Assiut J. Agric. Sci., (49) No. (2) 2018(157-176) *ISSN: 1110-0486*
Website: *www.aun.edu.eg/faculty_agriculture/journals_issues_form.php* ***E-mail: ajas@aun.edu.eg***

Effect of Irrigation Intervals and Genotypes on Growth and Yield of Eggplant (*Solanum melongena L.*) I- Vegetative Growth.

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Received on: 7/5/2018 **Accepted for publication on:** 8/5/2018

Abstract

The present experiment was carried out in the Experimental Farm of Vegetable Department, Faculty of Agriculture, Assiut University, Egypt, during the two seasons of 2014 and 2016. The soil texture of the experimental site was clay with a pH average of 7.65. Three irrigation periods (every 10, 20 and 30 days) and three eggplant genotypes (Hanen F1, Classic F1 and Alabaster F1) were used to estimate their effects on yield and quality of eggplant crop under Assiut conditions. Data showed that the 10 days irrigation treatment (control) significantly recorded the highest plant fresh and dry weight in the first and second seasons, respectively. The highest significant values of average plant height and stem diameter were recorded from 10 days irrigation intervals treatment in the second season only. However, in the first season, plots irrigated every 30 days intervals significantly produced the highest average branch numbers. The effect of eggplant genotypes was more constant in both seasons, Hanen F1 genotype, significantly gave the highest average plant height, stem diameter, average number of branch, plant fresh weight and plant dry weight. However, Classic F1 genotype significantly produced the lowest values of the growth parameters.

Keyword: *Drought, Genotypes, Irrigation and Intervals*

I. Introduction

Drought stress is a major problem that widely distributed worldwide (Kimura, 2007 and Passioura, 2007). Drought stress leads to many plant changes at the morphological, physiological, biochemical, and molecular levels that can negatively affect plant growth and productivity (Wang *et al*., 2003; Beck *et al.,* 2007; Kimura, 2007; Passioura, 2007; and Abdul Jaleel, 2009). In addition, the rapid increase of world population, pollution of natural resources, and climate change increase the burden on the limited water resources. This highlights the importance of developing methods of irrigation that minimize water requirements or maximize the water use efficiency. One of the conventional methods of irrigation is irrigation scheduling which aims at achieving an optimum water supply for productivity, with soil water content being maintained close to field capacity (Boamah *et al*., 2011).

Egypt is a dry country that is located at a high temperature zone and faced with increased competitions for water resources between different sectors (agriculture, industry or domestic consumption (Ismail and Ozawa, 2009; Hussein *et al.,* 2010; Mirdad, 2011; Amiri *et al*., 2012; El-Afifi *et al*., 2013; Rakha., 2014; and Abdrabbo *et al.,* 2017). Eggplant is grown in most cultivated areas in Egypt (Amiri *et al.,* 2012 and Rakha., 2014). According to FAO, 2016, 90% of eggplant production comes from only five countries. The top five producing countries are China (28.4 million tons; 57% of world's total), India (13.4 million tons; 27% of world's total), Egypt (1.2 million tons), Turkey (0.82 million tons), and Iran (0.75 million tons). In Asia and the Mediterranean, eggplant ranks among the top five most important vegetable crops (Frary *et al*., 2007).

Eggplant (*Solanum melongena L.*), also known as Aubergine, Brinjal or Guinea squash is one of the of the night shade family (Lester, 1991). The name 'eggplant' currently refers to three crops belonging to the genus *Solanum*, subgenus *Leptostemonum*, derived from the Old World: *Solanum melongena* L. (eggplant), *S. aethiopicum* L. (scarlet eggplant), and *S. macrocarpon* L. (Gboma eggplant). *Solanum aethiopicum* and *S. macrocarpon* are native to Africa, where they are grown locally for their edible fruits and young leaves (Lester 1991 and 1998; Macha 2005; Sękara *et al.* 2007; and Caruso *et al*., 2017). The *S. melongena* complex exhibits a series of morphological intermediates, from small-fruited spiny plants to large-fruited non-spiny plants. Regarding nutritional value, eggplant has a very low caloric value and is considered among the healthiest vegetables for its high content of vitamins, minerals and bioactive compounds for human health (Raigón *et al*., 2008; Plazas *et al*., 2014b; Docimo *et al*., 2016).

The effects of deficit irrigation on growth and yield of many vegetable and field crops are well documented (English, 1990; Pereira *et al*., 2002; Karam *et al*., 2006; Fereres and Soriano, 2007). Numerous studies have been conducted to study the effect of water stress on eggplant growth and productivity (Madramootoo and Rigby, 1991, Mitchell *et al*., 1991, Tan and Blake, 1993, Smittle *et al.,* 1994, Hartz, 1997, Chen *et al*. 2002; Kirnak *et al*., 2002, and Chaves *et al*., 2003, Lovelli *et al*. 2007, D´ıaz-Perez *et al*., 2015). Water stress was found to induce a reduction in the average weight, height, diameter, and volume of the fruits of eggplants, which resulted in a significant reduction in the fresh yield (Mitchell *et al*., 1991, Tan and Blake, 1993, Smittle *et al*., 1994, Hartz, 1997, Kirnak *et al*., 2002, and Chaves *et al*., 2003), In addition, Lovelli *et al.* 2007, demonstrated that the response to water stress of eggplants was expressed in high marketable yield decrements and a drop in water productivity. Moreover, Madramootoo and Rigby, 1991, found that water stress resulted in a reduction of the leaf area as well as the dry matter accumulation of eggplants. Also, D´ıaz-Perez *et al*., (2015) indicated that eggplants may tolerate moderate water stress at 67% ETc (D´ıaz-Perez *et al*., 2015). In addition, Kürklü *et al*. (1998) and Ramalan and Nwokeocha (2000) found that the performance of eggplants cultivated in good watering conditions was essentially due to the maintenance of the internal water balance of the crop, which ameliorates the water use capacity of the plant and its capability of using nutrients.

Evaluation of genotypes for relative drought tolerance can be challenging since it is difficult to predict the stage at which the moisture stress is encountered under drought conditions. Besides, the environmental factors also fluctuate from season to season (Kumar and Arumugam 2013). Growers have used water management practices to minimize water stress effects on their crops and to improve plant growth and yield under these conditions (Mitchell *et al.*, 1991). Controlled periods of soil water deficit were achieved by increasing the intervals between irrigations for eggplant production (Al-Jibury and May 1970). Therefore, this study aims at evaluating the effect of irrigation intervals, and the use of three different eggplant hybrids on plant development, growth, and yield.

II. Materials and Methods

The present experiment was carried out during the summer seasons of 2014 and 2016 at the Experimental Farm of Vegetable Crops Department, Faculty of Agriculture, Assiut University, Egypt. Unfortunately, seedlings that were planted in the 2015 season, failed to complete their germination and subsequent growth. Therefore, from this point onwards, we will only mention the results of the 2014 and 2016 sowing seasons.

Three irrigation intervals and the three hybrids of eggplants were used in this experiment. Both factors, irrigation intervals and eggplant genotypes were investigated at the present experiment to estimate their effects on growth, yield and quality of eggplant crops under Assiut conditions.

2.1. Description of the Experimental site

Assiut governorate is located at about 375 km to the south of Cairo. The present experiment was carried out at the Experimental Farm of Vegetable Crops Department, Faculty of Agriculture, Assiut University, Egypt (Figure 1). The experimental site was located at 270 18' latitude and 310 18' longitudes and at an elevation of 70 meters above sea level. Assiut city has a population of 420,585 making it the biggest city in Assiut governorate. The average annual rainfall is 13 mm (Ashour *et al.*, 2015). The highest absolute minimum and highest absolute maximum annual temperatures are of 0.4°C and 47.6°C, respectively.

Figure 1. Location of the experimental site.

2. 2. Characteristics of Soil

Before planting, random samples were obtained from the experimental soil at a depth of 0-30 cm to determine its physical and chemical contents according to the standard method as described by Jackson, (1958). The soil analysis was carried out at the Central Laboratory, Faculty of Agriculture, Assiut University and results are presented in Table (1). The soil texture of the experimental site was clay with an average pH of 7.65. Local cultivation practice recommendations for the control of insects and diseases were followed and were sufficient to maintain normal crop growth.

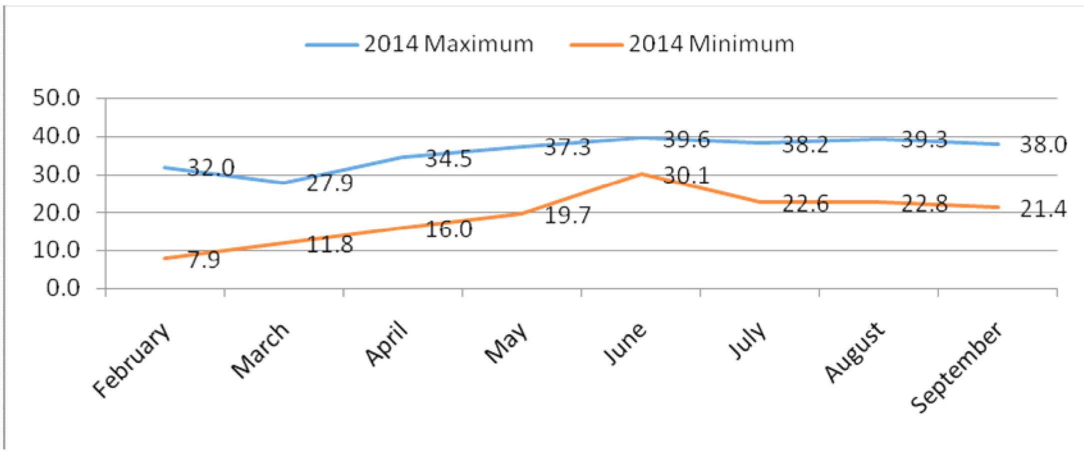
Data on some physical and chemical properties of the experimental site for the two seasons 2014 and 2016 are shown in Table (1).

Table 1. Physical and chemical properties of the soil in both seasons (2014 and 2016).

Year	Sand %	Silt %	Clay %	Texture	pH 1:1	ECe dS/m	Total $CaCO_3$ %	Total N %	Available nutrients ppm				
									P	K	Fe	Mn	Zn
2014	19.3	31.0	49.7	Clay	7.80	1.42	3.13	1.80	16.4	354	9.7	10.3	1.2
2016	21	29.2	47	Clay	7.5	1.1	3.5	1.72	12.2	325	8.6	12	1.5

2. 3. Weather Condition of the Experimental Site

Meteorological data of the average air temperature during the period of the experiment was collected from Assiut University Meteorological Station, Assiut, and presented in Figures 2 and 3 during the experimental period, climatic data were recorded at a weather station 200 m away from the experimental site. The experimental site has a subtropical climate, characterized by three distinct seasons, the winter season from November to February, the summer season from March to June and the fall season from July to October.



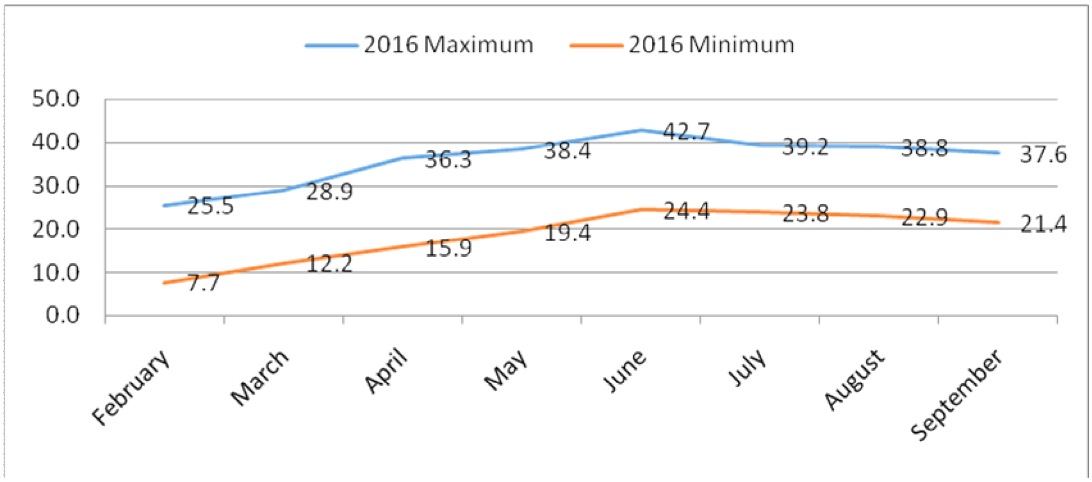


Figure 2. Average minimum and maximum temperatures (ºC) measured over the two years.

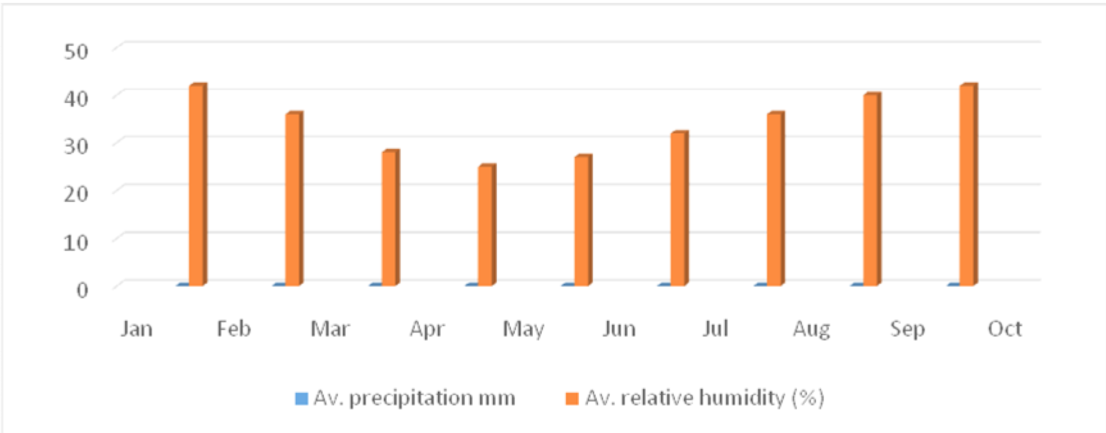


Figure 3. Mean monthly relative humidity over the year of 2016 under Assiut condition.

2. 4. Planting

Seeds of three eggplants genotypes were used during the two seasons of the study. Seeds were from the same seed lot, as enough seeds were obtained in the beginning of the experiment and stored in the deep freezer. Names and some morphological and economical characters of the three hybrids are shown in Table (2).

In order to raise seedlings for transplanting in the field, seeds of the three eggplant genotypes (Hybrids) were cultivated in the greenhouse of the Experimental Farm of Vegetable Crops Department. Eggplant seeds were sown in the nursery on 1st January and 1st February in the first and second seasons, respectively. Peat-based medium and polystyrene 200-cell (2.5* 2.5 cm cell) trays were used as a medium for the plants.

In the nursery, cultural practices recommendations for fertilization, and the control of weeds, insects and diseases were adequately followed to assure normal seedling growth in each season.

Transplanting took place on February 15th and March15th in the first and second season, respectively. Six-week old eggplant transplants were planted in the field by hand after they were hardened-off. Hardening-off the eggplant transplants was done by withholding water about 3-7 days before digging out. Transplants were arranged on five ridges, 70 cm apart, with 50 cm spacing between plants in the experimental plots. Experimental plot area was 12 m^3

2. 5. Experimental Factors

The experiment consisted of two factors. The first factor was the three irrigation intervals and the second factor was the three hybrids of eggplants.

Water Treatments Procedure

Furrows are small, parallel channels, made to carry water in order to irrigate the eggplant crops by surface irrigation. The seedlings are usually grown on the southern sides of the ridges between the furrows. Three irrigation regimes were used. Each irrigation period was separated by five meters of non-irrigated block to avoid horizontal soil water movement. Drought treatments began 30 days after seedlings cultivation in the two seasons. Irrigation treatments started on March 15th, 2014 and on April 15th, 2016. The harvest was done at the end of September in both seasons.

2.5.1 Irrigation Regimes

Irrigation treatments were beginning 45 days after transplanting as follows.

I 1. The control treatments: This was irrigated every 10 days (W1).

I 2.The second irrigation intervals: This was irrigated every 20 days (W2).

I 3.The third irrigation intervals: This was irrigated every 30 days (W3).

2.5.2 Genotypes of Eggplants:

The three genotypes used in the experiment were:

1- Alabaster F1 (white long hybrid)
2- Hanen F1 (black long hybrid)
3- Classic hybrid F1 (oval black hybrid)

Table 2. Description and some economical characters of the eggplant genotypes used in the present study.

Cultivars	Alabaster F1 (White)	Hanen F1 (Black)	Classic F1 Rome
Fruit color	white-skinned	Purple-black skin	Black skin
Shape	Long-shaped	Long-shaped	Oval-shaped
Earliness	Medium to early	Early	50 days
Growth Vigor	Medium vigor	Strong growth	Good
Plant Height	90-130 cm	100-130 cm	60-90 cm
Flower color	Purple	Purple	purple
Yield	High	High	High
Company	Syngenta	Advanta	Agri. Seeds

Field transplanting:

At transplanting time, ridges were thoroughly irrigated and transplanting took place on southern side of the ridge in the presence of water through furrows. To assure a good stand of the plants, healthy seedlings were set 40 cm apart on the southern side of the ridges. To avoid heat injury of seedlings, particularly on hot days, transplanting was conducted just after sunshine. Furthermore, the first irrigation was 3 to 5 days after, transplanting to keep sufficient soil moisture for transplant establishment. Absent hills were replanted before irrigation using transplants residual from trays.

Levels of applied fertilizer in the permanent field were at guidelines. The following amounts and types of fertilizers per feddan were applied:

15-20 m^2 of animal manure was broadcasted on soil surface at the time of soil preparation to be in incorporated in the soil by ploughing. Phosphorus at the rate of 200 kg/fed. in the form of calcium superphosphate (15.5% P_2O_5) was broadcasted at the time of soil preparation. Nitrogen at the rate of 200 kg/fed. in the form of ammonium nitrate (33.5% N) was applied in 3 dosages, the first dosage was about 100 kg/fed, side dressed four weeks after transplanting, the second dosage was about 50 kg/fed side dressed four weeks later and the third (50 kg/fed) dosage was applied one month thereafter.

Local cultivation practices recommendation for control of weeds, insects and diseases were followed and were sufficient to maintain normal crop growth in each sowing date.

2. 6. Measurements

2. 6. A. Growth characters

Four plants from the middle rows of each sub-plot treatments were randomly selected and labeled. Measurements were collected after 60 days from transplanting.

The following characters were recorded

A1-Average plant height (cm): Measured from the growing tip of the longest stem of each plant to the soil level.

A 2-Average number of lateral branches per plant: Number of primary, secondary and tertiary branches per stem that were formed on the main stem were counted and divided by number of plants per row.

A 3-Average stem diameter (mm): The values were measured at fruit maturity by measuring diameter of the plant (North to South and East to West dimension of the above ground part of sample plants).

2. 6. B. Plant Dry and Fresh weight.

At the end of the experiment, samples of four whole plants were chosen and separated into leaves, stems and roots to measure the following characters.

B -1 Whole plant fresh weights (gm) of leaves, stems and roots.

B -2 Whole plant dry weights (gm) of leaves, stems and roots, after drying in the oven at 80^oC for 48 h were recorded.

Statistical analysis:

This was a two-factor strip plot experiment with 3 replications in a Randomized Complete Block Design (RBCD). All data collected where subjected to analysis of variance using SAS 2002 and means that were significantly different according to the F test were then separated by Duncan's multiple range test at Pd"0.05(Gomez and Gomez, 1984).

III. Results and Discussion

A -1. Average plant height (cm)

Data of average plant height at harvest time as affected by the three irrigation periods and eggplant genotypes during the two seasons of 2014 and 2016 are shown in Table (3).

The main effects of the three drought intervals on average plant height were significant in the second season only. Eggplant plants irrigated every 20 or 30 days gave significantly the lowest plant height values. However, plants that irrigated every 10 days significantly gave the tallest plant. This finding agrees with those reported by Byari and Al-Rabighi (1995) concluded that drought stress resulted in more significant reduction in plant height of eggplant than control treatment. Amiri *et al*., (2012) showed that among irrigation treatments, the highest amounts of all studied traits of eggplant included plant height, fruit length, fruit diameter, number of leave per m^2; number of fruit per m^2, water use efficiency and fruit yield were observed in the 6 days irrigation interval. Also, El-Afifi *et al*., (2013) revealed that short irrigation intervals (10 days) significantly increased all vegetative growth parameters included plant height.

The opposite trend was recorded by Kirnak *et al*., (2001) they found that medium water stress treatment in semi-arid regions can be a good choice for fruit quality (in terms of size), and for increasing water use efficiency by eggplants. The authors also found no statistical difference in all growth parameters between well-watered treatment receiving 100% of water field capacity and water-stressed treatment receiving 90% at 4-day intervals treatments. Moreover, other studies showed that shorter irrigation interval had significant increases in all growth measurements of eggplant (Abbas, 2007; Habib *et al*., 2012, and Rakha, 2014. Amiri *et al.,* (2012) showed that among irrigation treatments, the highest amounts of all studied traits of eggplant included plant height, fruit length, fruit diameter, number of leave per m2, number of fruit per m2, water use efficiency and fruit yield were observed in the 6 days irrigation interval.

As shown in Table 3, average plant height was significantly affected by eggplant genotypes as an average all over the three irrigation intervals. Hanen genotype, which was characterized by the long black fruit, significantly gave the tallest plants (104.44 and 93.03 cm) in the first and second seasons, respectively. The shortest plants (66.82 and 71.44 cm) were obtained in Classic F1 genotype (Rome) in the first and second seasons, respectively. Byari and Al-Rabighi (1995) stated that significant differences were observed among different eggplant cultivars in their response to seasonal variation and drought stress causing substantial effect on plant growth in both seasons. They also reported that the maximum plant height was obtained from Florida Market and Long Purple cultivars, whereas the minimum plant height was occurred from Black Beauty followed by Egyptian White cultivar. More or less findings were recorded by Pirboneh *et al.,* (2012)- Sibomana, *et al.,* (2013), Osakabe *et al.,* (2014), Rahma (2016), Ana Fita *et al.,* (2015), Armita *et al.,* (2017) they concluded that different genotypes appear to have different mechanisms of drought tolerance.

Rakha (2018) found that the proper irrigation interval can play a major role in increasing the productivity of eggplants by applying the required amount of water when it needed. Opposite trends were recorded by, Zokaee-Khosroshahi. *et* *al*., (2014) mentioned that there were no significant changes in shoot length, individual leaf area, leaf dimension (length and width), or stomatal size and frequency were observed in response to drought treatments.

The interaction between irrigation intervals and eggplant genotypes were significant regard to average plant height in both seasons. Hanen F1 when irrigated every 10 days significantly produced the tallest plants in the two seasons. However, Classic F1 genotype irrigated every month significantly gave the shortest plants in the two seasons. Other studies have also shown that water stress induced a reduction in the average weight, height, diameter and volume of the fruits of eggplants which resulted in a significant reduction in total fresh yield (Mitchell *et al.* (1991), Tan and Blake (1993), Smittle *et al.* (1994), Hartz (1997) and Kirnak *et al.* (2002).

Table 3. Effect of drought periods and eggplant genotypes on plant height in 2014 and 2016 seasons.

Genotypes / Drought period	Hanen F1 (Black)	Classic F1 Rome	Alabaster F1 (White)	Average
		2014		
Control (W1)	107.78 a	64.89 c	73.89 bc	82.19 a
W2	106.67 a	68.89 bc	75.56 bc	83.70 a
W3	98.89 a	66.67 c	80.56 b	82.04 a
Average	104.44 a	66.82 b	76.67 b	
		2016		
Control (W1)	109.50 a	81.94 bcd	86.67 bc	92.70 a
W2	89.58 b	68.75 ef	77.92 cd	78.75 b
W3	80.00 cd	63.61 f	76.94 de	73.52 b
Average	93.03 a	71.44 c	80.51	

A-2. Average numbers of lateral branches per plant

The main effects of the three drought periods on the average number of lateral branches per plant were significant in the first season only (Table 4). It is confuse that longest irrigation period (every 30 days), significantly gave the highest average number of branches per plant (39.61). Acceptable results were recorded in the second season, the control treatment gave the highest average number of lateral branches per plant. However, the difference between the three irrigation treatments did not reach the level of significance. These results were agree with those recorded with El-Afifi *et al*., (2013) revealed that the shortest irrigation intervals (10 days) significantly increased vegetative growth parameters, i.e., plant height, stem diameter, leaf area/plant, number of leaves/plant, number of branches/plant, as well as fresh and dry weights of the whole plant. Also, Hussein *et al*., (2010) found that the average number of branches per plant was significantly affected by irrigation interval treatments in the two growing seasons. The greatest number of branches/plant was formed when irrigation was applied each 12 days while the least was recorded when irrigation was done at 30 days intervals. In addition, Abbas (2007) studied the effect of three irrigation intervals (4, 8 and 12 days) on eggplants, and found that irrigation every 8 days significantly increased plant height and the number of main branches per plant.

Data presented in Table 4 showed that Hanen F1 significantly gave the highest average number of lateral branches per plant, and Classic F1 (Rome) gave the lowest values in both seasons. However, Hussein *et al.,* (2010) found that the differences between cultivars regarding average number of branches/plant were insignificant during 2007 season. Eggplant cultivars showed different responses to water stress in plant height, stem diameters, and number of branches parameters (Armita *et al*., 2017). Byari and Al-Rabighi (1995) stated that eggplant cultivars showed different responses to water stress in leaf area, number of leaves, and number of branches. Florida Market (FM) cultivar showed more tolerance to stress than other eggplant cultivars in most morphological and physiological traits.

The interaction effects between drought periods and eggplant genotypes were significant for average number of branches per plant in both seasons. In the control irrigation treatment (10 days), Hanen F1 (black) genotype significantly gave the highest average number of branches per plant, whereas Classic F1(Rome) genotype gave the lowest average number of branches per plant in both season. Rodríguez *et al.*, (2010) reported that water stress strongly affects horticultural cultivars by reducing yield and fruit quality.

Table 4. Effect of drought periods and eggplant genotypes on average number of lateral branches per plant in 2014 and 2016 seasons.

Drought period \ Genotypes	Hanen F1 (Black)	Classic F1 Rome	Alabaster F1 (White)	Average
2014				
Control (W1)	55.5 a	21.7 e	33.4 cde	36.9 b
W2	43.2 abc	32.8 cde	27.3 de	34.4 b
W3	48.1 ab	29.4 cde	41.3 bcd	39.6 a
Average	48.9 b	28.0 b	34.0 b	
2016				
Control (W1)	108.9 a	39.0 cd	62.3 bc	70.1 a
W2	110.4 a	36.3 d	98.7 a	81.8 a
W3	73.2 b	33.7 d	71.7 b	59.5 a
Average	97.5 a	36.3 c	77.6 b	

A-3 Average stem diameters (mm)

Table 5 and figure 6 showed that the highest significant values (22.22 mm) of average stem diameter were recorded from 10 days irrigation intervals in the second season only. Results showed that the superiority of the 10 days irrigation period could be attributed to the sufficient irrigation quantity especially in the early stage of crop growth enhanced a deeper and more extensive root system (Marouelli and Silva, 2005; Ngouajio *et* *al.,* 2007; EI-Dolify *et al.,* 2016). Also, Kirnak *et al.* (2001) evaluated the effects of irrigation regime (100, 80, 60 and 40% of pot capacity (PC)) on eggplant and concluded that water stress resulted in significant decreases in chlorophyll content, leaf relative water content (LRWC) and vegetative growth. Severe water stress (40% of PC) slightly reduced plant height, stem diameter, total dry weight, and relative leaf expansion rate.

Also, results revealed that the lowest average stem diameter values (20.14 and 20.01 mm) were recorded in the plots irrigated every 20 and 30 days intervals, respectively. These results were comparable with that recorded by Bar-Yosef *et al.,* (1980); Maynard *et al.,* (1980); Lou and Kato (1988) and Sanders *et al.,* (1989) they reported remarkable increases in plant growth parameters with each increase in soil moisture. In the present study, the lowest average stem diameter values (20.14 and 20.01 mm) were recorded in plots irrigated every 20 and 30 days interval, respectively. Also, those two treatments resulted in reductions in stem diameter and plant height.

Data presented in Table 5 showed the significant effect of the three eggplant genotypes on average stem diameter in the two seasons of (2015 and 2016). The highest average stem diameter was obtained with Hanen F1 genotype in both seasons, however, the lowest values was occurred with genotype Classic F1 in both seasons. Ilahi *et al*., (2017) and Armita *et al*., (2017) found that drought stress effects on the morphology of the eggplant (*Solanum melongena* L.) in the vegetative phase which resulted in a decrease in width canopy growth at 3, 4, and 5 weeks after treatment, stem diameter growth at 2, 3, 4, 5, 6, and 7 weeks after treatment. Rahma (2016) showed that drought reduced stem diameter of all tested eggplant cultivars and the response of eggplant cultivars to drought was variable. Byari and Al-Rabighi (1995) found that eggplant cultivars showed different responses to water stress in leaf area, number of leaves, and number of branches. Drought reduced stem diameter of all eggplant cultivars and the response of eggplant cultivars to drought was variable.

The interaction of the irrigation regimes and eggplant genotype had a conspicuous significant effect on the average stem diameter in the two seasons of (2014 and 2016). The short irrigation period (10 days) and the long black fruit (Hanen F1) genotype significantly gave the highest average stem diameter in the both seasons, however, the oval fruit shape genotype Classic F1 (Rome) and the longest drought period (30 days) significantly gave the lowest average stem diameter in the two seasons. Rakha (2018) found that the effect of irrigation intervals on vegetative growth parameters indicated that shorter irrigation interval had significant increases in all growth measures of eggplant in two seasons. The effect of irrigation intervals showed that all previous parameters were decreased with increasing irrigation intervals. More or less were recorded by El-Afifi, *et al*., (2013) they revealed that short irrigation intervals (10days) significantly increased all parameters i.e., plant height (cm), stem diameter (cm), leaf area/plant (cm2), number of leaves/plant, branches/plant as well as fresh and dry weight (g) of whole plant under investigation.

Table 5. Effect of drought periods and eggplant genotypes on average stem diameter (mm) in 2014 and 2016 seasons.

2014				
Genotypes / Drought period	Hanen F1 (Black)	Classic F1 Rome	Alabaster F1 (White)	Average
Control (W1)	27.59 a	18.73 de	20.33 cd	22.22 A
W2	24.02 b	17.95 de	18.46 de	20.14 b
W3	23.51 bc	16.31 e	20.19 cd	20.01 b
Average	25.04 A	17.66 B	19.66 B	
2016				
	Black	Rome	White	Average
Control (W1)	23.01 a	16.77 d	20.15 b	19.98 a
W2	19.79 b	14.86 d	18.67 b	17.77 a
W3	18.65 b	14.15 d	19.06 b	17.29 a
Average	20.48 a	15.26 b	19.29 a	

a- 4 Plant fresh weights (g)

Regarding to the effect of irrigation intervals on vegetative growth parameters data in Table 6 clearly showed that the highest significant values of the whole plant fresh weight were recorded in the control treatment (irrigated every 10 days) during both seasons. It could be helpful to mentioned that increasing water quantity added to plant led to keep higher moisture content in the soil and this in turn leads to increase plant growth characters and to produce higher fresh and dry matter. This result agrees with those stated by Faten, Abd El-Aal- *et al.*, (2008); Bahawireth (2011); Osakabe *et al.*, (2014), Zokaee-Khosroshahi *et al.*, (2014); Chatterjee and Solankey, (2015); Kipchirchir (2016) and Rahma (2016) found that the longest irrigation intervals that irrigated every 30 days significantly gave the lowest eggplant growth parameters values in both seasons.

The highest whole plant fresh weight was always recorded with Hanen F1 genotype. The opposite results were recorded with Classic F1 (Rome) genotype, which gave the lowest whole plant fresh weight in both seasons. The results obtained clearly indicates that the genotype Hanen F1 tolerate drought stress while genotype Classic F1 is found to be drought sensitive which needs improvement for the abiotic stress tolerance.

The interaction between drought period treatments and eggplant genotypes was significant in the two seasons. In one hand, full irrigated treatment (control) cultivated with Hanen F1 genotype significantly gave the highest values of whole plant fresh weight in both seasons. On the other hand, Classic F1 genotype irrigated every 20 or 30 days significantly gave the lowest whole plant fresh weight in the two fall seasons. Armita *et al.*, (2017) summarized that drought stress caused significant reduction of plant height, stem diameter, leaves length and leaves width but the drought stress levels (mild and severe-stressed) were not significantly different. Obtained results showed that genotype I and genotype II were included in medium tolerant category toward mild and severe drought stress meanwhile genotype III was included in sensitive category toward mild and severe drought stress in vegetative phase.

Table 6. Effect of drought periods and eggplant genotypes on whole plant fresh weight in 2014 and 2016 seasons.

Genotypes / Drought period	Hanen F1 (Black)	Classic F1 Rome	Alabaster F1 (White)	Average
2014				
Control (W1)	752.67 a	489.33 cd	501.67 c	581.22 a
W2	586.00 b	459.33 cd	485.00 cd	510.11 b
W3	565.33 b	441.33 ed	398.33 e	468.33 c
Average	634.67 a	463.33 b	461.67 b	
2016				
Control (W1)	662.33 a	345.00 cd	619.33 a	542.22 a
W2	452.67 b	283.33 de	398.00 bc	378.00 b
W3	353.67 c	262.67 e	393.67 bc	336.67 b
Average	489.56 a	297.00 b	470.33 a	

a- 5 Plant dry weight (g)

Data illustrated in Table 7 showed that 10 days irrigation treatment (control) significantly recorded the highest plant dry weight (300.41 and 201.04g) in the first and second fall seasons, respectively. The severe irrigation treatment (30 days) produced the lowest average foliage fresh weight per plot (192.38 and 121.67g) in the first and second fall seasons, respectively. Rakha (2018) found that the effect of irrigation intervals on vegetative growth parameters indicated that shorter irrigation interval had significant increases in all growth measures of eggplant in two seasons. The effect of irrigation intervals showed that all vegetative growth parameters were decreased with increasing irrigation intervals. Byari and Al-Rabighi (1995) found that drought stress reduced the dry weight of plants in both seasons. The treatment differences were significant during spring and non-significant during summer. More, water stress caused reduction in plant height, number of branches, and dry weight of shoots and roots dry weight (Bonanno and Mack 1983; Abou-Hadid *et al*., 1986; Daunay *et al*., 1986; Tan 1988; Zhong *et al.,* 1989 and Bray 1990).

The obtained results showed conspicuous diversity within cultivated eggplant genotype for tolerance to drought stress Table 7. Hanen F1signficantly produced the highest plant dry weight; however, Classic F1 significantly gave the lowest whole plant dry weight in both seasons. Alabaster F1 ranked the second after Hanen F1 in the first season and both Hanen F1 and Alabaster F1 gave the highest dry weight in the second season. Zokaee-Khosroshahi *et al.*, (2014); Ana Fita *et al.,* (2015); and

Rahma (2016) revealed that eggplant cultivars displayed different responses in their tolerance to water stress during both seasons, for leaf dry weight, stem dry weight, and root dry weight. Also, Byari and Al-Rabighi (1995) revealed that eggplant cultivar Florida Market showed the best performance during both seasons for leaf dry weight, stem dry weight, and root dry weight. However, cultivar FM was ranked the second in leaf dry weight during spring. These results were similar to those obtained by Goncharova *et al*., (1982); Daunay *et al.,* (1986); and Sun *et al.,* (1990). They reported different responses of different cultivars to water stress and these differences were possibly due to the difference in genotype genetic structure. Moreover, under Assiut province conditions, Hussein *et al.,* (2010) summarized that cv. Black Beauty produced significantly the higher root fresh weight and dry weight, and early and total yield per feddan in both seasons, as an average of all tested irrigation interval**.**

The effect of irrigation interval and eggplant genotypes and their interaction on whole plant dry weight are shown in Table (7). The interaction between irrigation interval and eggplant genotypes was significant in the both seasons. In one hand, Hanen F1 genotype irrigated every 10 days as recommended under Assiut province conditions (heavy soil type) produced the highest plant dry weight (412.83 and 229.93 g) in the first and second seasons, respectively. On the other hand, the longest irrigation interval (every 30 days) cultivated with Classic F1 and Alabaster F1 in the first season gave the lowest plant dry weight (12.68 and 14.38 g.), respectively. Classic F1 in the second season gave significantly the lowest whole plant dry weight (112.80 g).

Table 7. Effect of drought periods and eggplant genotypes on whole plant dry weight in 2014 and 2016 seasons.

Genotypes / Drought period	Hanen F1 (Black)	Classic F1 Rome	Alabaster F1 (White)	Average
2014				
Control (W1)	412.83 a	220.23 cde	268.17 bc	300.41 a
W2	304.61 b	193.66 def	247.3 cd	248.52 b
W3	249.74 bcd	160.28 f	167.11 fe	192.38 c
Average	322.39 a	191.39 b	227.53 b	
2016				
Control (W1)	229.93 a	141.47 b	231.71 a	201.04 a
W2	155.44 b	104.18 cd	142.78 b	134.13 b
W3	147.51 b	92.74 d	124.76 bc	121.67 b
Average	177.63 a	112.80 b	166.42 a	

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Doi: 10.21608/ajas.1999.12763
Abdalla, et al., 2018 *http://ajas.journals.ekb.eg/*

تأثير فترات الري و التركيب الوراثية علي النمو والمحصول في الباذنجان
١- النمو الخضري

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الملخص

اجريت تلك التجربة في المزرعة البحثيه لقسم الخضر بكلية الزراعة جامعة أسيوط، أسيوط، مصر أثناء الموسمين الزراعيين ٢٠١٤و ٢٠١٦ وتمت الزراعه في تربة طميية ذات درجة القلوية ٧,٦٥. وقد تم تطبيق ثلاث فترت ري وهي (كل ١٠ و٢٠ او ٣٠ يوم) واستخدام ثلاث هجن للباذنجان وهي (هجين حنين وهجين كلاسيك وهجين الاباستر) وذلك لتقدير تاثيرهم علي جودة و كمية محصول الباذنجان تحت ظروف اسيوط، مصر). وقد اظهرت النتائج ان صفة وزن النبات الغض والجاف في كلا الموسمين الاول والثاني معاملة الري كل ١٠ ايام (الكونترول) سجلت اعلي معنوية بالتتابع. وكذلك سجلت معاملة الري كل ١٠ ايام اعلي فرق معنوي لصفتي متوسط طول النبات وقطر الساق وذلك خلال الموسم الثاني فقط. وعلي العكس في الصفات السابقه فأن الاحواض التي تم ريها كل ٣٠ يوم اعطت اعلي معنوية لمتوسط عدد الافرع للنبات. تاثير التراكيب الوراثية للباذنجان كان اكثر ثباتا في كلا الموسمين ، حيث اعطي هجين حنين اعلي معنوية لصفات طول النبات، قطر الساق، متوسط عدد الافرع ، وزن النبات الغض(الطازج) والجاف. في حين اعطي هجين الكلاسيك اقل قيم معنوية لمقاييس النمو.