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RESPONSE OF SOME QUINOA (*Chenopodium Quinoa*) GENOTYPES TO SOME IRRIGATION REGIMES

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ABSTRACT

This study was carried out at the farm of Faculty of Environmental Agricultural Sciences, Arish University, El-Arish, North Sinai, Egypt (31^0 08′ 40.3″ N, 33^0 49′ 37.2″ E), during 2016/2017 and 2017/2018 seasons. The aim of this study is to evaluate the response of three quinoa genotype (Giza 1, Danish KVL3704 and Misr 1) to three irrigation intervals. A split plot design with three replicates using Randomized Complete Block Design (RCBD) was performed. Three irrigation intervals used were [irrigation every (3days (I1), 6 days (I2) and 9 days (I3)]. Results showed that water stress caused a significant reduction in all studied traits except for 1000 -seed weight and carbohydrates content. Increasing irrigation intervals from 3 to 9 days decreased No. of panicles per plant from 13.62 to 9.68 in 2016/2017 season and from 16.29 to 10.53 in 2017/2018 season. Increasing irrigation intervals from 3 to 9 days decreased protein content (%) by (15.11%) in 2016/ 2017 season and (15.95 %) in 2017/2018 season.

Key words: Irrigation intervals, Water stress, Quinoa.

INTRODUCTION

Quinoa (*Chenopodium quinoa* Willd.) is an Indian pseudo-cereal that had been cultivated in the region for at least 5000 years. During European colonization of South America, quinoa was scorned by the Spanish ‘conquistadores’ and even actively suppressed, because of their high place in non-Christian original celebrations. Recently, it has been introduced into United States and Canada and also Europe where it is a good candidate crop for agricultural diversification **(Pulvento *et al*., 2010)**.

Quinoa is the annual Amaranthacea which shows good ability to adapt to various environmental conditions. In particular, they are drought-resistant and tolerate frosts, saline soils, pests and diseases. It grows in the Andes, near the equator, from sea level to a height of more than 4,000 meters but mainly between 2,500 and 4,000 meters. It also bears a wide range of soil pH from 4.5 to 9. In addition, this type is adaptable to different light periods, but there are short and neutral today varities **(Pulvento *et al*., 2010)**.

Quinoa (*Chenopodium quinoa* Willd.) is a seed crop from the Amaranthaceae family **(Abd El-Samad *et al*., 2018)**. Seed can be used in human food, in flour products and in animal feedstock because of its high nutritive value**.** As a result of quinoa nutritional qualities, the global interest in quinoa is increasing rapidly. The high nutritional value of quinoa seeds is attributed mainly to the high content of protein and essential fatty acids, as well as a wide range of minerals and vitamins **(Stikic *et al*., 2015);** there are glycosides that give a better taste but genotypes without saponins or with low saponin contents are

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also known. The saponins are usually removed from the seed during food preparation by rinsing in cold, alkaline water or by mechanical corrosion **(Stikic *et al.*, 2015)**. Special attention has been given to quinoa for people with celiac disease (allergy to gluten), as an alternative to the cereals wheat, rye and barley. Also, quinoa seeds contain high levels of polyphenols and flavonoids, which are beneficial for human health.

Different genotypes show different durations of their developmental stages and also different periods of total growth: 126–157 days under European conditions, 131–200 days in Peru and 110–190 days in South America **(Pulvento *et al.*, 2010)**. The results around the world also confirm the potential of quinoa for growth as an alternative crop in areas where drought, high temperatures, salt stress conditions or poor soil quality are major constraints to effective agricultural productivity. However, soil moisture plays an important role in determining the time and rate of germination and growth of quinoa seedling **(Gonzalez *et al.*, 2009; Stikic *et al.*, 2015)**. Due to their important nutritional values and their ability to grow under different agro-ecological conditions, FAO has chosen quinoa as one of the crops to provide food security in the twenty-first century. Egypt's population growth requires an increase in food production as well as a shift towards environmentally sound sustainable agriculture. Expansion of agriculture is available only in newly reclaimed land in desert areas of Egypt, where, water availability is poor. There is a need to cultivate crops or varieties that require minimal inputs including the availability of soil moisture. Quinoa can be called "untapped", especially for Egypt, because, despite its wide adaptability and nutritional superiority, its commercial potential has remained untapped. High-protein quinoa can help make meals more balanced.

So, this study aimed to evaluate some Quinoa genotypes to different irrigation intervals and their effects on growth parameters and yield under drought stress conditions of North Sinai and similar regions.

MATERIALS AND METHODS

Experiment and Location

This study was carried out at the farm of Environmental Agricultural Sciences Faculty, El-Arish, North Sinai, Arish University during 2016/2017 and 2017/ 2018 seasons. The aim of this study was to evaluate three quinoa (*Chenopodium quinoa* Wild) genotypes (Giza 1, DanishKVL3704 and Misr 1) which were obtained from Crops Research Institute, Agric. Research Center, Ministry of Agric, Egypt to three irrigation intervals (every 3 days, every 6 days and every 9 days) were used. Irrigation was after 40 days from sowing for 2 hr. day^{-1} by GR driooers 4 L hr^{-1}. The irrigation method used was drip irrigation system which gives the chance to supply a specific amount of water for each plant separately. Irrigation was stopped two weeks before harvest. Irrigation every 3 days got 20 irrigations from the beginning of transactions. Irrigation every 6 days got 10 irrigations from the beginning of transactions. Irrigation every 9 days got 7 irrigations from the beginning of transactions. Climate data of the experimental site are presente in Tables 1 and 2. Chemical and mechanical analyses for soil and water were presented in Tables 3 and 4.

Experimental Design

Quinoa seeds were sown on 8th December at the two successive winter seasons (2016/2017 & 2017/2018). The experiment was carried out in split plot design with three replications using Randomized Complete Block Design (RCBD). Three irrigation intervals were randomly distributed

Table 1. Chemical analysis of the irrigation water in two seasons 20016/2017 and 2017/2018

pH	EC	Soluble ions (mel^{-1})							
		Cations				Anions			
	Dsm^{-1}	Ca^{++}	Mg^{++}	Na^{++}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{--}	SO_4^{--}
First seasson (2016 /2017)									
7.55	5.93	20.50	16.80	18.50	0.24	45.92	2.90	-	7.22
Second season (2017 /2018)									
7.60	6.00	21.00	17.00	18.80	0.25	46.75	2.97	-	7.28

Table 2. Physical and chemical properties of the investigated soil profile (0.0-30 cm) in two seasons

Property	First season (2016 /2017)	Second season (2017/2018)
Particles size distribution (%)		
Coarse sand (%)	58.0	59.5
Fine sand (%)	19.8	19.3
Silt (%)	12.9	13.0
Clay (%)	9.3	9.2
Soil texture	Loamy sand	Loamy sand
Bulk density (Mgm^{-1})	1662	1661
Chemical properties (soulube ions (in 1:5 soil water extact)		
Ca^{++} (meq^{-1})	3.90	3.90
Mg^{++}(meq^{-1})	3.62	3.43
Na^{+}(me^{-1})	2.54	2.59
K^{+}(me^{-1})	0.34	0.32
CO_3^{--}(me^{-1})	-	-
HCO_3^{-}(me^{-1})	4.30	4.40
Cl^{-}(me^{-1})	4.70	4.35
SO_4^{--}(me^{-1})	1.50	1.45
EC (dSm^{-1}) in 1:5water extract	0.08	1.02
pH (in 1:2.5 Soil water suspenion extract)	8.10	8.13
Organic matter (%)	0.1533	0.171
$CaCo_3$ (%)	22.43	22.48

Table 3. Averages values of temperature, relative humidity, wind speed and total rain in the first season (2016/2017)

2016-2017 growing season						
Month	Temperature (C°)			Relative humidity (%)	Wind speed (km. h^{-1})	Total rain (mm)
	Max.	Min.	Average	Average	Average	Average
October	27.4	16.3	21.8	69	2.7	8
November	23.6	14.2	18.9	65	3.3	19.5
December	19.6	15.3	17.4	60	3.7	25.3
Jan.	20.6	9.4	15	63	3.5	22.4
Feb.	21.3	11.4	16.3	58	4.3	20.5
Mar.	25.5	20	22.7	55	4.8	15.6
April.	26.4	22.2	24.8	54	3.9	7.4

Table 4. Averages values of temperature, relative humidity, wind speed and total rain in the second season (2017/2018)

2017-2018 growing season						
Month	Temperature (C°)			Relative humidity (%)	Wind speed (km. h^{-1})	Total rain (mm)
	Max.	Min.	Average	Average	Average	Average
October	28.5	18	23.2	73	3.5	6
November	25.3	14.4	19.7	71	3.9	16.2
December	21.4	10.2	15.5	66	4.6	22.2
Jan.	19.2	8.5	13.6	70	4.7	20.3
Feb.	19.9	9.1	13.9	69	5.5	17.1
Mar.	21.3	18.8	16	67	5.7	12
April.	23.7	13.3	18.7	67	4.8	6.1

in main plots and Quinoa genotypes were allocated at random in sub- plots. Each plot area was 17.5 m^2 consisted of 6 rows with 7 m length, the spacing was 50 cm between rows, and both sides of rows were cultivated by sowing rate of 12 g/blot and a sowing depth of 2 cm.

Fertilization

Organic fertilizer was added at a rate of 10 tons/fed^{-1} before planting. Mineral fertilizers were added as recommended where, the levels were (25, 29 and 25 kg/ fed^{-1}) for N, P_2O_5 and K_2O, respectively.

Recorded Data

Yield and yield components

At harvest date after 95 days from sowing, a random sample of ten guarded plants were taken from each plot to measure number of panicles/plant, plant fresh weight (g), plant seed yield weight (g), harvest index HI (%) was calculated as the percentage of plant yield weight per plant fresh weight (**Geerts *et al.*, 2009**), 1000 seeds weight (seed index) (g), Yield (ton fed^{-1}).

Seeds chemical composition

At harvest time a random sample of each plot seeds was taken todetermine seedchemical composition according to **AOAC (2005)**. as follows (moisture, protien, fats, ash and carbohydrates).

Statistical Analysis

The obtained data were subjected to the proper statically analysis of variance based on randomized complete block design according to **Snedecor and Cochran (1990)** using SPSS computer program V.20. Mean alues of treatments were differentiated by using the least significant Range (Duncan's multiple range test) at 0.05 level probability (**Duncan, 1955**).

RESULTS AND DISCUSSION

The effect of irrigation intervals, varieties differences and their interaction on yield components and chemical composition during 2016/2017 and 2017/2018 seasons are presented in Tables 5, 6, 7 and 8.

Yield and its components

Results in Tables 5 and 6 indicate that there were significant effect due to irrigation intervals on most yield components except 1000 - seed weight and yield. Irrigation every 3 days gave the highest values in all yield components in the two seasons. Irrigation every 9 days gave the lowest values in all yield components in the two seasons. Increasing irrigation interval from 3 to 9 days decreased No. panicles from 13.62 to 9.68 in 2016/2017 season and from 16.29 to 10.53 in 2017/2018 season. Increasing irrigation interval from 3 to 9 days decreased plant fresh weight by 24.68% in 2016/2017 season and 22.09 in 2017/2018 season. Increasing irrigation interval from 3 to 9 days decreased plant seed weight from 18.44g to 12.30g in 2016/2017 season and from 21.64 g to 15.28 g in 2017/2018 season. Increasing irrigation interval from 3 to 9 days decreased harvest index by 7.8% in 2016/2017 season and 6.58% in 2017/ 2018 season. Increasing irrigation interval from 3 to 9 days decreased 1000 - seed weight from 3.56 g to 2.95 g in 2016/2017 season and from 3.90 g to 3.03g in 2017/ 2018 season. Increasing irrigation interval from 3 to 9 days decreased yield from 1.85 ton fed^{-1} to 1.23 ton fed^{-1} in 2016/2017 season and from 2.18 ton fed^{-1} to 1.54 ton fed^{-1} in 2017/2018 season. The low effect of water stress on yield could be due to an enhanced remobilization of pre-stored reserves driven towards grain filling, as reported in rice **(Yang *et al.*, 2001)** and pigeonpea **(Subbarao *et al.*, 2000).** Decline in yield traits under water deficit condition is related to the disruptions of leaf gas exchange properties which not only limits the size of source and sink tissues but also phloem loading, assimilate translocation and dry matter partitioning **(Farooq *et al.*, 2009)** Under dehydration stress, reduction of carbon assimilation shortens the grain filling period causing small sized grain which is the probable reason of reduced Seed weight per plant **(Taheri *et al.*, 2011)**. These results are similar to those obtained by **Martínez *et al.* (2009), Mohamed (2016), Fischer *et al.* (2013), Choukr-Allah *et al.* (2016), KIR and Temel (2016), Al-Naggar *et al.* (2017) and Elewa *et al.* (2017)**.

Results in Tables 5 and 6 indicate that there were significant genotype variation in yield components except 1000-seed weight. Giza1 genotype recorded the highest values

Table 5. Effect of irrigation intervals, genotype differences and their interactions on yield and yield components during 2016/2017 season

Treatment		Number of panicles	Plant fresh weight (g)	Plant seed weight (g)	Harvest index (%)	1000 - seed weight (g)	Seed yield (ton fed^{-1})
			Irrigation intervals (I)				
3 days		13.62^{a}	55.02^{a}	18.44^{a}	42.56^{a}	3.56^{a}	1.85^{a}
6 days		12.05^{b}	47.90^{b}	15.55^{b}	41.32^{ab}	3.08^{a}	1.56^{a}
9 days		9.68^{c}	41.44^{c}	12.30^{c}	39.22^{b}	2.95^{a}	1.23^{a}
F.test		*	*	*	*	NS	NS
			Genotypes (G)				
Giza 1		13.03^{a}	54.81^{a}	18.05^{a}	42.73^{a}	3.46^{a}	1.81^{a}
DanishKVL3704		10.26^{b}	40.87^{c}	12.66^{b}	40.68^{ab}	3.01^{a}	1.27^{a}
Misr1		12.05^{ab}	48.68^{b}	15.58^{a}	39.68^{b}	3.11^{a}	1.57^{a}
F.test		*	*	*	*	NS	NS
			Interaction (I*G)			**I**	**G**
3	**Giza 1**	14.74^{a}	60.75^{a}	20.20^{a}	44.12^{a}	3.90^{a}	2.03^{a}
	DanishKVL3704	12.75^{b}	48.30^{c}	16.40^{c}	42.85^{ab}	3.25^{a}	1.65^{a}
	Misr 1	13.36^{b}	56.02^{b}	18.73^{b}	40.71^{abc}	3.55^{a}	1.88^{a}
6	**Giza 1**	42.94^{ab}	55.30^{b}	18.31^{b}	42.94^{ab}	3.40^{a}	1.84^{a}
	DanishKVL3704	40.78^{abc}	40.76^{d}	12.54^{d}	40.78^{abc}	2.74^{a}	1.26^{a}
	Misr 1	40.24^{bc}	47.63^{c}	15.81^{c}	40.24^{bc}	3.10^{a}	1.59^{a}
9	**Giza 1**	11.08^{d}	48.39^{c}	15.65^{c}	41.14^{abc}	3.10^{a}	1.57^{a}
	DanishKVL3704	7.45^{e}	33.55^{e}	9.05^{e}	38.42^{c}	3.05^{a}	$.91^{a}$
	Misr 1	10.50^{d}	42.39^{d}	12.20^{d}	38.10^{c}	2.70^{a}	1.22^{a}
	F.test	*	*	*	*	*	*

*Means with same letter within the same column are not significant ($p<0.05$) according to DMRT

Table 6. Effect of irrigation intervals, genotype differences and their interactions on yield and yield components during 2017/2018 season.

Treatment		Number of panicles	Plant fresh weight (g)	Plant seed weight (g)	Harvest index (%)	1000- seed weight (g)	Seed yield (ton fed^{-1})
				Irrigation intervals (I)			
3 days		16.29^{a}	64.26^{a}	21.64^{a}	43.76^{a}	3.90^{a}	2.18^{a}
6 days		14.05^{b}	57.38^{ab}	19.00^{b}	42.13^{b}	3.52^{a}	1.91^{a}
9 days		10.53^{c}	50.06^{b}	15.28^{c}	40.88^{b}	3.03^{a}	1.54^{a}
F. test		*	*	*	*	NS	NS
				Genotypes (G)			
Giza 1		14.98^{a}	67.00^{a}	20.79^{a}	43.12^{a}	3.86^{a}	2.09^{a}
DanishKVL3704		12.14^{b}	46.66^{c}	15.27^{b}	42.40^{a}	3.17^{a}	1.53^{a}
Misr 1		13.75^{ab}	58.03^{b}	19.85^{a}	41.25^{a}	3.41^{a}	2.00^{a}
F. test		*	*	*	*	NS	NS
I	**G**			**Interaction (I*G)**			
3	**Giza 1**	17.10^{a}	74.17^{a}	23.51^{a}	45.67^{a}	4.25^{a}	2.36^{a}
	DanishKVL3704	15.35^{bc}	54.20^{e}	19.19^{d}	43.43^{ab}	3.65^{a}	1.93^{a}
	Misr 1	16.43^{ab}	64.40^{c}	22.24^{b}	42.18^{bc}	3.80^{a}	2.24^{a}
6	**G**			**Interaction (I*G)**			
	Giza 1	15.20^{bc}	67.19^{b}	20.65^{c}	42.29^{bc}	3.80^{a}	2.08^{a}
	DanishKVL3704	12.25^{d}	46.65^{g}	15.64^{e}	42.67^{bc}	3.40^{a}	1.57^{a}
	Misr 1	14.70^{c}	58.30^{d}	20.71^{c}	41.44^{bc}	3.40^{a}	2.08^{a}
9	**G**			**Interaction (I*G)**			
	Giza 1	12.64^{d}	59.65^{d}	18.22^{d}	41.41^{bc}	3.55^{a}	1.83^{a}
	DanishKVL3704	8.83^{e}	39.11^{h}	11.00^{f}	41.10^{bc}	2.50^{a}	1.10^{a}
	Misr 1	10.12^{e}	51.41^{f}	16.62^{e}	40.13^{c}	3.05^{a}	1.67^{a}
	F. test	*	*	*	*	*	*

*Means with same letter within the same column are not significant ($p<0.05$) according to DMRT

in all studied traits in both seasons. Giza1 genotype recorded the highest number of panicles (13.03), plant fresh weight (54.81 g), plant seed weight (18.05 g) and harvest index (42.73%) in 2016/2017 season and the same genotype recorded the highest number of panicles (14.98), plant fresh weight (67.00 g) and plant yield weight (20.79 g) in 2017/2018 season. Danish KVL3704 genotype recorded the lowest number of panicles (10.26), plant fresh weight (40.87 g) and plant seed weight (12.66 g) in 2016/2017 season and its recorded the lowest number of panicles (12.14), plant fresh weight (46.66 g) and plant seed weight (15.27 g) in 2017/2018 season. This may refer to the genetical differences among the studied genotypes.

According to the interaction between irrigation intervals and genotypes differences on the yield and its components in Tables 5 and 6, results showed significant effect on most yield components except 1000-seed weight. Giza 1 genotype with irrigation every 3 days recorded the highest number of panicles (14.74), plant fresh weight (60.75 g), plant seed weight (20.20 g) and harvest index (44.12) in 2016/2017 season and it recorded the highest number of panicles (17.10), plant fresh weight (74.17 g), plant seed weight (23.51 g) and harvest index (45.67%) in 2017/2018 season. Danish KVL3704 genotype with irrigation every 9 days recorded the lowest number of panicles (7.45), plant fresh weight (33.55 g), plant seed weight (9.05 g) and harvest index (38.42%) in 2016/2017 season and it recorded the lowest number of panicles (8.83), plant fresh weight (39.11 g) and plant seed weight (11.00 g) in 2017/2018 season.

Seed Chemical Composition

Results in Tables 7 and 8 indicate that there were significant variation due to irrigation intervals on all seed chemical composition. Irrigation every 3 days gave the highest values in most seed chemical composition except Carbohydrade in two seasons. Irrigation every 9 days gave the lowest values in most seed chemical composition except Carbohydrade in the two seasons. Increasing irrigation intervals from 3 to 9 days decreased moisture from 8.60 to 6.41 in 2016/2017 season and from 9.28 to 7.10 in 2017/1018 season. Increasing irrigation intervals from 3 to 9 days decreased protein content by 15.11% in 2016/2017 season and 15.95% in 2017/2018 season. Increasing irrigation intervals from 3 to 9 days decreased ash from 4.36 to 3.04 in 2016/2017 season and from 5.57 to 4.17 in 2017/2018 season. Increasing irrigation intervals from 3 to 9 days decreased fat content by (17.58%) in 2016/2017 season and (19.35%) in 2017/2018 season. The percentage of carbohydrades was the highest in irrigation every 9 days in both seasons and vatued (72.37 and 74.08) respectively. Exposure to stress may result in changes in biophysical processes, resulting in stomatal restrictions regarding the supply of carbon dioxide, loss of water vapor and restrictions on non-stomatal components. The water moves from high pressure to low pressure, from the cell to the outside. Resulting in lower moisture in the seeds. Nitrogen compounds, such as proteins and amino acids, are affected by water deficiency and are involved in osmotic adjustment. In the drought there is an increase in the levels of free amino acids and decrease in the rate of synthesis or decrease in proteins, where the protein breaks down into amino acids, including propylene, which is very important in the adaptation of plants during stress. These results are similar to those obtained by **Mohamed (2016)**, **Fischer *et al.* (2013) and (Elewa *et al.*, 2017)**.

Results in Tables 7and 8 indicated that there were significant variatal differences in seed chemical composition except ash and carbohydrates. Giza 1 genotype recorded the highest protein (13.63) and fat (8.56) in 2016/2017 season and it recorded the highest protein (13.91) and fat (9.33) in 2017/2018 season. DanishKVL3704 genotype recorded the highest moisture (8.49), ash (3.86) and carbohydrates (70.58) in 2016/2017 season and it recorded the highest moisture (9.72), ash (5.09) and carbohydrates (72.41) in 2017/2018 season. DanishKVL3704 genotype recorded the lowest protein (10.80) and fat (6.26) in 2016/2017 season and it recorded the lowest protein (11.46) and fat (6.40) in 2017/2018 season. Giza1 genotype recorded the lowest moisture (6.30), ash (3.45) and carbohydrates (68.04) in 2016/2017 season and it recorded the lowest moisture (7.28), ash (4.56) and carbohydrates (69.46) in 2017/2018 season. This may refer to genetical differences among the studied genotypes.

According to the interaction effect between irrigation intervals and genotypes differences on seeds chemical composition, Tables 7 and 8 showed significant effect on all studied traits. Giza1 genotype with irrigation every 3 days recorded the highest protein (14.60) and fat (9.40) in 2016/2017 season and it recorded the highest protein (14.90) and fat (10.00) in 2017/2018 season. DanishKVL3704 genotype with irrigation every 3 days recorded the highest moisture (10.23), ash (4.54) in 2016/2017 season and it recorded the highest moisture (10.96), ash (5.85) in 2017/2018 season. DanishKVL3704 genotype with irrigation every 9 days recorded the lowest protein (9.40) and fat (5.50) in 2016/2017 season and it recorded the lowest protein (9.60) and fat (5.10) in 2017/2018 season. Giza 1 genotype with irrigation every 9 days recorded the lowest moisture (5.20), ash (2.91) in 2016/2017 season and it recorded the lowest moisture (6.26), ash (3.94) in 2017/2018 season. The percentage of carbohydrides was the highest in Landraces in irrigation every 9 days in both seasons in proportion (74.77 and 77.10), respectively.

Table 7. Effect of irrigation intervals, genotype differences and their interactions on seeds chemical composition during 2016/ 2017 season

Treatment	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Carbohydrates (%)
		Irrigation intervals (I)			
3 days	8.60^{a}	13.50^{a}	4.36^{a}	8.13^{a}	65.40^{c}
6 days	7.33^{b}	12.50^{ab}	3.65^{ab}	7.40^{ab}	69.10^{b}
9 days	6.41^{b}	11.46^{b}	3.04^{b}	6.70^{b}	72.37^{a}
F.test	*	*	*	*	*
		Genotypes (G)			
Giza 1	6.30^{b}	13.63^{a}	3.45^{a}	8.56^{a}	68.04^{a}
DanishKVL3704	8.49^{a}	10.80^{b}	3.86^{a}	6.26^{c}	70.58^{a}
Misr 1	7.55^{a}	13.03^{a}	3.74^{a}	7.40^{b}	68.27^{a}
F.test	*	*	*	*	NS
I G		**Interaction (I*G)**			
Giza 1	7.36^{cd}	14.60^{a}	4.09^{a}	9.40^{a}	64.54^{d}
3 DanishKVL3704	10.23^{a}	12.00^{bc}	4.54^{a}	7.00^{bcd}	66.22^{bcd}
Misr 1	8.20^{b}	13.90^{ab}	4.45^{a}	8.00^{abc}	65.45^{cd}
Giza 1	6.35^{e}	13.50^{ab}	3.35^{a}	8.50^{ab}	68.30^{bcd}
6 DanishKVL3704	8.10^{bc}	11.00^{cd}	3.86^{a}	6.30^{cd}	70.73^{abc}
Misr 1	7.55^{bcd}	13.00^{ab}	3.76^{a}	7.40^{bc}	68.29^{bcd}
Giza 1	5.20^{f}	12.80^{abc}	2.91^{a}	7.80^{abc}	71.29^{ab}
9 DanishKVL3704	7.13^{d}	9.40^{e}	3.19^{a}	5.50^{d}	74.77^{a}
Misr 1	6.90^{de}	12.20^{bc}	3.03^{a}	6.80^{bcd}	71.07^{ab}
F.test	*	*	*	*	*

*Means with same letter within the same column are not significant (p>0.05) according to DMRT

Table 8. Effect of irrigation intervals, genotype differences and their interactions on seeds chemical composition during 2017/2018 season

Treatment		Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Carbohydrates (%)
Irrigation intervals (I)						
3 days		9.28^{a}	14.10^{a}	5.57^{a}	8.63^{a}	67.97^{c}
6 days		8.23^{ab}	13.03^{ab}	4.83^{ab}	7.83^{ab}	70.90^{b}
9 days		7.10^{b}	11.85^{b}	4.17^{b}	6.96^{b}	74.08^{a}
F. test		*	*	*	*	*
Genotypes (G)						
Giza 1		7.28^{b}	13.91^{a}	4.56^{a}	9.33^{a}	69.46^{a}
DanishKVL3704		9.72^{a}	11.46^{b}	5.09^{a}	6.40^{c}	72.41^{a}
Misr 1		7.61^{b}	13.60^{a}	4.93^{a}	7.70^{b}	71.08^{a}
F. test		*	*	NS	*	NS
I	**G**	**Interaction (I*G)**				
	Giza 1	8.40^{cd}	14.90^{a}	5.15^{a}	10.00^{a}	66.70^{d}
3	**DanishKVL3704**	10.96^{a}	13.00^{abc}	5.85^{a}	7.60^{bcd}	68.43^{cd}
	Misr 1	8.50^{c}	14.40^{ab}	5.73^{a}	8.30^{abcd}	68.80^{bcd}
	Giza 1	7.20^{e}	13.70^{abc}	4.59^{a}	9.40^{ab}	69.70^{bcd}
6	**DanishKVL3704**	10.00^{b}	11.80^{c}	4.97^{a}	6.50^{de}	71.70^{bc}
	Misr 1	7.50^{de}	13.60^{abc}	4.94^{a}	7.60^{bcd}	71.30^{bc}
	Giza 1	6.26^{f}	13.15^{abc}	3.94^{a}	8.60^{abc}	71.98^{bc}
9	**DanishKVL3704**	8.20^{cd}	9.60^{d}	4.45^{a}	5.10^{e}	77.10^{a}
	Misr 1	6.83^{ef}	12.80^{bc}	4.13^{a}	7.20^{cd}	73.16^{ab}
	F. test	*	*	*	*	*

*Means with same letter within the same column are not significant ($p>0.05$) according to DMRT.

Conclusions

The results indicated that there are differences among the genotypes of quinoa plant and their interactions with irrigation intervals. Drought caused a decrease in seeds chemical compositions, yields and its components. The decrease was evident in irrigation treatments (every 9 days). The decline in yield and its components differ from one genotype to another. Giza 1 genotype gave the highest value while, Landraces genotype gave the lowest yield value.

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الملخص العربى

إستجابة بعض التراكيب الوراثية من نبات الكينوا لبعض أنظمة الرى

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أجريت هذه الدراسة في مزرعة كلية العلوم الزراعية البيئية، جامعة العريش، العريش، شمال سيناء، مصر ٣١ درجه ٨ دقيقة ٤٠,٣ ثانية شمالاً، ٣٣ درجه ٤٩ دقيقة ٢,٣٧ ثانية شرقًا خلال موسمي ٢٠١٦/٢٠١٧ و ٢٠١٧/ ٢٠١٨، والهدف من الدراسة هو تقييم استجابة ثلاثة أصناف من نبات الكينوا (جيزة ١، لاندريسيز، مصر ١) لثلاثة فترات رى (كل ٣ أيام –كل ٦ أيام – ٩ أيام). تم استخدام تصميم القطع المنشقة مرة واحده فى ثلاثة مكررات بإستخدام تصميم القطاعات كاملة العشوائية. أظهرت النتائج أن الإجهاد المائي تسبب في انخفاض كبير في جميع الصفات المدروسة باستثناء وزن ١٠٠٠ بذرة ومحتوى الكربوهيدرات. زيادة فترات الري من ٣ إلى ٩ أيام أدى إلى انخفاض عدد القناديل من ١٣,٦٢ إلى ٩,٦٨ في موسم ٢٠١٦/٢٠١٧ ومن ١٦,٢٩ إلى ١٠,٥٣ في موسم ٢٠١٧/٢٠١٨. زياد فترات الري من ٣ إلى ٩ أيام ادت لإنخفاض البروتين بنسبة (١٥،١١٪) في موسم ٢٠١٦/٢٠١٧ و (١٥،٩٥٪) في موسم ٢٠١٧/٢٠١٨.

الكلمات الإسترشادية: فترات الرى، الإجهاد المائي، الكينوا.

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