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Genetic Variation of Response to irrigation system of three durum wheat varieties (*Triticum durum* Desf.) cultivated in Sidi Bouzid (Tunisia)

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Abstract - The interest of irrigation for the most important widely grown cereal crops in the world, durum wheat, is often questionable essentially in semi-arid climate region like SidiBouzid. In fact, adequate water service is essential for growth and vegetative development of field crop. If rains are insufficient in these regions, irrigation will be necessary to cover field crop needs water. However, farmers can't develop an irrigation strategy which meets these needs while preserving water. In addition, varieties choice which meets edaphoclimatic conditions of this region is not well studied and remains traditional. Our aims is to analyze the genetic variation between khiar, Razzek and Maali durum wheat varieties while evaluating the more adequate method of irrigation into three such as furrow, flood and drip. Our results show that for the same volume of water (400 m^3), the studied varieties have shown the largest grain yields in furrow than in flood irrigation. In addition, these varieties grown with drip irrigation, which uses less water (216 m^3), show grain yields values near from those obtained with flood irrigation. Furthermore, variation observed for this culture seems influenced by irrigation system (IS) effect which is significantly shown on ears number and plant height, and variety (V) effect revealed on its total dry matter and ears weight. This variance can also be explained by the effect of interaction between the irrigation systems and variety (IS X V) that manifest significantly on yield parameters and water use efficiency (WUE).General classification of studied varieties grown on different irrigation system shows that Khiar irrigated with furrow is characterized by important grain yield and large straw.

Key words: durum wheat, semi-arid climate, flood, furrow, drip, grain yield.

1. Introduction

Wheat is one of the most economically important cultivated crops in Tunisia, it covers an average area of 600 000 ha, with an average total production of 1.0-1.2 million tons (Nefzaoui et al. 2012). Tunisian durum wheat germplasm has been well characterized for morphological, physiological and agronomic traits and it has been shown that local germplasm is diverse and it is a source of genes for resistance/tolerance to biotic and abiotic stresses as well as technological qualities (Bœuf 1932; Rezgui et al. 1998; Karmous et al. 2002). Variability study is limited in durum wheat and it particularly decides the effectiveness of selection. It is fact that the higher the variability among the genotypes betters the chances for further improvement in the crop (Subhashchandra et al. 2009). On the other hand, climate variability and socio- economic factors are the main sources of uncertainty and concern for farmers in region, like west center of Tunisia that has experienced severe drought conditions and problems of competing water demands during the last decades. The regional economy of Sidi Bouzid is based on agriculture because of the existence of fertile plains. The governorate has become, in recent years, one of the main agricultural centers of the country. Arable land covers an area of 460 000hectares and irrigated areas cover 36,323 hectares. The main agricultural areas of the governorate are the vegetable crops, cereal crops, forage crops and finally the tree crops. A production of 41000 t/year for cereal crops was in irrigated zones of Sidi Bouzid region. On the other hand, durum wheat production must be simulated under future climate change conditions to evaluate the effects of increased maximum temperature and high rainfall variability on crop yield, and the adaptability of the crop response. In fact, water demand growth in urban, industrial, agricultural and environmental sections creates more competition for the limited and degraded water resources. Hence, it is crucial to plan accurately water resources distribution and allocation to attain sustainable agriculture. Where pests and diseases are controlled and nitrogen is not a limiting factor, water management is the main factor influencing yield for a given environment. This research aims to evaluate the agronomic diversity with three different method of irrigation of khiar, Razzek and Maali durum wheat varieties cultivated in SidiBouzid region of Tunisia.

2. Materials and methods

2.1 Field experiments

The field experiments were carried out on a silt loam soil plots (7.68% clay, 69.60% silt and 22.62% sand) located at Om Laadham station of Sidi Bouzid (Tunisia). This study was conducted during the 2013-2014 company characterized by climatic variation expressed by rainfall, temperature and evapotranspiration (ET0) which are shown in Figure 1.

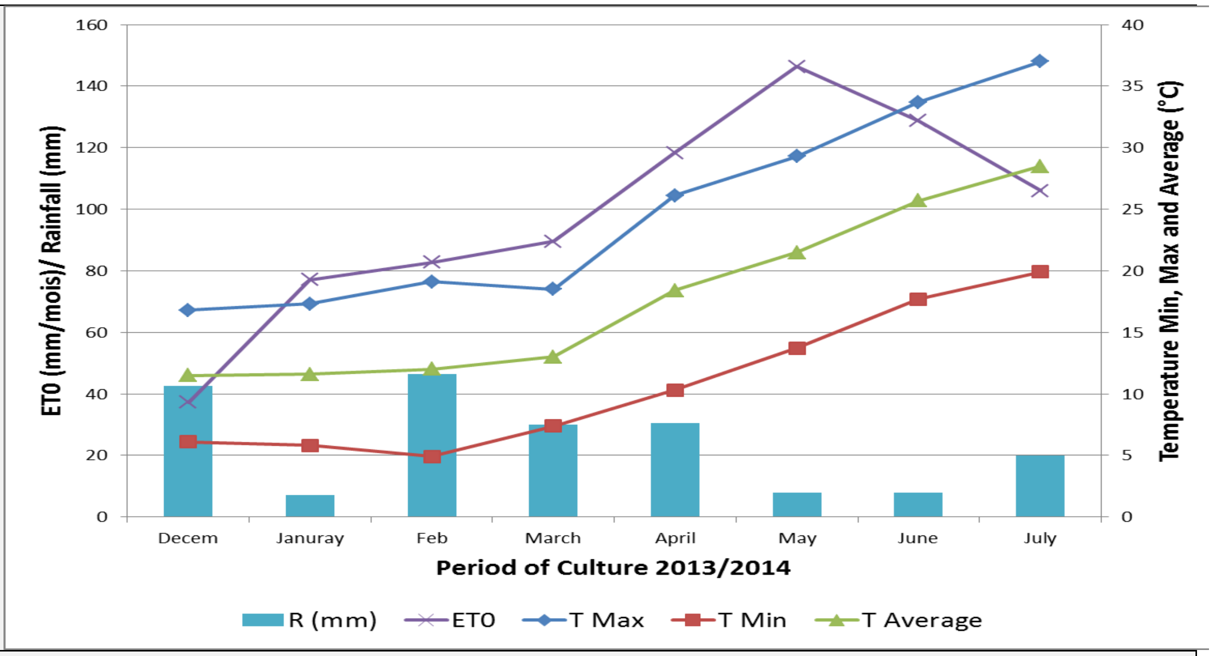

Figure 1: Variation in rainfall, temperature and potential evapotranspiration (ET0) during the culture period of 3 varieties of durum wheat in Om laadham station of SidiBouzid.

These climate data were monitored at a weather station situated in the experimental station. The three studied varieties of durum wheat (Table 1) were grown under three irrigation methods. Each studied varieties irrigated by flood and drip irrigation were repeated 4 times at random and seeded on 6 lines in block sizes 2m / 7m. However those irrigated by furrow irrigation were sown on 3 lines per stripe. Fertilization doses were adapted to plant requirements as three adding of amonitrate 33.5% at 3 leaves stage, heading stage and elongation. To determine areal dry weight (ADW), weight of ear (WE), number of ear (NbE), height of plant (H), grain weight (GW), grain number (GNb), weight of thousands grain (PMG), the grain yield (GY) and grain yield vs water use efficiency (GY_WUE) 1 m^2 sub-plots were hand harvested (Table 2). Irrigation consisted into water applications by three different methods. Flood irrigation when water is pumped to the fields and is allowed to flow along the ground among the crops, drip irrigation involves dripping water onto the soil at very low rates (2l/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers spaced from 10 cm and furrow irrigation consist of pumping water to the stripes.

Table 1: Characteristics of three studied varieties of durum wheat.

Variety	Origin: cross/selection	Pedigree	Date of registration
Razzak	INRAT/INRAT	Karin/Dmx69-331	1987
Maâli	INRAT/INRAT	CMH80A.1046/4TTURA/CMH77//CMH77.774/3YAV79/5/Razzak/6	2007
Khiar	CIMMYT-Mexico/INRAT	Chen"S"/Altar 84 CD57005-1Y-2B-5Y-1M-0Y-0Bj	1992

According to Brajcich et al. (1986): (/) cross giving hybrid F1, (-) in the old system; (//) a cross between F1 and another parent, (/) in the old system; ("S"): Soeur (sister). Numbers indicate the dosage of the recurrent parent for example 2 and 3.

Table 2: List of measured traits and their abbreviations.

Traits	Abbreviations
areal dry weight	ADW
weight of ear	WE
number of ear	NbE
height of plant	H
grain weight	GW
grain number	GNb
weight of thousands grain	PMG
grain yield	GY
Water use efficiency	WUE

2.2 Statistical analysis

Analysis of the effects of irrigation system, variety, and variety - irrigation system interaction on measured traits was performed using SAS Univeristy Edition (V.9.4). Phenotypic mean values of each variety were compared for all measured traits using the Duncan multiple range test at 5%.

3. Results and discussion

3.1 Genetic variation *vs* irrigation system effect

Table 3 resumes our results. In fact, variation observed for this culture seems influenced by irrigation system (IS) effect which is significantly shown on ears number and plant height, and variety (V) effect revealed on its total dry matter and ears weight. This variance can also be explained by the effect of interaction between the irrigation systems and variety (IS X V) that manifest significantly on yield parameters and water use efficiency (WUE).

3.1.1 Irrigation system effect

The number of ears per m^2 and a high of plant show a significant difference ($P < 0.05$), between the different studied varieties independently to the three irrigation system adopted in this study. We assume that plant involve more its growth favoring the number of ears and the high. This result was also shown by (Draoui et al. 2011) which assume that first water intake in the tillering stage, enables improved and stabilizing the performance of the number of ears per m^2.

3.1.2 Variety effect

Variance analysis showed that significantly studied variety involved its productivity on aerial dry weight and ears weight ($P < 0.05$). This result was confirmed by the positive correlation showed between ears weight and grain yield (Figure 2).

Journal of New Sciences

Table 3: Poroportion, significance effects and means comparison of variety, irrigation system and their interaction on measured traits for studied durum wheat varieties

		Total ADW		**EarsWeight**		**EarsNumber**		**Hight (cm)**		**SeedsWeight**		**SeedsNumber**		**PMG**		**Yield**		**Yield_WUE**	
		Pr	Means	Pr	Means	Pr	Means	Pr	Means	Pr	Means	Pr	Means	Pr	Means	Pr	Means	Pr	Means
Irrigation System (IS)		ns		ns		0,002 **		0,05 *		ns		ns		ns		ns		ns	
	F		700.00 a		424.44 a		463.78 a		107.89 a		258.18 a		3892.6 a		51.74 a		25.82 a		0.36 a
	D		580.00 a		351.11 a		375.56 b		107.89 a		215.42 a		4338.6 a		51.90 a		21.54 a		0.30 a
	Fl		771.67 a		460.00 a		488.11 a		94.06 b		319.43 a		5667.4 a		54.58 a		31.94 a		0.44 a
Variety (V)		0,03 *		0,01**		ns		ns		ns		ns		ns		ns		ns	
	Khiar		816.11 a		514.44 a		458.00 a		101.67 a		310.27 a		4707.9 a		49.54 a		31.03 a		0.43 a
	Razzak		636.11 b		379.44 b		448.33 a		102.39 a		248.26 a		4514.0 a		53.60 a		24.83 a		0.35 a
	Maali		599.44 b		341.67 b		421.11 a		105.78 a		234.51 a		4177.5 a		55.58 a		23.45 a		0.33 a
IS x V		0,02*		0,03*		ns		ns		0.03*		ns		ns		0.03*		0.03*	

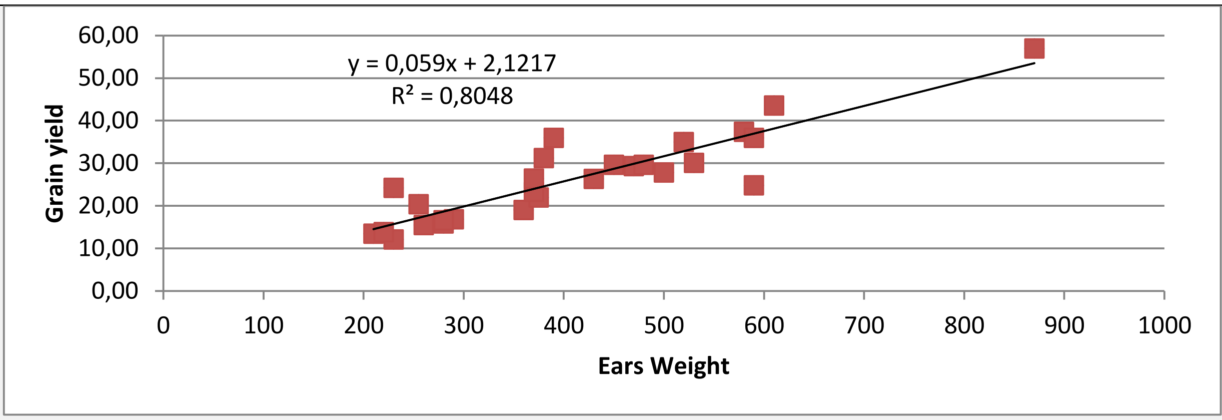

Figure 2: Estimated correlation between ears weight and grain yield for studied durum wheat varieties under the three system of irrigation.

3.1.3 Irrigation system *vs* variety

Analysis effect of the interaction between irrigation system and variety showed that productivity involved by plant was significantly manifested by aerial dry weight, weight of ears and grain per ears, grain yield and water use efficiency (Table 3). In fact water use efficiency for grain yield seems dependent with irrigation system. Furthermore, variation observed between studied varieties was also observed for each one if it was irrigated by furrow, drip or flood irrigation. Moreover, we obtain that for the same volume of water (400 m^3), the studied varieties have shown the largest grain yields in furrow than in flood irrigation. These varieties with drip irrigation, which uses less water (216 m^3) show grain yields values near from those obtained with flood irrigation.General classification of studied varieties grown on different irrigation system shows that Khiar irrigated with furrow is characterized by important grain yield and large straw. This finding is also valid for other Maali and Razzak varieties when they are irrigated by flood system (Figure 3).

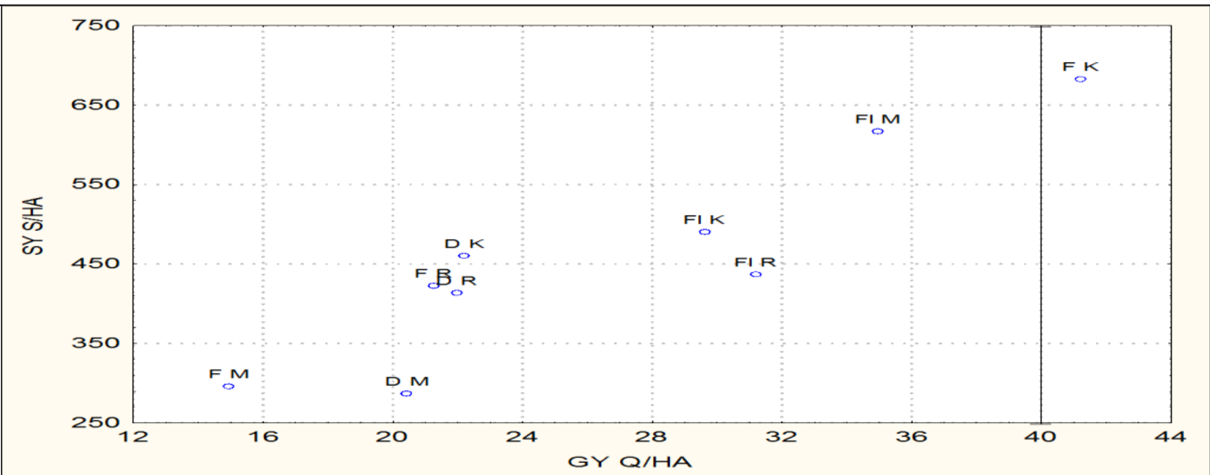

Figure 3: Straw (SY) and Grain (GY) Yield classement of studied varieties cultivated in Furrow (F), Flood (Fl) and Drip (D) irrigations. K: Khiar; M: Maali; R: Razzek.

4. Conclusion:

The significant effect of irrigation system and variety interaction found on grain yield and for yield / water use efficiency ratio suggest that choice of genotype accomplished by irrigation system was crucial to develop a good strategy to support arid climate. Our results confirm previous study of National Institute of Field Corps which showed that khiar variety is the most adequate one for SidiBouzid region of Tunisia. In fact, large areas in the center are cultivated annually in a semi-arid climate characterized by low annual rainfall (200-400mm), erratic and generally left with a bad drought especially during development and grain filling. The differences between the potential yield of durum wheat (9.5 t/ ha) (Brink and Belay 2006) and farm yields (1 t/ ha to 6 t/ ha) are mainly attributed to poor control the technical route and especially to drought (Rajaram and Braun 2008; Latiri et al. 2010). Consequently our study enters in this item in order to develop more extensive agricultural areas. Finally, further study is needed to validate our results where their usefulness should therefore be evaluated in another company.

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