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EFFECT OF DRIP IRRIGATION SYSTEM FACTORS ON SOME SOIL PHYSICAL PROPERTIES AND YIELD OF CAULIFLOWER

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Abstract

A field experiment was carried out during the 2018-2019 fall season at College of Agricultural Engineering Sciences/Baghdad University with in longitude (33°16′01.2″N) and latitude (44°22′63.4″E). The area was defined by dimensions of 15m*70 m. To study the effect of drip irrigation system design factors on some physical characteristics, growth and yield of cauliflower. The experiment was carried out using a randomized complete block design RCBD. According to the layout of split split plots with three replication to study the effect of drip irrigation factors which included discharge **(**Q**)** at three levels, (4,6,8) Lh^{-1}, distances between drip lines **(**D**)** with three levels (0.30,0.40, 0.50) m, distribution dropping lines relative to the plant rows **(**N**)** with two levels, at One line for each plant row and One line for Two plant row. Cauliflower *Brassica oleracea var. botrytis* seedlings planting Class study in 26/9/2018 the form of lines, the distance between one plant and another 0.40 m. Irrigation scheduled by evaporation- transpiration calculation using Penman-Monteith equation, and calculation of water requirements for cauliflower use CropWat program. The results showed that the values of the Uniformity Coefficient 94.74, 95.46 and 97.90% for the charges Q1, Q2 and Q3 respectively. The values of the Variation Percent 0.18, 0.13 and 0.09 for the charges of Q1, Q2 and Q3 respectively. The increase in the effect of discharges on the values of the bulk density and porosity, and the decrease of the measured water conductivity values and the rate of infiltration after the experiment ends. And that the discharge decrease significantly affected the productivity values, the biological yield and the dry weight of the root system. Water requirements for cauliflower crop reached 150.3 mm $season^{-1}$, at a daily average of 1.67 mm day^{-1}.

***Keywords*:** drip irrigation system, soil physical properties, cauliflower

Introduction

Drip irrigation mainly supplies water to the root zone (Xue *et al.*, 2017), and is the most efficient technology in providing specific quantities of water commensurate with the water consumption of the plant to achieve optimum crop growth and quality production (Thangaselvabai *et al.*, 2009). Drip irrigation provides higher use efficiency and can reduce water use by 50-80% compared with irrigation, and optimal irrigation levels in the appropriate way help to enhance economic returns and increase water use efficiency (Kadasiddappa and Praveen Rao, 2018), Drip irrigation system provides a large proportion of water compared to other irrigation systems as it can save 30-70% of added irrigation water (Zhao, Wang, 2016, Ibrahim *et al.*, 2016). Drip irrigation that treats water scarcity and increases crop yields is widely used in arid and semi-arid regions (Han *et al.*, 2015).

In Iraq, surface drip irrigation is used on a limited scale in open and protected agriculture. The results of Al-Hadi and Odeh (2014) showed that the use of the drip irrigation system improved the properties of the various physical soils and kept the building of the soil from deterioration, especially in dry and semi-arid areas, that the use of the drip irrigation system led to a reduction in the saturated water conductivity (Abdel Jabbar and Al-Obaid, 2016).

High drainage increases the wet area exposed to evaporation and increases the horizontal movement of the wet front, As the area of wet soil and its diameter are mainly affected by drainage. And the length of time for water to remain on the surface is greater at higher discharge and therefore is more likely to be lost, The results of Ghazal and Ismail (2017) showed a decrease in the soil moisture content when using discharge spots of 7.8 liters.

Materials and methods

A field experiment was carried out in the fall 2018-2019 autumn season in the College of Agricultural Engineering Sciences, University of Baghdad, Al-Jadriya, at longitude (33°16′01.2″N) and latitude (44°22′63.4″E). The area was determined by dimensions of 15 * 70 m. They are categorized under Typic Torrifluvent according to the modern American classification (Soil Survey Staff, 2006). Soil samples were taken from different sites from the field randomly before planting at a depth of 0.30-0 pm by Auger and I made a composite sample representing the field and was placed in bags and brought to the laboratory and aired and drained with a hammer from the plastic and then passed through the sieve of its holes 2 mm in diameter. These samples were used for the purpose of carrying out physical and chemical analyzes before planting.

The experiment was carried out study the effect of discharge at three levels 4 Lh^{-1}(Q1) and 6 Lh^{-1} (Q2) and 8 Lh^{-1}(Q3) and distances Between the drip lines at three levels 0.30 m (D1) and 0.40 m (D2) and 0.50 m (D3) and the distribution of drip lines relative to plant rows has two levels of drip line for each plant row (N1) and drip line for each two plant rows (N2). The experiment was applied using the design of the randomized complete sectors RCBD according to the order of split split plots with three iterations to extract the ANOVA analysis table to compare averages of the treatments with the interventions with a test of the Least Significant Difference (LSD) at 0.05 with a level of significance using GenStat.

The discharge was calculated from the equation (Hajim and Yassin, 1992):

$$q = \frac{v}{t} \qquad ...(1)$$

As:

Q: Dripper discharge (Lh^{-1})

V: volume of dripping water (L)

t: operating time (h)

The mean of discharge was calculated according to the following equation (Ismail, 2002):

$$\bar{q} = \frac{q1 + q2 + q3 + qn}{n} \qquad ...(2)$$

As:

$\bar{q}$: average measured discharge (Lh^{-1})

q1, q2: draining discharge (Lh^{-1})

n: number of Dripper.

The irrigation time was calculated according to the following formula:

$$t = \frac{v}{Q \times N} \qquad ...(3)$$

As:

t: irrigation time (h)

v: water volume for experimental unit (L)

Q: Dripper discharge ($L\ h^{-1}$)

N: number of Dripper In the experimental unit

The Variation Percent discharge discrepancy was calculated using the Wu and Gitlin equation (1983).

$$q\ var = \left[\frac{q_{max} - q_{min}}{q_{max}}\right] \qquad ...(4)$$

As that

q_{var}: Variation Percent.

q_{max}: highest discharge (Lh^{-1})

q_{min}: lowest drain (Lh^{-1}).

The consistency coefficient was calculated according to the formula

$$UC = \left[1 - \frac{\sum x}{Mn}\right]100 \qquad ...(5)$$

As:

UC: Uniform coefficient (%)

$\sum x$: sum of the absolute deviations from the mean of the discharge

M: Average discharge of the dots ($L\ h^{-1}$)

n: number of dots

According to the emission consistency, which is the correlative coefficient of the homogeneity of distribution, which is the ratio between the rate of the lowest quarter of discharge to the general discharge rate (Ortega *et al.*, 2002), it is calculated from the following formula:

$$EU = \frac{\bar{q}25\%}{\bar{q}} \times 100 \qquad ...(6)$$

As:

EU: emission Uniformity (%).

$\bar{q}$ average discharge of the dots (Lh^{-1}).

$\bar{q}_{25\%}$: rate of discharge for the lowest quarter of points ($l\ h^{-1}$).

The wet area of the dotted area, which is the wet area of each dotted area around a contact point with the ground, was calculated and calculated according to the formula (Ismail, 2002):

$$AW = 0.8\ (SW)^2 \qquad ....(7)$$

As:

AW: wetting area (cm^2)

SW: area wetting tape.

Table 1 : Design and technical evaluation criteria for drip irrigation system

Emission Uniformity (%)	**Uniformity Coefficient** (%)	**Variation Percent** (%)	**Average Discharge ($L\ h^{-1}$)**	**Discharge**
93.42	94.74	0.18	3.46	Q1
94.49	95.46	0.13	5.55	Q2
97.37	97.90	0.09	7.45	Q3

The bulk density of the soil was measured using the Core sampler, and the porosity was calculated according to the following equation

$$f = 1 - \frac{\rho b}{\rho s} \qquad ...(8)$$

As:

f: Total porosity ($cm^3\ cm^{-3}$)

ρb: bulk density ($Mg\ m^{-3}$)

ρs: true density ($Mg\ m^{-3}$)

The aggregate overflow was measured by field with the mini desk infeltrometer (MDI Users Manual, 2012). The saturated aqueous conductivity was measured by a mini desk infeltrometer, and the aqueous conductivity was calculated from the data obtained according to the formula (Zhang, 1997).

$$K = \frac{C1}{A} \qquad ...(9)$$

As:

C1: slope of the relationship curve between the summing tip and the square root of time.

A: tabular value related vanGenuchten measurements, by soil texture, degree of tension determined by device, and radius of semi-permeable device disk.

Biological quotient was calculated by cutting five plants from each experimental unit (Al-Sahaf & Al-Zamly, 2012). The dry weight of the root total of five plants was calculated from each experimental unit, then dried in the electric oven at a temperature of 65 °C. Then, it was removed from the oven according to its dry weight.

The production was calculated by the following equation:

$$\text{Productivity} = \frac{\text{Production}}{\text{Unit Area}} \qquad ...(10)$$

Results and Discussion

The bulk density and porous of the soil

Figure (1) and (2) show the effect of discharge on the bulk and porous density values, as we note that the increase in the discharge of dots has an effect on the values of both the bulk and porous density, as the values of the apparent density of the soil increased from 1.33 to 1.43 mcg m-3 for discharge Q1 and from 1.34 to 1.45 Mg m^{-3} at discharge Q2 and from 1.35 to 1.49 mcg m^{-3} for discharge Q3 The porosity values decreased from 0.498 to 0.471 at discharge Q1 and from 0.499 to 0.452 at discharge Q2 and from 0.50 to 0.437 to discharge Q3. This is due to the effect of drip irrigation and the success of the humidification and drying cycles And the occurrence of an inventory of air in the pores of the soil and the occurrence of air explosions that lead to the destruction of soil pools The heterogeneity of the moisture distribution, the rapid wetness of the soil bed, the increase in the wet area subject to evaporation, and the increase in the moisture content of the soil in areas with less discharge consistent with (Abdali, 2019). It is also attributed to the growth and spread of the roots that bind the soil particles and lead to an increase in the porosity of the soil consistent with (Abdul Jabbar and Al-Obaid, 2016).

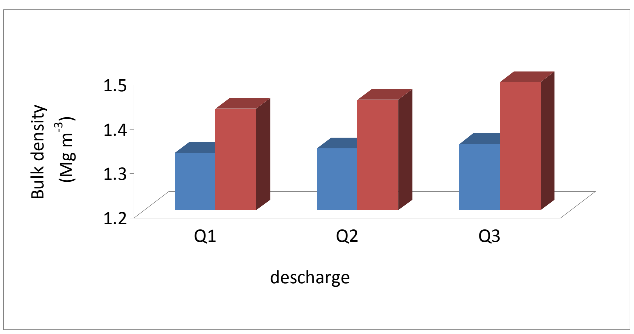

Fig. 1 : Effect of dripper discharge on soil bulk density

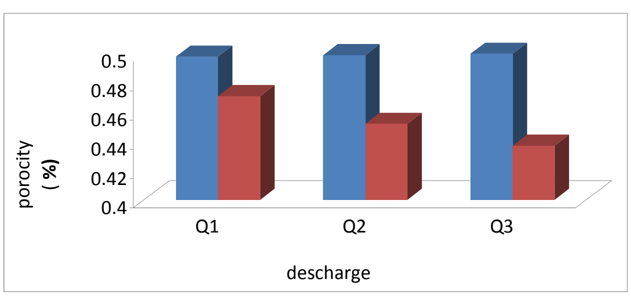

Fig. 2 : Effect of dripper discharge on the values of the percentage of porosity

Saturated water conductivity

Figure 3 shows the effect of discharge on the saturated water conductivity values of the soil, as we note the decrease in the value of the saturated water conductivity measured after the end of the field experiment. cm h^{-1} for discharge Q2 and from 2.175 to 1.97 cm h^{-1} and the reason for that is due to the increase in discharge and the increase in the values of both the bulk density and the low porosity and the breakdown of breeding communities as a result of different operations during the agricultural season of the crop due to the effect of crop service operations in addition to moistening and drying The greater the spread of the root system that leads to improving the physical properties of the soil. These results are consistent with Al-Ani (2016) and Al-Abdali (2019) who found a decrease in the values of saturated water conductivity after planting compared to the values of water conductivity before planting.

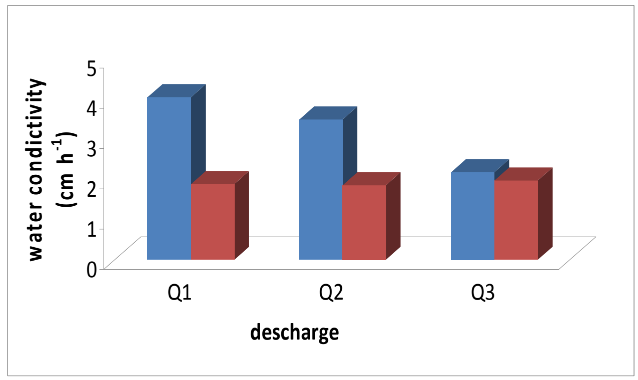

Fig. 3 : Effect of dripper discharge on saturated water conductivity

The infiltration

The results showed Figure (4) the effect of different factors on the tip rate, as we note the decrease in the combined tip from 26.922 to 8.094 cm h^{-1} at the discharge of Q1 and from 28.644 to 9.048 cm h^{-1} at the discharge of Q2 and from 25.353 to 11.124 cm h^{-1} at the discharge of Q3 This is attributed to the improvement in the construction of the soil that was plowed and fragmented at the beginning of the experiment. The soil was cultivated when the measurement was made, so we note the high values of the tip before the experiment, as well as the increase in the values of apparent density and low porosity at the end of the growing season and a decrease in water conductivity, in addition to the effect of the succession of the drying cycles and Moisturizing during drip irrigation Repeat during the agricultural season for the cauliflower crop and the accompanying operations from the service of the cauliflower crop, which leads to an increase in the apparent density values compared to their values before planting. In addition, the end-season tip measurement processes were carried out under field conditions, and the crop harvest process did not occur soil excitement, as well as the root spread of the crop. At the top of the soil is one of the reasons for obstructing the movement of water down, which led to the saving of the aggregate tip values. Agreed with (Abdul Jabbar and Al-Obaid, 2016 and Al-Shaabani, 2017.

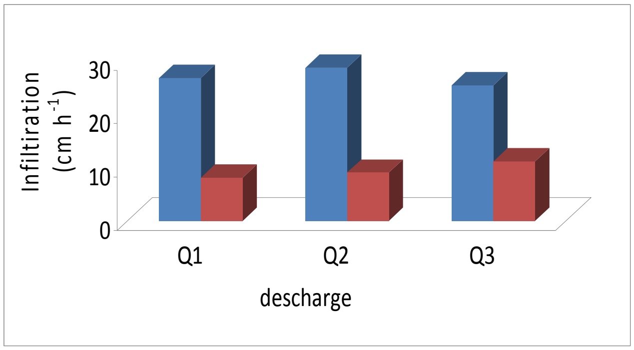

Fig. 4 : The effect of dripper discharge on the synthesis infiltration

Biological yield

Table (2) shows the effect of discharge and the distance between drip lines and the ratio of drip lines to the rows of plants in the biological yield of cauliflower. The statistical analysis shows that there were significant differences between the treatments of the different drainage averages, as the highest average of the biological yield reached 2.709 kg plant^{-1} at Q1 compared with the lowest average of the biological yield 1.693 kg plant $^{-1}$ for discharge Q3 and this is due to the effect of a difference in the distribution of moisture in the soil predator and a decrease The moisture content at high discharge of soil content is consistent with Al Abdali (2019).The results show that there were significant differences between the values of the interference averages in the distance coefficients and the number of punctuation lines, as the highest average at interference D2N1 reached 2.253 kg plant $^{-1}$ compared with the lowest average of 1.981 kg plant^{-1} at the overlap of D1N1 and this is due to the fact that the short distance leads to interference between the roots of plants And competition for nutrients in the soil solution, which is reflected negatively in the growth of the biological crop, and the further distances lead to a decrease in the moisture content of the soil and thus a lack of processing of the nutrients in the soil solution. The results also show that there were significant differences between the values of the interference averages in the QN interference factors, as the highest average was 2.800 kg plant^{-1} in the Q1N2 treatment compared with the lowest average of 1.539 kg plant^{-1} at the Q3N1 interference.

Table 2 : Effect of dripper discharge and the distances between the drip lines and its number on biological yield

DxN	Discharge			Number of line	Distance
	Q3	Q2	Q1		
1.981	1.600	2.297	2.047	N1	D1
2.206	1.877	2.043	2.697	N2	
2.253	1.677	2.530	2.553	N1	D2
2.248	1.797	1.830	3.117	N2	
2.096	1.340	1.693	3.253	N1	D3
1.983	1.867	1.497	2.587	N2	
0.325			NS		$LSD_{0.05}$
N					
2.110	1.539	2.173	2.618	N1	QxN
2.146	1.847	1.790	2.800	N2	
NS			0.325		$LSD_{0.05}$
D					
2.093	1.738	2.170	2.372	D1	QxD
2.251	1.737	2.180	2.835	D2	
2.039	1.603	1.595	2.920	D3	
NS			**0.528**		$LSD_{0.05}$
	1.693	1.982	2.709		Q
			0.319		$LSD_{0.05}$

Dry weight of the root of the plant

Table (3) shows the effect of the studied factors on the average dry weight of the root system, as the results show the significant effect (at a significant level of 0.05), as the root group weight decreased from 66.21 g plant^{-1} to 45.74 g plant^{-1} with increased discharge from Q1 To Q3, due to the increased drainage leading to a decrease in the apparent density and the heterogeneity of the distribution of moisture content and the size of the wet area, which negatively affects the root system. She agrees with Al-Abdali (2019) who found a decrease in the root mass from 20.10 to 18.05 g plant^{-1} and attributed the reason to the decrease in the moisture content which led to an increase in the apparent density by increasing the discharge.

The table also shows that the effect of the distances between dotting lines in the average dry weight of the root system, as the D3 treatment achieved 59.02 g plant $^{-1}$ is the highest value compared to the lowest value of 46.17 g plant^{-1} for the D1 treatment due to the lack of distance and low plant density leading to improved traits Vegetative growth, decreased competition between plants, increased photosynthesis, and hence the formation of a dense root mass, encouraged the absorption of water and nutrients in a good way, which activated vital activities in the plant as a result of the presence of a good vegetative group and an increase in photosynthetic materials, all of which contributed to the increase in total growth. The root of a single plant. As for the smaller distances, it leads to an overlap in the spread of the root system between adjacent plants in the soil and the occurrence of competition for water and nutrients, and thus reflects negatively in the mass of the root system compared to the greater distance.

Likewise, the effect of the number of drip lines achieved treatment N2 54.17 g plant^{-1} compared to the treatment of N1 52.17 g plant^{-1} The reason is attributed to the effect of the amount of water on the formation of the root system, because the presence of two drip lines for the row of plants per one leads to an increase in the moisture content of the soil and thus an increase Readiness of nutrients for absorption by plant roots and thus an increased root mass mass. Which attributed this to increasing the effectiveness of the roots and improving their absorption of the nutrients.

Table 3 : Effect of dripper discharge and the distances between the drip lines and its number on dry weight of root system.

DxN	Discharge			Number of line	Distance
	Q3	Q2	Q1		
43.95	43.20	41.36	47.30	N1	D1
48.40	40.40	45.50	59.29	N2	
54.58	42.42	45.92	75.40	N1	D2
55.23	59.73	41.69	64.27	N2	
59.15	43.86	60.14	73.44	N1	D3
58.88	44.84	54.25	77.56	N2	
1.025			1.775		$LSD_{0.05}$
N					
52.17	43.80	49.14	65.38	N1	QxN
54.17	48.32	47.14	67.04	N2	
0.592			1.025		$LSD_{0.05}$
D					
46.17	41.80	43.43	53.29	D1	QxD
54.91	51.08	43.80	69.83	D2	
59.02	44.35	57.20	75.50	D3	
0.725			1.255		$LSD_{0.05}$
	45.74	48.14	66.21		Q
			0.725		$LSD_{0.05}$

Yield Productivity

The results in Table (4) show that the productivity values increased with the decrease in discharge, as the highest mean values of productivity reached 72.99 Mg ha^{-1} in Q1 parameters compared with the lowest value of 60.60 Mg ha^{-1} in the Q2 treatment. This is due to the high drainage that increased the horizontal movement of water and nutrients, the loss of water by evaporation and the failure to take plant roots sufficient water. These results are consistent with Muhammadi (2011) and Abdali (2019) and agree with Jasim and Alkaabi (2017). The N2 coefficients achieved 65.69 Mg ha^{-1} compared with the N1 treatment 64.77 Mg ha^{-1}. Although the difference is not significant, it indicates the possibility of adopting the N2 treatment instead of the N1 treatment without there being a negative impact on production, but on the contrary, maintaining production while reducing the amount of water This is due to the fact that the N2 treatment provided the water requirement of the crop well and this was reflected in an increase in the productivity of the crop an increase in the productivity of the crop with the same amount of water. The treatment of interfering averages between Q1N2 achieved the highest productivity of 74.39 Mg ha^{-1} , compared with the lowest quotient of 57.32 Mg ha^{-1} in the Q2N1 treatment, and the treatment of interfering averages between Q1D3 achieved the highest throughput of 77.21 Mg ha^{-1}, compared with the lowest score of 55.56 Mg ha^{-1} When treating Q2D3, and if the interference treatment D3N1 achieved 68.50 Mg ha^{-1} the highest quotient, compared with the lowest quotient 59.97 Mg ha^{-1} when treating D1N1.

Table 4 : Effect of dripper discharge and the distances between the drip lines and its number on crop productivity

DxN	Discharge			Number of line	Distance
	Q3	Q2	Q1		
59.97	57.54	60.59	61.77	N1	D1
67.83	56.98	73.78	72.73	N2	
65.84	64.74	56.94	75.83	N1	D2
65.30	61.50	61.18	73.22	N2	
68.50	73.88	54.42	77.21	N1	D3
63.95	57.93	56.71	77.21	N2	
3.603			NS		$LSD_{0.05}$
N					
64.77	65.39	57.32	71.60	N1	QxN
65.69	58.80	63.89	74.39	N2	
NS			3.603		$LSD_{0.05}$
D					
63.90	57.26	67.19	67.25	D1	QxD
65.57	63.12	59.06	74.53	D2	
66.23	65.91	55.56	77.21	D3	
NS			4.412		$LSD_{0.05}$
	62.10	60.60	72.99		Q
			2.548		$LSD_{0.05}$

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