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Effect of irrigation scheduling on canopy cover development and crop-water management related parameters of *O.ficus-indica* under prolonged drought conditions.

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ABSTRACT

Opuntia ficus-indica is gaining scientists' and policy makers' interest worldwide as drought tolerant crop adopted to marginal low fertile soils. Few studies were conducted to estimate its water management parameters under different soil-climate conditions. *O.ficus-indica* was planted in the experimental farm of City of Scientific Research and Technological Applications (SRTA-City, Alexandria, Egypt) under different irrigation scheduling applications. The study aimed to understand the effect of severe water deficit on crop development and water management related parameters. First irrigation scheduling (T1) applied irrigation with fixed amount of water (7.2 m^3 ha^{-1} $week^{-1}$). The second (T2), was applied when soil water content (SWC) became below 35% of field capacity (Θ_{fc}) in effective root zone. The third (T3), was conducted when SWC was below 30% of Θ_{fc}. The results revealed higher yield under T1 than T2 and T3. Water productivity was the lowest in T1 (0.62 kg m^{-3}) and the highest in T3 (18.13 kg m^{-3}). Actual crop evapotranspiration (ET_a) was significantly higher in T3 (4.80 mm day^{-1}), than T2 (4.56 mm day^{-1}) and T1 (3.84 mm day^{-1}). No significant difference was found in soil water content, canopy cover, crop coefficient among the applied irrigation scheduling. Average canopy cover was 13.63%, 11.08%, and 10.22% for T1, T2, and T3, respectively indicating early crop development stage. The corresponding crop coefficient (kc) was between 0.19 in T1 to 0.23 in T2 and 0.24 in T3. Further study is recommended to confirm obtained results and estimate ET_a and kc under middle and end crop development stages.

KEYWORDS: Cactus pear, water management, actual evapotranspiration, crop coefficient, digital image processing

1. INTRODUCTION

Countries located in arid zones, such as Egypt, suffer limited water resources. The irrigated area in Egypt was ~3.76 million hectares in 2013 (MALR, 2014) that is threatened to be decreased due to illegal urbanization and land misuse. The agricultural sector in Egypt consumes about 85% of conventional available water (MWRI, 2014). The majority of Egyptian territory is desert, and rangelands that covers an area of about 100 million hectares (Kumar et al., 2018) with severe shortage in water supply. Planting well adapted crops to harsh environmental conditions in the Mediterranean area, especially in arid marginal lands, would positively contribute to more food security. However, this must not apply more pressure on already restricted water resources in these areas. *Opuntia spp.* Started to form part of the agricultural system (Inglese et al., 2017, Kumar et al., 2018). *Opuntia ficus-indica (O.ficus-indica)*, in particular, is one of the most important species of cactaceae family worldwide from the economic point of view (Kiesling, 1998). In Africa, it is well adopted in Algeria, Morocco, Tunisia, South Africa, and Ethiopia (Inglese et al., 2017). In Egypt, it is usually grown in sandy soils (Abo-El-Ela et al., 2001) especially in Giza, Menofyia, Ismailia, Sharkia, and Behira (Ammar et al., 2004). The interest of planting *O.ficus-indica* in Egypt is increasing year after another. The total cultivated area of *O.ficus-indica* in Egypt augmented from 650 ha in 1994 to 2550 ha in 2002 (Sáenz et al., 2013) and to 6000 ha in 2008 (Bakr, 2019). This is mainly due to the Egyptian policy that promoted cultivation of cactus pear (*O.ficus-indica*) in desert settlements to cope with climate change and empower women contribution to agricultural sector in these areas (Najjar, 2015). In the harvest season, in Egypt, the major percent of *O.ficus-indica* produced fruit is distributed by numerous vendors in street sides and consumed directly fresh and peeled. However, little information is available about commercial cultivation and production of Cactus pear worldwide (Sáenz et al., 2013). Several studies focused on *O.ficus-indica* as part of the agricultural system. Part of these studies focused mainly on crop origin, geographical distribution, and ecology (Kiesling, 1998; Inglese, et al., 2017, Kumar et al., 2018). Other studies were concerned about social impact of cactus pear plantation in marginal lands that empowered women contribution to agricultural production system (Najjar, 2015). Further studies provided good manual for the proper cultivation methods for *O.ficus-indica* (CAAES, 2005; Liguori and Inglese, 2015; Inglese et al., 2017) and its contribution as forage to animal production (Bakr, 2019). Khalafalla et al. (2016) recorded 71 species associated with *O.ficus-indica* in their vegetation analysis of plant species linked to the crop. Ammar et al. (2004) studied the major pathogens in Egypt that provoke cladode and fruit rots of *O.ficus-indica*. They found that *Fusarium solani*, *Alternaria alternata*, and *Botryodiplodia theobromae* are the main causes for plant rotting. Further studies reported the industrial uses of the crop as juices, jams, pharmaceutical products, etc. (Sáenz et al., 2013; Inglese et al., 2017; Kumar et al., 2018). From the on-farm water management point of view, Snyman (2005) reported that the majority of *O.ficus-indica* root mass was concentrated in the first 100 mm of soil profile at the beginning of the experiment and extended to reach ~1.8 m after the first growing season. This coincided with the observations of North and Nobel (1992) who indicated that the plant roots of *O.ficus-indica* could reach 4-8 m depth beneath soil surface. Yet, according to Snyman (2005) and Inglese et al. (2017), its effective root zone did not exceed 0.30 m depth in the soil under the most adequate growth conditions. Actual evapotranspiration (ET_a) as well as crop coefficient (kc) were estimated by Consoli et al. (2013) for *O.ficus-indica*. They applied a micrometeorological method to conduct their study. They found that average daily ET_a and kc were 2.5 mm and 0.40, respectively when average reference evapotranspiration (ET_o) was 5.0 mm. There are multiple methods to determine crop ET_a and its relationship with soil water content (SWC). Jung et al. (2010) conducted their study based on meteorological data and remote sensed ET_a and SWC values. They reported that global ET_a was affected negatively when soil water supply was limited. Duffková et al. (2011) used energy balance equation to estimate ET_a for different crops in different soil types, slopes, and properties. They found that soil properties had influence on ET_a especially during crop maturity stage and drought conditions. They indicated that ET_a was significantly lower in course-textured soil than fine-texture one. Graf et al. (2014) conducted a three years study from 2010 to 2013 to estimate SWC applying the wavelet coherence analysis. They conducted their study based on soil water balance model including precipitation (P), ET_a, ET_o and runoff. They found a relationship between soil water storage and the output of P-ET_a-runoff. They also reported that ET_a/ET_o ratio was affected positively by available water content in soil profile. Filgueiras et al. (2020) used regression algorithms and remote sensed vegetation index for maize crop to estimate ET_a and SWC for low-cost irrigation management. Their produced fitted models revealed the viability of vegetation index as information tool to increase the reliability of ET_a and SWC estimation and modelling. Rahmati et al. (2020) used lysimeter to estimate grassland ET_a and understand its relationship with SWC based on soil water balance method collecting data from 2012 to 2018. They reported strong relationship between ET_a and SWC, that was higher in dryer soils than wet soils. However, Seneviratne et al. (2010) reported in their literature review about the relationship between SWC and ET_a the high uncertainty level of the influence degree of SWC on ET_a. Koster et al. (2004) and Seneviratne et al. (2006) indicated that the higher influence of SWC on ET_a was observed when SWC reached the critical level were below this level the crop starts to suffer some constraints in its ET_a process. They classified soil moisture availability to three main regimes: i) Wet regime, where SWC is higher than the critical level, ii) Dry regime, where SWC is lower than the wilting point, and iii) the Transitional regime, where SWC falls in between the “Wet” and “Dry” regimes. They found that the major influence of SWC on ET_a was observed in the transitional regime. Fluctuation of SWC under this regime, resulted in fluctuation of ET_a. Yet, they reported that both “Wet” and “Dry” regimes did not influence ET_a. Studies also proved that *O.ficus-indica* could survive extreme drought conditions in arid and semi-arid soil and climate conditions. Souza et al. (2020) applied no irrigation or fertilization during two successive years (October 2015-August 2017) to study the effect of prolonged drought periods on “Gigante” *O.ficus-indica* yield and survival rate. They applied, in their study, six different treatments (i) no fertilization+no irrigation, (ii) no fertilization+0.6 L Plant^{-1} Week^{-1}, (iii) no fertilization+1.2 L Plant^{-1} Week^{-1}, (iv) no fertilization+1.2 L Plant^{-1} Week^{-1} (two applications per week), (v) organic fertilization+1.2 L Plant^{-1} Week^{-1}, (vi) organic fertilization+no irrigation. They concluded that irrigation with 0.6 L Plant^{-1} Week^{-1} increased the productivity of *O.ficus-indica*, in terms of mass and cladodes production, than rainfed plants and augmented its survival rate. However, few studies were focused on estimating crop-water management parameters for *O.ficus-indica* including soil water content (SWC), crop coefficient (kc), and actual crop evapotranspiration (ET_a) as relevant tools to compute crop water requirements and increase water productivity on farm level. The presented study aimed to understand the effect of different applied irrigation scheduling, in terms of applied water regime and timing, on *O.ficus-indica* water management parameters (ET_a, kc, SWC) and canopy development under severe prolonged soil water deficit.

2. MATERIAL AND METHODS

2.1. Experimental field setup

The study was conducted in the experimental farm of City of Scientific Research and Technological Applications, SRTA-City (30º53'33.17''N, 29º22'46'' E), New Borg Elarab, Alexandria, Egypt. The study area is characterized by Mediterranean arid climate conditions. Weather data during the experiment was obtained from the nearest weather station in New Borg Elarab Airport (31º13'12.17''N, 29º56'24'' E) available online at The Weather Company (©TWC Product and Technology LLC 2014, 2020). Daily reference evapotranspiration (ET_o) was calculated following FAO Penman-Monteith equation according to the procedure outlined in (Allen et al., 1998) using ET_o Calculator software (Version 3.2, ©FAO 2012).

The experimental field was of 0.1 ha divided into 3 plots with at least 8 m distance from each other to avoid possible lateral flow of water among the cultivated plots. The plant cladodes were soaked in a solution of copper oxychloride (1 g l^{-1}) to avoid potential infections before plantation as recommended by (CAAES, 2005). The cladodes were left in well-aired shadow area for four weeks before planting date. On 24 March 2019, the cladodes were inserted into the soil letting one third above soil surface facing sun from east to west all day long. *O.ficus-indica* was planted in furrows and irrigated using drip irrigation system. Spacing between furrows was 4 m and between plants at same furrow was 3 m. Each plant received a mix of fertilizers consisted of 12 kg organic compost+0.5 kg agricultural sulfur+0.5 kg ammonium sulfate+0.5 kg super phosphate. The fertilizer mixture was put in a 0.5 m^3 hole beneath soil surface at each plant location at the beginning of the experiment. The plant was cultivated under three irrigation scheduling applications based on soil moisture depletion in effective root zone. According to the United States Department of Agriculture (USDA, 2020), soil water depletion is the amount of water needed to increase soil moisture content (SWC) in effective root zone up to field capacity. Each application was cultivated with total 60 plants divided into three replicates. In the first irrigation scheduling application (T1), the plant was irrigated once per week with 7.2 m^3 ha^{-1} of water as recommended by Ministry of Agriculture and Land Reclamation (CAAES, 2005). The second irrigation scheduling application (T2) was irrigated only when SWC was below 35% of field capacity (Θ_{fc}) and the third application (T3) was irrigated when it got below 30% of Θ_{fc}. Every irrigation event in T2 and T3 lasted until filling effective root zone with 40% of Θ_{fc}. These different irrigation scheduling applications resulted in different amount of applied irrigation water and different irrigation timing. Figure 1 is a visual presentation of applied irrigation events timing under the three tested irrigation scheduling (T1, T2, and T3).

All plants received 7.2 m^3 ha^{-1} of water at the beginning of the experiment then applications were applied after that to ensure equal initial conditions. The plant was harvested twice on 4 August 2019 and on 27 September 2020. The effect of each applied irrigation scheduling on *O.ficus-indica* canopy cover development (CC), fruit yield, ET_a, kc, and water productivity (WP) was studied. The experiment was conducted with strip plot statistical design.

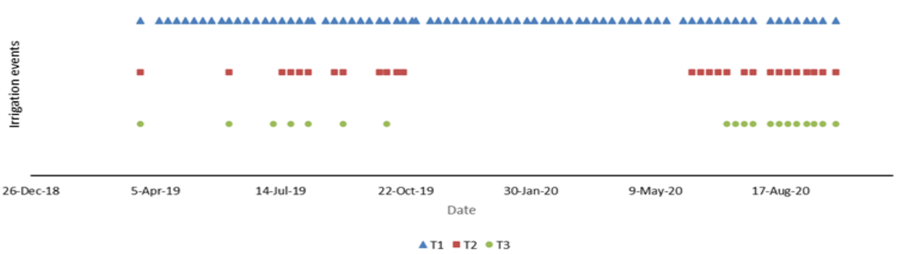

Figure 1. Date of different applied irrigation scheduling (T1, T2, and T3) during the experiment period in 2019-2020

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The One-Way Analysis of Variance (ANOVA) tool within the SPSS statistical program was used to determine significant difference in the obtained results among the applied irrigation scheduling (T1, T2, and T3). Results were checked at 0.05 significance level.

2.2. Soil water measurements

Soil texture and bulk density was determined at the beginning of the experiment. Bulk density is relevant parameter to compute depth of water content in effective root zone (25 cm). Soil water content (SWC) at saturation, field capacity (Θ_{fc}) and wilting point was determined gravimetrically following Estefan et al. (2013). SWC was determined as well on weekly basis and before each irrigation event to compute actual evapotranspiration (Michael, 2006) following Israelsen and Hansen (1962) as shown below:

$$ET_a = D \times Pb \times [\theta_{fc} - \theta_i]/100 \quad \text{(Equation 1)}$$

Where ET_a is actual evapotranspiration by plant, D is soil depth (cm), Pb is soil bulk density (gm cm^{-3}), Θ_{fc} is percent of SWC at field capacity, Θ_i is percent of SWC before irrigation.

Crop coefficient (Kc) for the planted crop was estimated during the experiment by dividing the actual evapotranspiration (ET_a) by reference evapotranspiration (ET_o) as explained in Equation (2).

$$kc = {}^{ET_a}/_{ET_o} \quad \text{(Equation 2)}$$

Water productivity (WP) for each applied irrigation scheduling was determined below following Molden et al. (2003):

$$WP = {}^{Y_a}/_{W_t} \quad \text{(Equation 3)}$$

Where Y_a is the actual harvested fruit yield in kilograms and W_t is total applied water in m^3.

2.3. Estimation of canopy cover development

Various studies estimated canopy cover (CC) using digital image processing (Korhonen and Heikkinen, 2009; Lee and Lee, 2011; Alivernini et al., 2018; Xiong et al., 2019). The presented research study used Image Processing and Analysis in Java tool (ImageJ 1.52p software, National Institutes of Health, USA) to estimate CC from digital images. The digital photos were taken by mobile camera of 12 MP at fix height of 2m on weekly basis. Three replicates per each irrigation scheduling application were taken and overall average was assessed. Brief steps for digital images processing using ImageJ tool are presented in Figure 2. Digital images were imported to ImageJ software and cropped to the center of each to avoid the error that could provoke due to lateral effect on the edges. Canopy cover area was selected using the free hand selection tool for the estimation. Then image was transformed into a binary image with 8 bits in black and white. After that, region of interest (ROI) was determined to estimate canopy cover. Once selected the ROI, the CC percentage was estimated using the area function tool of the software. The estimated area percentage is for the white pixels. To obtain the CC percentage (black area), the result was subtracted from 100.

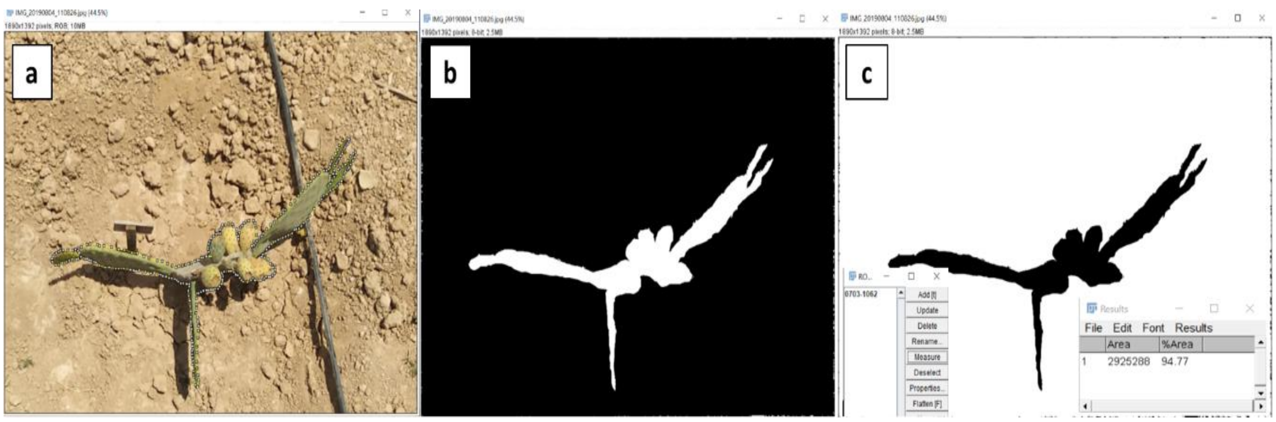

Figure 2. Digital image processing to estimate canopy cover for *O.ficus-indica* plant. a: cropped image to center and delimitation of green canopy cover, b: converting to binary image with 8 bits, c: determination of area of interest. Estimated CC=~5.23%

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3. RESULTS AND DISCUSSION

The experiment was conducted in a sandy loam soil (65.3% sand – 18.7% clay) with bulk density of 1.56 g cm^{-3}. SWC at saturation, field capacity, and wilting point was 42.8%, 22.7%, and 13.4% on weight basis, respectively. Daily rainfall and minimum and maximum temperature during the experiment run in 2019 and 2020 are presented in Figure 3. Average registered minimum and maximum temperature were 15.7ºC and 25.8 ºC, respectively. Total rainfall was 213.3 mm in 2019 and 256.0 mm until Nov. 2020. Precipitation is usually in winter and autumn seasons from October to March. Summer and spring seasons are usually dry and relatively hot were average rainfall is zero mm.

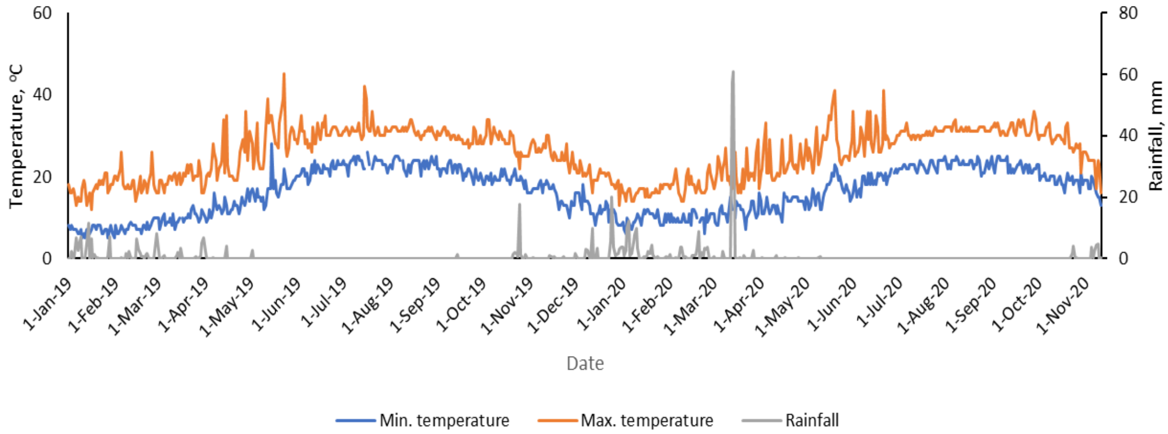

Figure 3. Daily minimum and maximum temperature (ºC) and rainfall (mm) during the experiment run in 2019 and 2020, Alexandria, Egypt

Calculated ET_o during 2019-2020 is presented in Figure 4. ET_o values varied from minimum of 0.8 mm day^{-1} during winter cold season to a maximum of 6.0 mm day^{-1} in summer hot season. ET_o values during summer (~average 4.0 mm day^{-1}) are generally higher than winter (~average 1.5 mm day^{-1}). Allen et al. (1998) indicated that principal weather parameters affect ET_o are radiation, air temperature, humidity, and wind speed. Wang et al. (2014) found in his study on the effect of climate change over ~50 years on ET_o that higher daily air temperature increased ET_o values by 11%. This coincided with Liu et al. (2019) who reported positive sensitivity of ET_o to air temperature and average sunshine hours.

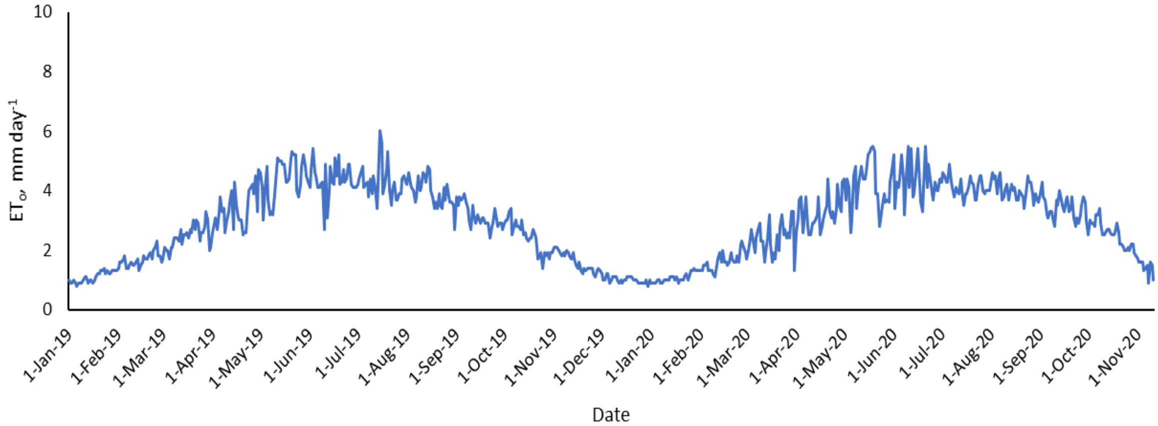

Figure 4. Reference evapotranspiration (ET_o) in mm day^{-1} along the study period in Alexandria during 2019 and 2020

Mean and standard error of soil water content (SWC) on weight basis, canopy cover (CC), fruit yield, water productivity (WP), actual evapotranspiration (ET_a), and crop coefficient (kc) for *O.ficus-indica* during experiment run in 2019-2020 are presented in the table below. It was found that mean SWC in T1 was significantly higher ($P \leq 0.05$) than T2 and T3. Meanwhile, no significant difference was observed between T2 and T3 in SWC. This might be due to the higher amount of applied irrigation water in T1 compared to T2 and T3. The noticed increase in total applied water for T1 (554 m^3 ha^{-1}) was due to the weekly applied irrigation process with 7.2 m^3 ha^{-1}. The total applied water for T2 and T3 was 16.62 and 12.54 m^3 ha^{-1}, respectively. This is primarily because of applying irrigation only when SWC dropped below 35% and 30% of Θ_{fc} for T2 and T3, respectively. The applied T2 and T3 irrigation scheduling resulted in irrigating *O.ficus-indica* mainly during summer (Figure 1) where higher temperature, fewer precipitation (Figure 3), and higher ET_o (Figure 4) than winter were recorded. In this case, precipitation supply in effective root zone in winter assisted in maintaining SWC in the chosen levels. This is also might be thanks to *O.ficus-indica* capacity of rapid absorption to water added to the soil, covered roots with moderately impermeable coat to water especially the fine roots in effective root zone, and its capacity to decrease shoot transpiration when needed (Passioura, 1988; Inglese et al., 2017).

Table 1. Mean±standard error of soil water content (SWC) on weight basis, actual evapotranspiration (ET_a), crop coefficient (kc), canopy cover (CC), fruit yield, and water productivity (WP) per each applied irrigation scheduling during 2019-2020.

Application	SWC, %	CC, %	Fruit yield, kg ha^{-1}	WP, kg m^{-3}	ET_a, mm day^{-1}	kc
T1	12.78±0.53^a	13.63±1.28^a	342	0.62	3.84±0.20^b	0.19±0.01^a
T2	10.79±0.54^b	11.08±1.06^a	226	13.60	4.65±0.21^a	0.23±0.21^a
T3	10.47±0.58^b	10.22±1.13^a	227	18.13	4.80±0.22^a	0.24±0.22^a

* different small letters a, b, and c reveal significant difference at 0.05 level among irrigation scheduling applications.

Despite the observed significant difference in SWC among irrigation scheduling applications, no significant difference was found at P≤0.05 in canopy cover (CC) of *O.ficus-indica* among the applied irrigation scheduling in T1, T2, and T3. Souza et al, (2020) also observed no significant difference in *O.ficus-indica* cladodes' number among the applied 4 different irrigation scheduling that varied from no irrigation at all for two successive years (2015-2017) to maximum of 1.2 L $Plant^{-1}$ $Week^{-1}$ when no fertilization was applied during the experiment run. Estimated CC development for *O.ficus-indica* during 2019 and 2020 is presented in Figure 5. The observed drop in CC values by the end of September 2019 was due to the conducted pruning process. The plant was subjected to pruning process on 17 September 2019 after the first harvesting season. The process kept only two cladodes per each mother cladode to allow more exposure to sunlight within the canopy supporting cladodes' growth, flowering, and fruit growth (Liguori and Inglese, 2015).

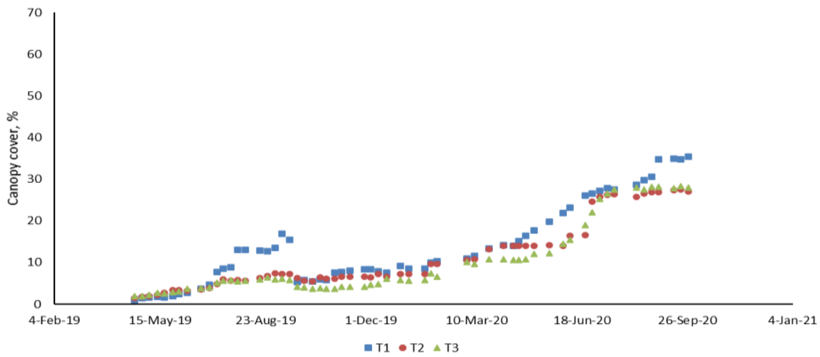

Figure 5. Estimated percentage of canopy cover development of *O.ficus-indica* during seasons 2019 and 2020 under the three applied irrigation scheduling.

Maximum canopy area percentage was 35% for T1, 27% for T2, and 28% for T3 which indicated that the plant was still in the early development stage. According to Hassan et al. (2020) study, the *O.ficus-indica* cladodes reached their maximum surface area entirely by the end of the first growing season. In the current study, the observed increase in crop canopy cover during second season was due to the observed new cladodes generated from the mother cladode. This is also might explain the higher yield of T1 (342 kg ha^{-1}) than T2 (226 kg ha^{-1}) and T3 (227 kg ha^{-1}) since the higher CC in this case was function of the higher number of cladodes. The experiment is running currently for third season to study canopy cover development and growth along different growth stages in successive growing seasons. On the other hands, WP was the lowest under T1 irrigation scheduling (0.62 kg m^{-3}) while T3 resulted in the highest WP (18.13 kg m^{-3}). As aforementioned, WP is the total kilograms of yield (fruits in this case) produced by one cubic meter of water. In the presented study, T1 produced higher yield in terms of kilograms compared to the other applied irrigation scheduling. Yet, it also consumed the highest amount of water compared to T2 and T3. Thus, WP for T1=342 (kg ha^{-1})/554.4 (m^3 ha^{-1}) =0.62 kg m^{-3}. While for T2, WP=226 (kg ha^{-1})/16.62 (m^3 ha^{-1}) =13.60 kg m^{-3}, and for T3, WP = 227 (kg ha^{-1})/12.54 (m^3 ha^{-1}) =18.13 kg m^{-3}.

Actual evapotranspiration (ET_a) is a function of the vegetative growth (Field et al., 1998; Phocaides, 2000) and SWC (Koster et al., 2004; Seneviratne et al., 2006; Seneviratne et al., 2010; Graf et al., 2014; Rahmati et al., 2020). The accumulated ET_a along 2019-2020 per each applied irrigation scheduling is shown in Figure 6. Mean daily ET_a was 3.84, 4.65, and 4.80 mm day^{-1} for T1, T2, and T3 respectively. No significant difference ($P \leq 0.05$) in crop coefficient (kc) among the applied irrigation scheduling was found. It was 0.19 in T1, 0.23 in T2 and 0.24 in T3. Obtained ET_a values were relatively higher than what was reported by Consoli et al. (2013) of 2.5 mm day^{-1}. They also estimated higher mean crop coefficient (0.40) than what was estimated in the current study. Despite the presented study coincides with Consoli et al. (2013) being conducted on *O.ficus-indica* under Mediterranean climate conditions, microclimate conditions were different. The study of Consoli et al. (2013) was conducted in Italy (north the Mediterranean) were average daily ET_o during the experiment run was 5 mm day^{-1} while average ET_o of the presented research study was 3 mm day^{-1} which might explain different ET_a estimations (Equation 2). Seneviratne et al. (2010) reported that ET_a estimation was strongly affected by geographical locations and microclimate conditions.

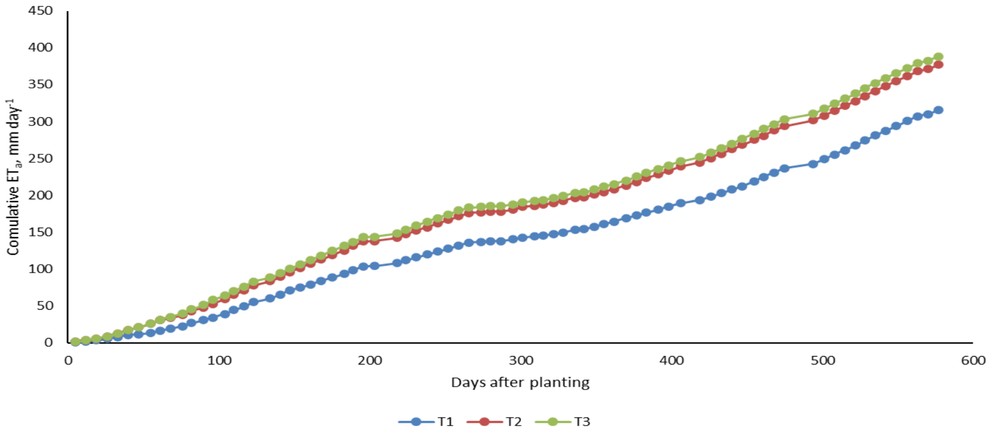

Figure 6. *O.ficus-indica* accumulated ET_a (mm day-1) during seasons 2019-2020 for each applied irrigation scheduling

Mean ET_a for T1 was significantly ($P \leq 0.05$) lower than T2 and T3 despite it received the highest amount of applied water (Table 1). No significant difference was found in ET_a between T2 and T3. This coincides with what was observed by Rahmati et al. (2020) who observed that ET_a did not increase when SWC increased during the years 2017 and 2018 in dry areas. They indicated that precipitation might imply relevant role in this observation. They explained that precipitation events would positively increase SWC values resulting in losing higher portion by deep percolation and driving smaller portion for ET_a process. In general, the soil climate regime in effective root zone along the study was "Dry". According to Koster et al. (2004) and Seneviratne et al. (2006), SWC in "Wet" and "Dry" regimes did not influence ET_a.

4. CONCLUSION

O.ficus-indica can maintain its productivity under severe extended drought conditions. The crop canopy cover development and crop coefficient were not affected by extreme water deficit in effective root zone. The plant evapotranspiration was higher when irrigation was practiced during summer season than being performed on weekly basis. On contrary, weekly irrigation produced higher fruit yield in terms of kilograms per hectare than irrigating only in summer season.

5. ACKNOWLEGMENT

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الملخص العربي

تأثير جدولة الري على نمو الغطاء النباتي ومعايير إدارة المياه على مستوى الحقل لنبات التين الشوكي (*Opuntia ficus-indica*) تحت الظروف المناخية الجافة في منطقة البحرالمتوسط

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نجح نبات التين الشوكي (*Opuntia ficus-indica*) مؤخرا في جذب انتباه العلماء وصناع القرار على مستوى العالم كمحصول متحمل للجفاف خاصة في المناطق الهامشية منخفضة الخصوبة. مع ذلك، فقط قليل من الدراسات قد أُجريت لتقدير معايير إدارة المياه في ظل الظروف شديدة الجفاف. تمت زراعة نبات التين الشوكي في المزرعة البحثية لمدينة الأبحاث العلمية والتطبيقات التكنولوجية (الإسكندرية – مصر) تحت تطبيقات مختلفة لجدولة الري. تهدف الدراسة إلى فهم تأثير كل جدولة ري مطبقة على نمو نبات التين الشوكي وعلى بعض معايير إدارة المياه الخاصة به على مستوى المزرعة. جدولة الري الأولى (T1) تم فيها تطبيق الري بكمية ثابتة من الماء (7.2 م^3 هكتار $^{-1}$) أسبوعيا. تم تطبيق الجدولة الثانية (T2) كلما أصبح المحتوى الرطوبي للتربة أقل من 35% من المحتوى الرطوبي عند السعة الحقلية في منطقة الجذر الفعال للنبات. الجدولة الثالثة (T3)، تمت كلما كان المحتوى الرطوبي للتربة أقل من 30% من المحتوى الرطوبي عند السعة الحقلية. كشفت النتائج عن ارتفاع الإنتاجية للنبات تحت جدولة الري الأولى (T1) بالمقارنة مع (T2) و (T3). ولكن من الناحية الأخرى كانت إنتاجية وحدة المياه من المحصول أقل ما تكون تحت T1 (0.62 كجم م$^{-3}$) وكانت أعلى ما يكون تحت T3 (18.13 كجم م$^{-3}$). وكذلك كان البخرنتح الفعلي للمحصول أعلى معنويا ($P\leq0.05$) تحت جدولة الري T3 (4.80 مم يوم$^{-1}$) من T2 (4.56 مم يوم$^{-1}$) و T1 (3.84 مم يوم$^{-1}$). أثبتت النتائج أيضا عدم وجود فرق معنوي في المحتوى الرطوبي للتربة والغطاء النباتي ومعامل المحصول بين معاملات جدولة الري المطبقة في التجربة. بلغ متوسط الغطاء النباتي للتين الشوكي 13.63%، 11.08%، 10.22% تحت كل من T1 و T2 و T3 على الترتيب، مما يشير إلى أن المحصول لايزال في المرحلة الأولى من النمو. وتراوح متوسط معامل المحصول المقابل من 0.19 في T1 إلى 0.23 في T2 و 0.24 في T3. توصي الدراسة بإجراء مزيد من الأبحاث لتأكيد النتائج المتحصل عليها وتقدير البخر نتح الحقيقي ومعامل المحصول في مراحل النمو المتوسطة والنهائية للنبات.