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A COMPARATIVE STUDY OF TWO TYPES OF EMITTERS AND TWO LEVELS OF IRRIGATION WATER PRESSURE AND THEIR EFFECT ON TWO VARIETIES OF PEPPER UNDER DRIP IRRIGATION SYSTEM

Hussain T.H. Tahir* and Nihayat H. Ameen

Collage of Agriculture, University of Kirkuk, Iraq.

Abstract

A field study was carried out at the Research Station of the College of Agriculture, University of Kirkuk for the agricultural season of 2017-2018, to evaluate the drip irrigation system and compare two types of GR and Turbo and two levels of operational pressure of irrigation water 0.5 and 1.25 bar with two varieties of Hungarian Wax and California Wonder. The results of the statistical analysis with RCBD design and Duncan test for the averages were higher than the California Wonder in the Hungarian Wax class. The characteristics of the stockings were analyzed using the T-Test to Comparative Between the emitters, where the GR emitter was superior to the Turbo emitter at the pressure of 0.5 bar in the uniformity of field emission 92.897% and 90.092% respectively and in the coefficient of manufacture variation 0.0502 and 0.0675, respectively and in the Statistical Uniformity Coefficient 94.807% and 93.247% respectively and the superiority of the emitter GR at the operational pressure of 1.25 bar in the field emission uniformity of 94.789% and 92.014 respectively. However, the Turbo emitter is superior to the GR emitter in the variation of emitter flow 12.089% and 14.347% respectively. The increase in operational pressure increased the uniformity of the field and absolute field emission and the efficiency of the water distribution of the two emitters, while the variation of emitter flow was increased by increasing the pressure of the Turbo emitter.

***Key words*:** Emitters, Uniformity of field emission, Statistical Uniformity Coefficient, Design Emission Uniformity, drip irrigation

Introduction

Modern irrigation technologies such as drip irrigation have become a new agricultural method for farmers to grow crops, including vegetable crops (Ansari and Majood, 2001). Because this system equips the plant with water in the root zone and thus exceeds water losses resulting from deep penetration, runoff and evaporation (Humman and Izuno, 1989). Nakayama and Bucks (1986) explained that the variation of emitter flow of the emitters is appropriate when it does not exceed 10% and is considered unacceptable when exceeding 20%. Al-Obeidi (2001) explained that the uniformity of the distribution of water for drip irrigation systems is the result of a number of factors, including the operational pressure available from the pump and the discharge of the pump and the pressure differentials caused by the friction in the water conveying pipes, diameter and length of the pipe as well as topography, Al-Hadithi *et al.,* (2010) noted that the coefficient of manufacture variation was used to evaluate the work of the emitters and as a criterion for describing the state of variation of discharges out of the emitters which produce a difference in manufacturing. Al-Janabi (2012) showed that the coefficient of homogeneity increases with the increase in operational pressure and decreases the variation in discharges of the meters with the increase of operational pressure when using three levels of pressure of 50, 100 and 150 kPa. The pressure of 150 kPa increased the homogenization coefficient and reduce the heterogeneity in the discharge of meteors. Ortega *et al.,* (2002) defined emission co-ordination as another criterion for homogenizing the distribution of precipitation. Abdul-Alrazzaq *et al.,* (2016) pointed out that increasing the operational pressure led to increasing the yield characteristics of the maize crop. It also increased the moisture content of 5.5% and the water distribution was 97.62%. The irrigation water efficiency was increased by 6.8% for subsurface irrigation by increasing irrigation water pressure. Hisham and Abdul

***Author for correspondence :** E-mail: hussein.tahir2@gmail.com

Rahman (2014). When evaluating the system of drip irrigation using T-Tape, GR and Turbo under the influence of pressure 20, 30, 40 and 60 kPa increased discharge by increasing pressure and decrease the percentage of variability significantly with increasing pressure of the type of Turbo, while there was an increase after pressure 40 for T-Tape and GR type. Wahab *et al*., (2017) concluded in a comparative study between the GR and the emitter Turbo and their effect on the eggplant hybrids. The system evaluated that the GR is superior to the uniform field and absolute field emission on the emitter turbo and positive effect on the plant. Abdul Rahman et al (2018) in a study on the yield of irrigation under the system of drip irrigation two types of GR emitters, which surpassed the emitter Turbo in the qualities of water efficiency and regular field emission and absolute field and reflected positively on the increase in productivity. Hassan *et al.,* (2017) indicated that the results showed that when the drip irrigation system was evaluated, the pressure of 2 bar was significantly higher than the water discharge, wetted area and the coefficient of manufacture variation and the field emission stability on the pressure of 1 bar. In view of the interconnected work between the springs and the operational pressure of the system, the aim of this study was to know the type of the emitter and the most appropriate pressure level by studying the drip irrigation characteristics.

Pepper (*Capsicum annuum* L.) is the third most significant family crop of Solanaceae in importance after potato and potato. The central regions of South America, southern Mexico and Guntimala are the original home of the pepper and have spread to other parts of the world (Khafaji and Mukhtar, 1989), as well as some mineral salts of potassium, calcium, phosphorus, magnesium and iron (Khalil, 2004). It is a good source of vitamins A, B1, B6, C, E and used in the See materials for medical treatments, in addition to its use as food and work of pickles. (Ewluo *et al.,* 2007).

The total cultivated area of this crop throughout Iraq for the year 2012 was 8460 hectares with a total production of 922925 tons and a yield of 6818.25 kg/ha (Statistical Abstract, 2017). This statistic is considered to be low in production compared to global production. Temperature and non-selection of suitable varieties, or local varieties of high productivity and lack of interest in plant nutrition, therefore, increasing the productivity of this crop in quantity and quantity is necessary to meet the growing needs of the population.

Materials and methods

The field experiment was carried out at the Agricultural Research Station of the College of Agriculture - University of Kirkuk in Al-Sayyada area during the agricultural season 2017 -2018, with the aim of influencing two types of GR and Turbo emitters and two levels of irrigation water pressure 0.5 bar and 1.25 bar in the growth and yield characteristics of pepper with evaluating irrigation system. (*Capsicum annuum* L.), the soil was divided into plates with three plates 90cm width and between a plate and another 60 cm. Drip irrigation pipes were used. This method was used to irrigate plants with many good qualities of plants. Pepper seeds were grown from the Hungarian Wax and California Wonder pepper on 20/8/2017 in the dishes and after the arrival of seedlings of good size, 10-15cm high and 4-5 real leaves were transferred to the field and planted on 5/10/2017 after the initial irrigation of the field and carefully and the distance between seedlings and another 40cm in the upper third of the board and on two sides and the number of experimental treatments 32 and each experimental treatments 10 seedlings and three replicates.

Table 1: Emitter status according to the value of differential manufacturing coefficient. (Al-Hadithi *et al.*, 2010).

Emitter Efficiency	Coefficient of manufacture variation *CV*
Excellent	$CV < 0.05$
Middle	$0.07 > CV > 0.05$
Below middle	$0.11 > CV > 0.07$
Poor	$0.15 > CV > 0.11$
Unacceptable	$CV > 0.15$

The experiment was carried out in randomize complete block design (R.C.B.D) and three replicates. The experimental treatments were 12 treatments compared to all the studied characteristics of the pepper plant according to the Duncan test at probability level 0.05. The T-test was used to test the drip irrigation characteristics at a probability level of 0.05, using the statistical program (SAS2000). The soil texture was loamy sand.

Studied characteristics:

Characteristics of Drip Irrigation System Assessment:

Discharge liter/hour and the discharge of the emitters are calculated as follows:

Whereas:

$$q\left(\frac{l}{h}\right) = \frac{v}{t} \quad (1)$$

q = Emitter discharge by liter / second. *vtll*

v = size of the test vessel by liter.

t = average fill time by second.

Coefficient of manufacture variation CV %:

The coefficient of manufacture variation (the difference of the work of the emitter) is the difference in the discharges of the emitters resulting from the inability to manufacture similar emitter and calculated using the following equation (Al-Hadithi *et al.,* 2010):

$$CV\ (\%) = SD/qm \qquad (2)$$

CV = difference coefficient (%).

SD = Standard deviation of discharges (L/h).

qm = Emitter discharge rate (L/h).

Variation of emitter flow qvar (%), (Christiansen, 1942):

$$qvar.\ (\%) = (qmax.-qmin.) / qmax. \times 100 \qquad (3)$$

Where:

qvar. = Variation of emitter flow (%).

qmax. = Highest discharges of the emitters (L/h).

qmin. = Less discharges for the emitters (L/h).

Statistical Uniformity Coefficient Us (%):

Statistical uniformity was calculated using equation 4. By using the statistical treatment, all of the various factors such as emitter manufacturing variation, lateral line friction, elevation difference, and emitter plugging are included.

$$Us\ (\%) = (1-CV) \times 100 \qquad (4)$$

A statistical discharge uniformity (Us) value of 80% or higher is required, where fertilizer is applied through an irrigation system.

Design Emission Uniformity (%) EU:

When designing an irrigation network, the efficiency of the addition of water is equal to the efficiency of the design water distribution calculated by the following equation: (Ismail, 2002).

$$EU(\%) = 100[1-(1.27 \times CV/\sqrt{n})] \times (qn/qm) \qquad (5)$$

Since

EU = Design Emission Uniformity (%).

qn = the measured mean of lowest 1/4 of emitter discharge (L/h).

Uniformity of Field emission F.EU (%):

The uniformity of field emission is due to the regularity of the water distribution of the plants or the indicator of the regularity of discharges of the emitters in the network.

They can be calculated using the following equation: (Mistry *et al.*, 2017).

$$F.EU\ (\%) = 100\ (qn/qm) \qquad (6)$$

Whereas:

F.EU = Uniformity of Field emission. (%)

Absolute Uniformity of Field emission F.EUa :(%)

The value of regular field water distribution uniformity (measured in practice in the field) on which the local irrigation system can be evaluated can be calculated using the following equation: (Mistry *et al.*, 2017).

$$F.EUa\ (\%) = 50\ [(qn/qm)/(qm/qx)] \qquad (7)$$

Whereas:

F.EUa = Absolute Uniformity of Field emission (%).

qx = the measured mean of hieghest 1/8 of emitter discharge (L/h).

Plant characteristics:

1. Plant height (cm): The height of plant was measured from the gowned to the pick of for all plants experimental treatments and then extracted the rate.
2. Number of leaves (paper/plant): The rate of number of leaves was calculated for several plants of each experimental treatment and then extracted the rate.
3. Average number of fruits (fruit / plant): The number of fruits per experimental treatments was calculated for each harvesting and measured according to the following equation: (Wahab, 2015)

   Average number of fruits (fruit/plant) = Number of experimental treatments fruits/ Number of plants in the experimental treatments (8)
4. Total yield (ton /ha): It was estimated from the yield of the production of one plant in the number of cultivated 644.53 plants per hectare.

Results and discussion

The results of table 5, which show significant differences in vegetative growth rates, were found to be higher than those of California Wonder in vegetative

Table 2: Criteria for an acceptable Statistical discharge uniformity (Us). (Mistry *et al.*, 2017).

Classification	Us – Value (%)
Excellent	>90
Very Good	80-90
Fair	70-80
Poor	60-70
Unacceptable	<60

Table 3: Comparisons between Statistical Uniformity coefficient (Us) and Design Emission Uniformity (Eu) for design Purposes.

EU (%)	Us (%)	Classification
94-100	95-100	Excellent
81-87	85-90	Good
68-75	75-80	Acceptable
56-62	65-70	Poor
<50	<60	Unacceptable

Table 4: Uniformity of emission *F.EU* & values F.EUa (Standard) according to standard recommendations of the American Society of Agricultural Engineers ASAE EP405.1 FEB03, (1996).

Valuation	*F.EU* values	*F.EUa* values
Excellent	More than 90%	94 – 100%
Very good	80 – 90%	81 – 87%
Good	70 – 80%	68 – 75%
Unacceptable	Less than 70%	56 – 62%

growth and achieved highest results in these two characteristics 74.250 cm/plant and 5.109 branch/plant Respectively, compared with the Hungarian Wax, which recorded the lowest 69.480 cm/plant and 4.710 branch / plant respectively. This may be due to the different genetic structure of plants in each type of pepper plant.

We also note from table 5, that there are significant and clear effects in the characteristics of the crop (the weight of the fruit and the total sum) of two varieties of pepper Hungarian Wax and California Wonder, 49.620 g /fruit and 3.210 ton/ha, respectively, compared to the Hungarian Wax, which recorded the lowest results 38.440 g /Fruit and 2.260 ton/ha, respectively and no significant difference was recorded in water discharge between the two cultivars.

Table 6, shows the effect of the first level of pressure on irrigation water 0.5 bar on two types of meters through the studied characteristics. The table shows that there are no significant differences between the studied characteristics except the Coefficient of manufacture variation *CV*, there was a significantly lower manufacturing variance and a significant improvement in the values of 0.0502 and 0.0675, respectively. As well as in the Statistical Uniformity Coefficient Us, where also surpassed the emitter GR on the emitter Turbo values were 94.807% and 93.247%, respectively.

Where we note the positive effect on the FEU feature with GR superiority in achieving a higher value of 92.89% while the emitter turbo 90.092%, which indicates the consistency of a better distribution of water on the ground for the emitter GR from the emitter Turbo and this corresponds with (Mistry *et al.*, 2017) and (Hassan *et al.*, 2017).

Table 7, shows the effect of the second level of water pressure of irrigation water 1.25 bar on two types of meters through the studied characteristics. There were no significant differences between the studied traits except FEU, where the GR spot exceeded 94.789%, compared with Turbo which recorded 92.014%. However, GR has achieved a better consistency in water distribution. This result is consistent with Wahab *et al.*, 2017 and Abdul Rahman *et al.*, 2018. Turbo is superior to GR in the difference in *qvar* where it achieved 12.0879% GR greater variation in water flow 14.347%, the reason may be due to increased percentage of variation in discharge by increasing operating pressure For the GR emitters, these pumps operate at low operational pressures and this is why the discharge of these emitters is irregular. As for the turbo emitters, the sensitivity of the emitter discharge is the direction of changes and differences in the pressure head when the flow reaches the state of disturbance within the disturbed flow inside pipe. This is consistent with (Hisham and Abdul Rahman, 2014).

In table 6 and fig. 7, when comparing the performance of the emitters line, they showed that their performance was within the good parameters for the FEU and FEUa values in table 3, although there were significant differences between the emitters. The value of the variation of emitter flow *qvar* was within the parameters required for the emitter, where it did not exceed 20% and there were no significant differences between

Table 5: Effect of two types of cultivars on plant characteristics.

Characteristics / Treatments	Plant height (cm)	Number of leaves leave/plant	Number of fruits fruit/plant	Total yield Ton/ha	Emitters water discharge L/h
Hungarian Wax	69.480b	4.710b	38.440b	2.260b	4.207a
California Wonder	74.250a	5.109a	49.620a	3.210a	4.210a

Same letters mean there is no significant difference but different letters mean significant difference.

Table 6: Effect of drip irrigation system and two types of emitters with the first level of irrigation water pressure on some system-related characteristics.

Measured Characteristics	Emitter type		Calculated T value	P value
	GR	Turbo		
Water discharge *qm* (L/h)	4.074	3.995	0.14	0.8956
*Coefficient of manufacture variation *CV* %	0.0502	0.0675	-3	0.0241
Variation of emitter flow *qvar* (%)	13.849	14.286	0.76	0.4776
*Statistical Uniformity Coefficient (%) *Us*	94.807	93.247	2.70	0.0355
Design Emission Uniformity (%) *EU*	98.505	98.068	0.76	0.4776
*Uniformity of Field emission (%) *F.EU*	92.897	90.092	3.27	0.0171
Absolute Uniformity of Field emission *F.EUa* (%)	93.551	92.583	1.68	0.1446

* There are significant differences between means. T-value of the T-test corresponding to the degree of freedom 4 and the probability of 0.05 = 2.77, Significant differences in the analysis of T test at a probability of 0.05.

Table 7: Effect of drip irrigation system and two types of emitters with the second level of irrigation water pressure on some system-related characteristics.

Measured Characteristics	Emitter type		Calculated T value	P value
	GR	Turbo		
Water discharge *qm* (L/h)	4.349	4.258	0.13	0.8996
*Coefficient of manufacture variation *CV* %	0.0413	0.0578	-2.34	0.0580
Variation of emitter flow *qvar* (%)	14.347	12.0879	3.91	0.0079
*Statistical Uniformity Coefficient (%) *Us*	94.301	94.221	0.14	0.8943
Design Emission Uniformity (%) *EU*	98.756	98.312	0.64	0.545
*Uniformity of Field emission (%) *F.EU*	94.789	92.014	4.81	0.0030
Absolute Uniformity of Field emission *F.EUa* (%)	94.713	93.312	2.45	0.0514

* There are significant differences between means. T-value of the T-test corresponding to the degree of freedom 4 and the probability of 0.05 = 2.77, Significant differences in the analysis of T test at a probability of 0.05.

the emitters, whereas GR recorded 13.849% at first level of water pressure and 14.34% at second level of water pressure, while Turbo emitter recorded 14.286% at first level of water pressure and 12.0879% at second level of water pressure and this is consistent with (Nakayama and Bucks, 1986) and (AL-Janabi, 2012).

Table 6 and 7, show that when the value of *CV* was increased the design emission uniformity Eu was increased too. GR was superior to the Turbo, where the *CV* values were excellent for 0.0502 and 0.0413 respectively, while *CV* values were moderate for the Turbo emitters were 0.0675 and 0.0578 respectively (AL-Hadithi *et al*., 2010).

We note from table 8 when comparing the irrigation water pressure levels of 0.5 bar and 1.25 bar with no significant differences between the studied traits except FEU where the second level of irrigation water pressure exceeded 1.25 bar by achieving 93.534% at the first level of irrigation water pressure 0.5 bar recording 91.495 Which indicates that the second level of irrigation water pressure is better in achieving homogeneity in the distribution of water on the field than the first level of irrigation water pressure. This is consistent with Ragheh (2005) and Hassan *et al.,* (2017). The reason for the increase in emission consistency is due to increased operational pressure in the drip irrigation system, which leads to the regularity of the water out of the field and the relationship between them. This is consistent with Ortega (2002) and Hisham and Akron (2014).

Conclusions

1. We deduce the superiority of the GR spot on the Turbo in the uniformity of the FEU and at two levels of operational pressure.
2. California Wonder surpasses Hungarian Wax in vegetative growth and yield characteristics.
3. Increasing the uniformity of field emission, the absolute uniformity of field emission and the Design Emission Uniformity for both the emitters and increasing the operational pressure.
4. The variability ratio was significantly decreased with the increase in the operational pressure of the turbo emitter while there was an increase in the variance ratio by increasing the operational pressure of the GR emitter.

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