Egyptian Journal of Agronomy
http://agro.journals.ekb.eg/

Effect of Regulated Deficit Irrigation and Compost Tea on Canola Yield and Quality under Drip Irrigation

Hisham M. Imam, Sabreen Kh. Pibars* and **Soha E. Khalil**

Water Relations and Field Irrigation Department, Agricultural and Biological Research Institute, National Research Centre (NRC), Giza, Egypt

Using a split split plot design; field experiments were carried out over two consecutive growing seasons to study the effects of the following: regulated deficit irrigation: 100% ETc throughout the growing season (IR1), applying an irrigation shift and skipping the next during the vegetative growth (IR2), flowering (IR3), and senescence (IR4) stages; compost tea dose: 142.8 (C1), 95.2 (C2), and 47.6 l/ha (C3); and variety: (Serw 4 and Bactol 1) on both seed and oil yield and water productivity of canola. Results indicated that skipping irrigation shifts and decreasing the applied compost tea dose affected the seed and oil yield of the canola. Water stress must be avoided at the flowering stage as it decreases seed yield. Canola can be water-stressed at vegetative growth and senescence stages achieving comparative growth characteristics and saving 14.6% of irrigation requirements.

Serw 4 variety had higher productivity than Bactol 1. The highest seed yield of Serw 4 (2380 kg/ha) was obtained for (IR2×C1) while the minimum one (2023 kg/ha) was obtained for (IR3×C3), respectively. The highest oil yield of Serw 4 (1576 kg/ha) was obtained for IR2 x C1 and the lowest (1190 kg/ha) was obtained for IR2×C1 and IR3×C3, respectively.

Compost tea acted as an organic fertilizer for plant nutrition and improved soil characteristics. Its main effect could be written in ascending order C3<C2<C1. The highest water productivity values were 1.3 and 1.25 (kg/m3) obtained by IR2×C1 while the lowest values were 1.15 and 1.1(kg/m3) obtained by IR3×C3 for Serw 4 and Bactol 1, respectively.

Keywords: Canola, deficit irrigation, compost tea, drip irrigation.

Introduction

Canola (Brassica napus L.) is a significant oilseed crop, positioned third in global production after soybean and palm oil **(Muhammad et al., 2007)**. It is utilized as biodiesel, lubricant, and feed **(Woźniak et al., 2019)**. The global cultivated area of this crop has rapidly expanded in recent years as a rotational alternative to cereals and other crops **(FAO STAT, 2013)**. The canola crop is distinguished by its substantial oil yield. The oil content of its seeds varies between 30% and 45% **(Sabreen and Mansour, 2015)**.

The growth, production, and quality of canola are significantly impacted by drought, one of the main abiotic stresses. Furthermore, climate change is expected to make water shortages more severe and common, especially in arid regions **(Nahid et al., 2023)**. Canola is among the many oilseed plants that are affected by water stress caused by deficit irrigation. Research indicates that water deficiency during different growth stages, particularly during reproduction and growth, influences both the quantity and quality of oil **(Angadi and Cutforth, 2003)**. Drought stress resulted in the most significant decrease in seed yield at early timing and oil yield during pod setting compared to other growing stages. A high reduction in seed quantity was noted under stress conditions during flowering **(Secchi et al., 2023)**. Growing high-performance cultivars over a wide range of environments can increase both the quantity and quality of rapeseed yield under drought conditions **(Moaveni et al., 2010; Shirani Rad, and Zandi, 2012)**. The number of seeds per pod was less changed than the pod per plant. Therefore, selecting genotypes with high seeds per pod seems better under water deficit conditions **(Asfour, 2013)**.

Deficit irrigation is regarded as an effective approach to address the scarcity of irrigation water in arid and semi-arid areas **(Afshar et al. 2014)**. It aims to increase crop water productivity by skipping irritation that don't significantly affect yield. The expected reduction in yield will not be

*Corresponding author email: sabreennrc@yahoo,com - Orcid ID: 0000-0001-7143-340X
Received: 27/11/2024; Accepted: 29/06/2025
DOI: 10.21608/agro.2025.339892.1573

significant compared to the benefits of using the saved water to irrigate other crops. Successful deficit irrigation requires consideration of the soil's water retention capacity. In sandy soils, plants may be subjected to quick water stress under deficit irrigation, but in deep soils of fine texture, plants may have adequate time to adapt to low soil water matric pressure and may keep unaffected by low soil water content **(Esmail et al., 2025; and Kirda, 2002)**.

Compost tea is an extracted liquid from compost fermented in water, encompassing all soluble nutrients, both organic and inorganic, along with an enormous number of microorganisms; thereby, it can reduce dependency on the excessive usage of inorganic fertilizers **(Litterick et al., 2004, Naidua et al., 2013, and Hatam et al., 2015)**. The extracted compost compounds are used to build micro-aggregates, thus improving the water retention capacity and structure of the soil **(Román et al., 2015 Hatam et al., 2015)**. It improves soil porosity, water retention capacity, soil pH, organic matter content, and total exchangeable bases while reducing soil bulk density to optimal levels. It enlarges plant height, stem diameter, leaf number per plant, leaf area, leaf area index, root yield, stem yield, chlorophyll, NPK contents, and protein% **(Bako et al. 2021, and Ali et al. 2018)**.

Egypt is in the semi-arid zone, with limited precipitation, and the desert covers most of its land. Fixed Nile quota, non-renewable deep groundwater reservoirs, difficulties in the country's relationship with the Nile Basin states, and climate change are challenges facing its water resources. **(Gad, 2017)**. A strategic aim of the Egyptian government is to save irrigation water to enhance agricultural productivity per unit area while utilizing limited irrigation resources. There is an urgent need to improve crop water productivity (WP) due to the rising water demand resulting from continuous population growth, industrial advancement, and improved living standards, alongside the significant reduction in water resources shared out for agricultural use **(El-Hamdi et al., 2011; Allam, 2007)**. To expand the area of irrigated land and thus augment overall agricultural productivity in Egypt while utilizing the same amount of available water, it is essential to follow novel strategies that save water and improve water productivity (WP). Deficit irrigation (DI) represents one of these alternatives for perfect water management and evaluates it in terms of yield losses. The objectives of this study were to determine: (i) the effect of regular deficit irrigation and application of compost tea on seed and oil yield of Canola crop, and irrigation water productivity, (ii) the selection of suitable canola variety grown under drought stress.

Materials and Methods

Experiments were performed throughout two consecutive growing seasons (2020–2021 and 2021–2022) in the Agricultural Research Station of the National Research Centre at El-Nubaria district, Egypt, located at a latitude of 30.286° N, longitude of 30.1033° E, and an elevation of 68.37 m. We collected soil samples from the experimental site and analyzed them according to **(Piper, 1950)** and (**Page et al., 1982)**. Table 1 details the physical, mechanical, and chemical properties of the soil samples. Chemical analysis of irrigation water was performed and the results are presented in Table 2.

Table 1. Physical and mechanical properties of soil at the experimental site.

Depth, cm	Physical properties						Mechanical characteristics, %			
	SP, %	θ_{Fc} %	θ_{wp} %	A.W, %	BD, g cm^{-1}	HC, cm hr^{-1}	Course sand	Fine sand	Clay + Silt	Texture
0 – 20	21	10.1	4.7	5.4	1.69	22.5	47.76	49.75	2.49	Sandy
20 – 40	19	13.5	5.6	7.9	1.69	19	56.72	39.56	3.72	
40 – 60	22	12.5	4.6	7.9	1.67	21	36.76	59.4	3.84	

Where: θ_{Fc} = Field Capacity (%), θ_{wp} =Wilting Point (%), A.W = Available Water (%), BD = Bulk density (g/cm^3), and HC = Hydraulic Conductivity (cm/hr).

Table 2. Chemical properties of the irrigation water.

pH	EC ds/m	Soluble Cations, meq/L				Soluble Anions, meq/L			SAR
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{--}	Cl^{-}	
7.1	0.83	1.72	0.85	4.78	0.85	2.18	0.14	5.88	4.22

Experimental Design:

The experiments were conducted in a split-split plot design with four replications combined over two varieties of canola (Serw 4 and Bactol one), sowed on October 15, during the winter seasons of 2020/2021 and 2021/2022. The experimental area was separated into two main plots for canola variety, every main plot was divided into three subplots for three regulated deficit irrigation (RDI) treatments and the control. Every RDI treatment was divided into three levels of compost tea the growth characteristics and the differences were tested at the 5% significance level.

Deficit irrigation regimes:

The experiments were conducted under a surface drip irrigation system with 16mm polyethylene lateral lines with built-in drippers. The built-in dripper spacing was 0.5 m along a 40m lateral length with a dripper average discharge of 4 L/h. Figure (1) shows a schematic diagram of the drip irrigation system.

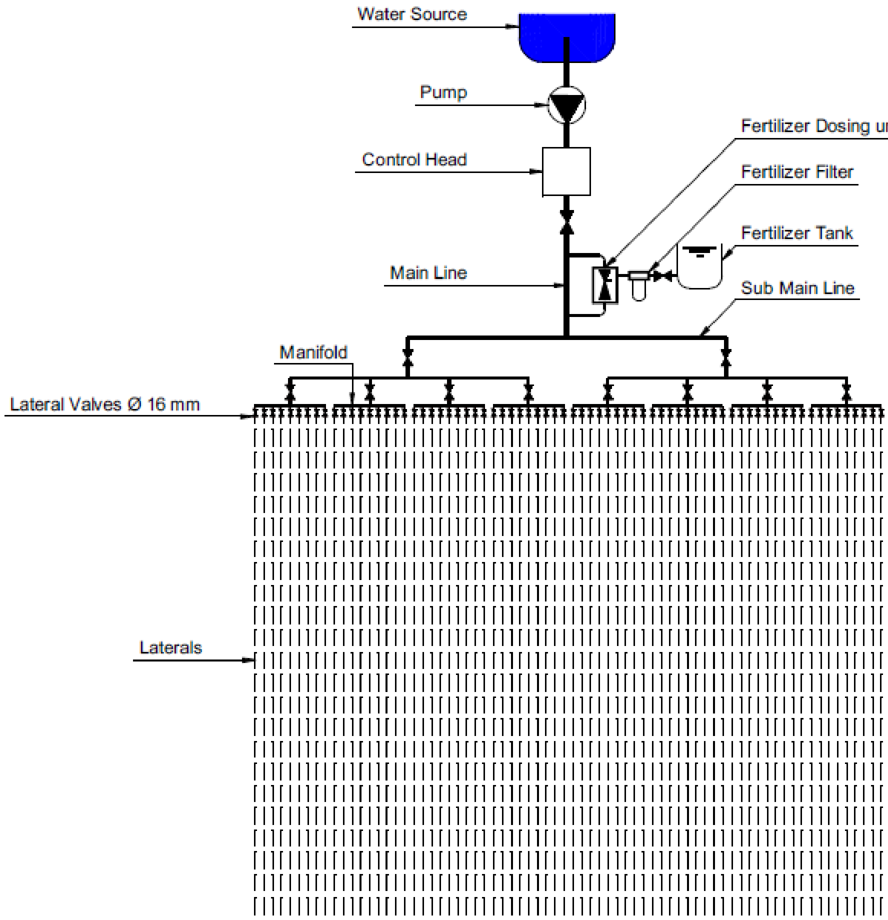

Fig. 1. Surface drip irrigation system components and experiment layout.

Irrigation treatments were divided into four regimes as follows:

IR1 =100% of ETc throughout the irrigation season (control),

IR2 =100% of ETc applying an irrigation shift and skipping the next throughout the vegetative growth stage,

IR3=100% of ETc applying an irrigation shift and skipping the next throughout the flowering stage, and

IR4 =100% of ETc applying an irrigation shift and skipping the next throughout the Senescence stage.

Compost tea fertigation treatments:

Three levels of compost tea solution with doses of 140, 95, and 50 L/ha C1, C2, and C3 respectively were injected using a venturi injector through the fertigation system. Every dose was injected over 20 irrigation shifts during the growing season.

All collected data were statistically analyzed using a split-split plot design with four replications, following the analysis of variance procedure as described by **(SAS, 2006)**. The differences between the means of various treatments were analyzed using the least significant difference (LSD) at a 5% significance level.

Irrigation water requirement:

The daily reference evapotranspiration for the canola crop was computed using the ET_o Calculator version 3.2, a public domain software developed by the FAO Land and Water Division. The application evaluates ET_o utilizing meteorological data through the FAO Penman-Monteith equation. The ET_o Calculator requires data on air temperature, humidity, radiation, and wind speed for daily computations. The elevation above sea level and latitude of the site are required to modify some meteorological parameters for the local mean air pressure and to calculate extraterrestrial radiation.

The climatic data were sourced from NASA/POWER CERES/MERRA2 Native Resolution. Daily data from 2014 to 2019 were utilized to calculate the average daily ET_o of the experimental site, as reported in Table (3), and to determine the irrigation water requirements for canola crops during the growing season.

Table 3. Average metrological data and calculated reference evapotranspiration along Canola crop growing season

Element Month		Temperature (C°)		Relative humidity (%)	Wind speed (m/sec)	ET_o (mm)
		Maximum	Minimum			
October	**15^{th} : 31^{th}**	29	17	62.83	2.61	3.29
November	**1^{th} : 15^{th}**	26	15	64.62	2.51	2.73
	15^{th} : 30^{th}	24	13	66.48	2.45	2.46
December	**1^{th} : 15^{th}**	21	11	68.17	2.73	2.10
	15^{th} : 31^{th}	19	9	68.81	2.73	1.92
January	**1^{th} : 15^{th}**	17	7	65.16	3	2.11
	15^{th} : 31^{th}	19	7	62.97	2.49	2.05
February	**1^{th} : 15^{th}**	20	7	63.56	2.61	2.29
	15^{th} : 28^{th}	21	8	65.98	2.58	2.59
Mars	**1^{th} : 15^{th}**	23	10	60.53	2.85	3.33
	15^{th} : 31^{th}	24	10	60.19	2.91	3.37
April	**1^{th} : 15^{th}**	26	12	57.29	3.03	4.09
	15^{th} : 30^{th}	30	13	52.14	2.92	4.89

Crop evapotranspiration, ET_c, is determined by multiplying the reference crop evapotranspiration, ET_o, by a crop coefficient, Kc (Allen et al. 2006):

$ET_c = Kc\ ET_o$ (1)

where: ET_c is the crop evapotranspiration [mm d^{-1}], Kc the crop coefficient [dimensionless], and ET_o reference crop evapotranspiration [mm d^{-1}].

The net irrigation requirements of the crops, are determined using the field water balance **(Doorenbos et al., 1996)**:

$In = ET_c - (Pe + Ge + Wb)$ (2)

Where: Pe precipitation, Ge groundwater input, and Wb retained soil water at the start of each interval.

All parameters of the net irrigation requirements except ET_c can be disregarded due to the semi-arid climatic conditions and sandy soil of the experimental site.

The growth irrigation water requirements can be obtained from **(Doorenbos et al., 1996)**:

$$V_i = \frac{10}{E_a} \Sigma_i \left[\frac{A \times I_n}{1 - LR}\right] \quad (3)$$

where: V is growth irrigation water requirements, (m3/month), E_a the drip irrigation system application efficiency which was evaluated at 93%, A the area cultivated with a specific crop, (ha), In net water requirements for a specific crop, (mm/month), and LR leaching requirements.

Water productivity (WP)

This term denotes the crop yield per cubic meter of irrigation water. The calculation was performed in accordance with **(Israelsen and Hansen, 1962)** as follows:

where: WP is the water productivity, (kg/m^3), Y crop yield (kg), and W applied irrigation water (m^3).

$WP = Y / W$ (4)

where: WP is the water productivity, (kg/m^3), Y crop yield (kg), and W applied irrigation water (m^3).

Statistical Analysis:

All collected data were statistically analyzed using a split-plot design with four replications. Analysis of variance (ANOVA) was performed to assess both main and interaction effects, following the methodology described by **(Snedecor and Cochran, 1982)**. Treatment means were compared using the Least Significant Difference (LSD) test at a 0.05 probability level.

Results and discussion

Irrigation water requirement of Canola crop:

The irrigation water requirement for the canola crop was determined using the ET_o Calculator to calculate the reference evapotranspiration at the Agricultural Research Station in El-Nubaria, as presented in Table (4).

Table 4. Irrigation water requirement during the different stages of canola crop growing.

Growing stage	K_c	ET_o (mm)	ETc (mm)	V (m^3)
Initial	0.57	59.16	20.71	222.64
Development	0.72	190.64	137.98	1483.64
Mid-season	1.15	190.54	219.12	2356.14
Late season	0.73	129.16	94.05	1388.81
End season	0.35			
Total		569.50	471.86	5451.23

The daily distribution of reference evapotranspiration, ETo, crop evapotranspiration, ETc, and crop coefficient, Kc values throughout the growing season are presented in Fig. (2).

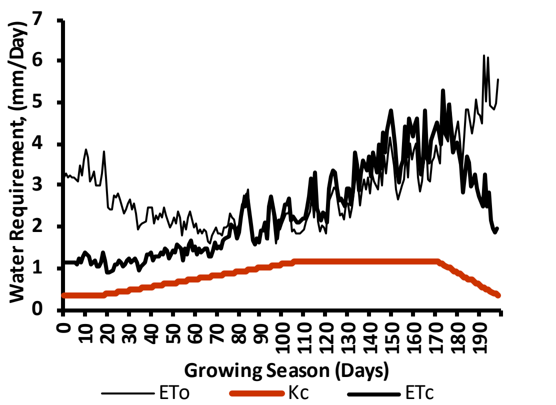

Fig. 2. Distribution of Average reference evapotranspiration (ET_o), crop evapotranspiration, and canola crop coefficient during growing season.

The irrigation water requirement was scheduled for two shifts weekly for every growing stage period according to farm working conditions.

Effect of deficit Irrigation Regimes:

Regarding seed yield (kg/ha) and oil yield (kg/ha), the irrigation regimes can be ordered in ascending sequence as IR3 < IR4 < IR2 < IR1 for both Serw 4 and Bactol 1 varieties, as illustrated in Figures 3, 4, 5, and 6. The yield differences of both seed and oil between any two irrigation regimes were significant at the 5% level. The sensitivity of canola to water stress depends upon its growth stage. Results indicated that the alternative skipping of irrigation shifts during the flowering stage (IR3) must be avoided. The Serw 4 variety exhibited the lowest seed and oil yields (2000 and 1190 kg/ha, and 2023 and 1199 kg/ha) over both growth seasons. Likewise, It was (1930 and 998 kg/ha), and (1946 and 1072 kg/ha) of Bactol one variety for the two growing seasons, respectively. Comparing IR1, the seed and oil yield of the Serw 4 variety was (2392 and 1586 kg/ha) and (2400 and 1586 kg/ha) and it was (2280 and 1456 kg/ha) and (2300 and 1490 kg/ha) for Bactol one variety for both two growing seasons, respectively.

According to the presented results, deficit irrigation regimes of IR2 and IR4 treatments achieved 95.1 and 93.8 % for the 1st growing season and 96.1 and 94.8 % for the 2nd growing season compared to the maximum seed yield of Serw 4 variety, respectively. The same two deficit irrigation regimes achieved 94.3 and 92.4 % for the 1st growing season and 98.4 and 96 % for the 2nd growing season, respectively, compared to the maximum seed yield of the Bactol 1 variety.

The produced oil yield of IR2 and IR4 deficit irrigation regimes was 98 and 92.5 % for the 1st growing season and 95.8 and 92.9 % for the 2nd growing season compared to the maximum seed yield of Serw 4 variety, respectively. While, it was 96.7 and 93.9 % for the 1st growing season and 96.6 and 93.2 % for the 2nd growing season compared to the maximum seed yield of Bactol 1 variety, respectively for the same deficit irrigation regimes.

The adverse impact of skipping irrigation shifts can be attributed to the reduction in photosynthesis resulting from stomatal closure during the flowering phase. This closure may be partial or total, contingent upon the surrounding conditions affecting the plant, which decreases seed number **(Secchi et al., 2023)**.

Water stress on canola must be avoided during the flowering period. In arid and semi-arid environments, canola subjected to deficit irrigation may experience water stress during the early and senescence stages, achieving comparable growth characteristics while saving 14.6% of the irrigation water requirement compared to the control (IR1). Furthermore, a reduction in water application decreases the solubility and absorption of compost tea (Sabreen et al. 2015; Sabreen and Mansour 2019; and Shrief et al., 2020).

Effect of compost tea:

Data demonstrated that the yield of both seed and oil increased with the application of compost tea. The parameter values analyzed indicate that compost tea treatments can be ordered in the subsequent ascending sequence: C3 < C2 < C1, as illustrated in the figures. (3), (4), (5); (6) and Table (5). Differences among compost tea treatments were significant at the 5% level.

It could be attributed to the compost tea potentially provides microbial biomass, fine particulate organic matter, organic acids, plant growth regulators-like substances, and soluble mineral nutrients to the plant surface and soil (Tayel and Sabreen, 2011; SabreenKh. Pibars, 2012; Ebtisamet al., 2015; Mahrous et al., 2015; SabreenKh. Pibars and H. A. Mansour, 2015; and Hussien, M. M.).

Concerning the primary plant growth characteristics like number of leaves per plant, leaf area, and total leaf area per plant, compost tea induces a moderate alteration in these growth parameters. The results endorsed by **(Mansour et al., 2015; and Imam and Pibars, 2019)** indicate that the application of compost tea significantly improves soil properties, including aggregate size, water retention, soil pH, and electrical conductivity, in comparison to lower dosages of compost tea treatments.

Effect of Canola variety:

As shown in Figs (3), (4), (5); (6), and table (5). Canola variety affected seed and oil yield under drought stress conditions of deficit irrigation regimes. The local variety Serw 4 was higher in seed and oil productivity by 5.6 and 4.2 % than the imported one Bactol 1 under all deficit irrigation regimes for the 1st and next seasons respectively. The highest seed yield was 2380 and 2253 (kg/ha) was recorded for Serw 4 and Bactol 1 under

RI2×C1 treatment for the 1st season, as well, it was 2384 and 2286 (kg/ha) for the 2nd season. This may be due to the Serw 4 variety's adaptation to local climatic and environmental conditions, resulting in a higher number of seeds per pod than Bactol 1, hence enhancing both the quantity and quality of Canola yields under drought stress **(Moaveni et al., 2010; Shirani Rad and Zandi, 2012; and Asfour, 2013)**.

Water productivity:

The water productivity (WP) was affected by both irrigation regimes and the application of compost tea. It can be noted that WP was increased by the increase of the applied irrigation water and compost tea dose as shown in Figs (7) and (8). The increase in water productivity was up to 13 and 15 % under RI2×C1 comparing the control treatment RI1×C1 and the highest values of WP under deficit irrigation regime and compost tea treatments were 1.3 and 1.25 (kg/m3) for Serw 4 and Bactol 1, respectively. The lowest WP values were 1.15 and 1.1 recorded for RI4×C3 treatment for Serw 4 and Bactol 1, respectively.

Interaction between irrigation treatments and compost tea on studied traits:

The influence of irrigation regimes and compost tea concentrations on canola seed and oil yield, as well as water productivity, is illustrated in Figures (3), (4), (5), (6), and Table (5). All interactions between IR×C resulted in significant differences in the studied parameters at the 5% significance level. The maximum and minimum values were observed with the interactions IR2×C1 and IR3×C3, respectively. This may be attributed to one or more characteristics of compost tea that were significant at the 5% level. The results of the current study demonstrate that organic media can enhance yield by increasing moisture storage and improving nutrient absorption **(Ebtisam et al., 2015)**. **(Sabreen and Mansouret, 2015)** found that the application of 71.4 and 184 L/ha of compost tea in lettuce considerably enhanced many properties.

Results showed that the Serw 4 (local) variety was more productive than Bactol 1 (imported) under all the studied treatments. It produced a higher number of seeds per pod than Bactol 1 improved both the quantity and quality of canola yields under drought stress conditions.

The water productivity of canola seed and oil % is positively affected by increased irrigation water while regulated deficit irrigation (RDI) is an effective method for saving irrigation water and achieving optimal production. This conclusion aligns with those reported by (Tayel and Sabreen in 2011; and Ebtisam et al. in 2012).

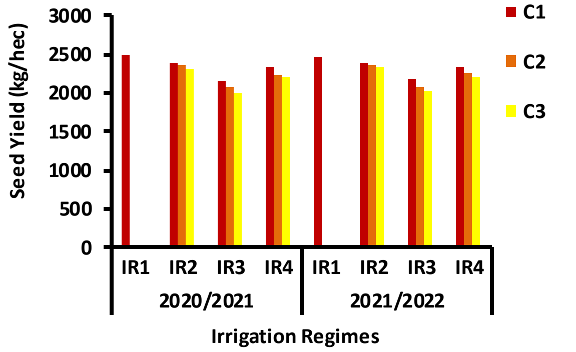

Fig. 3. Effect of deficit irrigation regime and compost teat dose on seed yield of Serw 4 variety.

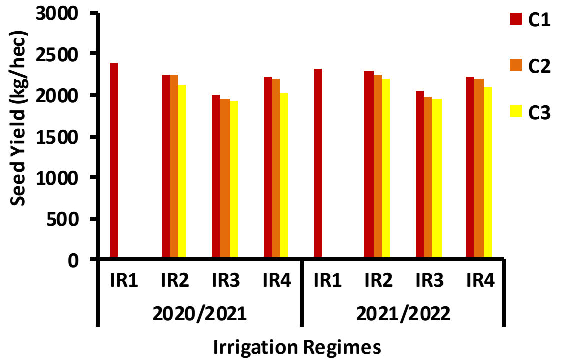

Fig. 4. Effect of deficit irrigation regime and compost teat dose on seed yield of Bactol 1 variety.

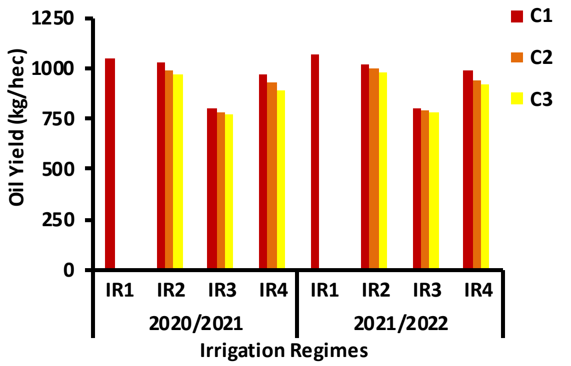

Fig. 5. Effect of deficit irrigation regime and compost teat dose on oil yield of Serw 4 variety.

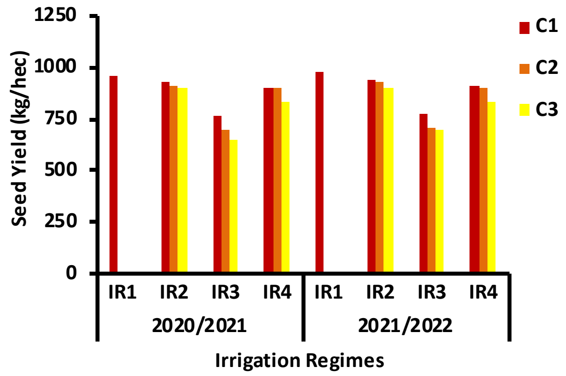

Fig. 6. Effect of deficit irrigation regime and compost teat dose oil yield of Bactol 1 variety.

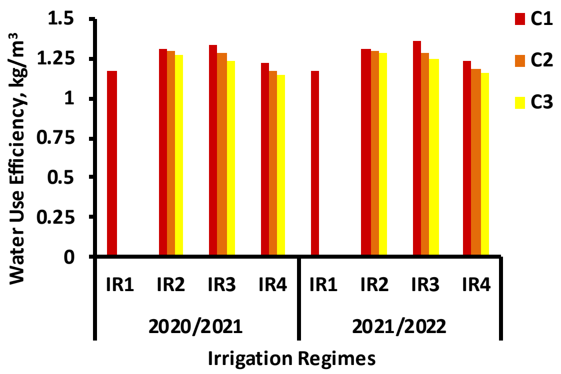

Fig. 7. The Water productivity (WP) of Serw 4 variety under deficit irrigation regimes and compost doses.

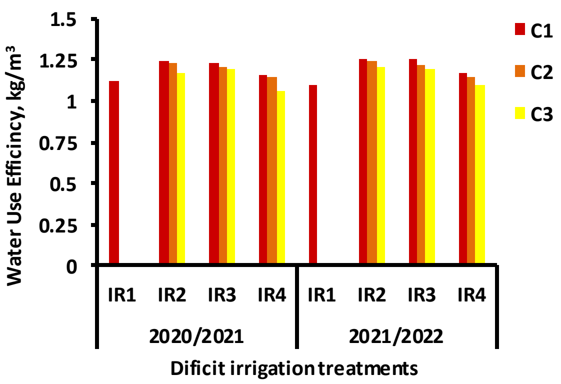

Fig. 8. The Water productivity (WP) of Bactol 1variety under deficit irrigation regimes and compost doses.

Table 5. Main effect of irrigation regimes, levels of compost tea, and variety on seed, oil yield, and water productivity of canola.

Treatments	Seed yield (kg/hec.)		Oil yield (kg/hec.)		WP (kg/m^3)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Serw 4	2230.4 a	2247.56 a	1387.89 a	1404 a	1.251 a	1.261 a
Bactol 1	2102.78 b	2135 b	1280.56 b	1301 b	1.179 b	1.197 b
IR2	2275.83 a	2300.83 a	1465.67 a	1479.17 a	1.251 a	1.265 a
IR3	2202.17 c	2226.83 b	1388.83 b	1408 b	1.245 b	1.260 b
IR4	2021.83 b	2046.17 c	1148.17 c	1170.33 c	1.149 c	1.162 c
C1	2224.83 a	2247.17 a	1381.5 a	1396.17 a	1.248 a	1.261 a
C2	2174.83 b	2191.33 b	1336.83 b	1351.67 b	1.219 b	1.229 b
C3	2100.17 c	2135.5 c	1284.33 c	1309.67 c	1.178 c	1.197 c

Conclusions

The presented work studied the effect of regulated deficit irrigation and the application of compost tea of two varieties of canola (Serw 4 and Bactol 1) on Canola seed and oil yield and water productivity under the surface drip irrigation method. Results indicated that under deficit irrigation in dry and semi-arid environments, canola can attain comparable growth characteristics, and save up to 14.6 % of irrigation requirement, relative to the control (IR1). It must be avoided during the flowering stage as it negatively affects crop yield compared to other growing stages. The main effect of the irrigation regimes could be arranged in ascending order as IR3 < IR4 < IR2 < IR1 for both Serw 4 and Bactol 1 verities. The locally bred Canola variety Serw 4 had higher productivity than the imported Bactol 1 under water stress conditions. Compost tea acted as an organic fertilizer for plant nutrition and improved soil characteristics. Its application of the right doses could result in the desirable growth of plants and improve Canola yield and quality. The main impact of compost tea on the studied attributes can be expressed in the following ascending sequence: C3 < C2 < C1.

References

Afshar, RK, Jovini MA, Chaichi MR, Hashemi M (2014) Grain sorghum response to arbuscular mycorrhiza and phosphorus fertilizer under deficit irrigation. Agron J 106:1212–1218

Ali O. A.M., Yasser A. El-Tahlawy and Shebl A. Abdel-Gwad (2018) Impact of Compost Tea Types Application on Germination, Nodulation, Morphological Characters and Yield of Two Lentil

Cultivars. Egyptian Journal of Agronomy. The 15th Int. Conf. Crop Science: 1 – 19.

Allen, G. R.; L. S. Pereira; D. Raes, M. Smith (2006). Crop evapotranspiration guidelines for competeing crop water requirements. FAO. Irrigation and drainage paper 56. Rome, Italy.

Angadi, S. V., Cutforth, H. V. 2003. Yield adjustment by canola grown at different by plant population under semiarid condition. Crop Sci, 43:1357–1366.

Asfour, M.M. (2013). Correlation and path coefficient analysis of some quantitative characters in canola oil (Brassica napus L.). Egyptian Journal of Agronomy 35(1): 65-75.

Bako, T., E. A. Mamai, A. B. Istifanus. (2021). Production and evaluation of compost tea for cultivation of Amaranthus hybridus. Agricultural Engineering International: CIGR Journal, 23(3): 60-74.

Doorenbos J.; W. O. Pruitt, (1996). Crop water requirements. FAO. Irrigation and drainage paper 24. Rome, Italy.

Ebtisam I. Eldardiry, Sabreen Kh. Pibars, M. Abd El Hady. 2012. Improving Soil Properties, Maize Yield Components Grown in Sandy Soil Under Irrigation Treatments and Humic Acid Application. Australian Journal of Basic and Applied Sciences, 6(7): 587-593, 2012

Ebtisam I. Eldardiry, Sabreen, Kh. Pibars, M. Abd El-Hady.2015. Influence of irrigation deficit and humic acid on soil and canola growth characters and water productivity. International Journal of ChemTech Research, Vol.8, No.6, pp 505-513.

FAOSTAT (2013) http://faostat3.fao.org/download/Q/QC/E. Accessed 27 Nov 2015

El-Hamdi, Kh. H; R.E. Knany, L. A. Abd El-Rahman .2011. Evaluation of some multinutrient fertilizers for tomato and squash rotation and soil health under different irrigation systems. Journal of Soil Sciences and Agricultural Engineering, 2 (4): 393-406. Fac. Agric. Mans. Univ, Egypt.

Esmail M., F. B. Fathallah, and Negm S. Abdel Samea (2025) Enhancing wheat genetic resources tolerant to water stress: F2 generation Ramadan. Egyptian Journal of Agronomy. 47 (2): 249 - 258

Hatam S. Bahman F-N. Hasan A. Gholam A, Sadegh S. (2015) An Overview of the Benefits of Compost tea on Plant and Soil Structure. Adv. Biores. 6 (1) January: 154-158. DOI: 10.15515/abr.0976-4585.6.1.154158.

Hussien, M. M.; and Sabreen, Kh. Pibars. 2012. Maize Response to Irrigation System, Irrigation Regimes and Nitrogen Levels in a sandy soil. Journal of Applied Sciences Research, 8(8): 4733-4743, 2012.

Imam, H. M., Sareen Kh. Pibar. (2019) Validation of EGY-DRIP program in determining the optimum lateral length. Agricultural Engineering International: CIGR Journal, 21(4): 14–23.

Kirda, C (2002) Deficit irrigation scheduling based on plant growth stages showing water stress tolerance. Deficit irrigation practices - FAO24. Food and Agriculture Organization of the United Nations, Rome, pp 3–10

Litterick, AM, Harrier L, Wallace P, Watson CA, Wood M. (2004) The role of uncomposted materials, composts, manures, and compost extracts in reducing pest and disease incidence and sevariety in sustainable temperate agricultural and horticultural crop production—A review. Critical Reviews in Plant Sciences. 23:453-479

Mansour, H. A., Sabreen Kh. Pibars, V. F, Bralts. (2015) The hydraulic evaluation of mti and dis as a localized irrigation systems and treated agricultural wastewater for potato growth and water productivity. Int.J. ChemTech Res., 8 (12): 142-150

Moaveni, P., A. Ebrahimi and H. Al. Farahani, (2010) Studying of oil yield variations in winter rapeseed (Brassica napus L.) cultivars under drought stress conditions, Journal of Agricultural Biotechnology and Sustainable Development. 2(5): 71-75.

Muhammad, N., Cheema, M. A., Wahid, M. A., Ahmad, N. and M. Zaman (2007) Effect of source and method of nitrogen fertilizer application on eed yield and quality of canola (Brassica napus L.). Pak. J. Agri. Sci. 44 (1): 74-78.

Naidua Y., S. Meon, Yasmeen Siddiqui (2013). Foliar application of microbial-enriched compost tea enhances growth, yield and quality of muskmelon (Cucumis melo L.) cultivated under fertigation system, Scientia Horticulturae. 159: 33–40.

Page, A.L., Miller, R.H. and Keeney, D.R. (1982) Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. American Society of Agronomy. In Soil Science Society of America, Vol. 1159.

Piper, C.S. (1950) Soil and Plant Analysis, Interscience Publisher Inc., New York, USA.

Román, P., M. M. Martínez, and A Pantoja. (2015) FARMER´S COMPOST HANDBOOK: Experiences in Latin America. Food and Agriculture Organization of the United Nations, Regional Office for Latin America and the Caribbean, Santiago.

Sabreen, Kh Pibars and H. A. Mansour (2019) Effect of tillage management practices and humic acid applications on some engineering properties of peanut. Plant Archives Vol. 19, Supplement 1, 2019: 636-643.

Sabreen Kh. Pibars and H. A. Mansour. (2015) Evaluate the response of sunflower productivity to modern chemigation systems in new reclaimed lands. International Journal of ChemTech Research, 8 (12): 160-169.

Sabreen Kh. Pibars, Ebtisam I. Eldardiry, Soha E. Khalil, M. Abd El-Hady. (2015) Effect of Compost Tea on Growth Character of Sunflower (Helianthus Annuus L.) Under Surface and Subsurface Drip Irrigation. International Journal of ChemTech Research, l.8 (6): 490-495.

SAS Institute, Inc. SAS Online Doc, Version 8. (2004) SAS Institute Inc., Cary, NC. [Online] Available: http://support.sas. com/documentation/ [2006 Mar.17].

Secchi, M. A., J. A. Fernandez, M. J. Stamm1, T. Durrett, P.V. Prasad, C. D. Messina, and I. A. Ciampitti. 2023. Effects of heat and drought on canola (Brassica napus L.) 1 yield, oil, and protein: A meta-analysis. Field Crops Research 293 108848 1-11. https://doi.org/10.1016/j.fcr.2023.108848.

Shirani, Rad A. H., P. Zandi; (2012) The effect of drought stress on qualitative and quantitative traits of spring rapeseed (Brassica napus L.) cultivars, Žemdirbystė=Agriculture. 99 (1), 47-54.

Snedcor, G.W. and W.G. Cochran, (1982) Statistical methods. 7th Edition, The Iowa State University Press, Iowa. [Citation Time(s):1]

Tayel, M. Y. and Sabreen, kh. P., (2011) Effect of Irrigation Regimes, Phosphorus Levels and TwoVicia FabaVarieties on: II-Yield, Water and Phosphorous Use Efficiency, Journal of Applied Science Research, 7(11): 1518-1526.

Tayel, M.Y. and Sabreen, Kh.Pibars. (2011) Effect of Irrigation Regimes and Phosphorus Level on Two Vicia Faba Varieties: 1-Growth characters. Journal of Applied Sciences Research, 7(6): 1007-1015.

Woźniak, E., Waszkowska, E., Zimny, T., Sowa, S. and T. Twardowski. (2019) The rape seed potential in Poland and Germany in the context of production, legislation, and property rights. Front. Plant Sci., 10, 1423. doi:10.3389/fpls.2019.01423.