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Irrigation Water Management of Canola Crop under Surface and Subsurface Drip Irrigation Systems at Toshka Area. Egypt.

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ABSTRACT

Experiments were conducted at South Valley Agricultural Research Station,Toshka Aswan Governorate, during the 2020 and 2021 seasons. An attempt to reach the highest efficiency of irrigation water use and the maximum response of an economical oil crop to modern irrigation systems anddeficit irrigationin the canola crop. Results of the values of ET_o through the canola growing season were 839.88 mm/season. Reference evapotranspiration (ET_o) measured for sowing and harvest were 211.03 mm and 156.6 mm. The total water requirements (m^3/fed.) were 2573.4, 2058.7 and 1544.0 under 100%, 80% and 60%, respectively. According to the findings, the dry zone began with soil in subsurface drip (SSI_{223}) and expanded as the drip line depth & deficit irrigation rose more so than surface drip (SI_{11}). Additionally, the highest yield of seeds, oil, protein (kg/fed.) and irrigation water productivity are the results of 100% water requirements under various treatments. Meanwhile, the application of 60 % water requirements under different treatments gave the lowest ones. The maximum seed, oil, and protein yield were achieved for the SI_{11} treatment, which was higher by 98.1%, 97.7% and 99.2% as compared with (SSI_{223}) treatment, respectively. The water use efficiency of canola was highest in SI_{11} treatment (0.368 kg/m^3). But lowest value in SSI_{223} was 0.011 kg/m^3. Therefore, it is clear from the results that SSI_{223} used less water as compared to SI_{11}but SI_{11} treatment gave higher yield and water used efficiency than those different treatments.

Keywords: Canola, Surface, Subsurface Drip Irrigation, Water use efficiency

INTRODUCTION

In various parts of the world, canola (Brassica napus L.) is grown to make biodiesel, vegetable oil for human use, and fodder. By 2017 there were 35 million hectares of canola plants produced 76.2 million Mg. Canola is the second most widely grown oil crop in the world, behind soybean (FAOSTAT, 2017). Canada, the European Union, China, India, Australia, and the United States of America are the top canola producers in the world. Canola is mostly grown in Europe as a cattle feed because of its high fat and moderate protein content. Canola is a crop that can withstand water stress and is suitable for dry and semi-arid regions (Pavlista et al., 2016). Canola has developed over the past few decades into a crop with significant global agro-economic importance, used for feed, food, and fuel (Kheir and Kamara, 2019).

Egypt's canola crop could help to make up part of the country's shortfall in the production of vegetable edible oils (Megawer and Mahfouz, 2010).Canola oil is one of the best vegetable oils when processed for human nutrition simply because it includes 6% of saturated fatty acids and 94% of unsaturated fatty acids. Canola is one of the oil crops after soybean and palm oil, important source of vegetable oil extraction. In international trade, canola oil is ranked fifth behind rice, corn, cotton, and finally canola. After wheat and barley, it is the third export crop for Canada. Egypt grows canola as a winter crop. On recently reclaimed soil, which is unsuitable for the customary winter crops, canola is also successfully grown. Therefore, expanding canola farming in the new areas is a national objective to boost Egypt's output of vegetable oils.

One of the most significant issues facing Egypt is the lack of oil output. The significant discrepancy between edible oil production and consumption reached 87%. It is required to increase the area under cultivation for oil crops, and canola is one of these oil crops (El-Hadidi et al., 2007).

Canola is one of the world's most significant oil crops on a global scale (Bybordi, 2010).With 27.5% of global production, China is one of the major canola producers. More than 120 nations around the world grow it. Canola has lately become popular in Egypt as a promising new vegetable oil crop to make up for part of the region's lack of production of vegetable edible oil. It was possible to grow it well in the winter. To avoid intense rivalry with other strategically important winter season crops, growers choose to plant canola in a newly recovered area outside the Nile Valley (Ghallab & Sharaan, 2002, and Megawer & Mahfouz, 2010). There are still several issues with growing this crop; one of them is the canola's heavy infestation with various insect pests, which stunts its growth and reduces its output (Lamb, 1989 and Dosdall & Mason, 2010).

The production of oil crops worldwide rose 240% during the past 30 years, while yield and area increased by 82 and 48%, respectively. (El-Hamidi and Zaher 2018)

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Egypt's current state of oilseed production and the discrepancy between consumption and production rates of edible oils Egypt's current condition in regard to edible vegetable oils numerous issues have arisen throughout the manufacture of edible vegetable oil in Egypt. Egypt was dependent on edible vegetable oils in the 1960s, despite having a 95% self-sufficiency rate. (Hassan and Sahfique, 2010).In 2007, this percentage dropped to 31.6%. This has caused the volume of oil imports to increase, reaching 5.6 thousand tones at a total cost of L.E. 1.992 billion in 2007. Due to Egypt's edible oil industry's reliance on imported raw materials—which accounted for about 85% of the private sector's dependence—the problem worsened. Canola is a crop that can withstand water stress and could be used as an alternative in regions with scarce water supplies. However, irrigation is required for canola cultivation to reach its full yield in desert and semi-arid regions where rainfall events are few and becoming more irregular. (López-Urrea, R., et al.2020).

An attempt is a dun to reach the highest efficiency irrigation water use. Also, to identify the highest economic return of the water unit per planting canola crop. To determine the response of modern irrigation systems & deficit irrigation water in the desert lands at Toshka region.

MATERIALS AND METHODS

Description of the Study Area

Experiments were conducted at South Valley Agricultural Research Station, Toshka, Agricultural Research Center of the Ministry of Agriculture and Land Reclamation during the 2020 and 2021 seasons. In Toshka District - Abu Simbel City, Aswan Governorate Egypt, located at the latitude of 22^0, 24`.11`N longitude of 31^0, 35`.43`E and the land level height of 188 m.

Experimental design:-

To fulfill the purpose of the current study, three similarly experimental were chosen using plot design.

The first experimental site was used surface drip irrigation (SI) whereas the second one was used sub-surface drip irrigation (SSI_1) with putting the drip lines at 20 cm depth, while the third one was used sub-surface drip irrigation (SSI_2) with putting the drip lines at 40 cm depth. Each of studying sites was divided into two divisions to study the spacing between laterals (30 cm - S_1) and (50 cm - S_2). Each division was subdivided into three areas the first one used 100% of water requirements, while the second one used 80% of water requirements, finally the third one used 60% of water requirements.

Each plot area of about 30 m^2 accordingly, the experimental work involved 54 plots {3 irrigations system × 2 spacing between emitter × 3 water requirements ×3 replicates}. The experimental Irrigationtreatments included irrigation scheduling as follows illustrated in (Table1)

Table 1. The experimental irrigation treatments (main plot).

	Surface drip irrigation (SI)	Sub Surface drip irrigation 20cm (SSI_1)	Sub Surface drip irrigation 40cm (SSI_2)
Emitter Spacing (30 cm)	100% of water requirements (SI_{11})	100% of water requirements (SSI_{111})	100% of water requirements (SSI_{211})
	80% of water requirements (SI_{12})	80% of water requirements (SSI_{112})	80% of water requirements (SSI_{212})
	60% of water requirements(SI_{13})	60% of water requirements (SSI_{113})	60% of water requirements (SSI_{213})
Emitter Spacing (50 cm)	100% of water requirements (SI_{21})	100% of water requirements (SSI_{121})	100% of water requirements (SSI_{221})
	80% of water requirements (SI_{22})	80% of water requirements (SSI_{122})	80% of water requirements (SSI_{222})
	60% of water requirements (SI_{23})	60% of water requirements (SSI_{123})	60% of water requirements (SSI_{223})

Soil and water type and its characteristics

The soil of experimental site is classified as loam sandy soil. Some physical properties of the experimental soil are presented in table (2) and the irrigation water chemical characteristics at the study in table (3).

Measurement of soil water content

Soil water content was determined using the gravimetric method (θ_g), samples were taken with auger from the middle row of every plot before irrigation and 2 hrs after irrigation during the initial, development, mid-season and harvest. Every 20 cm, up to a depth of 60 cm, a sample of each was taken. The soil's moist bulk was identified right away following the sampling. To determine (θ_g), soil samples were dried for 48 hours at 105°C. Unaltered soil samples were collected at the start of the experiment in order to compute the bulk density, which was used to calculate the volumetric (θ_v) soil water content.

Table 2.some physical properties of the soil before cultivation

Soil depth (cm)	Particle size distribution (%) Sand	Silt	Clay	Tex. class	S.P. (%)	F.C (%)	W.P (%)	A.W (%)	BD (g/cm³)
0- 20	86.19	0.86	12.95	L. S	28.70	13.9	2.0	11.9	1.41
20-40	86.21	1.18	12.61	L. S	29.30	13.6	2.0	11.6	1.41
40-60	90.80	1.23	7.97	S	27.40	12.3	2.1	10.2	1.40

L.S =Loamy sand, S.P= Saturation percent, F.C= Field capacity W.P = Wilting point, A.W=Available water, B.D=Bulk density

Table 3. Irrigation water chemical characteristics

Water sample	pH	EC(ds|m)	TDS mg/l	Cations (meq/l)				Anions (meq/l)				SAR	RSC	SSP%
				Na^+	K^+	Mg^{+2}	Ca^{+2}	Cl^-	CO_3^{-2}	HCO_3^-	SO_4^{-2}			
1	8.67	0.250	118	0.71	0.24	0.48	0.80	0.16	0.20	0.70	0.73	0.89	0.00	31.89
				Cations.ppm				Anions.ppm						
				Na^+	K^+	Mg^{+2}	Ca^{+2}	Cl^-	CO_3^{-2}	HCO_3^-	SO_4^{-2}			
				16	9.3	5.8	16	21	6.0	43	35			

SAR= Sodium Adsorption Ratio RSC: Residual Sodium carbonate SSP%: Sodium soluble percentage

Water relations

Actual evapotranspiration (ET_0)

Table (4) of Reference Evapotranspiration displays the weather for each month of the canola growing seasons in 2020 and 2021. The monthly averages for air temperature and wind speed were 7.5–37.4 °C and 2.1–3.9 m/s, respectively. The calculate actual evapotranspiration. It was impacted by irrigation rates it was computed the formula based on Doorenbos *et al* (1977)

Table (4) shows the reference evapotranspiration and the weather conditions for each month duringthe 2020 and 2021 canola growing seasons. Monthly averages of air temperature ranged between 7.5–37.4 °C, and wind speed between 2.1 - 3.9 m/s. The meteorological data were taken from Toshka meteorological station. Reference evapotranspiration (ET_0, mm/day) was calculated according to the Penman-Monteith (PM) equation as specified by the FAO protocol. As crop evapotranspiration ET_c can be calculated by Doorenbos *et al*. (1977) and Allen *et al*. (1998):

$$ET_c = K_c \times ET_0 \quad \text{.................} (1)$$

Where

ET_c = crop evapotranspiration (mm/day).
ET_o = reference evapotranspiration (mm/day).
k_c = crop coefficient.

The quantity of irrigation needed (IR100) was determined using Keller and Bliesner (1990) and Allen *et al.* (1998) by the Eq. 2

$$\mathbf{IR} = \frac{ETc+Lr}{Ea} \times 4.2 \quad \text{......(2)}$$

Where

IR = Irrigation water requirement (m^3/ fed).
ET_c = Crop evapotranspiration (mm/day).
Lr = Leaching factor 10 % (since electrical conductivity of soil solution is low, LR was neglected).
Ea = Irrigation system efficiency, % (drip irrigation efficiency = 90%).

Table 4. the average of monthly meteorological variables of Toshka weather.

Element Month		Temperature (ºc) Minimum	Maximum	Relative humidity (%) Minimum	Maximum	ET_o (mm)	Wind speed (m/sec)
October	15st : 31th	*27*	37. 4	16.2	48.6	7.62	3.5
November	1st : 15th	17.5	32.3	21.2	52.4	6.3	3.3
	15st : 30th	15.4	30.8	19.6	53.6	5.6	3.7
December	1st : 15th	10.7	26.4	26.4	59.3	5.1	3.6
	15st : 31th	7.5	25.7	22.7	63.8	5.2	2.7
January	1st : 15th	7.9	22.8	20.8	58.3	4.5	3.9
	15st : 31th	12.7	27.7	13.3	43.5	3.9	2.1
February	1st : 15th	10.4	25.2	14.5	51.9	5.0	3.3
	15st : 28th	11.5	24.6	17.6	48.3	5.7	3.9
March	1st : 15th	11.2	27.4	10.4	45.2	6.7	3.4

Water use efficiency (WUE)

Water use efficiency is the outcome of an entire suite of plant and environmental processes operating over the life of a crop to determine both yield and ET_o. Consequently, biomass production per unit ET_o, has been used extensively as an interim measure of water use efficiency, The Water use efficiency (WUE) values were calculated as follows (Vites ,1965) :-

WUE (kg/m³) = {Grain yield (kg / fed.) / ET_c (m³/fed.)}

Irrigation water use efficiency (IWUE)

The (IWUE) is measured in of water applied, has been used to assess how effectively irrigation techniques produce the highest yield per water unit absorbed for the crop by Vites (1965) as the following

IWUE = {Grain yield (kg/fed.) / Irrigation water requirement (m^3/fed.)}

RESULTS AND DISCUSSION

Estimation of reference evapotranspiration, crop water requirements and the total of water requirements (m^3/fed)

Data in Table (5) illustrate the results of the ET_o calculations for the weather station located in Toshka, Station region under current and future conditions. The values of daily ET_o through the canola growing season were 839.88 mm/season. ET_o during the canola growing seasons (from sowing to harvest) was 211.03 mm and 156.6 mm. And table (5) shows ET_c values increased quickly as the crop development period progressed due to the fast increaseof the canopy cover, facilitated by the favorable spring temperatures.

Table 5. Reference Evapotranspiration (ET_o (mm)), Crop Coefficients K_c, Crop evapotranspiration (ET_C (mm)), Total Water Requirements (m^3/fed/ stage) and Total Water Requirements (m^3/fed./season)

		Growth stages Seedling	Vegetative	Flowering	Maturation	Total
ET_o (mm)		211.03	211.22	261	156.63	839.88
Crop Coefficient, K_c		0.54	0.80	1.15	0.53	0.75
ET_C (mm)		95.0	169.0	300.2	54.82	618.9
Irrigation system efficiency, %				0.90		
IR(mm)		85.5	152.1	270.1	49.3	557.0
Leaching requirements		8.5	15.2	27.0	4.93	55.7
The total of water requirements (m^3/ fed.)	100%	394.9	702.6	1248.0	227.9	2573.4
	80%	315.9	562.1	998.4	182.3	2058.7
	60%	236.9	421.6	748.8	136.7	1544.0

And table (5) shows estimates of ET_c values, it is clear that ET_c values increased as the plant age progresses till the flowering growth stages, then the rate decreased till the end (maturation) of the season, the values of daily ET_c through the canola growing season were 618.9 mm/season, where were values 95.0 and 300.2 mm/season in seedling and flowering crop growth stage.The total amount of water requirements (m^3/fed.) after taking into account the proportion of crop coefficient, with the rate of leaching were 10% and irrigation efficiency was 90% and found that average overall irrigation water requirements was during the seasons for different treatments are given in table (5). Also, the results show that total water requirements (m^3/fed./season) it is clear that the values of 2573.4, 2058.7 and 1544.0 under 100%, 80% and 60% respectively.

Soil moisture content response for the irrigation treatments

Figs. from (1 to 6) show the soil moisture before and after irrigated for the different patterns in response to the different treatments. So when comparing surface irrigation (SI), sub-Surface irrigation 20 cm (SSI_1) and Sub-Surface irrigation 40 cm (SSI_2) there were found that the (SSI_1) and (SSI_2) except surface soil later was not completely wetted as in the case of (SI). However, the upward capillary movement of water was nonsufficient, and soil water content at the surface decreased significantly any where most wettings occurred close to the water source. The average soil moisture values during the initial stage (until 20 - 40 cm) were similar in different treatments. Early in the developmental process, when root formation had not started, at 0.0 – 20.0 cm depth the soil was approximately at field capacity. Therefore, the soil surface under the dripper wetted in the case of surface drip line (SI_{11}) treatment (Fig. 1). The average soil moisture values at depths of 0.6 m were either above or near the F.C after starting the irrigation treatments. But there is a difference between the soil moisture under the surface drip irrigation, subsurface drip 20 cm and subsurface drip 40 cm irrigation because the water movement up and down in the subsurface drip either in surface irrigation is moves down only.

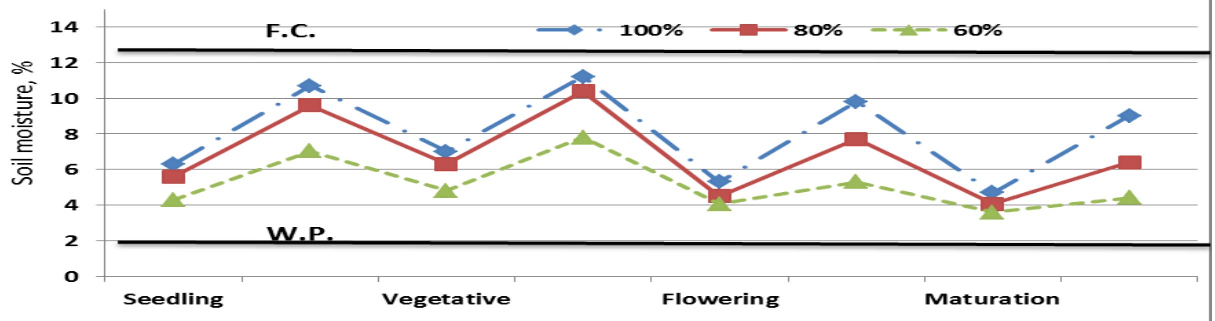

Fig (1) Soil moisture befor and after irrigation at surface drip irrigation (GR30) at growth stages under 100%, 80 % and 60 % of water requirements .

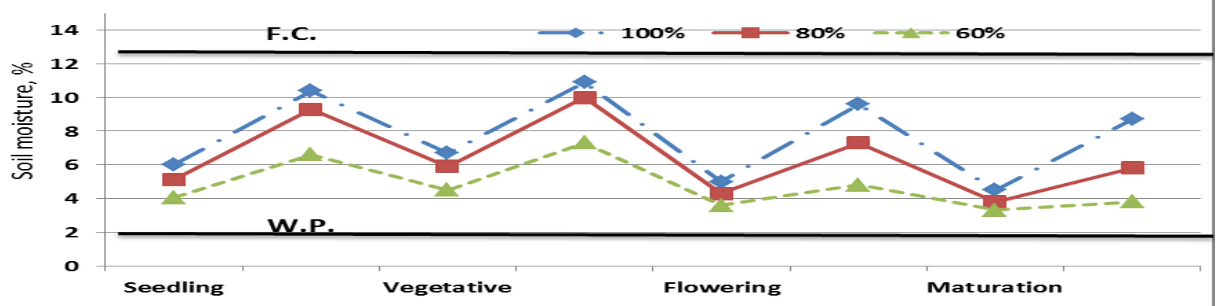

Fig (2) Soil moisture befor and after irrigation at surface drip irrigation (GR50) at growth stages under 100%, 80 % and 60 % of water requirements .

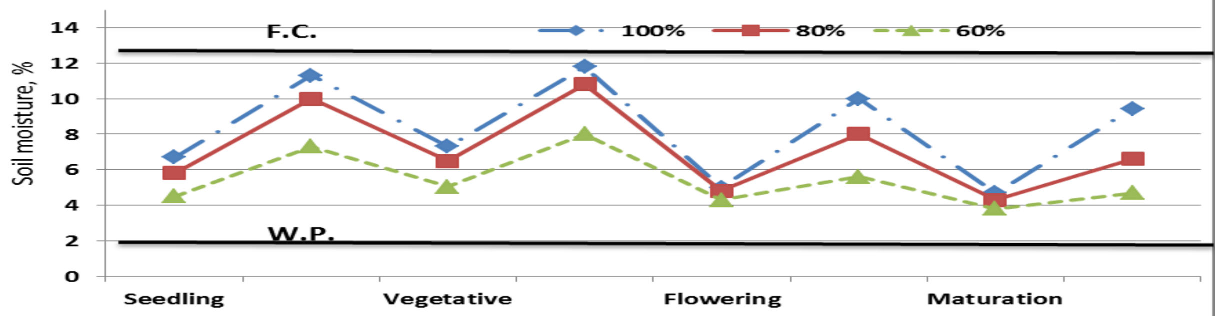

Fig (3) Soil moisture befor and after irrigation at sub surface drip irrigation 20cm (GR30) at growth stages under 100%, 80 % and 60 % of water requirements .

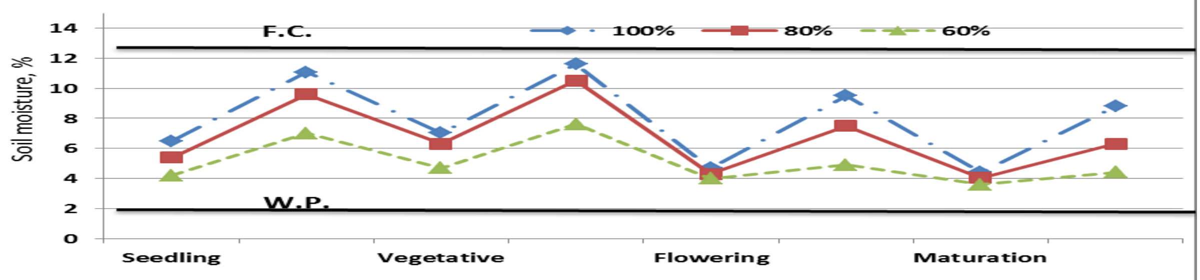

Fig (4) Soil moisture befor and after irrigation at sub surface drip irrigation 20cm (GR50) at growth stages under 100%, 80 % and 60 % of water requirements .

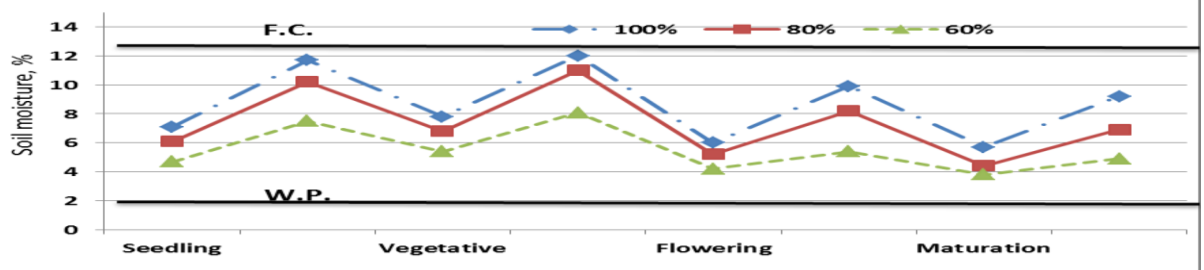

Fig (5) Soil moisture befor and after irrigation at sub surface drip irrigation 40cm (GR30) at growth stages under 100%, 80 % and 60 % of water requirements .

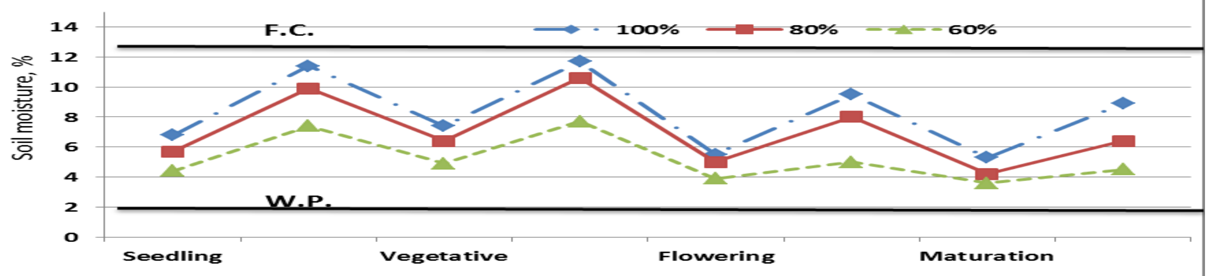

Fig (6) Soil moisture befor and after irrigation at sub surface drip irrigation 40cm (GR50) at growth stages under 100%, 80 % and 60 % of water requirements .

According to the findings, the dry zone began with soil in subsurface drip (SSI_{223}) and expanded as the drip line depth and deficit irrigation rose more so than surface drip (SI_{11}). Also, an adequate amount of moisture was still available in the region of the plant roots and better moisture transmission to the surrounding soil and keeps on replenishing the crop root zone in surface drip and 100% water requirements (SI_{11}).

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Yield seeds, Oil and Protein, (Kg/ fed) and Irrigation Water Productivity (IWP)

One of the important oil crops in Egypt is canola. It grows in the winter, where as the majority of oil crops are planted in the summer and compete for limited farmed space with big summer crops like cotton, maize, and rice. More than 45% of the canola seed's weight is good edible oil. The tables from (6 to 8) displays averages of seed, oil, protein, and oil yield as influenced by irrigation regimes, irrigation type (surface and subsurface), and drip line.

Table 6. Seed yield (kg/fed.), irrigation water use efficiency (kg/m^3), water use efficiency (kg/m^3),oil content (%),oil yield (kg/fed), protein content (%) and protein yield (kg/fed) at 100 % water requirements (2573.4 m^3/fed) under different treatment.

Treatments	Seed yield (kg/fed)	IWUE kg/m^3	WUE kg/m^3	Oil content %	Oil yield (kg/fed)	Protein content %	Protein yield (kg/fed)
SI_{11}	945.8	0.368	0.364	38.12	360.8	20.6	195.1
SI_{21}	808	0.314	0.311	37.3	301.4	19.75	160
SSI_{111}	766.6	0.298	0.295	36.8	282.1	19.6	150.8
SSI_{121}	500.8	0.195	0.193	35.5	177.9	16.8	84.34
SSI_{211}	409.3	0.159	0.157	35.4	145.1	15.7	64.2
SSI_{221}	338.4	0.131	0.130	34.6	117.3	15.1	51.01

Table 7. Seed yield (kg/fed.), irrigation water use efficiency (kg/m^3), water use efficiency (kg/m^3), oil content (%), oil yield (kg/fed), protein content (%) and protein yield (kg/fed) at 80 % water requirements (2058.7m^3/fed) under different treatment.

Treatments	Seed yield (kg/fed)	IWUE kg|m^3	WUE kg| m^3	Oil content %	Oil yield (kg/fed)	Protein content %	Protein yield (kg/fed)
SI_{12}	463.2	0.225	0.178	35.03	162.4	16.4	76.1
SI_{22}	428.5	0.208	0.165	34.5	147.8	15.9	68.3
SSI_{112}	407.5	0.198	0.157	33.1	135.04	14.2	58.2
SSI_{122}	331.7	0.161	0.128	32.5	107.9	13.6	45.3
SSI_{212}	250.3	0.122	0.096	31.6	79.04	13	32.5
SSI_{222}	163.7	0.079	0.063	30.8	50.5	11.9	19.7

Table 8. Seed yield (kg/fed.), irrigation water use efficiency (kg/m^3), water use efficiency (kg/m^3), oil content (%), oil yield (kg/fed), protein content (%) and protein yield (kg/fed) at 60 % water requirements (1544.04 m^3/fed) under different treatment.

Treatments	Seed yield (kg/fed)	IWUE kg/m^3	WUE kg/m^3	Oil content %	Oil yield (kg/fed)	Protein content %	Protein yield (kg/fed)
SI_{13}	223.2	0.145	0.086	30.5	68.1	12.7	28
SI_{23}	196.5	0.127	0.076	28.6	56.4	12.4	24.2
SSI_{113}	114	0.074	0.044	27.15	31.2	10.5	11.9
SSI_{123}	75.3	0.049	0.029	23.7	17.9	10.2	7.7
SSI_{213}	50.2	0.033	0.019	21.3	10.8	9.45	4.7
SSI_{223}	17.6	0.011	0.008	19.2	8.4	3.4	1.5

The various treatments' irrigation schedules had a considerable impact on them. The maximum yields of seeds, oil, and protein (kg/fed) are produced when 100% of the water required is applied under various treatments. Meanwhile, the application of 60 % water requirementsunder different treatment gave the lowest yields of seeds, oil and protein kg/fed. The highest seed, oil and protein yield was obtained at the (SI_{11}) treatment, which was higher by 76%, 81% and 85% as compared with (SSI_{23}) treatments, respectively. Meanwhile, the highest values of seed yield, oil yield and protein yield reached about 945.8, 360.8 and 195.0 under surface drip irrigation (GR30) respectively. This trend is in general accordance with those obtained by El-Samanody et. al. (2004), Rana et. al. (1991b) and Nour El-Din et. al. (1993) they found that increasing irrigation frequency increased oil yield. The water use efficiency of the canola under all treatments are illustrated in tables (6-8) these result showed that water use efficiency was highest in SI_{11}treatment, it was 0.368 kg/m^3 but the lowest values in $SSI_{223,}$ it was 0.011 kg/m^3. Therefore, it is clear from the results that SSI_{223} use less water as compared to SI_{11} and SI_{11} treatment gave higher yield and water used efficiency than Yields of seeds, oil and protein kg/fed under different treatments.

CONCLUSIONS

This study analyzed the combined effects of surface and sub-surface drip irrigation and deficit irrigation on canola crop growth. The goal was to provide additional insights into the improvement of an economic oil crop to modern irrigation systems anddeficit irrigation water in the desert lands represented in the Toshka region. It is helpful to define new and more effective management practices to improve yield and WUE. The results confirmed that severe water restrictions in both irrigation systems have negative effects on canola yield and WUE. The result showed that water used efficiency highest in SI_{11} treatment at 0.368 kg/m^3 but lowest values in $SSI_{223,}$ it was 0.011 kg/m^3. Therefore, it is clear from the results that SSI_{223} used less water as compare to SI_{11} and SI_{11} treatment gave higher yield and water used efficiency than all different treatments.

REFERENCES

Allen G. R.; L. S. Pereira; D. Raes and M. Smith (1998). Crop evapotranspiration guidelines for competing crop water requirements. FAO. Irrigation and drainage paper 56. Rome, Italy.

Bybordi A. (2010). Effects of salinity on yield and component characters in canola (Brassica napus L.) cultivars. Not Sci Biol. 2:81-83.

DoorenbosJ. and W.O. Pruitt(1977). Crop water requirement. Irrigation and drainage epaper, No.24,FAO, Rome.

Dosdall, L.M. and P.G.Mason (2010). Key pests and parasitoids ofrape or canola in North America and the importance of parasitoids in integrated management. In: Williams, I.H. (Ed.), Biocontrol-Based Integrated Management of Oilseed Rape Pests.Springer, pp. 167–213 (Chapter 6).

El-Hadidi, M., Abu-Al-Kheer, A.M., Sakr, M.T., Farouk, S.A., (2007). Structural and physiological studies and oil constituent of canola plants under salinity conditions. Afri. Crop Sci. Conf. Proc. 8,1679–1684.

El-Hamidi M. and Zaher F. A. (2018).Production of vegetable oils in the world and in Egypt: an overview. Bulletin of the National Research Centre 42:19. https://doi.org/10.1186/s42269-018-0019-0

El-Samanody, M. K. M; M. A. Awad and S. M. El-Marsafawy(2004). Scheduling irrigation of canola under nitrogen sources in Middle Egypt. Misr J. Ag. Eng. 21 (1): 165-188.

FAOSTAT, (2017). Food and Agriculture Organization of the United Nations. Statistic Division . (Accessed 12 December 2019).

Ghallab, K.H., Sharaan, A.N., (2002). Selection in canola (Brassicanapus L.) germplasm under conditions of newly reclaimed land. II.Salt tolerant selections. Egypt. J. Plant Breed. 6 (2), 15–30.

Hassan MBE, Sahfique FA (2010). Current situation of edible vegetable oils andsome propositions to curb the oil gap in Egypt. Nat Sci 8:1–7

Keller, J., &Bliesner, R. D., (1990).Sprinkle and trickle irrigation, Van Nostr and Reinhold, New York, ISBN: 0-442-24645-5.

Kheir, A and M. Kamara (2019). Effects of sugar beet factory lime, vinasse, and compost mixed with vinasse application on sandy soil properties and canola productivity. Journal of Soil Sciences and Agricultural Engineering, 10(1): 69-77. .Fac. Agric. Mans. Univ, Egypt

Lamb, R.J., 1989. Entomology of oilseed Brassica crops. Ann. Rev.Entomol. 34, 211–229.

López-Urrea, R., Sánchez, J. M., De la Cruz, F., González-Piqueras, J., & Chávez, J. L. (2020). Evapotranspiration and crop coefficients from lysimeter measurements for sprinkler-irrigated canola. Agricultural Water Management, 239, 106260.

Megawer, E.A., Mahfouz, S.A., (2010). Response of Canola (Brassicanapus L) to Biofertilizers under Egyptian conditions in new lyre claimed soil. Int. J. Agric. Sci. 2 (1), 12–17.

Nour El-Din, N. A. ; M. S. El-Habbal ; M. A. Hamada and M. A. Hamed (1993). Yield response of two rapeseed cultivars to irrigation intervals and nitrogen fertilizer under sandy soil condition. Ann. Agric. Sci., Ain Shams Univ. Cairo, 38(2):511-519.

Pavlista, A.D., Hergert, G.W., Margheim, J.M., Isbell, T.A., (2016). Growth of spring canola (Brassica napus) under deficit irrigation in Western Nebraska. Ind. Crops Prod. 83, 635–640.

Rana, D. S.; H. P. Singh and I. P. S. Ahlawat (1991b). Oil yield and nitrogen uptake in mustard (Brassica juncea) as affected by irrigation, plant density and nitrogen application. Indian J. of Agron. 36 (supplement):143-146.

Vites F.G. (1965). Increasing water use efficiency by soil management. America Society Agronomy, Madison, Wisconsin, p: 259-274.

إدارة مياه الري لمحصول الكانولا تحت نظام الري بالتنقيط السطحي وتحت السطحي في منطقة توشكى،مصر.

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الملخص

أجريت تجربة في محطة جنوب الوادي للبحوث الزراعية، توشكى، موسمي 2020 و 2021. محاولة للوصول إلى أعلى كفاءة وعائد اقتصادي لوحدة المياه لمحصول الكانولا، وتحديد الاستجابة القصوي لمحصول زيتي اقتصادي لأنظمة الري الحديثة، والري الناقص. وكانت نتائج (ET_o) البخر نتح المرجعي خلال موسم نمو الكانولا 839.88 مم/موسم. في حين كان (ET_o) خلال المواسم (من الزراعة الى الحصاد) 211.03 الي 156.6 مم. وكانت قيم البخر نتح المحصولي (ET_c) خلال الموسم 618.9 مم/موسم، وكانت 95.0 و 300.2 مم/ موسم في مرحلة الانبات و الازهار. وكانت الاحتياجات المائية الكلية (م3/فدان) هي 2573.4 و 2058.7 و 1544.0 للمعاملات 100٪ و 80٪ و 60٪ من الاحتياجات اليومية على التوالي. أشارت النتائج إلى أنه مع زيادة عمق دفن خط التنقيط و نقص الري، تزيد المنطقة الجافة التي ظهرت في نظام الري بالتنقيط تحت سطح التربة (SSI_{223})عن الري بالتنقيط السطحي (SI_{11}) . وعند اضافة 100٪ من الاحتياجات المائية أعطي أعلى محصول للبذور والزيوت والبروتين (كجم/فدان) في المعاملة (SI_{11}). وفي الوقت نفسه ، فإن تطبيق 60٪ من الاحتياجات المائية تحت جميع المعاملات أعطت أقل كمية من المحصول، بذور وزيوت وبروتين (كجم/فدان). وقد وجد أن إنتاج البذور والزيوت والبروتين للمعاملات (SI_{11}) أعلى بنسبة 98.1٪ و 97.7٪ و 99.2٪ بالمقارنة بالمعاملة (SSI_{223}) . وكانت كفاءة استخدام المياه لمحصول الكانولا هي الأعلى في المعاملة SI_{11} حيث كانت 0.368 كجم/م^3 في حين كانت 0.011 كجم/م^3 أقل قيمة في المعاملة SSI_{223} . اتضح من النتائج أن المعاملة SSI_{223} استخدم كمية أقل من مياه الري مقارنةً بالمعاملة SI_{11}ولكن المعاملة SI_{11} أعطت أعلى إنتاجية و أعلى كفاءة استخدام مياه من جميع المعملات الاخري.

الكلمات الدالة: الكانولا ، الري بالتنقيط السطحي، تحت سطحي، كفاءة استخدام المياه.