Misr J. Ag. Eng., 26(3): 1245- 1262 IRRIGATION AND DRAINAGE

EFFECT OF IRRIGATION FREQUENCY AND POTASSİUM SOURCE ON THE PRODUCTİVİTY, QUALİTY AND STORABİLİTY OF GARLIC

M. E. M Ahmed[1]; A. Derbala[2] and N. Abd El-Kader[3]

ABSTRACT

Two field experiments were conducted during the winter season of 2006/2007 and 2007/2008 at the experimental farm of the Faculty of Agriculture, Tanta University. The objective of this study was to investigate the effect of both irrigation frequency i.e. irrigation once every 10, 15, 20 and 25 days intervals and potassium source i.e. K_2SO_4 and KCl. on water application, water distribution, water use efficiency using furrow irrigation system, productivity and storability of garlic (clone sids-40).

Results indicated that irrigation once every 15 days then every 20 days were superior and significantly increased water application, water distribution, water use efficiency, plant height, leaves number, leaves fresh weight, yield and its components as well as bulb diameter, bulb weight, volatile oils in bulbs and carbohydrate content of leaves and bulbs. Also, storability was improved with irrigation every 15 days and every 20 days compared with other treatments. Application of K_2SO_4 fertilizer was more beneficial than KCl fertilizer it exerted increases in vegetative growth characters. Moreover, markedly increased total yield, its components and storability with K_2So_4 fertilizer. The study recommended that, irrigation once every 15 days then every 20 days and using K_2SO_4 fertilizer gives best results under such conditions.

INTRODUCTION

Garlic is the foremost alliaceous vegetable plant, and one of main vegetable crops in Egypt. It has been used for flavoring, soup, sausages and salads, in addition to it's medical value. The increase in yield and improving bulb quality of garlic is usually dependent on many factors that influence the plant growth throughout the growth

1) Horticulture Dept., Faculty of Agric., Tanta University, Egypt
2) Agric. Eng. Dept., Faculty of Agric., Tanta University, Egypt.
3) Soil and Water Dept., Faculty of Agric., Tanta University, Egypt.

period, improving agricultural treatments especially application of optimal source of potassium fertilizer and the amount of available soil moisture especially the problem now is finding ways by which available water could be economically utilized. Many investigators found a direct relationship between yield and its components of bulb crops and available moisture at the time of irrigation. El-Bheidi et al. [1983]; Baten et al. [1992]; Panchal et al. [1992]; Pandy and Sing [1993]; Lipinski et al. [1996]; Patel et al. [1996]; Abo-Sedera and Badr [1998]; Hanson et al. [2003b] and Ortega et al. [2004] on garlic. Potassium element is very important in overall metabolism of plant enzymes activity, it was found to serve a vital role in photosynthesis by direct increasing in growth. Also, potassium has a beneficial effect on water consumption [Gardener et al., 1985 and Mansour, 2006]. Furthermore, many plant species including garlic were differing in growth and yields when supplied with either K_2SO_4 or KCl as sole source of potassium. Garlic plant react adversely to excessive increase of KCl fertilizer by exhibiting toxicity symptoms and by growing and yielding less than they would with K_2SO_4 [Gunadi and Asandhi, 1986; King et al., 1997; Park et al., 1997 and Abdel-Fattah et al., 2002].

Thus, this study was planned to evaluate the effect of irrigation frequency and K-sources on water application, water distribution, water use efficiency, productivity and storability of garlic.

MATERIALS AND METHODS

Two field experiments were carried out during the winter seasons of 2006/2007 and 2007/2008 at the experimental farm of the Faculty of Agriculture, Tanta University. The experimental field soil was clay loam in texture with pH 7.7. Each experiment included eight treatments which were the combinations of four irrigation intervals and two sources of potassium as follows:

A. Irrigation intervals:

1- Irrigation every 10 days by intervals [the plant received 15 irrigations during the growing season, whereas the plants were received the same total quantity of water].
2- Irrigation every 15 days by intervals [the plant received 10 irrigations].

3- Irrigation every 20 days by intervals [the plant received 7 irrigations].
4- Irrigation every 25 days by intervals [the plant received 6 irrigations].

B. Potassium sources [suitable for Egyptian soils]:

1- Potassium sulphate [K_2SO_4].
2- Potassium chloride [KCl].

The irrigation treatments began after 30 days from planting. All treatments received equal amounts of water at the first irrigation. Representative soil samples were randomly taken on regular basis before each irrigation time from 5 plots for every irrigation treatment to determine the soil moisture content within 0.4 m depth of soil. The furrow length was 4 m and the slop can be negligible. Siphon tubes were used to regulate the rate of water flow and to calculate the quantity of water applied for each plot. The quantity of water applied for each plot was calculated using the following equation [Khurmi, 1984]:

$$Q = Ca.\ A\ \sqrt{2gh} \qquad [1]$$

Where: Q = the quantity of water applied in $m^3.s^{-1}$,

Ca = coefficient of discharge (0.6),

A = $(\pi d^2/4)$ where π = equal to 3.14,

d^2 = inside radius square for the siphon tube,

g = the gravity equal to 9.81 $m.s^{-2}$ and

h = the head of water in the main irrigation canal in m.

The soil moisture content as volume percent and total quantity of applied water for each irrigation treatment are shown in Table 1. The field capacity of experiments field was 33% at 0.4 m soil depth.

Cloves of garlic [clone sids-40] were sown on October 7^{th} and 8^{th} in 2006 and 2007 seasons, respectively. Sowing was on both sides of ridges and the experimental layout was split-plot with four replications. Irrigation treatments were randomly distributed in the main plots whereas; potassium sources treatments were in the sub-plots. Each sub-plot consisted of six ridges, 4 m long, 0.6 m width and inter-ridge spacing was 0.07 m, sub-plot area was 14.4 m^2 and the data were recorded as follows:

- Soil water distribution and efficiencies:

The water application efficiency [E_a], the water distribution efficiency [E_d] and the water use efficiency [WUE] were determined for each treatment according to [James, 1988] as follows:

- Application efficiency:

$$E_a = [w_s/w_f] * 100 \quad [2]$$

Where:

E_a = water application efficiency in %,

w_s = stored water within irrigation in mm and

w_f = depth of added water to the irrigated area in mm.

- Water distribution efficiency:

$$E_d = [1 – s/d] * 100 \quad [3]$$

Where:

E_d = water distribution efficiency in %,

s = average numerical deviation from d, in mm and

d = average of soil water depth stored along the furrow during the irrigation in mm.

- Water use efficiency:

$$WUE = [Y_i/w_a] \quad [4]$$

Where:

Y_i = total grain yield in kg/fed., and

w_a = total applied water in m^3/fed.

Table 1: The soil moisture content and total quantity of applied water

Irrigation intervals [day]	Soil moisture content, vol. %			Quantity of water [$m^3.fed.^{-1}$]		
	2006/ 2007 Season	2007/ 2008 Season	Mean	2006/ 2007 Season	2007/ 2008 Season	Mean
10	25.12	25.05	25.09	2819	2637	2728
15	22.85	23.38	23.12	2703	2567	2635
20	20.53	21.02	20.77	2590	2438	2514
25	18.68	19.70	19.19	2498	2348	2423

- Vegetative growth:

Randomly 10 plants were selected from each treatment. At 145 days after planting for measuring the vegetative growth measurements expressed as plant height, number of leaves, leaves fresh weight and leaves dry weight.

- Yield and its components:

At harvest time [190 days after sowing], all plants of each treatment were harvested and the total yield per feddan was calculated after curing for 7 days. Also, a random sample [10 bulbs] was taken from each treatment to determine bulb weight, bulb diameter and number of cloves per bulb.

- Chemical constituents:

The chemical constituents of garlic plants as total nitrogen, phosphorus, potassium and total hydrolysable carbohydrates in dry matter of leaves and bulbs were determined following to Association of Official Analytical Chemists International [A.O.A.C., 1995]. Also, voliate oils were determined in fresh samples.

- Storability:

After curing random samples 10 kg each were taken from each treatment, stored at the normal room conditions. The percentage of total weight loss, sprouting and decay were calculated and recorded at the storage period [9 months]. On the other hand, all obtained data from this study were subjected to analysis of variance using MSTATC program.

RESULTS AND DISCUSSION

- Water application and distribution efficiencies:

Both treatments, irrigation every 15 and every 20 days by intervals reflected the highest value of water application efficiency and water distribution efficiency during the growing seasons [Fig. 1]. The highest values of water application efficiency were 75.48 and 74.20% at 15 and 20 days intervals, respectively. On the other hand, the highest values of water distribution efficiency were 78.86 and 75.25% at 15 and 20 days intervals, respectively. Under both 10 and 25 days irrigation intervals, the soil is wet or very dry, respectively. For this reason the water application and the water distribution efficiencies may be lowest than other treatments.

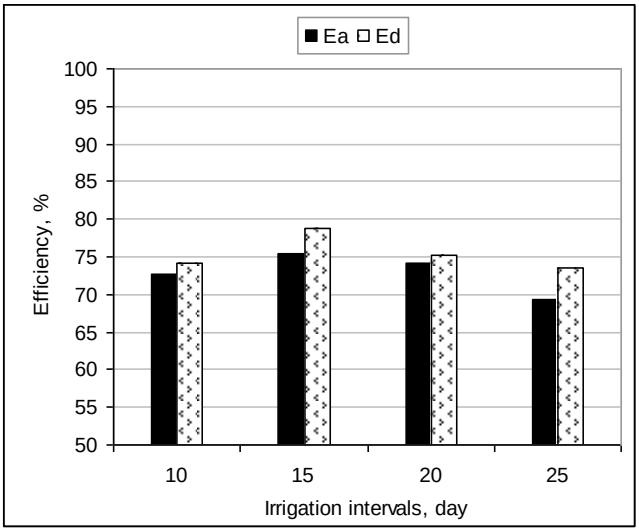

Fig. 1: The effect of irrigation intervals on the water application [E_a] and water distribution [E_d] efficiencies

- The water use efficiency:

Fig. 2 show the relationship between irrigation intervals and both water use efficiency and the total weight loss under two sources of potassium. The data in this figure presented the average values for two seasons. The interactions between irrigation frequency and potassium source affects on both water use efficiency and the total weight loss of bulbs. Under KCl, the highest values of water use efficiency were 3.25 and 3.19 kg/m^3 at 15 and 20 days irrigation intervals, respectively. At the same time, the lowest values of total weight loss were 67.46 and 71.31 %, respectively.

On the other hand and under K_2SO_4, the highest values of water use efficiency were 3.32 and 3.26 kg/m^3 at 15 and 20 days irrigation intervals, respectively. At the same time, the lowest values of total weight loss were 63.07 and 67.43 %, respectively. These results revealed that, garlic irrigated every 15 or 20 days and fertilized using K_2SO_4 reduced total weight loss and the water use efficiency improved.

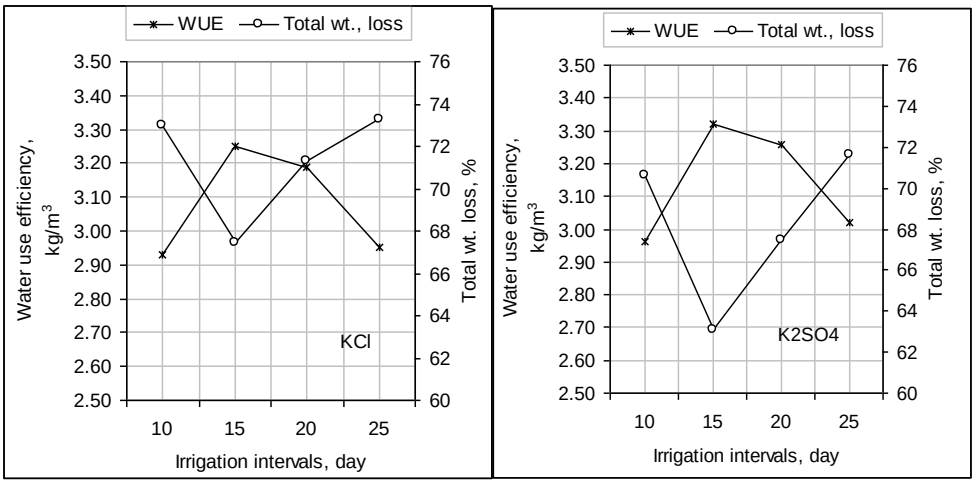

Fig. 2: The relationship between irrigation intervals and both water use efficiency and weight loss under two sources of potassium

- Vegetative growth:

Data presented in Table 2 show the effect of different sources of potassium on vegetative growth of garlic. In this respect, plant height, number of leaves per plant, leaves fresh weight and leaves dry weight were increased with K_2SO_4 than those with KCl. These results suggest that chloride ions toxicity might be inhibited photosynthesis process and hence limited plant growth with KCl as previously [Kang et al., 1997]. Who indicated that garlic plants were reacted adversely to excessive increase of KCl by exhibiting toxicity symptoms and by growing less than that with K_2SO_4. Also, sulphur [SO_4] is one of many elements required for plant growth, it is important in the formation of protein and chlorophylls. In addition, sulphur was found to improve soil structure and to increase water penetration and availability of nutrients under garlic plants [Hilal et al., 1992 and Mazrouh and Ragab 2000]. These results agree with those obtained by Hilman and Noordiyati [1988] and Abdel-Fattah et al. [2002].

Data in Table 2 show also that vegetative growth characters as plant height, number of leaves per plant, leaves fresh weight and leaves dry

weight were significantly affected by irrigation frequency in both seasons. In this concern, irrigation every 15 days intervals or every 20 days reflected the highest values of all vegetative growth characters. Such increment effect of increasing the number of irrigation i.e. irrigation 10 times per season on vegetative growth characters may be due to both increasing the mobility of nutrients in the soil and consequently increased the minerals uptake by plant and increasing carbohydrates assimilation [Tables 4 and 5] which are necessary for different growth processes. Positive response to irrigation frequency were reported by El-Habasha et al. [1981]; Maksoud et al. [1984]; Baten et al. [1992]; Abo-Sedera and Badr [1998] Hanson et al. [2003a] and Ortega et al. [2004] on garlic.

The interaction effects between irrigation frequency and potassium source on plant height, number of leaves per plant, leaves fresh weight and leaves dry weight were significant in both seasons [Table 2]. The results showed that, plants fertilized with K_2SO_4 and irrigated every 15 days intervals were very tall and had the highest number of leaves and highest values of leaves fresh weight and leaves dry weight in both seasons.

- Yield and its components:

Yield and its components like fresh weight and diameter of bulb, were affected by different sources of potassium. Results indicated that application of K_2SO_4 was generally more effective than KCl in both seasons [Table 3]. The highest values of all characters were obtained from application of K_2SO_4 [yield was 8.225 and 7.964 ton/fed. in the first and second seasons, respectively]. These results may be due to the favorable effect of SO_4 ions on photosynthetic pigments formation and carbohydrates assimilation diverted to the bulb filling and hence increasing yield. Conversely, Cl ions have a harmful effect on photosynthesis and translocation of carbohydrate from plant leaves to bulbs [Kang et al., 1997 and Hilal et al., 1992]. These results agree with Gunadi and Asandhi [1986] and Abdel-Fattah et al. [2002].

In Table 3, it is noticed that, garlic total yield and its components except number of cloves per bulb were significantly affected by irrigation frequency in both seasons. In this respect, irrigation every 15 days then 20 days by intervals recorded the highest values in the total yield [yield was 8.743 and 8.540 ton/fed. in the first and second seasons, respectively]

and its components except number of cloves per bulb. Similar positive responses of garlic plants were reported by Kamel and Abou El-Maged (1981); El-Beheidi et al. (1983); Baten et al. (1992); Panchal et al. [1992]; Pandy and Singh [1993]; Abo-Sedera and Badr [1998]; Hanson et al. [2003b] and Ortega et al. [2004] on garlic.

The interaction effects between irrigation frequency and potassium source clearly that, there were significant interactions on total yield and its components except number of cloves/bulb. The highest values of yield and its components were obtained by using K_2SO_4 and irrigation every 15 days intervals.

- Chemical constituents:

Regarding the effect of potassium source on percentage of N, P and K in plant foliage and bulbs of garlic were ineffective but, application of K_2SO_4 fertilizer increased total carbohydrates in leaves and bulb and voliate oils in bulb compared with KCl fertilizer, in both seasons [Tables 4 and 5]. These results agree with Park et al. [1997] and Abdel-Fattah et al. [2002]. The results showed that total carbohydrates in leaves and bulb and voliate oils in bulb were significantly affected by irrigation frequency in both seasons. In this respect, irrigation every 15 days by intervals recorded the highest values. But, percentage of N, P and K in plant foliage and bulbs of garlic were insignificant in both seasons. Positive response of irrigation frequency was reported by El-Beheidi et al. [1983] and Abo-Sedera and Badr [1998].

The interactions between potassium source and irrigation frequency significantly affected total carbohydrates in leaves and bulb and voliate oils in bulb in both seasons. Plants fertilized with K_2SO_4 and irrigated every 15 days intervals had highest values of total carbohydrates in leaves and bulb and voliate oils in bulb. The effect of all spraying treatments on percentage of N, P and K in plant foliage and bulbs of garlic were insignificant in both seasons.

- Storability:

Concerning the effect of potassium source on garlic storability, data in Table 6 revealed that garlic storability was markedly influenced by the applied potassium source. In this respect, storability of plants which received K_2SO_4 fertilizer was generally better than that of plants received

KCl fertilizer. Furthermore, application of K_2SO_4 reduced total weight loss, decay and sprouting percentage of garlic stored compared with KCl in both seasons. Obtained results may be due to the role of sulphur [SO_4] as a constituent of pungency substances, which is positively connected with the storability of bulbs [Mansour, 2006]. Also, these results may be due to the increased dry matter in plants. Similar results were reported by Kang et al [1997] and Abdel-Fattah et al. [2002].

As for the effect of the interaction, the highest value of water utilization was obtained by using K_2SO_4 and irrigation every 15 or 20 days intervals. Also, the total weight loss, decay and sprouting percentage of garlic stored were significantly affected by irrigation frequency in both seasons. In this concern, irrigation every 15 days then 20 days intervals reflected the lowest values of total weight loss, decay and sprouting percentage of garlic stored. The interaction effects between potassium source and irrigation frequency on garlic storability were significant in both seasons. From these results, plants fertilized with K_2SO_4 and irrigated every 15 days intervals had the lowest values of total weight loss, decay and sprouting percentage of garlic stored in both seasons.

Table 2: Effect of irrigation frequency and potassium source on vegetative growth of garlic during 2006/2007 and 2007/2008 seasons

Treatments	First season 2006/2007				Second season 2007/2008			
	Plant height (cm)	No. of leaves/ plant	Leaves fresh wt. (g)	Leaves dry wt. (%)	Plant height (cm)	No. of leaves/ plant	Leaves fresh wt. (g)	Leaves dry wt. (%)
K Sources								
KCl	67.91	8.57	29.27	14.03	66.63	8.31	28.07	13.03
K_2SO_4	68.96	9.31	31.35	14.14	71.61	9.03	29.83	13.15
Irrigation treatments								
Every 10 days	71.92	9.10	29.60	13.99	69.43	8.76	28.63	13.01
Every 15 days	81.38	10.03	35.87	14.24	79.87	9.83	34.25	13.22
Every 20 days	72.53	9.16	30.28	14.07	71.37	8.83	28.67	13.10
Every 25 days	59.90	7.47	25.50	14.04	55.80	7.27	24.25	13.03
L.S.D. at 5%		0.296	0.9145	0.2754	2.192	0.2278	0.804	0.184
Interactions								
KCl + 10 days	69.93	8.74	29.13	13.97	67.10	8.20	27.83	13.00
K_2SO_4 +10 days	73.90	9.47	30.07	14.02	71.77	9.32	29.43	13.01
KCl + 15 days	78.03	9.58	34.33	14.11	76.67	9.39	32.97	13.05
K_2SO_4 + 15 days	84.73	10.48	37.40	14.37	83.07	10.28	35.53	13.39
KCl + 20 days	70.47	8.89	28.87	14.05	69.47	8.55	27.73	13.06
K_2SO_4 + 20 days	74.60	9.44	31.70	14.09	73.27	9.10	29.60	13.15
KCl + 25 days	57.40	7.09	24.77	14.01	53.27	7.12	23.73	13.01
K_2SO_4 + 25 days	62.40	7.85	26.23	14.07	58.33	7.42	24.77	13.06
L.S.D. at 5%	2.259	0.404	1.356	0.157	2.611	0.1883	1.569	0.084

Table 3: Effect of irrigation frequency and potassium source on yield and quality of garlic during 2006/2007 and 2007/2008 seasons

Treatments	First season 2006/2007				Second season 2007/ 2008			
	Bulb fresh wt. (g)	Bulb diameter (cm)	No. of cloves /bulb	Total yield (ton/fed.)	Bulb fresh wt. (g)	Bulb diameter (cm)	No. of cloves /bulb	Total yield (ton/fed.)
K Sources								
KCl	74.92	5.94	21.40	8.053	71.92	5.76	22.67	7.817
K_2SO_4	78.80	6.31	21.36	8.225	75.48	5.90	22.74	7.964
Irrigation treatments								
Every 10 days	74.40	6.31	21.53	8.078	71.12	5.58	22.68	7.970
Every 15 days	87.95	6.95	21.33	8.743	83.43	6.83	22.83	8.540
Every 20 days	77.13	6.02	21.49	8.293	73.85	5.82	22.73	8.025
Every 25 days	67.97	5.21	21.18	7.442	66.42	5.07	22.60	7.028
L.S.D. at 5%	2.83	0.889	N.S	0.134	2.272	0.0446	N.S	0.155
Interactions								
KCl + 10 days	71.83	5.73	21.16	8.027	68.67	5.52	22.66	7.933
K_2SO_4 + 10 days	76.97	6.90	21.90	8.130	73.57	5.64	22.70	8.007
KCl + 15 days	85.43	6.92	21.50	8.643	81.53	6.76	22.78	8.450
K_2SO_4 + 15 days	90.47	6.99	21.16	8.843	85.33	6.91	22.89	8.630
KCl + 20 days	74.97	5.95	21.73	8.193	71.97	5.71	22.70	7.930
K_2SO_4 + 20 days	79.30	6.08	21.26	8.393	75.73	5.93	22.75	8.120
KCl + 25 days	67.47	5.17	21.23	7.350	65.53	5.05	22.55	6.957
K_2SO_4+ 25 days	68.47	5.25	21.13	7.533	67.30	5.10	22.64	7.100
L.S.D. at 5%	1.498	1.176	N.S	0.060	2.094	0.1031	N.S	0.103

Table 4: Effect of irrigation frequency and potassium source on chemical contents of garlic leaves during 2006/2007 and 2007/2008 seasons

Treatments	First season 2006/2007				Second season 2007/ 2008			
	N (%)	P (%)	K (%)	Total carbohydrates (mg/100g)	N (%)	P (%)	K (%)	Total carbohydrates (mg/100g)
K Sources								
KCl	2.76	0.80	1.78	47.22	2.73	0.78	1.76	46.56
K_2SO_4	2.80	0.80	1.80	49.18	2.76	0.79	1.77	47.30
Irrigation treatments								
Every 10 days	2.75	0.73	1.77	47.85	2.72	0.72	1.76	48.98
Every 15 days	2.87	0.87	1.87	54.55	2.84	0.84	1.83	51.42
Every 20 days	2.79	0.84	1.81	48.58	2.75	0.84	1.80	47.58
Every 25 days	2.72	0.75	1.71	41.82	2.65	0.74	1.68	39.73
L.S.D. at 5%	N.S	N.S	N.S	1.331	N.S	N.S	N.S	1.882
Interactions								
KCl + 10 days	2.74	0.74	1.76	47.70	2.70	0.72	1.76	49.00
K_2SO_4 + 10 days	2.76	0.72	1.77	48.00	2.75	0.73	1.75	48.97
KCl + 15 days	2.85	0.86	1.85	52.67	2.81	0.83	1.81	50.13
K_2SO_4 + 15 days	2.89	0.88	1.89	56.43	2.86	0.85	1.85	52.70
KCl + 20 days	2.76	0.84	1.81	48.20	2.75	0.84	1.80	47.70
K_2SO_4 + 20 days	2.82	0.84	1.81	48.97	2.76	0.84	1.79	47.47
KCl + 25 days	2.69	0.75	1.69	40.30	2.64	0.74	1.67	39.40
K_2SO_4+ 25 days	2.75	0.75	1.74	43.33	2.67	0.74	1.69	40.07
L.S.D. at 5%	N.S	N.S	N.S	1.981	N.S	N.S	N.S	1.730

Table 5: Effect of irrigation frequency and potassium source on chemical contents of garlic bulbs during 2006/ 2007 and 2007/ 2008 seasons

Treatments	First season 2006/2007					Second season 2007/2008				
	N (%)	P (%)	K (%)	Total Carbohydrates (mg /100g)	Voliate oil (g/100g f.w.)	N (%)	P (%)	K (%)	Total Carbohydrates (mg /100g)	Voliate oil (g/100g f.w.)
K Sources										
KCl	1.37	0.53	1.62	67.98	0.316	1.35	0.49	1.57	64.14	0.313
K_2SO_4	1.39	0.55	1.64	69.53	0.395	1.36	0.50	1.59	66.64	0.394
Irrigation treatments										
Every 10 days	1.36	0.53	1.63	67.96	0.345	1.34	0.51	1.59	65.64	0.330
Every 15 days	1.44	0.60	1.71	76.38	0.423	1.40	0.56	1.66	74.08	0.413
Every 20 days	1.37	0.56	1.65	69.49	0.360	1.37	0.50	1.59	66.06	0.365
Every 25 days	1.35	0.47	1.54	61.22	0.293	1.30	0.43	1.47	55.76	0.307
L.S.D. at 5%	N.S	N.S	N.S	1.591	0.019	N.S	N.S	N.S	1.877	0.0446
Interactions										
KCl + 10 days	1.36	0.53	1.63	67.01	0.297	1.32	0.49	1.58	64.01	0.287
K_2SO_4 + 10 days	1.37	0.53	1.64	68.90	0.393	1.35	0.52	1.60	67.28	0.373
KCl + 15 days	1.43	0.59	1.69	75.90	0.370	1.40	0.55	1.65	73.25	0.370
K_2SO_4 + 15 days	1.45	0.61	1.72	76.85	0.477	1.41	0.56	1.67	74.92	0.457
KCl + 20 days	1.37	0.55	1.65	68.84	0.323	1.38	0.50	1.59	65.15	0.317
K_2SO_4 + 20 days	1.38	0.56	1.65	70.13	0.397	1.35	0.50	1.59	66.98	0.413
KCl + 25 days	1.34	0.46	1.53	60.18	0.273	1.29	0.42	1.46	54.14	0.280
K_2SO_4 + 25 days	1.36	0.49	1.55	62.25	0.313	1.31	0.43	1.48	57.39	0.333
L.S.D. at 5%	N.S	N.S	N.S	1.209	0.084	N.S	N.S	N.S	2.231	0.059

Table 6: Effect of irrigation frequency and potassium source on Water use efficiency and storability of garlic bulbs during 2006/2007 and 2007/2008 seasons

Treatments	First season 2006/2007			Second season 2007/ 2008		
	Total wt. loss (%)	Sprouting (%)	Decay (%)	Total wt. loss (%)	Sprouting (%)	Decay (%)
K Sources						
KCl	71.42	4.54	78.40	71.06	4.56	79.53
K_2SO_4	67.67	4.49	70.69	68.70	4.52	70.71
Irrigation treatments						
Every 10 days	71.56	4.59	74.20	72.04	4.58	72.78
Every 15 days	65.25	4.24	73.25	65.27	4.27	73.36
Every 20 days	68.88	4.56	74.09	69.85	4.61	75.84
Every 25 days	72.50	4.67	76.65	72.35	4.70	78.50
L.S.D. at 5%	1.431	N.S	0.734	1.727	N.S	2.108
Interactions						
KCl + 10 days	73.28	4.61	78.68	72.66	4.63	77.59
K_2SO_4 + 10 days	69.85	4.56	69.72	71.43	4.53	67.97
KCl + 15 days	67.91	4.25	77.65	67.00	4.28	78.60
K_2SO_4 + 15 days	62.59	4.22	68.85	63.54	4.27	68.13
KCl + 20 days	71.09	4.57	78.10	71.52	4.63	80.74
K_2SO_4 + 20 days	66.67	4.54	70.08	68.18	4.58	70.93
KCl + 25 days	73.42	4.71	79.18	73.04	4.71	81.21
K_2SO_4 + 25 days	71.59	4.64	74.13	71.66	4.70	75.80
L.S.D. at 5%	2.273	N.S	1.194	1.891	N.S	2.446

CONCLUSION

From the results of this study, it could be concluded that, under such condition soil fertilization with K_2SO_4 fertilizer and irrigation every 15 days or 20 days irrigation intervals being the superior treatment for producing the maximum garlic yield with the best storability and quality as well as highest application, distribution and use efficiencies of irrigation water.

REFERENCES

Abdel-Fattah, A. E.; Afaf T. M. Kasim and Z. S. El-Shal (2002). Effect of some sources and levels of potassium fertilizer on growth, yield and quality of garlic (*Allium sativum* L.). *Annals of Agric. Sc., Moshtohor.* 40(3):1727-1738.

Abo-Sedera, F. A. and L. A. A. Badr (1998). Plant growth and chemical composition of galic plant as affected by irrigation frequency and NPK fertilization. *Annals of Agric. Sc., Moshtohor.* 36(2):1057-1071.

A.O.A.C. (1995). Official method of analysis 16th ed., Association of Official Analytical Chemists International, Arlington Virginia, USA.

Baten, M. A; B. S Nahar; S. C. Sarker and A. A. Muhsi (1992). Effect of different intervals of irrigation on growth and yield of garlic. *Pakistan J. of Sci. and indust. Res*. 35:7-8, 297-299.

El-Beheidi, M. A.; N. H Kamel and M. M. Abou-Elmagd (1983). Effect of water regime and nitrogen fertilizer on some mineral content, yield and amino acid contents of garlic. *Plant Ann. Of Agric. Sci. Moshtohor*. 19(1):149-169.

El-Habbasha, K. M.; N. H Kamel and M. M. Abou-Elmagd (1981). Growth and dry matter accumulation in garlic plants as influenced by water supply and nitrogen fertilizer. *Zagazig J. Agric. Res. Bull.* No. 367:1-18.

Gardener, F. D.; R. B. Pearce and R. L. Mitchell (1985). Pysiology of crop plants. *The Iowa State Univ. Press. Amer*., 327 pp.

Gunadi, N. and A. A. Asandhi (1986). Effect of source and dosage of nitrogen fertilizer and source of potash fertilizer on growth and yield of garlic. *Indonesia Bulletin Penel Hort*., 13(3):23-32.

Hanson, B.; D. May; R. Voss; M. Cantwell and R. Rice (2003a). Response of garlic to irrigation water. *Agric. Water Management.* 58(1):29-43.

Hanson, B. R.; D. May; R. Voss; M. Cantwell and R. Rice (2003b). Garlic in clay loam soil thrives on little irrigation. *California-Agriculture*. 56(4):128-132.

Hilal, M. H.; A. M. Selim and A. S. El-Neklawy (1992). Enhancing and retarding effect of combined sulphur and fertilizers applications on crop production in different soils. *In Proceedings Middle East Sulphur Symposium 12-16 February, Cairo, Egypt.*

Hilman, Y. and I. Noordiyati (1988). Equilibrium N, P and K fertilization trial on garlic. *Indonesia Bulletin Penel Hort.*, 16(1):48-53.

James, L. C. (1988). Principles of farm irrigation system design. John Willey and Sons (ed.), New York, pp. 543.

Kamel, N. H. and M. M. Abu El-Magd (1981). Effect of water supply and nitrogen fertilization on the water forms and photosynthetic pigments of garlic plants. *Zagazig J. Agric. Res. Bull.* No.366:1-13.

Khurmi, R. S. (1984). A text book of hydraulics, fluid mechanics and hydraulic machines *Chand S. and Company Lted., Ram Nagar. New Delhi.*

Kang, U. G.; H. W. Kang and K. B. Park (1997). Effect of sulfur and K sources application on of garlic (*Allium sativum* L.) varieties. *Agro-Env. Sci. J.* 39(2):35-39.

Lipinski, V.; D. H. S. Gavoila and M. F. Filippini (1996). Effect of irrigation, nitrogen fertilization and clove size on yield and quality of coloured garlic (*Allium sativum* L.) *Ciencia del suels (1995)* 13(2):80-84.

Maksoud, M. A.; S. Fouda; F. M. Taha and H. A. Ibrahim (1984). Effect of different fertilizers on quality and yield of garlic. *Egypt. J. Hort.* 11(1):51-57.

Mansour, F. Y. O. (2006). Physiological studies on garlic (*Allium sativum* L.). M.Sc. Thesis, Fac. Agric.; Minufiya Univ.; Egypt.

Mazrouh, A. Y. and A. El-B. Ragab (2000). Effect of some nitrogen and sulphur sources on plant growth and yield of onion (*Allium cepa*, L.). *J. Agric. Sci. Mansoura Univ*.; 25 (1):611-625.

Ortega, J. F; J. A. de Juan and J. M. Tarjuelo (2004). Evaluation of the water cost effect on water resource management: application to typical crops in a semiarid region. *Agric. Water Management.* 66 (2):125-144.

Panchal, G. N.; M. M. Modhwadia; J. C. Patel; S.G. Sadaria and B. S. Patel (1992). Response of garlic to irrigation, nitrogen and phosphorus. *Ind. J. Agro.* 37(2):397-398.

Pandy, U. B. and D. K. Sing (1993). Response of garlic to different levels of irrigation and nitrogen. *Ind. National. Hort. Res.* 13:3-4, 10-12.

Park, H. M.; J. O. Kim and U. G. Kang (1997). Effect of sulfur and K-source on yield and volatile compounds of garlic (*Allium sativum* L.) varieties. *Agro-Env. Sci. J.* 39(2):53-59.

Patel, B. G.; V. D. Khanpara; D. D. Malavia and B. B. Kaneria (1996). Performance of drip and surface methods of irrigation for garlic (Allium sativum) under varying nitrogen levels. *Indian J. Agronomy.* 41(1):174-176.

الملخص العربى

تأثير فترات الرى ومصدر السماد البوتاسى على إنتاجية وجودة الثوم وقابليته للتخزين

محمد السيد محمد أحمد[1]، أسعد عبد القادر دربالة[2]، ناصر إبراهيم عبد القادر[3]

أجريت دراسة حقلية بالمزرعة البحثية بكلية الزراعة – جامعة طنطا خلال الموسمين الشتويين لعامى ٢٠٠٦/٢٠٠٧، ٢٠٠٧/٢٠٠٨ لدراسة تأثير فترات الرى (كل ١٠ ، ١٥ ، ٢٠ ، ٢٥ يوم) وكذلك دراسة مصدر السماد البوتاسى (سلفات بوتاسيوم وكلوريد البوتاسيوم) على النمو والمحصول وجودتة لنبات الثوم وكذلك قابليته للتخزين. وقد وزعت المعاملات فى قطع منشقة مرة واحدة فى أربع مكررات. ويمكن تلخيص النتائج المتحصل عليها فيما يلى:-

- أحسن قيم بالنسبة للنمو الخضرى (إرتفاع النبات، عدد الاوراق، الوزن الطازج والجاف للاوراق) كانت عند معاملة الرى على فترات كل ١٥ يوم يليها معاملة الرى كل ٢٠ يوم.
- أعلى قيم للمحصول ومكوناتة (الوزن الطازج للبصلة وقطرها ومحتوى الفصوص من الكربوهيدرات والزيوت الطيارة) كانت عند معاملة الرى على فترات كل ١٥ يوم يليها معاملة الرى كل ٢٠ يوم.
- معاملة الرى على فترات كل ١٥ يوم يليها معاملة الرى كل ٢٠ يوم حسنت من زيادة قابلية الأبصال للتخزين وزادت من كفاءة توزيع وإستخدام مياه الرى.
- إستخدام سماد سلفات البوتاسيوم كان بصفة عامة أكثر فائدة من سماد كلوريد البوتاسيوم حيث أدى إلى حدوث زيادة فى إرتفاع النبات، عدد الأوراق والوزن الطازج والجاف للأوراق. كما أدى الى زيادة المحصول الكلى وكذلك وزن البصلة وقطرها ومحتوى الفصوص من الكربوهيدرات والزيوت الطيارة. بالاضافة الى ذلك تحسنت قابلية تخزين الأبصال مع سماد سلفات البوتاسيوم مقارنة مع سماد كلوريد البوتاسيوم.

ومن هذه النتائج، يمكن التوصية برى نباتات الثوم كل ١٥ يوم أو الرى كل ٢٠ يوم مع إستخدام سماد سلفات البوتاسيوم وذلك تحت ظروف الاراضى الطينية والمشابهه لظروف أراضي محافظة الغربية للحصول على أحسن صفات خضرية وأعلى محصول (من ناحية الكمية والنوعية) وكذلك أعلى كفاءة إضافة وتوزيع وإستخدام لمياه الرى وأعلى قابلية لتخزين الأبصال.

[1] مدرس بقسم البساتين – كلية الزراعة – جامعة طنطا – مصر.
[2] مدرس بقسم الهندسة الزراعية – كلية الزراعة – جامعة طنطا – مصر.
[3] مدرس بقسم الأراضي والمياه – كلية الزراعة – جامعة طنطا – مصر.