The impacts of deficit irrigation levels and intervals on Tomatoes and Eggplants yield in unconditions plastic house

Salahaddin A. Aziz[*], Sarkawt T. Ahmad[**], Bakhtear A. Rasheed[**], Hewa B. Sharef[**], Dlsos H. Talb[**]

[*] Department of Soil and water science, Faculty of Agriculture Sciences, University of Sulaimani, Salah_salah725@yahoo.com.

[**] Directorate of Agriculture Research of Sulaimani, Kurdistan Region.

Abstract:

This study was carried out to determine the most suitable irrigation scheduling and crop coefficient for fresh market tomatoes (Ringo – F1) and eggplants (F-1Roma) grown on a silty clay soil in unheated greenhouses condition at the Directorate of Agriculture research at Bakrajow site situated to the southwest of Sulaimani during the 2011seseon. The yield response of tomatoes and eggplants to drip irrigation were investigated. Three different irrigation levels (WL-100, WL-75 and WL- 50% of available water) the highest yield was obtained from the (WL-100%) treatment. Tomatoes' and eggplants yields decreased with available water. The highest water use efficiency (WUE) value for tomatoes and eggplants were obtained from WL- 50% of available water were (11.41kg /m^2), (9.1841kg /m^2) respectively. WUE increased in all treatments as the amount of irrigation water decreased. The crop coefficient (kc) of tomatoes and eggplants were obtained from (WL-100%, WL-75% and WL-50% of available water) were (1.38, 0.92and 0.68), (2.02, 1.27and 0.88) respectively. And the highest crop coefficient (kc) of tomatoes and eggplants (1.38), (2.02) were obtained from (WL-100% of available water.

Keywords:

1- Introduction:

Tomato and eggplants are the most popular vegetable with the highest consumption rate and economic importance throughout the world. Since the market values of the early varieties were high.

Water availability is generally the most important natural factor limiting the widespread and development of agriculture in arid and semi-arid regions. Sulaimani is located in a semi-arid region and there are large areas which are not irrigated due to lack of irrigation water and also agriculture in greenhouse has increased in recent years. Irrigated agriculture will face significant challenges in the future. Most of the increased food production in the world will depend on irrigation and water use efficiency (WUE) (Najafi and Tabatabaei, 2007). In all agricultural systems, low (WUE) can occur when soil evaporation is high in relation to crop evapo-transpiration, early growth rate is slow, and water application does not correspond to crop demand and when shallow roots are unable to utilize deep water in the profile (Gallardo et al., 1996). Scheduling water application is very critical to make the most efficient use of drip irrigation system, as excessive irrigation reduces yield, while inadequate irrigation causes water stress and reduces production (Yazgan et al., 2008).

The supply of the required water to the plant **is** of prime importance for its growth and economic production, especially into greenhouse, where irrigation is the unique source of water for the plant.

Drip irrigation, which ensures efficient water use, improved fertilizer application, salinity control and labor saving, is mainly used by our farmers but irrigation intervals and water volumes are usually set according to empirical criteria. Although a lot of papers deals with water requirements of greenhouse grown vegetables, the results are not applicable to our region, since they are referred to different climatic conditions (Frenz and Lechl, 1981), different growing season (Chiaranda and Zebri, 1984**)** or to heated greenhouse (Eliades, 1988, 1992).

The objectives of these studies, carried out on one year, were to determine the water requirements of the main vegetable crop tomato's and eggplants and to estimate crop coefficient (Kc) of them.

2-Materials and methods:

The experiment was carried out during the 2011seseon in unheated greenhouses for tomato and eggplants, at the experimental farm at Directors of Agriculture research of Bakrajow, south-west of Sulaimani, with the latitude 35^0 32' N and the longitude 45^0 22' E and altitude 740 m above sea level. Soil physical and chemical properties of the experiment were determined according to the standard procedures as described by Page (1982) and Klute (1986), and are presented in Tables (1 and 2). The metrological during the growing season of 2011 data are summarized in table (3).

Sulaimani has typical Mediterranean climate conditions with hot dry summers and mild-rainy winters.

The experimental design for tomatoes and eggplants were a completely randomized design with three replications. In the experiment, three different irrigation levels were tested.

Irrigation levels treatments 100, 75 and 50% of available water (field capacity – wilting point), which were represented by symbols

The plots were 10.0 m long and 1.50 m wide. Each plot had three rows of plants. The plants were transplanted in the greenhouse at a spacing of (0.4 m x 0.4) m on (25) April 2011. A common recommended fertilization program was followed in the experiment.

All the treatment plots received the same amounts of fertilizer which consisted of 100 kg ha-1 P_2O_5 (mono potassium phosphate 52% P_2O_5; 34% K_2O), 200 kg ha-1 K_2O (potassium sulfate 51% K_2O) and 150 kg ha-1 N (ammonium nitrate, 33.5% N). All fertilizers were applied using drip fertigation in three split application.

Firstly, the drip laterals was established. The supplementary irrigations were applied for subsistence of the crops after the transplanting; the traditional drip lateral lines were installed in all the experimental plots on the soil surface with three drip lines per plot after planting.

The drip irrigation laterals were 16 mm in diameter. The drippers were inline type and were placed 0.40 m apart from each other and had (2.6) L flow rate at (5) m pressure. The irrigation system has a typical control unit consisted of a pump, fertilizer tank, gravel and disc filters, control valves, pressure gauges and a flow meter. The applied water was controlled by the flow meter.

After stand establishment on the (25) of April 2011, the first irrigation (50 mm) was applied to all the treatment plots using drip irrigation system to stabilize the soil water content in effective root depth. After that, irrigations were started in three plots. The amount of irrigation water was calculated and actual evapotranspiration by using Equation (1):

$$I + P + G - D - R = ø0 \text{ for long period} \quad (1)$$

I: irrigation, P: Precipitations, G: Ground water, D: Drainage water, R: Rainfall, ETa: actual evapotranspiration, ETo: potential evapotranspiration, Kc: Crop coefficient

$$I - ETa = \Delta pw \quad (2)$$

And calculated (Kc) by equation

$$Kc\ ETo = Eta \quad (3)$$

$$Kc = Eta / ETo \quad (4)$$

Class A pan is located at the center of the experimental plots in the greenhouse. Daily readings of the Class A pan evaporation was made in the mornings during the study. Soil water contents were measured gravimetrically at 30 cm increments down to 60 cm during the study. Soil water status of the irrigation plots was also determined.

Table (1): Some Soil physical properties.

Physical property	Average value	Physical property	Average value
Sand **g/kg**	51.90	Field capacity **g/kg**	330.0
Silt **g/kg**	483.32	Available water content **g/kg**	110.0
Clay **g/kg**	464.49	Bulk density **Mg m^{-3}**	1.22
Texture	SiC	saturation **%**	44.262
Wilting point **g/kg**	220.0		

Table (2): Some Soil chemical properties.

Chemical property	Average value	Chemical property	Average value
pH	7.30	Na^{+} (meq /L)	0.178
$CaCO_3$%	22.50	$CO3^{-}$ (meq /L)	0.00
O.M%	1.60	$HCO3^{-}$ (meq /L)	2.00
Total nitrogen	1.40	Cl^{-} (meq /L)	1.20
Available phosphorus(ppm)	4.362	K^{+} (meq /L)	-
Ca^{2+} (meq /L)	2.70	ECe(dS $m^{-1)}$ at 25 C^{0}	0.26
Mg^{2+} (meq /L)	1.30		

Table (3): Some selected metrological data obtain from the directorate weather station of Bakrajow for the growing season 2011.

Month	Metrological parameters						
	Min. Temp °C	Max. Temp °C	Humidity %	Wind km/day	Sunshine hours	Radiation MJ/m?/day	ETo mm/day
January	2.5	10.7	71	88	4.7	8.8	1.06
February	3.8	12.2	66	87	4.4	10.4	1.39
March	7.5	17.9	54	149	7.1	16.3	2.81
April	12.2	22.2	57	100	4.6	15.3	3.01
May	17.2	28.5	48	107	6.7	19.6	4.33
June	23.7	36.4	27	160	8.5	22.7	6.67
July	27.3	40.7	26	95	9.0	23.1	6.18
August	25.8	39.7	25	136	10.3	23.7	6.85
September	20.9	34.9	30	90	9.6	20.3	4.88
October	14.9	26.5	41	94	7.4	14.5	3.29
November	6.0	15.5	61	81	6.2	10.6	1.59
December	3.5	14.8	53	61	6.3	9.6	1.15
Average	**13.8**	**25.0**	**47**	**104**	**7.1**	**16.2**	**3.60**

3-Results and Discussion:

1. Tomatoes and eggplants marketable yields:

Fig. (1, 2) And Table (4) illustrates the effect of water levels of the total marketable yield of tomatoes and eggplants fruits that were harvested at a rate of three times in a week period during the indicated growing period. The results indicated that the (%100 of available water) treatment produced higher yield (76.88 t /ha) , (85.4 t /ha) than (%75 of available water) treatment was (57.25 t /ha), (65.5 t /ha) for tomatoes and eggplants, respectively. but these increase in yields were significant at $P < 0.05$ Table (4) At the mean time, it can be noticed from Table (4) that (%75 of available water) treatment brought about not significant increase in total marketable yield of tomatoes and eggplants compared to the (%50 of available water) treatment were (51.95 t /ha) , (50.7 t /ha) at $P< 0.05$.

Crop yields response to different amounts of water applied is given in Fig. (1,2). the highest yield (76.88 t /ha)) was achieved with a seasonal wafer application of 974.187 mm for tomatoes and (85.4 t /ha) for eggplants while at decrease in water application did not increase yield with less amount of applied water, fruit yield were reduced significantly; because fruits were smaller (Table 5). For instance, Blaine, et al. (2006) obtained 104.5 t/ha yields of tomatoes. While Ebrahim, et al. 2012 obtained 79.68 t/ha yields of eggplants. The highest yield (6.3 kg /plant) was obtained with a seasonal water application of 260 while any farther increase in water application did not increase yield (Chartzoulakis and Drosos, 1 995). With less amount of applied water, fruit yield was reduced significantly.

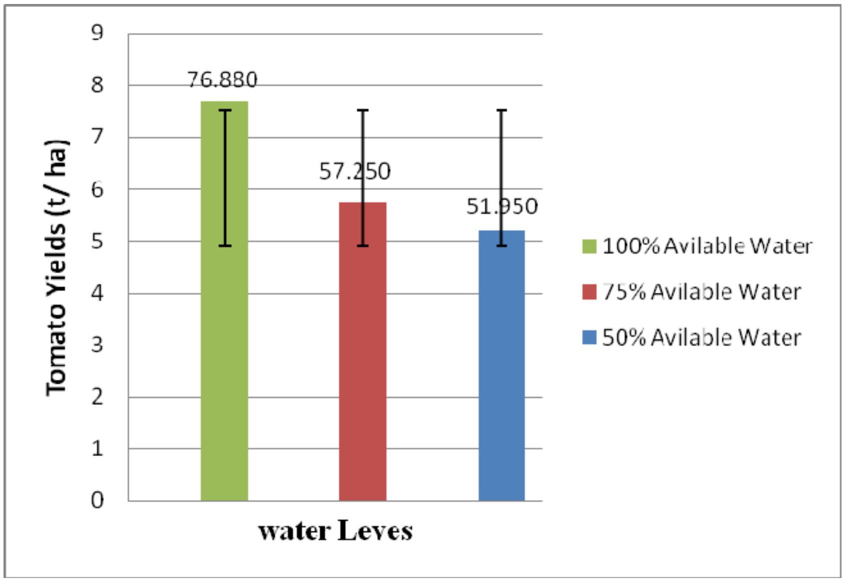

Fig. (1): Tomatoes yields as affected by water levels under greenhouse conditions.

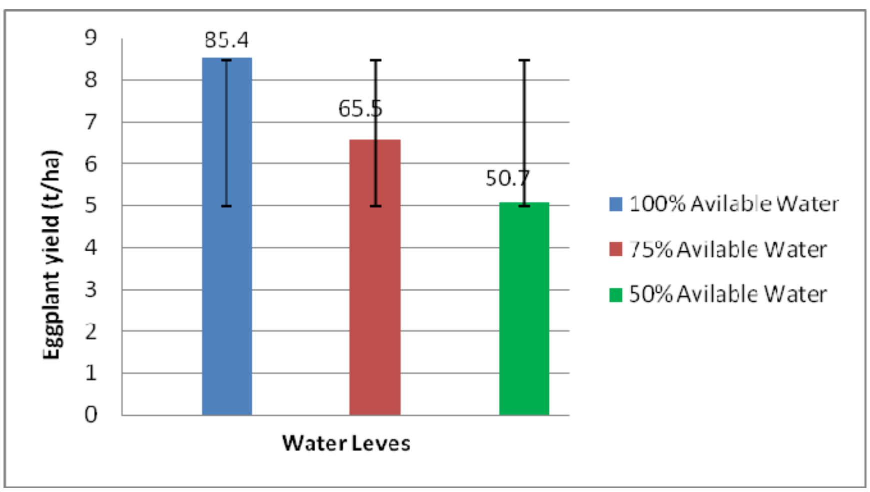

Fig. (2): Eggplants yields as affected by water availability level under unconditioned plastic house.

2-Plant height:

Table (4) illustrates the effect of water levels on the Plant height. The statistical analysis indicated significant difference between tomato lengths and between eggplants lengths. Generally Plants height were raised from (4.66 cm), (12.42 cm) at the (%50 of available water to a minimum of (3.95 cm), (11.05 cm) for (%75 of available water) treatment and to (4.25 cm), (12.15 cm) for tomato and eggplants, respectively, for the higher water application rate, the (%100 of available water) treatment at $P< 0.05$.

Table (4): Effect of water levels on mean Characteristics of tomatoes and eggplants in unheated greenhouse**.**

Characteristics of tomatoes and Eggplants	Level of available water					
	Tomatoes			Eggplants		
	%100 A.W	%75 A.W	%50 A.W	%100 A.W	%75 A.W	%50 A.W
Yield kg / m^2	7.688 a	5.725 b	5.195b	8.54	6.55	5.07
Stem length (cm)	4.25 a	3.95 b	4.66 c	12.420 a	12.043 a	11.053b
Stem diameter (cm)	49.71 a	44.88 b	42.97 b	41.930 a	42.993 b	41.010 a
Dry mass (gm)	341.0 a	338.3 a	389.7 a	321.00 a	224.03 b	200.83 b
Root depth vertical (cm)	36.33 a	34.33 a	49.99 a	81.333 a	87.666 b	91.333 c
Root depth horizontal (cm)	80.33 a	64.0 b	63.66 b	53.33 a	56.00 b	66.00 c

3. Tomato and Eggplants water requirement:

To assess the effectiveness of different treatments on crop water requirement for Tomato and Eggplants grown in unheated greenhouse at Bakrajow during the period from April, 25^{th} to August th 2011, the total crop requirement as affected by (%100 of available water) treatment at P< 0.05 was illustrated in Fig (1, 2). It is worthy to mention that each treatment has received 2.6L (mm) of water by conventional method after seeding for crop establishment. It can be noticed from Table. (5) For both crops that there is a significant reduction in crop water requirements under (%100 of available water) treatment whether they were (%75 of available water) treatment compared with the (%50 of available water) treatment. Also the results Furthermore, it can be observed that the trend of the influence of (%50 of available water) treatment on crop water requirement is not clear. For instance under the (%100 of available water) treatment, the (%50 of available water) treatment resulted in a higher crop water requirement as opposed to the other materials.

The results of Fig.(3,4) for tomatoes and eggplants Indicate that overall, the (%100 of available water) treatment had the highest of the crop water requirement during the growing season, while the (%75 of available water) and (%50 of available water) treatment had the second highest performance.

A method the wets the soil surface can have both soil evaporation and can also results in more weed development and loss of applied water through weed transpiration.

Table (5): Effect water levels on water requirement, water use efficiency and yield of tomatoes and eggplant.

Characteristics of tomatoes and eggplant	Treatments					
	tomatoes			eggplant		
	%100 A. w	%75 A .w	%50 A. w	%100 A. w	%75 A. w	%50 A. w
Water application (mm)	974	655	495	1418.1	899.43	629.85
Water application (m^3 / ha)	8937.5	6012.5	4550	11079.1	7310	5525
Tomatoes yields (t /ha)	76.88	57.25	51.95	85.40	65.50	50.70
water use efficiency (kg /m^3)	8.60	9.51	11.41	7.71	8.96	9.18
Crop coefficient (Kc)	1.38	0.92	0.68	2.02	1.27	0.88

Statistical analysis revealed that the crop water requirement for tomatoes and eggplants were not affected by (%100 of available water) treatment condition, but it were high significantly affected (P < 0.5) compared by (%75 of available water) treatment and (%50 of available water) treatment. On the other (Blaine 2006) has shown that the crop water requirement for tomatoes under all the treatments was high significantly different from the control treatment.

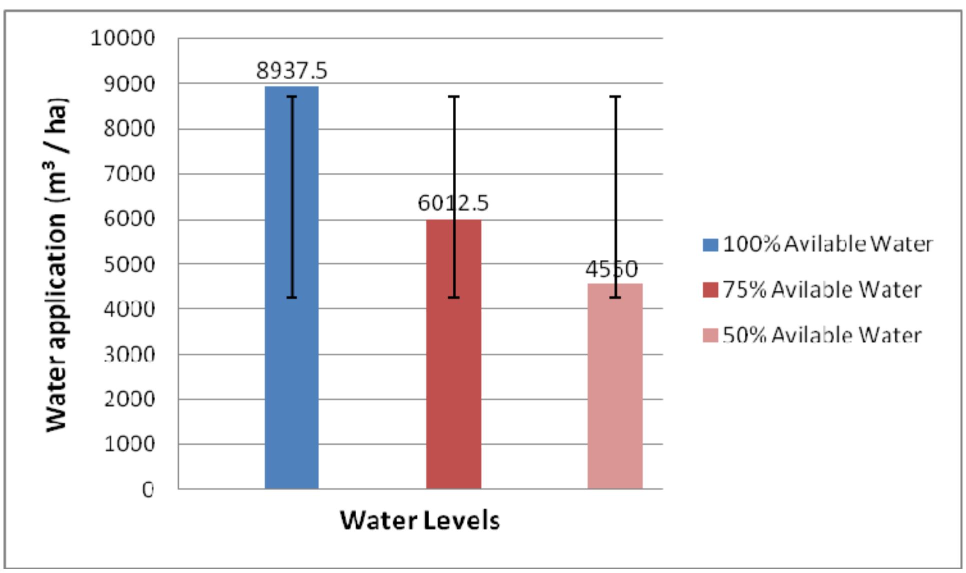

Fig. (3): Water application rate for tomato crop as affected by level of available water.

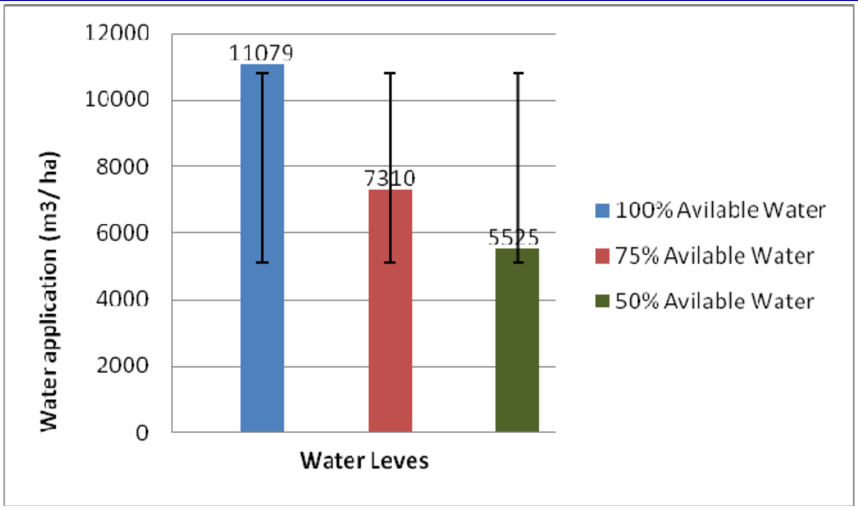

Fig. (4): Water application rate for eggplants as affected by level of available water.

4. Dry weight of tomato and eggplants:

The results of the average shoot and root dry weight presented in Table (4) for (%100, %75 and %50) were 341; 338.3, 389.7 gm(and (321; 224.03, 200.83 gm) for tomatoes and eggplants, respectively. The results indicated that the dry weight was decreased by decrease in available water. The dry weights for %100 available water was higher than %75 available water and %50 available water. The amount of water supply for %100 available water was the highest. Increasing the available water led to an increase in water use efficiency (amount of water used to produce 1 gm of dry weight). Increasing dry weights led to a decrease in yield (Saleh et al. (2007). The low soil moisture content resulted in reduced shoot and leaf dry weights (Singandhupe, R.B., Rao, 2007). The reductions in shoot or leaf dry weights under high moisture deficit may be due to lateral root elongation resulting in a decrease in shoot to root ratio (Kramer, P.J. 1959, Leskovar, D.I. 1998, Singandhupe, R.B., Rao, 2007). Decreasing root system due to water stress leads to a decrease in shoot dry weight because there is a close correlation between roots and shoot development (Saleh et al. 2007).

The 3 and 4 days irrigation frequencies saved 32.7% and 47.8 % of irrigation water compared to 2-day irrigation frequency, respectively however, using 4-days frequency is not recommended under hot weather conditions. This was consistent with the findings of Saleh et al. (2007), who found that the dry weight was decreased by an increase in irrigation interval. The shoots and roots dry weight for 1-day irrigation frequency was higher than 3 and 5 days frequencies. The root-shoot ratio for 1 and 5 days irrigation frequencies were similar but were look lower than that of 3-days frequency. Increasing irrigation intervals reduced the amount of water supply.

5-Tomato and eggplants water use efficiency:

In this study, water use efficiency was expressed in kg of fruits per m^3 irrigation water applied was calculated by the quotient of marketable yields (kg ha^{-1}) and the total seasonal irrigation water applied under each treatment (m^3 ha^{-1}). This could be a quite useful parameter to be used because the high water efficiency arises from higher yield and lower crop water requirement. It is evident from Fig.(3,4) for both crops tomatoes and eggplants that the (%50 of available water) treatment condition gave higher WUEs as opposed to (%100 of available water) treatment and (%75 of available water) treatment, but the difference were not significant. The percent of increase in WUE under (50% of available water) treatment was only 16.6% and 24.6% for tomatoes and 15.99% and 2.35% for eggplants as compared with the (%100 of available water) and (%75 of available water) treatment. Moreover, we to keep in mind the water availability in the root zone are not the only factor to maximize water use efficiency.

6. **Tomato and Eggplants crop coefficient:**

Total growing season was of 109 days tomatoes, 132 days for eggplants and the average crop coefficient varied from 0.68 to 1.38 for tomatoes and 0.88 to 2.03 for eggplants. The highest Kc = 1.38, 2.02 for tomatoes and eggplants, respectively, can be explained due to frequent irrigation events that occurred during the season. The highest (Kc) was obtained with the treatments (%100 of available water). The effect of the difference in aerodynamic properties between the grass reference surface and agricultural crops is not only crop specific but also varies with the climatic conditions (wind, humidity, etc) and crop height. More arid climates and conditions of greater wind speed will have higher values for (Kc) mid. More humid climates and conditions of lower wind speed will have lower values for (Kc) mid Čereković et al. (2010).

REFERENCES

Blaine, R. H., and *D.*M. May. (2006). New crop coefficients developed for high-yield processing tomatoes. California Agriculture, vol.60, No. 2.

Boyac, HF. (2007). Resistance resources and its inheritance against to fusarium wilt in eggplants, Cukurova University, Ph D Thesis, Natural and Applied Sciences. 108 p.

Chiaranda, Q. F.and G. Zebri (1984). Experimental results on irrigation requirements of protected crops in southern Italy. Proc. Int. Cod. On Crop Water Requirements, INRA, p. 397- 405.

Chartzoulakis, K. And N. Drosos, (1995). Water use and yield of greenhouse grown eggplant under drip irrigation. Agric. Water Manag. 8: 113-120.

Čereković, N. M. Todorovi, and R. L. Snyde, (2010). The relation between leaf area index and crop coefficient for tomato crop grown in southern Italy. University of Business Studies, (Number 1/June 2010/Volume 1.pp: 3-10).

Cevik B, Baytorun N, Tanriverdi C, Abak K, Sari N (1996). Farklı sulama suyu uygulamalarının serada yetiştirilen patlıcanın verim ve kalitesine etkileri. Ankara TÜBĐTAK, Turkish J. Agric. For., 2: 175-181 (in Turkish press).

Doorenbos, J. and Pruitt, W. O. (1977). Crop Water Requirements. Irrigation and drainage paper No.24, FAO, Rome.

Eliade, G., (1992). Irrigation of eggplants grown in heated greenhouses. J. Hort. Sci., 67(1): 143- 147.

Ertek A, Sensoy S, Yildiz M, Kabay T (2002). Determination of the irrigation interval and amount of application water in eggplant by using the free surface evaporation values in greenhouse conditions, KSU J. Sci. Eng., 5: 57-67.

Ebrahim, A., A. A. Gohari1 and Y. Esmailian. (2012). Effect of irrigation and nitrogen on yield, yield components and water use efficiency of eggplant African Journal of Biotechnology Vol. 11(13), pp. 3070-3079.

Frenz, F. W. and P. Lechl, (1981). The influence of different water suctions on yield and water requirements of tomatoes, cucumbers, radishes and lettuce in greenhouse. Acta .Hort. 119: 323- 331.

Gallardo, M., L. E. Jackson, K. Schulbach, R. L. Snyder, R. B. Thompson, L. J. Wyland (1996). Production and water use in lettuces under variable water supply, Irrig Sci. 16: 125–137.

Klute, A. (1986). Methods of Soil Analysis. 2nd Ed., Part 1, Soil Sci. Amer., Madison, Wisc., USA.

Kirda, C., B. Cevik, and K. Tulucu. (1988). A simple method to estimate the irrigation water requirement of greenhouse grown tomato. Acta Hort. (ISHS), 366: 371-380.

Kramer, P.J. (1959). Transpiration and water economy of plants (Ed. Steward, F.C. Plant Physiology) Vol. II. Academic Press, New York, USA.

Leskovar, D.I. (1998). Root and shoot modification by irrigation. Hort Tech., Vol. 8, No.4.

Najafi P, Tabatabaei SH (2010). Application of sand and geotextile envelope in subsurface drip irrigation, African Journal of Biotechnology Vol. 9(32), pp. 5147-5150

Najafi. P, SH. Tabatabaei, (2007). Effect of using subsurface drip irrigation and ET-HS model to increase WUE in irrigation of some crops. Irrig. Drain. J. 56: 477-486.

Saleh M. Ismail, K. Ozawa and Nur A. Khondaker, (2007). Effect irrigation frequency and timing on tomato yield, soil water dynamics and water use efficiency under drip irrigation. Soil & Water Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Stewart J.I, Cuenca RH, Pruitt WO, Hagan RM, Tosso J. (1977). Determination and utilization of water production functions for principal California crops. W-67 CA Contributing Project Report. University of California, Davis, USA.

Singandhupe, R.B., Rao, G.G.S.N., Patil, N.G. and Brahmanand, P.S. Fertigation, (2003). studies and irrigation scheduling in drip irrigation system in tomato crop (Lycopersicon esculentum L.). Europe J. Agro., Vol. 19, PP. 327-340.

Page, A.L. (1982). Methods of Soil Analysis. 2nd Ed., Part 1, Soil Sci. Soc. Amer., Madison, Wisc., USA.

Van OS EA (1994). Closed growing system for more efficient and environmental friendly production. Acta Hortic., 396: 25-32.

Yazgan S, Ayas S, Demirtas C, Buyukcangaz H, Candogan BN (2008). Deficit irrigation effects on lettuce (Lactuca sativa var. Olenka) yield in unheated greenhouse condition. J. Food Agr. & Environ. 6(2): 357- 361.

Yuan, B., Y. Kang,and S. Nishiyama. (2001). Drip irrigation scheduling for tomatoes in unheated greenhouses. Irrig. Sci. 20:149-154.

کاریگەری جیاوازی ڕێژەی ئاستی ئاودان لە سەر بەروبوومی تەماتە و باینجان لە خانوی پلاستیکی بیٚ سازکردنی هەواکەی

صلاح الدین عبدالقادر عزیز*، سەرکەوت طه احمد**، بەختیار عبدالقادر رشید**، هیوا بایز شریف**، دلسۆز حمه طالب**

* زانکۆی سلیمانی، فاکەلتی زانستە کشتوکالیەکان، بەشی خاك وئاو.

** بەریوەبەرایەتی تۆژینەوەی کشتوکالی سلیمانی.

پــوختــە

تۆژینەوەیەك بۆ مەزەندەکردنی پیوانەی ئاوی پیویست و فاکتەری بەرووبومی تەماتە لە جۆری (Ringo – F1) و بەرووبومی باینجان لە جۆری (F1- Roma) کە چینراون لە سەر خاکی (silty clay) لە ژێر کەشووهەوایەکی سازنەکراو لەناو دوو خانوی پلاستیکی جیاوازدا لە ناو یەکیك لە کیلگەکانی بەریوەبەرایەتی تۆژینەوەی کشتوکالی لە بەکرەجۆ لە پاریزگای سلیمانی لە سالی 2011. لە ئەنجامی تۆژینەوەکە دەرکەوت کەوا بەرهەمی بەرووبومی تەماتە و باینجان لە ژێر بەکارهینانی سیستمی ئاودیری بە دلۆپاندن وە بە هەلسەنگاندنی سی ئاستی ئاو کە بریتیە لە (100٪, 75٪,50٪) لە ئاوی ئامادەکراو بۆ رووەك لە ناو خاکدا, بەرزترین بەرهەم لە هەردوو بەرووبومی تەماتە و باینجان گەیشتنە (76.88 طن /هکتار) , (85.4 طن/هکتار) لە معامەلەی (100٪) لە ئاوی ئامادەکراو. وە تیبینی کرا تاکۆ ئاستی ئاوەکە کەم بیت بەرووبوومی تەماتە و باینجان کەمتر ئەبیت. وە تیبینی کرا دووبارە لە بابەت توانای بەکارهینانی ئاو لە لایەن هەردوو بە رووبومی تەماتەو باینجان گەورەترین توانای بەکارهینانی ئاو یان لە معامەلەی (50٪) برەکەی گەیشتە (11.4کغم /م^2)، (9.18کغم /م^2) وە لە ئەنجامی تۆژینەوەکە دەرکەوت کەوا تاکو ئاوی ئامادەکراو کەم بیت توانای بەکارهینانی ئاو لە لایەن رووەکەوە زۆرتر ئەبیت. وە دەربارەی فاکتەری بەرووبومی تەماتە(kc) لەکاتی سی ئاستی ئاوی ئاودان (100٪, 75٪, 50٪) بری (kc) ئەمانە بوو (1.38,0.92,0.68) یەك لە دوای یەك بۆ رووەکی تەماتە وە بری (kc) ئەمانە بوو (2.02,1.27,0.88) بۆ باینجان وە بەرزترین (1.38) , (2.02) بوو بۆ رووەکی تەماتە و باینجان یەك لە دوای یەك لە معامەلەی (100٪) .وە دەربارەی بری بەکارهینانی ئاو لە هەر سی ئاستی ئاودان دا (974, 655 لە گەل 495) ملم بوو بۆ رووەکی تەماتە وە (1418, 899.43 لە گەل 629.85) ملم بوو بۆ رووەکی باینجان وە لە راسپاردنی جوتیارەکان بۆ بەکارهینانی بری ئاوی پیویست متمانە دەکاتە سەر فاکتەری بەرووبومی تەماتە (kc).