

Effect of Irrigation Intervals and Potassium Levels on Yield and Quality of Watermelon

Abdel-All, H.M. and Seham M.Aly

Vegetable Res. Division, Hort. Res. Inst., ARC, Dokki, Giza, Egypt.

Abstract: Two field experiments were conducted at the Experimental Farm of Hort. Res. Inst. at Kaha, Qalubia Governorate during the summer season of 2010 and 2011 to study the effect of both irrigation intervals (7, 14 and 21 days) and potassium fertilization at rate of (75, 150 and 225kg K₂O/fed.), as well as their interaction on growth, yield and its components as well as fruit quality of watermelon (*Citrullus lanatus* L.) cv. Aswan plants cultivated in clay loam soil with pH 8.2. The obtained results indicated that elongating irrigation period linearly decreased the means of all vegetative growth parameters, while potassium treatments improved them, especially at the rate of 225kg/fed. which gave the highest values. Irrigation every 7 days by intervals increased fruit weight, diameter, length and cortex thickness, but decreased number of fruits/plant, total and marketable yield and TSS content. The opposite was the right concerning irrigation every 14 and 21 days. Fruit unmarketable yield was increased as a result of irrigation every 7 days, but was markedly decreased when irrigation was done every 14 or 21 days. The medium and high levels of potassium (150 and 225kg/fed., respectively) induced a significant increment in No. of fruits/plant, fruit weight, diameter and length, marketable yield and TSS content comparing with the low level (75kg/fed.). They were also reduced the percent of unmarketable fruits and cortex thickness to the minimum values in comparison to the low level. Data also showed that irrigation intervals had no effect on acidity, whereas total sugars, K and N contents were progressively increased with elongating irrigation period. On the other hand, increasing potassium rate significantly reduced acidity, but cumulatively raised the content of total sugars, K and N. In addition, water use efficiency (WUE) was progressively increased with elongating irrigation interval, while potassium use efficiency (KUE) was only improved by 14 days interval treatment. Potassium fertilization was positively effective at the rate of 150kg/fed. that elevated WUE to the highest value, whereas KUE argumentatively decreased with increasing K rate. The interactions or combined treatments between irrigation intervals and K levels had more pronounced effect on all characters mentioned before, especially the interaction between either 14 or 21 days interval and 150kg K₂O/fed., which improved the most studied traits over other interactions in both seasons. So, to obtain the best vegetative growth from watermelon plants cultivated under conditions similar to those of Delta region, it is preferred to irrigate once every 7 days and fertilize with 150kg K₂O/fed., while to score the highest yield suitable for marketing, it is advised to irrigate once every 14 days + fertilization with the same previous level of K. To get the best quality and highest TSS content with uncracked fruits, it could be recommended to irrigate once every 21 days plus fertilization with 150kg K₂O/fed.

Key words: watermelon, irrigation intervals, potassium levels, marketable yield, TSS, (WUE), (KUE).

INTRODUCTION

Watermelon is one of the most famous and cheap vegetable crops used in Egypt during summer as it contains a high water content giving the feeling of freshness and containing significant amounts of sugar, A, B and C vitamins. In order for watermelon to grow well, it needs adequate water and proper nutrition. It is negatively affected by either deficit water or low fertilization (Okur and Yagmur, 2004).

Water is fast becoming an economically scare resource in any areas of the world, especially in arid and semi-arid regions such as Mediterranean basin. The increased competition for water among agricultural, industrial and urban consumers creates the need for continuous improvement of irrigation practices in commercial vegetables production, among of which specifying the suitable intervals for irrigation of each crop (Rouphael *et al.*, 2008). In this regard, Erdem *et al.*, (2001) revealed that total yield and some yield components of watermelon cv. "Crimson Sweet", as well as water use efficiency were improved by increasing irrigation water amounts., Wang *et al.* (2004) who postulated that 45mm of irrigation increased yield by about 36% and 68mm increased yield by about 46%. Drip irrigation with 68mm had the highest water use efficiency (WUE); 24.7kg/m³, which was 29.3% more than the non-irrigated treatment. Fruit weight and size were also increased. Imam and Ibrahim (2005) indicated that fruit weight was not affected the irrigation level, whereas No. fruits/plant and yield were the highest by 0.6ETo irrigation level. Fruit diameter, cortex thickness, TSS and dry matter content were not affected by irrigation level, while flesh firmness, titratable acidity and total sugar

Corresponding Author: Abdel-All, H.M, Vegetable Res. Division, Hort. Res. Inst., ARC, Dokki, Giza, Egypt.

E-mail: hatemabdelall@yahoo.com

content reached the highest values in plants irrigated with 0.6ET₀ level. Analogous observations were also attained on watermelon by Erdem and Yuksel (2003), Erdem *et al.* (2005), Roupael *et al.* (2008), He and Li (2011).

Potassium (K) is an essential mineral element for plants as it involved in many biochemical and physiological processes vital to plant growth, yield, quality and stress (Cakmak, 2005). It is also involved in stomatal regulation of transpiration and photosynthesis, photophosphorylation, transportation of photo assimilates from source tissues via the phloem to sink tissues, enzyme activation, turgor maintenance and stress tolerance (Marschner, 1995 and Pettigrew, 2008).

The previous benefits of K are documented by numerous investigators, such as Okur and Yagmur (2004) who found that 240kg/ha of K₂O yielded the highest yield of watermelon as 54320kg/ha. Number of fruits, fruit weight and width were also the maximum. Song *et al.* (2007) reported that K at 480kg/hm² significantly increased fruit weight and yield of watermelon. Soluble sugar content, vit. C and nitrate were linearly increased with increasing K₂O dose, but to a certain volume. Similar results were also gained by Nan *et al.* (2008) and Shao *et al.* (2011) on watermelon, and Lester *et al.* (2009) on melon (*Cucumis melo* L.).

However, the current work was done to detect the response of watermelon cv. Aswan plants to various irrigation intervals and potassium rates under conditions similar to those of Delta region.

MATERIALS AND METHODS

This study was carried out at the Experimental Farm of Hort. Res. Inst. at Qaha, Qalubia Governorate during the summer season of 2010 and 2011 to investigate the effect of irrigation intervals (7, 14 and 21 days) potassium fertilization at the rates of 75, 150 and 225kg K₂O/fed. and their interactions on vegetative growth, yield and its components, fruit quality and chemical composition of watermelon (*Citrullus lanatus* L.) cv. Aswan. The soil of the experimental field was clay loam in texture with pH 8.2. The mechanical and chemical analyses of the soil was determined according to the methods described by Jackson (1973) and are shown in Table (a)

Table (a): The main physical and chemical properties of the experimental soil during 2010 and 2011 seasons.

Soil characteristics	2010	2011
	Values	Values
Clay %	41.02	42.00
Silt %	36.15	33.91
Fine sand %	15.60	14.81
Coarse sand %	7.55	7.98
Texture class	Clay-loam	
Chemical analysis as meg/100g.soil.		
pH (1:2.5 suspension)	8.0	8.2
Organic matter %	1.78	1.91
HCO ₃ ⁻	1.91	1.94
Cl ⁻	1.42	1.35
SO ₄ ⁻	0.59	0.64
Ca ⁺⁺	1.27	1.29

Data presented in Table (b) show the monthly averages of temperature, relative humidity percentage (R.H.%) and quantity of rainfall at Qalubia Governorate in the region surrounding the experimental site during the two seasons of the experimental work.

Table b: Average monthly temperature, relative humidity (%), at kalubia Governorate in the region surrounding the experimental site through the two seasons of the experimental work.

Month	temperature			Relative humidity
	Min.	Max.	Mean	
April	14.0	29.8	21.9	56
May	17.2	33.4	25.3	50
June	21.5	36.4	28.9	50
July	22.8	35.8	39.3	68.1
August	25.0	37.6	31.3	61.6
April	14.3	28.1	21.2	54.3
May	16.4	29.8	23.1	52.6
June	20.5	34.1	27.3	54.0
July	22.5	35.8	29.1	60.3
August	22.5	35.1	28.9	67.0

Table (C): Irrigation treatments as irrigation intervals in days, number of irrigation and quantity of applied water (m³/fed.) during 2010 and 2011 seasons.

Irrigation regime	Soil moisture at irrigation (%/field capacity	No. of irrigation	Quantity of water (m ³ /fed.) received before treatments application during 2010/2011		Quantity of water (m ³ /fed.) received after treatments application during 2010/2011		mean
			2010	2011	2010	2011	
Irrigation every 7 days	42-49	8	805	940	3024	3326	4047
Irrigation every 14 days	31-37	5	805	940	2646	2814	3602
Irrigation every 21 days	23-29	3	805	940	2014	2116	2512

The quantity of water applied for each experiment plot was by using siphon pipes and calculated from the following equation mentioned by Khumi (1984) and registered in Table (C).

$$Q = Ca \cdot a \sqrt{2gH}$$

Where

Q = The quantity of water applied in m³/second.

Ca = Coefficients of discharge (0.6).

a = (Πd^2)/4; where Π = equal to 3.14, and d² = Radius square for the siphone tube.

g = The gravity equal to 9.18m/Sec².

H = The height of water in the main irrigation canal.

The experimental design was split plot with three replicates. Transplants were cultured at 1m apart within rows of 2m width and 5m length on 5th and 3rd April in the first and second seasons, respectively. The area of the experimental plot was 30m². the experiment included 9 treatments; 3 irrigation intervals (7, 14 and 21 days) within 3 potassium levels (75, 150 and 225kg K₂O/fed.). The water interval treatments were distributed in the main plots, whereas potassium levels were located in the sub-plots. The amounts of potassium fertilizer were divided to 3 equal portions and added at 30, 55 and 70 days after planting. In addition, nitrogen and phosphorus were added as the recommended dose (80kg N/fed. and 45kg P₂O₅/fed.). They were also divided to 3 equal portions and added at 30, 55 and 70 days after planting for N, but for P₂O₅ at was added at pre-planting, 30 and 70 days after planting. Watermelon transplants were planted in the present of water, all the plots were equally irrigated. After one month from planting, the irrigation interval treatments were began as indicated before in Table (C).

Surface irrigation system was used through weir to regulate the rate of water flow and calculate the quantity of water applied for each plot.

Data Recorded:

1. Growth Characters:

Vegetative growth of watermelon plants was measured at 75 days after planting. Representative sample of 5 plants from each experimental plots was taken for measuring the vegetative growth aspects as follows: average plant length (cm), number of branches/plant, number of leaves/plant and leaf area (cm²).

2. Yield and its Components:

At harvesting time (102 days after planting), number of fruits/plant average, fruit weight (kg), total yield (ton/fed.) marketable yield (ton/fed.), unmarketable yield (ton/fed.) and fruit unmarketable percentage (fed.4200 m²).

3. Fruit Physical and Chemical Characteristics:

Fruit length and diameter (cm), cortex thickness (cm), TSS (%), total acidity as mg/100g F.W. (A.O.A.C., 1980) and total sugars (mg/ 100g F.W.) according to Somogi (1952) and Nelson (1974). Potassium and nitrogen percentages were also determined according to Jackson (1973).

4. Water and Potassium use Efficiency:

Water use efficiency (WUE) is defined as the relationship between units produced and volume of irrigation water applied (Sinclair *et al.*, 1984). Potassium use efficiency (KUE) by plants calculated as kg of the fruit yield produced by each unit of potassium nutrient used.

Association of irrigation intervals and T.S.S contents in watermelon irrigation intervals and water use efficiency, potassium levels and potassium use efficiency and was determined by calculating simple correlation and regression of these variables using the following formula according to Nageswara (1983):

$$\text{Cov.} x_1 x_2$$

$$r = \frac{\text{Cov.} x_1 x_2}{\sqrt{(\text{Variance } X_1)(\text{Variance } X_2)}}$$

$$r = \frac{\text{Cov.} x_1 x_2}{\sqrt{(\text{Variance } X_1)(\text{Variance } X_2)}}$$

r = the correlation coefficient.

Cov. = covariance.

X1=measurement of one variable.

X2= measurement of the other variable.

Linear regression between the two variables was done.

All obtained data were subjected to statistical analysis according to Data were then tabulated and subjected to analysis of variance using SAS program (1998) and Duncan's Multiple Range Test (1955) to compare among means of the various treatments.

RESULTS AND DISCUSSION

Effect of Irrigation Intervals, Potassium Levels and Their Interactions on:

1. Vegetative Growth Parameters:

Data in Table (1) show that water deficit treatments decreased the means of all vegetative growth traits with significant differences when compared to 7 days interval treatment in most vegetative characters of the two seasons. On the contrary was the trend of potassium treatments, as the means of all vegetative growth measurements were significantly increased, with the prevalence of 225kg K₂O/fed. level that gave the highest means of all traits, while the level of 75kg K₂O /fed. gave the lowest of all traits under studies in both seasons. Increment of vegetative growth due to the reduction of irrigation interval may be attributed to the role of luxurious water in increasing the availability and diffusion of nutrients, and consequently increasing uptake of macro-and micronutrients by roots which greatly reflects on plant growth. On the other hand water deficit, decreases water absorption by roots, and that in turn negatively affect on bioaccumulation. Increasing vegetative growth due to K application may be indicate the role of such nutrient in activating vital processes which had a positive effect on plant growth.

Concerning the effect of the interaction, it was noticed that the combining between 7 days interval treatment and either 150 or 225 K₂O/fed. level recorded the best results with the mastery of 7 days interval + 225kg K₂O/fed. combination, which gave the utmost high means in the two seasons. This may be ascribed to lump the benefits of both water abundance and high potassium.

The aforementioned results are coincided with those of Erdem *et al.* (2001), Emam and Ibrahim (2005), Rouphael *et al.* (2008) and Shao *et al.* (2011) on some cultivars of watermelon.

2. Yield and its Components:

From data averaged in Tabs (2 and 3) and fig. 1, it could be concluded that irrigation every 7 days increased fruit weight, diameter and cortex thickness, but decreased No. of fruits/plant, total and marketable yield (ton/fed.) and TSS (%) in the two seasons. The opposite was the right concerning irrigation every 14 or 21 days, as they were greatly improved No. of fruits/plant, total and marketable yield (ton/fed.) and TSS (%), but significantly decreased fruit weight and cortex thickness. On the other side, fruit unmarketable yield (ton/fed.) and its percentage (%) were increased as a result of irrigation every 7 days, but were markedly decreased when irrigation was done every 14 or 21 days with significant differences in both seasons. However, the best results was recorded by 21 days interval treatment which followed by 14 days interval one.

As for potassium effect, it was clear that the medium and high levels (150 and 225kg/fed., respectively) significantly raised No. of fruits/plant, fruit weight and diameter, total and marketable yield and TSS (%) comparing with the low level (75kg/fed.). On the contrary, these two levels were reduced the yield and percent of unmarketable fruits, as well as cortex thickness to the minimum values compared to the low level. In general, the best gains was recorded by the medium level (150kg/fed.) which gave the best results in most cases of the two seasons. Fruit length was not affected by either water intervals or K application rates in both seasons.

Data also revealed that the interaction treatments had a significant effect on yield and quality of the fruits. In this connection, the best results were obtained from irrigation every 21 days plus fertilization with 150kg K₂O/fed., as such combination gave the utmost high means of No. of fruits/plant, total and marketable yield that was accompanied with the least percent of fruit unmarketable yield. This may be indicate the role of water supply and K application in assimilation and translocation of the synthetic assimilated molecules from the organs of synthesis to the fruits. The increasing of total yield either per plant or fedden are connected with the increasing

in number of fruits produced by plant and the increment of average fruit weight, fruit diameter and fruit length were higher due to the interaction between 7 days interval and 225kg K₂O/fed. in both seasons, while TSS (%) was higher due to the interaction of irrigation at 21 days interval + fertilization with 150 or 225kg K₂O/fed. level in the two seasons.

Table 1: Effect of irrigation intervals, potassium levels and their interactions on vegetative growth of watermelon during 2010 and 2011 seasons.

Treatments	2010				2011			
	Plant length (cm)	No. of leaves/plant	No. of branches/plant	Leaf area (cm ²)	Plant length (cm)	No. of leaves/plant	No. of branches/plant	Leaf area (cm ²)
Irrigation								
Irg. 7 day	190.7 a	173.8 a	6.7 a	4955.3 a	200.7 a	157.0 a	6.0 a	4343.3 a
14 day	188.2 a	127.1 b	5.4 b	3768.0 b	189.1 b	119.8 b	5.2 a	3733.0 b
21 day	165.7 b	87.0 c	4.7 c	2326.0 c	166.2 c	84.2 c	4.3 b	2491.7 c
Potassium levels								
K 75kg/fed.	176.1 a	119.4 c	5.4 a	3139.7 c	180.9 b	100.1 c	4.6 b	2943.0 c
150kg/fed.	186.2 a	130.1 b	5.6 a	3841.0 b	186.3 a	125.3 b	5.4 a	3696.7 b
225kg/fed.	182.3 a	138.3 a	5.8 a	4069.2 a	189.1 a	135.6 a	5.6 a	3928.3 a
Interaction								
Irg. 7 day 75kg k	193.3 a	151.8 b	6.3 ab	3960.0 c	198.1 ab	129.3 c	5.0 cd	3540.0 b
150kg k	196.6 a	184.1 a	7.0 a	4970.0 b	203.3 a	167.0 a	6.5 ab	4510.0 b
225kg k	182.3 ab	185.5 a	7.0 a	5936.0 a	201.2 a	174.8 a	6.7 a	4980.0 a
Irg. 14 day 75kg k	180.0 ab	116.5 c	5.0 cd	3149.0 d	185.3 c	100.1 e	4.7 cd	3019.0 e
150kg k	192.3 a	111.3 c	5.3 bcd	4006.0 c	191.1 bc	118.7 d	5.3 bcd	3990.0 cd
225kg k	192.5 a	151.8 c	6.0 abc	4149.0 c	190.9 bc	140.7 b	5.7 abc	4190.0 bc
Irg. 21 day 75kg k	155.1 c	90.0 d	5.0 cd	2310.0 f	159.3 e	70.9 g	4.1 d	2270.0 f
150kg k	169.9 bc	93.3 d	4.6 d	2547.0 e	164.0 e	90.4 f	4.5 cd	2590.0 e
225kg k	172.3 c	77.8 e	4.5 d	2122.7 f	175.4 d	91.3 ef	4.5 cd	2615.0 e

• Values followed by different letters within the same column are significantly different according to Duncan's Multiple Range test at 5% level.

Table 2: Effect of water intervals, potassium levels and their interactions on yield of watermelon during 2010 and 2011 seasons.

Treatments	2010						2011					
	Number of fruits/plant	Fruit wt. (kg)	Total yield (Ton/fed)	Market yield (Ton/fed.)	Fruit creaking unmarketable yield (Ton/fed.)	Fruit unmarketable yield %	Number of fruits/plant	Fruit wt. (kg)	Total yield (Ton/fed)	Market yield (Ton/fed.)	Fruit creaking unmarketable yield (Ton/fed.)	Fruit unmarketable yield %
Irrigation												
Irg. 7 day	2.1 c	6.888 a	28.949 a	24.441 b	4.609 a	15.7 a	2.0 c	6.411 a	26.489 b	21.606 b	4.926 a	18.5 a
14 day	2.6 b	5.988 b	30.425 a	26.809 a	3.617 b	11.9 b	2.5 b	5.318 b	27.620 a	23.783 a	3.835 b	13.9 b
21 day	3.1 a	5.726 c	28.848 a	25.708 ab	3.132 b	10.8 c	3.0 a	4.281 c	26.356 b	23.097 a	3.256 c	12.4 c
Potassium levels												
K 75kg	2.5 b	5.365 b	27.967 a	23.870 b	4.154 a	14.5 a	2.3 b	5.187 b	24.247 c	20.069 c	4.178 a	17.1 a
150kg	2.6 ab	5.988 a	30.140 a	26.449 a	3.694 b	12.2 b	2.6 a	5.618 a	29.125 a	25.157 a	4.010 ab	13.6 b
225kg	2.7 a	5.726 ab	30.160 a	26.639 a	3.510 b	11.6 b	2.5 ab	5.316 ab	27.06 b	23.260 b	3.830 b	14.0 c
Interaction												
Irg. 7 day 75kg k	2.0 f	6.605 abc	27.740 c	22.782 d	5.138 a	17.8 a	1.9 e	6.110 ab	24.378 c	19.068 e	5.310 a	21.7 a
150kg k	2.1 f	7.120 a	29.305abc	24.819 bc	4.486 b	15.3 b	2.0 cde	6.605 a	27.741 b	22.931 cd	4.940 ab	17.3 b
225kg k	2.2 ef	6.940 ab	29.802abc	25.722 b	4.203 b	14.0 c	2.0 de	6.520 a	27.348 b	22.818 cd	4.530 b	16.5 bc
Irg. 14 day 75kg k	2.5 de	5.190 de	27.247 c	23.171 cd	4.076 b	14.6 bc	2.3 cde	5.340 c	24.198 c	20.382 e	3.816 c	15.7 c
150kg k	2.7 cd	6.095 abc	32.254 a	28.789 a	3.465 c	10.7 d	2.6 bc	5.730 bc	31.285 a	27.380 a	3.901 c	12.4 e
225kg k	2.8 bcd	5.709 cd	31.775 ab	28.463 a	3.312 c	10.4 d	2.5 bcd	5.218 cd	27.378 b	23.588 bc	3.790 c	13.8 d
Irg. 21 day 75kg k	3.0 abc	4.301 e	28.915abc	25.654 b	3.248 c	11.2 d	2.8 bc	4.110 e	24.166 c	20.756 de	3.410 cd	14.1 d
150kg k	3.1 ab	4.750 e	28.861abc	25.738 b	3.132 c	10.8 d	3.2 a	4.520 de	28.349 b	25.159 b	3.190 d	11.2 f
225kg k	3.3 a	4.450 e	28.782 bc	25.732 b	3.017 c	10.6 d	3.0 ab	4.215 e	26.554 b	23.375 bc	3.170 d	11.9 ef

• Values followed by different letters within the same column are significantly different according to Duncan's Multiple Range test at 5% level.

In general, results of yield and its components are connected with those recorded in case of vegetative growth. Similar results were also reported by Cakmak (2005), Erdem *et al.* (2005) and Song *et al.* (2007) on watermelon, and Lester *et al.* (2009) on melon.

3. Chemical Compositions:

It was obvious from data presented in Table 4 that irrigation intervals had no effect on total acidity, while total sugars and the percentages of K and N were progressively increased with elongating irrigation interval in both seasons. Prolonging irrigation interval may be cause a reduction in water volume in pulp of fruits, and that leads to concentrated the active constituents in the pulp juice. On the other hand, increasing K rate decreasingly reduced acidity of fruit juice, but cumulatively raised the means of total sugars, K and N content in the two seasons. This may be reasonable, as K plays a vital role in transportation of photo assimilates from source tissues to sink tissues.

It was obvious from data presented in Table (4) that irrigation intervals had no effect on titratable acidity (mg/100g F.W.), while total sugars (mg/100g F.W.) and the percentages of K and N were progressively increased with elongating irrigation interval in both seasons. Prolonging irrigation interval may be cause a reduction in water volume in pulp of fruits, and that leads to concentrated the active constituents in the pulp juice. On the other hand, increasing K rate decreasingly reduced acidity of fruit juice, but cumulatively raised the means of total sugars, K and N content in the two seasons. This may be reasonable, as K plays a vital role in transportation of photo assimilates from source tissues to sink tissues.

Table 3: Effect of irrigation intervals, potassium levels and their interactions on quality of watermelon during 2010 and 2011 seasons.

Treatments	2010				2011			
	Fruit diameter (cm)	Fruit cortex thickness (cm)	Fruit height (cm)	T.S.S. (%)	Fruit diameter (cm)	Fruit cortex thickness (cm)	Fruit height (cm)	T.S.S. (%)
Irrigation								
Irg. 7 day	24.7 a	1.01 a	24.8 a	9.489 c	25.4 a	1.04 a	25.6 a	9.444 c
14 day	23.5 b	0.99 ab	23.6 a	10.800 b	23.5 b	0.93 a	21.4 b	11.600 b
21 day	22.5 b	0.91 b	20.2 a	12.033 a	22.0 c	0.90 a	21.8 b	12.233 a
Potassium levels								
K 5kg/fed.	23.2 b	1.10 a	23.4 a	10.456 b	23.3 b	1.13 a	21.2 a	10.744 b
150kg/fed	23.6 ab	0.90 b	21.4 a	10.800 ab	23.5 ab	0.90 b	23.5 a	11.167 ab
225kg/fed	23.8 a	0.84 b	23.8 a	11.007 a	24.1 a	0.84 b	24.0 a	11.367 a
Interaction								
Irg. 7 day 75kg k	24.3 bc	1.3 a	24.9 a	9.267 e	24.9 bc	1.21 a	25.4 ab	9.133 d
150kg k	24.7 ab	0.9 c	24.8 a	9.400 e	25.1 ab	1.0 bc	25.3 ab	9.500 d
225kg k	25.2 a	0.84 c	24.9 a	9.800 de	26.2 a	0.93 bcd	26.1 a	9.700 d
Irg. 14 day 75kg k	23.3 cde	1.2 a	23.4 ab	10.400 cd	23.2 de	1.1 ab	23.1 ab	11.200 c
150kg k	23.5 bcd	0.94 bc	23.7 ab	10.900 c	23.7 d	0.80 d	23.9 ab	11.700 bc
225kg k	23.7 bcd	0.85 c	23.9 ab	11.100 bc	23.8 cd	0.80 d	23.9 ab	11.900 abc
Irg. 21 day 75kg k	22.2 e	1.03 b	22.0 ab	11.7 ab	21.8 f	1.1 ab	21.9 ab	11.900 abc
150kg k	22.7 de	0.85 c	22.5 ab	12.1 a	21.9 f	0.9 cd	21.4 ab	12.300 ab
225kg k	22.7 de	0.85 c	22.8 ab	12.3 a	22.5 ef	0.85 d	22.1 ab	12.500 a

• Values followed by different letters within the same column are significantly different according to Duncan's Multiple Range test at 5% level.

Table 4: Effect of irrigation intervals, potassium levels and their interactions on chemical content of watermelon during 2010 and 2011 seasons.

Treatments	2010				2011			
	total acidity (mg/100gf.w)	Total sugar (mg/100gf.w)	K %	N %	total acidity (mg/100gf.w)	Total sugar (mg/100gf.w)	K%	N %
Irrigation								
Irg. 7 day	0.33 a	8.23 c	4.50 c	2.16 c	0.37 a	11.29 a	4.28 c	2.26 c
14 day	0.35 a	10.53 b	5.41 b	2.45 b	0.37 a	10.39 b	4.78 b	2.52 b
21 day	0.34 a	11.75 a	5.61 a	2.76 a	0.36 a	8.46 c	5.04 a	2.83 a
Potassium levels								
K 75kg/fed.	0.37 a	9.75 b	4.66 c	2.40 b	0.43 a	9.66 b	4.36 c	2.50 b
150kg /fed.	0.34 ab	10.35 a	5.24 b	2.43 b	0.36 b	10.15 a	4.72 b	2.55 a
225kg /fed.	0.31 b	10.42 a	5.62 a	2.54 a	0.32 b	10.33 a	5.01 a	2.58 a
Interaction								
Irg. 7 day 75kg k	0.37 ab	7.91 d	4.00 f	2.010 d	0.40 abc	8.11 f	3.92 f	2.21 f
150kg k	0.32 ab	8.33 d	4.56 e	2.05 d	0.38 bcd	8.38 ef	4.19 e	2.30 e
225kg k	0.31 b	8.47 d	4.94 cd	2.33 c	0.34 cd	8.91 e	4.73 d	2.29 e
Irg. 14 day 75kg k	0.38 a	9.98 c	4.85 d	2.41 c	0.47 a	9.97 d	4.39 e	2.49 d
150kg k	0.36 ab	10.75 b	5.41 b	2.45 bc	0.35 bcd	10.71 c	4.96 bc	2.51 cd
225kg k	0.31 b	10.89 b	5.97 a	2.51 abc	0.31 d	10.49 cd	4.99 bc	2.57 c
Irg. 21 day 75kg k	0.37 ab	11.37 ab	5.13 c	2.71 ab	0.42 ab	10.91 bc	4.79 cd	2.81 b
150kg k	0.35 ab	11.99 a	5.75 a	2.79 a	0.35 bcd	11.37 ab	5.03 b	2.84 ab
225kg k	0.31 b	11.91 a	5.94 a	2.78 a	0.31 d	11.59 a	5.31 a	2.89 a

• Values followed by different letters within the same column are significantly different according to Duncan's Multiple Range test at 5% level.

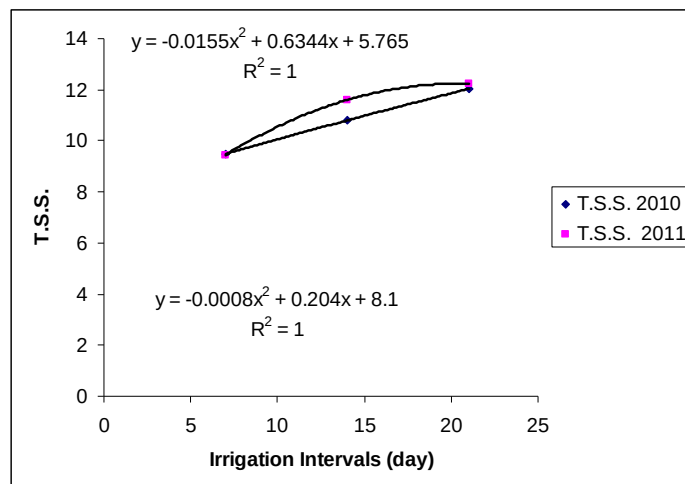


Fig. 1: Linear regression between irrigation intervals and T.S.S content in watermelon.

Interaction treatments exhibited a great effect on chemical composition of treated plants, especially 14 days interval + 75kg K₂O/fed. interaction which elevated titratable acidity mean to 0.38 and 0.47 (mg/100g F.W.) in the first and second seasons, respectively over all other interactions. However, prolonging irrigation interval to 21 days markedly increased total sugars, K and N content when combined with any level of K fertilization. The prevalence in the two seasons was for the interaction between 21 days interval plus either 150 or 225kg K₂O/fed., as these two interactions gave the highest contents in both seasons. These results are in accordance with those attained by Erdem and Yuksel (2003), Song *et al.* 2007 and He and Li (2011) on watermelon.

4. Water and Potassium Use Efficiency:

The water and potassium use efficiency expressed as kg of yield produce by one m³ of water and one kg of K₂O, respectively was greatly affected by the different treatments employed in this study as shown in Table (5) and fig.2. In general, water use efficiency (WUE, kg/m³) was argumentatively increased as the irrigation interval was prolonged to reach the maximum average by 21 days interval treatment in the two seasons, while potassium use efficiency (KUE, kg/kg K₂O) was only improved by 15 days interval treatment which gave the highest yield comparing with either 7 or 21 days intervals in both seasons.

In relation to the effect of K fertilization, data in Table (5) and fig. 3 show that WUE was the highest when plants fertilized with 150kg/fed., whereas KUE was progressively decreased with increasing the rate of K application in the two seasons.

Regarding the interaction effect, it was obvious that 21 days interval recorded the highest values of WUE in the two seasons, especially when combined with the rate of 150kg K₂O/fed., while KUE was progressively decreased with increasing the rate of potassium, irrespective of the duration of irrigation interval. So, the highest means of KUE was achieved by 75kg K₂O/fed. treatment under the various durations of irrigation interval.

On the same line were those findings postulated by Wang *et al.* (2004), Song *et al.* (2007) and Nan *et al.* (2008) on watermelon.

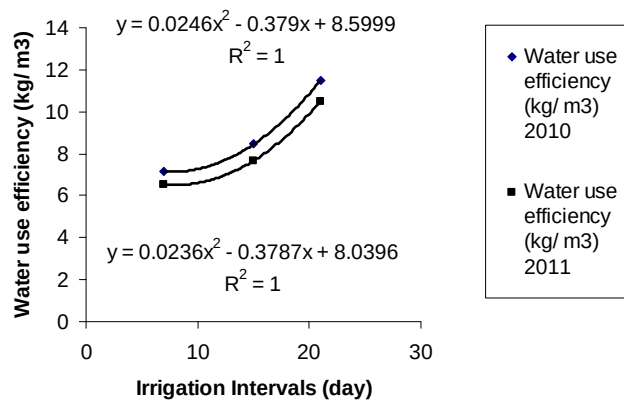
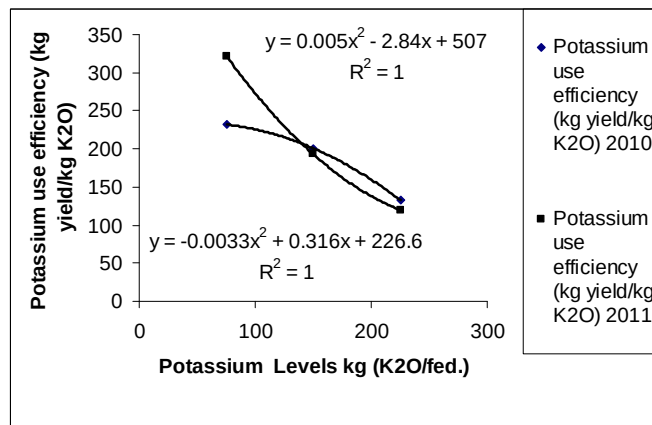
Hence, to obtain the best vegetative growth from watermelon plants cultivated under Delta conditions, it is preferred to irrigate every 7 days and fertilize with 150kg K₂O/fed., while to score the highest marketable yield, it is advised to irrigate every 14 days + fertilization with the same previous level of K₂O. in order to get the highest quality and TSS content with the least percent of unmarketable fruits, it could be recommended to irrigate every 21 days plus fertilization with 150kg K₂O/fed.

In the case of agriculture under a high temperatures and sun bright prefers the first result (irrigation every 7 Days + 150kg K₂ O/fed.,) as in Upper Egypt, but in the case of agriculture regular local under circumstances Delta prefers the second result (irrigation every 14 days +150 kg potassium) while either irrigation each (21 days +150 kg potassium) prefer in case of crop production for export, where smaller fruit sizes and high quality suitable for consumer taste.

Table 5: Effect of irrigation intervals, potassium levels and their interactions on water and potassium use efficiency of watermelon during 2010 and 2011 seasons.

Season		2010		2011	
Treatments		Water use efficiency (kg/m ³)	Potassium use efficiency (kg yield/kg K ₂ O)	Water use efficiency (kg/m ³)	Potassium use efficiency (kg yield/kg K ₂ O)
Irrigation intervals (day)	Potassium levels kg (K ₂ O/fed.)				
7 days		7.152 c	232.51 a	6.545 c	210.46 b
15 days		8.449 b	239.81 a	7.667 b	217.59 a
21 days		11.499 a	235.23 a	10.491 a	209.69 b
	75kg	8.654 a	372.87 a	7.453 c	323.24 a
	150kg	9.227 a	200.89 b	8.941 a	194.12 b
	225kg	9.220 a	133.82 c	8.309 b	120.37 c
7 days	75kg	6.845 c	372.87 a	6.023 g	323.24 a
	150kg	7.240 c	195.33 b	6.854 f	194.12 b
	225kg	7.363 c	132.43 c	6.757 f	120.27 c
15 days	75kg	7.564 c	363.27 a	6.717 f	324.97 a
	150kg	8.963 b	214.91 b	8.685 d	208.53 b
	225kg	8.821 b	141.17 c	7.600 e	121.63 d
21 days	75kg	11.544 a	385.50 a	9.619 c	322.17 a
	150kg	11.479 a	192.33 b	11.285 a	188.93 c
	225kg	11.476 a	127.87 c	10.570 b	117.97 d

• Values followed by different letters within the same column are significantly different according to Duncan's Multiple Range test at 5% level.

**Fig. 2:** Linear regression between irrigation intervals and water use efficiency.**Fig. 3:** Linear regression between potassium levels and potassium use efficiency.

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