J. Plant Production, Mansoura Univ., Vol. 9 (11): 923 - 929, 2018

Effect of Irrigation Intervals and Kaolin Particle Film Applications on Growth, Yield and some Water Relations of Eggplant

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ABSTRACT

The present study was conducted during consecutive summer season of 2014 and 2015 at a private farm in Kafrelsheikh Governorate, Egypt. This study aimed mainly to investigate the effect of irrigation intervals i.e., 7, 11 and 15 days among irrigations and kaolin foliar application with different concentrations, 0, 2 and 4% on Eggplant cv. Sawad EL Laiel. The shortest irrigation interval 7 days increased the all plant growth parameters under study namely, stem length, branche number, leaf number, leaf area, plant fresh weight and yield components as well as increased the parameters of fruit quality and productivity of irrigation. The kaolin foliar application concentrations improved plant growth, yield and fruit parameters. The highest early and total yields with favorable quality were attained under the shortest period (7 days) with kaolin foliar application at (2%), while the kaolin concentration at 4% under water stress condition (irrigation at 11 or 15 days period) was the best for plant growth, yield, and productivity irrigation with water saving the seasonal applied water than without kaolin or 2% treatments.

Keywords: Irrigation intervals, water productivity, Kaolin, eggplant

INTRODUCTION

Eggplant (*Solanum melonegena* L.) is one of the most imperative crops in summer season of Egypt. It is a classic commodity for domestic consumption as well as for export. Water is one of the most important factors in agricultural production, which depends on what is called irrigated crops.

In Egypt, water resources are limited, depending on the Nile water, which supplies Egypt with 55.5 billion cubic meters, which represents 95% or more of fresh water, and despite the availability of other resources, it may be expensive such as the use of sewage, groundwater and seawater desalination, With the increase in population and agricultural expansion projects, it was found that the per capita share in Egypt does not exceed 1000 m^3 / year which equivalent to the international standards of water poverty limit or water safety limit (EL–Quosy, 1998).

agricultural sector used about 85% from the total renewable water. Thus water management is the major way towards the rationalization policy for the countries of the world.

The suitable irrigation interval can play a main part in improving the productivity and fruit quality by stratifying the required quantity of water when it is needed – water scarcity during eggplant growing season decreases fruit yield and quality due to water and nutrients deficiency . Shalata (2013) found that increasing intervals of irrigation from 10 to 20 days decreased vegetative growth characters, yield and fruit quality of eggplant.

Anttranspirants on of the important techniques that used to decrease water use by plant is like as kaolin which is natural white material form coating films on the leaves which increases the leaf reflectance by reflecting the radiation and increases the vapour pressure gradient and thus minimize transpiration (Glenn *et al*., 2002 and Greamer, 2005). Kaolin is an significant materials for antitranspirant to mitigate the negative effects of water deficiency and environmental stresses i.e. heat stress and sunburn injury (kahn and Damicone, 2008). The maine goal of this present research was to study the influence of irrigation intervals, kaolin foliar application and the interaction effects between them on growth characters, yield, fruit quality of eggplant and some water relations under surface irrigation system.

MATERIALS AND METHODS

Tow field investigations were performed at a private farm in El-Shamarka village Kafrelsheikh Governorate during the two successive summer growing seasons of 2014 and 2015 to investigate the impact of irrigation intervals and foliar application of kaolin on growth, yield and some water relationships for Eggplants cv .Sawad EL Laiel .The physical characters of the studied experimental site were determined before cultivation and climatic conditions, as shown in Tables (1), and (2) ,respectively. Soil samples from (0-30cm.) were collected and analyzed for some physical and chemical properties according to Klute, (1986) Table (1). Soil field capacity (FC%),. permanent wilting point(PWP,%), were determined according to James (1988), soil bulk density (Bd, kg/m^3) were determined according to klute, (1986) and analyzed for some chemical properties Total soluble salts (soil, Ec), soil reaction (PH), were presented in Table (1).

The experimental design which was used in this current investigation was split plot with four replications. The treatments were:

A:Main treatments (irrigation intervals, I)

0: irrigation every 7 days through the whole growing season (Actual irrigation practiced by local formers).

I_1: irrigation every 11 days through season and

I_2: irrigation every 15 days through the whole growing season.

B: Sub-main treatments (kaolin foliar application).

The sub-main plots were randomly assigned by three levels of kaolin foliar application which were:

K_0: Control treatment, without foliar application of kaolin (traditional) , spraying with water only.

K_1: foliar application of kaolin with concentration of 2% and.

K_2: foliar application of kaolin with concentration of 4%.

Table 1. some physical and chemical properties of the experimental soil before cultivation in 2014 and 2015 seasons

Seasons	Particle size distribution			Texture	Field capacity %	Wilting point %	Bulk density Kg/m^3	O M %	E C dsm^{-1}	PH	Available nutrients mg/kg (PPM)		
	Sand%	Silt%	Clay%								N	P	K
2014	18.71	20.76	54.53	Clayey	41.80	22.25	1.22	2.3	2.75	8.35	26	5.4	327
2015	20.31	26.86	52.83	Clayey	42.43	22.40	1.20	2.4	2.50	8.27	28	5.6	334

Table 2. Mean of some metrological data at KafrElsheikh region during 2014 and 2015 seasons.

Month	T.(c^o)			RH (%)			Ws	Pan Avapo.	Rain
	Max.	Min.	Mean	Max.	Min.	Mean	m/sea	mm/day	Mm
				2014 season					
May	30.46	19.56	25.01	77.20	48.60	62.90	1.14	5.86	0.0
June	32.64	20.61	26.62	86.21	52.30	69.27	0.95	6.55	0.0
July	33.14	23.63	28.40	83.18	55.12	69.15	1.13	7.74	0.0
Aug.	34.11	21.81	27.94	92.41	53.51	72.95	1.15	8.13	0.0
Sep.	32.48	20.75	26.62	87.56	52.20	69.89	1.03	6.66	0.0
Oct.	29.74	18.74	24.24	80.91	53.38	76.16	0.94	4.51	0.0
				2015 season					
May	30.18	18.79	24.49	77.3	46.1	61.7	1.33	7.15	0.0
June	30.85	21.40	26.13	78.8	51.2	65.0	1.22	6.65	0.0
July	30.00	22.40	27.70	85.2	54.1	69.8	1.13	6.86	0.0
Aug.	35.11	25.00	30.11	83.8	51.6	67.9	1.06	8.15	0.0
Sep.	34.60	23.80	29.20	82.7	46.5	64.5	1.14	6.64	0.0
Oct.	29.91	20.60	25.30	80.9	54.1	67.4	1.01	4.53	65.8

Source: Metrological Station at Sakha 31^o 07 N latitude 31^o 57 E Longitude with an elevation of about 6 meters above mean sea level.

Experimental layout:

Eggplant as a summer crop (*Solanum melongena* L.) variety Sawed EL Laiel was used in this current study. Seedling transplanting was performed on 16th and 5th of May in the first and second growing seasons respectively. The distance between rows was 50cm apart. All agronomic practices were carried out agreeing to the recommended for both crop and the studied area excepting the above-mentioned studied treatments which were irrigation intervals and kaolin foliar application. The irrigation plot area was 44.8 m^2.To avoid lateral movement for irrigation water from each irrigation treatment to another was isolated by 1.6 m wide. The sub main plot area was 28.8 m^2 6 rows, 6 m length and 0.8 m in width. Three irrigation treatments were applied at 7, 11 and 15 days from the first irrigation which was after 5 days after transplanting.

Kaolin water suspensions spraying at 40 days after transplanting and repeated after that 3 times through the growing seasons every 15 days apart were sprayed by using a portable spray motor to cover all plant parts. Control plants were sprayed with distilled water. Plants were fertilized with 200 kg / fed. calcium super phosphate 15.50 % P_2O_5 before transplanting and incorporated in the soil, 400 kg/ fed. ammonium nitrate 33.5% in four doses, 100 kg/ fed. Potassium sulphate 50% k2o in one dose with the flowering stage. Other agricultural practices were conducted according to recommendations for the crop and the area.

During the growing seasons the following data was recorded

After 90 days from transplanting five plants from each sub plot were rand only taken for measuring the vegetative growth parameters as stem length (cm), number of branches, number of leaves, leaf area (cm^2) and shoots fresh weight (g/ plant). Early yield (ton/fed.) was determined as fruit weight for the first four pickings. Total yield (ton/fed.) was determined as fruit for all pickings during the season up to harvesting (16 pickings). Five fruits from each sub- plot were randomly taken from three pickings during the season for measuring average fruit weigh (g), fruit length (cm) , fruit width (cm) and fruit shape index (fruit length / fruit width).

Water parameters.

1. Seasonal amount of applied water (m^3/fed) :

Quantity of applied water was measured for all irrigation treatments and then seasonal amount applied water was recorded by using cutthroat flume (20 x 90 cm) through the both seasons and calculated as m^3/fed. conferring to early (1975).

2. Productivity of irrigation water (PIW, kg/m^3) :

productivity of irrigation water was calculated according to Ali *et al*. (2007)

$$PIW=Y/AW$$

Where:

PIW =productivity of irrigation water (kg/m^3)
Y= fruit yield (kg/fed.) and
AW= amount of seasonal applied water (m^3/fed.)

Statistical analysis:

Data of both seasons were tabulated and statistically analyzed according to procedures described by Snedecor and Cochran (1980). Comparisons among means of treatment were tested by using Duncan's multiple rang lest (1955).

RESULTS AND DISCUSSION

Results presented in Table (3) indicated that irrigation intervals high significantly affected eggplant growth parameters as: stem length, number of branches per plant, number of leaves /plant in both seasons. The highest values 84.42 and 89.42 cm/plant of stem length, 14.92 and 14.78 of number of branches and 152.17 and 161.80 of number of leaves / plant in the first and second season, respectively were achieved with shortest irrigation interval every 7 days and the lowest values were resulted with longest irrigation intervals every 15 days. These results are in harmony with those obtained by Kirnak *et al* (2001); Pirboneh *et al*., (2012); Monte *et al*., (2013) and Luvai *et al*., (2014). Regarding foliar application of kaolin at 4%

high significantly increased Plant stem length 81.92 and 85.71, 13.7 and 14.2 of number of branches and 136.67 and 144.46 of number of leaves / plant in the first and second season, respectively compared to the lowest values obtained by untreated plants.

Table 3. Effect of irrigation intervals and kaolin foliar application stem length, No. of branches and No. of leaves of eggplant during 2014 and 2015. Seasons.

Treatments		Stem length (cm)		No. of branches		No. of leaves / plant	
Irrigation intervals (days)	kaolin foliar application	First season	Second season	First season	Second season	First season	Second season
7		84.42 a	89.42 a	14.92 a	14.78 a	152.17 a	161.80 a
11		81.83 a	87.17 b	13.50 b	14.14 a	131.58 b	135.32 b
15		71.00 b	73.75 c	9.33 c	11.79 a	109.00 c	119.09 c
F. test		**	**	**	**	**	**
	Control	76.50 c	81.25 c	11.33 c	13.01 b	123.59 c	131.59 c
	2%	78.83 b	83.92 b	12.75 b	13.54 ab	132.42 b	140.16 b
	4%	81.92 a	85.17 a	13.67 a	14.17 a	136.67 a	144.46 a
F. test		**	**	**	*	**	**
	control	83.75 a	89.50 ab	13.50	14.25	151.25 a	159.75 a
7	2%	85.25 a	90.25 a	15.75	15.25	154.00 a	163.73 a
	4%	84.25 a	88.50 b	15.50	14.85	151.25 a	161.93 a
	Control	80.00 b	85.50 d	12.00	13.25	120.50 d	125.80 cd
11	2%	81.50 b	87.00 c	13.25	14.00	132.25 c	137.65 b
	4%	84.00 a	89.00 ab	15.25	15.18	142.00 b	142.50 b
	Control	65.75 e	68.75 g	8.50	11.53	99.25 f	109.23 e
15	2%	69.75 d	74.50 f	9.25	11.38	111.00 e	119.10 d
	4%	77.50 c	78.00 e	10.25	12.48	116.75 de	128.95 c
F. test		**	**	NS	NS	**	**

** and Ns indicate significant differences at p < 0.01 and not significant, respectively according to F. test.
Data in a column followed by the same symbol are not significant different according to Duncan's multiple range test (DMRT).

The interaction treatment between the intervals of irrigation and kaolin , revealed high significant effect on stem length and number of leaves / plant , but no significant variation of number of branches these results are true in both seasons. The highest values 85.25 and 90.25 of stem length , 154.00 and 1163.73 for number of leaves per plant were obtained with irrigation every 7 days and spraying the plant by 2% kaolin level while kaolin 4% concentration gave the highest values with 11 or 15 days intervals compared to the lowest values 65.75 and 68.75 cm of stem length, 99.25 and 109.23 leaves/ plant in the first and second seasons , respectively obtained from the water deficit irrigated every 15 days and control without kaolin (spraying with water only). These results in line with those obtained by Byari and A1- Rabighi (1996); Kirnak *et al* (2001); Guang-cheng *et al*. (2011). Confirmed by EL-Said (2015) found that eggplant growth linearly increased with increasing irrigation level and application kaolin foliar spraying.

Eggplant leaf area and fresh weight in both seasons were highly significantly affected by irrigation as shown in Table (4). The highest values of leaf area 5249.98 and 5269.74 cm^2/plant and 1003.91 and 1103.14 g/plant of fresh weight were achieved with shortest intervals every 7 days compared to 4040.38 and 4197.74 cm^2 / plant of leaf area and 834.38 and 900.69 g/ plant of fresh weight were obtained from longest intervals irrigation every 15 days in both seasons, respectively.

Table 4. Effect of irrigation intervals and kaolin foliar application on leaf area and fresh weight of eggplant at 90 days after transplanting during the two seasons of 2014-2015

Treatments		Leaf area (cm^2/plant)		Fresh weight (g/ plant)	
Irrigation intervals (days)	kaolin foliar application	First season	Second season	First season	Second season
7		5249.98 a	5269.74 a	1003.91 a	1103.14 a
11		4447.50 b	4630.83 b	930.85 b	1013.40 b
15		4040.38 c	4197.74 c	834.38 c	900.69 c
F. test		**	**	**	**
	Control	4361.43 c	4504.63 c	840.16 c	930.10 c
	2%	4630.47 b	4733.90 b	952.25 b	1015.54 b
	4%	4745.98 a	4859.78 a	976.73 a	1071.59 a
F. test		**	**	**	**
	control	5089.28 ab	5185.58 a	950.73 cd	997.18 c
7	2%	5357.13 a	5345.83 a	1048.00 a	1162.80 a
	4%	5303.55 a	5277.83 a	0113.10 b	1149.45 a
	Control	4320.00 d	4567.90 b	818.05 e	968.13 c
11	2%	4438.13 d	4618.10 b	975.35 bc	987.25 c
	4%	4584.38 c	4706.48 b	999.15 b	1084.83 b
	Control	6375.00 f	3760.43 d	751.80 f	825.00 e
15	2%	4096.15 e	4237.78 c	833.40 e	896.58 d
	4%	4350.00 d	4595.03 b	917.93 d	980.50 c
F. test		**	**	**	**

** and Ns indicate significant differences at p < 0.01 according to F- test.
Data in a column followed by the same symbol are not significant different according to Duncan's multiple range test (DMRT).

Irrigation of eggplant at enough water supply was favorable to give good solubility of soil nutrients and their uptake. Also, suitable soil moisture enhanced photosynthesis and translocation of the assimilates to different plant organs .on the other hand , the reduction in plant water potential under water deficit tends to close the stomata which interferes with carbon dioxide and hence reducer growth (Winter, 1981). These results in agreement with those by Ibrahim and Selim (2010); EL- Said (2015) and Marija *et al* (2016).

Concerning, the kaolin application , it high significantly increased leaf area and fresh weight of eggplant in both seasons .The highest leaf area 4745.98 and 4859.78 cm^2/plant and the highest values of fresh weight 976.37 and 107.59 g/plant were exhibited with 4% kaolin compared to 4361.43 and 4504.63 cm^2 / plant of leaf area and 840.16 and 930.10 g/ plant of fresh weight were obtained by control (without kaolin) in the first and second seasons ,respectively .the positive effects of kaolin foliar application on vegetative growth were obtained by Ibrahim and Selim (2010); Shalata (2013) and El-Said (2015).

The combined interaction between irrigation and kaolin suspensions high levels gave high significant effects on leaf area and fresh weight in the two seasons. The highest leaf area 5357.13 and 5345.83 cm^2/plant and the highest fresh weight 1048.00 and 1162.80 g/ plant in both seasons, respectively, were achieved with the highest amount of irrigation water (every 7 days) and kaolin concentration at 2% while , kaolin level at 4% gave the highest results at intervals (11 or 15 days) while, the lowest values of two parameters were exhibited with water deficit at 15 days intervals and without kaolin (control) in both seasons . It in mention that, the positive effect of increasing kaolin concentration was exhibited in increased eggplant growth with increasing irrigation intervals in two seasons. Similar results by Shalata (2013) and EL- Said (2015).

Important of kaolin foliar spraying specially under water deficit at the longest intervals an eggplant growth may be related the kaolin role an improving water regime in plant by reduction the loss moisture content by transpiration . Marija Cosic *et al* (2016).

Early and total yields .data listed in Table (6) indicated that early and total yields were gradually increased by increasing amount of irrigation water and decreased irrigation intervals from 15 to 7 days. The results were highly significant in both seasons. The eggplant which were irrigated every 7 days produced the highest values of early yield 12.965 and 13.047 ton/fed and 45.219 and 46.109 ton/fed. of total yield in the first and second seasons, respectively, followed by the plants irrigated at 11 days interval compared to those plants irrigated every 15 days which produced the lowest values 10.512 and 10.840 ton/fed of early yield and 26.166 and 27.127 ton/fed. of total yield in the first and second seasons, respectively.

The improvement in early and total yields of eggplant with increasing amount of irrigation water may be attributed to the important role of water in enhancing the vegetative growth (Tables 3 and 4). The positive effect of increasing amount of irrigation water on early and total yield was obtained by Kirnak *et al*. (2001); Pirboneh *et al*., (2012); Ezzo *et al*., (2012); Montel *et al*., (2013); EL-Said (2015) and Etissa (2016).

Concerning kaolin effect, the results declared that kaolin spraying high significantly increased early and total yields, the highest early yield 12.943 and 12.487 ton/fed., 37.306 and 39.155 ton/fed. Of total yield in the first and second seasons, respectively were achieved by highest level of kaolin 4% followed by mid level 2% kaolin, but the lowest early yield 10.093 and 10.844 ton/fed. In both seasons were obtained from control treatment (spraying with water only). These results are in line with those by Ibrahim and Selim (2010); EL-Said (2015); and Abd-Allah (2017).

Table 5. Effect of irrigation intervals and kaolin foliar application on early and total yields of eggplant during 2014 and 2015 seasons.

Treatments		Early yield (ton /fed)		Total yield (ton/fed.)	
Irrigation Intervals (days)	kaolin foliar application	First season	Second season	First season	Second season
7		12.965 a	13.047 a	45.219 a	46.109 a
11		11.795 b	11.774 b	35.566 b	35.985 b
15		10.512 c	10.840 c	26.166 c	27.127 c
F. test		**	**	**	**
	Control	10.093 c	10.844 b	33.398 c	32.698 c
	2%	12.235 b	12.330 a	36.247 b	37.367 b
	4%	12.943 a	12.487 a	37.306 a	39.155 a
F. test		**	**	**	**
	Control	11.199	12.148 bc	43.210 c	42.377 b
7	2%	13.476	13.533 a	47.130 a	48.474 a
	4%	14.219	13.460 a	46.318 a	47.475 a
	Control	10.297	11.075 e	32.853 f	32.228 e
11	2%	12.139	11.885 cd	35.277 e	39.327 d
	4%	12.949	12.362 b	38.567.d	23.490 c
	Control	8.784	9.308 f	24.132 i	23.132 g
15	2%	11.090	11.571 d	26.333 h	27.227 f
	4%	11.661	11.640 cd	28.032 g	30.662 e
F. test		NS	**	**	**

**** and Ns indicate significant differences at p < 0.01 and not significant, respectively according to F- test.**

Data in a column followed by the same symbol are not significant different according to Duncan's multiple range test (DMRT).

The highest values of early and total yield were obtained with shortest intervals treatment (7 days) and kaolin foliar application 2% followed by spraying plant with 4% kaolin and 11 days interval then 4% kaolin with 15 days intervals in the late. On the other hand, the lowest early and total yield were exhibited from water deficit when the plants irrigated every 15 days and without kaolin spraying. These results had true in both seasons. The response of eggplant yield to increasing kaolin level was obtained , especially under water stress by increasing irrigation intervals between irrigations. These results may be attributed to the role of kaolin to keep more water content in plant tissue which improved photosynthetic capacity operation in leaf, and this in turn led to enhanced for the plant growth and subsequently increased yield (Nakano and Uehara, 1996; Marija Cosic *et al*, 2016 and Abd-Allah, 2017).

Data of the effects of irrigation intervals on fruit characteristics of eggplant as average weight, fruit length , fruit width and fruit shape index) are presented in Table (6) the results indicated that average fruit weight, fruit length and fruit width were high significantly increased with increasing the amount of irrigation water by shorting the irrigation intervals , the highest values 249.73 and 246.28 (g) of average fruit weight,12.76 and 12.92 (cm) of fruit length and 11.17 and 11.11 (cm) of fruit width in first and second seasons , respectively were achieved by the shortest intervals (7days), but the lowest values were exhibited from the longest intervals (15 days) whereas ,the fruit shape index was not significantly affected by irrigation intervals treatments in two seasons . These findings are in accordance with those of pirboneh *et al* (2012) and EL-Said (2015)

Regarding the effect of kaolin concentration on these fruit characteristics, the results in same table cleared that increasing kaolin concentration as foliar spraying was increased these fruit parameters and the highest values were attained from highest level of kaolin (4%) 236.68 and 236.16 (g) of average fruit weight,12.41 and 12.40 (cm) of fruit length and 10.87 and 10.84(cm) of fruit width in both seasons compared to control (without kaolin) that gave the lowest ones ,but the fruit shape index was no significant effect by kaolin in two seasons. Similar results were obtained by Ibrahim and Selim (2010) and EL-Said (2015).

Table 6. Effect of irrigation intervals and kaolin foliar application on average fruit weight , fruit length ,fruit width and fruit shape index of eggplant during two season of 2014-2015.

Treatments		Average fruit weight (g)		Fruit length (cm)		Fruit width (cm)		Fruit shape index	
Irrigation intervals(days)	kaolin foliar application	First season	Second Season	First season	Second season	First season	Second season	First season	Second season
7		249.73 a	246.28 a	12.76 a	12.92 a	11.17 a	11.11 a	1.14	1.16
11		220.77 b	224.73 b	11.92 b	12.14 b	10.59 b	10.73 b	1.13	1.13
15		209.34 c	210.06 c	10.80 c	10.54 c	9.49 c	9.33 b	1.14	1.13
F. test		**	**	**	**	**	**	**	**
	Control	215.13 c	217.34 c	11.32c	11.38 c	10.00 c	9.93 c	1.13	1.14
	2%	228.03 b	227.57 b	11.74 b	11.83 b	10.38 b	10.40 b	1.13	1.13
	4%	236.68 a	236.16 a	12.41a	12.40 a	10.87 a	10.84 a	1.14	1.15
F. test		**	**	**	**	**	**	**	**
	Control	238.40 c	240.53 c	12.30	12.67 b	10.90 c	10.70 cd	1.13	1.18
7	2%	249.73 b	245.83 b	12.80	12.93 ab	11.10 b	11.17 ab	1.15	1.15
	4%	261.07 a	252.47 a	13.17	13.17 a	11.50 a	11.47 a	1.15	1.15
	Control	211.30 f	215.90 f	11.47	11.80 cd	10.23 e	10.40 d	1.12	1.13
11	2%	223.20 e	225.07 e	11.90	12.10 c	10.63 d	10.80 c	1.12	1.12
	4%	227.80 d	233.23 d	12.40	12.35 b	10.90 c	11.00 bc	1.14	1.14
	Control	195.70 g	195.60 h	10.20	9.69 f	8.87 g	8.70 g	1.15	1.10
15	2%	211.17 f	211.17 g	10.53	10.47 e	9.40 f	9.23 f	1.13	11.13
	4%	221.17 e	222.77 e	11.67	11.50 d	10.20 e	10.07 e	1.15	1.14
F. test		**	**	NS	**	**	**	NS	NS

**** and Ns indicate significant differences at p > 0.01 and not significant, respectively according to F- test.**
Data in a column followed by the same symbol are not significant different according to Duncan's multiple range test (DMRT).

Eggplant irrigated every 7 days and sprayed with kaolin at 4% recorded the highest values of fruit weight, length and width. The lowest values were obtained with longest period 15 days and without kaolin

Kaolin foliar spraying improvement the characteristics of fruit with increasing the concentration from 0 to 4% specially, with increasing the periods between irrigations the kaolin spraying recorded clear increases in eggplant fruit parameters.

The fruit shape index was not significantly affected by this interaction. These results in improving the eggplant fruit quality may be attributed to role of water on biological processes that led to increasing plant growth and also to important role of kaolin to keep more water content in plant tissue which positively reflected on plant growth (Tables 3 and 4).

Results presented in Table (7) cleared that the seasonal values for both amount of applied water and productivity of irrigation water were high significant affected by irrigation intervals and kaolin treatments. Regarding the effect of irrigation intervals, shortest irrigation intervals (7 days between irrigations) gave the highest values and 2840.37 and2867.51 ^{m3}/fed in 2014 and 2015 seasons, respectively .On the other hand, the lowest values 2170.54 and 2244.56 m^3/fed obtained with the longest intervals (15days) in 2014 and 2015 seasons, respectively . Increasing the values under irrigation treatment (every 7 days) may be due to increasing number of watering and later increasing the amount of applied water. These results are in the same line with those obtained by Ibrahim and Selim (2010) on squash crop.

Table 7. Effect of irrigation intervals and kaolin foliar application on total amount of water applied of irrigation (m^3/fed) and productivity of irrigation water PIW (kg/m^3)

Treatments		Total amount of water (m^3/fed)		Productivity of irrigation water (Kg/m^3)	
Irrigation Intervals (days)	kaolin foliar application	First season	Second season	First season	Second season
7		2840.37 a	2867.51 a	15.92 a	16.10 a
11		2537.01 b	2601.00 b	14.06 b	13.88 b
15		2170.54 c	2244.56 c	12.08 c	12.13 c
F. test		**	**	**	**
	Control	2591.04 a	2647.90 a	12.72 c	12.19 c
	2%	2502.01 b	2557.05 b	14.28 b	14.42 b
	4%	2454.88 c	2508.12 c	15.06 a	1550 a
F. test		**	**	**	**
	Control	2890.03 a	2917.40 a	14.95 c	14.53 c
7	2%	2819.81 b	2846.78 b	16.69 a	17.03 a
	4%	2811.26 b	2838.34 b	16.48 a	16.73 a
	Control	2635.42 c	2593.03 c	12.47 f	11.93 d
11	2%	2527.82 d	2508.64 d	13.96 d	14.04 c
	4%	2447.80 e	2324.97 e	15.76 b	12.68 b
	Control	2247.68 f	2324.97 f	10.74 g	10.10 e
15	2%	2158.38 g	2231.33 g	12.20 f	12.20 d
	4%	2105.57 h	2177.38 h	13.31 e	14.08 c
F. test		**	**	**	**

**** indicate significant differences at p > 0.01 according to F- test.**
Data in a column followed by the same symbol are not significant different according to Duncan's multiple range test (DMRT).

Regarding the effect of kaolin foliar application, the highest seasonal amount of applied water was recorded under control treatment (without foliar application of kaolin) but, the lowest values were recorded under the highest concentration of kaolin foliar application (4%), this might be attributed to the role of kaolin as antitranspirant materials which plays an important role for decreasing the transpiration rate from plant surfaces leaves . These results are in a good agreement with those obtained by Marija Cosic *et al*., (2016).

Concerning the interaction effects between irrigation intervals and kaolin foliar application, showed highly significant effects on seasonal amount of applied irrigation water and the highest values were recorded under the shortest irrigation interval and the control (without foliar application of kaolin) .The same trend was observed under other irrigation treatments, but the values were less comparing with 7 days between irrigations. Generally the values of applied irrigation water can be descended in order 7 days > 11 days >15 days between irrigations and kaolin application : control > 2% >4%

Concerning the effect of the two studied treatments irrigation intervals and kaolin foliar application on productivity of irrigation water the highest values during 2014 and 2015 seasons were recorded under the shortest irrigation intervals and the values were 15.92 and 16.10 Kg/m^3,respectively on the contrary , the lowest values were recorded under the longest irrigation interval 15 days and the values were 12.08 and 12.13 Kg/m^3 in the first and second growing season respectively. Increasing the values of Productivity of irrigation water under the shortest irrigation interval might be due to increasing the fruit yield under the condition of this treatment Comparing with other irrigation treatments. These findings are in the same line with those reported by Ibrahim and selim, (2010). Regarding the effect of kaolin foliar application on productivity of applied irrigation water, which illustrated high significant effect on it. The results showed that the highest concentrations of kaolin gave the highest values comparing with the lowest concentrations and without foliar application (control). In general the values of productivity of applied irrigation water can be descended in following order : 4% > 2% >control increasing the values of productivity of applied irrigation water under the highest concentration of kaolin application might be due to increasing fruit yield under the conditions of foliar application of kaolin 4%.(Marija Cosic *et al*., 2016). Concerning the interaction effects between irrigation intervals and kaolin applications on productivity of irrigation water showed highly significant effect where the highest values were recorded under the shortest irrigation interval and the highest concentration of kaolin foliar application in the two seasons

CONCLUSION

Under the conditions of this present work this study is recommended to maximize growth, yield, fruit quality and productivity of irrigations water. Eggplant crop variety Sawad EL-Laiel should be irrigated every 7 days, in addition to foliar application of kaolin at a concentration of 4%

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تأثير فترات الرى والرش بالكاولينين على النمو والمحصول وبعض العلاقات المائية للباذنجان

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اجريت هذه الدراسة فى مزرعة اهلية بمحافظة كفرا لشيخ خلال عامى 2014 و 2015 لدراسة تأثير كل من فترات الرى على 7 و 11و 15 يوم والرش بالكاولينين بتركيزات صفر,2 ,4 % على نبات الباذنجان صنف (سواد الليل) وكانت النتائج كما يلى: 1- ادى الرى على اقصر فترات الرى (7 ايام) الى زيادة جميع قياسات النمو وهى طول الساق وعدد الافرع وعدد الاوراق والمساحة الورقية والوزن الطازج للنبات. كذلك أدت هذة المعاملة الي زيادة المحصول المبكر الكلى وجودة الثمار مع تحقيق اعلى انتاجية لمياة الرى. 2- ادى الرش الورقى بأعلى تركيز للكاولينين (4%) الى زيادة جميع صفات النمو السابقة وزيادة المحصول المبكر الكلى وكذلك تحسين صفات الثمار وزيادة انتاجية مياة الرى. 3- ادى التفاعل بين فترات الرى والرش بالكاولينين الى زيادة معنوية لجميع صفات النمو ماعدا عدد الفروع ومعامل الشكل للثمار وكانت اعلى القيم لصفات النمو عند الرش الورقى (بالكاولينين) بتركيز 2% مع الرى على 7 ايام وكذلك زاد المحصول الكلى وصفات الثمار وانتاجية مياة الرى. 4- كانت افضل النتائج للنمو والمحصول والجودة وكذلك توفير مياة الرى وزيادة انتاجية مياة الرى مع الرش بأعلى تركيز للكاولينين (4%) عند الرى على فترات متباعدة (11أو 15 يوم).