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Effect of Alternative Irrigation on Tomato (*Solanum lycopersicum* L.) Growth and Productivity under Clay Soil Conditions

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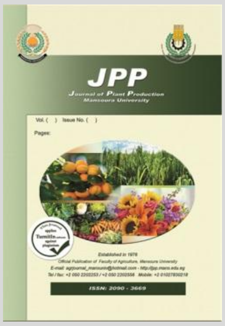

ABSTRACT

Afield explore was led on tomato plants (*Solanum lycopersicum* L.) In the mid year times of 2023 and 2024, at Benha College's Staff of Horticulture's Exploratory Homestead in Moshtohor, the location of the experimental site is latitude: 30º36"N, longitude: 31º22"E. The trial was designed as randomized completely block with three replications, where the treatments were I_0= traditional irrigation like practice by local farmer within the investigated area I_1= alternative irrigation furrow by furrow exchange and I_2 = alternative irrigation furrow by furrow fixed through the whole growing season the main findings. The most significant values for all the investigated vegetative parameters were recorded under irrigation treatment I_0 on comparison with I_1 and I_2 . The highest values for early yield, total yield and marketable yield were noticed under I_0 in comparison with $I_1$and I_2, on the contrary, the unmarketable yield the highest values were record under stress conditions I_2. For chemical parameters the highest values of T.S.S% , lycopene and acidity were recorded under irrigation treatment I_2 stress conditions, but for V.C were recorded under I_0 .The best values for applied water and consumptive use were recorded under irrigation treatment I_0 . On the contrary, the highest values for consumptive use efficiency were recorded under irrigation treatment I_2. The highest values for Wp and PIW were noted under irrigation treatment I_1 comparing with I_0 and I_2. The values for water saving were observed under using alternative irrigation system.

Keywords: tomato, water relations, traditional irrigation, applied water.

INTRODUCTION

In Egypt, the tomato (*Solanum lycopersicum*, Modern Office) is the most well-known and widely produced solanaceous vegetable. Across the globe, the United States, Egypt, India, and Italy were the primary producers of tomatoes. One of Egypt's most important vegetable harvests is tomato. It is grown all year long. About 171820 hectares of tomato crops were grown in Egypt, yielding 6.78 million tonnes (2018-2019 statistics, Faied *et al*., 2022). Tomatoes are widely recognized for both their culinary and medicinal quantities. More than 85% of the dietary lycopene is addressed by tomatoes and tomato growing. The vast majority of tomatoes' outstanding attributes are what buyers want to buy (Ghada *et a1*., 2013 and Khalifa 2023). This suggests continuing to be aware of the quantity, nutritional value, and degree of disease prevention expertise that are present in the new everyday items. These include carotenoids like lycopene and beta carotene as well as enhancements A, C, and E. Several traditional factors, like water pressure, limit the production of tomatoes. Reduction in the amount of normal across almost no tomato varieties in light of increased pressure from dry spells in addition to Oti *et al*., (2023), Musa and Kolawole (2024).

Water is essential to the production of crops in Egypt. Egypt's climate has a low level of rainfall with erratic creation and dispersal. Accordingly, the creation of plants is essentially based on phony watering or horticulture that is overpowered. Water resources are limited and derived from the Nile Stream, which supplies at least 95% of Egypt's water needs. According to the silent agreements among the countries of the Nile bowl, Egypt plans or farming consumes 48 milliord cubic metres of water from the Nile which represents about 85% from water allocation for Egypt. Other water resources, such as rainfall, ground water, reusing of drainage water but less in their magnitude and others are dery expensive in lifting and using.

The capita share of water in Egypt is under 1000m3/capita/year which indistinguishable from the overall standards of water poverty edge (El-Quosy,1998, Elsherpiny and Helmy, 2022 and Elmasry, 2024). Water framework is the key region in water interest at the general population level. Water relegated to water framework is around 85% from irrefutably the manageable water. Thusly, effective water the leaders at the region is the fundamental way towards the legitimization technique for the country. In this point, effective on farm water framework the board transforms into a verifiable prerequisite. Under limit of water sources in Egypt, justification of water in this area is turning into an unquestionable requirement. Utilizing elective water system framework is pressing to make water saving by diminishing wetted region and consequently misfortunes by dissipation from soil surface. along these lines, diminishing water immoderate use. Consequently, diminishing measure of applied water contrasting and conventional water system like practice by nearby ranchers in the concentrated on area . In this way, from the previously mentioned realities about utilizing elective water system in watering a few yields which established on wrinkles is turning into an unquestionable necessity to make justification for water system water. There

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are several methods of surface irrigation, including alternate irrigation, which includes applications such as furrow irrigation and furrow deprivation (season-long), alternate irrigation between furrow irrigation and furrow deprivation, then the next irrigation deprives the irrigated line and irrigates the furrow deprived of irrigation. Therefore, the study assumes saving irrigation water using several applications of alternate irrigation on tomatoes.

The amount of dry spell pressure increment, both the size and number of natural products diminished Khan *et al*., (2020). Deficit irrigation (DI) solutions could therefore significantly help this crop uses less water for irrigation (El-Nady and Hadad, 2016 and. Du *et al.*, 2017). Hu *et al.* , *(2021),* DI might make it possible to get the most out of water productivity. and improvement of product quality. In addition, DI management possesses the potential to greatly increase irrigation water productivity (Yassen *et al.,* 2020). Growing tomatoes under a surface irrigation system, while providing the amount of irrigation water that does not affect the final product (crop).

The aim of the study includes saving the largest amount of water used in irrigation and also obtaining an economic crop that achieves an acceptable financial return for the farmer.

MATERIALS AND METHODS

A field investigation was performed on tomato plants (*Solanum lycopersicum* L c.v nerose.) during the 2023 and 2024 seasons at the Exploratory Farm of the Staff of Agribusiness, Behna University, Moshtohor, Kalubia Governorate, Egypt, to investigate the effect of elective water framework on growth, chemical composition, fruit yield, quality, and certain water relations, its quality also, some water relations of tomato under earth soil conditions. The preliminary site is arranged at scope: 30o36''N, longitude: 31o22''E. geographical location of the trial site is shown Fig.1.

The dirt of the field was mud in surface with pH 7.9 Soil mechanical and substance examinations are displayed in Tables (1and 2) Check for experimental soil and soil sample at depth of 0 - 60 cm depth before planting. pipette method was used to determine particle-size distribution with Klute , (1986) Soil field capacity besides permanent wilting point were determined through using pressure membrane method at 0.33 and 15 Atm, respectively consistent with James , (1988). pH and electrical conductivity of soil were analyzed consistent with Page *et al.,* (1982). Metrological information were determined as month to month implies like greatest and least temperatures, stickiness what's more, the downpour are displayed in Table (3).

Fig.1. Experimental site (Google map, Satellite)

Table 1. Physical and chemical properties of the experimental soil.

Soil texture	**Heavy clay**
pH (1:2.5)	7.9
EC (dSm^{-1})	2.16
O.M ($g\ kg^{-1}$)	1.41
$CaCO_3$ (gkg^{-1})	1.53
Available N ($mg\ kg^{-1}$)	23
Available P ($mg\ kg^{-1}$)	9
Available K ($mg\ kg^{-1}$)	120
FC ($cm^3\ cm^{-3}$)	37.89
PWP ($cm^3\ cm^{-3}$)	20.59
Saturation capacitance ($cm^3\ cm^{-3}$)	75.78

Where: Fc = Soil field capacity, PWP= Permanent wilting point .

Table 2. Chemical composition of irrigation water used in the experiment

PH	**Ec**	**Soluble cations (mmole/L)**				**Soluble anions (mmole/L)**			
	dSm^{-1}	**Ca^{+2}**	**Mg^{+2}**	**Na^{+}**	**K^{+}**	**Cl^{-}**	**CO_3^{--}**	**HCO_3^{-}**	**SO_4^{--}**
6.8	0.27	1.6	0.8	0.1	0.2	1.0	0.00	1.1	0.6

Table 3. Metrological data (as month to month means like most extreme and least temperatures, mugginess also, wind speed) in 2023 and 2024 seasons.

Month*	**Air temperature [°C] Min.**	**Air temperature [°C] Max.**	**Relative humidity [%] Aver.**	**Wind speed [m/sec] Aver.**	**Solar radiation Dgt [MJ/m^2]**	**Soil temperature [°C] Min.**	**Soil temperature [°C] Max.**	**ETo [mm] Aver.**
				First season (2023)				
March	4.6	32.5	72.9	0.8	422.7	3.9	35.8	2.6
April	7.6	40	64.2	1	545.56	6.7	42.3	4.0
May	12.7	36.1	58.1	1.3	689.12	11.9	39.7	5.3
June	15.7	39.6	65.6	1.3	535.47	29.3	30.2	4.6
Jule	17.8	37.2	71	1.1	472.97	19.1	53.1	4.1
				Second season (2024)				
March	2.70	31.00	74	1.17	454.17	11.94	27.4	2.8
April	7.86	34.98	68	1.25	601.66	16.85	29.8	3.9
May	14.03	38.72	62	1.27	587.47	22.82	37.86	4.8
June	14.85	40.50	64	1.40	556.3	26.87	33.17	5.1
Jule	14.46	36.28	75	1.02	536.71	21.38	37.9	4.5

***Metrological information were gotten from Research facility for Farming Environment (CLAC).**

Each exploratory plot recollected four redges 4 metres for quite a while and 1 circulate in width. Three redges were planted and one was left as a guard between plots to prevent water movement from any plot to adjacing one. Moving was finished on one side of edge at 50 cm detached between seedlings. Migrating was done on fourth of May in 2023 and 2024, independently. All cultivation practices were done as proposed by Administration of Cultivating and land recuperation for the yield and the focused on district.

Irrigation treatments:

I_0 =Traditional irrigation (practice by local farmers).

I_1 = Alternative irrigation furrow by furrow exchanged (through the whole growing season).

I_2 = Alternative irrigation furrow by furrow fixed (through the whole growing season).

Amount of water applied for each exploratory plot was determined by utilizing water stream meter.

In both seasons, randomized complete block design with three replications was used in study area. The cultivating works on concerning development, preparation, bug and infectious prevention were directed as regularly followed by recommended by the Ministry of Agriculture for commercial tomato production.

Information recorded:

Information on vegetative boundaries, yield, its parts, physical and substance natural products attributes were recorded as follows:

Vegetative development quantities.

After 70 days of relocation, three plants were removed from each plot for a delegate test, and the results were documented to provide information. Plant height (cm), fresh weight (g /plant), dry weight (g /plant), number of leaves/plant, leaf area/plant (cm^2). The leaves were gauged, then, at that point, 10 circles of a steady region (cm^2) for every treatment were taken from the leaves with a puncher and gauged. The leaf region was determined agreeing the accompanying equation: Leaf region (cm^2) = Fresh weight of leaves X region of the plates Fresh weight of plates.

Chemical composition:

Photo synthetic pigments: According to Murquard and Timpton (1987), a portable leaf chlorophyll meter (Minolta Model SPAD 501) is used to measure total chlorophyll in SPAD units. The Proline content: The ninhydrin reagent method, as outlined by Bates *et al.*, (1973), was used to measure the free proline content after it was extracted using 3% (w/v) aqueous sulphosalycylic acid. Total carbohydrates: After being extracted from the dried foliage in HCl for six hours at 100 C, the powdered samples were filtered. A known volume was reached by raising the filtrate. At 480 nm, the total carbohydrate content was measured photometrically using Cherry's (1973) phenol-sulfuric acid technique.

Fruit yield and its parts

At harvesting mature fruits approximately after 75 days from transplanting were picked along the collecting season furthermore, the accompanying information were recorded : Early yield (ton/ fed), total fruit yield per fed, total fruit yield per fed, total fruit yield per fed, marketable fruit yield per fed and unmarketable yield per fed.

Fruit quality

Physical quality: From 10 natural products at full ready stage from each plot, the physical quality properties were determined: fruit parameters i.e. length and diameter for 5 fruit using vernier calibre and average fruit weight using top balance loading to determine the average fruit weight. Chemical quality: T.S.S. (%): An irregular example of 10 natural products from each trial plot at full maturing stage was taken to decide the level of dissolvable strong substance by utilizing the hand refractometer. Total titratable acidity (T.T.A%): An irregular example of 100g of natural product at full maturing stage from each plot was taken to decide T.T.A. of juice by titration with 0.1 N NaOH (Sodium hydroxide) arrangement utilizing phenolphthalein pointer, as per the technique portrayed in A. O. A.C. (1990). L ascorbic acid "Vitamin C" was estimation by the sign of 2,6 dichlorophenol indophenol by titration as the strategy referenced in A. O. A. C. (1990)

Lycopene:

The natural product's lycopene fixation (mg kg^{-1} F.W.) was isolated in this way: A research facility homogenizer was used to first cleave and homogenize the tests: Five milliliters of 0.05% (w/v) butylated hydroxytoluene (BHT) in $CH_3)_2CO$, five milliliters of ethanol, and ten milliliters of hexane were added to experiments weighing between 0.3 and 0.6 grams. The recipient spent fifteen minutes combined in ice on a pretty blending dish. Following shaking, the samples were shaken on ice for five minutes after adding three milliliters of deionized water to each vial. After five minutes at room temperature to allow the two stages to separate, the tests were monitored using spectrophotometry at 472 nm. UV-Vis mechanical assembly. A Janways spectrophotometer has been used to complete otherworldly research (Ravelo-Pérez *et al.*, 2008). Lycopene (mg/kg) consumed is equal to 503 * 31.2/g of tissue.

Water relations :

Seasonal water applied (m^3/fed): The irrigation system used was surface irrigation for the experiment**.** Amount of water applied for each exploratory plot was determined by utilizing water meter. Water consumptive use (m^3/fed): Water utilization by developing plants was determined in light of soil moisture depletion (SMD) as per Hansen *et al.*, (1979).

$$\mathbf{Cu} = \sum_{i=1}^{1=4} D_1 \times D_{b1} \times \frac{PW_2 - PW_1}{100}$$

CU = Water consumptive use (cm) in the effective root zone (60 cm).
D_1 = Soil layer depth (15 cm each).
D_{b1} = Soil bulk density, (g/cm^3) for this depth.
PW_1 = Soil moisture percentage before irrigation (on mass basis, %).
PW_1 = Soil moisture percentage, 48 hours after irrigation (on mass basis, %).
I = Number of soil layers each (15 cm) depth.

Water productivity:

Water efficiency is for the most part characterized as harvest yield per m^3 of water utilization. Idea of water efficiency in farming creation frame works is centered around delivering more food with similar water assets or creating similar measure of food with less water assets which calculated by (Ali *et al.*, 2007)

$$\mathbf{WP} = \frac{Y}{ET}$$

Where: WP = Water productivity (kg/ m^3), Y = Total yield (kg/ fed) and ET = Evapotranspiration.

Productivity of irrigation water:

It was calculated by (Ali *et al.*, 2007)

$$\mathbf{PIW = Y/IW}$$

Where : PIW = Productivity of irrigation water (kg m^3),Y = Total yield kg/fed and IW = irrigation applied water (m^3/ fed).

Consumptive use efficiency (ECU, %):

Consumptive use efficiency (ECU, %) was calculated as the ratio of crop water use (CU) to irrigation water applied

(IW), following the method described by Doorenbos and Kassam (1979).

ECU = (Cu/ IW) x100

Where: ECU = Consumptive use efficiency (%), CU = Consumptive use, IW = Irrigation water.

Statistical analysis :

The examination of difference was completed by Gomez and Gomez (1984). Treatment implies were looked at by bundle (Duncan , 1955).

RESULTS AND DISCUSSION

Results

Vegetative growth characteristics

Introduced information in Table (4) showed that significant all vegetative development trademark (plant height, number of leaves,, number of branches, fresh and dry weights and leaves area) under study were obviously impacted by water system treatments. This most noteworthy quantities through the first season for the development attributes were number of leaves 63.45 and leaves area 4294.07 cm^2, meanwhile plant height 90. 20 cm, number of branches 8.10, and fresh and dry weights 814.25 g/plant, 127.32 g/plant in second season were recorded under water system treatment I_0 (traditional irrigation like practice by local farmer within the investigated area (control) contrasting and other water system treatments, I_1(alternative irrigation furrow by furrow exchange) and I_2 (alternative irrigation furrow by furrow fixed through the whole growing season). And minimum values under same scored data by stating the traits were 76.57 cm, 6.2, 49.8, 501.55 g/plant, 79.51g/plant and 4103.36 cm^2 under treatment I_2.

Table 4. Impact of water treatment on vegetative development quantities of tomato plants developed under study condition during 2023 and 2024 summer seasons

Characters	Plant height(cm)		NO. of branches/ plant		No. of leaves/plant		Fresh weight g/plant		Dry weight g/plant		Leaves area (cm2)	
	Seasons											
Irrigation treatments	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
I_0	90.12a	90,20 a	8.03a	8.10 a	63.45a	63.12a	810.65a	814.25a	123.82a	127.32a	4294.07a	4282.07a
I_1	84.07b	80.70b	7.80 a	7.82 a	62.17a	60.75a	770.42b	764.20 b	123.25a	122.70a	4285.27a	4277.92a
I_2	76.57c	76.60 c	6.20b	6.42 b	49.80b	50.42b	501.55c	507.92c	79.51 b	80.75 b	4103.36b	4022.77b
F.test	**	**	**	**	**	**	**	**	**	**	**	**

I_0 =Traditional irrigation (practice by local farmers), I_1 = Alternative irrigation furrow by furrow exchanged (through the whole growing season), I_2 = Alternative irrigation furrow by furrow fixed (through the whole growing season). = Significant at 0.01 level and a,b,c Dunc,s letters.**

Chemical composition of plant foliage

Impact of water system treatments on compound synthesis of tomato plants foliage developed under dirt soil conditions. Introduced information in Table (5) showed that compound creation under study were plainly impacted by water system treatments.(I_0, I_1 and I_2). Concerning the impact of water system treatments on absolute chlorophyll reading, proline (mg/100g dry weight) and Carbohydrates(mg/100g d.w) of tomato plant foliage, information given in table (5) demonstrated obviously that high significant between water system treatments I_0 and I_1 during the two times of development gives the greatest quantities and expanded absolute chlorophyll reading contrasting and other water system treatments I_2 (1.46 SPAD unit) without tremendous contrasts between them with the exception of proline (0.73 mg/100g f.w) and Carbohydrates content in the both seasons.

Table 5. Impact of water treatment on compound sythesis of tomato plant foliage developed under study condition during 2023 and 2024 seasons.

Characters	Carbohydrates(g/100mg d.w)		Proline(mg/100g f.w)		Chlorophyll reading (SPAD unit)	
	Seasons					
Irrigation treatments	2023	2024	2023	2024	2023	2024
I_0	56.25 a	56.34 a	0.59 c	0.66 c	1.20 c	1.17 c
I_1	52.36 a	54.31 a	0.66 b	0.67 b	1.33 b	1.31 b
I_2	42.86 b	43.07 b	0.72 a	0.73 a	1.46 a	1.46 a
F.test	**	**	**	**	**	**

I_0 =Traditional irrigation (practice by local farmers), I_1 = Alternative irrigation furrow by furrow exchanged (through the whole growing season), I_2 = Alternative irrigation furrow by furrow fixed (through the whole growing season). = Significant at 0.01 level and a,b,c Duncs letters.**

Fruit yield and its components:

Information introduced in Table (6) showed that significant the impact of irrigation treatments (I_0, I_1 and I_2).

On complete natural product yield and its parts during the two times of development. Early yield per fedden, attractive yield per fedden and complete yield per fedden care of were essentially impacted because of water system treatments.

Table 6. Impact of water treatment on natural product yield and its components of tomato plants developed under study condition during 2023 and 2024 seasons.

Characters	Early yield (t/fed)		Total yield (t/fed)		Marketable yield (t/fed)		Un marketable yield (t/fed)	
	Seasons							
Irrigation treatments	2023	2024	2023	2024	2023	2024	2023	2024
I_0	11.46 a	11.56 a	33.20 a	33.17a	31.64a	31.85a	1.56 b	1.32 b
I_1	10.90 a	11.02 a	32.74 a	32.75a	31.66a	31.96a	1.08 b	0.79 c
I_2	6.48 b	6.91b	22.70 b	22.73b	20.81b	20.85b	1.88 a	1.88 a
F.test	**	**	**	**	**	**	**	**

I_0 =Traditional irrigation (practice by local farmers), I_1 = Alternative irrigation furrow by furrow exchanged (through the whole growing season), I_2 = Alternative irrigation furrow by furrow fixed (through the whole growing season). = Significant at 0.01 level and a,b,c Duncs letters.**

In this regard, the plants watered with I_0 and I_1created the most extreme upsides of early yield per fedden care of, all out yield per fedden and attractive yield per fedden care of without huge contrasts between them, but it diminished the unmarketable natural product yield contrasted and different treatments under study. Maximum scored data by stating the traits were 11.56 and 33.20 t/fed for early yield, total yield, 31.96 t/fed (treatment I_1) with marketable yield and 1.88 t/fed for un marketable yield under treatment $I_{0.}$ And minimum values were 6.48, 22.7, 20.81 t/fed under early yield, total yield and marketable yield with treatment I_2, 0.79 t/fed un marketable yield under treatment I_2.

Physical fruit quality:

Information in Table (7) showed that significant for the impact of water system treatments (I_0, I_1 and I_2) on actual organic product nature of tomato during the two times of growth. Regarding the impact of water system treatments on physical fruit quality of tomato expressed as average fruit weight, length and fruit diameter, data in Table (7). This highest values through the two growing seasons for physical fruit quality were recorded under irrigation treatments I_0 and values were (110.52 gm, 6.66 and 5.46cm) contrasting and other water system treatments I_1 and I_2. While, I_2 recorded the lowest values of physical fruit quality of tomato in both seasons of study and values were 77.7 gm, 4.88 and 4.01cm) under the same scored data.

Chemical fruit quality:

Information in Table (7) showed that significant the impact of both water system treatments (I_0, I_1 and I_2) on compound constituents of tomato organic products during the two times of study. T.S.S and causticity were fundamentally impacted because of water system treatments. In this regards, water system with I_2 gave the most noteworthy upsides of T.S.S and acridity in the two times of study thought about with $I_1$and I_0 , anyway I_0 kept the most reduced upsides of T.S.S and acridity in the two developing seasons. While the I_2 what's more, I_1 recorded the most noteworthy upsides of lycopene without critical between them in the two times of study.

Table 7. Impact of water treatment on physical and substance natural product nature of tomato plants developed under study condition during 2023 and 2024 seasons.

Characters	Fruit weight(g)		Fruit length(cm)		Fruit diameter (cm)		T.S.S %		Lycopene(mg/kg)		V.C (mg/100g)		Acidity %	
	Seasons													
Irrigation treatments	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
I_0	109.52 a	110.05 a	6.64 a	6.66 a	5.44 a	5.46 a	5.82 c	5.84 b	2.43 b	2.41 b	22.80a	22.67 a	1.50 c	1.52 c
I_1	97.52 b	99.81 b	5.86 b	5.98 b	4.69 b	4.78 b	6.24 b	5.84 b	2.75 a	2.79 a	21.33 b	22.08 b	2.10 b	2.02 b
I_2	77.71c	79.21 c	4.88 c	4.94 c	4.01 c	4.03 c	7.00 a	6.94 a	3.09 a	2. 89 a	20.24 b	19.47 b	2.87 a	2.63 a
F.test	**	**	**	**	**	**	**	**	**	**	**	**	**	**

I_0 =Traditional irrigation (practice by local farmers), I_1 = Alternative irrigation furrow by furrow exchanged (through the whole growing season), I_2 = Alternative irrigation furrow by furrow fixed (through the whole growing season). = Significant at 0.01 level and a,b,c Duncs letters.**

Irrigation water relationships

Seasonal amount of applied water (m^3/fed)

Introduced information in Fig.2. obviously showed that significant the impact of both water system treatments (I_0, I_1 and I_2), the general mean quantities for occasional measure of applied water were impacted by water system treatments which utilized in this review. As obviously displayed in this table the quantities can be dropped all together I_0, I_1, I_2 and the quantities are (2635.01, 2178.5 and 2113.21 m^3/fed) for water system medicines , individually.

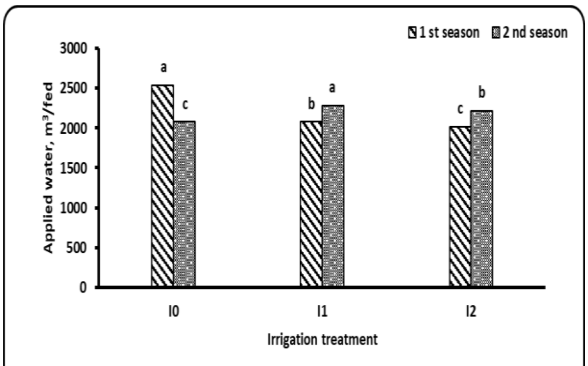

Fig. 2. Impact of applied water during the two developing seasons 2023 and 2024.

Consumptive use (m^3/fed)

Information in Fig.3. shown that significant the impact of both water system treatments (I_0, I_1 and I_2), the general mean upsides of occasional wasteful use were impacted by the contemplated water system treatments. The quantities can be dropped all together I_0, I_1,I_2 and the quantities are 1516.73 , 1452.33 and 1438.76 (m^3 / fed) under water system treatments separately. Expanding the upsides of water wasteful use under water system treatment I_0 in examination with other water system treatments I_1 and I_2 may sign to increment measure of applied water under the states of this treatment and thus expanding wetted region.

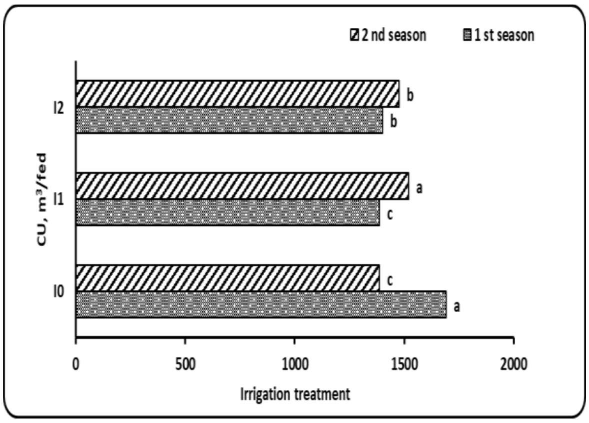

Fig.3. Effect of irrigation treatments seasonal CU, m^3/fed during the two growing seasons 2023 and 2024

Consumptive use efficiency (ECU, %):

Introduced information in Fig.4. showed that significant the impact of both water system treatments (I_0, I_1 and I_2), general mean quantities for (Ecu, %) were plainly impacted by the contemplated water system treatments in this present investigation. The values can be slid all together I_2, I_1, I_0 and the quantities are 68.15, 66.66 and 57.88 % for the previously mentioned water system treatments, separately.

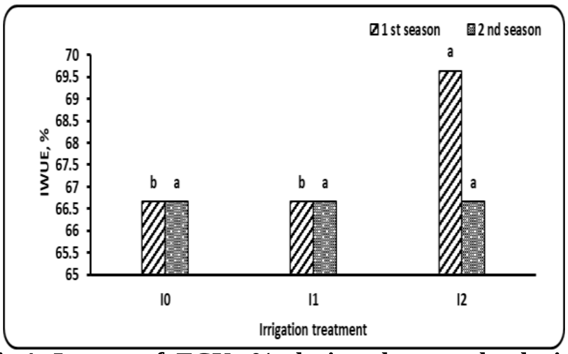

Fig.4. Impact of ECU, % during the two developing seasons 2023 and 2024.

Water productivity (WP, Kg /m^3) and productivity of irrigation water (PIW, Kg/m^3)

Information in Fig.4&5 represented that significant the impact of both water system treatments (I_0, I_1 and I_2), the upsides of WP and PIW were plainly impacted by the concentrated on water system treatments in this current review.

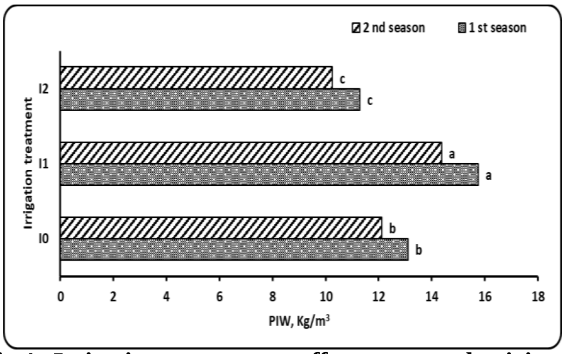

Fig.4. Irrigation treatments effects on productivity of irrigation water (PIW, Kg/m^3)during the two seasons 2023 and 2024.

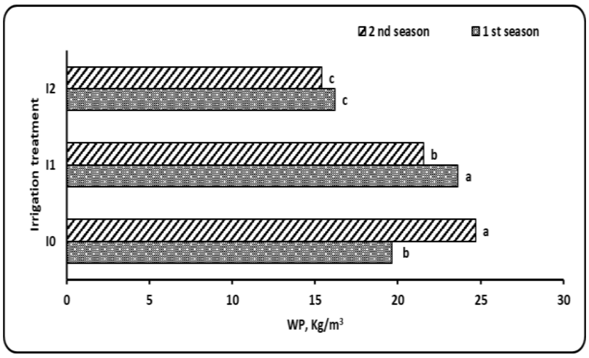

Fig.5. Irrigation treatments effects on water productivity (WP, Kg/m^3)during the two seasons 2023 and 2024.

The most noteworthy quantities were recorded under water system treatments I_1 contrasting and I_0 and I_2 and the most elevated values are 22.59 and 15.06 kg/ m^3 for WP and PIW separately. These outcomes are in an extraordinary concordance with those got by Rashed and E.A. Moursi (2012).

Water saving (m^3 / fed and %)

Present information in Table (8) obviously showed that significant using alternative irrigation system making saving for irrigation water (m^3 / fed and %) comparing with local irrigation practice in the studied area (traditional), generally mean values through the two seasons are 17% and 19.5 % for I_1 and I_2 contrasting and I_0.

A Principal Component Analysis (PCA) biplot, as shown in Figure 8, is an effective way to visualize the relationships between irrigation treatments and plant growth parameters. The plot features two main axes—Principal Components 1 and 2 which together explain 92.7% of the total variance (81.8% and 10.9%, respectively).

Table 8. Impact of water treatment on water saving (m^3/fed and %) during the both seasons 2023 and 2024.

Irrigation treatments	1st season		2nd season		In general mean quantities through the two season	
	m^3 / fed	Water saving%	m^3 / fed	Water saving%	m^3 / fed	Water saving%
I_0	0.0	0%	0.0	0%	0.0	0%
I_1	456.6 b	18% b	456.5 b	16% b	456.5 b	17% b
I_2	521.8 a	20% a	521.8 a	19% a	521.8 a	19.5% a
F-test	**	**	**	**	**	**

I_0 =Traditional irrigation (practice by local farmers), I_1 = Alternative irrigation furrow by furrow exchanged (through the whole growing season), I_2 = Alternative irrigation furrow by furrow fixed (through the whole growing season).

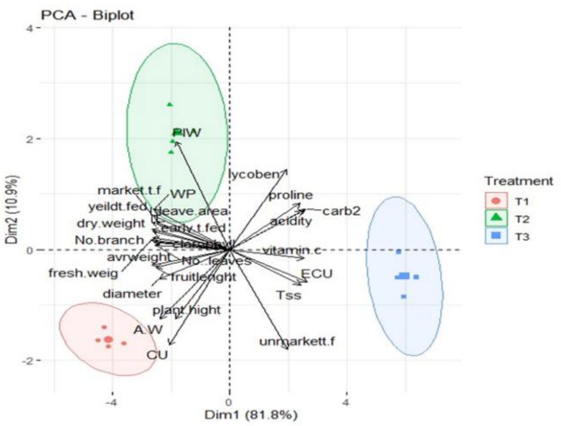

Figure 8. Principal Component Analysis (PCA) biplot illustrating the relationships between irrigation treatments and various plant growth parameters.The plot displays how treatments (T1, T2, and T3) are associated with different growth and yield-related variables based on their positions along the two principal components.

This indicates a strong representation of the original data in just two dimensions. Based on the biplot, the following relationships can be observed:

T1 treatment (Traditional irrigation) is positioned toward the negative end of Dimension 1. Numerous vectors point in this direction, including those for diameter, plant height, fruit length, fresh weight, average weight, number of leaves, dry weight, early yield (t/fed), total yield (t/fed), marketable yield (t/fed), water productivity (WP), leaf area, number of branches, average weight (A.W.), and cumulative water use (CU). This suggests that T1 is associated with higher values for these variables.

T2 treatment (Alternative irrigation furrow by furrow exchanged) is located near the center of the plot, slightly positive along Dimension 2. Vectors for PIW and lycopene point in this direction, indicating a potential association with these parameters.

T3 treatment (Alternative irrigation furrow by furrow fixed) is distinctly separated from T1 and T2 along the positive side of Dimension 1. Variables such as marketable yield (upmarket t/fed), total soluble solids (TSS), vitamin C, acidity, proline, and carbohydrate content (carb2) point in this direction, suggesting that T3 is linked to higher values for these traits.

Discussion:

Vegetative growth characteristics

These findings hold true for both study periods. These improvements in vegetative development characteristics brought about by raising the water system's level may be the result of water's ability to quicken physiological cycles and increase the dissolution and absorption of both large-scale and small-scale supplements that make up and solidify the arrangement of protoplasmic materials necessary for cell development, thereby promoting plant vegetative development. Acquired results are in concurrence with those revealed by Preveze *et al.* (2009), Wahb-Allah *et al.* (2011), Abdalalli *et al.* (2012), El-Koumy *et al.* (2012), Abd El-hady *et al.* (2017) and Shaban (2020). Additionally, Malash *et al.* (2019) and Shaban (2020) they detailed that dry spell pressure essentially diminished most vegetative development attributes. According to El-Koumy *et al.,* (2012), increasing the water system from 40 to 70 percent of the field limit increased all vegetative development characteristics, including plant level, branch count, new weight per plant, leaf count, leaf region per plant, and dry weight per plant.

Chemical composition of plant foliage

Water system treatment I_2 has a higher proline and carbohydrate content and, at the same time, shows the fewest benefits of chlorophyll reading.. These outcomes are in concurrence with the outcomes acquired by El koumy *et al.* (2012) , Malash *et al.* (2019) and Shaban (2020). Likewise, Shaban (2020) they revealed that dry spell pressure essentially diminished chlorophyll reading and expanded proline and carbohydrate content.

Fruit yield and its components

Plants watered with I_2 recorded the most noteworthy upsides of unmarketable yield t/fed contrasted and I_0 and I_1 in the two developing seasons. This finding hold genuinely valid for the first and second seasons. These finding are in concurrence with those got by El koumy *et al.* (2012), Malash *et al.* (2019), Monte *et al.* (2013) , Etissa *et al.* (2016) , Lu *et al.* (2019), Shaban (2020) and Arab *et al.* (2022). In this regard, EL Koumy *et al.* (2012) came about that rising water system from 40 to 70 % from the field limit altogether expanded early and absolute yields. The most noteworthy early, complete yields were acquired from the plants which watered at the 70 % from the field limit. Additionally, Shaban (2020) demonstrated that shortfall and stress water system diminished natural product yield and its part aside from un attractive.

Physical fruit quality

The most noteworthy actual characters of organic products, i.e., normal organic product weight and organic product length were acquired from the most noteworthy water system level (70% F.C.) contrasted and the least water system level (40% F.C.) which gave the most minimal upsides of actual characters. What's more**, Shaban (2020)** they revealed that rising water system at soil dampness content from 66.42% to 79.45 % of field limit kept the most noteworthy quantities in undeniably estimated actual natural product quality. Such improvement in physical fruit traits as a result of using irrigation intervals treatments may be due to increasing in photosynthetic pigments and mineral elements content of plant foliage which affected positively on plant growth and consequently on quality of produce fruit as well as the main role of water on increasing number and size of fruit cells which in turn may affect on fruit size and weight.

Chemical fruit quality

Plants irrigated with I0 recorded the maximum values of V.C in both seasons of study compared with I1 and I2 without significant between them. Similar results were reported by Shaban *et al.* (2020) and Arab *et al.* (2022) observed that decreasing the level of irrigation from 100 to 80 and 60%, the TSS, acidity and lycopene in fruits increased while the fruit content in vitamin C decreased in the two seasons of study.

Seasonal amount of applied water (m^3/fed)

Increasing the values of seasonal amount of applied water under irrigation treatment I_0 comparing with other irrigation treatments I_1 and I_2 might be due to increasing number and time of irrigation practice of local farmers in the studied area. These results are in a great harmony with those obtained by Moursi and El-Mansoury (2015).

Consumptive use (m^3/fed)

Increasing the values of water consumptive use under irrigation treatments I_0 in comparison with other irrigation treatments I_1 and I_2 might be clue to increasing amount of applied water under the conditions of this treatment and hence increasing wetted area. Therefore, increasing the losses by evaporation from soil surface. So, increasing the values of water consumptive use. Also, under the conditions of irrigation treatment I_0 practice of local farmers in the studied area. Increasing amount of seasonal applied water, so, for miry strong plant with condensed canopy. Therefore, increasing losses by transpiration from plant surfaces. So, increasing the values of consumptive use. These results are in a great harmony with these obtained by Moursi and Darwesh (2014).

Consumptive use efficiency (Ecu, %), Water productivity (WP kg/m3) and productivity of irrigation water (PIW, kg / m3)

Decreasing the values of Ecu % under irrigation treatment I_0 (practice of local farmers in the studied region) comparing with I_1 and I_2 using alternative irrigation might be attributed to increasing amount of seasonal applied water under I_0 in comparison with I_1 and I_2 and hence, Decreasing the values of Ecu under the conditions of irrigation treatment I_0. The values of WP and PIW were clearly affected by the studied irrigation treatments in this present study. The highest values were recorded under irrigation treatments I_1 comparing with I_0 and I_2 and the highest values are 22.59 and 15.06 kg / fed for WP and PIW respectively. These results are in a great harmony with those obtained by Rashed and Moursi (2012).

Water saving of water irrigation water (m^3 / fed and %)

Water saving of water system water may be expanding wetted region under I_0 and thus, expanding the misfortunes by dissipation from soil surface. Thus, expanding the upsides of destructive use. Expanding the upsides of the previously mentioned concentrated on boundaries under I_0 contrasting and I_1 and I_2 may be because of expanding complete yield under the states of this treatment (I_0) in correlation with I_1 and I_2.

CONCLUSION

Under constraint of water assets in Egypt, the significance of tomato crop in the Egyptian food diet and the cultivating conditions for tomato plants as a summer crop. The highest values for chlorophyll reading were recorded under irrigation treatment I_0 but for proline and carbohydrates were found under irrigation treatment I_2 and the lowest values were recorded under traditional irrigation (I_0).The highest values for early yield, total yield and marketable yield were noticed under I_0, on the contrary, the unmarketable yield the highest values were record under I_2. The highest values for the physical measurement under irrigation treatment I_0. For chemical parameters the highest values of T.S.S%, lycopene and acidity were recorded under irrigation treatment I_2, but for V.C were recorded under I_0 .The best values for AW and CU were recorded under irrigation treatment I_0. On the contrary, the highest values for Ecu were recorded under irrigation treatment I_2. The highest values for Wp and the highest values for Wp and PIW were noted under irrigation treatment I1. The values for water saving were observed under using alternative irrigation system. The creators suggested that using alternative irrigation system instead of using traditional irrigation to make water saving and increasing the values of water productivity and productivity of irrigation water. In addition to conducting more studies in this regard.

REFERENCES

A.O.A.C (1990). Official methods of analysis. Association of official analytical chemists. 15th ed. Washington D.C., USA.

Abd El-hady, S.A., N.A.I. Abu El-Azm and S.H. El-Kafafi (2017). Effect of deficit irrigation levels and NPK fertilization rates on tomato growth, yield and fruits quality. J. Agric. Res., (3):587-604.

Abdalaali, H.H., C.H. Abdul-Jabar and A.M. Abdulkareem (2012). Effect of mulching, irrigation regime and N fertilization on dry weight and N-uptake of tomato plant. El Kofa J. Agric.Sci.,4(2):20-40.

Ali, M.H.; M.R. Hoque: A.A. Hassan and A. Khair (2007). Effect of deficit irrigation on yield, water productivity and economic returns of wheat. Agricultural water management, 92 (3): 151-161.

Bates, L.S., R.P. Waldern and I.D. Teare (1973). Rapid determination of free proline water stress studies. Plant and soil, 39: 205-207.

Cherry, J.H. (1973). Molecular biology of plants test-Manual. Clombia Univ. Press. New York and London 68-71.

Doorenbos, J. and Kassam, A.H, (1979). Yield response to water. FAO Irrigation and Drainage Paper No.33. FAO, Rome.

Du Y, Cao H, Liu S, Gu X, Cao Y (2017). Response of yield, quality, water and nitrogen use efficiency of tomato to different levels of water and nitrogen under drip irrigation in Northwestern China. J. Integr. Agric., 16:1153- 1161.

Duncan, B. (1955). Multiple Range and Multiple F. test. Biometrics, 11: 1-42.

El-Koumy, H. M. (2012). Effect of irrigation regime and mulch on growth, yield and water use efficiency of pepper plants grown in the late summer season. Ph.D. Thesis, Fac. Agric. Kafr elsheikh Univ. Egypt.

Elmasry, H.M. (2024). The effect of antitranspirants on physiological aspects and Yield of wheat crop under varied irrigation levels. Egyptian J. Soil Sci., 64(1):, 63-81.

El-Nady, M.A. and Hadad, W.M. (2016). Water use efficiency of soybean under different tillage and irrigation methods. Egyptian J. Soil Sci., 56(2):, 295-312.

El-Quosy, D. (1998). The challenge for water in the twenty first century. The Egyptian experience. Arab-water98.Ministry of Water Resources and irrigation (MWRI) April 26-28, 1998, Cairo, Egypt.

Elsherpiny, M.A. and Helmy, A. (2022). Response of maize plant grown under water deficit stress to compost and melatonin under terraces and alternate furrow irrigation techniques. Egyptian J. Soil Sci, 62(4):, 383-394.

Etissa, E., N. Dechassa and Y. Alemayehu (2016). Estimation of yield response (Ky) and validation of crop wat for tomato under different irrigation regimes. Irrigation Drainage Sys Eng. 5, (2):, 1-6.

Faied K. Engy and ELshater A. M. Amira (2022). Socioeconomics study of Tomato production in Egypt: A case study. Middle East J. of Agric. Res., 11 (01): 312-323.

FAO, (1998). Production year book, Agriculture statistics series. FAO, Rome. Vol. 52.

Ghada, H.M., Mostafa, M.A., Khalil, N.S.A.M. and Manal, M. (2013). Manufacturing Amino Acids Biofertilizers from Agricultural Wastes. I-Usage of Tomatoes and Sugar Beet Straw to Prepare Organic Synthesized Fertilizers. Egyptian J. of Soil Sci., 53:, 461-474.

Gomez, K. A. and A. A. Gomez (1984). Statistical procedures for Agricultural Researches. 2nd Ed., John Wiley &Sons., USA.

Hansen, V.W,: D.W. Israelsen and D.E. Stringharm (1979). Irrigation principle and practices, 4 th ed Johns Willey& Sons; New York.

Heba E.Shaban (2020). Effect of irrigation and anti transpirant on growth and productivity of some tomato cultivars under Kafr Elsheikh condition. ph. D. Thesis, fac. Agric. Moshtohor, Benha, Univ, Egypt.

Hu J, Gettel G, Fan Z, LV H, Lin S (2021). Drip irrigation promotes water and Nitrogen use efficiency and yield stability through improved root growth for tomatoes in plastic greenhouse production. J. Agric.Ecosyst Environ.313,107379

James, L.G. (1988). Principles of farm irrigation system design. John Willey&Sons (ed.), New Yourk, pp.543.

Khalifa, R.M., (2023). Effects of Inadequate Drip Irrigation and Organo-Mineral Fertilizer on Tomato Production, Quality and Water Use Efficiency in Sandy Soils. Egyptian J.of Soil Sci., 63(3), :,325-238.

Khan, H., Basit, A., Alam, M., Ahmad, I., Ullah, I., Alam, N., Ullah, I., Khalid, M.A., Shair, M. and Ain, N.U. (2020). Efficacy of chitosan on performance of tomato (*Lycopersicon esculentum* L.) plant under water stress condition. Pakistan J. of Agricultural Res., 33(1): 27-41. DOI: 10.17582/journal.pjar/2020/33.1.27.41.

Klute, A.C (1986). Water retention: laboratory Methods. In: A. Koute (ed), Methods of Soil Analysis, part12nd (ed). Agron Monogr.9, ASA, Madison, W1 U.S.A, pp.635-660.

Lu, J., G. Shao, J. Cui, X. Wang, and L. Keabetswe (2019) . Yield, fruit quality and water use efficiency of tomato for processing under regulated deficit irrigation: A meta-analysis. J. Agric., Water Management, (222): 301–312.

Malash , N.M., M.A. Fattahalla, M.R. Khalil and E.S.A. Ibrahim (2019). Enhancing drought tolerance of tomato plants grown under different irrigation regimes by some cultural practices. Menoufia J. Plant prod., 4 (6) :181-205.

Monte, J.A., D.F. de carvalho, L.O. Medici, L.D.B. da Silva and C. Pimentel (2013). Growth analysis and yield of tomato crop under different irrigation depths. R. Bras, Eng. Agric. Ambiental., 17 (9): 926-931.

Moursi, E.A. and Mon A.El-Mansoury (2015). Effect of cultivation method and different irrigation levels on water relations for sugar beet crop in North Nile Delta region J.soil sci and Agric.Eng. Mansoura Univ, 6(8): 983-999.

Moursi, E.A. and R.Kh. Darwesh (2014). Effect of irrigation and nitrogen fertilization on sugar beet yield quality and some water relations in heavy clay soils. Alex. Si. Exch. J., 35 (3):, 234-248.

Murquard, R. D. and J. L. Timpton(1987). Relationship between extractable chlorophyll and an in situ method to estimate leaf green . Hort. Sci., 22(6): 1327.

Musa, T. L. and Kolawole, O. S.(2024). Influence of drought stress on the fruit and yield quality of three different varieties of tomato (*Lycopersicum esculentum* L.). J. of Sci., 8 (3):, 332 – 337. DOI: https://doi.org/10.33003/fjs-2024-0803-2360.

Nahed, M. Rashed and E.A Moursi (2012). Influence of Cultivation Method and Irrigation Regime on growth, oil yield and yield some water relations of sage (*Salvia officinalis*, L.) in heavy clay soils. Alexandaria Science Exchange Journal. Vol. 33(2).

Oti, E.C., Aliero, A.A., Gumi, A.M., Hassan, S. and Alhassan, J. (2023). Effect of Drought Episodes on Yield and Biochemical Contents of Rice (*Oryza sativa* L.) Accessions in Sokoto Agro-Climatic Zone. FUDMA J. of Sci., 7(5): 213-220. DOI: https://doi.org/10.33003/fjs-2023-0705- 2014

Page, A.L., R.H. Miller and D.R. Keeney (1982). Methods of Soil Analysis -Chemical and Microbiological Properties. Madison, Wisconsin.

Pervez, M.A., C.M. Ayub, H.A. Khan, M.A. Shahid and I. Ashraf (2009). Effect of drought stress on growth, yield and seed quality of tomato (*Lycopersicon esculentum* L.). Pak. J. Agri. Sci., 46(3): 174-178.

Ravelo-Pérez L.M., Hernández-Borges J., Rodríguez-Delgado M.A., Borges-Miquel T. (2008). Spectrophotometric analysis of lycopene in tomatoes and watermelons: a practical class. Chem. Educ., 13:11–13

Wahb-Allah M. A, A. A. Alsadon and A. A. Ibrahim (2011). Drought tolerance of several tomato genotypes under greenhouse conditions. World Appl. Sci. J. 15 (7): 933-940.

Yassen, R., Hegab, R., Kenawey, M., Eissa, D. (2020). Effect of super Absorbent polymer and biofertilization on maize productivity and soil fertility under drought stress conditions. Egypt. J. Soil. Sci., 60(4):, 377-395. https://doi.org/1 0.21608/ejss.2020.35386.1372. Zhang H, Xiong Y, Huang G, Xu

Zeinb E. Arab, Nadia, S.A. Shafshak, M. M. El Nagar and A. S. Sham (2022). Implications of water stress and foliar application with some stimulants on productivity, fruit quality and water use efficiency of some tomato genotypes. Sci. J. Agri, 4 (1): 57-68.

تأثير الري التبادلي على نمو و إنتاجية الطماطم تحت ظروف التربة الطينية

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الملخص

تم إجراء تجربة حقلية على نباتات الطماطم في منتصف عامي عام 2023 و ٢٠٢٤، في المزرعة التابعة لكلية الزراعة في مشتهر جامعه بنها ، محافظة القليوبية، مصر..تم تصميم التجربة فى قطاعات كاملة العشوائية مع ثلاث مكررات، حيث معاملات كانت I_0 الري التقليدي كما يمارسه المزارع المحلي في المنطقة موضع الدراسة ، (I_1) الري البديل خط وخط بالتبادل و I_2 الري البديل خط وخط ثابتًا طوال موسم النمو بدون رى. وكانت معظم القيم المعنوية لصفات النمو المدروسة تحت نظام الرى التقليدى مقارنة بالرى التبادلى والرى خط وخط اخر ثابت بدون رى طوال الموسم .معظم القيم معنوية لكل القياسات الخضرية حيث سجلت تحت معاملة الرى التقليدى I_0 بالمقارنة I_1, I_2 أعلى القيم لمحتوى الكلوروفيل تحت الرى التقليدى لكن البرولين والكربوهيدرات كانت اعلى القيم مع الرى التبادلى وخاصة مع الرى خط وخط اخر ثابت بدون رى طول موسم النمو I_2بينما كانت اقل القيم لهم تحت نظام الرى التقليدى I_0فى حين سجلت اعلى القيم للمحصول المبكر والمحصول الكلى والمحصول القابل للتسويق وعلى العكس سجل المحصول الغير قابل للتسويق اعلى القيم تحت ظروف الاجهاد (خط وخط ثابت بدون رى طول موسم النمو I_2) فى حين سجلت اعلى القيم للصفات الطبيعية و الفيزيائية تحت معاملة الرى التقليدى I_0 مقارنة I_1 , I_2 بالنسبة للصفات الكيميائية كانت اعلى القيم لنسبة المواد الصلبة الذائبة الكلية والليكوبين والحموضة تحت ظروف الاجهاد I_2 ولكن بالنسبة لفيتامين ج تم تسجيل اعلى القيم مع الرى التقليدى I_0 وكانت اعلى القيم بالنسبة لكفاءة الاستهلاك المائى تحت معاملة الرى I_2 واعلى القيم بالنسبة لانتاجية وحدة المياه المستهلكة والمضافة سجلت تحت معاملة الرى I_1 مقارنة I_0 , I_2 كمية المياه المتوفرة تم ملاحظتها تحت نظام الرى التبادلى اعلى القيم بالنسبة للمقاييس الاقتصادية سجلت تحت معاملة الرى I_0 بالمقارنة I_1 , I_2 .