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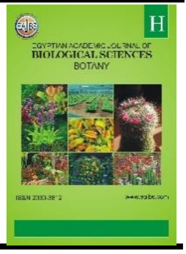

Evaluation Performance of Some Wheat Varieties Under Drought Conditions

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ABSTRACT

The present study was carried out at Abess, Alexandria, Egypt, during the two seasons of 2018/2019 and 2019/2020 to study the performance of wheat varieties by different markers under drought. This experiment was conducted in a split-plot system in three replications during the two seasons. The main plots were irrigation treatments (Full irrigations (control), skipping one irrigation at the vegetative growth stage and skipping one irrigation at the heading stage), wheat varieties (Gemmieza 11, Giza 168, Giza171 and Shandaweel l) distributed in a subplot in both seasons. The obtained results showed that sowing the wheat cultivar Giza 171 or Giza 168 under normal irrigation recorded the highest mean value of yield, yield components, and protein (%) in grain under study conditions at Abess, Alexandria Governorate, Egypt.

INTRODUCTION

Wheat is grown all over the world and covers more of the earth's surface than any other cereal crop. It is an edible grain constituting the staple food for many countries. Wheat is the essential crop in Egypt and grows on an area of 1.41 million hectares with an annual production of about 9.28 million tonnes and with an average yield of 6.58 tons/ha (FAO, 2018).

Wheat (*Triticum aestivum L.*) is grown all over the world and covers more of the earth's surface than any other cereal crop. It is an edible grain constituting the staple food for many countries. There is a lot of challenges facing wheat production in the arid region of Egypt, one of them is drought which is the most devastating abiotic stress factor worldwide. (Mardeh *et al.*, 2006). Wheat yields are reduced by 50–90% of their irrigated potential by drought on at least 60 million ha in the developing world. Development of candidate genotypes at target growing environments and drought conditions and minimizing confounding impacts of other stresses in the breeding programs will improve selection for drought tolerance (Mwadzingeni *et al.*, 2016). On the other side, Mondal *et al.* (2016) revealed that to face wheat production challenges, an aggressive research program is needed to enhance genetic potential, develop new systems, and introduce wheat to new areas, as well as, cultivating wheat under marginal conditions. The ultimate criteria for genotype selection should however be guided by how well the variety integrates its adaptive mechanisms to optimize yields, other than being based on a single trait. Yield is the principle selection index commonly under drought stress conditions. However, the use of selection indices is more efficient than direct selection for grain yield alone (Muhe, 2011).

Environmental stresses are the main constraints for world food production. Though, wheat is probably the only cereal crop that can survive a large range of temperature, altitudes, and water availability ranges (Reynolds and Rebetzke, 2011). Drought is one of the most common environmental stresses that affect the growth and production of crops. Drought remains to be the main challenge to plant breeders. Tolerance to water stress is a complicated parameter in which crop performance can be influenced by many characteristics (Ingram and Bartels 1996). Tolerance can be classified into two parts including drought avoidance and dehydration tolerance (Kramer and Boyer, 1995). Drought avoidance contains root depth, reasonable use of available water by crops, and changes in crops lifestyle to use rainfall. Dehydration tolerance consists of crop capability to partially dehydrate and grow again when rainfall continues (Salekdeh *et al*., 2002).On the other side, drought or any stress reduced the agronomic characters differently among the wheat, barley, and rice among varying growth stages. These crop yields declined. The drought had larger detrimental impacts during the blooming stage, filling stage, and maturity stages. However, water stress reduced wheat performance during the complete growth cycle. (Abid *et al.*, 2016; Baenziger 2016; Zhang *et al.*, 2018; Eltahan *et al*., 2019; Gomaa *et al*., 2019; Sallam *et al.*, 2019; Kandil *et al*., 2020; Fouda *et al*., 2020).

On the other hand, Blum (2005) proposed that plant breeding programs should mainly focus on selecting genotypes that have high yield firstly under yield potential conditions (non-stress) and secondly under stress conditions. To reach this aim, the classical postulate, widely accepted by breeders for selection, is that a genotype with high yield potential will perform well under most environments. Several stress indices have been proposed to screen genotypes for drought tolerance. In contrast, Khayatnezhad *et al*. (2010) revealed that none of these indices could clearly identify varieties with high yield in environments stress and non-stress.

The main objective of this study was to investigate wheat cultivars performance under drought conditions.

MATERIALS AND STUDY AREA

The present study was carried out at Abess, Alexandria, Egypt, during the two seasons of 2018/2019 and 2019/2020 to study the performance of wheat varieties by different markers under water stress.

The preceding crop was maize in the two seasons. The physical and chemical properties of experimental soil are presented in Table (1) which according to the method described by Page *et al.* (1982).

A split plot system with three replications was used in both seasons, were the main plots were irrigation treatments (Full irrigations (control), skipping one irrigation at the vegetative growth stage, and skipping one irrigation at the heading stage), wheat varieties (Gemmieza 11, Giza 168, Giza171 and Shandaweel l) distributed in a subplot in both seasons.

Wheat grains at the rate of 168 kg/ha were sown on 15th and 10th November in 2018/2019 and 2019/2020 seasons, respectively. The area of the subplot was 10.50 m^2 (3.50 m long and 3.00 m width).

Phosphorus fertilizer was added at a rate of 60 kg P_2O_5/ha in the form of calcium superphosphate applied with soil preparation. Mineral nitrogen fertilizer at 168 kg N/ha was in the form of urea (46 % N) applied at two doses the first dose was 112 kg N/ha applied with soil preparation, while the second dose was 56 kg N/ha applied with the first or second irrigation according to the irrigation treatments and K fertilizer was added at a rate of 60 kg K_2O/ha in form potassium sulphate applied soil preparation and all the other cultural practices were followed as Ministry of Agriculture and Land Reclamation recommendations.

Table 1. Physical and chemical properties of experimental soil in both seasons.

Soil properties	Season	
	2018/2019	**2019/2020**
A) Mechanical analysis:		
Clay %	40.00	38.00
Silt %	29.00	31.00
Sand %	31.00	31.00
Soil texture	Clay loam soil	
B) Chemical properties		
pH (1 : 1)	8.00	8.10
Ec (dS/m)	3.99	3.80
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.53	1.54
Ca^{++}	9.30	9.10
Mg^{++}	10.30	12.00
Na^+	11.50	10.60
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.80	2.70
Cl^-	16.40	17.00
SO_4^{--}	11.60	11.50
Calcium carbonate (%)	5.50	6.10
Total nitrogen %	1.10	0.92
Available phosphate (mg/kg)	3.10	3.20
Organic matter (%)	1.52	1.61

At harvest time, plant height (cm), number of spikes/m^2, number of grains/spike, number of spikelets/spike, 1000- grain weight (g) grain yield (t/ha), straw yield (t/ha), biological yield (t/ha), harvest index (%), and grain protein content (%) were recorded in both seasons**.**

Where total nitrogen was determined in digested plant material (wheat grain) calorimetrically by Nessler`s method. Nessler solution (35 IK/100 ml D.W. + 20g HgCl2 / 500 ml D.W.) +120 g NaOH / 250 ml D.W. Reading was achieved using a wavelength of 420 nm and N was determined as a percentage as follows: % N = NH4 % x 0.776485. Protein percentage was determined by estimating the total nitrogen in the grains and multiplied by 5.75 to obtain the percentage according to the method described by AOAC (1995).

All collected data were subjected to analysis of variance according to Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique by means of CoStat (2005) computer software package.

RESULTS AND DISCUSSION

The results in Table (2) showed the effect of irrigation intervals and wheat varieties and their interaction on plant height, number of spikes/m^2, number of spikletes/spike, number of grains/spike, and 1000- grain weight during 2018/2019 and 2019/2020 seasons.

Results in Table (2) showed that irrigation intervals significantly affected in plant height, number of spikes/m^2, number of spikletes/spike, number of grains/spike, and 1000- grain weight, whereas full irrigation recorded the highest mean values of these traits followed by the irrigation treatment skipping the first one, while when skipping one irrigation at vegetative or heading stages decreased all these traits in both seasons. The decrease of these characters may be due to the effect of drought on physiological which is explained by Daryanto *et al.* (2017) who stated that variability of wheat growth and yield might be related to variations in plant physiological traits since different species adopt different adaptation mechanisms to drought. These results are in the same line as those obtained by Leilah and Alkhateeb (2005); Maqbool *et al*. (2015); Abid *et al.* (2016); Baenziger (2016); Daryanto *et al.* (2017); Zhang *et al.* (2018); Sallam *et al.* (2019) they indicated that water stress decreased wheat performance during the complete growth cycle and skipping one or two irrigation caused reducing in growth and yield of the crops.

Results in Table (2) showed the significant difference among the four wheat varieties on plant height, number of spikes/m^2, number of spikletes/spike, number of grains/spike, and 1000-grain weight, in both seasons, where the highest mean values of these characters recorded with sowing Giza 171 variety followed Giza 168, meanwhile the lowest one recorded by Gemmieza 11 in the two seasons. This difference among wheat varieties may be due to genetic factors. These findings are in agreement with those obtained by Abdelsalam and Kandil (2006); Sikder and Paul (2010); Omar *et al.* (2010); Boutraa *et al.* (2011); Farshadfar *et al*. (2012); Bakry *et al.* (2013); Kandil *et al.* (2013); Sharma (2015) they showed significant differences among the genotypes on growth and yield characters of wheat.

Table 2. Plant height, number of spikes/m^2, number of spikletes/spike, number of grains/spike, 1000-grain weight of wheat varieties as affected by irrigation treatments and their interaction in both seasons.

Treatment	Plant height		Number of spikes/m^2		Number of spikletes/spike		Number of grains/spikes		1000- grain weight	
	Seasons									
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
A- Irrigation treatments										
I_1	110.5a	115.7a	422.4a	433.4a	31.9a	35.7a	40.4a	43.7a	41.2a	43.4a
I_2	100.9c	103.5b	393.7b	415.4b	28.8c	32.3b	35.7b	38.1b	39.1b	41.3b
I_3	103.2b	103.1b	385.1b	386.8c	30.2b	32.9b	33.7b	35.6c	38.1b	39.9
LSD at 0.05 (A)	2.2	6.3	17.2	17.9	0.3	2.2	2.1	1.4	1.7	0.9
B- Wheat varieties										
Gemmieza 11	93.8d	96.4d	355.1c	384.9c	26.7d	29.1d	32.3c	34.7c	33.9c	37.3b
Giza 168	107.7b	110.3b	423.5a	416.6b	31.4b	35.1b	38.7a	39.8b	43.0a	44.9a
Giza 171	118.4a	117.8a	424.0a	452.6a	34.2a	37.8a	39.9a	44.2a	44.0a	44.8a
Shandweel 1	99.6c	105.2c	387.1b	393.4c	28.9c	32.4c	35.7b	37.9b	36.9b	39.2b
LSD at 0.05 (B)	2.5	3.6	13.4	16.1	0.3	1.3	2.2	1.9	1.6	3.6
Interaction										
A x B	*	*	*	*	*	*	*	*	*	*

I_1= Full irrigation, I_2= skipping at the vegetative growth stage, I_3= skipping at the heading stage, *: significant difference at 0.05 level of probability.

The results in Tables (3) showed that the interaction between of irrigation treatments and wheat varieties significantly affected plant height, number of spikes/m^2, number of spikletes/spike, number of grains/spike, and 1000- grain weight, in both seasons 2018/2019 and 2019/2020, where the highest mean values of these traits achieved by irrigated wheat variety Giza 171 by full irrigation, while the lowest ones recorded with skipping the at heading stage + Gemmieza 11 in both seasons**.**

Table 3. The interaction effect between irrigation treatments and wheat varieties of plant height, number of spikes/m^2, number of spikelets/spike, number of grains/spike, and 1000- grain weight of wheat in both seasons.

Treatments		Plant height		Number of spikes/m^2		Number of spikletes/spike		Number of grains/spikes		1000- grain weight	
Irrigation treatments	Wheat varieties	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
I_1	Gemmieza 11	97.6	99.0	373.5	418.3	28.0	31.4	38.1	40.2	35.7	38.7
	Giza 168	114.5	120.6	443.1	456.7	33.1	37.1	41.8	45.5	44.4	46.3
	Giza 171	124.5	125.0	463.9	441.0	36.0	40.3	44.3	49.6	45.8	47.9
	Shandweel 1	105.4	118.0	409.3	417.7	30.5	34.1	37.5	39.6	38.8	40.9
I_2	Gemmieza 11	91.5	96.2	337.1	377.5	25.3	28.3	31.1	34.9	32.8	35.9
	Giza 168	103.3	105.3	447.7	478.1	29.9	33.5	36.5	36.9	43.7	46.8
	Giza 171	112.3	114.3	423.7	428.7	32.5	36.4	41.3	44.9	44.1	45.3
	Shandweel 1	96.3	98.3	366.4	377.3	27.5	30.8	33.8	35.6	35.7	37.2
I3	Gemmieza 11	92.3	93.9	354.8	359.0	26.6	27.5	27.7	29.0	33.3	37.3
	Giza 168	105.4	105.0	415.7	423.0	31.1	34.9	37.7	37.0	40.8	41.7
	Giza 171	118.2	114.2	384.3	380.0	34.2	36.6	34.0	38.1	42.2	41.2
	Shandweel 1	97.0	99.2	385.7	385.3	28.9	32.4	35.6	38.4	36.2	39.5
$LSD_{0.05\ (A \times B)}$		4.3	6.3	23.2	27.9	0.5	2.2	3.8	3.3	2.8	6.2

I_1= Full irrigation, I_2= skipping at the vegetative growth stage, I_3= skipping at the heading stage

The results in Table (4) showed the effect of irrigation treatments and wheat varieties and their interaction on grain yield, straw yield, biological yield, harvest index (HI%), and grain protein content (%) in both seasons 2018/2019 and 2019/2020.

Results in Table (4) revealed that irrigation treatments significantly affected in grain yield, straw yield, biological yield, harvest index (HI) and grain protein content, where normal irrigation recorded the highest mean values of these traits followed by the irrigation treatment skipping at the vegetative stage, while when skipping one irrigation at the heading stage gave the lowest ones in both seasons. The decrease of these characters may be due to the effect of drought on physiological which is explained by Daryanto *et al.* (2017) who stated that variability of wheat growth and yield might be related to variations in plant physiological traits since different species adopt different adaptation mechanisms to drought. These results are in the same line as those obtained by These results are harmony with those recorded by Maqbool *et al.* (2015); Abid *et al.* (2016); Baenziger (2016); Daryanto *et al.* (2017); Zhang *et al.* (2018); Sallam *et al.* (2019) they indicated that water stress decreased wheat performance during the complete growth cycle and skipping one or two irrigation caused reducing in growth and yield of the crops. They indicated that water stress decreased wheat performance during the complete growth cycle and skipping one or two irrigation caused reducing in growth and yield of the crops.

Results in Table (4) showed the significant difference among the four varieties of wheat in grain yield, straw yield, biological yield, harvest index (HI), and grain protein content in both seasons, where the highest mean values of these characters recorded with Giza 171 followed by Giza 168, meanwhile, the lowest one recorded by Gemmieza 11 in the two seasons. This difference among wheat varieties may be due to genetic factors. These results are confirmed with those observed by Abdelsalam and Kandil (2006); Sikder and Paul (2010); Omar *et al.* (2010); Boutraa *et al.* (2011); Farshadfar *et al*. (2012); Bakry *et al.* (2013); Kandil et al. (2013); Sharma (2015) they showed significant differences among the genotypes on growth and yield characters of wheat.

Table 4. Grain yield, straw yield, biological yield, harvest index (HI), and grain protein content of wheat varieties as affected by irrigation intervals and their interaction in both seasons.

Treatment	Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (HI)		Grain protein (%)	
	Seasons									
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
A- Irrigation treatments										
I_1	7.6a	6.8a	6.2a	6.4a	13.8a	13.2a	55.1a	51.5a	11.4a	11.5a
I_2	6.5b	6.3b	5.4c	5.9c	11.9b	12.2b	54.6a	51.6a	10.6b	11.0b
I_3	6.1c	5.8c	5.8b	6.3b	11.9b	12.1b	51.3b	47.9b	10.5b	10.9c
$LSD_{0.05\ (A)}$	0.3	0.4	0.3	0.1	0.2	0.3	2.2	1.4	0.3	0.5
B- Wheat varieties										
Gemmieza 11	6.0c	5.8b	5.1d	5.4d	11.1c	11.2d	54.1a	51.8a	9.6c	9.9c
Giza 168	7.4a	6.6a	6.1	6.4b	13.5a	13.0b	54.8a	50.8ab	11.6a	11.9a
Giza 171	7.0a	6.8a	6.4a	7.0a	13.4a	13.8a	52.2b	49.3b	11.9a	12.3a
Shandweel 1	6.6b	6.0b	5.5c	6.0c	12.1b	12.0c	54.5a	50.0b	10.2b	10.4b
$LSD_{0.05\ (B)}$	0.5	0.4	0.2	0.1	0.5	0.4	1.9	1.9	0.3	0.4
Interaction										
A x B	*	*	*	*	*	*	*	*	*	*

I_1= Full irrigation, I_2= skipping at the vegetative growth stage, I_3= skipping at the heading stage
*: significant difference at 0.05 level of probability.

The results in Table (5) showed that the interaction between of irrigation treatments and wheat varieties significantly affected grain yield, straw yield, biological yield, harvest index (HI), and grain protein content of wheat in both seasons 2018/2019 and 2019/2020, where the highest mean values of these traits achieved by irrigated Giza 171 with normal irrigation, while the lowest ones recorded with skipping one irrigation at heading stage with Gemmieza 11 in both seasons**.**

Table 5. The interaction effect between irrigation intervals and wheat varieties of grain yield, straw yield, biological yield, harvest index (HI), and grain protein content of wheat in both seasons.

Treatments		Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (HI %)		Grain protein (%)	
Irrigation	Wheat Varieties	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
I_1	Gemmieza 11	6.9	6.7	5.4	5.4	12.3	12.1	56.1	55.4	9.9	9.6
	Giza 168	8.0	7.4	6.7	6.6	14.7	14.0	54.4	52.9	12.3	12.6
	Giza 171	8.1	6.9	6.6	7.2	14.7	14.1	55.1	48.9	12.5	12.8
	Shandweel 1	7.4	6.2	5.8	6.4	13.2	12.6	56.1	49.2	10.9	10.9
I_2	Gemmieza 11	6.1	5.7	4.8	5.2	10.9	10.9	56.0	52.3	9.4	9.9
	Giza 168	7.3	6.2	5.6	6.1	12.9	12.3	56.6	50.4	10.9	10.9
	Giza 171	6.7	6.9	6.0	6.5	12.7	13.4	52.8	51.5	12.1	12.9
	Shandweel 1	6.0	6.5	5.2	5.7	11.2	12.2	53.6	53.3	9.9	10.4
I3	Gemmieza 11	5.3	5.1	5.1	5.5	10.4	10.6	51.0	48.1	9.5	10.2
	Giza 168	6.9	6.2	6.0	6.6	12.9	12.8	53.5	48.4	11.6	12.4
	Giza 171	5.9	6.5	6.5	7.1	12.4	13.6	47.6	47.8	11.2	11.3
	Shandweel 1	6.3	5.4	5.5	6.0	11.8	11.4	53.4	47.4	9.7	9.8
$LSD_{0.05\ (A\ x\ B)}$		0.8	0.8	0.3	0.1	0.9	0.7	3.2	3.3	0.6	0.7

I_1= Full irrigation, I_2= skipping at the vegetative growth stage, I_3= skipping at the heading stage

Conclusion:

As a result of these two seasons field's study, it was concluded that yield, its components of wheat increased with planting the cultivar Giza 171 or Giza 168 with normal irrigation under study conditions at Abess, Alexandria Governorate, Egypt.

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ARABIC SUMMARY

تقييم أداء بعض أصناف القمح تحت ظروف الجفاف

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القمح أكثر المحاصيل الغذائية أهمية في العالم. وتعتمد عليه ملايين من سكان العالم على الأغذية التي تصنع من حبوبه ويعتبر الغذاء الرئيس لكثير من الدول النامية خاصة مصر. وتقل مياه الري في بعض أوقات موسم القمح مما يقلل من انتاجية القمح ويعود بالضرر على المزارع وهناك بعض الأصناف التي تتحمل نقص المياه واذا تم زراعتها في المناطق التي تعاني من نقص المياه توفر كمية المياه المستخدمة في ريه او أكثر وترتفع كفاءة استخدام المياه. لذا أقيمت تجربتان حقليتان خلال موسمي زراعة 2019/2018 و 2020/2019 لدراسة تأثير فترات الري على بعض أصناف القمح والتداخل بينهما على انتاجية محصول القمح وتحديد الأصناف التى تتحمل الاجهاد المائي باستخدام المعلمات الوراثية المختلفةوكان التصميم المستخدم هو تصميم تجريبي قطع منشقة مرة واحدة في عدد ثلاث مكررات . ووزعت المعاملات عشوائياً كما يلي:

أ- القطع الرئيسية :(معاملات الري وهي : الري العادي ، منع رية في طور النمو الخضري ، منع رية في طور طرد السنابل).

ب- القطع الشقية (4 أصناف من القمح وهي جميزة 11 ، جيزة 168 ، جيزة 171 ، شندويل 1 **).**

ولخصت أهم النتائج فيما يلي:

- أثرت معاملات الري الثلاثة تأثيراً معنوياً على الصفات المدروسة مثل ارتفاع النبات وعدد السنابل في المتر المربع وعد السنيبلات للسنبلة وعدد الحبوب للسنبلة ووزن 1000 حبة ومحصول الحبوب ومحصول القش والمحصول البيولوجي ونسبة البروتين في الحبوب حيث وجد أن الري الطبيعي حقق أعلى متوسطات قيم لهذه الصفات في حين أن منع ريه واحدة في اى من المراحل سواء النمو أو طور طرد السنابل أعطت أقل القيم للصفات المدروسة خلال الموسمين.
- اختلفت أصناف القمح الأربعة معنوياً فيما بينها في الصفات المدروسة مثل ارتفاع النبات وعدد السنابل في المتر المربع وعد السنيبلات للسنبلة وعدد الحبوب للسنبلة ووزن 1000 حبة ومحصول الحبوب ومحصول القش والمحصول البيولوجي ونسبة البروتين في الحبوب حيث حقق زراعة الصنف جيزة 171 أعلى متوسطات قيم لها متبوعاً بالصنف جيزة 168 في حين ان الصنف جميزة 11 اعطى أقل القيم يسبق الصنف شندويل-1 خلال موسمي الزراعة.
- كان التداخل بين عاملي الدراسة معنوياً في جميع الصفات المدروسة حيث حقق زراعة صنف جيزة 171 مع الري الطبيعي أعلى متوسطات قيم للمحصول ومكوناته ومحتوى الحبوب من البروتين في موسمي الدراسة.

التوصية:

تحت ظروف الدراسة بمنطقة ابيس – محافظة الأسكندرية في جمهورية مصر العربية ومن النتائج المتحصل عليها وجد أن زراعة صنف جيزة 171 مع الري العادي أعلى متوسطات قيم للمحصول ومكوناته ومحتوى الحبوب من البروتين مقارنة بزارعة أصنف جميزة 11 أو شندويل 1 مع منع ريه أثناء طور النمو الخضري او طور طرد السنابل.