9,5^{a}±0,91	3,4^{a}±1,11	140^{c}±0,70
Sémito	25,84^{cd} ±3,63	82,29^{c-e}±6,58	17,29^{bc}±2,65	6,5^{b}±0,58	3,69^{a}±0,70	143,75^{b}±0,25
Waha	17,64^{e}±5,17	87,31^{bcd}±18,98	14,16^{cd}±1,78	6,02^{b}±1,26	2,41^{a}±1,34	135,75^{d}±0,47
Wahbi	19,63^{de}±2,41	69,68^{e}±4,82	12,17^{d}±1,95	5,64^{b}±0,54	2,46^{a}±0,80	142^{bc}±0,70
Bidi 17	24,62^{cd}±4,52	77,94^{de}±10,91	12,14^{d}±3,38	6,09^{b}±0,72	2,74^{a}±0,65	143,75b±0,85
Sémito	20,23^{cde}±7,13	71,38^{e}±7,17	12,95^{d}±0,49	5,42^{b}±1,27	2,74^{a}±0,63	141c±0,91
G.Mean	25,19±6,85	88,99±20,47	15,31±3,8	6,95±1,782	3,06±0,94	143,34±1,02
LA : leaf area ; PH : plant height in cm ; PL : peduncle length of in cm ; SL: spike length in cm ; WS: weight spike in grams; NDH						

(days) : the number of days to heading ; a, b, c, d, e: homogenises groups by Duncan test.

Table 2: Averages values of grain yield and their components in both agricultural companions (2011/12-2012/13): average year, average genotype and average genotype ×year effect

	NP .m^{-2}	NS.m^{-2}	NG.S^{-1}	BIO	TKW	GY
Mean year effect						
2011/2012	$166,65^{a}$±8,88	$366,87^{a}$±32,75	$55,81^{a}$±9,68	$43,36^{a}$±22,47	$54,08^{a}$±5,12	$36,03^{a}$±7,26
2012/2013	$116,19^{b}$±5,67	$180,25^{b}$±48,33	$36,51^{b}$±8,6	$9,46^{b}$±5,81	$47,17^{b}$±6,65	$7,33^{b}$±2,47
Mean genotype effect						
Waha	$157,38^{a}$±13,18	$285,62^{a}$±115,5	$46,6^{a}$±12,82	$28,78^{a}$±20,32	$50,52^{a}$±8,5	$21,8^{ab}$±14,19
Wahbi	$125,61^{b}$±10,11	$284,06^{a}$±101,6	$46,65^{a}$±19,17	$36,72^{a}$±34,95	$50,61^{a}$±6,74	$25,015^{a}$±18,43
Bidi 17	$162,94^{a}$±16,25	$273,62^{a}$±101,5	48^{a}±12,77	$27,74^{a}$±20,76	$51,88^{a}$±5,61	$18,78^{b}$±13,89
Sémito	$119,75^{b}$±9,69	$250,93^{a}$±110,5	$43,37^{a}$±8,78	$12,38^{b}$±6,87	$49,46^{a}$±7,26	$21,06^{ab}$±17,61
Mean genotype ×year effect						
Waha	191^{a}±2,27	385^{a}±57,44	$55,75^{ab}$±3,30	$45,69^{a}$±12,64	$55,49^{ab}$±2,62	$34,79^{bc}$±4,57
Wahbi	$140,33^{b}$±9,72	370^{a}±27,38	63^{a}±7,78	$63,68^{a}$±28,6	$55,93^{a}$±1,27	$42,05^{a}$±3,74
Bidi 17	202^{a}±10,33	360^{a}±21,21	$58,5^{ab}$±9,146	$45,75^{a}$±11,26	$52,65^{ab}$±7,84	$29,84^{c}$±10,98
Sémito	$133,25^{b}$±12,73	$352,5^{a}$±8,66	46^{bc}±10,36	$18,31^{b}$±3,84	$52,24^{ab}$±6,83	$37,42^{ab}$±2,09
Waha	$123,75^{b}$±7,25	$186,25^{b}$±39,02	$37,5^{cd}$±12,28	$11,86^{b}$±6,40	$45,56^{b}$±9,83	$8,96^{d}$±2,03
Wahbi	$110,88^{b}$±15,44	$198,12^{b}$±60,39	$30,31^{d}$±9,19	$9,77^{b}$±9,56	$45,29^{b}$±5,39	$7,97^{d}$±2,10
Bidi 17	$123,88^{b}$±10,73	$187,25^{b}$±61,15	$37,5^{cd}$±1,77	$9,73^{b}$±3,86	$51,11^{ab}$±3,25	$7,72^{d}$±1,76
Sémito	$106,25^{b}$±12,43	$149,37^{b}$±30,98	$40,75^{cd}$±7,36	$6,45^{b}$±1,23	$46,69^{ab}$±7,47	$4,69^{d}$±2,30
G.Mean	141,42±38,94	273,56±103,13	46,16±13,31	26,40±23,60	50,62±6,81	21,6±15,52

NP .m^{-2} : number of plants per square meter ; NS.m^{-2}: number of spike per square meter ; NG.S^{-1}: the number of grains per spike; WS: weight spike in grams; BIO : ground biomass in grams ; TKW : Thousand kernel weight in grams; GY(qx.ha^{-1}): grain yield (quintals per hectare)

However, at the same conditions, the number of grain per spike (NG. $Spike^{-1}$) ranged from the average value of 55, 81±9, 68 NG.$Spike^{-1}$ under rain fed year 2011/2012 to 36, 51±8, 6 NG.$Spike^{-1}$ under rain fed year 2012/2013 with the reduction value (-34, 57%).This component is varied according the climate changing characterised the reproductive stage under tow rain fed year. Drought stress occurring at the anthesis stage under rain fed year 2012/2013 reduced significantly the number of grains per spike. However, the agricultural companion 2011/2012 is considered the favourable year, while Wahbi, Bidi17 and Waha had the highest number of grains per spike, such as (63, 0±7, 78; 58, 5±9,15and 55, 75±3, 30NG. $Spike^{-1}$ respectively, were the lowest values is recorded in Sémito variety with (46±10, 36 NG. $Spike^{-1}$) Spike weight (SW) is varied with a several climate change under two agricultural companions. It is respectively ranged from (3, 54±0,83g) to (2, 59 ± 0,82g; Table 2). Under rain fed year 2012/13 all genotypes produced a smaller spike weight compared to previous year 2011/12 with an average reduction value of (-26, 83%). In addition, the biomass production was highest (with average value 43, 36 ±22,47g) in all genotypes in the 1st year and was lowest (with average value of 9, 46±5, 81 g) for this same genotype's in the 2 nd year, which the average reduction value was (-78, 18%) characterised the biomass production in 2012/2013 compared to the previous test (Table 2).

The grain yield is the quantitative trait which expression is the results of genotype effect, year effect and the interaction between genotypes and years effect. During the agricultural companion 2011/2012, the average grain yield is highly relative compared to the grain yield of durum wheat genotypes in rain fed year 2012/2013 (Table 3). The Wahbi variety is the most productive which recorded the highest performance (42, 05±3, 74 qx.ha^{-1}) followed by Sémito, Waha and Bidi 17, with a decrease values of GY 37, 43±2,09; 34, 79±4, 57 and 29, 83±10,98 qx.ha^{-1} respectively. In contrast, a very lowest GY was observed in all genotypes under rain fed year 2012/2013, it is ranged from 8,96±2,03 qx.ha^{-1} in Waha to 4,70±2,30 qx.ha^{-1} in Sémito , substantial yield losses of all varieties studied in comparison with the performance of the previous test with the average reduction value (-79,65%; Table 2). This reduction was attributed to reduced number of spikes per M^2, the number of grains per spike, the spike weight and the biomass production. This reduction could be explained by climate changing conditions during heading and maturity.

- *Correlation between grain yield and yield components:*

A multi-varies analysis was performed on both tests in the two agricultural companions, namely grain yield, yield components, morphological and phenological characters (date to heading; Table 3). A very highly positive and significant correlations was observed between the grain yield (**GY**) and their components which are **NS.m^{-2}**, **NG.S-^{1}**, **SW**, **BIO** and **TKW** so , the correlation coefficients are **R=0,96***** ; **R=0,88*****; **R=0,96***** ; **R=0,82*****; **R=0,82***** respectively ; and a highly coefficients correlations was observed between the grain yield and the morphological parameters, which are leaf area (**LA)** , peduncle length (**PL)** and speak length (**SL)**, the correlation coefficients are **R=0,71*****; **R=0,66**; R=0,71***** respectively (Table 3; Fig 3) . The date of heading which represents a positive and significant correlation with the agricultural variables studied, which are the speak weight (**SW**), the biomass (**BIO**), a Thousand kernel weight (**TKW**) and the grain yield

Advances in Environmental Biology, 10(4) April 2016, Pages: 108-119

Table 4: Correlation matrix of the different morphological and agricultural variables Analyzed

Variable	Correlations matrix of the diffrent morpgological and agricultural variables analyzed under two rainfed years (2011/1										
	NP.m -2	NDH	LA	PH	PL	SL	NS.m -2	NG.S -1	SW	BIO	TKW	GY
NP.m-2	1,0	0,012ns	0,92***	0,84***	0,62**	0,65**	0,74***	0,76***	0,51	0,69**	0,64**	0,57
NDH		1,0	0,28ns	0,03ns	0,19ns	0,53	0,50	0,58	0,66**	0,67**	0,69**	0,62**
LA			1,0	0,74***	0,61**	0,68**	0,83***	0,82***	0,70***	0,73**	0,84***	0,71***
PH				1,0	0,88***	0,86***	0,61**	0,76***	0,52	0,69**	0,49	0,50
PL					1,0	0,85***	0,68**	0,74**	0,72**	0,63**	0,48	0,66**
SL						1,0	0,72**	0,91***	0,73**	0,90***	0,70***	0,71***
NS.m-2							1,0	0,90***	0,91***	0,84***	0,86***	0,96***
NG.S-1								1,0	0,85***	0,96***	0,88***	0,88***
SW									1,0	0,76***	0,87***	0,96***
BIO										1,0	0,82***	0,82***
TKW											1,0	0,86***
GY												1,00

NP .m^{-2}* : *number of plants per square meter* ; *NDH* (days) :** *the number of days to heading ;* ***NS.m^{-2}*:** *the number of spike per square meter ;* ***LA* :** *leaf area* ; ***PH* :** *plant height in cm ;* ***PL *: peduncle length of in cm ;* ***SL:*** *spike length in cm ;* ***NG.S^{-1}*:** *the number of grains per spike; WS: weight spike in grams;* ***BIO* :** *ground biomass in grams ;* ***TKW* :** *Thousand kernel weight in grams*; ***GY(qx.ha^{-1})*** *: grain yield (quintals by hectare)*; **p ≤ 0,1, **p ≤ 0,05, ***p ≤ 0,001 : respectively significant, highly significant and very highly significant;* ***NS****: not significant.*

the coefficients correlations are **R=0, 66**; R=0, 67**; R=0, 69****and **R=0, 62****respectively. No significant correlation was observed between the dates of heading and the morphological parameters especially leaf area (**LA)**, plant high (PH) and peduncle length (**PL**), the correlation coefficients are **R=0, 28ns; R=0, 03 ns; R= 0, 19 ns** respectively, and between the date of heading and the number of plant per metre square (NP.m^{-2}) (Table 3; Fig 3). Assuming that the some lowest values of the morphological and agricultural variables characterised the genotypes tested may be caused by oxidative stress during the year 2012/2013. Heavy rains that spread from October to April immediately affect the grain yield because of water stagnation in some basic plots which delays the phenomenon of flowering and in the same way affects "grain filling" period which is a critical phase in the production of durum wheat (Fig 3). However, the results showed that the morphological parameters, leaf area, plant height and the peduncle length are positively correlated with each other (Table 3; Fig 3).The correlation values of the measured variables and individuals in the first principal axes are shown in Figure 9. The first two axes (axis 01 and axis 02) explained respectively (73, 82% and 13, 53%), whether 90, 43% of the total variation, the plane formed by these two axes is a good basis for interpretation and evaluation of individuals and the variables measured (Fig 3; 4).

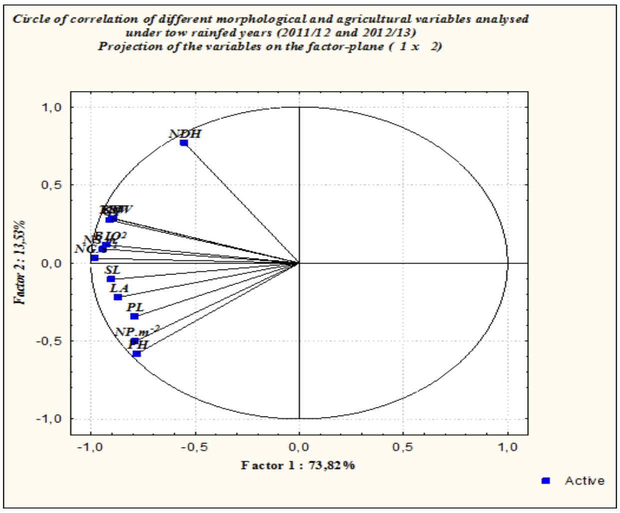


Fig. 3: Circle of correlation of different morphological and agricultural variables both agricultural companions 2011/2012 and 2012/2013

The distribution of individuals indicates the existence of three groups (Fig 4). The first group is formed by the three varieties in growing season 2011/2012; Waha Y1, Wahbi Y1, and Sémito Y1 are characterized by the highest values of the variables NP.m^{-2}, NS.m^{-2}, PH, LA, SL, SL, NG.S^{-1}, WS, TKW, BIO and GY. The second group is diametrically opposite to the first one formed by the four varieties growing under rain fed year 2012/2013 such as Waha Y2, Wahbi Y2, Bidi 17 Y2 and Sémito Y2. These individuals are characterised by the lowest values of this same variables especially agricultural traits. The third group includes the local variety Bidi 17, this cultivar is characterized by the highest values of morphological traits and the longest value of date to heading (Fig 4). The expression of these variables in a given location is likely to change in another location. These results show that the effect of year and the effect of genotypes are present. The behaviour of genotypes varies with climate change in these areas from one year to another (Fig 4).

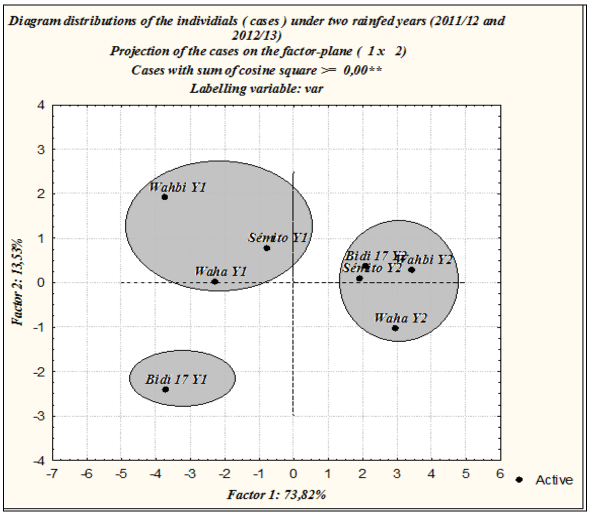


Fig. 4: Diagram distributions of individuals both agricultural companions 2011/2012 and 2012/2013

- *Relationship between grain yield and date heading during two agricultural companions 2011/2012 and 2012/2013:*

A positive and significant correlation was observed between grain yield and heading date in four durum wheat genotypes during the agricultural company 2011/2012 (correlation coefficient is R= 0.959***; Fig 5.C) .The period of this heading is a plant mechanism to avoid drought. In opposite, no significant correlation was observed between grain yield and heading date in four durum wheat genotypes under rain fed year 2012/2013, correlation coefficient is R= 0.187; Fig 5.D). In contrast, during the year 2012/2013, according to the longest sowing-time heading and the lowest yield potential in all genotypes, In addition, late varieties have a low yield potential in an unfavourable year (Fig 5.D).

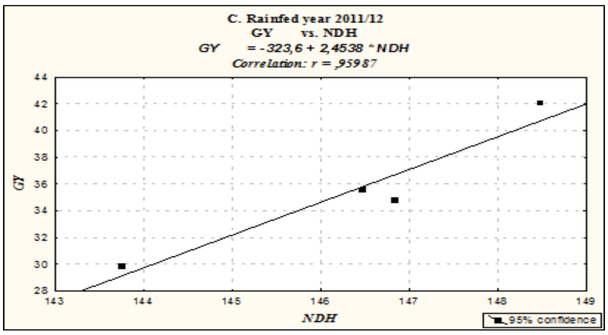


Fig. 5: C. Relationship between grains yields and date to heading under rain fed year 2011/12

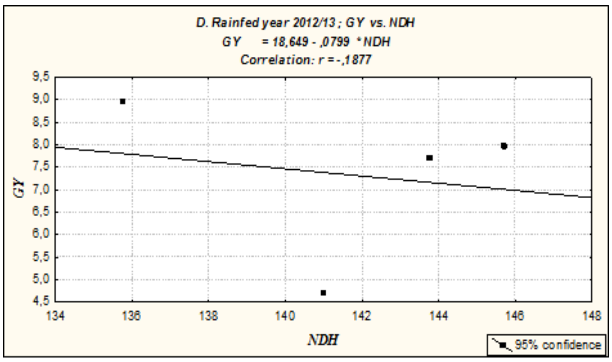


Fig. 5: D.Relationship between grains yields and date to heading under rain fed year 2012/2013

- *Cluster analysis of morpho-phenological and agricultural traits:*

Separate cluster analysis (using Average Linkage between groups method) based on heading date, grain yield and their components were performed between wheat genotypes studies (Fig 6). Using the discriminate function analysis allowed the highest differences among groups when genotypes were categorized into three groups (Fig 6). Mean values of wheat genotypes groups in cluster analysis were presented in table 2and 3. The third group indicated the grain yield GY and majority of the agricultural and morphological traits such as LA, PL, SL, WS, BIO, NG.S-^{1}, and TKW showed maximum deviance of total means and this group may recommend as superior group (Fig 6). Also cluster analysis supported the results of principal component analysis because genotypes Wahbi, Waha and Sémito under rainfed year 2011/12 were in this group and cleared a superiority of these genotypes in both two years for these parameters. Their cluster analysis results showed that these agricultural traits (LA, GY, PL, SL, WS, BIO, NG.S-^{1}, BIO and TKW) were more effective in identifying high yielding cultivars in divers' climatic areas (Fig 6). The second group represented the plant height and the NS.m^{-2} characterized the local cultivar Bidi17 both rain fed years 2011/12.

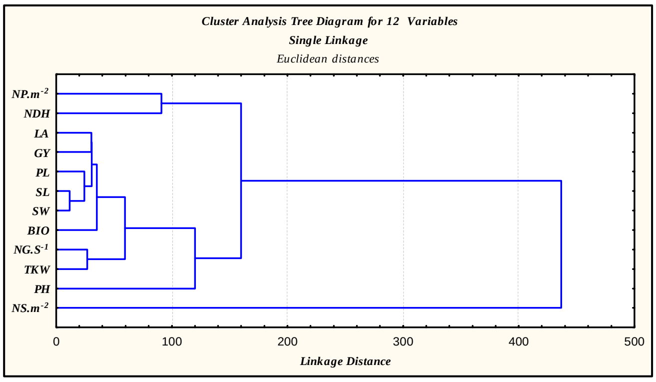


Fig. 6: Clustering of wheat genotypes based on grain yield, morphological, phenological and agricultural, traits during two agricultural companies (2012-13)

Discussion:

According to these results, the varieties studied present a wide variety in behaviour regarding the drought stress during agricultural companions 2011/2012 and 2012/2013, analysis of variance showed that the year effect is present and affects differently all the characters measured. During the agricultural companion 2012/2013, the local variety Bidi17 retains its highest leaf area (24, 62±2, 26 cm^2), the Waha variety recorded the lowest surface. Indeed, according to Blum [4], the reduction in leaf area is considered as a response of adaptation to water shortage. This reduction is a strategy that allows the plant water savings and it will be used to survive during stress and to adapt to an unfavourable environment. Kirkham *et al.,* [22], suggested that a reduced leaf area can be advantageous, since it effectively reduces the total water loss from the plant. The change in the production of plant height shows that the highest stem is stored in the local variety Bidi17 under rain fed year 2011/12. While, under season 2012/2013, the Waha variety has the highest straw (87, 32 ±9, 49 cm). This behaviour can be explained by a higher potential formation of carbohydrate reserves. This contribution of stubble height with substrates stored especially between the last node and the peduncle length which provides grain yield under stress [4]. Moreover, in semi-arid areas, the plant height is pertinent in the selection of varieties which were better adapted to drought and considered as the seat storage assimilates transferred to the grains. The highest peduncle length characterized Bidi 17 and Waha varieties less than two seasons. Evans and Wardlaw argued that peduncle of wheat due to its higher green area, highly intensive photosynthesis and proximity to spike plays an important role in grain filling. Concerning the weight of thousand kernels, a lower value of (TKW) characterizes the four genotypes during the year 2012/2013, this is probably due to a lack of precipitation (May to June: Fig 1). These results were obtained also by Geslin and Jonnard (1948), they reported that a temperature of 30°C for two days only is enough to cause scalding especially milky grain stage in drought conditions. Therefore, average yield reduction due to drought condition of two agricultural companions was -79, 08%. Temperature and precipitations are important environmental factors that have a great impact on durum wheat yield [19], generally; the behaviour of durum wheat in the semi-arid areas is influenced by the climatic conditions of these regions. Severe water stress from the seedling stage to maturity reportedly reduced all grain yield components, particularly the number of fertile ears per unit area by 60%, grain number per spike by 48%, dry mater and harvest index [14]. Under drought conditions during two years, Waha, Wahbi and Bidi 17 had the highest number of spike per metre square and the most number of grains per spike (NG. Spike^{-1}). Since number of grains per spike is typically the yield component that is most thermal stress and drought; it has been suggested as a selection criterion for drought tolerance. A significant positive correlation were found between the grain yield and their components, the number of plants per square meter, the number of spikes per square meter, the number of grains per spike, the spike weight, the Biomass and the thousand kernel weight (Table 3). These results are similar approximate to another study of durum wheat yield components [31,1,20], which found that the number of grains per spike and grain weight had a significant positive effects on grain yield under stress conditions, as well as under well-watered conditions. However, no correlation was observed between these all characters and date to heading (Table 3). Kihç *et al*., [21], it was reported that the number of days for heading, number of spike per m^2, the thousand kernel weight and grain yield of durum wheat are reduced in the drought and terminal heat stress conditions. The time to heading is often used as an indicator which is considered as an important character which influences cereal yields especially in areas where the distribution of rainfall, the variability of temperature and precipitation affect the length of the development cycle of the plant [16]. The significant correlation were found between grain yield and date of heading have been described in four durum wheat genotypes during rain fed year 2011/2012 (Fig 5.C) . This is explained by their precocity, according to escape way that allows them to benefit from the favourable moisture conditions during the season. These results are also confirmed by [10,2]. They considered that the genotypes which flowered and matured early may have been favoured by partial escape from drought and have an ability to complete their life before dehydrated by high summer temperature. Zamani and Nassri [32] considered that the precocity enhances the grain yield of durum wheat.Cluster analysis has been widely used for description of genetic diversity and grouping based on similar characteristics [15,26].

Conclusion:

Developing drought adaptation varieties in arid and semi arid environmental conditions has been accepted as the most important factor for increasing crop potential, yield improvement and stability. Therefore, the identification of effective parameters on yield and their relationship under rain fed conditions is a fundamental challenge for cereals improvement programs. This study focused on the diversity and variation of morphological and agricultural characters of some varieties of durum wheat for adaptation to drought in semi-arid area. Both tests were conducted at the Farm Driver of Technical Institute of Great Cultures; Elkhroub, Constantine, full interior eastern Algeria for two agricultural companions 2011/2012 and 2012/2013. They accuse periods of heat, water and oxidative stress during the vegetative cycle of the plant. These climatic hazards experienced severely disrupted the performance of these four genotypes for adaptation to draught (a heading lateness and a very sharp decrease in yield especially under rain fed year 2012/2013).

On morphological characteristics, genotypes Bidi17 and Waha develop a large plant height during 2011/2012. However, during the rain fed year 2012/2013 the local variety Bidi17 retained its high leaf area, while the Waha variety recorded the lowest surface. The reduction in leaf area can be an advantage because it effectively reduces water loss through transpiration of the plant. The plant height would be relevant to the selection varieties better adapted to drought. Furthermore, our results show that the response of durum wheat to a biotic stress such as drought manifested by morphological changes noticed in the aerial parts. Indeed, stressed plants suffer from reductions in leaf area and the plant height [6]. These changes are introduced by a decrease in photosynthetic capacity [24]. Even so, on agronomic traits, the results of thousand kernel weight of the four genotypes in full fields are valid under climate change of two years. It is a varietals character and a valid criterion for the selection of drought tolerance in durum wheat. Grain yields are generally acceptable for all genotypes studied during the year (2011/2012) with a superiority of Wahbi (42, 05±1, 87 $qx.ha^{-1}$).However, the rain fed year 2012/2013 was the worst in particular for grain yield, this component was decreased in all varieties, especially in Sémito cultivar, these genotype is the most unstable to their potential yield for a given one year to another. Introduced varieties are the least efficient in the semi-arid areas. The reduction in grains yield due to drought stress has been confirmed by Hooker *et al.*, [17]; Gebeyehoub and Knot, [12]; Ali *et al*., [1]. During two years, the biomass and the grain yield are greatest in rain fed year 2011/2012 and are least during the year 2012/2013. Waha and Bidi17 are distinguished by favourable valuations for the majority of variables studied during the year 2011/2012. Moreover, these two genotypes are identified by morphological and agricultural drought adaptations, and can be used as donors of genes to drought adaptation and we suggest their use in any research program of selection in areas and semi-arid areas. This is confirmed by genotype Wahbi which represents a pedigree created by cross between Bidi17, Waha and Bidi17.

Varietals behaviour of durum wheat in semi-arid areas is affected by different types of climatic change conditions that are water stress, thermal stress and oxidative stress from one year to another, which explains the presence of the interaction genotype × environment and the interaction genotype × year. This is a necessary adaptation, stability and thus tolerance to various stresses that characterize the selection environment and production. The results obtained from the study of four varieties are preliminary and necessary for understanding the behaviour of durum wheat production in the interior plains of eastern Algeria (Constantine). Significant positive correlations were found between the grain yield and date to heading, this explain that the introduced and selected genotypes are characterized by highest yield potential and lowest during of days to heading. It is concluded that introduced and selected cultivars performed superior than the local's cultivars under both moisture environment conditions. Heading date is a critical phase that characterizes Cereals in semi arid zone. It is affected by changing weather conditions which directly affect the yield potential of these crops. It is necessaries to test these genotypes are characterized by an early to ensure a good yield for these areas. Ours results indicate that performances of genotypes in terms of traits studied were different at each condition and year.

Appendix:

NP.M^{-2} IS NUMBER OF PLANTS PER SQUARE METER
NDH (DAYS): THE NUMBER OF DAYS TO HEADING
NS.M^{-2}: IS THE NUMBER OF SPIKE PER SQUARE METER
LA: IS THE LEAF AREA
PH: IS THE PLANT HEIGHT IN CM
PL: IS PEDUNCLE LENGTH IN CM
SL: IS SPIKE LENGTH IN CM
NG.S^{-1}: IS THE NUMBER OF GRAINS PER SPIKE;
WS: IS WEIGHT SPIKE IN GRAMS
BIO: IS GROUND BIOMASS IN GRAMS
TKW: IS THOUSAND KERNEL WEIGHT IN GRAMS
GY: IS GRAIN YIELD
QX.HA^{-1}: IS THE QUINTALS BY HECTARE
***P ≤ 0, 1:** IS SIGNIFICANT
****P ≤ 0, 05:** IS HIGHLY SIGNIFICANT
*****P≤ 0,001: IS** VERY HIGHLY SIGNIFICANT
NS: IS NOT SIGNIFICANT
CV: IS THE CRITICAL VALUES OF TURKEY
A, B, C, D, AND **E:** IS THE HOMOGENISES GROUPS BY DUNCAN TEST.
MS: IS MEAN SQUARES
P: IS THE PROBABILITY
Max.T (°C): Maximum temperature
Min.T (°C): minimum temperature
Aver.T (°C)**:** average monthly temperature

ACKNOWLEDGMENTS

My thanks specially to Mr. Benbelkacem Abd Elkader; Research Director of National Agronomic Institute; Elharach; Algeria and Mr. Sakhri Mohamed El Hadi; Director of Technical Institute of Great Cultures. Elkhroub, Constantine. Algeria

REFERENCES

[1] Ali, A., A. Nawab, A. Immrani, A. Mohammad, U. Nimat and Z.A. Swati, 2013. Morphological and genetic diversity of Pakistani wheat germplasm under drought stress. In: International Journal of Advancement in Research & Technology, 2(5): 186-193.
[2] Bayoumi, T.Y., H. Manal and E.M. Metwali. 2008. Application of physiological and biochemical indices as a screening technique for draught tolerance in wheat genotypes. African .J. Biotech, 14: 2341-2352.
[3] Benlaribi, M., P. Monneveux, 1988. Etude comparative en situation de déficit hydrique de deux variétés algériennes de blé dur (*Triticum durum* Desf.) Adaptées à la sécheresse. In : *C* R Séances Acad.Agr.fr. 74(5): 73-83.
[4] Blum, A., 1988. Plants breeding for stress environments, in: Boca Raton, 4, CRC, Press. Florida.USA. p: 223.
[5] Blum, A., 1996. Crop responses to drought and the interpretation of adaptation plant growth regulation. 20. p 135.
[6] Bousba, R., 2012. Caractérisation de la tolérance à la sécheresse chez le blé dur (*Triticum durum* Desf.): Analyse de la Physiologie et de la capacité en production : *Thèse du Doctorats es-Sciences Université de Constantine 1*. p: 117.
[7] Chehat, F., 2007. Analyse macroéconomique des filières, la filière blés en Algérie Projet PAPLIM: Perspectives Agricoles et Agroalimentaires Maghrébines Libéralisation et Mondialisation .7-9 Avril, Alger.
[8] Chenafi, H., H. Bouzerzour, A. Aidaoui and A. Saci, 2006. Yield response of durum wheat (*Triticum durum Desf.*) cultivar Waha to deficit irrigation under semi arid growth conditions. Asian. J. Plant. Sci., 5: 854-860.

[9] CIC., 2013. Bulletin du Conseil International des Céréales, Algérie.
[10] Daaloul, A., H. Bchiri and R. Sayer, 2009. Variabilité génétique de quelques parameters du système racinaire du blé dur sous deux régimes hydriques. Plant. Genetic. Ressources, 129: 25-31.
[11] Djermoun, A., 2009. La production céréalière en Algérie: les principales caractéristiques. Revue Nature et Technologie. N°01 : 45-53.
[12] Gebeyehoub, G., D.R. Knot, Response of durum wheat cultivars to water stress in the field and green house. Can. J. Plant. Sci., 63: 215-223.
[13] Geslin, H. and P. Jonard, 1948. Rendement et composantes du rendement dans l'Environnement Méditerranéen Français.Communication présentée in : Séminaire A-grimed de Bari (Italie). 30 Septembre au 2 Octobre P185-195.
[14] Giuanta, F., R. Mortzo and M. Deielda, 1993. Effect of drought on yield and yield components of durum wheat and Triticale in Mediterranean environment. Field. Crop. Res., 33: 399-409.
[15] Golestani, M and H. Pakniat, 2007. Evaluation of drought tolerance indices in sesame lines.J.Sci.Tech.Agri.Nat.Res., 41: 141-149.
[16] Hadjchristodoulou, A., 1987. The effect of optimum heading date and its stability on yield and consistency of performance barley and durum wheat in dry areas. J. Agri. Sci. Camb., 108: 599-608.
[17] Hooker, M.I., S.H. Mohiuddin and E.T. Kanemasu, 1983. The effect of irrigation timing on yield and components of winter wheat. Can. J. Plant. Sci., 2: 293-303.
[18] Kara, Y., A.L. Martin, D. Rekika and P. Monneveux, 2000. Roots characteristics in durum wheat (*T.turgidum conv.durum*) and some wild *Triticeae Species'*. Genetic variation and relationship with plant architecture. Cereal Research and communication., 28(3): 147-254.
[19] Karimizadeh, R., M. Mohammadi, M. Armion, M.K. Shefazadeh and H. Chalajour, 2012. Determining heritability, reliability and stability of grain yield and yield-related components in durum wheat (*Triticum durum L.*). Bulg. J. Agric. Sci., 18: 595-607.
[20] Kihç, H and T. Yağbasanlar, 2010. The effect of drought stresses on grain yield, yield components and some quality traits of durum wheat (*Triticum turgidum* ssp.durum) cultivars. Not. Bot. Hort. Agrobot. Cluj., 38 (1): 164-170.
[21] Kihç, H., H. Özbek and I. Özberk, 1999. Bazi mkarnalik bugday çeşitlerinin sicak ve kuraga toleranslarinun belirlenmesi in: GAPI. Tarim. Congress. Şanhurfa. 26-28 mayis.
[22] Kirkham, M.B., E.L. Smith, C. Danasobhon and T.I. Draket, 1980. Resistance to water loss of winter wheat flag leaves. Cer. Res Commun.
[23] Laument, P and J. Eroux, 1961. Inventaires des blés durs rencontrés et cultivées en Algérie : Mémoires de la Société d'Histoire Naturelle de l'Afrique du Nord., 5: 96.
[24] Lefi, E., J. Gulias, J. Cifre, M. Ben Yones and H. Medrano, 2004. Drought effects on the dynamics of leaf production and senescence in field-grown *Medicago arborea* and *Medicago criteria*. Ann. Appl. Biol., 144: 176-196.
[25] Loss, S.P and K.H.M. Siddique, 1994. Morphological and physiological traits associated with wheat yield increases in Mediterranean environments. Adv. Agron., 52: 229-276.
[26] Malek shahi, F., H. Dehghani and B. Alizedeh, 2009. Study of drought tolerance indices in some cultivar of winter rapeseed (*Brassica napus L.*) J.Sci.Tech.Agri.Nat.Res., 48: 78-89.
[27] Mekhlouf, A., H. Bouzerzour, A. Benmahammed, A. Hadj Sahraoui and N. Harkati, 2006. Adaptation des variétés de blé dur (*Triticum durum Desf.*) au climat semi-aride. Sécheresse, 17(4): 507-513.
[28] Pinter, J.R.P.J., G. Zipoli, R.J. Reginato, R.D. Jackson and S.B. Idso, 1990. Canopy temperature as an indicator of differential water use and yield performance among wheat cultivars. Agric. Water. Manag, 18: 35-48.
[29] Rajaram, S., 2001. Prospects and promise of wheat breeding in the 21st century. Euphytica., 119: 3-15.
[30] Shpiler, L and A. Blum, 1991. Heat tolerance for yield and its components in different wheat cultivars Euphytica. 51: 257-263.
[31] Simane, B., P.C. Struik, M.M. Nachit and J.M. Peacock, 1993. Ontogenetic analysis of yield components and yield stability of durum wheat in water-limited environments. Euphytica., 71: 211-119.
[32] Zamani, A. S and A. Nasseri, 2008. Response of dry land wheat production and precipitation water productivity to planting date. Asian. J. Plant. Sci., 7: 323-326.