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Water supply efficiency of brought for phenological stages on a few morpho-physiological parameters of the durum wheat (*Triticum durum Desf.*)

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Abstract: Our work consists in quantify the benefits effects of a water supply brought to different phenological phases on the durum wheat yield and morpho-physiological traits associated to it. For this purpose, two tests are performed in the field: the first conducted under rainfed conditions and the second with the addition of water at 50 mm tillering and heading, and 60 mm during the filling phase grain. Results obtained for first trial confirm poor performance in the rainfed treatment compared with the irrigated treatment for all measured characters. However, the effect is more or less significant, depending on the caseon account of difference of the period for elaboration of each component of yield.

Keywords: *Triticum durum* Desf., Water Supply, Morpho- Physiological Traits, Yield, Sidi Bel Abbes

1. Introduction

The environmental stresses are very common in Algeria. Drought, cold and hot weather are often presented. In recent years, drought has become common, thus damaging the northern regions, especially those in western Algeria. The production constraint is abiotic aggravates loss of crop yields, especially durum. In Algeria, the practice of rained agriculture represents only 4.8 million hectares, which constitute almost the half of area, so two million hectares annually are not worked due to lack of rain and especially due to its poor distribution in space and time (Smadhi & Mouhouche, 2000).rainfall deficiency cause an important abiotic stress (frost, high temperatures, soil salinity, etc.) that results a significant yield losses (Baldy, 1992).

In fact, for stability or increased production, two alternatives are presented and must be moreover carried out:

- Further investigation on the identification and definition of morpho-physiological traits of adaptation, resistance, tolerance or escape to water stress,
- Develop a reasoned approach that fits the needs of the plant that help better characterize the water variable (precipitation), identify periods of stress and provide additional water for irrigation (Slama, 2002). This can be done through the identification of drought events, their occurrences, their intensities and durations, identifying likely risks of coincidence of these occurrences with sensitive phases of the plant and finally the estimated contributions of additional water and the responses of the plant in terms of efficiency, which are measured at harvest.

The objective of stabilizing or increasing the yield by additional inflows during critical phases of the growth cycle must be sought in the light of optimum utilization of this water. It is in this context that our work is to characterize six durum wheat genotypes vis-a-vis water stress in two different trials (*Triticum durum Desf.*): The first is conducted under rainfed conditions and the second with a supply of water at different phenological stages by measuring certain morphological, physiological and phenological characters.

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2. Material and Methods

2.1. Biological Material

Six durum wheat genotypes have been the subject of this study (Table 1).

Table 1. *Code, name, pedigree and origin of genotypes tested*

Code	Name	Pedigree	Origin
1	Oued Zénati	Sélection dans la population locale Bidi 17 T *Durum leucomelan*	GUELMA (Algérie)
2	Vitron	JO 's' //fg's'	Espagne
3	Oum Rabie 9	Haurani 27/Joc69	ICARDA (Syrie)
4	Chen 's'	Shwa's'/Bit's'	CIMMYT (Mexique)
5	Waha	Waha's'PLC's'/Ruff//Gta's'/3/Rolette	ICARDA (Syrie)
6	Boussalem	Heider/Marte//Huevo De Oro	ICARDA – CIMMYT

2.2. Study Area

The study was performed during the year 2010/2011 in the experimental station of the Technical Institute of the Field crops in the Sidi Bel Abbes region (Western Algeria), located west longitude 0 ° 38 'to latitude 35 ° 11 'and at an altitude of 486 meters, where the inter-annual and seasonal variability of rainfall is considered the major cause of changes in cereal yields which remain very low, ranging from 3 to 13 quitals / ha as indeed most arid areas where water is a limiting factor (Mourret *& al.,* 1990).

The soil of study area is characterizing by moderate alkaline pH (8.92), non-saline (0.100 µmhos / cm), rich in limestone (24.83%), rich in phosphorus (33.00 ppm), low in organic matter (1.93%) and have a moderate concentration in nitrogen (0.06 %). The climate is semiarid lower-cost winter; precipitations are poorly distributed in space and time, situated between 200 and 400 mm / year, often resulting in significant water deficit (Benseddik & Benabdelli, 2000).

Our experiment was practicing in an environment with a total rainfall of 262.7 mm, and an overall deficit of - 62.3 mm compared to the average Seltzer (1946). This deficit is even greater if we consider the period of settlement stand and tillering which corresponds to december (-7.6 mm) and January (- 28 mm) and the period of maximum development of dry matter which is in February (- 26 mm) (ONM, 2011). In addition, the number of days in winter frost is important during the months of January (13 days) and February (18 days) periods coincided with the installation of the stand and tillering stages.

2.3. Methodology

We have adopted supplementary irrigation system, made by sprinkling. A factorial arrangement is adopted when the main factor is the irrigation system and the secondary factor is all genotypes thus established, planted in randomized blocks with three replications. The unit area is 6 m². The plots are irrigated with the aforementioned irrigation system and soil moisture is measured by gravimetry each decade.

We have applied a phosphorus and nitrogen fertilization background and burndowns anti-cotyledons tillering stage. Sowing was made december 17, 2010 with a population of 250 plants / unit area.

For this study, both treatments were adopted:

1 Treatment 1: control of the water supply is carried out using rain gauges. The amounts of water have been made of two irrigations of 50 mm, made during the two stages tillering and heading, and a third 60 mm irrigation during the grain filling stage, or 160 mm in total.
2 Treatment 2: it is the trial in dry (under rained conditions).

2.4. Evaluation of the Measured Parameters

2.4.1. The Morpho-Phenological Parameters Evaluated are

- The number of days from sowing to heading: number of days from emergence to the release date of 50% of ears per variety and per plot (DHE)
- The number of semi-mature days: number of days from emergence to the date when the envelope spike lose their green color (DMA)
- The plant height (PH): Average height in centimeters plants, measured from the ground to the top of the spikes (barbs not included)
- The spike cervical length (SCL)
- The length of the last inter-node (LLIN)
- The spike length (S.L)
- The beards length (B.L)
- Senescence of the flag leaf (LAD).

2.4.2. The Physiological Parameters are

- Leaf area (SF) by the method of Paul et al. (1979).
- Relative Water Content (RWC) by the method of Barrs (1978).
- Rate water loss (cuticular transpiration) (CT), by the method of Clarke (1990).
- Chlorophyll content (Chl.C) by method Hicox Israelstam & (1978).

2.4.3. Yield Components are

- The tillers number per square meter (Tillers / m²)
- The spikes number per square meter (Spikes / m²)
- The rate of tillers regression (RT.R)
- The grains number per spike (Grs. /spike)
- The thousand kernel weight in grams (TKW)
- Biological yield in quintals per hectare (Bio. yield)

- The crop yield in quintals per hectare (yield grains.)
- Harvest index (HI).

2.5. Statistical Analyses

We have treated our data by the Test of Variance to show means and correlations between our results, for this we have using STATISTICA version 6

3. Results

The observations of our study demonstrate the positive effect of supplemental irrigation on all yield components and show that earliness at heading is a key character in the adaptation of wheat durum to water stress and water intake during this period, and enable it to better express its growth and development, to obtain high yields. In fact, it is therefore imperative to understand the climate risk management, often the cause of low agricultural production. As earliness at heading is a key character in the adaptation of durum wheat to water stress and water intake during this period, and enable it to better express its growth and development, to obtain high yields. It is therefore imperative to understand the climate risk management, often the cause of low agricultural production.

3.1. ANOVA for the Various Traits Measured

The response of the different genotypes tested, providing natural or artificial water, shows an improvement in most of the parameters measured. In our study, we note a significant early genotypes Chen's' and Waha in both treatments with 102.33 respectively, 103 days in rainfed and irrigated 160 and 165.33 (Table 2); and the best Straw yields correspond to greater heights irrigated. Statistical analysis revealed a significant genotype effect and irrigation on all yield components in both treatments (Table 3).

Table 2. *Variance analysis of the morpho-phenological caracters.*

	DHE (days)		DMA (days)		HP (cm)		SCL (cm)	
	Rainfed	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***
- Oued Zénati	*119.67*	*168.67*	*123.67*	*174.67*	*71.25*	*113.75*	20.3	29.20
- Vitron	*116.67*	*165.33*	*122.33*	*174.00*	*69.58*	*115.92*	18.58	22.10
- Chen's'	*102.33*	*160.00*	*117.00*	*170.00*	*55.00*	*81.67*	26.70	32.10
- Boussalem	*109.67*	*167.00*	*112.33*	*164.33*	*67.50*	*90.00*	21.33	28.60
- Waha	*103.00*	*165.33*	*109.00*	*164.33*	*61.25*	*95.83*	21.33	32.93
- Oum Rabie 9	*111.67*	*160.33*	*105.00*	*167.00*	*68.33*	*88.33*	25.24	35.00
- C.v (%)	*2.00*	*1.40*	*1.00*	*1.00*	*8.30*	*7.20*	*8.16*	*14.20*
- Standart variation	*2.17*	*1.62*	*1.65*	*1.74*	*4.45*	*7.02*	*1.94*	*4.26*
- Génotype effect	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*
- Average experimenti	*110.50*	*114.89*	*164.78*	*169.06*	*65.49*	*97.58*	*22.30*	*29.99*

Table 2. *Continued*

	L.LIN (cm)		Spike L (cm)		Barbs L. (cm)	
	Rainfed	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***
- Oued Zénati	9.32	13.36	4.73	4.90	12.46	14.23
- Vitron	10.48	15.05	5.10	4.23	12.77	14.2
- Chen's'	10.1	13.01	5.83	6.13	11.92	13.83
- Boussalem	10.59	13.85	5.63	6.47	12.07	15.7
- Waha	10.63	11.67	6.57	5.90	13.07	14.83
- Oum Rabie 9	8.61	13.37	5.20	5.63	12.46	13.27
- C.v (%)	*10.00*	*9.40*	*6.90*	*11.10*	*7.50*	*13.80*
- Standart variation	*1.69*	*2.20*	*0.38*	*0.62*	*0.93*	*1.98*
- Génotype effect	*NS*	*NS*	*S*	*S*	*NS*	*NS*
- Average experimenti	*9.95*	*13.39*	*5.51*	*5.54*	*12.46*	*14.34*

Table 3. *Variance analysis of yield and its components.*

	Tillers / m²		Spikes / m²		RTR (%)		Grs / épi	
	Rainfed	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***
- Oued Zénati	465.00	551.67	212.50	273.50	61.48	41.18	19.93	24.87
- Vitron	569.17	582.50	206.67	271.67	64.52	52.26	16.67	22.20
- Chen's'	505.33	509.83	287.50	303.33	43.55	40.03	30.60	44.53
- Boussalem	456.17	579.17	247.50	415.00	45.74	28.34	23.73	31.27
- Waha	600.00	726.33	271.67	320.83	54.72	55.85	23.80	30.13
-Oum Rabie 9	529.17	589.17	238.33	335.00	54.96	43.14	27.73	41.07
- C.v (%)	*7.00*	*7.10*	*8.10*	*14.10*	*5.20*	*7.40*	*17.40*	*16.30*
- Standart variation	*37.66*	*71.89*	*19.66*	*45.07*	*7.88*	*6.3*	*4.12*	*5.28*
- Génotypeeffect	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*
- Mean experiment	*538.14*	*572.53*	*244.03*	*320.72*	*54.16*	*43.46*	*23.74*	*32.34*

Table 3. *Continued*

	TKW (grs)		Bio. yield (qx/ha)		HI (%)		Grains yield (qx/ha)	
	Rainfed	***Irrigated***	***Rainfed***	***Irriauted***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***
- Oued Zénati	47.65	56.75	32.18	62.33	17.93	25.61	5.77	15.98
- Vitron	52.00	57.36	30.39	39.65	21.25	32.53	6.46	12.90
- Chen's'	41.60	44.09	51.37	56.85	10.53	42.14	5.41	23.96
- Boussalem	50.33	53.16	41.89	59.49	19.33	28.10	6.28	16.72
- Waha	45.44	49.41	49.04	55.67	12.80	37.11	8.10	20.66
-Oum Rabie 9	44.27	49.60	39.81	44.43	14.01	35.98	5.58	15.99
- C.v (%)	*7.20*	*6.80*	*11.40*	*9.50*	*8.70*	*7.60*	*7.85*	*8.50*
- Standart variation	*3.44*	*3.47*	*5.06*	*6.29*	*8.00*	*7.90*	*0.74*	*3.27*
- Génotypeeffect	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*
- Mean experiment	*47.71*	*50.90*	*40.78*	*53.06*	*15.97*	*33.57*	*6.27*	*17.70*

Table 4. *Variance analysis of the physiological parameters.*

	SF (cm²),		RWC (%)		RWL (gr.10^{-3}/cm2/min)		Chl. C (µg/gMF)	
	Rainfed	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***	***Rainfed***	***Irrigated***
- Oued Zénati	29.42	39.86	33.22	65.95	1.54	1.98	26.23	42.47
- Vitron	36.83	40.05	37.24	67.24	1.04	1.66	37.00	60.02
- Chen's'	32.05	37.46	40.63	68.75	1.38	1.91	26.60	47.35
- Boussalem	29.53	33.96	53.21	70.17	1.02	1.80	29.35	52.24
- Waha	26.04	42.18	47.96	71.25	2.34	3.04	38.73	59.47
- Oum Rabie 9	27.01	34.24	41.02	70.96	1.98	2.51	36.58	60.29
- CV (%)	*9.00*	*12.30*	*4.02*	*8.90*	*9.20*	*12.30*	*9.50*	*10.20*
- standart variation	*4.56*	*5.36*	*7.9*	*6.45*	*0.35*	*0.42*	*2.31*	*4.84*
- Genotype effect	*S*	*NS*	*S*	*NS*	*S*	*S*	*S*	*S*
- Mean experiment	*30.14*	*37.95*	*42.21*	*69.05*	*1.55*	*2.15*	*32.41*	*53.64*

S: significant effect; NS: insignificant effect; CV: coefficient of variation

The relative water contents of six genotypes is higher in irrigated trial conducted (Table 4). Genotypes Boussalem, Waha and Umm Rabie recorded the highest values in both treatments (53.21, 47.96, 41.02, 70.17, 71.25, and 70.96% respectively in dry and irrigated). Also, genotypes lose more water and recorded a rate greater than total chlorophyll irrigated stress conditions (Table 4).

3.2. Correlation between Performance and the Parameters Measured

1 *In the trial conducted under rainfed conditions, yields are correlated:*

- Positively to the spike length (+ 0.621 +) and spike cervical length (+ 0.723); negatively and DHE(- 0.931) and DMA (- 0.747),
- Positively to the spikes number per unit area (+ 0.955) and grains number / spike (+ 0.771); and negatively correlated with the thousand kernels weight (- 0.803)
- Positively to all the physiological parameters measured.

2 *In the trial conducted under irrigation, yields are correlated:*

- Positively to the barbs length (+ 0.894), the harvest index (+ 0.704), the tillers number (+ 0.255) and of spikes per unit area (+ 0.311)
- Negatively total chlorophyll content (- 0.404).

4. Discussion

In the six genotypes, we note a clear difference in all measured parameters, not only between genotypes and between treatments.

Heading date is often used as an important character that influences grain yields, especially in areas where the distribution of rainfall and temperature variability affect the length of the development cycle (Hadjichristodoulou, 1987). It is at this stage that the plant architecture becomes apparent and has a maximum reaches; it often gives an indication of the differential capacity of genotypes (Kirby et al., 1999). In our study, there is a significant negative correlation between not only DH E and final yield (- 0.931) against dry - 0.397 in irrigated), but also with the spike length, grains / spike and TKW (- 0.858, - 0.790, and + 0.762, - 0.853, - 0.705 and + 0.779), respectively in rainfed and irrigated). Given the random distribution of rainfall in semi-arid to arid regions, thus the adoption of genotypes in a relatively short cycle is required. Fisher & Maurer (1978) found that daily gain in early generates an efficiency of 30-85 kg / ha.

In the environment where late frost is a constraint to cereal production (10 days of frost in March), excessive precocity is of no use; rather, it may be a source of instability in grain yields. Too much early is not always advantageous following the negative effects of low spring temperatures on fertility of the pollen grain and that of the ovary (Bouzerzour & Benmahammed 1994). Dodging allows the plant to reduce or cancel the effects of water stress by a good fit of the crop cycle the length of the rainy season (Amigues & *al.,* 2006). Performance of many genotypes was improved by shortening the life cycle in almost all annual crop species (Turner et al., 2001), legume (Subbarao, 1995), as the corn (Fokar & *al.,* 1998).

In fact by using irrigation, we note a significant correlation between plant height, fertile spikelets number, grains number / spike, and the DHE and DMA with a coefficient respectively - 0.815 - 0.877 + 0.705 and + 0.711. By cons in trial in rainfed conditions, the height recorded a low correlation with all the traits measured; water deficit recorded during the run causes regression of large, lower stems and the surface of the outer leaves (Gate *et al.,* 1990). Similarly, it should be noted that the best yields straw correspond to greater heights in irrigated (Oued zenati with a height of 113.75 cm and recording a biological yield of 62.33 quintals / ha). According to Ben Abdellah and Ben Salem (1993), genotypes with high straw have better adaptation to water deficit.

For beards, their length is strongly correlated with irrigated yield (+ 0.894), whereas it is very weakly correlated dry (+ 0.318). Their presence, in cereals, increases the possibility of use of water and the development of dry matter during the maturation of seeds. The photosynthesis in bearded to genotypes hairless show that genotypes are less sensitive to the inhibitory action of high temperatures during grain filling (Fokar & *al.,* 1998). Comparing three durum wheat genotypes by Slama (2002) found that the genotype with the beard most developed under water stress, has the best performance. Indeed, the barbs can improve performance under drought conditions by increasing the photosynthetic area of the spike (Slama *& al.,* 2005).

The reduction in leaf area, when water stress is very important as mechanism for reducing the need for water (Perrier & Salkini, 1987). In rainy conditions, this surface is highly correlated with Chl.C (+ 0.871) and L.LIN (+ 0.975); while it is insignificant in irrigated (+ 0.005).

Researchers conducted under conditions of water restriction on the response of wheat to an addition of natural or artificial water show an improvement in most components of performance that strongly depends on the grains number / spike , weight grains / spike and spikes number / m² (Assem & *al.,* 2006), except for those who are sensitive to the phenomenon of compensation or interaction, which particularly affects the TKW for a high number of grains per spike and / or HI for high biomass production. After the vegetative period, for the development of the biomass used for ensuring the achievement of the breeding season, their development is carried out in several stages. During the first stage, it is to ensure a high rate of heading which ensures better grains / spike. Thereafter, it will, on the one hand to maintain the high number of maximum grain avoiding the phenomenon of seed abortion implemented. On the other hand, it will properly meet these seeds giving good assimilate transfer from vegetative organs, which allows a high TKW.

Factually, tillering is a factor in determining grain yield in cereals (Hucl & Baker 1989) and early during water stress reduces the number and size of tillers in wheat vegetative phase (Davidson & Chevalier, 1990; Stark & Longley, 1986; Blum & *al.,* 1990). Water stress occurring at the vegetative stage causes a reduction in the number of tillers fertileset early during water stress reduces the number and size of tillers in wheat vegetative phase. Waha genotype had the best coefficient of tillering (600 and 726.83 tillers / m², respectively in dry and irrigated). Under rainfed conditions, this component is positively correlated with spikes / m² (+ 0.716) and L. barbs (+ 0.889); by against irrigated, it is correlated to spikes / m² (+0. 5.72).

The ability to produce high-ground biomass indicates a better adaptation to the production environment (Austin *et al.,* 1980). As against an excess of foliage can also lead to a waste of water, following a greater leaf area at a time when the plant has more need (Araus & *al.,* 1998). The appearance of tillers seems to be related to the general characteristics of the genotype and environmental conditions; while their disappearance is linked to deficiencies caused by competition between tillers to environmental factors (Baldy, 1992) and water (Day & *al.*, 1978).

Spikes number / m² comes from the number of tillers emitted by the plant during tillering and tiller number lost during the next phase, and water deficit in the run results in regression of spikes number / m² (Megherbi & *al.,* 2012). This component is highly correlated with the number of spikelets fertile in both treatments with a correlation, coefficient of + 0.723 and + 0.933 respectively in irrigated and dry. The supply of water is a significant way to the formation of the ears stand. Boussalem genotype produced the best number spikes irrigated (415 spikes / m²) and Chen's' dry (287.50 spikes / m²).

For Grs.N / spike, the determination of this component is more complex because it depends on the number of spikelets / spike and number of grains per spikelet that occur at different times of the cycle; and the final amount of each component depends on the number of differentiated organs. Thus, genotypes Oum Rabie and Chen's' maintain a high number grains / spike in both treatments (27.73 and 30.60 in dry, 41.07 and 44.53 respectively irrigated). Under rainfed conditions, this parameter is positively related to S.C.L. (+ 0.980), spikes N. / m² (+ 0.917), and grains yieldns (+ 0.771); while in irrigated, it is positively related to SCL (0751) and spikes N./ m² (+ 0.624) and negatively with plant height (- 0.877).

To make the best bet of the water, increase the useful plant biomass where each party involved in grain filling and thus creating a high TKW (Riou, 1993).

The results show that the difference is not significant between the two treatments for TKW (gain = 3.19 gr). The weather is a key during the maturation phase vis-a-vis the TKW; However, you should know that stress occurring before heading may limit the weight acting on the envelope size (Couvreur, 1985). In rainy conditions, this component is positively correlated with DHE (+ 0.762) and DMA (+ 0.931) and negatively Grs. N. / spike (- 0.884) and grains yield (- 0.804); which irrigated it is positively correlated with plant height (+ 0.630) and DHE (+ 0.779), negatively to Grs. N./ spike (- 0.804) and biological yield (- 0.799). The lack of water after flowering, combined at elevated temperature results in a decrease of TGW by alteration of the rate of grain filling and / or the filling time (Triboi 1990). During this phase, the lack of water results in a reduction of the grain size (scalding), thus is reducing the yield.

Irrigation is very significant effect on biological yield. Irrigated, it is strongly correlated with spike length (+ 0.823), spikes N. / m² (+ 0.855), Grs. N. / spike (+ 0.719) and S.C.L. (+ 0.666). In this context, the genotype Oued zenati recorded the fastest straw yield (62.39 quintals / ha), genotype (at considerable height) seems better use the water supply; followed Boussalem (59.49 quintals / ha).

Genotypes Chen's' and Waha have low H.I. under rainfed conditions (10.80 and 12.53%) and higher in irrigated (42.14 and 37.11%) compared to others. That irrigated, it is positively correlated with the spike length. (+ 0.500) and SCL (+ 0.710), characters highlighted in the selection (Ferrera *et al.,* 2004), spikes N. / m² (+ 0.628), Grs. N. / spike (+ 0.825) and biological yield (+ 0.841); and negatively for TKW (- 0.882) and DHE (- 0.798). In rainy conditions, it is positively correlated with tillers N. / m² (+ 0.796), the spike L. (+ 0.629), to SCL (+ 0.692) and Grs. N. / spike (+ 0.652).

Leaf area is an important determinism sweating thus one of the first responses of plants to drought stress is to reduce the leaf area in order to keep their water resources (Lebon *et al.,* 2004). The results reflect the existence of a positive relationship between the S.F and the TKW, HI, RWC, RWL and L. LIN under rainfed conditions, with respective correlation coefficients of + 0.958 + 0.956 + 0.764 , + 0.965 + and + 0.975 ; and negatively with the tillers number / m². Irrigated, it is positively correlated with the height plant (+ 0.660) and negatively with tillers N. / m² (- 0.725) and grs. N. / spike (- 0.605).

Water scarcity induced in stressed plants, we look a decrease in the RWC, which gives an indication of the water status of the plant at a time when beginning to determine grain yield (Clark & Mac Caig, 1982). Richards and Townley (1987) mentioned that this characteristic is positively correlated to the efficiency of water use. The water content of the sheets decreases proportionally with durum the reduction of water in the soil (Bajji & *al.,* 2001). The decrease in the RWC is faster in susceptible genotypes than in resistant genotypes (Scofield *& al.,* 1988).

Our results also show the existence of a positive correlation between RWC and height (+ 0.715), PMG (+ 0.690), the grains yield (+ 0.538) and HI (+ 0.865) and negatively with tillers N. / m² (- 0.613) under rainfed conditions. Irrigated, there is a positive relationship between RWC and Grs. N. / Spike (+ 0.465) and negatively with DHE (- 0.550), the DMA (- 0.943) and plant height (- 0.819).

For RWC, several researchers have shown that the leaves that come from stressed plants lose more water than non-stressed plants (Clark and Mac Caig, 1982). Kirkham *et al.,* (1980) directly link the loss of water to the leaf surface, the more it is wider, the attrition rate increases as in the case of our study. Some genotypes have the feature to roll their leaves during water deficit, allowing the reduction of water loss by cuticular transpiration. Clark and Romagosa (1991) also note that the rate of loss of leaf water is indicative of the ability of drought tolerance.

RWC, under rainfed conditions, correlates positively with Grs. N. / spike (+ 0. 519), TKW (+ 0.948), the biological yield (+ 0503), the grains yield (+ 0.518), HI (+ 0.907 +) and the RWC (+ 0.669); and negatively tillers N. / m² (- 0.660). In irrigated, the RWL is positively correlated with spikes N. / m² (+ 0531), the RWC (+ 0.670), the Chl. C. (+ 0607) and SCL (+ 0.706) and was negatively correlated with DMA (- 0.572) at tillers N. / m² (- 0.779) and L.LIN (-0837). In rrigated, this parameter is positively correlated to the RWC (+ 0.607) and negatively biological yields (- 0.780); under rainfed conditions, it is positively correlated with height plant (+ 0.601), the TKW (0813 +) to HI (+ 0.930), RWC (+ 0.915), the RWL (+ 0.803), SF (+ 0.871) and L.LIN (+ 0.830) and negatively correlated to the number of tillers / m² (-0.630).

Quantitative differences in the total chlorophyll content noted between genotypes are related to drought tolerance (Gummuluru and Hobbs, 1989). Hireche (2006) shows in his work on alfalfa, the genotype Dessica tends to fight against water stress by lowering its chlorophyll content. Falling Chlorophyll is the consequence of the reduction in stomatal aperture to limit water loss through evapotranspiration and increased resistance to the input of atmospheric CO2 for photosynthesis (Bousba *et al.,* 2009). The amount of chlorophyll of the leaves can be influenced by many factors such as age of the leaves, the leaves and the position of the environmental factors such as light, temperature and water availability.

5. Conclusion

In the Mediterranean region, drought is a major cause of yield losses ranging from 10-80% depending on the year.

As we have pointed out, much of the biomass production is developed before the breeding season, which accounts for the bulk of our two experiments designed to study the effect of supplemental irrigation brought at different phenology stages of the breeding season on yield components of durum wheat. However, the function of development and growth continues to be achieved during the first part of the breeding season, but with less intensity as the results (development of tillers and spikes number per unit area) shows The beneficial effects of supplemental irrigation are apparent for most of the parameters studied. We see that the most important seed weight components are represented by Grs N./ spike and TKW, respectively with a relative production of grains +8.60 / +3.19 gr spike over the trial in terms storm.

The results obtained by the storm treatment especially show that lack of water is much more negatively on the TKW on the number of seeds / spike.

Comparison of results for the first test confirms the poor performance of rainfed treatment versus irrigated treatment for all yield components. Indeed for the second test, a make-up water for each of the three phenological phases had a beneficial effect on all components of performance. However, this effect is more or less important, as appropriate, due to the shift of the period of development of each component of return that actually corresponds to a specific phase of the breeding season. This confirms the interest for focused the most sensitive phases that promote better irrigation water.

Although understanding the mechanisms developed by the cereal in response to additional water supplies is a useful approach, analysis in terms of efficiency only, is less cumbersome to implement and may be recommended to users.

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