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IMPACT OF IRRIGATION FREQUENCIES, POTASSIUM FERTILIZER AND VITAMIN TREATMENTS ON YIELD, NUTRIENTS AND AMINO ACID CONTENTS OF BREAD WHEAT GRAINS

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Abstract

This study is conducted to investigate the effect of irrigation intervals in combination with soil application and / or foliar spray of potassium fertilizer and soaking in some vitamins (ascorbic acid and pyridoxine) on wheat yield, certain nutrients and amino acid contents in grains, as well as field water use efficiency. The main aim of the study is to save of the irrigation water without reduction of wheat yield with facility of practical application. Two field experiments were carried out during the two successive winter seasons of 2005/2006 and 2006/2007 at the experimental farm, Faculty of Agriculture, Al-Azhar University at Assiut Governorate. The obtained results are as the follows:

The grain yield and its components were significantly affected by the main treatments i. e. irrigation frequencies, vitamins and potassium fertilizer. The irrigation every 21-day interval gave higher values of grain yield and all studied characters as compared with the other irrigation frequencies (28-day and 35- day intervals) in two seasons. The soaking in pyridoxine gave higher values of grain yield and all other characters as compared with control and ascorbic acid in both seasons. The superior grain yield of wheat per Feddan which resulted from treatment with potassium as foliar spray during growing seasons was applied.

The interaction effects between irrigation frequencies, every 21-day and soaking in pyridoxine vitamin gave higher values of grain yield of wheat and all other characters only except harvest index as compared with the other treatments in both seasons. The highest values of grain yield of wheat and all other characters were obtained when irrigation every 21-day and application of all potassium as foliar spray in both seasons.

The highest values of the grain yield and its components were obtained when irrigation was applied every 21-day, with soaking in pyridoxine vitamin and application of potassium fertilizer as foliar spray in both seasons. However, the lowest values of the grain yield and its components were recorded by applied irrigating the plants every 35-day, soaking in water and without potassium fertilizer in 2005/2006 and 2006/2007 seasons.

The interactions of irrigation interval x vitamins x potassium application significantly affected the macronutrients and total amino acid contents in wheat grains. Irrigation every 28-day interval with soaking in ascorbic acid and potassium application as foliar spray realized the highest values of nitrogen and phosphorus and total amino acid contents in wheat grains. Also, the highest amounts of potassium content in wheat grain were found under the same treatment but without soaking in any vitamins (soaking in water).The field water use

efficiency increased when moisture stress increased. The highest value of field water use efficiency was calculated when plant irrigated at 35-day interval with soaking in pyridoxine and foliar sprayed with potassium.

Keyword: irrigation frequencies, vitamins, potassium fertilizer, grain yield, macronutrients and total amino acids.

Introduction

In all countries of the world, water is considered a main limiting factor in agricultural expansion. In Egypt, Wheat (*Triticum aestivum* L.) is considered a major feed crop. With over growing population, increasing wheat productivity with decreasing water consumption is a national target. In this context, many studies were performed to increase of wheat yield and improve its quality, as well as increase water consumptive use efficiency through popper fertilization and good management. Similarly, soil moisture is one of the factors, which influence the yield and quality of crops. Thus, scheduling irrigation for wheat plant may improve its production per unit area and / or consumed water unit.

Potassium is considered as an essential element in nearly all processes needed to sustain growth, reproduction and metabolic activities of plants, such as photosynthesis, protein synthesis, and ion balance control, regulation opening and closing of plant stomata and water uses (Marschner, 1995). It has been mentioned that, potassium application play an important role in plants grown under water deficit. Since, potassium fertilization slightly decreased daily and monthly actual water consumptive use. Moreover, foliar spray of potassium ensures the quick and adequate K- supply for plants at the time of yield formation to improve its productivity (Talha *et al.,* 1987; El Yamany, 1994; Abdel – Hafez *et al.,* 1999; Hussien *et al.,* 2000; Abdel-Aziz *et al.,* 2004; El-Saei *et al.,* 2006).

El-Saei *et al.,* (2006) found that, the values of wheat yield and field water use efficiency increased with increasing the rate of potassium fertilizer. Also, Abdel-Aziz *et al.,* (2004) found that, gradual and significant increases of maize productivity as a result of the reduction in soil moisture depletion. The same response was observed for raising K- level up to 3 % as foliar spray. On the other hand, Abd El-Gawad *et al.* (1993) reported that when wheat plants were subjected to water stress at any physiological stage depressed yield and yield attributes.

Irrigation every 10-days or 20-days interval increased significantly the yield of components and growth characters of sorghum cultivar. Moreover, the highest

values of grains and N- recovery in grains could obtained under any applied of N-fertility level at irrigation every 10-days or 20-days interval, while the lowest values were recorded at irrigation every 30- days interval (Ragheb and Elnagar, 1997). Also, Ibrahim *et al*. (1992) reported that leaf area of plant and grain yield (ard /Fed) of maize plant were significantly increase with the decreased in irrigation period.

Vitamins are considered as triggers and cofactors in metabolism of plant cells. In this context, many attempts have been performed to counteract the noxious effect of drought stress on growth and physiological activities of plants. By using various vitamins such as ascorbic acid, and pyridoxine on *Lupinus termis*, *Vigina sinensis* and *Vicia faba* plants grown under normal and stress conditions, Azooz (1990) and El-Tayeb (1991) stated that these vitamins were important for growth of plants under stress conditions. Presowing soaking of seeds in either ascorbic acid or pyridoxine significantly stimulated the root and shoot length (Shaddad *et al*. 1990).

To attempt spare irrigation of water without reduction of wheat yield and in the same time facility of practical application. Thus, the present study is conducted to study the effect of irrigation intervals in combination with soil application and / or foliar spray of potassium fertilizer and soaking in some vitamins (ascorbic acid and pyridoxine) on wheat yield, certain nutrients and amino acid contents in grains, as well as field water use efficiency.

Materials And Methods

Two field experiments were carried out during the two successive winter seasons of 2005/2006 and 2006/2007 at the experimental farm, Faculty of Agriculture, Al-Azhar University at Assiut Governorate. Some soil physical and chemical characteristics of soil of the experimental site were determined according to methods of Page (1982) and Klute (1986) as shown in table (1). Giza – 168 cultivar of wheat (*Triticum aestivum* L.) was chosen for this study , where it is the most commonly used cultivar by farmers in Upper Egypt .The experimental design was split- split plot design with three replicates. The replicate includes 36 plots combination between used treatments. The area of each plot was 10.5 m^2 (3.5 X 3 m^2) with area of 1/400 Fed. Irrigation frequency was fixed in the main plots, the vitamins soaking (ascorbic acid and pyridoxine 200 ppm) in the sub –plots and the potassium application in the sub-sub-plots. To avoid the interference between irrigation treatments, 3 m beds were left between the main plots.

Table (1): Some physical and chemical properties of the studied soil.

Characteristics	Depth (cm)		
	0-30	30-60	60-90
Sand	26.30	25.80	25.30
Silt	38.00	38.50	39.50
Clay	35.70	35.70	35.20
Texture grade	Clay loam	Clay loam	Clay loam
Organic matter %	1.25	0.95	0.73
Ca CO_3 %	3.45	2.60	2.25
pH (1: 2.5)	8.25	8.50	8.55
EC (ds/m 1: 5)	0.25	0.28	0.30
Soluble Cations (mg/l)			
Ca^{+2}	0.55	0.40	0.30
Mg^{+2}	0.50	0.60	0.40
Na^{+}	1.50	1.55	1.65
K^{+}	0.04	0.03	0.02
Soluble Anion(mg/l)			
HCO_3^{-}	0.06	0.09	0.10
Cl^{-}	1.60	1.55	1.50
SO_4^{-2}	0.93	0.84	0.74
Macronutrients (ppm)			
N	45.50	40.20	30.00
P	9.20	8.50	6.00
K	360	310	270

The following treatments conducted:-

1- Irrigation frequencies

I_1 - Every 21- days interval.
I_2 - Every 28- days interval.
I_3 - Every 35- days interval.

2- Vitamins soaking

V_0 - Control (soaking in water)
V_1 - Soaking in 200 ppm of ascorbic acid
V_2 - Soaking in 200 ppm of pyridoxine

3- Potassium application

K_0 - Control (without K fertilizer)
K_1 - All dose as a soil application
K_2 - Half dose as a soil application and another foliar spray.
K_3 - All dose as a foliar spray.

Wheat seeds were soaked in water, solution of ascorbic acid and pyridoxine for 6 hours, and then sown in the prepared soil on the 24 November for growing season. The three irrigation frequencies, every 21-, 28- and 35-days intervals which started after 35- days from planting and provided 6, 5, 4 irrigations per growth season. The required amount of irrigation water to each plot for each one irrigation was

calculated to be 1.25 m^3. This amount of irrigation water was conveyed to the plot through surface pipes from the main pipe in the sub- surface irrigation system. Also, potassium fertilizer was applied in the form of potassium sulphate (48 % K_2O) at the rate 24 Kg K_2O/ Fed. Concerning soil application, it was divided into equal two doses; the first one was added with planting irrigation and the second one with the starting irrigation treatments. However, foliar application was sprayed two times with the first and the second irrigations of irrigation treatments, with the concentration of 3 % of K_2O solution. Regarding soil and foliar application treatment, soil application was given with planting irrigation and the foliar application was sprayed with the starting irrigation treatments. Other cultural practices were performed as usual.

At harvest, one square meter from each sub-sub- plot was sampled and the number of spikes / m^2 was estimated. Moreover, a random sample of ten plants was collected from the central area of each plot to estimate the following characters:-

1- 1000 – grains weight (g).
2- Straw yield (ton/ Fed).
3- Grain yield (ard / Fed), where ardab = 150 kg.
4- Biological yield (Kg) = Grain yield/fed+ Straw yield / fed.
5- Harvest index (Hi) calculated as :

$$Hi = \frac{\text{Grain yield / Fed}}{\text{Grain yield + Straw yield / Fed.}} \times 100$$

Determination of N, P and K were performed as described by Jackson (1970).Field water use efficiency was calculated for each treatment by dividing the yield (Kg/Fed) on unit of applied irrigation expressed as cubic meter of water (Al-Barrak(2006).

Total amino acids were determined according the method of Moore and Stein (1948). The total free amino acids were calculated as µg mg^{-1} dry weight / dry grain.

The obtained data obtained in each season were statistically analyzed according to producer outline by Gomez and Gomez (1984). Comparisons of means were estimated using the Least Significant Difference (L.S.D) at 5% level of probability.

Results And Discussion

Wheat Yield and Its Components :

a- Effect of main parameters:

The data presented in Table (2) indicate that the grain yield and its components were significantly affected by irrigation frequencies. The irrigation every 21-day interval gave higher values of grain yield (17.72 and 17.08 ard/Fed.), and all studied characters as compared with the other irrigation frequencies (28-day and 35- day intervals) in both 2005/2006 and 2006/2007 seasons. All studied other characters showed significant increases: 1000-grain weight (8.04 and 7.15%), straw yield (17.33 and 22.30%), grain yield (21.12and 20.96%) and biological yield (18.73 and 21.74%) when irrigated every 21-days interval compared with the irrigation every 35- days in both seasons, respectively. These finding are in harmony with those of Hussein (2005) and El-Saei *et al*. (2006).

It was also found that the grain yield and its components were significantly affected by vitamins soaking, except the harvest index of wheat during two seasons (Table,2). The soaking in pyridoxine (V_2) obtained higher values of grain yield (16.69 and 16.44 ard/Fed.), and all other characters as compared with control (V_0) and ascorbic acid (V_1) in both seasons. These results indicated that significant increases in 1000-grain weight (2.65 and 3.18%), straw yield (14.29 and 15.62%), grain yield (15.34 and 16.64%) and biological yield (14.61 and 15.97 %) when performance soaking in (V_2) as compared with control (V_0) during 2005/2006 and 2006/2007 seasons, respectively. These results are in agreement with those of Zidan (1990) who found that effects of some vitamins such as pyridoxine on growth parameters and some metabolic activities of wheat *(Triticum aestivum* L.) were comparatively raised.

Results in Table (2) reveal that the grain yield and its components were significantly affected by applied potassium application only except harvest index in both seasons. The superior grain yield of wheat per feddan which resulted from treatment all potassium as foliar spray (17.43 and 17.27 ard/Fed.) during growing 2005/2006 and 2006/2007 seasons, respectively. On the other hand, application of potassium all does as foliar spray gave significant increases of 1000-grain weight (4.87 and 4.67%), straw yield (23.33 and 22.54 %), grain yield (23.17 and 32.51 %) and biological yield (23.37 and 23.51%) as compared with control (without potassium fertilizer) in both seasons, respectively. Similar results were obtained by Saad *et al*. (1990), El-Defan *et al*. (1999), El-Kholy (2000), Mahdy and Teama (2000), Abd-Alla (2002), Abdel-Aziz *et al*., 2004 Hussien (2005) and El-Saei *et al.* (2006).

Table (2): Effect main parameters on yield and its components of wheat during two seasons.

Parameters	Level	1000-grain weight (g)		Straw yield (ton/ Fed.)		Grain yield (ard/Fed.)		Biological yield (kg/Fed)		Harvest index (%)	
		2005/2006	2006/2007	2005/2006	2006/2007	2005/2006	2006/2007	2005/2006	2006/2007	2005/2006	2006/2007
Irrigation frequencies	**I_1**	45.13	44.77	4.27	4.44	17.72	17.08	6888.65	6998.31	38.80	36.97
	I_2	43.30	43.08	4.22	4.11	15.12	14.81	6492.77	6334.33	34.86	34.99
	I_3	41.50	41.57	3.53	3.45	13.78	13.50	5598.86	5476.92	36.92	36.93
L.S.D at 0.05 level		0.26	0.43	0.41	0.17	0.52	0.19	447.55	190.76	2.42	0.62
Vitamins soaking	**V_0**	42.59	42.31	3.66	3.62	14.13	13.63	5782.68	5661.63	36.63	36.16
	V_1	43.58	43.42	4.09	4.10	15.74	15.35	6414.53	6398.04	36.71	36.14
	V_2	43.75	43.7	4.27	4.29	16.77	16.44	6783.07	6750.22	37.14	36.58
L.S.D at 0.05 level		0.47	0.5	0.15	0.17	0.48	0.11	186.22	219.13	N.S	N.S
Potassium application	**K_0**	42.23	42.08	3.45	3.47	13.66	13.21	5444.37	5448.33	37.29	36.41
	K_1	42.85	42.85	3.81	3.82	14.77	14.34	6026.50	5968.17	36.83	36.10
	K_2	43.76	43.49	4.27	4.23	16.30	15.63	6716.82	6576.69	36.49	35.75
	K_3	44.39	44.14	4.50	4.48	17.43	17.15	7119.35	7086.22	36.83	36.92
L.S.D at 0.05 level		0.37	0.43	0.17	0.15	0.56	0.17	199.37	154.28	N.S	N.S

b – Effects of irrigation frequencies with both vitamins soaking and potassium application:

Results given in Table (3) indicate that the wheat grain yield and its components of wheat were significantly affected only except 1000-grain weight and harvest index. The interaction effects between irrigation every 21-days and vitamin soaking in pyridoxine gave higher values of grain yield of wheat (19.09 and 18.62 ard/fed.) and all other characters only except harvest index as compared with the other treatments in both seasons, respectively. The interaction effect between irrigation every 21- day and soaking in pyridoxine gave significant increases of : 1000-grain weight (7.72 and 10.52%), straw yield (28.84 and 34.28%), grain yield (34.00 and 34.64%) and biological yield (30.78 and 34.40%) as compared with irrigation every 35-days and soaking in water during growing seasons (2005/2006 and 2006/2007), respectively.

Data in Table (3) show the interaction between irrigation frequencies and potassium application which had significant effects on the straw yield, biological yield and harvest index in both seasons. The highest value of 1000-grain weight (46.40 and 46.03 gm.), straw yield (5.00 and 5.12 ton/fed.), grain yield (19.39 and 18.96 ard/Fed.) and biological yield (7904.67 and 7967.83 kg/ Fed) could be obtained when irrigation was applied every 21-days and application of potassium as foliar spray in both seasons, respectively. These results are similar to those reported by Kansal and Sokhon (1973), Mohamed and Ali (1982), Hussein (2005) and El-Saei *et al*. (2006).

Table (3): Effects of interaction between irrigation frequency and both soaking in vitamins and potassium application on yield and its components of wheat during two seasons.

Irrigation frequencies	Soaking in vitamins			Straw yield (ton/Fed.)		Grain yield (ard/Fed.)		Biological yield (kg/ Fed)		Harvest index (%)	
		2005/ 2006	2006 /2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007
I_1	V_0	44.18	43.67	3.67	3.79	16.36	15.41	6128.04	6104.38	40.27	38.23
	V_1	45.33	44.74	4.38	4.59	17.72	17.21	6930.04	7168.25	38.14	36.36
	V_2	45.87	45.91	4.75	4.93	19.09	18.62	7607.88	7722.29	37.98	36.32
I_2	V_0	42.83	42.17	3.94	3.82	13.42	13.30	5953.71	5815.00	33.71	34.24
	V_1	43.68	43.69	4.28	4.15	15.63	15.14	6624.38	6420.38	35.41	35.31
	V_2	43.38	43.38	4.45	4.36	16.36	16.07	6900.21	6767.63	35.47	35.42
I_3	V_0	40.77	41.08	3.38	3.24	12.60	12.17	5266.29	5065.50	35.91	36.01
	V_1	41.73	41.82	3.61	3.55	13.87	13.72	5689.17	5605.50	36.58	36.76
	V_2	42.00	41.81	3.61	3.57	14.87	14.62	5841.13	5759.75	38.27	38.01
LSD at 0.05 level		N.S	N.S	0.26	0.30	0.82	0.21	322.54	297.65	1.69	N.S
Irrigation frequencies	Potassium application										
I_1	K_0	43.79	43.27	3.30	3.60	15.75	15.73	5509.33	5960.00	41.76	39.99
	K_1	44.63	44.60	3.86	4.13	17.29	16.21	6456.83	6561.50	40.38	37.26
	K_2	45.69	45.19	4.91	4.89	18.46	17.41	7683.78	7503.89	36.09	34.86
	K_3	46.40	46.03	5.00	5.12	19.39	18.96	7904.67	7967.83	36.96	35.77
I_2	K_0	42.10	42.44	3.81	3.67	13.02	12.06	5767.61	5479.50	33.85	33.04
	K_1	42.92	42.64	4.12	3.99	13.99	14.11	6214.67	6103.33	33.82	34.71
	K_2	43.58	43.18	4.37	4.26	15.98	15.36	6761.89	6567.83	35.38	35.07
	K_3	44.58	44.06	4.60	4.52	17.48	17.72	7226.89	7186.67	36.39	37.13
I_3	K_0	40.80	40.53	3.22	3.13	12.22	11.84	5056.17	4905.50	36.25	36.19
	K_1	40.99	41.30	3.45	3.34	13.03	12.69	5408.00	5239.67	36.30	36.33
	K_2	42.02	42.11	3.54	3.54	14.45	14.10	5704.78	5658.33	37.99	37.33
	K_3	42.18	42.34	3.91	3.80	15.42	15.38	6226.50	6104.17	37.13	37.86
LSD at 0.05 level		N.S	N.S	0.30	0.26	N.S	0.30	345.32	267.22	2.16	1.77

c – Effect of interaction between irrigation frequencies, soaking in vitamins and potassium application:

Results in Table (4) indicate that the interaction between irrigation frequencies, soaking in vitamins and potassium application had significant effect on grain yield only in 2006/2007 season. While, the 1000-grain weight, straw yield, grain yield, biological yield and harvest index in both seasons were non significant, respectively. The highest values of 1000-grain weight (47.42 and 47.17 gm), straw yield (5.62 and 5.71 ton/Fed.), grain yield (21.26 and 21.12 ard/fed.) and biological yield (8878.17 and 8868.00 kg/Fed) were obtained by irrigating t every 21- days, soaking pyridoxine and application of all potassium fertilizer as foliar spray in both seasons, respectively (Table 4).

However, the lowest 1000-grain weight (40.13 and 40.12 gm.), straw yield (3.12 and 3.05 ton/Fed.), grain yield (11.95 and 11.19 ard/Fed.) and biological yield (4912.00 and 4728.50 kg) were given when the plants were irrigated every 35-days,

soaking in water and without potassium fertilizer in 2005/2006 and 2006/2007 seasons, respectively (Table 4).

These results are in agreement with those obtained by El-Kholy (2000),Hussien (2005) and El-Saei *et al*. (2006).

Table (4): Effect of interaction between irrigation frequency, soaking in vitamins and potassium application on yield and its components of wheat during two seasons.

Irrigation frequency	Soaking in vitamins	Potassium application	1000-grain weight (g)		Straw yield (ton/Fed.)		Grain yield (ard/ Fed.)		Biological yield (kg/Fed)		Harvest index (%)	
			2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007
I_1	V_0	K_0	42.32	42.15	3.11	3.21	14.63	14.41	5301.17	5371.50	41.37	40.90
		K_1	43.97	43.60	3.21	3.35	15.74	14.67	5570.50	5550.50	42.55	39.64
		K_2	45.02	44.21	4.18	4.21	16.36	15.21	6636.83	6491.50	36.95	35.17
		K_3	45.59	44.72	4.20	4.40	18.71	17.36	7003.67	7004.00	40.20	37.19
	V_1	K_0	44.61	43.51	3.35	3.47	16.44	16.25	5369.33	5907.50	42.40	41.48
		K_1	44.82	44.25	3.92	4.67	17.56	16.61	6553.50	7161.50	40.16	34.79
		K_2	45.73	45.00	5.09	4.95	18.71	17.55	7893.17	7582.50	35.54	34.72
		K_3	46.18	46.21	5.18	5.26	18.18	18.41	7904.17	8021.50	34.46	34.45
	V_2	K_0	44.45	44.15	3.34	4.12	16.18	16.54	5857.50	6601.00	41.51	37.59
		K_1	45.29	45.95	4.46	4.37	18.58	17.35	7246.50	6972.50	38.44	37.36
		K_2	46.32	46.35	5.47	5.52	20.32	19.47	8521.33	8437.67	35.76	34.68
		K_3	47.42	47.17	5.62	5.71	21.26	21.12	8806.17	8878.00	36.22	35.68
I_2	V_0	K_0	41.18	41.20	3.60	3.49	11.64	11.45	5345.50	5207.50	32.60	32.98
		K_1	42.68	41.79	3.86	3.67	12.62	12.19	5756.33	5498.50	32.84	33.26
		K_2	43.61	42.52	4.10	3.95	14.22	13.75	6232.50	6012.50	34.22	34.39
		K_3	43.84	43.15	4.20	4.17	15.20	15.81	6480.50	6541.50	35.17	36.32
	V_1	K_0	42.92	43.67	3.89	3.71	13.83	12.41	5967.33	5571.50	34.79	33.43
		K_1	43.48	43.21	4.04	3.92	14.35	14.59	6192.50	6109.00	35.03	36.08
		K_2	34.79	43.51	4.43	4.32	16.09	15.22	6843.50	6603.00	35.26	34.58
		K_3	44.54	44.37	4.76	4.65	18.25	18.32	7494.17	7398.00	36.56	37.15
	V_2	K_0	42.20	42.45	3.95	3.81	13.60	12.33	5990.00	5659.50	34.17	32.71
		K_1	42.61	42.91	4.45	4.37	14.99	15.55	6695.17	6702.50	33.59	34.81
		K_2	43.34	43.52	4.57	4.52	17.62	17.12	7209.67	7088.00	36.66	36.23
		K_3	45.37	44.65	4.84	4.73	19.24	19.27	7706.00	7620.50	37.45	37.93
I_3	V_0	K_0	40.13	40.12	3.12	3.05	11.95	11.19	4912.00	4728.50	36.49	35.50
		K_1	40.30	40.45	3.24	3.11	12.01	11.42	5042.00	4823.00	35.74	35.52
		K_2	41.23	41.83	3.42	3.23	12.32	12.35	5257.33	5082.50	35.09	36.45
		K_3	41.43	41.92	3.72	3.57	14.20	13.72	5853.83	5628.00	36.31	36.59
	V_1	K_0	41.09	40.10	3.25	3.13	12.26	12.11	5088.50	4946.50	36.11	36.73
		K_1	41.05	42.00	3.65	3.35	12.70	12.45	5555.00	5217.50	34.45	35.81
		K_2	42.24	42.32	3.48	3.71	15.19	14.50	5758.50	5885.00	39.59	36.96
		K_3	42.52	42.85	4.06	4.00	15.32	15.82	6354.67	6373.00	36.18	37.53
	V_2	K_0	41.19	41.36	3.30	3.21	12.45	12.21	5168.00	5041.50	36.15	36.34
		K_1	41.63	41.45	3.47	3.55	14.38	14.19	5627.00	5678.50	38.71	37.65
		K_2	42.59	42.17	3.71	3.69	15.92	15.45	6098.50	6007.50	39.30	38.57
		K_3	42.59	42.25	3.96	3.82	16.74	16.61	6471.00	6311.50	38.90	39.47
L.S.D. at 0.05 level			N.S.	N.S.	N.S.	N.S.	N.S.	0..51	N.S.	N.S.	N.S.	N.S.

Macronutrients content in grains:

Data in Table (5) show that the macronutrients content of wheat grains is significantly affected by using different treatments. During the two seasons, 28-days irrigation interval significantly increased the nitrogen and phosphorus contents,

whereas, the highest value of potassium content (0. 36 and 0.35) could be detected when the plants were subjected to irrigation at 21- days interval. . Soaking grains in pyridoxine gave the highest values of nitrogen (2.45) and phosphorus (0.21) in both seasons. While the soaking in water gave the highest values of potassium content (0.38 and 0.37) as compared with any vitamin in both seasons, respectively. Potassium application as foliar spray increased the contents of macronutrient in wheat grains. In general, the macronutrients content increased due to potassium application as soil addition toward foliar spray treatment in growing seasons.

The effects of irrigation interval x soaking in vitamins and irrigation interval x potassium application interactions on macronutrients content were significantly increased, with the highest values of macronutrients were observed when plants irrigated at 28-day interval (Table 6).

The interaction of irrigation interval x vitamin x potassium application significantly affected the macronutrient contents in wheat grains (Table 7). Results clearly show that irrigation at 28-days interval with soaking in ascorbic acid and potassium application as foliar spray realized the highest values of nitrogen and phosphorus contents (2.96 and 0.25) in wheat grains. However, the lower values were could be detected under irrigating the plants at 21 day interval with soaking in water and without potassium fertilizer (Table 7). Also, the highest amounts of potassium content (0.45) in wheat grains was found under irrigation at 28-days interval with foliar spray of potassium fertilizer but without soaking in any vitamins (soaking in water), however, the lower values were recorded by soaking in both vitamins.

These results are in agreement with those obtained by Ibrahim *et al*. (1986) and El-Sayed (2007), they concluded that the nitrogen percentage in wheat grains was increased with the moderate soil moisture contents.

Total amino acids content in grains:

Data in Tables (5, 6 and 7) indicate that total amino acids contents were significantly affected by the irrigation intervals, soaking in vitamins and potassium application as well as their combinations. It is obvious from these data that, the content of total amino acids in both growing seasons increased with increasing irrigation interval up to 28-days. The maximum content of total amino acid (14.90 µg mg^{-1} dry weight) was obtained in plants irrigated at 28-days interval with soaking in ascorbic acid and foliar sprayed with potassium fertilizer, while its minimum content (7.49 µg mg^{-1} dry weight) was recorded under irrigation at 35-days interval

combined with soaking in ascorbic acid and without potassium application. Using pyridoxine vitamin increased the total amino acid contents, whereas, pyridoxine (B_6 vitamin) is the pyridine ring containing precursor of essential enzyme pyridoxal phosphate, which is utilized by enzymes in all phases of amino acid metabolism (Bender, 1985).Also, foliar spray of potassium fertilizer increased the total amino acid contents in both seasons, whereas potassium is essential in protein synthesis (Marschner 1995).

Field water use efficiency:

It is the weight of marketable crop production per the volume unit of applied irrigation was expressed as cubic meter of water. Data listed in Table (8) and illustrated in Fig.(1) revealed that the values of field water use efficiency were affected by water stress, where it was increased by increasing interval between irrigation. It could be concluded that in both seasons the field water use efficiency increased when moisture stress increased. The highest value of field water use efficiency was calculated when plant irrigated at 35-days interval with soaking in pyridoxine and foliar spray of potassium fertilizer. These results are in accordance with those reported by Hussien *et al*. (2000), El-Saei *et al*. (2006) and El-Sayed (2007).

Table (5) : Effect of different treatments on micronutrients (N, P , K) and total amino acid contents (µg mg^{-1} dry weight) of wheat grains during two seasons.

Main Parameters	Level	N %		P%		K %		Total Amino Acids	
		2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007
Irrigation interval	I_1	2.35	2.32	0.181	018	0.36	0.352	12.23	11.11
	I_2	2.55	2.41	0.21	0.21	0.33	0.33	12.85	11.79
	I_3	2.32	2.32	0.18	0.18	0.34	0.34	9.88	8.61
L.S.D at 5 %		0.020	0.001	0.001	0.010	0.001	0.0001	0.040	0.070
Vitamins Soaking	V_0	2.32	2.25	0.170	0.171	0.38	0.37	11.04	9.80
	V_1	2.44	2.35	0.20	0.20	0.33	0.32	11.70	10.70
	V_2	2.45	2.45	0.198	0.199	0.322	0.33	12.32	11.01
L.S.D at 5 %		0.09	0.001	0.001	0.001	0.001	0.001	0.020	0.040
Potassium application	K_0	2.08	2.08	0.16	0.16	0.248	0.29	10.94	9.75
	K_1	2.50	2.42	0.19	0.19	0.347	0.34	11.52	10.53
	K_2	2.55	2.44	0.20	0.20	0.356	0.36	11.97	10.84
	K_3	2.50	2.47	0.21	0.21	0.372	0.37	12.19	10.90
L.S.D at 5 %		0.01	0.01	0.001	0.001	0.01	0.01	0.04	0.05

Table (6): Effect the interactions between, irrigation intervals, soaking in vitamins, potassium applications and irrigation intervals on micronutrients (N, P, K) and total amino acid contents (µg mg^{-1} dry) weight of wheat grains during two seasons .

Irrigation interval time (day)	Soaking in vitamins	N %		P%		K %		Total amino acids	
		2005 /2006	2006 /2007	2005/ 2006	2006 /2007	2005 /2006	2006/ 2007	2005/ 2006	2006 /2007
I_1	V_0	2.13	2.15	0.15	0.14	0.35	0.34	11.24	10.13
	V_1	2.41	2.36	0.20	0.20	0.37	0.36	13.11	12.14
	V_2	2.50	2.44	0.20	0.20	0.34	0.35	14.20	13.10
I_2	V_0	2.59	2.34	0.18	0.18	2.30	0.30	10.89	10.13
	V_1	2.58	2.67	0.21	0.22	0.30	0.30	11.78	10.68
	V_2	2.49	2.23	0.21	0.21	0.40	0.38	14.03	12.53
I_3	V_0	2.58	2.26	0.18	0.18	0.31	0.31	9.56	8.35
	V_1	2.35	2.34	0.18	0.19	0.33	0.33	10.00	8.59
	V_2	2.36	2.35	0.18	0.19	0.39	0.39	10.09	8.90
L.S .D at 5 %		0.15	0.01	0.01	0.01	0.01	0.001	0.04	0.06
Irrigation interval time (day)	Potassium application								
I_1	K_0	2.03	2.06	0.16	0.16	0.32	0.31	12.30	11.20
	K_1	2.40	2.33	0.173	0.18	0.353	0.34	12.85	11.81
	K_2	2.48	2.54	0.192	0.19	0.373	0.37	13.16	12.12
	K_3	2.47	2.45	0.200	0.20	0.380	0.38	13.10	12.04
I_2	K_0	2.12	2.10	0.176	0.17	2.90	2.90	11.40	12.20
	K_1	2.77	2.60	0.199	0.20	0.33	0.32	12.18	11.27
	K_2	2.76	2.45	0.213	0.22	0.34	0.34	12.58	11.63
	K_3	2.56	2.49	0.231	0.22	0.36	0.36	12.76	11.76
I_3	K_0	2.08	2.08	0.139	0.14	0.29	0.28	9.13	8.16
	K_1	2.33	2.32	0.182	0.18	0.54	0.35	9.53	8.52
	K_2	2.42	2.42	0.198	0.20	0.36	0.35	10.17	8.79
	K_3	2.46	2.46	0.212	0.21	0.37	0.37	10.70	8.99
L.S.D at 5 %		0.17	0.01	0.01	0.01	0.01	0.01	0.06	0.07

Table (7): Effect of interaction between irrigation interval, soaking in vitamins and potassium application on micronutrients (N, P, K) and total amino acid contents (µg mg^{-1} dry weight) of wheat grains during two seasons.

Irrigation Interval (day)	Soaking in vitamins	Potassium applications	N%		P%		K%		Total amino acids	
			2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007	2005/ 2006	2006/ 2007
I_1	V_0	K_0	1.95	1.90	0.12	0.12	0.29	0.28	10.90	9.60
		K_1	2.10	2.05	0.13	0.14	0.30	0.30	10.95	9.730
		K_2	2.20	2.31	0.16	0.15	0.40	0.41	11.52	10.50
		K_3	2.25	2.32	0.17	0.16	0.42	0.41	11.60	10.70
	V_1	K_0	2.0	1.96	0.18	0.18	0.34	0.33	12.80	11.60
		K_1	2.50	2.45	0.19	0.20	0.38	0.36	13.20	12.40
		K_2	2.60	2.52	0.21	0.21	0.38	0.36	13.35	12.50
		K_3	2.50	2.50	0.22	0.22	0.39	0.38	13.10	13.07
	V_2	K_0	2.10	2.31	0.18	0.18	0.32	0.32	13.20	12.40
		K_1	2.60	2.50	0.20	0.20	0.38	0.36	14.40	13.30
		K_2	2.65	2.52	0.20	0.20	0.34	0.35	14.60	13.35
		K_3	2.66	2.52	0.21	0.22	0.33	0.35	14.60	13.35
I_2	V_0	K_0	2.10	2.03	0.15	0.15	0.33	0.33	11.60	11.10
		K_1	2.80	2.64	0.19	0.19	0.40	0.38	11.65	10.30
		K_2	2.87	2.15	0.20	0.20	0.42	0.40	11.90	11.20
		K_3	2.58	2.22	0.19	0.19	0.45	0.42	11.95	11.10
	V_1	K_0	2.15	2.16	0.20	0.19	0.27	0.28	12.20	10.15
		K_1	2.90	2.60	0.21	0.22	0.32	0.30	12.53	13.20
		K_2	2.77	2.96	0.22	0.24	0.29	0.30	14.47	13.30
		K_3	2.48	2.96	0.25	0.24	0.30	0.30	14.90	14.35
	V_2	K_0	2.10	2.10	0.18	0.18	0.27	0.26	10.35	9.40
		K_1	2.60	2.25	0.20	0.20	0.28	0.23	10.40	10.30
		K_2	2.65	2.25	0.22	0.24	0.30	0.32	11.38	10.38
		K_3	2.60	2.30	0.25	0.24	0.35	0.35	11.43	10.45
I_3	V_0	K_0	2.03	2.05	0.12	0.13	0.30	0.29	9.55	8.59
		K_1	2.30	2.31	0.21	0.20	0.41	0.40	9.60	8.66
		K_2	2.35	2.43	0.19	0.20	0.42	0.43	10.60	8.40
		K_3	2.35	2.36	0.20	0.213	0.45	0.44	10.80	8.70
	V1	K_0	2.10	2.10	0.15	0.140	0.29	0.28	8.55	7.49
		K_1	2.31	2.31	0.16	0.157	0.31	0.30	9.40	8.40
		K_2	2.45	2.46	0.20	0.200	0.32	0.31	9.50	8.66
		K_3	2.52	2.50	0.20	0.223	0.33	0.33	10.80	8.66
	V2	K_0	2.10	2.10	0.15	0.157	0.27	0.23	9.50	8.40
		K_1	2.38	2.35	0.17	0.177	0.34	0.34	9.60	8.40
		K_2	2.45	2.45	0.20	0.200	0.34	0.34	10.40	8.50
		K_3	2.52	2.52	0.21	0.207	0.34	0.35	10.50	9.30
L.S.D at 5%			0.020	0.020	0.01	0.01	0.020	0.020	0.11	0.14

Table (8): The values of water applied (m^3 / Fed), wheat grain yield (Kg/Fed) and field water used water used efficiency (Kg/ m^3) for different treatments of vitamins soaking during two seasons.

Irrigation Frequencies	Soaking in vitamins	Potassium Application	Water Applied	Grain yield (Kg/Fed.)		field water use efficiency (kg/m3)	
				2005/2006	2006/2007	2005/2006	2006/2007
I_1	V_0	K_0	3000	2194.50	2161.50	0.73	0.72
		K_1	3000	2361.00	2200.50	0.79	0.73
		K_2	3000	2454.00	2281.50	0.82	0.76
		K_3	3000	2806.50	2604.00	0.94	0.87
	V_1	K_0	3000	2466.00	2437.50	0.82	0.813
		K_1	3000	2634.00	2491.50	0.88	0.83
		K_2	3000	2806.50	2632.50	0.94	0.88
		K_3	3000	2727.00	2761.50	0.91	0.92
	V_2	K_0	3000	2427.00	2481.00	0.81	0.83
		K_1	3000	2787.00	2602.50	0.93	0.87
		K_2	3000	3048.00	2920.50	1.02	0.97
		K_3	3000	3189.00	3168.00	1.06	1.06
I_2	V_0	K_0	2500	1746.00	1717.50	0.70	0.69
		K_1	2500	1893.00	1828.50	0.76	0.73
		K_2	2500	2133.00	2062.50	0.85	0.83
		K_3	2500	2280.00	2371.50	0.91	0.95
	V_1	K_0	2500	2074.50	1861.50	0.82	0.74
		K_1	2500	2152.50	2188.50	0.86	0.88
		K_2	2500	2413.50	2283.00	0.97	0.91
		K_3	2500	2737.50	2748.00	1.10	1.10
	V_2	K_0	2500	2040.00	1849.50	0.82	0.74
		K_1	2500	2248.50	2332.50	0.90	0.93
		K_2	2500	2643.00	2568.00	1.06	1.03
		K_3	2500	2886.00	2890.50	1.15	1.16
I_3	V_0	K_0	2000	1792.50	1678.50	0.90	0.88
		K_1	2000	1801.50	1713.00	0.90	0.86
		K_2	2000	1848.00	1852.50	0.92	0.93
		K_3	2000	2130.00	2058	1.07	1.03
	V_1	K_0	2000	1839.00	1816.50	0.92	0.91
		K_1	2000	1905.00	1867.50	0.96	0.93
		K_2	2000	2278.50	2175.00	1.14	1.09
		K_3	2000	2298.00	2373.00	1.15	1.19
	V_2	K_0	2000	1867.50	1831.50	0.93	0.92
		K_1	2000	2172.00	2128.50	1.09	1.06
		K_2	2000	2388.00	2317.50	1.19	1.16
		K_3	2000	2511.00	2491.50	1.26	1.25

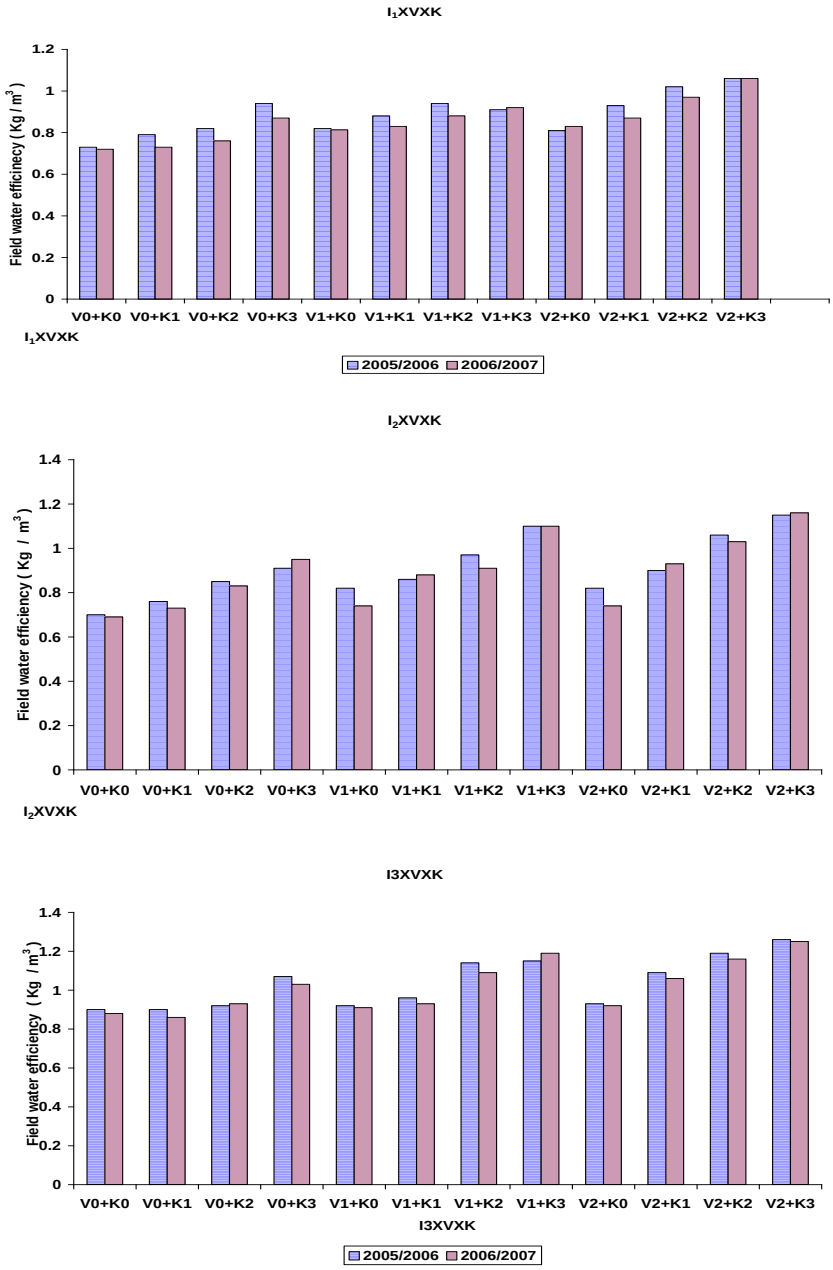

Fig. (1): The values of field water used efficiency (Kg/ $m^{3)}$ for different treatments of vitamins soaking during two seasons.

Conclusion

Although the maximum grain yield of wheat was grained from irrigation at 21-day interval with soaking in V_2 (pyridoxine B_6 vitamin) and foliar spray of potassium fertilizer, it can be recommended that irrigation at 28-day interval with soaking in V_1 (ascorbic acid AA) and foliar spray of potassium fertilizer under Assiut conditions are more suitable according to the following reasons:

1- Spare about 500 m^3 from irrigation water per one feddan.
2- The higher contents of macronutrients and total amino acids.
3- The grain yield was only less 2 ard/Fed. than the treatment ($I_1V_2K_3$) gave the higher grains values.

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