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Effect of some climatic factors and irrigation regimes on tomato growth and chemical constituents

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Abstract

This work was performed in 2012 and 2013 seasons at El- Bostan Protected Cultivation Experimental Site, Agricultural Research Center. The aim of the study was to investigate the growth of tomato plants under various shading densities and water regimes. Tomato variety (V.T.916) F1 hybrid was used. Tomato seeds were sown on 1st of March during both seasons of 2012 and 2013, in multi-pot transplant. Treatments used were four different levels of shade net (73%,60% and 40%) in addition to the control(without shading). Three water regimes which were tested as follow: 120%, 100% and 80% from class A pan. Results indicated that the application of 73% shading was the most effective in reducing average air temperature and radiation, followed by 60%, and finally 40%. On the other hand, the highest values of air temperature and radiation were observed in the control treatment throughout the two growing seasons. In addition, 73% of shade density reflected the highest values of all growth aspects such as plant height, stem diameter, number of leaves and stems, fresh and dry weight of leaves and except stem diameter compared to the unshaded treatment. As for the effect of irrigation regime on vegetative growth parameters, using the highest level of irrigation water (120% of water requirement) reflected the highest values in all determined growth parameters. With regard to the effect of the interaction between shading densities and irrigation regimes on the vegetative growth traits of tomato plants grown under sandy soil conditions. Shaded plants at 73% shade density and irrigated with the highest level of irrigation water (120% of water requirement) exhibited the highest vegetative growth measurements except stem diameter. Moreover, shaded plants with the highest used level of shade (73%) exhibited the highest content of total nitrogen, phosphorus, potassium and carbohydrates content compared with the medium (60%) and low level of shading 40%. In addition, the highest levels of irrigation water (120% of water requirement) reflected the highest values of such elements. In this connection, the highest shading density (73%) combined with the highest level of irrigation water (120% of water requirement) led to the highest concentration of all assayed mineral macronutrients (N, P and K) or organic constituents (carbohydrates) in tomato leaves

Key words: Tomato, Shading, Water regimes, Climatic conditions, GROWTH , CHEMICAL CONSTITUENTS

Introduction

Tomato *(Lycopersicon esculentum Mill.)* is the most popular and widely grown vegetables in Egypt .Major producers of tomatoes include the United States, Turkey, Egypt, India and Italy where by Egypt produces 8625219 ton (FAO statistics 2012), Tomatoes are popular for their culinary properties and their health benefits. . Tomatoes and tomato-based products account for more than 85% of the dietary lycopene. Consumers demand tomatoes for many of their original characteristics. This means maintaining the color, nutritional content and level of antioxidant compounds present in the fresh fruit. These include vitamins A, C, E and carotenoids such as beta-carotene and lycopene. Irrigation is considered as one of the main agricultural practices that judge the vegetative growth of tomato plants grown either under open field or protected cultivation conditions .In this respect many investigations were carried out to study the effect of irrigation regime on vegetative growth of tomato plants. In this connection, **El-Beltagy *et al.* (1984), Giradini *et al.* (1988), Fattahallah (1992), Merghaney(1997), Byari and Al Sayed(1999), Navarrete and Jeannequin(2000)**,all reported negative effect of water stress on tomato growth and chemical constituents of plant foliage Irrigation water is a limited agricultural resource so this study has been related to rational use water in the intensive tomato growing technology, hence the principal resource of water in Egypt is the River Nile which provide us yearly with about 55 Billion cubic meters and the second source is under ground water. Irrigation water requirements can be defined as the quantity, or depth, of irrigation water in addition to precipitation required to produce the desired crop yield and quality and to maintain an accept able salt balance in the root zone. This quantity of water must be determined for such uses as irrigation scheduling for a specific field and seasonal water needs for planning (National Engineering Handbook, 1993).

Shading has been used to limit the amount of solar radiation entering greenhouses. Shade can be used over the top of the greenhouse (outside) or suspended inside the greenhouse above the crop. Using shade screen improved greenhouse climate vapor pressure deficit and air temperature. This improvement implied a 36 per cent reduction of the total integral of the incident global radiation during the cropping cycle. Moreover, using shade screen during growing season contributes to increase water and radiation use efficiencies and to improve the quality of fruits **(Lorenzo *et al*., 2003).** In this regard, **El-Gizawy *et al*. (1992) , El-Abd *et al*.(1994), Adam *et al*. (2002), Abd al Mateen *et al*.(2007), Bushra *et al*.(2012), Shehata *et al*.(2013)** studded the effect of shading density at different rates on vegetation growth of tomato plant expressed as plant height, stem diameter, number of leaves and stems, fresh and dry weight of leaves and chemical constituents of plant foliage. They found that such studded growth parameters were positively affected by shading at different level. However highest level of density in some cases reflected and reduced the effect on such parameter of growth in addition shading tomato plants in hence the absorption of micro nutrient (N,P,K and the assimilation of carbohydrates content) **Gomaa(1966), El-Kassas(1985), Moustafa(1991) , El-Gizawy *et al*. (1992) , De Groot *et al*. (2002), Liuxian *et al*. (2003) Gent (2005), El-sayed (2009)**.Therefore less investigation was performed to study the effect of shading at different density and irrigation regimes as well as their interaction on growth and chemical constituents of tomato plants grown during summer season and sandy soil condition.

Materials and methods

1. Experimental layout:

Two field experiments were performed during the two successive summer seasons of 2012and 2013 at El- Bostan Protected Cultivation Experimental Station, Agricultural Research Center, Ministry of Agriculture and land reclamation. Location of the experimental site as follows: latitude 30^o 41\ 24.9\\ N, longitude 30^o 18\ 06.3\\ E and 29 m above sea level. Soil in the experimental site is sandy soil in texture with pH of 7.89 and Ec of 1.34 ds/m.Physical and chemical analysis of soil and water are shown in Table 1.

Table 1. Average of Physical and chemical analysis of soil and water during the two seasons of study

	pH	EC ds/m	Anions (Meq/L)				Cations (Meq/L)			
			Cl^-	HCO_3^-	CO_3^{--}	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
Soil	7.89	1.34	2.5	2.6	-	43.3	12.2	1.2	25.0	10.0
Water	6.5	0.5	1.6	2.7	-	0.7	1.6	0.2	3.0	0.2

The current study was conducted in four single type net houses each of them135 m^2 (9m width, 15m length and 3.2m height) to investigate the growth and chemical composition of tomato plants grown under different levels of shading and water regimes.

1.1. Nursery materials:

Seeds of tomato *(Lycoperscon esculentum Mill.)* F1 hybrid (V.T.916) were sown on 1st of March during both seasons of 2012 and 2013, in multi-pot transplant trays filled with mixture of peat-moss and vermiculite media (1:1 v/v). After sowing, trays were covered by black plastic mulching for four days, then moved to high tables and were cared by irrigation, fertilization and pest management in the nursery according to the recommendation of the Ministry of Agriculture.

1.2. Transplanting:

After 45 days from seed sowing, transplants were set up into the net houses (on April 15th during both seasons (2012 and 2013) on the two sides of ridges 1 m in width and 15 m in length. The distance between transplants was 50 cm within the row.

1.3. The experimental treatments:

1.3.1 Shading treatments:

Three different levels of shade net was tested and compared with non-shaded house . All shading plastic net were fixed before transplanting. Used tested black shading net levels were 73%, 60% and 40% and compared with 0% as control.

1.3.2 Water regime treatments

Three water regimes were tested as follows: 120%, 100% , 80% from class A pan .

1.3.2.1 Calculation of water regimes:

Data of class A pan (Epan)for El- Bostan experimental site expressed in mm/day were obtained from agro meteorological station located in the site.

- The first step was calculation of potential evapotranspiration which was made according to the following formula (FAO, 1977):

$Et_o = K_p$ X E Pan (mm / day)

Where:

Et_o = Potential evapotranspiration in mm / day.

K_p (Pan coefficient) = three stage (0.5, 0.75and1)

E Pan = Pan evaporation in mm/day.

- The second step was to obtain values of crop water consumptive use (Etcrop) as follows (FAO, 1977).

$Et_{crop} = Et_o$ x Kc mm / day

Where:

Et_o = the rate of evapotranspiration in mm/day from an excessive surface of green cover of uniform height (8 to 15 cm), actively growing, completely shading the ground and did not face shortage in water.

Kc = Crop coefficient "between"(0.3 to 1).

The third step is to calculate water requirements (WR) for each treatment as following:

WR = Et crop x L% mm / day

Where:

L % = Leaching requirement percentage in this saline as follows.

L % = (Eciw / Ecdw) x 100

Where:

Eciw = Electrical conductivity of irrigation water dS/cm-1.

Ecdw = Electrical conductivity of drainage water mMho. Cm-1

L % was estimated to be 1.25.

The fourth step was to calculate irrigation requirement (IR)

As:

IR = WR x R

Where:

WR= water requirement

R = Reduction factor for drip irrigation only covers apart of land and leaves the rest dry. Therefore, it was recommend by **FAO (1977)** to use R-value, which its estimated range is between 0.25 and 0.9 for drip irrigation system. Finally, calculation of open field water duty (WD) was as follows:

WD = IR x (area / 100)

1.3.2.2. Amount of used water:

Total amount of the added water through the drip irrigation system was measured by giger for each water regimes treatment.

Table 2. The amount of applied water in each treatment (m^3/feddan) for the two seasons (2012 and 2013).

Period			
	80%	100%	120%
15-30 April	17.24	21.55	25.86
1-15 May	59.13	73.92	88.70
16-31 May	88.70	110.88	133.05
1-15 June	165.11	206.39	247.67
16-30 June	220.15	275.18	330.22
1-15 July	260.48	325.60	390.72
16-31 July	325.60	407.00	488.40
1-15 August	282.45	353.06	423.68
16-31 August	251.07	313.83	376.60
total	1669.93	2087.41	2504.89

1.4. Climatic conditions:

The micro climate is a major factor in this study, thus the following data were recorded

1.4.1. Air temperature and relative humidity:

Average air temperatures and relative humidity of in each of the tested net-house were recorded by using digital thermo/hygrometer Art. No. 30.5000/30.5002 (Produced by TFA, Germany) placed at the middle of each plastic house the meteorological data of minimum and maximum air temperatures and relative.

1.4.2. Light intensity:

Average radiations in and out plastic house were measured by using Lux meter INS Dx-200, serial No. 949275

1.5. Vegetative growth:

Five plants were labelled from each experimental plot and the following data were recorded.

1.5.1. Plant height, number of leaves per plant and stem diameter (10cm from the soil surface) were recorded at two times after 30and 60 days from transplanting.

1.5.2. Leaf area: The leaf area of the fifth leaf from the top was recorded two times after 30 and 60 days after transplanting by using a digital leaf area meter (LI-300 Portable Area Meter Produced by LI. COR, Lincoln, Nebraska, U.S.A).

1.5.3. Arepresentative sample of three plants from each experimental unit were taken during the growth period, 180 days from transplanting to measure fresh and dry weight

1.6. Chemical properties:

Dry samples of plant foliage were ground and then 0.2 g.of each was digested in sulphuric and percloric acid at ratio 2:1 by volume and then used for determining the chemical constituents.

Nitrogen: It was determined in leaves by the distillation in a Macro-Kjeldahle apparatus **ADAS/MAFF (1987).**

Phosphorus: It was colorimetrically determined in leaves in the acid digest using ascorbic acid and ammonium molybdate as described by **Watanabe and Olsen (1965)**.

Potassium: was determind flame-photometrically as described by **ADAS/MAFF (1987).**

1.7 Experimental design:

The studied treatments were arranged using the split plot design, where, shading treatments were arranged in the main plots and water regimes treatments were arranged in the sub plots. All treatments were applied with three replicates. Randomize has been considered in the application of the studied treatment.

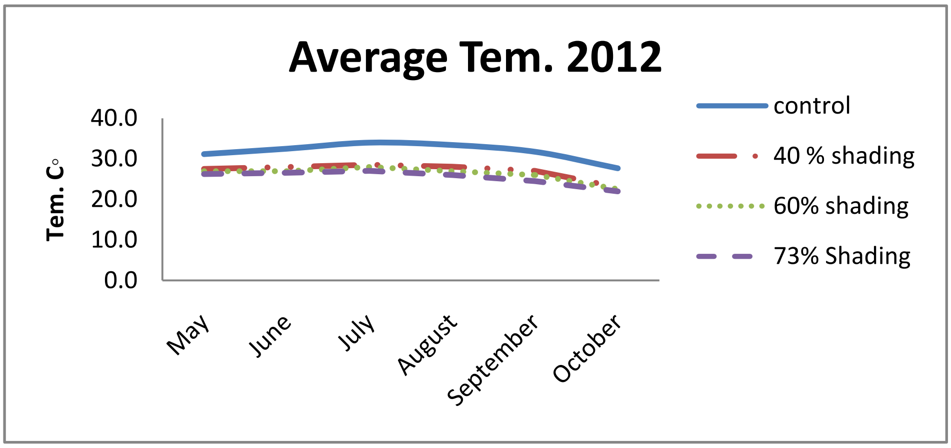
1.8. Statistical analysis procedures:

The obtained data were statistically analyzed using the analysis of variance method according to **Snedecor and Cocharn (1980)**. Duncan's multiple range test at the 5% level of probability was used to compare means of treatments.

Results and Discussion

1. Climatic data:

The greatest values of average air temperatures, relative humidity and sun radiation, , were detected in the control treatment followed by 40% and 60%shading treatment as shown in (Figs. 1, 2and 3). However, the lowest average air temperatures, relative humidity and sun radiation were found at 73% shading. In other words, the 73% shading treatment reduced the temperature and radiation values compared to the other treatments. Results were in agreement with those reported by **Hasni *et al*. (2006), Coelho *et al.* (2006), Bartzanas and Kittas (2006) Teitel *et al*. (2008)), El-Sayed (2009) , Ali (2010)and El-Sawy(2011)**



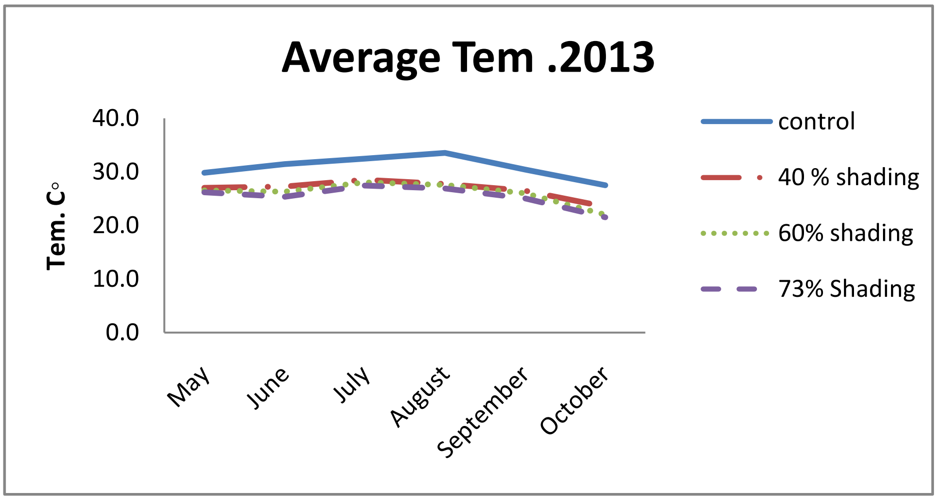


Figure (1): Effect of Shading on average air temperature at El- Bostan Protected Cultivation site during 2012 and 2013 seasons.

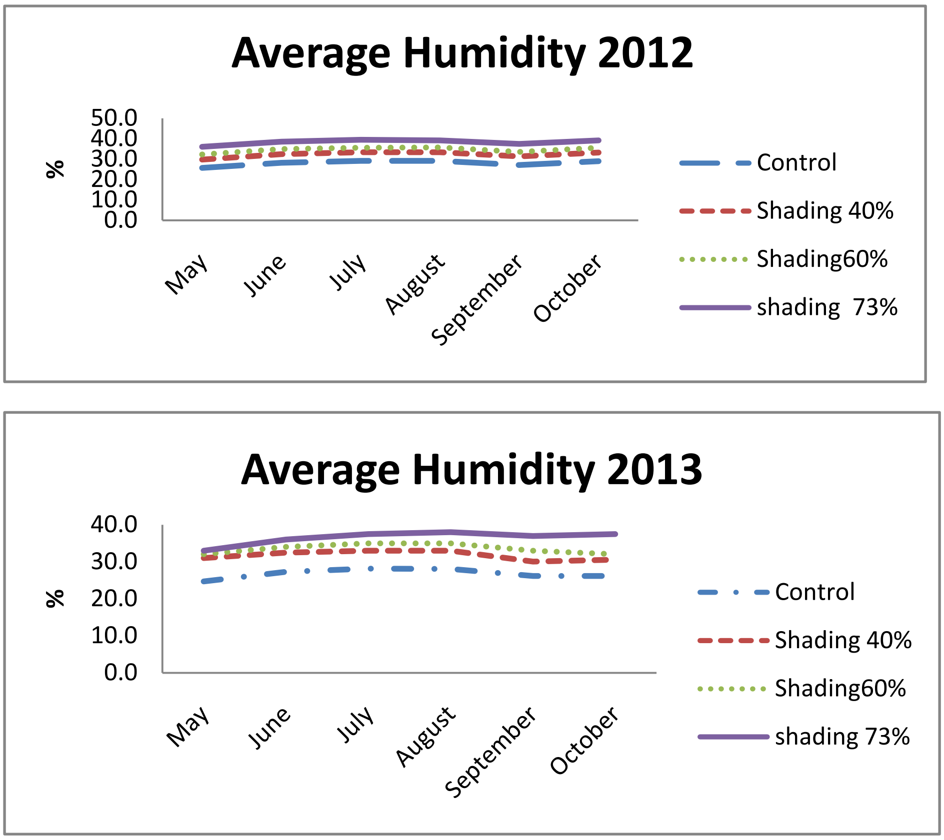


Figure (2): Effect of Shading on average relative humidity at El- Bostan Protected Cultivation site during 2012 and 2013 seasons.

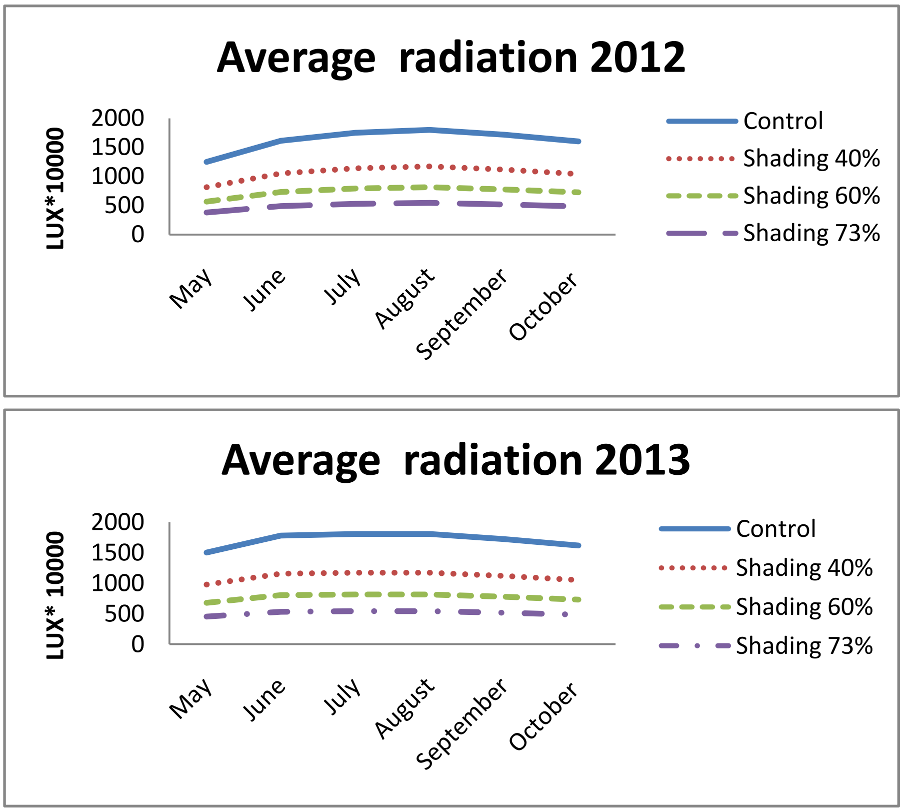


Figure (3): Effect of Shading on average sun radiation at El- Bostan Protected Cultivation site during 2012 and 2013 seasons.

2. Vegetative growth characteristics.

Data presented in Tables3, 4,5and6 show the effect of shading and irrigation regimes on vegetative growth traits of tomato plants expressed as plant height, stem diameter ,number of leaves and leaf area as well as fresh and dry weight of leaves, stem and total fresh and dry weight per plant during the two seasons of study.

2.1. Effect of shading

Data in Tables 3, 4,5and6 indicate that irrespective of plant height during both seasons after 30 days from transplanting, and number of leaves per plant after 60 days from transplanting during the first seasons only, dry weight of stem and total dry weight of plants during both seasons of study which were not significantly affected as a result of shading tomato plants with different levels of shade i-e., 40,60 and 73% . In this respect, the shaded plants with 73% of shade density reflected the highest values of all growth aspects except stem diameter compared with other shaded (60 and 40%) and the unshaded treatment. Obtained results were true during the two seasons of study. In this respect, such increments in studied morphological characters of tomato plants as a result of shading with different tested shade densities may be attributed to the decrement effect of shading on ambient temperature during the summer season under shading compared to the full sun shine and in turn decreasing the respiration rate which consequently decreased the consumption of nutrients which used in formation of new cells and tissues and consequently increased the vegetative growth.

Moreover, increasing the plant height during the two samples after 30 and 60 days from transplanting in both seasons of study may be due to the elongation of the internode to reaccept sun light radiation, but not to the increase of the number of the internodes. In this connection, **El- Gizawy *et al.* (1992), El- Abd *et al.* (1994), Hamamato *et al.(*2000) Adam *et al* (2002),** found that shading rates were more favorable for plant height and leaf area, but it had a decrement effect on number of leaves as well as fresh and dry weight of leaves and stems. In addition, **Liu *et al* (2002) and Abdul Mateen *et al* (2007)** reported that shading tomato plant with 60% of total sun light in the first case and 55 or 75% in the second case produced the maximum values for plant height, number of leaves and leaf area and total dry weight production.

2.2. Effect of irrigation regime.

As for the effect of irrigation regime on vegetative growth parameters data in the same Tables refer that increasing the amount of irrigation water from 80 to 100 and 120% of water requirement gradually enhanced all measured morphological aspects during both seasons of study. In this connection, such enhancing effect did not reach the level 5% of significance except in case of leaf area in both seasons and dry weight of leaves during the second season .

However, using the highest level of irrigation water (120% of water requirement) reflected the highest values in all determined growth parameters .Obtained results are true during the two seasons of growth. Such results are in confirmety with those reported **by EL- Beltagy *et al* .(1984), Fattahallah (1992), Merghaney (1997) Byari and Al-Sayed (1999),Navarrete and Jean nequin (2000) , Ibrahim (2005) Itarmanto et al (2005), Sibomana *et al* (2013)** all working on tomato.

2.3. Effect of the interaction.

With regard to the effect of the interaction between shading densities and irrigation regimes on the vegetative growth traits of tomato plants grown under sandy soil conditions, data in Tables 3, 4,5and6 indicate that there were significant differences that was found of all determined growth aspects except plant height and number of leaves in the first sample after 30 days from transplanting in the first and second season, respectively and number of leaves at the second sample (60 days from transplanting) during the first season and total dry weight per plant in the first season as well as fresh weight of leaves and dry weight of stem during the second season only . In this regard , shaded plant at 73% shade density and irrigated with the highest level of irrigation water (120% of water requirement) exhibited the highest vegetative growth measurements except stem diameter which was higher in case of un shaded plants and irrigated with 120% of water requirement treatment of irrigation . Such results were true during both seasons of growth.

3. Chemical composition of plant foliage.

3.1. Effect of shading.

Concerning the effect of shading on total nitrogen, phosphorus, potassium and carbohydrates content in plant leaves, data in Tables 7and 8 reveal that shading at different tested rates had increasing effect on all assayed chemical, compared with unshaded plant. In this respect, such increments did not reach the level of significance in case of phosphorus during both seasons of study .In addition, shaded plants with the highest used level of shade 73% exhibited the highest content of total nitrogen phosphorus and potassium compared with the medium 60% and low level 40%of shading. Such trend was obtained in both pea was . The gradual increase of assayed macro- elements and carbohydrates with increasing shade density was connected with the increasing in vegetative growth aspects as a result of shading. Also, such gradual increasing in the concentration of macro-elements as a result of shading may be attributed to the decrement effect of shading on prevailing temperature during the summer season which affect and reduce respiration rate and consequently increased the vegetative and root growth which in turn increase the absorption and accumulation of such elements in plant tissues. Obtained results are in the same line with those reported by **Gomaa(1966)Moustafa(19991), El-Gizawy *et al.(*1992), De Groot *et al.* (2002), Liuxian *et al.(*2003) Gent (2005) and El-Sayed (2009)** all working on tomato and **El- Kassas(1985)** working on cucumber who reported that shading the plants at different densities of shading increased the concentration of nitrogen , phosphorus and potassium in plant leaves compared with unshaded plants.

Table 3. Effect of shading levels and irrigation regimes and their interaction on vegetative growth haracteristics of tomato plants after 30 days from transplanting during the two seasons of study.

Treatment		Season (2012)				Season (2013)			
		Plant height (cm)	Stem diameter (cm)	No. Of leaves/plant	Leaf area (cm^2)	Plant height (cm)	Stem diameter (cm)	No. Of leaves/plant	Leaf area (cm^2)
Control		66.3	1.24	12.5	69.3	65.7	1.08	10.5	53.7
Shading 40%		78.6	1.14	15.6	140.7	71.2	0.94	11.1	125.7
Shading 60%		79.5	1.04	16.0	152.0	72.1	0.86	11.2	127.1
Shading 73%		84.5	0.75	16.2	173.0	78.0	0.79	12.7	156.1
L.S.D $_{at\ 0.05}$		N.S	0.47	2.8	18.4	N.S	0.09	N.S	22.1
80% W.R		71.9	0.97	13.9	100.2	68.7	0.80	10.8	126.9
100% W.R		73.3	1.05	15.1	113.6	70.6	0.93	11.3	130.2
120% W.R		86.3	1.11	16.2	133.1	75.9	1.02	12.1	144.0
L.S.D $_{at\ 0.05}$		N.S	N.S	N.S	30.4	N.S	N.S	N.S	26.1
Control	80% W.R	67.0	1.14	11.8	67.3	61.5	0.81	9.8	49.2
	100% W.R	64.8	1.23	12.2	68.9	64.0	1.16	10.4	51.7
	120% W.R	67.0	1.35	13.7	71.5	71.5	1.26	11.3	60.3
Shading 40%	80% W.R	71.5	1.05	14.3	133.3	69.1	0.85	10.4	116.0
	100% W.R	75.5	1.17	15.7	137.8	70.5	0.94	11.2	121.4
	120% W.R	88.8	1.20	16.9	150.9	74.0	1.04	11.7	139.7
Shading 60%	80% W.R	71.9	0.98	14.7	148.5	69.2	0.80	10.7	101.1
	100% W.R	75.4	1.04	16.2	152.5	71.1	0.85	11.0	134.1
	120% W.R	91.2	1.12	17.1	154.8	76.1	0.93	12.1	146.0
Shading 73%	80% W.R	77.3	0.73	14.8	158.5	75.1	0.75	12.2	134.5
	100% W.R	77.7	0.76	16.5	161.7	76.9	0.77	12.8	147.2
	120% W.R	98.4	0.78	17.2	198.9	82.0	0.86	13.2	186.5
L.S.D $_{at\ 0.05}$		N.S	0.35	3.7	29.7	15.2	0.47	N.S	34.6

3.2. Effect of irrigation.

With regard to the effect of irrigation regime on macro-nutrients (N,P,K) and carbohydrates content in plant leaves . Data in Tables 7 and 8indicate that increasing the irrigation level from 80 to 120% of water requirement of tomato plants tended to increase the concentration of assayed macro-element, i-e., total nitrogen, phosphorus , potassium and carbohydrates in leaves. In this concept, using the highest level of irrigation water (120% of water requirement) reflect the highest values of such elements. In addition, such increases in macro-elements reached the level of significant only in case of phosphorus and potassium during the first season only while such enhancing effect in case of carbohydrate reached the level of significant during both seasons . Such enhancing effect of irrigation on determined N,P,K elements may be available for absorption by plant and translocate and accumulated. Obtained results are in agreement with those reported by **Locasico *et al.* (1986), Fatia hallah (19992), Locascio and Saniastria (1996), Nahar and Gretzmacher(2002)**all working on tomato. However, **Ibrahim (2005)** on tomato reported that increasing the amount of irrigation resulted in decreasing the concentration of N, P, K in plant leaves.

3.3. Effect of the interaction.

As for the effect of the interaction, the same data in Tables 7and 8 indicate that except total nitrogen in first season and phosphorus content in second one which were not significantly affected due to the interaction treatment, using the highest shading density (73%) combined with the highest level of irrigation water (120% of water requirement) all assayed macro-nutrient and carbohydrate content in leaves reflected of the highest concentration

Table 4. Effect of shading levels and irrigation regimes and their interaction on vegetative growth haracteristics of tomato plants after 60 days from transplanting during the two seasons of study.

		Season (2012)				Season (2013)			
Treatment		Plant height (cm)	Stem diameter (cm)	Of No .leaves/plant	Leaf area (Cm^2)	Plant height (cm)	Stem diameter (cm)	No. Of leaves/plant	Leaf area (Cm^2)
Control		145.1	1.31	20.2	80.2	134.4	1.24	17.3	64.9
Shading 40%		158.6	1.26	22.5	159.9	147.5	1.05	21.0	147.8
Shading 60%		163.7	1.15	21.7	167.6	152.3	0.96	20.1	154.0
Shading 73%		176.9	1.24	22.5	191.1	162.8	0.94	18.5	174.1
L.S.D $_{at\ 0.05}$		10.1	0.28	N.S	11.2	10.2	0.15	2.3	20.7
80% W.R		152.0	1.16	19.8	133.6	140.0	0.95	18.1	119.8
100% W.R		157.3	1.24	21.3	151.0	145.6	1.05	19.3	134.2
120% W.R		173.9	1.32	22.7	164.5	162.2	1.14	20.2	151.6
L.S.D $_{at\ 0.05}$		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Control	80% W.R	139.7	1.32	19.2	76.7	128.5	1.03	15.7	55.9
	100% W.R	144.3	1.42	20.2	78.9	133.2	1.30	17.9	61.7
	120% W.R	151.1	1.56	21.3	85.0	141.7	1.40	18.2	77.2
Shading 40%	80% W.R	150.3	1.24	18.5	133.8	138.3	0.96	17.5	136.8
	100% W.R	153.4	1.33	21.0	167.8	142.7	1.03	18.3	141.5
	120% W.R	172.2	1.38	22.4	178.2	161.5	1.16	19.8	165.0
Shading 60%	80% W.R	150.1	1.07	20.2	143.9	140.3	0.93	19.4	134.2
	100% W.R	156.0	1.20	22.1	169.8	144.4	0.96	20.0	154.5
	120% W.R	185.0	1.28	22.7	189.2	172.2	1.00	21.1	173.4
Shading73%	80% W.R	168.0	0.99	21.2	180.2	153.0	0.90	20.0	152.4
	100% W.R	175.4	1.00	22.0	187.4	161.9	0.93	21.0	179.0
	120% W.R	187.2	1.05	24.3	205.8	173.3	1.00	21.8	190.8
L.S.D $_{at\ 0.05}$		25.9	0.32	N.S	40.8	31.7	0.46	4.3	36.2

Table 5. Effect of shading levels and irrigation regimes and their interaction on fresh and dry weight of tomato plants foliage at the end of harvesting season during the first season of growth.

Treatment		Season (2012)					
Treatment		leaves fresh weight (gm)	Leaves dry weight (gm)	Stem Fresh weight (gm)	Stem dry weight (gm)	Total fresh weight (gm)	Total dry weight (gm)
Control		110.1	19.9	97.0	20.4	207.1	40.3
Shading 40%		123.5	22.5	113.6	21.8	237.1	44.3
Shading 60%		134	24.4	120.8	22.5	254.8	46.9
Shading 73%		147.6	26.5	128.6	24.2	276.2	50.7
L.S.D $_{at\ 0.05}$		36.9	5.1	15.1	N.S	32.0	N.S
80% W.R		114.1	19.2	103.3	17.7	217.4	36.9
100% W.R		130.6	22.3	118	21.2	248.6	43.5
120% W.R		141.6	28.3	123.7	26.8	265.3	55.1
L.S.D $_{at\ 0.05}$		N.S	N.S	N.S	N.S	N.S	N.S
Control	80% W.R	89.21	17.6	89.8	15.9	179.01	33.5
	100% W.R	112.3	19.8	96.8	19.3	209.1	39.1
	120% W.R	128.9	22.3	104.4	25.9	233.3	48.2
Shading 40%	80% W.R	117.6	21.5	99.8	16.3	217.4	37.8
	100% W.R	121.6	24.6	118.9	20.9	240.5	45.5
	120% W.R	131.3	33.0	122	24.2	253.3	57.2
Shading 60%	80% W.R	125.7	19.0	104.3	22.2	230	41.2
	100% W.R	132.7	22.8	125.8	19.5	258.5	42.3
	120% W.R	143.7	31.3	132.4	26	276.1	57.3
Shading73%	80% W.R	124.1	21.5	119.3	16.3	243.4	37.8
	100% W.R	156.1	24.6	130.3	25.0	286.4	49.6
	120% W.R	162.7	33.0	136	31.2	298.7	64.2
L.S.D $_{at\ 0.05}$		52.98	10.7	37.5	10.4	65.11	N.S

Table 6. Effect of shading levels and irrigation regimes and their interaction on fresh and dry weight of tomato plants foliage at the end of harvesting season during the second season of growth.

Treatment	Season (2013)					
Treatment	leaves fresh weight (gm)	Leaves dry weight (gm)	Stem fresh weight (gm)	Stem dry weight (gm)	Total fresh weight (gm)	Total dry weight (gm)
Control	102.3	17.7	99.48	23.5	201.78	41.2
Shading 40%	115.7	20.3	116	23.5	231.7	43.8
Shading 60%	126.2	22.2	123.3	25.6	249.5	47.8
Shading 73%	139.8	24.3	131.0	27.3	270.8	51.6
L.S.D $_{at\ 0.05}$	36.9	5.1	15.1	N.S	32.0	N.S
80% W.R	112.5	17.0	105.4	20.7	217.9	37.7
100% W.R	122.0	20.1	120.6	25.2	242.6	45.3
120% W.R	128.5	26.2	126.3	29.0	254.8	55.2
L.S.D $_{at\ 0.05}$	N.S	8.9	N.S	N.S	N.S	N.S

Control	80% W.R	87.6	15.4	91.9	19.0	179.5	34.4
	100% W.R	103.6	17.6	99.5	23.4	203.1	41
	120% W.R	115.8	20.1	107.0	28.1	222.8	48.2
Shading 40%	80% W.R	115.9	16.6	106.4	19.4	222.3	36
	100% W.R	112.9	20	128.4	24.9	241.3	44.9
	120% W.R	118.1	24.3	135.0	26.3	253.1	50.6
Shading 60%	80% W.R	124.0	16.8	102.0	25.2	226	42
	100% W.R	124.0	20.6	121.6	23.5	245.6	44.1
	120% W.R	130.5	29.1	124.6	28.1	255.1	57.2
Shading73 %	80% W.R	122.4	19.3	121.4	19.4	243.8	38.7
	100% W.R	147.4	22.4	133.0	29.1	280.4	51.5
	120% W.R	149.6	31.2	138.6	33.4	288.2	64.6
L.S.D $_{at\ 0.05}$		N.S	10.2	37.5	N.S	66.4	21.2

Table 7: Effect of shading levels and irrigation regimes and their interaction on total nitrogen , phosphorus , potassium(mg/100gm) and carbohydrate %content of leaves at the end of harvesting season during the first seasons of growth.

Season (2012)					
Treatment		N	P	K	Total carbohydrates
Control		1328.0	145.6	1724.0	9.64
Shading 40%		1392.0	175.6	2286.0	11.59
Shading 60%		1504.0	184.4	2567.0	11.97
Shading 73%		1712.0	198.9	2911.0	12.72
L.S.D $_{at\ 0.05}$		67.1	N.S	907.6	0.89
80% W.R		1413	134.2	1707	10.32
100% W.R		1467	163.3	2172	11.28
120% W.R		1592	230.8	3236	12.84
L.S.D $_{at\ 0.05}$		N.S	96.2	1263	1.50
Control	80% W.R	1190	1067.0	1207	8.60
	100% W.R	1257	1367.0	1590	9.80
	120% W.R	1290	1933.0	2377	10.53
Shading 40%	80% W.R	1347	140.0	1723	10.47
	100% W.R	1363	163.3	2400	11.30
	120% W.R	1450	223.3	2733	13.00
Shading 60%	80% W.R	1437	140.0	1733	10.80
	100% W.R	1500	173.3	2267	11.73
	120% W.R	1650	240.0	3700	13.37
Shading 73%	80% W.R	1677	150.0	2167	11.40
	100% W.R	1750	180.0	2433	12.30
	120% W.R	1980	266.7	4133	14.47
L.S.D $_{at\ 0.05}$		N.S	109.4	1437	1.70

Table 8. Effect of shading levels and irrigation regimes and their interaction on total nitrogen , phosphorus , potassium(mg/100mg) and carbohydrates %content of leaves at the end of harvesting season during the second seasons of growth.

Treatment		N	P	K	Total carbohydrates
Season (2013)					
Control		1412	1500	1792	10.13
Shading 40%		1380	1722	2300	12.18
Shading 60%		1540	1778	2811	12.60
Shading 73%		1720	1889	2889	13.40
L.S.D $_{at\ 0.05}$		70	N.S	891.3	0.99
80% W.R		1439	1392	1967	10.85
100% W.R		1453	1633	2294	11.73
120% W.R		1560	2142	3083	13.65
L.S.D $_{at\ 0.05}$		N.S	N.S	N.S	2.65
Control	80% W.R	1450	123.3	1433	9.03
	100% W.R	1250	143.3	1577	10.20
	120% W.R	1283	183.3	2367	11.17
Shading 40%	80% W.R	1340	136.7	1667	11.00
	100% W.R	1380	170.0	2533	11.73
	120% W.R	1457	210.0	2700	13.80
Shading 60%	80% W.R	1380	140.0	2467	11.37
	100% W.R	1483	170.0	2467	12.20
	120% W.R	1650	223.3	3500	14.23
Shading73 %	80% W.R	1587	156.7	2300	12.00
	100% W.R	1700	170.0	2600	12.80
	120% W.R	1850	240.0	3767	15.40
L.S.D $_{at\ 0.05}$		253	N.S	1370	3.01

Conclusion

It can be concluded that , using shade screen net 73% enhance all morphological aspects of tomato plants grown at summer seasons, in addition ,the most suitable water regime to produce tomato during the summer seasons was 80%. The same results could be obtained using 100, and 120% from class A pan, but without any significant difference. So, it's recommended to use the less water regime to save water. Finally, the best vegetative growth obtained when 73% shading density interacted with any water regime without any significant differences between them, so, it's recommended to use the shading with 73% density as well as 80% water regimes

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تاثير بعض العوامل المناخية والرى على النمو والمحتوى الكميائى للطماطم

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اجريت تجريتيان حقليتان خلال موسم 2011,2012 بموقع البستان للزراعة المحمية مركز البحوث الزراعية لدراسة اثر التظليل بمستويات(73و60و40%) مقارنة بالكنترول وكذلك تاثير المقننات المائية باستخدام ثلاث مقننات مائية هى(80,100و120%) من الاحتياجات المائية للنبات باستخدام حلة البخر والبيانات المناخية وكذلك التفاعل بينهما عل النمو والتركيب الكميائى لنباتات الطماطم وتم استخدام هجين طماطم (V.T.916) وتم زراعة البذور فى 1 مارس فى الموسمين وقد اظهرت النتائج ان التظليل بنسبة 73% قد خفض درجة الحرارة والاشعاع يليه 60% ثم 40% مقارنة الكنترول وايضا ادى التظليل بنسبة 73% الى زيادة الرطوبة الجوية عن بقية المعاملات(60,40, و الكنترول) على التوالى وقد اظهرات النتائج ايضا ان التظليل بنسبة 73% قد تفوق على بقية المعاملات فى صفات النمو الخضرى ممثلة فى (طول النبات و عدد الاوراق ومساحة سطح الورقة و الوزن الطازج للاوراق والسيقان والوزن الجاف ايضا) وعلى العكس فى سمك الساقه وقد ادى التظليل الى ارتفاع محتوى الاوراق من النيتروجين ,الفسفور ,البوتاسيوم والكربوهيدرات وكذلك ادت معاملات الرى بنسبة 120% مقنن مائى الى زيادة فى صفات (طول النبات و عدد الاوراق ومساحة سطح الورقة الوزن الطازج للاوراق والسيقان والوزن الجاف ايضا) كما تفوقة معاملة الرى بنسبة 120% مقنن مائى فى زيادة محتوى الاوراق من الفسفور والبوتاسيوم فى الموسم الثانى فقط) ومحتوى الكربوهيدرات خلال الموسمين للدراسة بفرق معنوي بينما محتوى النيتروجين لم يظهر فرق معنوي اما عن التفاعل بين معاملات التظليل ومعاملات الرى فقد اعطت معاملة 73% تظليل مع 120% مقنن مائى افضل النتائج ولكن دون فرق معنوى مع 100% مقنن مائى و 80% مقنن مائى .