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WHEAT RESPONSE TO ASCORBIC ACID UNDER DIFFERENT SOIL WATER STRESS

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ABSTRACT

A field experiment was conducted at Sakha Agricultural Res. Station during 1998/1999 to study the effect of ascorbic acid (C_1 = 1000, C_2 = 3000 ppm as foliar spraying), and soil moisture stress (D_1 = 50%, D_2 = 70% and D_3 = 90% depletion) on yield, yield components, and consumptive use indices of some wheat varieties (V_1 = Sakha 8, V_2 = Sakha 61 and V_3 = Sakha 69).

Results could be summarized as follows:

* Irrigation at 50% depletion produced greater values of grain and straw yields, number of spikes/m^2, number of grains/spike, and 1000 grain weight than at 70% and 90% depletion.
* The variety of Sakha 69 was superiour when compared with Sakha 8, and Sakha 61 for grain and straw yields, number of spikes/m^2, and number of grains/spike, while Sakha 61 had the greatest value of 1000-grain weight.
* The 1000 ppm ascorbic acid (as foliar spraying) resulted in greater values of grain yield, No. of spikes/m^2 and 1000 grain weight than those obtained by 3000 ppm, which has the greatest values of straw yield, and No. of grains/spike.
* The combined interaction (D x V x C) showed significantly positive effect on yield and agronomic traits of wheat crop.

  The values of grain and straw yields as well as 1000 grain-weight reached maximum (3.487, 5.957 ton/fed. and 52.3 gm, respectively) by treatment (D_1 x V_1 x C_1) whereas the treatment (D_2 x V_3 x C_1) and (D_2 x V_2 x C_2) recorded the greatest values of 467 and 41.87 for No. of spikes/m^2 and No. of grains/spike, respectively.

  For consumptive use indices, it was cleared that water consumptive use (Cu) was decreased with increasing soil moisture depletion and the greatest (41.12 cm) was obtained at treatment 50% depletion compared with 25.48 cm for 90% depletion.
* Irrigation at 90% depletion resulted in significant value of W.U.E. (2.29 kg/m^3) in comparison to 50% (1.67 kg/m^3) and 70% (1.97 kg/m^3).
* The greatest values of moisture uptake from the surface layers were 38.25%, 32.83%, and 32.36% with water treatments D_1, D_2, and D_3, respectively.
* For seasonal values of crop coefficient (Kc), generally Blaney-Criddle equation gave over estimated values (1.108, 0.862, and 0.647 for D_1, D_2 and D_3) while Penman and Radiation equations recorded the same values approximately and then each of them can be suitable for using in the studied area.

INTRODUCTION

Egypt is facing new agricultural problems with the high rates of population increase and limited cultivated land area.

The urgent agricultural development requires continuous scientifically based implementation of both vertical and horizontal schemes under more efficient irrigation water management and more effective agricultural practices. Wheat (*Triticum aestivum* L.) is the most important cereal crop in Egypt. Increasing wheat production is essential national target to fill the gap between production and consumption. Water stress is the most important limitation to wheat productivity in semi-arid regions of the world. Water stress significantly decreased spike length, grain weight per spike as well as it restricted grain formation at anthesis stages (Muhammad *et al.*, 1996). Patel and Singh (1998) reported that water stress reduced both grain yield and nutrient uptake in the order P > N > K. On the other hand root and shoot fresh weight yield and transpiration rate were reduced as water stress increased (Hamada and Garab, 1998). Ismail *et al.* (1999) found that all water stress treatments (at tillering, stem elongation and ripening stages) resulted in significant decrease in grain yield and other agronomic characteristics. Therefore using wheat cultivars that can deplete available water more efficiently and are able to tolerate drought is a major goal for increasing productivity in drought prone environment as in Egypt. Recently organic acids (as growth regulators) were investigated for some crops and remarkable responses in their growth and yield were found. Foliar application of ascorbic acid significantly increased grain and straw yields, of wheat crop, the increase in grain yield as related to increase in N-uptake which resulted in higher DM accumulation (Zade *et al.*, 1995). Padole (1981) reported that soaking wheat seeds in ascorbic acid solutions significantly increased the grain yield and N, P, K uptake. In this respect Bhat *et al.* (1987) reported that wheat seed treatment with 50-150 ppm ascorbic acid increased the grain yield and the yield components. They also indicated (1990) that wheat seeds treated with 50, 100 or 150 ppm ascorbic acid increased total chlorophyll content, grain yields, relative water content and leaf moisture content as well as reduced transpiration rates. Genaidy *et al.* (1995) found that adding organic acids such as ascorbic and citric to some field crops i.e. maize, wheat, and faba bean, has a beneficial, role of increasing plant growth and yield whether as single addition or combined with Fe, Mn, Zn, fertilizers nutrients.

The objective of this research is to study the effect of ascorbic acid as foliar spray on yield, agronomic characteristics and water consumptive use indices of some wheat crop varieties under different soil moisture stress in Northern Delta soils.

MATERIALS AND METHODS

A field experiment was carried out during 1998/1999 season at Sakha Agric. Res. Station Farm (Kafr El-Sheikh Governorate) in order to study the effect of ascorbic acid as foliar spraying under different soil water stress on wheat productivity and consumptive water use indices.

The experiment was conducted in split split plot design with three replicates. The main plots devoted to the water treatment and subplots were used to three wheat varieties while the two ascorbic acid concentrations were represented the sub-sub plots. The used treatments were as follows:

A. **Water treatments**: Irrigation at 50% (D_1), 70% (D_2), and 90% (D_3) depletion of the available soil moisture from the successive depth 0-60 cm.

B. **Wheat varieties**: Three cultivars were examined, Sakha 8 (V_1), Sakha 61 (V_2), and Sakha 69 (V_3) were used.

C. **Ascorbic acid concentration**: two levels, 1000 ppm (C_1) and 3000 ppm (C_2) were added foliarly two times (at tillering and booting stages).

Surface soils samples were taken from the experimental land and prepared for analysis.

The particle size distribution was determined according to the pipette method piper (1950), and the chemical analysis according to Black (1965) Table 1. Field capacity, bulk density, wilting point, and available soil moisture, for the experimental soil are recorded in Table 2. The climatic data supplied by Sakha Meteorological Station are listed in Table 3. While Table 4 represented the soil moisture percentage of different soil depth before irrigation.

Table 1: Mechanical and chemical analyses of the experimental soil, before experiment.

Particle size distribution			Texture	pH	ECe	Anions (meq/L)				Cations (meq/L)			
Sand %	Silt %	Clay %	class	1: 2.5	dSm^{-1}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
25.35	31.15	42.92	Clayey	8.11	3.66	0.00	3.80	20.50	12.4	8.5	5.8	22.11	0.35

Table 2: Soil moisture characteristics and bulk density of the experimental field.

Soil depth	Soil moisture percent by weight			Bulk density
	Field capacity	Wilting point %	Available moisture %	gm cm^{-3}
0-15	43.91	23.86	20.05	1.07
15-30	41.09	22.31	18.78	1.12
30-45	39.20	21.27	17.93	1.17
45-60	36.36	19.80	16.56	1.23
Mean	40.14	21.81	18.33	1.15

Table 3: Meteorological data of Sakha Agriculture Research Station during 1998/1999 season.

Month	Temperature °C		Relative humidity		Wind sp. km/hr	Rain mm
	Max.	Min.	Max.	Min.		
Nov. 1998	26.00	12.00	75.40	42.50	73.00	-
Dec. 1998	21.30	8.00	72.20	41.90	109.90	3.6
Jan. 1999	19.33	8.80	69.83	46.69	60.90	7.8
Feb. 1999	17.73	6.73	67.46	46.00	98.11	11.8
Mar. 1999	21.13	10.71	67.84	44.90	109.23	-
April 1999	25.43	9.22	73.57	45.77	124.30	5.1
May 1999	29.27	15.50	70.06	41.42	141.13	-

Table 4: Soil moisture percentage of different soil depth before irrigation.

Soil depth	Depletion of available soil moisture		
cm	50%	70%	90%
0-15	33.89	29.88	25.87
15-30	31.70	27.94	24.19
30-45	30.24	26.65	23.06
45-60	28.08	24.77	21.46

At harvest, one square meter from each plot was harvested to determine grain and straw yields (ton/fed.).

Also, the agronomic characteristics (number of spikes/m^2, number of grains/spike, and 1000-grain weight) were estimated.

Soil-water relations:

1. Water consumptive use (Cu):

Water consumptive use in each irrigation was calculated according to (Hansen *et al.*, 1979) as follows:

$$Cu = \sum_{i=1}^{i=4} \frac{(P_{w2} - P_{w1}) \times (Db_i \times D_i)}{100}$$

Where:

Cu = Water consumptive use (cm) for the effective root zone (0-60 cm).

i = Number of soil layers.

P_{w2}-P_{w1} = Percentage of soil moisture content 48 hours after irrigation and before irrigation for specified soil layer.

Db_i = Bulk density gm/cm^3 of specified layer

D_i = Depth of layer (0-15 cm).

2. Water use efficiency (W.U.E):

$$W.U.E. = \frac{\text{Grain yield (kg fed.}^{-1})}{\text{Actual evapotranspiration m}^3 \text{ fed}^{-1}}$$

3. Soil moisture extraction pattern (S.M.E.P):

It was calculated according to (Hansen *et al.*, 1979) as follows:

$$S.M.E.P = \frac{\text{Cu (layer)}}{\text{Cu (seasonal)}} \times 100$$

4. Crop coefficient (Kc):

Crop coefficient is defined as the ratio between actual crop evapotranspiration (ETa) and potential evapotranspiration (ETp) when both are in large field under optimum growing condition (F.A.O. irrigation and drainage paper, Doorenbos and Pruitt 1977).

$$KC = ETa/ETp$$

Where:

ETa = Actual evapotranspiration

ETp = Potential evapotranspiration

Kc = Crop coefficient

Statistical analysis:

Data are subjected to the statistical analysis according to Snedecor and Cochran (1982) and treatment means were compared by least significant differences (L.S.D.) at the level 1% and 5% probability.

RESULTS AND DISCUSSION

1. Grain and straw yields:

1.1. Grain yield (ton/fed.):

Data in Table 5 show that grain yield was significantly greater with irrigation at 50% depletion of total available soil moisture than 70%, and 90% depletion. The values 2.891, 2.744 and 2.453 ton/fed. were recorded with 50%, 70%, and 90% depletion, respectively. Generally it is clear that grain yield was decreased with increasing the soil moisture stress, these results are in agreement with those obtained by Singh *et al.* (1990), Patel and Singh (1998), and Ismail *et al.* (1999). In this respect Siddique *et al.* (2000), reported that exposure of plants to drought led to noticeable decreases in leaf water potential and relative water content as well as higher leaf temperature, these were associated with a lower photosynthetic rate and then decreased the yield.

Data also reveal that grain yield was significantly affected by studied wheat varieties, the highest value (2.772 ton/fed.) was produced by Sakha 69 followed by 2.727 and 2.589 ton/fed. for Sakha 8 and Sakha 61, receptively. In this regard, such differences might be due to variability among wheat varieties genotypes (Essam *et al.,* 1993). Furthermore, it is shown in Table (5) that Sakha 69 gave the greatest value of number of spikes/m^2 and No. of grain/spike. These results supported the finding of El-Marakby *et al.* (1992) who reported that the greatest direct effect on grain was contributed to number of spikes/plant which amounted to 53.14% due to the genotype.

Table 5: Effect of depletion, cultivars, and ascorbic acid on yield (ton/fed.), and yield components.

Treatments	Yield ton/feddan		No. of spike	No. of grains	1000-grain
	Grain	Straw	per m^2	per spike	weight (gm)
Depletion					
(D_1)50%	2.891 a	5.277 a	372.86 a	37.33 a	48.62 a
(D_2)70%	2.744 b	4.956 b	353.40 a	36.77 b	47.27 b
(D_3)90%	2.453 c	4.577 c	346.18 a	36.18 c	46.09 c
Cultivars					
(V_1) Sakha 8	2.727 a	4.774 b	357.06 b	35.73	47.83 b
(V_2) Sakha 61	2.589 b	4.493 c	336.21 c	36.93	48.67 a
(V_3) Sakha 69	2.772 a	5.543 a	379.17 a	37.62	45.49 c
Ascorbic. conc.					
(C_1)1000 ppm	2.751	4.722	363.04	35.60	48.30
(C_2)3000 ppm	2.641	5.151	351.92	37.92	46.36
L.S.D.	**	**	**	**	**

Means followed by a common letter are not significantly different at 0.05 level by DMRT
***, ** significant at 0.05 and 0.01 probability levels.**

Results also clarified that ascorbic acid had significant effect on grain yield where, the greatest value of grain yield (2.751 ton/fed.) was obtained by 1000 ppm level and 3000 ppm recorded the lowest one (2.641 ton/fed.). These results agree with Bhat *et al.* (1990) and Zade *et al.* (1995), who showed that foliar spraying of ascorbic acid significantly increased grain and straw yield.

Regarding to the influence of interaction (D x V x C) on grain yield, data in Table (6), reveal that the optimum grain yield (3.487 ton/fed.) could be produced by the treatment of Sakha 8 cultivar planted under 50% depletion and sprayed with 1000 ppm ascorbic acid compared to the other two cultivars.

1.2. Straw yield (ton/fed.):

The data given in Table (5) reveal that the straw yield produced under different depletion levels is decreased with increasing the soil water stress. The straw yield decreased with increasing depletion, the magnitudes of decrease were 5.08 and 15.15% under 70% and 90% depletion treatments, respectively as compared with 50% depletion of available soil moisture. Also, data revealed that the mean of straw yield had different values for the three tested varieties, it is observed that variety of Sakha 69 is generally superior in both grain and straw yield production compared with Sakha 8 and Sakha 61 varieties. The highest straw yield value (5.54 ton/fed.) was recorded by Sakha 69 followed by 4.774 and 4.493 ton straw fed^{-1} for Sakha 8 and Sakha 61 varieties respectively. Data in Table (5) show also that ascorbic acid had significant effect on straw yield, it was observed that the largest value was obtained from 3000 ppm, followed by 1000 ppm ascorbic acid concentration. Concerning the effect of interaction (D x V x C) on straw yield as shown in Table (6) it is found that the greatest value of straw yield (6.55/ton/fed) was produced by Sakha 61 variety when sprayed with 3000 ppm ascorbic acid under the 50% depletion of soil available water.

2. Yield components:

2.1. Number of spike per m^2:

Comparing the different treatments of irrigation, it was indicated that the irrigation at 50% depletion of available soil moisture gave the higher number of spikes per m^2 (373.0) followed by 353 and 346, for 70% and 90% depletion, respectively. Data presented in Table (5) reveal that number of spikes per square meter was high significantly affected by wheat varieties. The overall mean values recorded in Table (5). Sakha 69 was significantly superior to Sakha 8 and Sakha 61 varieties such superiority of Sakha 69 might explain the significant higher grain and straw yields by this cultivar as was previous indicated. The over all mean number of spikes/m^2 were 379, 357 and 336, for Sakha 69, Sakha 8, and Sakha 61, respectively. Jack and Major (1994) concluded that number of spikes per plant was the most important yield component determining final yield.

Regarding to the effect of ascorbic acid on number of spikes per m^2, data presented in Table (5), showed that plants were significantly affected by spraying with ascorbic acid, the higher value of number of spikes was produced when plants received 1000 ppm ascorbic acid. The values of 363 and 352 were obtained by 1000 ppm and 3000 ppm ascorbic acid respectively.

The analysis of variance indicated the effect of interaction (D x V x C), on number of spikes per m^2 as recorded in Table (6). Data reveal that the optimum value (467) will be obtained by Sakha 69 when sprayed with 1000 ppm ascorbic acid under 70% depletion of available soil moisture. But the lower value (252), was listed against Sakha 8 variety subjected to 1000 ppm ascorbic acid as foliar application when irrigated at 90% depletion of available soil moisture content.

2.2. Number of grains per spike:

Data in Table (5) indicate that irrigation treatments resulted in significantly larger number of grains per spike. The highest number of grains per spike was obtained from 50% depletion whereas the lowest one was produced by irrigation at the depletion 90% of available soil moisture. The general mean values of number of grains per spike was (37.33) at 50% depletion followed by 36.77 and 36.18 for 70% and 90% depletion of available moisture respectively. These results are in agreement with those obtained by Sonia *et al.* (1996) who concluded that water stress during meiosis severely reduced the activity of acid invertase during and after the stress period. Therefore, the reduction in its activity may restricted the available assimilate in a form suitable for starch biosynthesis. Data reveal also that the number of grains per spike was high significantly affected by studied wheat varieties, Sakha 69 gave the highest number of grains of spikes as compared with two tested varieties. The overall mean values are 37.62, 36.93 and 35.73 for Sakha 69, Sakha 61, and Sakha 8, respectively. Such differences might be due to variability among wheat varieties (Essam *et al.,* 1993). Concerning the effect of ascorbic acid on number of grains per spike data show that, the highest value 37.92 was produced by plants sprayed with 3000 ppm ascorbic acid. While the 1000 ppm concentration resulted in the lowest value (35.60). Table (6) shows data representing the effect of the interaction between depletion, varieties, and ascorbic acid concentrations, results clear that the number of grains per spike was influenced by the combination between water stress, cultivars, and ascorbic acid concentration, the highest value (41.87) was obtained by Sakha 61 when was planted under 70% depletion and subjected to spraying with 3000 ppm ascorbic acid, followed by Sakha 69 and Sakha 8 which produced 41.43 and 40.0 grains per spike respectively when were sprayed with the same concentration (3000 ppm ascorbic acid) and irrigated at 50% depletion of available soil moisture content.

2.3. 1000 grains weight:

Comparing the different treatments of irrigation, it was observed that the irrigation at 50% gave the higher 1000 grains weight than 70% and 90% depletion of available soil moisture, 1000-grains weight values were 48.62, 47.27 and 46.09 at 50%, 70% and 90% soil moisture depletion. These results are similar to those obtained by Sonia *et al.* (1996), who reported that increasing soil moisture depletion tended to reduce the 1000-grain weight since at anthesis, the stressed anthers had approximately 30% lower starch

Table (6): Effect of interaction between depletion, cultivars, and ascorbic acid concentrations on yield and agronomic characteristics.

Depletion	Cultivars	Grain yield ton/fed.		Straw yield ton/fed.		No. of spikes per m^2		No. of grain per spike		1000-grain weight	
		C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2
50% (D_1)	V_1	3.487 a	3.024 a	5.958 a	4.536 c	389.0 b	385.0 a	36.87 a	40. b	52.3 a	43.2 b
	V_2	2.184 c	3.107 a	4.200 c	6.551 a	339.0 c	392.0 a	33.03 b	35.4 c	51.6 a	51.1 a
	V_3	2.856 b	2.688 b	5.040 b	5.376 b	427.0 a	304.0 b	33.99 b	41.4 a	44.1 b	49.8 a
70% (D_2)	V_1	3.111 a	2.110 c	4.788 b	6.048 a	389.0 b	287.0 b	36.73 b	34.07 c	46.7 a	49.9 a
	V_2	2.772 b	2.772 a	3.781 c	4.452 c	327.0 c	340.0 a	39.30 a	41.87 a	48.3 a	44.7 b
	V_3	3.107 a	2.604 b	5.711 a	4.956 b	467.0 a	309.0 b	33.63 c	38.37 b	44.6 b	49.3 a
90% (D_3)	V_1	2.200 b	2.436 b	6.30 a	5.63 b	252.0 c	438.0 a	36.6 b	30.1 b	51.9 a	42.8 b
	V_2	2.100 b	2.604 a	1.74 c	6.21 a	283.0 b	336.0 c	31.9 c	40.1 a	51.5 a	44.8 a
	V_3	2.940 a	2.436 b	4.96 b	2.60 c	392.0 a	375.0 b	38.4 a	40.0 a	43.6 b	41.5 b

Means followed by a common letter are not significantly different at 0.05 level by DMRT content than those from well-watered plants. Moreover, the three wheat varieties significantly influenced the 1000-grain weight. the general mean values were 48.67, 47.83, and 45.49 gm for Sakha 61, Sakha 8 and Sakha 69, respectively. These results are in accordance with the findings of Essam *et al.* (1993). Regarding the ascorbic acid concentrations, the data of Table (5) indicate of that the 1000-grain weight was significantly affected by concentration of ascorbic acid, the highest 1000-grain weight (48.30 gram) was obtained by 1000 ppm. While adding 3000 ppm ascorbic acid as foliar application decreased the 1000-grain weight which reached 46.36 gram. These results are supported those obtained by Bhat *et al.* (1987), and Zade *et al.* (1995). Concerning the effect of interaction between depletion, varieties, and ascorbic acid on 1000-grain weight as shown in Table (6). It was evidence that 1000-grain weight was significantly influenced by the combination between the studied factors. The optimum 1000-grain weight values (52.3 and 51.6 gram) were produced by Sakha 8, and Sakha 61 where grown under 50% depletion of available soil moisture and received 1000 ppm ascorbic acid as foliar application, followed by Sakha 69 which resulted in 49.80 gram (1000 grain weight) by spraying with 3000 ppm ascorbic acid under irrigated at 50% depletion of available soil moisture content. On the other hand, there is no different between 1000 grain weight values obtained by Sakha 8, and Sakha 61 grown under 50% and 90% depletion at the same concentration (1000 ppm) these due to the effect of ascorbic acid on drought, Hamada, and Garab (1998), who reported that root and shoot fresh weight yield and transpiration rate were reduced as water stress increased, and ascorbic acid treatments alleviated the effects of drought and also had stimulatory effects. It could be concluded that the optimum wheat production may be carried out by irrigation Sakha 8 plants at 50% depletion of available soil moisture and added 1000 ppm ascorbic acid as foliar application or by irrigation Sakha 69 plants at 90% depletion which received 1000 ppm ascorbic acid spraying at tillering and booting stages.

3. Water relations:

3.1. Water consumptive use (Cu):

Monthly and seasonal consumptive use as affected by water treatments are recorded in Table (7). Regarding monthly consumptive use during the growing season, it is clear that the rate was low during the beginning of the season as a result of small vegetative growth of wheat varieties, then increased during crop development (mid-season) and arrived its maximum during the late season (March) for 50% and 70% and (April) for 90% depletion this followed by dropping during ripening (May).

The results show that seasonal consumptive use amounts increased as the available moisture increased. The highest value of (Cu) was 41.12 cm, when plants were irrigated at 50% depletion while lowest one was 25.48 cm when irrigation was done at 90% depletion. The same trend was observed with the rate of (Cu) and irrigation amounts relationship. The corresponding values were 0.23 and 0.14 cm/day for treatment 50% and 90% depletion of available soil water content respectively.

Seasonal consumptive use values of wheat cultivars were found to be 41.116, 33.115 and 25.48 cm for 50%, 70% and 90% depletion respectively. These results agree with those reported by Abd El-Hafez *et al.* (1992) and El-Yamany (1994). In general, it was noticed that there were no significant difference in consumptive use values among the different wheat varieties used, and almost the average values were the same. Under the previous study water consumptive use was not calculated for each wheat variety.

Table (7): Effect of irrigation treatments on monthly or seasonal consumptive use and water uptake pattern.

Dept.	Layer depth	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Season Cu	W.U.P. pattern
D_1 50%	0-15	0.467	1.445	2.157	3.365	5.522	1.939	0.829	15.728	38.25
	15-30	0.423	1.312	1.911	2.739	4.534	1.545	0.675	13.139	31.95
	30-45	0.174	0.540	1.193	1.902	2.903	1.194	0.507	8.413	20.46
	45-60	0.072	0.223	0.602	0.921	1.478	0.367	0.173	3.836	9.33
Total		1.136	3.524	5.863	8.927	14.437	5.045	2.184	41.116	
D_2 70%	0-15	0.467	1.449	1.706	1.668	2.48	1.900	1.200	10.87	32.83
	15-30	0.423	1.312	1.514	1.470	2.371	1.816	1.147	10.053	30.36
	30-45	0.174	0.510	0.904	1.043	2.170	1.583	0.987	7.401	22.35
	45-60	0.072	0.223	0.448	0.552	1.349	1.289	0.858	4.791	14.47
Total		1.136	3.524	4.572	4.733	8.370	6.588	4.192	33.115	
D_3 90%	0-15	0.467	1.449	1.174	0.864	0.956	1.884	1.451	8.245	32.36
	15-30	0.423	1.312	1.046	0.758	0.839	1.821	1.418	7.617	29.89
	30-45	0.174	0.540	0.578	0.529	0.586	1.731	1.390	5.528	21.69
	45-60	0.072	0.223	0.278	0.276	0.306	1.604	1.335	4.094	16.07
Total		1.136	3.524	3.076	2.427	2.687	7.04	5.594	25.48	

Sowing irrigation 400 m^3/fed.
Rain off 172.2 m^3/fed.

3.2. Water use efficiency (W.U.E.):

Values of water use efficiency in kg grain of consumptive use as affected by depletion of available soil moisture content are presented in Table (8).

Table (8): Means water use efficiency (Kg/m^3) as affected by irrigation treatments, wheat varieties, and ascorbic acid concentrations.

Characters	Water use efficiency kg/m^3
Depletion	
50% (D_1)	1.674
70% (D_2)	1.973
90% (D_3)	2.292
Variety	
Sakha 8 (V_1)	1.953
Sakha 61 (V_2)	1.855
Sakha 69 (V_3)	1.986
Ascorbic acid concent.	
1000 ppm (C_1)	1.971
3000 ppm (C_2)	1.892

Results reveal that, the values of water use efficiency were 1.674, 1.973, and 2.292 kg/m^3 for 50%, 70% and 90% depletion respectively. Treatment 90% depletion recorded the highest values of W.U.E. and was superior among the other two irrigation treatment (50%, and 70% depletion). The previous results are in agreement with those obtained by Shanlun and Suiqu (1991) and El-Yamany (1994). Data show also that there are significant differences among the three wheat varieties in water use efficiency, it is clear that Sakha 69 significantly exceeded Sakha 8 and Sakha 61 in this character in the grown season. The mean values were 1.986, 1.953 and 1.855 kg/m^3 for Sakha 69,. Sakha 8, and Sakha 61, respectively.

Such differences might be due to genetic variation exists for long season water use efficiency (Bahman and Wains, 1993). Data in Table (8) show also that the water use efficiency was affected by ascorbic acid concentration, the highest value 1.971 kg/m^3 was produced by spraying the plants with 1000 ppm while the lowest one recorded 1.892 kg/m^3 when plants received 3000 ppm, these results are in the same line with those reported by Bhat *et al.* (1990) who showed that the ascorbic acid increased grain yield, relative water content and leaf moisture content, and reduced transpiration rates.

c.3. Water uptake patterns of studied wheat varieties:

This parameter might be used as a tool to predict the degree of root distribution among different depths of the effective root zone. Data illustrated in Table (7) show that, the rate of soil moisture uptake decreased with the soil depth. the highest average percentage values of moisture uptake were 38.25, 32.83 and 32.36% for the surface layer of the water treatment 50%, 70%, and 90% depletion of available soil water content, respectively. While the less water was extracted from underneath soil depth. The relatively high water uptake from the upper layers compared to the deepest ones attributed to the high concentrated roots in the upper layer (Ibrahim *et al.*, 1988), in this respect El-Yamany (1994), reported that the percentage of water extracted by wheat roots from the upper 30 cm soil depth was 70.20% and following 30 cm contributed to less than 30% with 75% soil moisture depletion treatment.

C.4. Crop coefficient (Kc):

Crop coefficient of wheat as affected by water treatments are presented in Table (9), to account the effect of crop characteristics on crop water requirement, it relates potential evaportranspiration (ETp) to crop consumptive use (Cu) computed through the soils moisture depletion by wheat during the growing season. Factors affecting the values of the crop coefficient (Kc) are mainly crop characteristic crop planting or sowing date, rate of crop development, length of growing season, climatic conditions, and frequency of irrigation (El-Sabagh, 1993), values of crop coefficient are listed in Table (9), the values were calculated according to the actual evapotranspiration (ETa) of wheat plants which were irrigated at 50%, 70%, and 90% depletion of available soil moisture to potential evapotranspiration (ETp) that has been estimated by the following equations, modified Penman, the Radiation, and modified Blaney-Criddle during the growth period of wheat. The average values of seasonal crop coefficient values (Kc)increased with increasing (Cu). Kc values for wheat were 0.721, 0.715 and 1.108 under 50% depletions for modified Penman, Radiation, and Blaney-criddle respectively, data showed that Kc value s were 0.577, 0.568, and 0.862 at 70% depletion for modified Penamn, Radiation, and Blaney-criddle respectively, while the values of seasonal Kc were 0.45, 0.438, and 0.647 for modified Penman Radiation, and Blaney-cridle respectively, under 90% depletion of available soil moisture, Table (9) also indicates that ETp values from Blaney-criddle equation is lower estimated than the actual consumptive use of water (Cu) which determined experimentally. However, modified Penman or Radiation equation agree well with the values of Cu determined under the present study. Results indicated that crop coefficient (Kc) gave the lowest values at early stages of growth, then increased gradually and reached its maximum in the mid season at heading and grain filling and then declined at maturity. This trend was found to be true under all studied treatments.

Table (9): Monthly actual (ETa) and potential (ETp) evapotranspiration (mm/day) and monthly crop coefficient (Kc).

Depletion	Months	ETa	Modified penman		Radiation		Blaney-criddle	
		mm/day	ETp	Kc	ETp	Kc	ETp	Kc
	Nov.	1.136	2.10	0.541	2.63	0.432	2.13	0.533
	Dec.	1.137	1.60	0.711	1.97	0.577	1.45	0.784
50%	Jan.	1.891	1.99	0.950	2.01	0.941	1.35	1.401
(D_1)	Feb.	3.188	2.79	1.143	2.63	1.212	1.62	1.968
	Mar.	4.657	3.82	1.219	3.62	1.286	2.13	2.186
	Apr.	1.682	5.17	0.325	4.59	0.366	2.66	0.632
	May	1.092	6.8	0.160	5.75	0.1899	4.29	0.255
Mean		2.112	3.467	0.721	3.314	0.715	2.233	1.108
	Nov.	1.136	2.10	0.541	2.63	0.432	2.13	0.533
	Dec.	1.137	1.60	0.711	1.97	0.577	1.45	0.784
70%	Jan.	1.475	1.99	0.741	2.01	0.734	1.35	1.093
(D_2)	Feb.	1.690	2.79	0.606	2.63	0.643	1.62	1.043
	Mar.	2.700	3.82	0.707	3.62	0.746	2.13	1.268
	Apr.	2.196	5.17	0.425	4.59	0.478	2.66	0.826
	May	2.096	6.8	0.308	5.75	0.364	4.29	0.488
Mean		1.776	3.467	0.577	3.314	0.568	2.233	0.862
	Nov.	1.136	2.10	0.541	2.63	0.432	2.13	0.533
	Dec.	1.137	1.60	0.711	1.97	0.577	1.45	0.784
90%	Jan.	0.992	1.99	0.498	2.01	0.494	1.35	0.735
(D_3)	Feb.	0.867	2.79	0.311	2.63	0.329	1.62	0.535
	Mar.	0.867	3.82	0.227	3.62	0.239	2.13	0.407
	Apr.	2.347	5.17	0.454	4.59	0.511	2.66	0.882
	May	2.797	6.80	0.411	5.75	0.186	4.29	0.652
Mean		1.449	3.467	0.450	3.314	0.438	2.233	0.647

REFERENCES

Abd El-Hafez, S.A.; M.S.M. Abu-Soliman; W.S. El-Sabry and N.M. El-Mowelhi (1992). Estimation of irrigation needs for wheat and summer maize crops-using the crop wat program. J. Agric. Sci. Mansoura Univ., 17(10): 3377-3385.

Bahman, E.A. and J.G. Wains (1993). Variation in water use efficiency and its components in wheat. Crop Sci. 33: 294-299.

Bhat, M.L.; A. Sen and N.M. Misra (1990). Rainfed wheat as affected by cycocel, ascorbic acid, and gibberellic acid seed treatment. Rachis, 9 (1): 17-20 India.

Bhat, M.L.; N.M. Misra and A. Sen (1987). Effect of cycocel, ascorbic acid and gibberellic acid as seed treatment on yield of wheat under dry land condition. Madras. Agricultural Journal 74: 1, 42-45. India.

Black, C.A. (ed.), (1965). Methods of Soil Analysis, Amer. Soc. Agron. Inc. Pub. Madison Wisconsin, U.S.A.

Doorenbos, J. and W.O. Pruitt (1977). Crop water requirements, Irrigation and drainage paper., 24, FAO, Rome.

El-Marakby, A.M.; O.S. Khalil; A.A. Mohamed and M.F. Abd El-Rahman (1992). Estimation of the relative importance of characters contributing in yield of a diallel cross of bead wheat. Annals Agric. Sci. Ain Shams Univ., Cairo, 37(1): 69-75.

El-Sabagh, A.A. (1993). Effect of soil moisture stress and foliar application of zinc on some maize varieties Ph.D. Thesis, Agronomy Department Fac. of Agric. Zagazig Univ.

El-Yamany, M.S. (1994). Study of the efficiency of some fertilizers treatments on wheat under different irrigation conditions. Ph.D. Thesis, Department of Soil, Faculty of Agriculture, Kafr El-Sheikh, Tanta University.

Essam, E.S.; M.M. El-Ganbeehy and M.H. El-Sheikh (1993). Response of several wheat genotypes to different level of nitrogen fertilization. Menofia, J. Agric. Res., Vol. 18: 1079-1096.

Genaidy, S.A.; A.A. Abd El-Magid and M.H. Hegazy (1995). Effect of some organic acids in relation to some mineral fertilizers for production of some main field crops. Egypt. J. Appl. Sci., 10(5): 835-846.

Hamada, A.M. and G. Garab (1998). Effect of exogenously added ascorbic acid, thiamin or aspirin on photosynthesis and some related activities of drought-stressed wheat plants. Proceedings of the XIth International Congress on Photosynthesis Budapest, Hungary, 17-22 August, 2581-2584.

Hansen, V.W.; O.w. Israelsen and Q.E. Stringharm (1979). Irrigation Principles and Practices. Edition, John Wiley and Sons., 1979.

Ibrahim, M.A.M.; S.A. El-Gohary and M.A. Rezk (1988). Preliminary studies towards effective water management in Kafr El-Sheikh Governorate. Alex. Eng. J. Alex. Univ., 23: 29-36.

Ismail, M.I.; M. Duwayri; M. Nachit and O. Kafawin (1999). Effect of water stress on growth and productivity of different durum wheat crosses compared to the parents. Dirasat, Agricultural Sciences. 26: 1, 98-105.

Jack, M.C. and D.J. Major (1994). Effect of irrigation application depth on cereal production in the semi-arid climate of southern Alberta. Irrig. Sci. (1994). 15: 9-16.

Muhammad, J.; M.S. Naazir; A. Nazir; S.H. Shah; N.H. Shah; M. Jamal and N. Ahmad (1996). Wheat yield components as affected by low water stress at different growth stages. Effect on ear length, grain weight and number of grain per ear. Sarhad-Journal of Agriculture., 12 (1): 19-29.

Muhammad, J.; N.M. Shafi; S.S. Hussain; A. Nazir; M. Jamal; M.S. Nazir; S.H. Shah and N. Ahmad (1992). Wheat response to water stress at different growth stages. 1- Effect on earing, maturity and plant height. Sarhad. J. of Agric., 8 (4): 405-411.

Padole, V.R. (1981). Effect of IAA, NAA, ascorbic acid and succinic acid as seed soaking treatment on wheat. Punjabrao-Krishi-vidyapeeth-Research. Journal, 5 (2): 139-142 India.

Patel, A.L. and J. Singh (1998). Nutrient uptake and distribution in aerial parts of wheat under water stress at different growth stages. Annals of Agric. Bio Research., 3 (1): 5-8.

Piper, C.S. (1950). Soil and Plant Analysis. Inter-Science Publisher, New York.

Shanlun, D.X. and Z. Suiqu (1991). Physio-Ecological response of spring wheat to limited irrigation water use efficiency in agriculture. Proceedings of the Binational, China-Israel Workshop. April., 22-26. Page 102-110.

Siddique, M.R.; B.A. Hamid and M.S. Islam (2000). Drought stress effects on water relations of wheat. Biological Abstracts. 107(9). Ab-2. May 15, 2000.

Singh, C.B.; S. Gurcharan; D.K. Das and G. Singh (1990). Root growth, soil water depletion, nitrogen uptake and yield of wheat in relation to irrigation and nitrogen application. Annals of Agricultural Research, 11: (2): 161-170.

Snedecor, G.W. and W.G. Cochran (1982). Statistical Methods 7th Edn. Iowa State Univ., Press Iowa, U.S.A.

Sonia, D.; L. Sylvie and S.S. Hargurdeep (1996). Induction of male sterility in wheat by meiotic-stage water deficit is preceded by a decline in Invertase activity and changes in carbohydrate metabolism in anthers. Plant Physiol., 111: 137-145.

Zade, K.B.; D.G. Vitkare; G.N. Satpute and N.G. Zode (1995). Grain yield improvement in wheat by foliar spray with chemicals and growth promoters. Annals of Plant Physiology, 9 (2): 158-160.

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استجابة القمح للرش بحامض الأسكوريك تحت مستويات إجهاد رطوبى مختلفة

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أجريت تجربة حقلية بمحطة البحوث الزراعية بسخا – عام ١٩٩٨/١٩٩٩م لدراسة تأثير حامض الأسكوربك (١٠٠٠ جزء/مليون ، ٣٠٠٠ جزء/مليون بالرش الورقى) ومستويات مختلفة من نقص رطوبة التربه (نقص رطوبى ٥٠% ، ٧٠% ، ٩٠% من الماء الميسر فى التربه) على المحصول والأستهلاك المائى لبعض أصناف القمح (سخا ٨ ، سخا ٦١ ، سخا ٦٩).

ويمكن تلخيص النتائج المتحصل عليها كالآتى:

- أعطى الرش عند نقص ٥٠% من الماء الميسر محصول حبوب ومحصول قش وعدد السنابل فى المتر المربع وعدد الحبوب فى السنبلة ووزن الألف حبه أعلى من مثيلتها بالرى عند نقص ٧٠% أو ٩٠% من الماء الميسر فى التربه.
- تفوق الصنف سخا ٦٩ على الصنفين سخا ٨ ، سخا ٦١ فى تأثيره على محصول الحبوب والقش وعدد السنابل/م^{2} ، وعدد الحبوب فى السنبلة بينما تفوق الصنف سخا ٦١ على باقى الأصناف فى تأثيره على وزن الألف حبه.
- أعطى رش النباتات بحامض الأسكوربك بتركيز ١٠٠٠ جزء مليون أعلى محصول حبوب وعدد السنابل/م^{2} ووزن الألف حبه بالمقارنة بتركيز ٣٠٠٠ جزء فى المليون الذى أعطى أعلى قيم لمحصول القش وعدد الحبوب فى السنبله.
- كان التأثير المشترك للعوامل (D x V x C) معنويا وسجلت أعلى قيم ٣,٤٨٧ ، ٥.٩٥٨ طن/فدان ، ٥٢,٣جم لمحصول الحبوب والقش ووزن الألف حبه على الترتيب باستخدام معاملة (D_1 x V_1 x C_1) بينما أعطت المعاملات (D_2 x V_3 x C_1) ، (D_2 x V_2 x C_2) أعلى قيم ٤٦٧ ، ٤١,٨٧ لعدد السنابل فى المتر المربع وعدد الحبوب فى السنبلة على الترتيب.
- أتضح نقص الأستهلاك المائى لمحصول القمح بزيادة النسبة المئوية لنقص الماء الميسر فى التربه حيث وجد أعلى قيمة استهلاك مائى (٤١,١٢سم) عندما تم رى الأرض عند نقص رطوبى ٥٠% من الماء الميسر بالمقارنة مع ٢٥,٤٨سم استهلاك مائى بالرى عند نقص ٩٠% من الماء الميسر.
- أعلى قيمة لكفاءة الأستهلاك المائى (٢,٢٩كجم/م^{3}) حصل عليها بالرى عند نقص ٩٠% من الماء الميسر مقارنة بالقيم ١,٦٧ ، ١,٩٧ كجم/م^{3} للرى عند نقص ٥٠% ، ٧٠% على الترتيب.
- كانت أعلى قيم لأستخلاص الماء من الطبقات السطحية للتربه هى ٣٨,٢٥% ، ٣٢,٨٣% ، ٣٢,٣٦% مع معاملات ٥٠% ، ٧٠% ، ٩٠% نقص للماء الميسر فى التربه على الترتيب.
- بتقدير معامل المحصول السنوى للقمح أتضح بصفة عامة أن قيمه المحسوبة باستخدام معادلة Blaney-Criddle كانت عالية ١,١٠٨ ، ٠,٨٦٢ ، ٠,٦٤٧ للمعاملات ٥٠% ، ٧٠% ، ٩٠% نقص من الماء الميسر فى التربه بينما كانت قيم معامل المحصول السنوى المحسوبة باستخدام معادلتى Penman, Radiation متقاربة جدا ومناسبا لأستخدام هاتين المعادلتين فى منطقة الدراسة.