Assiut Journal of Agricultural Sciences 54 (3) 2023 (119-134) Website: http://ajas.journals.ekb.eg/
ISSN: 1110-0486 / EISSN: 2356-9840 E-mail: ajas@aun.edu.eg

(Original Article)

Effect of Irrigation Levels on Growth and Fruiting of Manfalouty Pomegranate Trees Grown in New Reclaimed Region

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DOI: 10.21608/ajas.2023.211452.1255

Abstract

This study was performed throughout consecutive seasons of 2020 and 2021 on 8 years age trees of Manfalouty pomegranate trees grown in a sandy soil at special farm situated at Banu Uday, Manfalout city, Assiut Governorate, for studying the impact of three levels irrigation: 60, 80 and 100% of water requirement (WR) via drip irrigation on growth, yield, fruit quality and irrigation water efficiency (WUE).

The current results declared that all studied vegetative traits significantly decreased due to irrigate with 60% of water requirement compared to 100% of water requirement (control). No significant differences were recorded for studied parameters due to reducing water from 100 to 80%. Also, using 80 or 100% of WR significantly increased yield and marketable yield as well as improved the fruit quality. Using 60% of WR gave the maximum water use efficiency (WUE). It is evident from the obtained data that using 80% of water requirement via drip irrigation induce an improve the trees growth traits and increasing the market value of resulting crop. Moreover, raising efficiency and reduce water used by about 20% of water requirement.

Keyword: *Irrigation, Water requirement, Pomegranate, Yield, Efficiency.*

Introduction

The trees of pomegranate are preferable fruit of tropical and subtropical regions, enters within to the family punicaceae. Manfalouty is counted as one of important remarkable pomegranate c.v. successfully grown in Egypt. The total area of pomegranate trees was about 0.5% of the total area of fruit trees in Egypt (76924 fed). Governorate of Assiut is considered as a main producer of Egyptian pomegranate according to Ministry of Agriculture and Land Reclamation (M.A.L.R., 2020).

Irrigation that one of the most important and vital activities associated with agriculture during growth period of seasons. Irrigation system depends on climate, soil type and tree cultivar. The execution of pomegranate trees in expressions of growth, fruiting storage ability and sustainability productivity depends on

Received: 17 May 2023/ Accepted: 18 June 2023/ Published online: 1 July 2023

irrigation. Taking these with that in mind, favorable strategies have to be contrivance to improve use efficiency of water (Meshram *et al*., 2010).

The lack of safe water is one of the most global problems that facing the continuity of sufficient for production food necessary to meet the growing nutritional needs (Molden, 2007). In many regions of world, water shortage is the most important factor effects on agriculture productive (Azevedo *et al*., 2003). Water is one of the most important components in the biological assignment is water. Water is an essential combination for vital interactions happening inside of plants. Also, water is major as it transfers plant nutrients and other materials inside the tree, as well as supports protect plant from high heat through transpiration and preserving leaf and fruit turgidity (Salisbury and Rose, 1985 and Devid *et al*., 1999).

Fruit trees management and saving irrigation water to raise use efficiency of water is important tasks. The quantity and quality in irrigation water available in the arid and semi-arid provinces of the world such as Egypt, is one of the most important factors determining the expansion of agriculture production (Beaumont, 1993). Shortage of irrigation water retarded plant growth and development (Wright and Stark, 1990). In Egypt, the orchards of pomegranate are irrigated by the surface irrigation system. Trees could be advanced under drought stress conditions but including sufficient soil moisture will essentially promote of plant growth and yield. Nowadays, regulation of water uses became a national priority, irrigation water using is very important in Egyptian lands, due to lack of the water exchequer and the extending of cultivation of the new and desert lands. Then, it is requested to define appropriate doses water for fruit trees to get the highest crop production.

The strategies of improving irrigation efficiency including establish modern irrigation systems, reduce losses of irrigation water reduction useless evaporating and decrease pollution of water. Researchers are acting to obtain the highest productivity by using the lowest rate irrigation and fertilization (Abdel-Aziz *et al.,* 2013).

Currently, activated researches are being conducted on modern irrigation techniques to regulate the leak of irrigation water and increase the use efficiency of water used and the production of trees. One of the most promising techniques that increase the efficiency of the water used in terms of increasing water spread and nutrient solution and delivering directly to root absorption area, while reducing evaporation from soil surface and the flow of water for percolation to the depths of soil (Behnia, 1999).

Nowadays, the use of water to irrigate fruit trees is a widely used bad practice. Therefore, it has become necessary, especially in second years, to find means that increase the efficiency, of irrigation water. In addition, in order to remedy the rapid shortage of resources available water in many parts of the world (Kang *et al*., 2002).

The available information on modern irrigation methods in pomegranate orchards that associated with increasing irrigation water efficiency, increasing vegetative growth and the nutritional status of trees. In addition, increasing yield and improving fruit characteristics as well as and save it under the current conditions of water shortage.

Then, the aim of this investigation is to recognize the impact of irrigation levels on vegetative growth, yield and fruit quality of pomegranate orchards.

Material and Methods

This search was carried through the alternate seasons of 2020 and 2021 on Manfalouty pomegranate orchard situated at Banu Uday, Manfalout City, Assiut Governorate, Egypt, the trees were growing in a sandy loam texture soil (Table 1); soil analysis was carried out due to Wilde *et al*. (1985).

Table 1. Physiochemical characteristics of soil (0-90 cm deep) of the experimental site

Soil characteristic	Rate	Soil characteristics	Rate
Sand (%)	79.52	Organic matter (%)	0.53
Silt (%)	10.0	Total nitrogen (%)	0.16
Clay (%)	10.48	Mg (ppm)	194.4
Texture grade	Sandy loam	K (ppm)	15.60
Field capacity, FC (%)	27.91	Na (ppm)	172.5
pH (1-2.5)	7.75	Cl (ppm)	667.4
EC (ds m^{-1})	0.98	HCO_3 (ppm)	610.0
Ca (ppm)	376.0		

The annually fertilization of the trees using 15 m^3/feddan of organic manure in December of each year combined with 1.0 Kg/ tree calcium superphosphate (15.5% P_2O_2). Also, 2.0 Kg/tree ammonium sulphate (20.6% N) and 1.0 Kg/tree of potassium sulphate (48% K_2O) were inserted in three similar dosages at February, April and June.

Eighteen healthy trees, 8 years old grown at 3.5×3.5 m apart under drip irrigation system. The selected trees are free from symptoms of elemental deficiency, disease and pests. These trees were divided to carry out the study. All know horticulture practices were applied to all chosen trees, except for the studied treatments, which were applied according to the experimental plan. Three irrigation levels of the recommended rate of irrigation (RRI) were arranged as follows:

T_1- 60% of the (RRI), (4.34 m^3/tree/year) = 1475 m^3/feddan/year.

T_2- 80% of the (RRI), 5.78 m^3/tree/year) = 1967 m^3/feddan/year.

T_3-100% of the (RRI) (7.23 m^3/tree/year) = 2459 m^3/feddan/year) (check treatment).

The irrigation water requirement was calculated as potential crop evapotranspiration (ETc), based on metrological data obtained from the meteorological station of Assiut. Crop water was measured according to Allen *et al*. (1998) by the following equation: ETc = ETo * Kc, where ETc is crop evapotranspiration [mmd^{-1}], Kc is coefficient of crop and ETo is reference transpiration of crop [mmd^{-1}]. Then, the irrigation water requirement was calculated according to the following equation:

IR = ETc × A × irrigation system efficiency × leaching requirements.

where, IR is volume of water in liter per plant, ETc is evapotranspiration. A is plant area, the space covered with plant (m^2), (Choudhary and Kadam, 2006).

The design of the experiment was constituted as a complete randomized block with three redundant per treatment two trees each. The amounts of daily irrigation water increased in liters per tree are presented in Table (2).

Table 2. Dividend of the irrigation water (L/day/tree) and no. of irrigation/ month and no. of irrigation/month during 2020 and 2021 seasons

Month Treat.	J.	F.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	T.M^3/ tree	T.M^3/ feddan
4 day/tree	4	4	5	10	30	50	50	50	30	10	5	4	-	-
No. irri/month	2	4	30	30	30	30	30	30	30	30	30	2	-	-
T_1 60%	4.8	9.6	90	180	540	900	900	900	540	180	90	4.8	4.34	1475
T_2 80%	6.4	12.8	120	240	720	1200	1200	1200	720	240	120	6.4	5.78	1967
T_3 100%	8	16	150	300	900	1500	1500	1500	900	300	150	8	7.23	2459

The next characteristics were estimated through the two studied seasons:

A- Vegetative growth traits

Four main branches almost equal in growth and spread on four hands of tree were elected and classified in April for measured the following vegetative measures:

1- Length of shoot (cm).

2- Area of leaf (cm2), was estimated due to Ahmed and Morsy (1999) and then the total leaf area/shoot were calculated.

3- Total chlorophyll of leaf was mensurated using chlorophyll meter for ten leaves (Minolta SPAD 502 plus).

B- Nutritional status of leaves

Species of fifty mature leaves were looked random from the spring branches in mid-September to estimate nitrogen, phosphorus and potassium, leaf samples were dried in oven and digested with a mixture of sulfuric acid and hydrogen peroxide (Wilde *et al*., 1985). Nitrogen was measured by the micro-Kjeldahl methods (Bremner and Mulvaney, 1982), phosphorus was determined spectrophotometry and potassium was determined by flame photometer (Jackson, 1958).

C- Yield

Fruits were harvesting and yield/tree (kg) was recording. The infamous fruits were detailed to calculate the percentage of cracking and sun-burning fruits.

D- Fruit quality

Specimens of ten fruits were randomly taken from each tree to determine the traits of fruits. The weight of fruit, arils %, percentage juice, the chemical fruit quality including contents of soluble solids and acidity (expressed as g citric acid/100 ml juice), ascorbic acid (mg/100 ml juice) and reducing sugar were estimated due to A.O.A.C. methods (1985). Also, the content juice of anthocyanin was estimated due to Rabino and Mancinelli (1986).

E- Efficiency use of water (EUW)

Efficiency use of water (EUW) was estimated as follow:

EUW = tree yield (kg)/IR (m^3) which is the ratio of yield (Y) to the total amount of expend irrigation water (IR) throughout the development season (Hussein, 2004).

F- Overall valuation of used irrigation water

Scoring valuation of the irrigation levels were counted on criterion scale of 100 points that were divided into between the growth of vegetative, yield and fruit quality. Hundred points were shared among the studied parameters as following 30 points for vegetative growth (shoot length, leaf area/shoot and chlorophyll SPAD value), 30 points for the yield component (yield/tree, fruit cracking % and commercial fruit %), and 40 points for fruit quality parameters (fruit weight, TSS, V.C and anthocyanin contents) 10 points for each. Within each of these traits, the trait was registered the maximum values given 10 units for it. Relative values due to the other tested treatments were calculated. The following equation was used to estimate these traits.

$\text{Trait} = \sum \frac{B}{A}$ x10 where:

A= The highest values recorded for studied traits.

B= Value recorded for the specific trait of considered treatments.

The exiting data were analyzed statistically due to Gomez and Gomez (1984) and Mead et al. (1993) by the L.S.D. values at 5% to find the significance differences among between treatment means.

Results

Impact of irrigation levels on vegetative growth and leaf nutrient contents:

Date in Tables (3, 4 & 5) showed the impact levels of irrigation on growth of Manfalouty pomegranate during 2020 and 2021 seasons. It is clear from the obtained results that data of both seasons took identical trend.

In general, data declared a marked variation in most of studied vegetative growth among the different irrigation levels. The highest values were recorded by irrigation with 100% levels (control).

Table 3. Impact of levels on shoot length and leaf area of Manfalouty pomegranate trees in 2020 and 2021 seasons

Irrigation levels	Shoot length (cm)			Leaf area (cm^2)			Leaf area/shoot (cm^2)		
Seasons	**2020**	**2021**	**Mean**	**2020**	**2021**	**Mean**	**2020**	**2021**	**Mean**
T_1 60% WR	51.3	53.4	52.35	5.65	5.48	5.57	216.8	225.1	220.9
T_2 80% WR	58.92	60.2	59.56	6.18	5.95	6.07	260.1	269.6	264.9
T_3 100% WR	59.4	61.8	60.60	6.26	6.11	6.19	258.9	276.7	267.8
L.S.D. 0.5	2.36	2.12		0.26	0.23		11.68	12.31	

Table 4. Impact of irrigation levels on chlorophyll, N and P-leaf of Manfalouty pomegranate trees in 2020 and 2021 seasons

Irrigation levels	Chlorophyll (SPAD value)			Nitrogen %			Phosphorus %		
Seasons	**2020**	**2021**	**Mean**	**2020**	**2021**	**Mean**	**2020**	**2021**	**Mean**
T_1 60% WR	54.7	52.4	53.6	1.33	1.42	1.38	0.193	0.217	0.205
T_2 80% WR	60.7	59.1	59.9	1.61	1.72	1.67	0.269	0.296	0.283
T_3 100% WR	61.6	60.8	61.2	1.64	1.76	1.70	0.274	0.306	0.290
L.S.D. 0.5	2.06	1.97		0.05	0.05		0.015	0.013	

All the studied vegetative traits significantly decreased when irrigation level was reduced to 60% of water requirement (WR) compared to use 100% of water requirement. Reducing the water amount to 80% failed did not to show any significant decrease in the studied growth and leaf nutrient parameters.

Leaf area (cm^2)/shoot, total chlorophyll and leaf nitrogen percentage were significantly reduced due to irrigate by 60 or 80% compared with 100% of WR. The recorded values of them were (220.9, 264.9 & 267.8 cm2), (53.6, 59.9 & 61.2 SPAD) and (1.38, 1.67 & 1.70% as an average two study seasons) due to irrigate by 60, 80 and 100% of WR, respectively.

The obtained data showed a decrement traits of leaf area/shoot, total chlorophyll and leaf-N % were attained (17.51 & 1.08), (12.42 & 2.12) and (18.82 & 1.76%) as an av. two studied seasons, due to irrigate by 60 or 80% of WR compared to use 100% of WR (check treatment), respectively.

The irrigation levels have a direct and positively effected of pomegranate trees vegetative growth. Since the shortages of induce due to reduce in plant growth due to prevented leaf and shoot elongation and reducing nutrient uptake by tree roots.

Effect of irrigation levels on yield

Data in Tables (5 & 6) displayed that, quenched trees by 80 or 100% of the water requirement (WR) considerably raised the yield and the fruit cracking percentage and decreased percentage sunburn that led to a considerable rise in the popular fruit's percentage comparing to use 60% of WR. The highest yield/tree and marketable fruits percentage were recorded by using of 100% WR (31.56 kg and 80.68% as an average studied two seasons) due to 100% and 80% of WR, while the lowest values (23.77 kg and 77.17%) was recorded for using 60% of WR (Table 6). Hence, the percentage of increment of yield/tree was (15.42 & 17.84%)

and the marketable fruits (4.55 & 3.68%) were recorded for application 100 or 80% of water requirement compared to 60% of WR, respectively.

Table 5. Effect of irrigation levels on leaf-K and yield of Manfalouty pomegranate trees in 2020 and 2021 seasons

Irrigation levels	Potassium %			Yield (kg)/tree			Fruit cracking %		
Seasons	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1 60% WR	1.11	1.16	1.14	22.81	24.72	23.77	9.83	8.75	9.29
T_2 80% WR	1.36	1.45	1.41	28.53	30.65	29.59	10.18	9.06	9.62
T_3 100% WR	1.37	1.48	1.43	30.88	32.23	31.56	11.00	9.84	10.42
L.S.D. 0.5	0.05	0.04		0.97	1.10		0.82	0.71	

Table 6. Impact of irrigation levels on marketable yield of Manfalouty pomegranates in 2020 and 2021 seasons

Irrigation levels	Sunburn %			Marketable %			Fruit weight		
Seasons	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1 60% WR	14.41	12.68	13.55	75.75	78.60	77.17	255.1	263.9	259.5
T_2 80% WR	10.38	9.11	9.75	79.44	81.91	80.68	338.3	373.3	355.8
T_3 100% WR	10.16	8.98	9.57	78.84	81.18	80.01	344.9	383.8	364.4
L.S.D. 0.5	0.70	0.62		2.16	1.78		8.31	9.22	

On other hand, the incidence of sunburn fruit significantly increased due to reduce the irrigation levels 60% of WR that recorded the highest values (13.55% as an average of studied two seasons), whereas the lowest value (9.57%) recorded for using 100% of WR. The percentage of sunburn fruit was recorded by (28.04 & 29.37%) for 100% of WR comparing to use 60% of WR as an average of two seasons, respectively.

Moreover, irrigate by 60% of WR considerably reduced the fruit percentage of comparing to use 100% of WR. No significant variations recorded on such parameters due to irrigate by 100 or 80% of water requirement for pomegranate trees.

In general view data declared that highest weight yield/tree and popular of percentage of fruits and least inglorious fruits percentage were found due to use with 80 or 100% of WR via drip irrigation method for trees. Then it is obvious that irrigation by 80% of WR have beneficial effects on the pomegranate production.

It could be concluded that all the irrigation levels have direct effect on productivity of trees. Since water shortage often induce decreasing the growth of tree by inhabiting shoots elongation and reducing nutrient uptake by trees and consequently reduction of tree production.

Fruit quality as influence by irrigation levels

Physical fruit characteristics

According to the specified effect of irrigation levels on fruit physical traits, data in Table (7 & 8). It could be noticed that irrigation by either of 80% or 100%

levels considerably improved the fruit traits in expression of rising the fruit weight (g), fruit size, aril (%) and juice volume compared to use 60% of WR which achieved the lowest values. Irrigation by 100% of water requirement amount gave the maximum values of these traits. The highest fruit weight (364.4g), length of fruit (8.43 cm), diameter of fruit (8.69 cm), percentage of aril (56.18%) and juice volume (62.7 cm^3) as average of two studied seasons, respectively. No significant variations were seen among 80 and 100% of WR. The lowest values (259.5 g, 7.38 cm, 7.62 cm, 52.67% and 58.1 cm^3, as an average two studied seasons) were recorded for weight of fruit, length of fruit, percentage of aril and juice volume of trees that irrigated with 60% of WR, respectively. Then the percentage of increases of weight fruit was (37.11 & 40.42%) as an average of two seasons for irrigated by 80 and 100% of WR compared to use 60% of WR, respectively.

Table 7. Impact of irrigation levels on fruit characteristics of Manfalouty pomegranate trees in 2020 and 2021 seasons

Irrigation levels	Fruit length			Fruit diameter			Arils %		
Seasons	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1 60% WR	7.44	7.31	7.38	7.67	7.56	7.62	52.38	52.96	52.67
T_2 80% WR	7.80	8.29	8.04	8.24	8.54	8.39	54.66	55.38	55.02
T_3 100% WR	8.33	8.53	8.43	8.56	8.81	8.69	55.91	57.45	56.18
L.S.D. 0.5	0.16	0.17		0.18	0.19		1.22	0.98	

Table 8. Impact of levels irrigation on juice volume and contents of Manfalouty pomegranates in 2020 and 2021 seasons

Irrigation levels	Juice volume			TSS%			Reducing %		
Seasons	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1 60% WR	58.5	57.6	58.1	17.5	16.6	17.1	13.41	12.75	13.08
T_2 80% WR	61.4	60.3	60.9	16.9	16.1	16.5	13.10	12.58	12.84
T_3 100% WR	63.3	62.1	62.7	16.8	16.0	16.4	13.0	12.46	12.73
L.S.D. 0.5	1.62	1.54		0.19	0.16		0.24	0.20	

Fruit juice constituents

The juice constituents of fruit juice under variations levels of irrigation in Tables (8, 9 & 10). The obtained data showed significant variations among irrigation levels for all recorded traits. Data declared that using 60% of WR via drip system significantly raised soluble solids content, reducing sugar and content of anthocyanin in juice and fruit peel and considerably reduced the vitamin C content compared to use 80 or 100% of WR. No differences were observed between 80 or 100% of WR. Moreover, the highest or lowest values were recorded due to use 100% of WR. The TSS and reducing sugar content were (17.1, 16.5 & 16.4) and (13.08, 12.84 & 12.73% as an average of two seasons) with irrigation 60, 80 or 100% of WR, respectively. The decrement percentage of TSS attained (3.51 & 4.09%) due to use 80 or 100% of WR compared to use 60%, respectively.

Table 9. Impact of levels irrigation on acidity and V.C contents of Manfalouty pomegranates in 2020 and 2021 seasons

Irrigation levels	Acidity			TSS/acidity			V.C.		
Seasons	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1 60% WR	1.23	1.17	1.20	14.31	14.19	14.25	19.31	20.16	19.74
T_2 80% WR	1.29	1.20	1.25	12.17	13.40	12.79	22.51	24.62	23.57
T_3 100% WR	1.31	1.23	1.27	12.93	13.01	12.97	22.38	24.48	23.43
L.S.D. 0.5	0.06	0.05		0.89	0.71		0.39	0.42	

Table 10. Influence of levels irrigation on anthocyanin and water use efficiency of Manfalouty pomegranates in 2020 and 2021 seasons.

Irrigation levels	Anthocyanin in juice			Anthocyanin in arid			Water use efficiency		
Seasons	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1 60% WR	57.39	58.94	58.14	54.11	55.18	54.65	5.26	5.69	5.47
T_2 80% WR	52.74	54.18	53.46	50.31	51.63	50.97	4.94	5.30	5.12
T_3 100% WR	50.85	52.69	51.77	48.53	50.35	49.44	4.24	4.46	4.35
L.S.D. 0.5	1.51	1.63		1.49	1.54		0.41	0.49	

Impact levels of irrigation on efficiency use of water (EUW)

Data in Table (10) declared the impact of variation irrigation levels on efficiency use of water during (2020 and 2021).

Efficiency use of water (EUW) is a significant indicator to recognize the superior irrigation levels.

Data indicated that, efficiency of water significantly impacted by different levels of irrigation. Irrigation with 60 or 80% of water requirement amount (WR) significantly raised efficiency use of water comparing utilize to 100% of WR. No significant variations on EUW for irrigation by whatever 60 or 80%.

The getting efficiency use of water was (5.47, 5.12 and 4.35 kg/m^3 water) as the av. of the two seasons of studied, for irrigation with 60, 80 and 100% of WR irrigation, respectively.

The percentage increment of efficiency use water through the two seasons of studied were (25.75 & 17.70%), due to irrigate with 60 or 80% of WR via trickle irrigation over the control (100% of WR), respectively.

Furthermore, results declared the reduction percentage of yearly amount of water around 40 and 20% due to use 60 or 80% of water requirement amount via drip irrigation compared to (check treatment), respectively.

General evaluation of the studied treatments

Data in Tables (11 & 12) cleared that, irrigation by 100% of water requirement amount (WR) or 80% of WR recorded the highest value in the estimation valuation, had gated the maximum score (97.2 & 96.8) while using 60% of WR which occupied the third ranked (89.2).

The gross outcome score for quality of fruit of pomegranates (fruit weight, TSS, V.C and anthocyanin) was considerably various according to use of different irrigation treatments. Using 100% of WR gave the highest values followed 80% of

WR compared with using 60% of WR. The studied treatment could be coordinated descending instituted on gross score (40) for quality of fruit as follows: 38.4, 38 and 35.5 units for using 100, 80% and 60% of WR, respectively.

Table 11. General evaluation of level irrigation effects on vegetative growth and yield components of Manfalouty pomegranates as average of two studied season

	Vegetative growth				Yield components			
Characters	**Shoot length**	**Leaf area**	**Chloro.**	**Total**	**Yield**	**Fruit cracking**	**Marketable %**	**Total**
Score	10	10	10	30	10	10	10	30
T_1 60% WR	8.6	8.2	8.8	25.5	8.5	10.0	9.6	28.2
T_2 80% WR	9.8	9.9	9.8	29.4	9.8	9.7	10.0	29.4
T_3 100% WR	10	10	10	30.0	10	8.9	9.9	28.8

Table 12. General evaluation of level irrigation effects on fruit quality of Manfalouty pomegranates as average of the two seasons

Characters	**Fruit weight**	**TSS**	**V.C**	**Anthocyanin**	**Total**	**G. Total**
Score	10	10	10	10	40	100
T_1 60% WR	7.1	10	8.9	10.0	35.5	89.2
T_2 80% WR	9.2	9.6	10	9.2	38.0	96.8
T_3 100% WR	10	9.6	9.9	8.9	30.4	97.2

In general view, irrigating pomegranate trees with 80% of estimated water requirement, leads to an increase in yield and save 20% of irrigation water. This means an increase the irrigation efficiency and improve the soil moisture and aeration which improve soil fertility and nutrients uptake by trees.

Hence, such results showed clearly that irrigation by 80% of WR via drip irrigation system is considered promising tool to improve yield and fruit quality, in additionally reducing the amount of irrigation water used. Variations among these treatments could be due to their effects on growth aspects, nutritional situation, yield and fruit quality. These results accordance with Aseri *et al*. (2008) and El-Halaby (2015) who reported that there is preferable in trees growth and productivity under irrigation by 80% of estimated amount water via drip irrigation system.

Discussion

Irrigation systems have a considerable effect on growth and fruiting yield of the fruit crops. Yield in growth characteristics were raised under drip irrigation system comparing with surface irrigation. In trickle irrigation system, holding the appropriate humidity content in functional root area of the trees and decrease the downing of nutrients a crosses the course of soil deepest. Also, drip irrigation minimize troubles of plant roots that progress the tree growth, yield and fruit traits comparing with conventional flood irrigation suit (Granatstein and Sánchez, 2009).

The influence stress of water on shoot growth may be explained by the impact of stress of water in decreasing the hormone transport from roots to shoots and raised the amount of leaf abscisic acid. The alteration in growth regulators balance induced a decreasing in growth cell and leaf surface expansion. These results findings correspond by that found by El-Iraqy *et al*., (2006) on guava and Khattab *et al*. (2010) on pomegranate, that who found that vegetative growth aspects were significantly raised due to increase irrigation water doses.

Fruit trees demand optimum soil humidity for rapid cell division and cell elongation of development fruits. Higher amount of water is supplied in conventional flood irrigation comparing with modified irrigation system. Additionally, trickle irrigation progressed the intensity of major nutrients such as N, P, K and Zn that gave high yield with good fruit comparing with conventional flood. Moreover, irrigation had big effect on fertilizers use efficiency, yield and fruit quality. In appropriate irrigation pursuits damage fruit quality by reducing nutrients uptake from the soil (Hutton *et al*., 2007 and Quiñones *et al*., 2007). Highest nutrient uptake and minimum nutrient filtrating were obtained by using modern irrigation arrangement (Shirgure and Srivastava, 2013).

Such findings were found in our study, the maximum nutrient contents N, P and K in leaf of Manfalouty pomegranate were recorded for trees growing with 80% of the estimated amount of water compared with trees under 60 or 100% of estimated amount water.

Our findings are in regularity with the findings found by Abo-Taleb *et al*. (1998), Abou El-Wafa (2002), Ibrahim and Abd El-Samad (2009), Khattab *et al*. (2011), Abd-Ella (2011) and El-Bolok *et al*. (2022) who detected that shoot traits and leaf area of pomegranate significantly affected by irrigation regimes.

Yield per tree was raised due to improve in the tree growth under 80 or 100% of estimated amount water (WR).

Thus, trickle irrigation maintenance the constant applies of humidity comparing with conventional flood irrigation leading to improve tree yield (Raza *et al.*, 2016). Trees grown under 80% of WR gave the highest yield and marketing fruits with an increasing about (22.89 and 35.19% as an average of two seasons of studied) compared used 60% of WR, respectively.

These findings come by that found by Abd El-Rahman (2010) and Khattab *et al*. (2011) they declared that fruit splitting of Manfalouty pomegranate reduced under lower soil humidity content. Also, they seen that, the heaviest yield was recorded due to high humidity availability meantime, the least number of fruits was recorded by lowest level of irrigation (El-Khoreiby and Salem, 1989).

Obtained results, 80% of WR reduce the water use by up to 20% without reduction in tree growth and productivity compared to use 100% or WR. The trees under 80% of WR produce higher yield and have better WUE.

Irrigation has direct effect on fruit trees productivity. Since, irrigation affecting in tree growth and nutrient uptake. Use 80% of estimated water requirements improved the soil moisture and aeration which were responsible for increasing growth, photosynthesis rate and carbohydrate translocation and consequently improve the tree fruiting (El-Halaby, 2015).

The same finding declared that receive more doses irrigation had greater water use than trees receive less doses irrigation under similar climatic conditions (Smitle *et al*., 1994; Abd El-Samad, 2005 and Khattab *et al*., 2011).

Conclusion

Hence, it could be concluded that irrigation by 80% of estimated water requirements via trickle irrigation increase growth of tree and its status of nutrients and yield and quality of fruit and lead to an increase in the marketable yield, as well as minimize the production costs.

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تأثير مستويات الري على نمو وإثمار أشجار الرمان المنفلوطي في مناطق الاستصلاح

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الملخص

أجريت هذه الدراسة بمزرعة خاصة بمنطقة بني عدي – منفلوط – محافظة أسيوط- مصر خلال موسمي 2020 و2021 بهدف دراسة تأثير مستويات الري المختلفة على نمو وإثمار أشجار الرمان المنفلوطي حيث اشتمل البحث على ثلاث مستويات من الري بمعدل 60، 80 أو 100% من الاحتياج المائي لأشجار الرمان من خلال الري بالتنقيط. وكان تصميم التجربة بنظام القطاعات كاملة العشوائية تحتوي على ثلاث معاملات وكل معاملة تحتوي على ثلاث مكررات وتتكون كل مكررة من شجرتين. وقد تم تقدير بعض صفات النمو الخضري ومكونات المحصول وخصائص الثمار وكفاءة الري خلال سنتي الدراسة لتقدير تأثير معاملات الري على هذه الصفات.

ويمكن تلخيص نتائج الدراسة كالتالي

سبب الري بمعدل 60% من الاحتياج المائي نقصاً معنوياً في صفات النمو الخضري (طول الفرع مساحة الورقة الكلوروفيل الكلي – محتوي العناصر) مقارنة بالري بمعدل 100% مع عدم وجود فروق معنوية بين استخدام الري بالتنقيط بمعدل 80% أو 100% من الاحتياج المائي (معاملة المقارنة).

سبب الري بمعدل 100% من الاحتياج المائي زيادة جوهرية في مكونات المحصول وخصائص الثمار مقارنة باستخدام 60% من الاحتياج المائي مع عدم وجود فروق معنوية عند استخدام 80% أو 100% من الاحتياج المائي من خلال الري بالتنقيط.

تسبب الري بمعدل 60 أو 80% من الاحتياج المائي زيادة كفاءة استخدام الماء مقارنة بالري بمعدل 100% مع عدم وجود فروق معنوية بين استخدام 60 أو 80% من الاحتياج المائي.

من هذه الدراسة ينصح باستخدام الري بمعدل 80% من الاحتياج المائي حيث يؤدي إلي زيادة كفاءة الماء المستخدم مع تحسين النمو الخضري والحالة الغذائية للأشجار مع نقص الماء المستخدم حوالي 20% مما تسبب زيادة المحصول وتحسين خصائص الثمار وتقليل تكاليف الإنتاج.