EFFECT OF WATER STRESS ON OKRA YIELD AT VEGETATIVE STAGE

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ABSTRAK

Penelitian ini dilaksanakan di Sekolah Tinggi Ilmu Pengetahuan Terapan, Universitas Politeknik Sulaimany, selama tahun 2017. Berbagai tingkat irigasi digunakan untuk produksi tanaman okra. Rancangan Acak Lengkap digunakan untuk mengatur tata letak percobaan, dengan tiga perlakuan tingkat irigasi dan empat ulangan. Hasil pengamatan yang dilakukan adalah bobot segar tanaman, bobot kering tanaman, faktor hasil dan respons tingkat irigasi yang berbeda. Hasil tertinggi ditunjukan dari perlakuan T1 (3.17 t.ha.-1) dan yang terendah ditunjukan dari T3 (2,988 t.ha.-1). Juga, berat segar maksimum dan kering bobot tanaman terlihat pada T1 (61.40, 11.218 t.ha.-1), dan hasil terendah diperoleh pada perlakuan T3 (57,00, 8,783 t.ha.-1). Efisiensi penggunaan air dan indeks panen tertinggi diperoleh dari T3 (1,615 kg.m-3, 0,095), dan terendah diperoleh dari perlakuan T1 (1,055 kg.m- 3, 0,094). Faktor respons tanaman dan hasil dalam penelitian ini menunjukkan bahwa tanaman okra memiliki respon stres air yang baik. Sebagai hasilnya, kami dapat merekomendasikan budidaya okra pada waktu itu tanpa irigasi di wilayah tersebut.

Kata kunci: *Crop yield response factor, Harvest index, Okra, Water use efficiency, Yield*.

ABSTRACT

This study was conducted in Technical College of Applied Sciences, Sulaimany Polytechnic University, during 2017. Different levels of irrigation were used to production of okra plant. Complete Randomize Design used to layout of the experiment, with three level of irrigation in four replications. Yield, fresh weight of plant, dry weight of plant, yield response factor and different levels of irrigation were observed. The highest yield was given from treatment T_1 (3.17 t.ha.$^{-1}$) and the lowest was given from T_3 (2.988 t.ha.$^{-1}$). Also, the maximum fresh weight and dry weight of plant were given from T_1 (61.40, 11.218 t.ha.$^{-1}$), and their minimum was given from treatment T_3 (57.00, 8.783 t.ha.$^{-1}$). The highest water use efficiency and harvest index were obtained from T_3 (1.615 kg.m^{-3}, 0.095), and the lowest was given from treatment T_1 (1.055 kg.m^{-3}, 0.094). The crop response factor and the results in this study showed that the okra plants have a good response of water stress. As a result, we can recommend cultivating the okra at that time without irrigation in that region.

Keyword: Crop yield response factor, Harvest index, Okra, Water use efficiency, Yield.

INTRODUCTION

The okra plant, *Abelmoschus esculentus* (L.), Moench, is an annual vegetable crop; it is belonging to the family of (Malvaceea). It is more popular vegetable in the world and acceptable in the market (Farias *et al*. 2017). Also, okra pods contain carbohydrate, protein and vitamin (Farinde *et al.,* 2007; Varmudy, 2011). Okra plant has the same comparable soybean, containing essential and nonessential amino acid (Farinde *et al,* 2007). However, okra pods has great important role in human nutrition (El-Kader *et al.,* 2010; Varmudy, 2011).

Okra plant is cultivated throughout tropical and subtropical region (Akinyele & Osekita, 2006). To product the vegetable in the word, it needs an amount of water. Consequently, demand for water usage in the word has increased in both agricultural and particular government sectors at high rates (Singh & Rajput, 2007).

Both drip and surface irrigation are most popular applied in agricultural sectors. Drip irrigation has some advantages such as decreasing evaporation, more efficiency of water use, reducing water waste and easily managing the water to applied nutrition and some pesticide and fungicide (Singh & Rajput, 2007; Sengkhamparn, 2009). However, drip irrigation enhances the yield and quality of the crops (Camp, 1998; Sengkhamparn, 2009).

In order to reduce waste of water in agriculture and to use fewer water in irrigation, it is necessary to manage the implementation irrigation system (Agodzo, *et al.,* 1997). However, the efficiency of water to irrigation crop affects productive characteristic (Farinde *et al.,* 2007). Moreover, water stress on the plants directly impact the reduced fruit dry matter and yield of the plant (Bhatt& Srinivasarao, 2005; Sankar *et al.*, 2008; Bahadur *et al.*, 2009).

Recently, in Kurdistan Region-Iraq, water utilization in agricultural sectors and decreasing water in that country have spread; hence, in the future, water use has to be decreased in agricultural particularly in municipal, sector by applying the right way to irrigation the plant. The aim of the study is to test the effects of water stress on the yield and vegetative stage of okra.

Material and Methods

Field experiment for the study was conducted in Technical College of Applied Sciences, Halabja, Sulaimani Polytechnic University, during spring season of (2017), and location of the experiment area on (35°12'47.4"N latitude 45°57'34.9"E longitude), and the altitude (690m) above sea level. The local cultivar of okra was used to observation the Yield ton/ hectare, amount of water use, weight of plant ton /hectare and dry weight ton/hectare. The average rainfall in the area was between (650 -700 mm) in 2017, the relative humidity (55±30%) and air temperature (18±10 C0). Also, surface irrigation systems are used to irrigate the Okra in that region and applied two times a week.

In this study, the experiment compose of cultivates okra plant, irrigation unit and germinate seed. Then, it is divided in to three treatments: first, normally, irrigation weekly depends on soil moisture; second, irrigation the plant one time after germination until flowering; and third, treatment okra plant does not have irrigation from germination until flowering Table 2. Complete randomize design is used to layout

for the experiment. The experiment area ploughed twice and is divided in to 12 equal plots with 3 treatments and 4 replications, and the dimensions of plot (6 m) length and (3 m) width and the line width (0.75 cm) spacing, the spacing between the plants are (25X25 cm).

Okra seeds were sown on 15of April 2017. In this experiment, 1.5 kg/ sub plot of Diamonium Phosphate was applied by broadcasting at time of crop sowing. Gravimetric method was used to determine the moisture content of the soil. To determine the soil chemical, physical characteristic is digging the soil (60cm) depth Table 1.

The irrigation process for first treatment was applied when 50% of the available water was depleted, and then 50% of water was added to reach 100% of the available water. Drip irrigation is used to irrigation of okra. Depth of irrigation water was calculated by following equation Eq. (1):

$$D= 0.5Aw*Rz \qquad (1)$$

Where:

D: Applied of water (mm)

Aw: Available water (Difference between field capacity and wilting point.

0.5 *Aw*: Volumetric water content when 50% of available water was depleted (m^3/ m^3)

Rz: root zone depth according plant growth stage (10:20:30 cm) for each month (April, May and Jun) respectively.

Use the following equation to find the field water use efficiency, and harvesting index was calculated by the equation given by Hunt (1978) Eq. (2).

$$F.W.U.E= \frac{Yield \quad \llbracket Kg \rrbracket}{amount \ of \ water \ applied \ \llbracket m^{-3} \rrbracket} \qquad (2)$$

The crop yield response factor (Ky) was estimated by using the equation reduction in relative yield Stewant's model Eq. (3), as given below:

$$[1-ya/ym= ky (1-Eta/Etc)] \qquad (3)$$

The estimate value of (ky) depends on the maximum yield from full irrigation treatment and

Table 1 Chemical and physical properties of the soil

Chemical properties	Value/Unit	Physical properties	Value/Unit
Organic mater	20 g kg^{-1}	Sand	133.6 g kg^{-1}
PH	7.57	Silt	244.3 g kg^{-1}
EC	1.4 dS m^{-1}	Clay	622.1 g kg^{-1}
PH water	7.7	Soil texture	Clay
EC water	1.05 dS m^{-1}	Bulk density	1200 Kg m^{-3}
Total Nitrogen	20 mg kg^{-1}	Field capacity, (33 kPa)	320g kg^{-1}
Phosphors (soluble)	19 mg kg^{-1}	Wilting point, (1500 kPa)	188g kg^{-1}
Potassium (soluble)	13.7 Meq kg^{-1}		
alcium (soluble)	7.5 Meq kg^{-1}		
Magnesium (soluble)	2.8 Meq kg^{-1}		
Sodium (soluble)	6.3 Meq kg^{-1}		

yield of treatment that exposed to stress. The amount of water used in this study illustrated in Table 2. The data were analyzed by one-way ANOVA using (XLSTAT-pro version 7.5.2) program with comparison L.S.D at P<0.05.

Table 2 Amount of water was used in this study

Plant age/ week	Depth of water applied		
	T_1	T_2	T_3
1	1.44	1.44	1.44
2	1.44	-	-
3	1.44	-	-
4	2.88	2.88	-
5	2.88	-	-
6	2.88	-	-
7	4.32	4.32	4.32
8	4.32	4.32	4.32
9	4.32	4.32	4.32
10	4.32	4.32	4.32
Total	30.24 cm	21.60cm	18.72cm

Results and Discussion

Effect of water stress on the yield was shown in figure 1. The results showed a significant vary between the different levels of irrigation at P<0.05. The maximum yield was obtained from the treatment one (3.17 t.ha.$^{-1}$), and the minimum was given from treatment three (2.988 t.ha.$^{-1}$). Those results agree with those Singh & Rajput, (2007), who worked on okra using subsurface of drip irrigation and (Bhatt& Srinivasarao, 2005; Bahadur, 2009; Akande, *et al.,* 2010). Observing the results of the study, the yield from treatment three compared with other treatments economically is not a significant different, but statically different, because the amount of water use is much less than the other treatments. Also, Sankar *et al.*, 2008 stated that the water stress affects to the yield and Martin, 2000 stated that too little water with too much water both effect to yield reduction. Otherwise, the results disagree with (Dilruba, *et al.,* 2009), who worked on okra using the growth hormone.
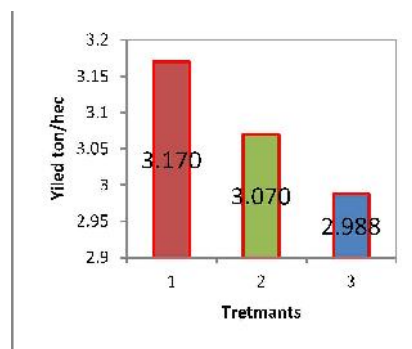

Figure 1 Effect of different levels of irrigation on the yield

The weight of vegetative part of plant and the dry weight of vegetative part of plant were illustrated in Table 3. The highest weight of fresh vegetative part for three treatments and four replications was given from T_1 (61.40 t.ha.$^{-1}$), and the lowest was obtained from T_3 (57.00 t.ha.$^{-1}$). The result showed a significant different between treatment at p< 0.05. In case the amount of water use to irrigate the okra plant affect to the fresh weight of the okra plant. Also, the results agree with (Zodape, *et al.*, 2008) worked on okra plant use liquid fertilizer to increase yield and quality, and showed in that result the amount of use water with fertilize directly affect to the growth and vegetative part with yield. El-Kader *et al.,* 2010) who recorded the same result using the water by drip irrigation to increase the yield and quality of okra as well as. However, the highest weight of dry vegetative part was given in T_1 (11.218 t.ha.$^{-1}$) and the lowest was given in T_3 (8.783 t.ha.$^{-1}$). The results of dry weight of okra plant under water stress agree with (Zodape, *et al.*, 2008), because the water in to the plant have a majority role to growth. So that, the okra plant like other plants need to the water to growth but in that study showed the okra plant not irrigated form that time.

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Table 3 Effect of different levels of irrigation on the weight of vegetative part of the Okra plant

Treatments	Weight of fresh vegetative part t.ha.$^{-1}$	Weight of dry vegetative part t.ha.$^{-1}$
T_1	61.40a	11.218a
T_2	58.72b	9.528b
T_3	57.00c	8.783c

L.S.D. comparison at $p<0.05$ the same letter show no significant otherwise to different

In this study, the field water use efficiency and harvest index clarified the results in Table 4. Water use efficiency refers the ratio between amount of water retained in the root zoon and the amount of water applied (Martin, 2000). The comparison between treatments to field water use efficiency showed a significant different at $p<0.05$. The highest water use efficiency and harvest index was given from treatment T_3 (1.615 kg.m^{-3}, 0.095). Moreover, not irrigation for a long time from flowering in okra plant effect to reduce the loss water, because the stomata closure and decreased CO_2 fixation. This illustrated the photosynthesis in the plant increased at the cost of water loss affected to use water efficiency. The results of water use efficiency agree with Bahadur, (2009). The results of harvest index showed no significant different between treatments.

The crop yield response factor of okra is showed in Table 5. The rustles showed that the ratio of response factor of water in okra plant is near to zero. Thus, the okra plants resist to water stress, because okra plant a deep taproot, semi woody stem and leaves are lobed with hairy and when the plants they suffer water deficiency this stress tend to close their stomata and thus reduce the photosynthetic rate (Farias *et al*. 2017). Also, that results agreed with Sankar *et al.*, (2008).

Table 4 Illustrated the Field water use efficiency and harvest index

Treatments	F.W.U.E. (kg.m^{-3})	Harvest index
T_1	1.055a	0.094a
T_2	1.435b	0.095a
T_3	1.615c	0.095a

F.W.U.E.: field water use efficiency, L.S.D. comparison at $p<0.05$ the same letter show no significant otherwise to different letter

CONCLUSION

In this study, the results of the okra yield showed no economical different. Hence, an amount of water can be saved without effect of the reducing okra yield. Thus, it has been recommended that the okra plant should not be irrigated until flowering in that region because of okra plant resistance to water stress. Also, it has been recommended that other researchers should work on different crops in that region in the future.

Table 5 Show the yield of okra plant response factors of water

Treatments	Yield kg/ha. Mena	W. applied m^3/ ha. Mena	1-Ya/Ym	1-Wa/Wm	Ky
T_1	3205	3024	-	-	-
T_2	3105	2160	0.03	0.28	0.10
T_3	3016	1872	0.06	0.38	0.15

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