Influence of Different Irrigation Levels on Varieties of Tomato (Lycopersicon esculentum Mill.)Under Plastic House Conditions. الطماطه من اصناف على الري من مخحلفة مس...

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تاثير مستويات مختلفة من الري على اصناف من الطماطه (*Lycopersicon esculentum* Mill.) تحت ظروف البيت البلاستيكي.

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Abstract:

Tomatoes are one of the more important horticultural crops in the world. The obtained results proved that the shortage irrigation has a negative effect on tomato development. More irrigation showed a decrease of morphological and production. The non-significant increase in irrigation of water will be increase of the efficiency and reduction. The study also, indicated that it is sensitive to tolerance for drought stress through greenhouse. At 80 % of water holding capacity led to save 36.30 % of the irrigation water and reduction in yield by 30.76% in variety Kexin12. However, at 60% of water holding capacity resulted in 51.18 % of irrigation water saving but 56.13% of the in yield were lost. Supplying 40% will be save about 62.54 % of irrigation in produce by 68.19 %. Therefore, the suggested results that supplying this variety Kexin 12 by 80% of WHC reduction in produce by 30.76% will be save 36.30 % of water.

Key words: Tomato, Varieties, Irrigation, *Lycopersicone sculentum* Mill.

الخلاصة :

الطماطه هي احد محاصيل الخضر الاكثر اهمية في العالم، لوحظ في السنوات السابقة فقدان كميات كبيرة من الحاصل بسبب الجفاف، في هذا الدراسة، شرعنا للتحقيق في الاثار السلبية للجفاف مع كفاءة استخدام مياه الري على اصناف من الطماطه للاربع معاملات من عجز المياه (الجفاف)، واظهرت النتائج الى انخفاض كبير في المعايير المظهرية والانتاجية للمحصول ، حيث اثرت المعاملة 80% توفير نسبة 36.30 % من مياه الري المستخدمة وفي نفس الوقت تقليل الحاصل الى 30.76 % في الصنف (Kexin 12) وعند استخدام المعاملة 60 % ادى الى توفير مياه الري المستخدمة 51.18 % انخفاض الحاصل الى 56.13 وفي المعاملة 40% ادى الى توفير 62.54 % من مياه الري مع انخفاظ الحاصل الى 68.19. وبذلك تفوقت معاملة 80% والصنف (Kexin 12) في توفير بكمية المياه المستخدمة للري مع الحصول على اعلى كمية من الحاصل.

1. Introduction

The tomato (*Lycopersicon esculentum* Mill.) is very sensitive to water shortage. Several studies have shown that root growth is most impedance to water stress than shoot growth and product [1]. The increasing of water request of growth plantlets in advanced stage of plant growth, because water and air are very important. Also the pant needs more oxygen to roots [2] [3] [4]. However, the establishing high values for plantlets by decrease the water with increase of fertilizer is the most method to solve the resources difficulties.

In the world, the best water necessity for tomato has been stay not obviously specified. In contrast, the climate models have indicated that of droughts become in the most frequently. For this, highlighting the urgent need to develop adaptive agricultural strategies for the changing environment.

However, these approaches ranging of the variations to the classical organization to use of indicator assisted range for the development. Many several research work revealed to the irrigation organization is important for cultivating the amount of tomato growth. The pan evaporation approach is used to estimate water ingesting [5] [6]. Generally, the oxygen level in the roots has immediate effects on root growth, nutrient uptake, and other metabolic activities [7]. As a result, the water it is one of the main factors of tomato to use effectiveness and growth during the life [8].

Tomato is one of the most important and has the highest acreage of any vegetable crop in the world [9]. Accordingly, the irrigation system and water is a significant reason for tomato construction in Mediterranean weathers, where the increasing period accords with a epoch of high evaporative request. The quantity of irrigation and its control through the plants life effect on fruition quality [10], [11]. More specially, the protect and value of marketable are reliant on upon native agronomic and ecological situations. \ Therefore, the wrong irrigation will cause and effect on the on the yield and quality of tomato also irrigation disorganizations. In this regard, the varied possessions of deficit irrigation on tomato, this work is used to estimate the properties of irrigation system on morphological, and the growth of tomato. On the other hand, to determine the critical deficit irrigation level for good growth of two varieties tomato under greenhouse conditions.

2. Materials and Methods

The work is proposed by greenhouse in AL-Musaib Technical College-Babylon- Iraq. The Chinese tomato varieties are taken. Two tomato varieties are used in this work, the first one is Kexin12 (early cultivar) and second is Jinghu9 (early cultivar), also the period from October to April 2015.

2.1. Plant Materials and Irrigation Treatments

The experimental date seeds of a their parents were planted in grow box before 30 to 45 days from planting, the plantlets of tomato were transplanted at three-true-leaves stage one plant per pot (20 cm diameter) containing a mixture of sand culture + peat moss (1:1 v/v) under plastic house conditions. The experiment was organized in a Completely Randomized Design (CRD), each treatment had nine plantlets, three replicates. Furthermore, a mixture of organic and inorganic fertilizers containing N, P, K ≥ 25%, organic ≥ 25%, water ≤ 20% and the active number of living bacteria about ≥ 0.2 hundred million/ gram is used in the work to ensure from the proposed work. The fertilizer is mixed with the growth medium at 10 kg/m3 before any transplanting. The dosage of 10g fertilizer/ pot is added three times at 25, 35 and 60 days after transplanting process. Moreover, four treatments of irrigation are used through the growth period as follow: The first one: C1, 100%, the second: C2, 80%, the third: C3, 60% and the fourth: C4, 40%. A full irrigation treatment (C1) is measured as control value. The other treatments are careful shortage irrigation. All the treatments are given to the pots on the same day of transplanting. The desired moisture contents of pots are daily monitored by TSC-V, moisture of water content and maintained through water application, if required (The percentage of water content in growing media by moisture meter water and calculate how much water should be added according to this reading and the treatment of irrigation we need to keep).

2.2. Morphological Characteristics

Three plants are randomly chosen by each treatment duplication to determine morphological for each plantlets as follow: the height in cm, the number of branches, the stem diameter in cm, the leaf area in cm^2 are measured by Area meter based on AM 300. Bio Scientific. Ltd. UK, five leaves from different parts of the plant were selected, fresh and dry weight to the shoot (g) with samples was dried at 70 ^{C} until stop the weight and then weighted by the same balance. Additionally, the root is sensibly taken from the pot to get the whole roots amount. After several time of washes, the length of the root, fresh and dry mass and shoots ratio are calculated. The weight of the dry root dry in gram is gotten after the samples are dried at 65 0 ^{C} until a constant weight.

2.3. Data of Fruit Harvesting

The Fruits are harvested during three periods in the season. The first dated happening 48 days after transplanting. The other periods started after 20 days and 35 days respectively. The following characteristics are calculated; number of fruits for the plant, the weight in gram, the yield for each harvest time. The number of fruits are measured from three randomly chooses plant. Ten fruits are randomly selected to determine the average of the weight. The yield is planned from the number of fruits/ plant multiplied by the weights. Finally, Total yield is a assembly of yield for the plant in all three harvesting time. The yield Reduction is determined by:

$$y = \left[\frac{y_c - y_t}{y_c}\right] * 100$$

Where: y is yield reduction; yc is the yield of control; y_t is the yield of treatment.

2.3.1. Irrigation Water and Use Efficiency

The efficiency is calculated based on reference [12]:

$$I = \left[\frac{Total\ \ fresh\, yeild}{Irrigation\, water\ in\ different\ treatment}\right]$$

Where I is the Irrigation water use efficiency in (g/I)

2.3.2. Water Saving

The water saving is determined from the water saving equation as follow:

$$\textbf{Water saving\%} = \left[\frac{\text{(water consumption of control} - \text{water consumption of treatment)}}{\text{water consumption of control}}\right] * \textbf{100}$$

$$W_s = \left[\frac{W_c - W_t}{W_c}\right] * 100$$

Where; W_s is the water saving, W_c is the water consumption of control, and W_t is the water consumption of tenement

2.4.Statistical Analysis

The tested data and information are taken and analyzed by statistical program SA (Statistical Analysis System) based on reference [13]. The Data are stated as mean ±SEM. After an analysis of variance (ANOVA). The important changed between the means values are explained by Duncan’s Test also the Significance in the differences is based on $p < 0.05$.

3. Results and Discussion

3.1.Morphological Characteristics of Tomato

The table 3.1 demonstrates that morphological of tomato plantlets were affected by drought. Maximum averages of the stem diameter, branches number and leaf area have been obtained at (Kexin 12) were recorded 8.33, 7.15 and 5932.3, respectively. It was obvious that average water holding capacity of gave the lowest of average of all morphological characteristics with deficit irrigation decreased. The Interaction (Varieties and WHC %) has a significant effect of the plant height highest reduction to plant height was 61.22 cm followed by 75.23 cm and 81.77cm for C4, C3 and C2, respectively, as compared with the control with variety (Kexin 12). In addition, the highest reduction recorded in the plant height for variety Jinghu9 was 69.67cm at C4. Stem diameter exhibited an alike tendency to plant height as illustrated in Table 3.1 Increasing deficit irrigation caused a significant reduction in stem diameter. This reduction reached7.9, 7.1cm and 8.8cm for C4, C3 and C2, respectively, with variety (Kexin12). Furthermore, variety (Jinghu9) 7.3 at C4, as compared with the control. However, deficit irrigation had a negative effect on number of branches. C4 and C3 resulted in the maximum reduction (4.90 and 6.80, respectively) in number of branches, as compared with the control of variety (Kexin12) .Furthermore, variety (Jinghu9) which recorded the lowest branches number 5.10 under higher level of drought stress. Deficit irrigation showed a significant reduction in leaf area. The reduction in leaf area was increased as a result of increasing the deficit irrigation reaching the maximum reduction (4200 followed by 4876cm^2 relative to the control) in C4, respectively of varieties (Jinghu9 and Kexin12). The reduction magnitude was positively correlated with the decrease in water supply on the Shoot fresh weight (g) gave the lowest rate 199.32g, and in the shoot dry weight (g) recorded the lowest rate 93.99g. This decrease could be attributed to a reduction in shoot cell expansion and possibly by lesser volume of cell in plant as the effect of drought on sunlight absorption and photosynthesis of the plant due to reducing leaf area which leads to the reduction in the dry matter they are also similar to production data reported by [14], [15], [16].

Table 3.1: Influence of variety and irrigation on morphological traits of tomato.

Varieties	WHC%	Plant height (cm)	Stem diameter (cm)	Branches number	Leaf area (cm^2)	Shoot fresh weight (g)	Shoot dry weight (g)
Kexin12	C1(0)	88.76 a	9.4 a	8.78 a	6723.32 a	333.14 a	129.12 a
	C2	81.77 ab	8.80 a	8.10 a	6231 b	313.22 b	126.33 b
	C3	75.23 b	7.11 c	6.80 b	5899 b	280.43 c	111.30 c
	C4	61.22 c	7.92 b	4.90 d	4876 c	199.32 d	93.99 d
Jinghu9	C1(0)	85.54 a	8.98 a	8.44 a	7231 a	345.23 a	131.34 a
	C2	79.90 b	8.21 a	8.25 a	6490 b	309.15 b	128.17 a
	C3	73.87 b	8.74 a	6.18 b	4889 c	288.22 c	112.23 c
	C4	69.67 c	7.32 b	5.10 c	4200 d	202.44 d	97.54 d
Average of Varieties							
Kexin12		76.7 b	8.33 a	7.15 a	5932.3 a	281.59 a	115.17 b
Jinghu9		77.2 a	8.29 a	6.98 a	5702.5 b	286.28 a	117.32 a
Average of WHC %							
C1(0)		87.1 a	9.11 a	8.61 a	6977.12 a	339.10 a	130.23 a
C2		80.8 ab	8.51 a	8.16 a	6360.51 b	311.1 7 a	127.25 b
C3		74.5 b	7.96 b	6.44 b	5394.00 c	284.34 b	111.72 c
C4		65.4 c	7.64 b	5.00 c	4538.00 d	200.87 c	95.79 d

WHC, water holding capacity.

3.2.Fruit Characteristics at Harvesting

The table 3.2 Maximum averages of most of the morphological characteristics have been obtained at periods of harvesting to both the varieties, variety Jinghu9 recorded the highest average 124.95 g of fruit weight and early period, also variety Kexin12 recorded the highest 7.91 with average of fruit number and middle period. Additionally, varieties recorded less average of WHC % with water stress and periods of harvesting to most morphological characteristics. The interaction (varieties * WHC% * periods of harvesting) had a drastic effect on the number of fruit with variety Kexin12 and C4 which recorded the lowest 4.32 and 5.97, respectively. Additionally, with variety Jinghu9 recorded the lowest during the Middle period and late period of harvesting which are 4.87 and 4.99 respectively. Weight exhibited similar trends to number of fruit as in table 3.2. Lessening water source caused a important reduction in weight of fruit throughout periods of harvesting. The maximum weight and diameter were found at C1 all periods by C2, C3 and C4 in a descendent order of varieties (Kexin12 and Jinghu9). These findings indicated that there were significant differences between fruits yields and per plant grown under water stress an increase in stored carbohydrates in plant, this approves with the results of the study by [17], [18], [19].

Table 3.2: Influence of variety and deficit irrigation on fruit of tomato during periods of harvesting.

Varieties	WHC%	Periods of harvesting					
		Early period		Middle period		Late period	
		Average of fruit number	Average of fruit weight(g)	Average of fruit number	Average of fruit weight(g)	Average of fruit number	Average of fruit weight(g)
Kexin12	C1(0)	9.88 a	130.78 a	9.22 a	128.89 a	8.21 a	127.99 a
	C2	8.23 a	129.98 a	8.90 a	128.21 a	7.11 b	125.12 a
	C3	6.76 b	122.12 b	7.22 b	124.97 b	6.88 b	120.59 b
	C4	4.32 d	99.14 d	6.54 c	112.76 d	5.97 c	117.89 c
Jinghu9	C1(0)	8.98 a	129.99 a	8.20 a	128.86 a	7.89 ab	129.13 a
	C2	7.98 b	128.68 a	8.02 a	126.33 ab	6.98 b	124..19 a
	C3	5.43 c	121.87 b	6.90 c	124.99 b	6.22 b	121.43 b
	C4	5.32 c	119.11 c	4.87 d	118.98 c	4.99 d	118.87 c
Average of Varieties							
Kexin12		7.27 a	91.28 b	7.91 a	123.76 a	7.02 a	122.81 a
Jinghu9		6.91 a	124.95 a	6.94 b	124.79 a	6.51 a	123.45 a
Average of WHC %							
C1(0)		9.43 a	130.35 a	8.71 a	128.83 a	8.08 a	128.57 a
C2		8.10 a	129.39 b	8.49 a	127.25 a	7.06 b.	124.60 b
C3		6.05 b	121.95 c	7.01 b	124.96 b	6.50 c	121.04 b
C4		4.88 d	109.12 d	5.7 c	115.84 c	5.46 d	118.31 c

WHC, water holding capacity.

3.3.Fresh of Fruit and production

The table 3.3 average of varieties, Jinghu 9 with early period of harvesting recorded highest average 279.81 (g)/plant of fresh fruit yield. In addition, in the highest fresh fruit number value was 288 (g)/plant, which recorded in average of WHC % with control and early period of harvesting. On the other hand, the Total fruit yield (g) average of varieties, variety Kexin12 recorded the highest average 824.33 and average of WHC % for total fruit recorded the highest at C1 control 847.66 (g). The fresh of fruit production per plant, through stages of harvesting and total production were strongly affected by irrigation. Through the early period of harvesting the maximum fresh of fruit production decline was 268.88 and 268.71 of varieties (Kexin12and Jinghu9), respectively. While, the highest decrease in fresh of fruit production at late period of harvesting 257.89 of variety Jinghu9, the maximum increase was 24.17 and 23.86, respectively, relative to the control. Similar results were obtained by [20],[21].

Table 3.3: Influence of variety and irrigation on fruit production of tomato.

Varieties	WHC%	Fresh fruit production (g)/plant			Total fruit production (g)
		Early period	Middle period	Late period	
Kexin12	C1(0)	287.69 a	282.45 a	278.89 a	849.03 a
	C2	280.87 a	278.78 a	276.49 b	836.14 a
	C3	272.76 b	270.34 b	267.76 b	810.86 b
	C4	268.88 c	267.21 b	265.43 c	801.52 c
Jinghu9	C1(0)	288.32 a	284.54 a	273.43 b	846.29 a
	C2	285.76 a	280.55 a	270.88 b	837.19 a
	C3	276.76 b	263.73 c	261.88 c	802.37 c

	C4	268.71 c	260.32 c	257.89 d	786.92 c
Average of Varieties					
Kexin12		277.55 b	274.61 a	272.14 a	824.33 a
Jinghu9		279.81 a	272.28 a	266.02 b	818.19 b
Average of WHC %					
C1(0)		288.00 a	283.49 a	276.16 a	847.66 a
C2		283.31 a	279.66 b	273.68 a	836.64 ab
C3		274.76 b	267.04 c	264.82 b	806.61 b
C4		268.79 b	263.76 c	261.65 b	794.22 c

WHC, water holding capacity.

3.4.Saving Irrigation Water

In table 3.4. The same time, average of varieties, variety Kexin12 and Jinghu9 of total water applied (l/ plant) and irrigation water use efficiency recorded highest value 23.27 and 21.83, respectively. Whereas, variety Kexin12 recorded the highest percentage 37.76 and 39.02 % of the saving water and reduction in yield, respectively, while average of WHC % recorded total water applied 34.97 (l/ plant) with C1 control, while C4 %, recorded less rate of reduction in yield 68.24% with saving water 60.41. The Irrigating tomato at 80% of (WHC) the whole growing season total production by 30.76 % and saved 36.30 % of the water. The irrigation at 60 % and 40% of the water holding capacity abridged the production by 56.13 % and 68.19 %, respectively. the saved about 51.18 % and 62.54 % of irrigation water,

Table 3.4: Influence of variety and irrigation on reduction in production saving water.

Varieties	WHC%	Total Irrigation use (l/ plant)	Irrigation use efficiency (g/l)	Saving water (%)	Reduction in yield (%)
Kexin12	C1(0)	34.82 a	20.61 a	1.00 d	1.00 d
	C2	28.20 b	19.22 b	36.30 c	30.76 c
	C3	18.38 c	21.13 a	51.18 b	56.13 b
	C4	11.68 d	24.17 a	62.54 a	68.19 a
Jinghu9	C1(0)	31.13 a	22.49 a	1.00 d	1.00 d
	C2	26.43 b	18.20 b	32.98 c	34.13 c
	C3	13.14 c	22.78 a	45.87 b	52.74 b
	C4	10.98 d	23.86 a	58.28 a	68.30 a
Average of Varieties					
Kexin12		23.27 a	21.28 a	37.76 a	39.02 a
Jinghu9		20.42 b	21.83 a	34.53 b	39.04 a
Average of WHC %					
C1(0)		34.97 a	21.55 a	1.00 d	1.00 d
C2		27.31 b	18.71 b	34.64 c	32.44 c
C3		15.76 c	21.95 a	48.52 b	54.43 b
C4		11.33 d	24.01 a	60.41 a	68.24 a

WHC, water holding capacity..

respectively, of variety Kexin12. Furthermore, the lowest percentage of variety Jinghu9 of (WHC) throughout the whole growth period low the total production by 34.13% the saved about 32.98% irrigating of tomato at 80%. At the same time, the irrigating tomato at 60 % and 40% of the water holding capacity reduction the total yield by 52.74% and 68.30% the saved 45.87% and 58.28% of water this is in arrangement with [22], [23].

3.5.Root Prescriptions, Fresh and Dry Weight of Tomato.

The table 3.5. That morphological characteristic of tomato plantlets were affected by deficit irrigation. Maximum averages of most of the morphological characteristics have been obtained at Jinghu9. While, it was obvious that average water holding capacity of gave the lowest of average of all morphological characteristics with deficit irrigation decreased. Furthermore, in the average of varieties recorded and Kexin12 the lowest value of root length and root dry weight 39.15 cm and 16.47g, respectively,), but in the root fresh weight and Kexin12 give the highest average 48.55g. Additionally, the result showed in average of WHC %, recorded in the highest value withe control. The maximum decrease in length of root about 36.13cm, the maximum lessening in fresh and dry weight to 39.88g and 12.66, respectively, relative to the control in the variety Kexin12. Moreover, the highest reduction in root length (cm), fresh and dry weight was 38.23 cm, 37.18g and 15.15g, respectively in C4 treatment of variety Jinghu9. Similarly, in the root / shoot ratio by water stress treatments during growth Table 3.6 the observation data indicated that the highest ratio 0.371 in variety Kexin12. However, in variety Jinghu9 which recorded highest ratio 0.387 in C4 treatment. Similar comments were also noticed by [24], [25].

Table 3.5: Influence of irrigation on root traits and root to shoot ratio of tomato.

Varieties	WHC%	Length of Root (cm)	Fresh weight of Root (g)	Dry weight of Root (g)	Root /Shoot
Kexin12	C1(0)	41.12 a	59.23 a	19.77 a	0.288 b
	C2	38.60 b	48.99 b	18.78 a	0.291 b
	C3	40.56 a	46.22 b	14.54 c	0.298 b
	C4	36.13 b	39.88 c	12.66 d	0.371 a
Jinghu9	C1(0)	43.22 a	48.76 b	20.12 a	0.267 c
	C2	39.71 b	43.61 b	18.83 a	0.279 b
	C3	45.19 a	43.22 b	16.75 b	0.298 b
	C4	38.23 b	37.18 c	15.15 c	0.387 a
Average of Varieties					
Kexin12		39.15 a	48.55 a	16.47 a	0.312 a
Jinghu9		41.51 b	43.10 b	17.71 a	0.307 a
Average of WHC %					
C1(0)		42.11 a	53.99 a	19.92 a	0.227 c
C2		39.00 b	46.37 a	18.80 a	0.285 b
C3		42.86 a	44.79 a	15.65 c	0.298 b
C4		37.19 b	38.51 b	13.99 d	0.379 a

WHC, water holding capacity.

4. Conclusion

The increasing in the deficit irrigation will decrease the growth and fruit factors, and decreasing the yield and overall production. Non-significant increasing in the water irrigation due to decreasing and will effect on the efficiency and reduction in the amount of water. The obtained results of irrigation level represent good and practical technique to save the water. The Kexin12 variety is better choosing for increasing the morphological features under water stress situation.

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