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The Role of Micro-Irrigation Systems in Date Palm Production and Quality: Implications for Sustainable Investment

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Abstract: This research examines the role of micro-irrigation systems, i.e., sprinkler and drip irrigation, on date palm production and quality in a semi-arid region. The field experiment was carried out for two successful seasons at a private farm, in the Al-Nubaria region of Egypt. The date palm was planted under pressurized irrigation (drip irrigation and mini-sprinkler irrigation) to investigate the effect of both irrigation systems and three water treatments (100, 80, and 60% from ETc) on the yield and quality of date palms. Results on the productivity of date palm yields showed that the yield of date palm under a drip-irrigation system with 80% of crop water demand was an equal match to the yield of the sprinkler-irrigated date palm with 100% of crop water demand. This reflects the high efficiency of the drip irrigation system compared to the sprinkler irrigation system in date palms, especially in the semi-arid region. The results showed a significant increase in productivity by increasing water applied from 60% up to 80 and 100%. Quality attributes of date palm (particularly, sucrose, purity, and extractable sugar %) have a rise with increasing water deficit. The results have numerous implications, especially for sustainable investment in date palms. Implications for three aspects of sustainable investment, economic, social, and environmental, are discussed.

Keywords: micro-irrigation; sprinkler; drip; ETc; water productivity; yield; Barhi variety

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1. Introduction

Date palm usually uses traditional irrigation techniques such as flood irrigation through different methods to deliver irrigation water to the target crops. This is often done through the method of irrigation by basins, borders, or furrows. In this method, it saturates almost the entire surface of the soil without taking into account the water required for any plant species [1]. However, wrong practices cause the loss of large quantities of water thus leading to an increase in the problems of water saturation and salinization, which causes a decrease in irrigation efficiency due to the presence of layers that prevent the arrival of total water in small proportions. Irrigation accounts for two-thirds of water use worldwide and as much as 90 percent in some developing countries. There is a rise in the demand for agricultural products, which calls for the need to optimize and increase productivity to overcome yield reduction due to poor and/or distribution of irregular rainfall. However, irrigation faces many challenges, such as producing more food with better quality while using less water per unit of output. Other challenges include providing rural communities with resources and opportunities to live a healthy and productive life, applying climate-smart technologies that ensure environmental sustainability, and contributing in a productive way to the local and national economy. Optimizing irrigation water management for crop production could result in increased productivity and water savings. This will be realistic only if appropriate strategies are adopted to provide high efficiency for water use in agriculture. One important strategy is to more efficiently manage water applications to increase water productivity [1]. In addition, one of the most effective strategies for improving water use efficiency is a deficit irrigation program in water shortage areas. Under good management, irrigation water shortages demonstrated substantial savings with little impact on the quality and quantity of harvest.

Date palm tolerates the shortage of plant water in the middle and late seasons, which make it suitable for production with limited irrigation [2]. Sprinkler and drip irrigation, mulching, and protected cultivation have contributed to improved water use efficiency in agriculture by significantly reducing runoff and losses of evapotranspiration [3]. It is important to develop new irrigation techniques, not necessarily based on a full crop water requirement, but ones designed to ensure the optimal use of the water available. Improved return from agricultural inputs and environmental quality from irrigation can be achieved, among others, through practicing irrigation scheduling [4,5]. Date palm can be grown without competing with other winter crops because of its ability to tolerate salinity and limited water needs as compared to other traditional winter crops. Moreover, in Egypt, the total cultivated area reached about 504,299 faddens, and the total production exceeded 11.045 million tons of roots with an average of 21.9 ton/fad in the 2016 season [6]. The great importance of the date palm crop is not only from its ability to grow in the newly reclaimed areas as an economic crop, but also for production higher of sugar under these conditions. Most of these areas face some stress problems, i.e., shortage of irrigation water, salinity, and unbalanced nutrient elements. Drought stress significantly reduced plant growth and crop productivity [7]. Tarkalson et al. [8] studied the function of yield production under an irrigated date palm in an arid climate to quantify the date palm yield response to water application and actual crop evapotranspiration. They indicated that these relationships were valuable to understanding date palm responses over a range of water availability and in developing tools to assess future production under water shortages, and they found significant positive linear relationships (0.05 probability level) between evaporation, date palm water requirement, and root yields (R^2 = 0.78). The quantitative relationship between evaporation, water application, and date palm yield can be used to measure the production of date palm under water deficit conditions (data derived from pivot/linear, drip, and solid set irrigation types), which may arise as a result of water shortage scenarios or when drought occurs non-irrigated areas. Abayomi and Wright [9] found that leaf growth showed high sensitivity to soil water deficit and responses varied with periods at which the deficit occurred. They also reported that water deficit at early growth stages affected leaf growth and leaf area index, while at mid or late growth stages showed relatively smaller effects. This was also observed in putative drought tolerant, date palm genotype because of a considerable reduction in shoot growth, which was compensated for by a large increase in fibrous root development [10].

Date palm can grow in all types of sandy, saline, and calcareous lands. The states that the farming method of date palm summarized in the plowing process are carried out in three orthogonal areas, where the soil is softened and the planning is done at a rate of 12–14 lines in the quarries [11–17]. The soil should be cut every 8:10 m by constructing a channel or a perpendicular planner to control the irrigation process. Agriculture is carried out in the upper third of the line at a distance of 15:20 cm between the jaws on the marine feather in the case of early planting. The direction of planting should be from east to west and the tribal feathers in the case of late cultivation and the eastern feather in the case of planning from sea to kaili. This method is often used in large areas of new land where advanced irrigation methods (sprinkling or drip irrigation) are used during the month of August. Care should be taken when planting using single-embryo seed for the possibility of exposure to severe insecticide as well as high temperatures, which may affect the germination and seedling growth and plant density field [18–26].

Date palm grows in Egypt from early August until the end of November. The most suitable date for planting the crop is from mid-September to mid-November, due to the need to prolong the industrialization season. Because of the lack of optimal, climatic conditions for germination and growth, as well as the increase of disease due to the high temperature in that period. Agriculture in August requires full attention to the land of agriculture and animal life for its utmost importance in this period so as not to be affected by sowing and death, which results in re-planting and mud land during agriculture in August. It should be cold farming, hence the lines are completely saturated with water and wastewater excess. The following morning should not be carried out until after the complete integration of germination and the period between the irrigation of the soil and the marine life of at least 10–20 days depending on the temperature and nature of the soil and the wind of the courtyard on the protector and conditions [11,13,14,26–33]. The objectives of this research is to investigate the effect of irrigation systems, i.e., sprinkler and drip irrigation, using three water treatments (100, 80, 60% from ETc) on yield and quality of date palm.

2. Materials and Methods

2.1. Field Experimental

The field experiment was carried out for two successful seasons at a private farm, in the Al-Nubaria region, Egypt. The Barhi variety was used in this study, and the collection of physical data for the study was completed after the completion of the harvest process, which ended at the beginning of September and began in mid-August. The palms were planted at 8×8 m^2 and take the same cultural particles. There were 18 palms selected as uniformly as possible and used the same male pollen tree. Date palm was planted under pressurized irrigation (drip irrigation and mini-sprinkler irrigation) to investigate the effect of both irrigation systems and three water treatments (100, 80, and 60% from ETc) on the yield and quality of the date palm crop. Water pumped through the irrigation system was analyzed using standard methods to determine the chemical properties. The soil samples were collected from different depths (0~15, 15~30, 30~45, and 45~60 cm) of the soil profile to determine the physical-chemical properties of the soil. These results of some chemical properties of the irrigation water measured at the laboratory are presented in Table 1.

Table 1. Some chemical properties of irrigation water.

pH	EC dS/m	Soluble Cations, meq/L				Soluble Anions, meq/l				SAR
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	$CO_3{}^{2-}$	$HCO_3{}^{-}$	$SO_4{}^{2-}$	Cl^{-}	
7.8	0.34	0.71	0.23	2.45	0.9	0	0.94	0.31	3.04	3.57

Al-Nubaria cultivated land is classified as sandy soil. Physical properties were determined according to Hema-vaidyanathan et al. [34]. Field Capacity (F.C) and permanent wilting point (P.W.P) were determined according to Ibrahim et al. [21]. Soil hydraulic properties of a representative soil profile were determined according to the equation developed by Soil Survey [35]. The data is shown in Table 2.

Table 2. Some physical properties of soil in the experimental farm.

Depth, Cm	Particle Size Distribution, %				Texture Class	θS % on a Weight Basis			HC (cm/h)	BD (g/cm^3)	P (cm^3 Voids/ cm^3 Soil)
	C. Sand	F. Sand	Silt	Clay		F.C.	P.W.P.	A.W			
0–15	8.4	75.6	8.3	5.3	Sandy	12.0	4.0	8	6.55	1.65	0.34
15–30	8.4	75.7	8.5	5.2	Sandy	12.0	4.0	8	6.75	1.65	0.34
30–45	8.5	75.7	8.6	5.1	Sandy	12.0	4.0	8	6.81	1.65	0.35
45–60	8.6	76.7	8.6	5.6	Sandy	12.0	4.0	8	6.57	1.65	0.36

Particle size distribution after [36] and moisture retention after [37] F.C.: field capacity, W.P.: wilting point, AW: available water, HC: hydraulic conductivity (cm h^{-1}), BD: bulk density (g/cm^3) and P: porosity (cm^3 voids/cm^3 soil). These results of some chemical properties of the soil estimated at the laboratory are shown in Table 3.

Table 3. Some chemical properties of soil in the experimental farm.

Depth	pH	EC	Soluble Cations, meq/L				Soluble Anions, meq/L			
cm	01:02.5	dS/m	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	$CO_3{}^{2-}$	$HCO_3{}^{-}$	$SO_4{}^{2-}$	Cl^{-}
0–15	7.9	0.4	0.55	0.37	1.04	0.25	0	0.14	0.81	1.26
15–30	7.9	0.41	0.5	0.44	1.04	0.24	0	0.15	0.84	1.23
30–45	8.1	0.41	0.54	0.41	1.05	0.22	0	0.15	0.84	1.23
45–60	8.3	0.49	0.58	0.59	1.04	0.22	0.18	0.14	0.86	1.25

Fertilizers and chemicals needed for date palms were added according to the guidelines recommended by the Egyptian Ministry of Agriculture and the Palm Research Center of the Ministry of Agriculture and Land Reclamation in Egypt.

This took 30–50 days of planting before working with the irrigation of the soil to be the appropriate proportion of moisture so that the removal of excess plants could happen in full. Nitrogen fertilization must be more than 80–90 kg Azut (4 urea or 5 nitrates) and should not be more than that and should not be added to the municipal fertilizer and the completion of nitrogen fertilization after 90 days of agriculture. Irrigation should be moderate and should not increase the irrigation water to the weaning flag and note that date palm of crops disliking the abundance of water. It is preferable to add the minor elements (iron–zinc–manganese–boron) because it increases the yield and sugar. The plants are resistant insect pests as soon as they appear. In the harvest after about 180–210 days, it is noteworthy that both the crop and sugar increases with an increase in life up to 240 days. The crop should be supplied immediately after the harvest and not more than 2–3 days at the most free of impurities (vegetative growths—clay and soil).

Biological control of insects and diseases was also carried out according to the guidelines recommended by the Egyptian Ministry of Agriculture and the Palm Research Center of the Ministry of Agriculture and Land Reclamation in Egypt.

Date palm was grown under conditions of drip and sprinkler irrigation systems in two separates experimental fields. The experimental field covered an area of about 2000 m^2 divided into two main plots to represent the two-irrigation system (sprinkler and drip irrigation). Every main plot was divided into three sub-plots included three treatments, represented the two water deficit treatments (80% and 60% of calculated irrigation water requirements). Mini-sprinkler and drip irrigation systems were established according to the treatments as shown in Figure 1.

The system components for the pressurized irrigation consist of:

- Control head: is located at the source of the water supply. It consists of the centrifugal pump (30 HP), $n \approx 1450$ rpm and discharge 50 m^3/h and 55 m lift with efficiency 75:80%), sand filter 48″ diameter, backflow prevention device, pressure regulator, control valve, pressure gauges, flow meter, and chemical injection equipment.
- Mainline: it was (110/90 mm in diameter), made of (P.V.C).
- Sub-main line: it was (75 mm diameter, P.V.C) used to carry the water from the main line to the manifold through a control unit.
- Laterals: it was (16mm diameter, P.E.) and the emitters were built-in (GR) with an average discharge 3.8 L/h at 1.0 bar operating pressure and 0.3 m emitter spacing. Laterals spacing were 0.80 m. Nominal operating pressure and 0.3 m spacing in-between, manufacturer's R^2 = 0.9867 and discharge equation as follows:

$$y = 3.5591x + 0.45 \ldots\ldots\ldots \tag{1}$$

where y is emitter discharge values on Y-axis and x is pressure head values on X axis.

- Sprinkler: it was a 63 mm diameter line connected to the sub-main lines to feed the group of risers. The sprinkler rise was 1-inch diameter and 1 m height derived from the manifold lines and ended of the sprinkler. The average discharge of sprinkler head was about 3.5 m^3/h.

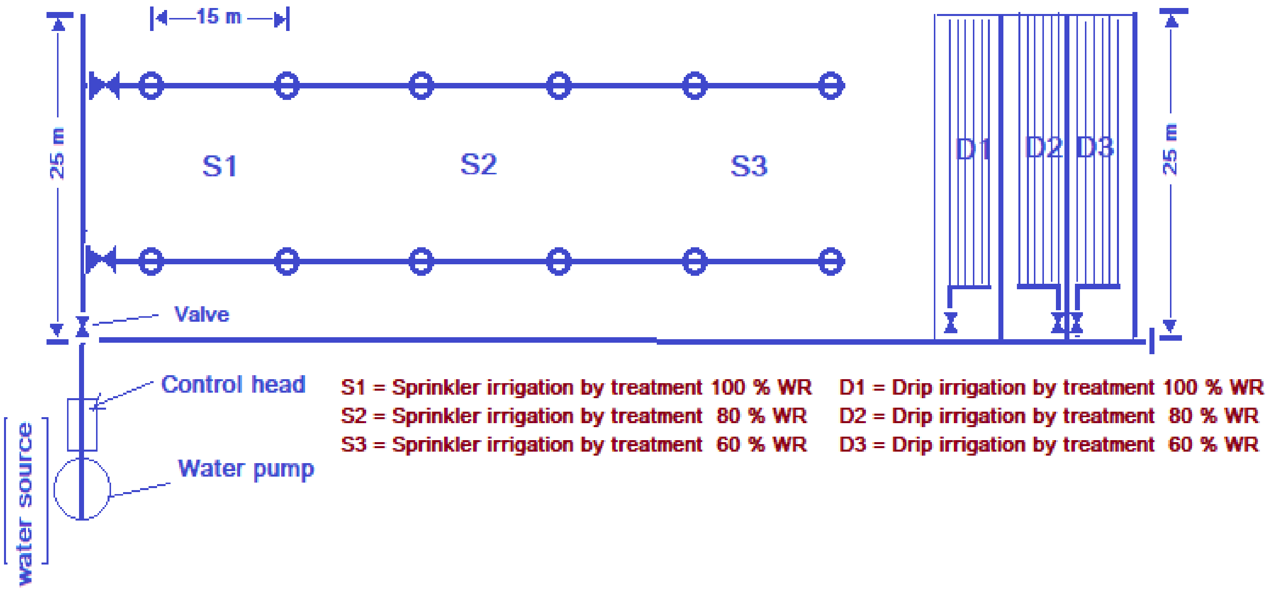

Figure 1. Experimental design layout.

Costas program used to carry out the statistical analysis between treatments. Treatments' means were compared using randomized blocks design and the least significant difference (L.S.D) between systems at 5% [38]. After a homogeneity test combined with the analysis, it was ready to compare between the two irrigation systems.

2.2. Metrological Data of Experimental Farm Area

The monthly averages weather data in experimental location during the study periods can be seen in Figures 2 and 3. The reference evapotranspiration (ETc, mm day^{-1}) was calculated according to the Penman–Monteith (PM) equation (Equation (1) as specified by the FAO protocol [26]. The average monthly water requirements over the date palm tree during growth period, based on PM equation.

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma\frac{900}{T+273}u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad (2)$$

Note: ET_o reference evapotranspiration (mm day^{-1}),
R_n net radiation at the crop surface (MJ m^{-2} day^{-1}),
G soil heat flux density (MJ m^{-2} day^{-1}),
T mean daily air temperature at 2 m height (°C),
u_2 wind speed at 2 m height (m s^{-1}),
e_s saturation vapor pressure (kPa),
e_a actual vapor pressure (kPa),
$e_s - e_a$ saturation vapor pressure deficit (kPa),
Δ slope vapor pressure curve (kPa $°C^{-1}$),
γ psychrometric constant (kPa $°C^{-1}$).

2.3. Fruit Quality

Random collection of 20 fruit samples from each experimental replicates were taken and the following the physical properties measurements were carried out, namely the length and width (mm), pulp weight (g), seed weight (g), pulp/seed ratio, moisture content (%), and fruit weight (g) were determined for the dates. The chemical properties were also determined, in terms of the total soluble solids (TSS), acidity content (%) as malic acid, total reducing, and non-reducing sugars. Assessments consisted of moisture content, total soluble solids (TSS), acidity, and sugars content according to AOAC standard methods of analysis [28] were also achieved.

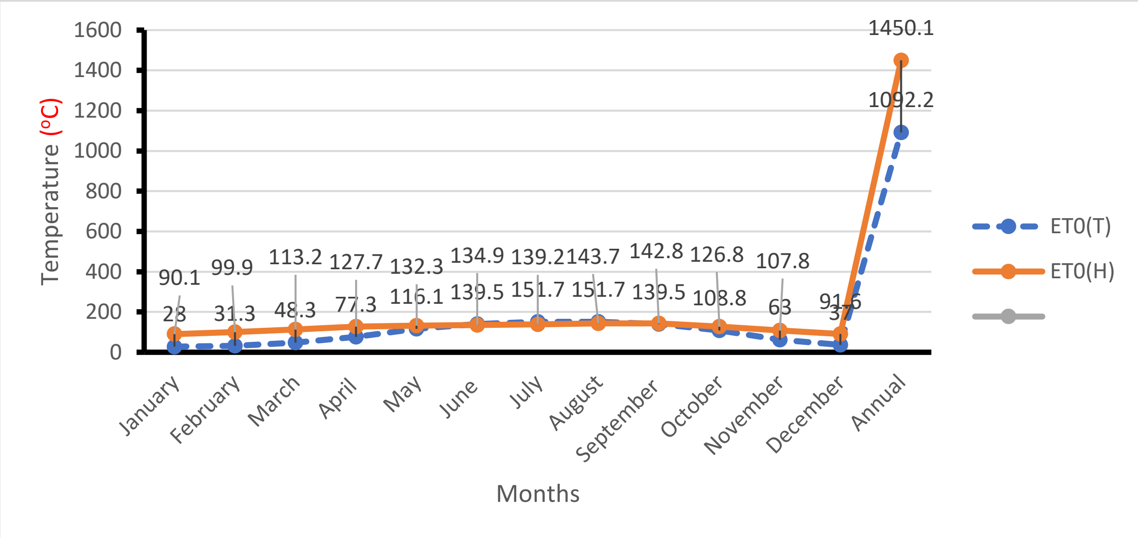

Figure 2. Potential evapotranspiration (ETo) at different temperature. T: mean daily air temperature at 2 m height (°C). H: mean height from sea lecel (m).

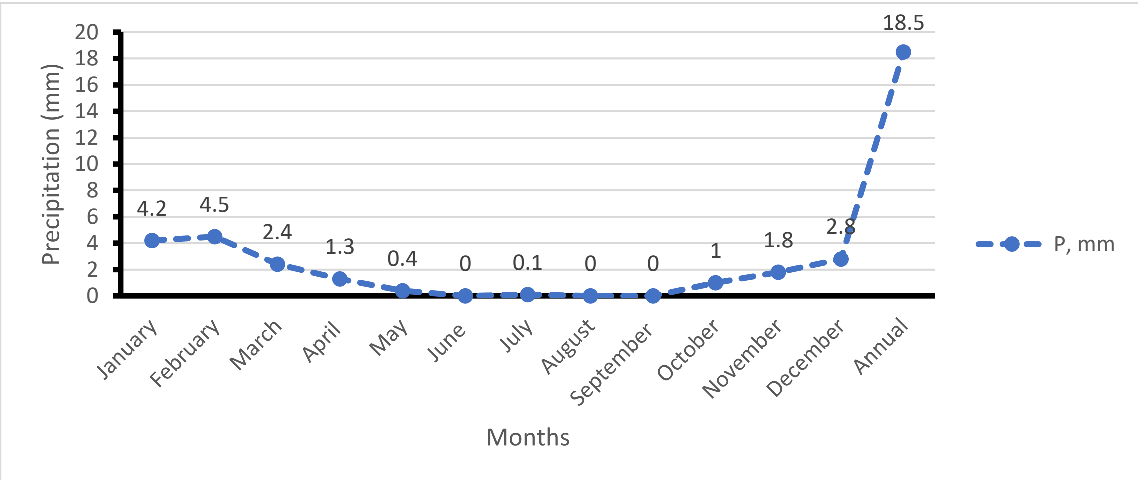

Figure 3. Precipitation (mm).

3. Results and Discussion

The effect of water stress on date palm yield component was examined. The results showed that the effect of water deficit on some attributes of date palm and yield under drip and sprinkler irrigation systems as showing in Tables 4–6 and Figures 4–6.

As observed date palm, productivity yield (g/tree) were significantly affected by increasing water stress from 100% up to 60% of crop water demand under both irrigation systems, (Table 4). According to LSD 0.01, the data averaged over season revealed an application of 100% crop water demand and gave the highest value of yield/fed under drip and sprinkler irrigation systems as shown in Figure 4. In Table 5 and Figure 4, drip-irrigated date palm plants with 80% of crop water demand recorded the % sugar (28.77%), acidity (0.32%) and TSS (42.61%). In addition, there was no significant difference between 60%

and 80% of irrigation water requirements. However, under sprinkler irrigation, total sugar traits values fluctuate among the three irrigation regimes with a significant difference.

Table 4. Effect of different irrigation and water treatments on bunch weight, total yield fruit and flesh weight of date palm.

Water Treatment (ETc)	Irrigation System	Bunch Weight (kg/Tree)	Total Yield (kg/Tree)	Fruit Weight (g/Tree)	Fresh Weight (g/Tree)	Yield Kg/ha	Water Amount (M^3)	WP (M^3/kg)
100	Drip	23.85 *	214.58 *	20.68 *	18.75 *	54.36 *	559 *	9.92 *
	Sprinkler	23.69 *	213.20 *	19.24 *	17.62 **	47.39 *	617 *	7.68 *
80	Drip	20.87 *	173.68 *	22.76 *	20.64 **	48.00 *	436 *	11.02 *
	Sprinkler	19.17 *	172.55 *	21.49 *	19.92 **	34.01 *	493 *	6.89 *
60	Drip	22.68 *	197.68 *	23.52 **	22.69 **	33.57 *	326 *	10.28 *
	Sprinkler	21.86 *	196.78 *	23.07 **	21.38 **	27.54 *	372 *	7.44 *
LSD 0.01		0.11	0.18	0.46	0.14	0.02	2.05	0.35

Significant differences *, Non-significant **, (ha): Hectare, WP: Water productivity, M^3: Quebec meter.

Table 5. Effect of different irrigation and water treatments on seed weight, fruit size, fruit length, diameter and thickness of date palm.

Water Treatment (ETc)	Irrigation System	Seed Weight (g)	Fruit Size (cm^3)	Fruit Length (cm)	Fruit Diameter (cm)	Fruit Thickness (cm)
100	Drip	1.78 *	22.36 *	5.97 *	3.52 *	0.98 *
	Sprinkler	1.67 *	21.42 *	5.29 **	3.30 *	0.94 *
80	Drip	1.71 *	20.68 *	5.68 *	3.04 *	0.97 **
	Sprinkler	1.62 *	19.94 *	5.27 **	2.94 *	0.93 **
60	Drip	1.52 *	18.56 *	5.48 *	3.11 *	0.96 **
	Sprinkler	1.46 *	18.09 *	5.07 *	2.84 *	0.91 *
LSD 0.01		0.03	0.24	0.08	0.05	0.01

Significant differences *, Non-significant **.

Table 6. Effect of different irrigation and water treatments on fruit acidity, TSS, total sugars, reducing and non-red sugars of date palm.

Water Treatment (ETc)	100		80		60		LSD 0.01
Irrigation Systems	Sprinkler	Drip	Sprinkler	Drip	Sprinkler	Drip	
%Acidity	0.30 *	0.32 *	0.29 **	0.31 *	0.28 *	0.29 **	0.01
%TSS	39.82 *	42.05 *	40.86 *	41.23 *	42.61 **	42.54 **	0.11
%Sugar	25.36 *	27.43 *	27.41 *	28.77 *	27.72 *	28.57 *	0.08
% Reducing sugar	25.86 *	28.83 **	27.21 *	28.51 *	27.61 *	28.97 **	0.17
% Non reducing sugar	10.48 *	10.98 *	10.12 **	10.06 **	9.63 *	10.32 *	0.07
%Total sugar	36.36 *	38.12 *	37.25 *	37.67 *	37.12 *	38.14 *	0.08

Significant differences *, Non-significant **.

In Table 6, increasing water deficit from 100% to 60% of crop water demand significantly decreased % sugar and % reducing and non-reducing sugar under both irrigation systems, with productivity decreasing to 36.40% and 41.91% under drip and sprinkler irrigation systems, respectively, showing a very high negative impact, especially under sprinkler irrigation. Contrariwise, the water productivity increased under both irrigation systems with a decreasing water amount rate as shown in Figure 5, meaning that there is a big chance to produce more yield by cultivated more area with the same water amount applied under full irrigation. Total sugar (%) is equal the sugar (%) plus the non-reducing sugar (%).

In addition, data averaged over the growing season revealed that application of 80% of crop water demand gave the highest values of extractable sucrose percentage under both irrigation systems Figure 6. The yield decrease amounted to 37% and 42.05% as the difference between (100% ETc and 60%ETc traits) under drip and sprinkler irrigation systems, respectively, shown in Figure 7 and quality parameters in Figures 8 and 9. However, the decrease in yield accompanying high water deficit might have been due to sucrose percentage. Results in Table 4 also show the date palm yields, and the yield of drip-irrigated date palm with 80% of crop water demand nearly matched with the yield of sprinkler-irrigated date palm with 100% of crop water demand, and this might be due to the highly efficient of drip irrigation system compared with sprinkler irrigation system.

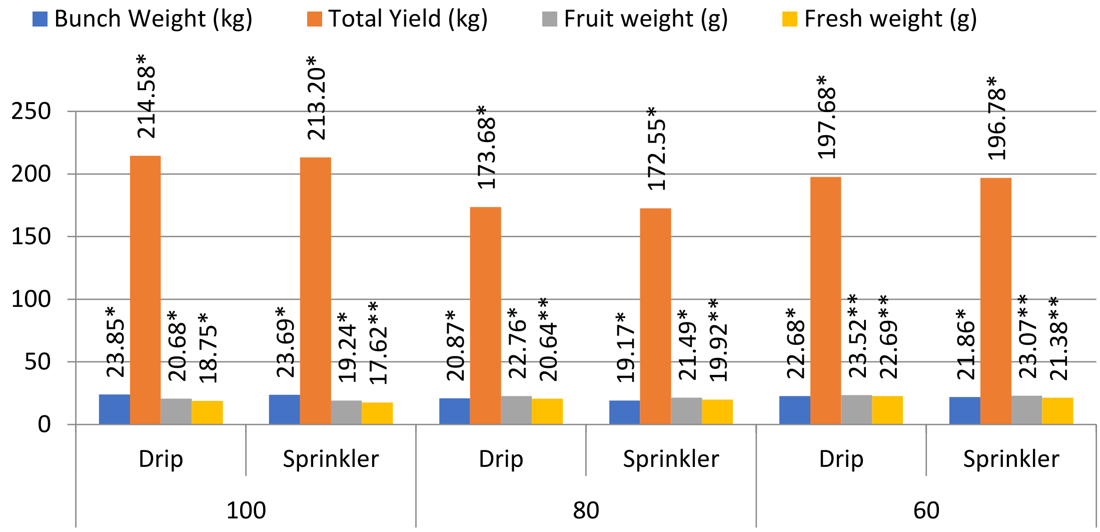

Figure 4. Effect of different irrigation and water treatments on bunch weight, total yield fruit and flesh weight of date palm. Significant differences *, Non-significant **.

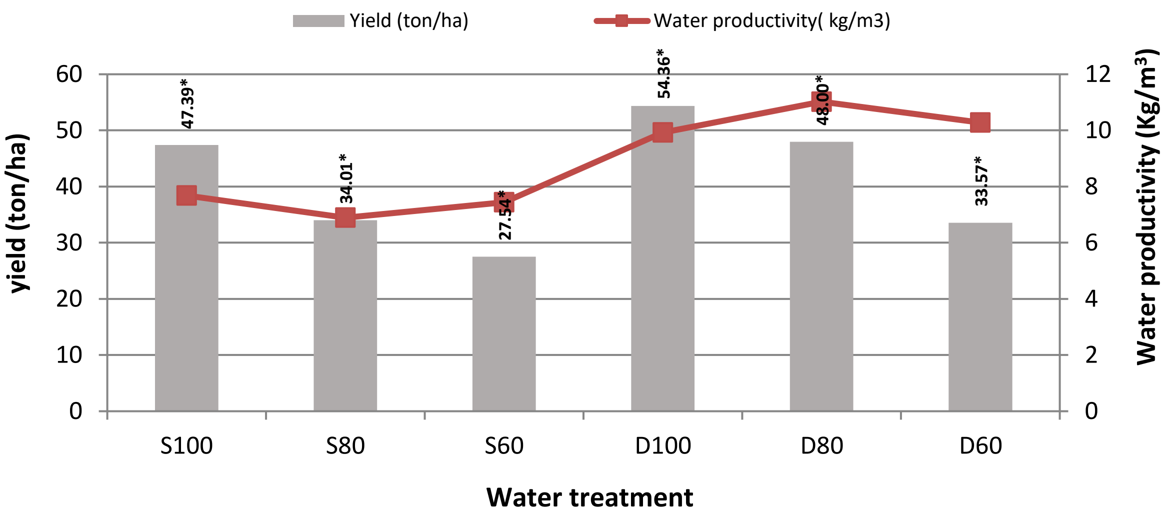

Figure 5. Yield and water productivity under different irrigation systems with different regimes. Significant differences *, (ha): Hectare.

The irrigation process is carried out immediately and irrigation is preferred at night, especially during August and September as well as the months of April, May, and June. The regularity of the irrigation process that was done until weaning, which was done before the harvest, is 15–20 days maximum, but can be up to 30 days in the early harvest during February and March. When the rain falls either in the calcareous and baby land, it takes about 3–4 days to disassemble the soil surface. These data agree with previous research [11,13,14,26–33] that irrigation should be heavy; hence, the lines are fully saturated with water until the germination is integrated. There is no need to conduct the irrigation of the remaining areas for at least 10–20 days in the clay and muddy soil according to the temperature of the air, as it is the irrigation of the yard after 7–10 days. The presence of a high degree of moisture in the soil leads to the injury of seedling diseases and death, and should be the first irrigation time, protector, and preferably saturate the tops of the lines completely. Date palm needs seven to nine irrigations according to the age of the plant at harvest. All irrigation on the protector and conditions until the harvest must be done as much as possible, with the need to discharge excess water after irrigation in the sandy soil. Moisture must be available after planting until the integration of germination, at 7 days, according to regional conditions, temperature, and irrigation system [22,37–53].

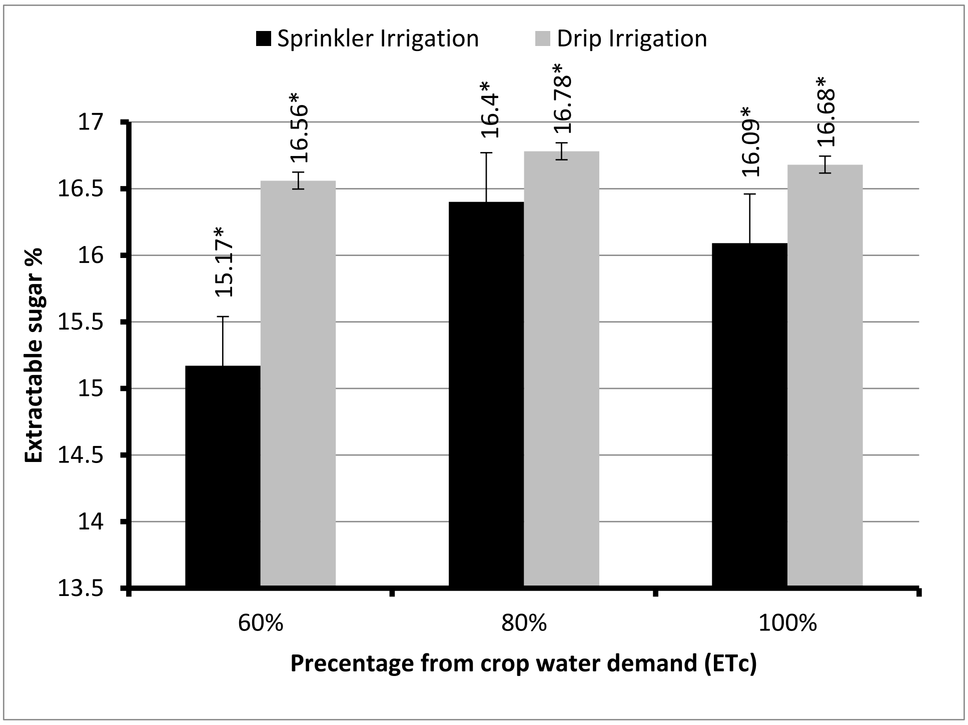

Figure 6. Date palm's extractable sugar (%) under drip and sprinkler irrigation systems with different regimes. Significant differences *.

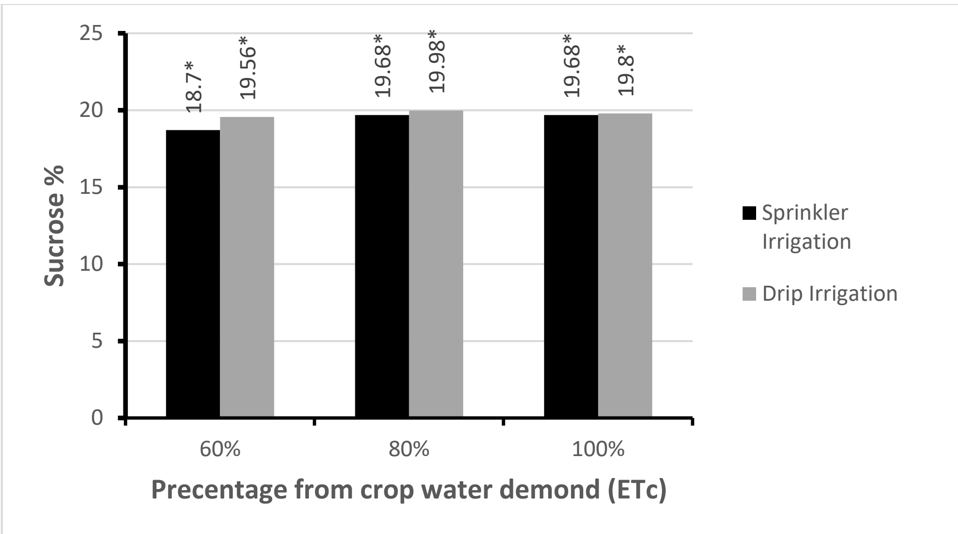

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Figure 7. Date palm sucrose (%) under different irrigation systems with different regimes. Significant differences *.

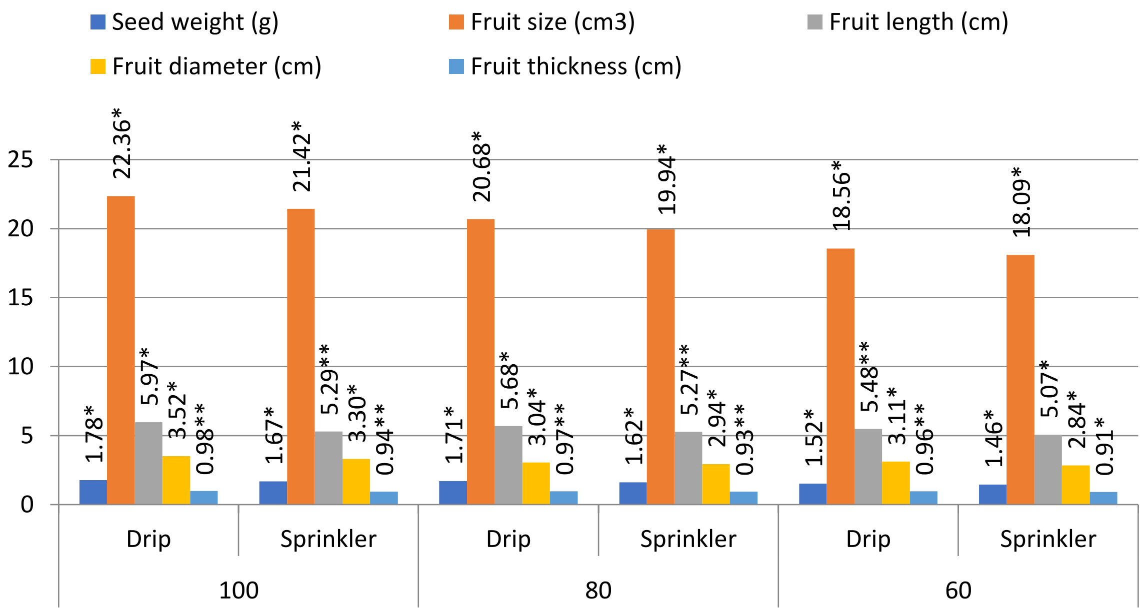

Figure 8. Effect of different irrigation and water treatments on seed weight, fruit size, fruit length, diameter and thickness of date palm. Significant differences *, Non-significant **.

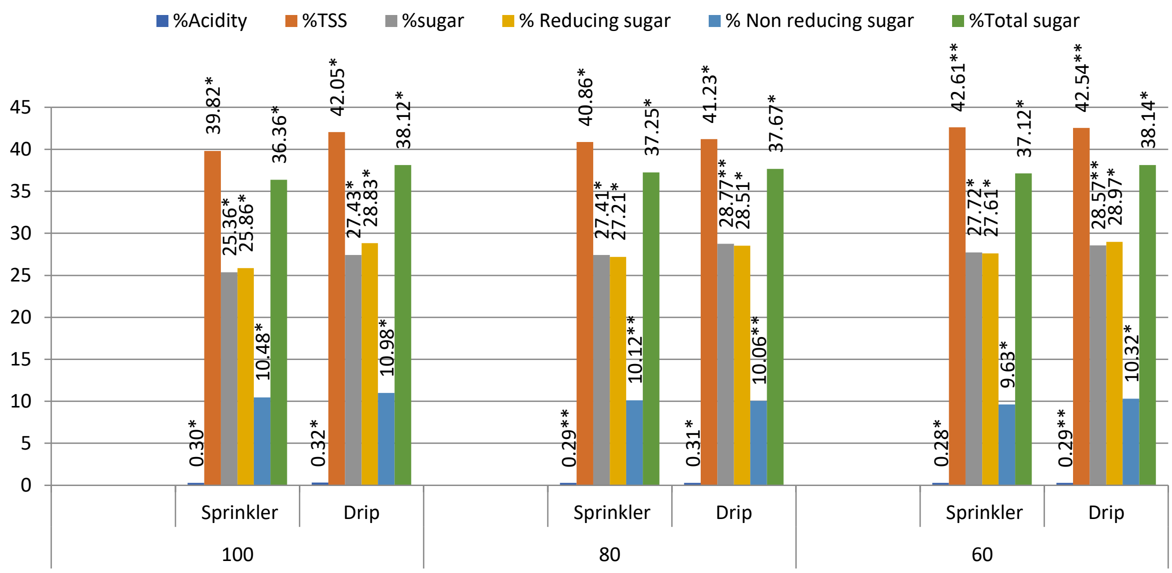

Figure 9. Effect of different irrigation and water treatments on fruit acidity, TSS, total sugars, reducing and non-red sugars of date palm. Significant differences *, Non-significant **.

The shortfall in yield is compensated by the allowance for early breeding. In the late loop, the age may be more than 210 days and may exceed 240 days. It should be noted that the increase in life from 210 to 240 days increases the yield by at least 15–20 0/0 and should stop irrigation for 20–30 days before harvest, according to the temperature and nature of the land, in agreement with the representatives of the plant to determine the date of harvest and supply. Harvesting is usually carried out by cutting, removing the green throne, stowage, transport, or harvesting using the jars to harvest the crop. The green throne is then removed long before the reduction, as this leads to a reduction in sugar because of the new growth. Harvesting is a costly process that requires large labor, and the cost of harvesting and transportation per ton is between 30 and 50 pounds. To lower the sugar content of the crop, the crop should be delivered after two or three days at most, until it is harvested or the sugar contents are harvested [54–61].

Several factors were identified to help improve yield and sugar content. First, the provision of a good cradle for agriculture by plowing, softening, tempering, and laser leveling and planning. Second, dividing the land, hence, the length of the line is not more than 7–9 m, so that irrigation can be controlled. Third, agriculture at a depth of not more than 1–2 cm, preferably to be carried out by hand fingers. Fourth, the use of an herbicide specialized after agriculture immediately before planting and irrigation. Fifth, raya agriculture is heavy and cold, so lines will be saturated completely and the discharge of excess water will occur after the completion of irrigation or the next morning. Sixth, adding the bait after irrigation for 2–3 days so as to avoid injury to the excavator and worm bite. Seventh, the first irrigation after the integration of germination and that after about 10–15 days of agriculture, according to the date of agriculture and air temperature, must be on the protector and conditions.

These results have some implication for sustainable investment in date palm. Environmentally, the study contributes to water conservation, while maintaining high production and quality, which contributes to the economic aspect. The increase in productivity will definitely contribute to the financial returns of these palm trees. Additionally, there are some implications for social aspects, which are related to the saving of effort and time of farmers by applying these methods of irrigation.

4. Conclusions

The current research examines the role of micro-irrigation systems, i.e., sprinkler and drip irrigation, in date palm production and quality in a semi-arid region. The results on productivity showed that the yield of date palm under a drip-irrigation system with 80% of crop water demand matched the yield of sprinkler- irrigated date palm with 100% of crop water demand. This is due to the high efficiency of the drip irrigation system compared to the sprinkler irrigation system. The results showed a significant increase in productivity and white sugar yield by increasing water applied from 60% up to 80 and 100%. Quality attributes of date palm (sucrose, purity, and extractable sugar %) rose with increasing water deficit. Date palm helps Egypt's production of sugar to reduce the gap, which is estimated to be about one million tons of sugar imported annually. The spread of date palm plantations in all governorates of the country can withstand the different climatic conditions. In addition, the possibility of production in different types of land will be successful in the cultivation of areas vulnerable to salt and lime, especially when it needs a small amount of hay fertilizer compared to other crops. This will also help in the expansion of the cultivation of the crop successfully in all the provinces of Lower and Middle Egypt.

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