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The role of the use of some soil enhancers and the type of subsurface drip irrigation tube in some of the physical properties of the soil and the efficient use of water for the Growth and yield of eggplant crop under protected farming conditions.

Ayhame S. Alobaidy[1] **Hussain T. Tahir[2]**
Wael F. A. Alshamary[3]
[1]*Department of Soil Science and Water Resources, college of Agriculture, University of Kirkuk, Kirkuk, IRAQ.*
*Corresponding Author: aksm22003@uokirkuk.edu.iq

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ABSTRACT

A field experiment was carried out in two plastic greenhouses to study the performance of two types of subsurface drip irrigation pipes by adding two types of soil conditioners and their effect on some physical properties of soil and the growth and yield of eggplants in greenhouses during the autumn season 2023 at the research station of the College of Agriculture, University of Kirkuk- IRAQ. The experiment included three main factors; the type of irrigation pipes of two kinds, the first pipes (T-Tape) and the second filtering pipes (RDI), the second factor involved the conditioner type (perlite and zeolite); and the third factor included addition levels (no addition, adding 0.5% of the weight of the experimental unit); and the design of split-split plots was used in the order of randomized completely block design (RCBD). An evaluation of the drip irrigation system was carried out before the start of cultivation. The type (RDI) irrigation pipe was given when evaluating the pre-cultivation irrigation system the highest value for each of design emission uniformity (EU%), field emission uniformity (FEU), absolute field emission uniformity (FEUa), the lowest values of coefficient of manufacture variation (C.V%), the difference in discharge (qvar%), and the discharge rate (qm litre hour^{-1}) as the values reached (97.96%, 97.93%, 99.36%, 0.0646%, 0.013%, 0.765 litres hour^{-1}), respectively compared to the T-Tape type drip irrigation pipe. Increased volumetric moisture content and lower salt concentration of RDI type irrigation pipe compared to T-tape drip irrigation pipe, the addition of perlite at the level of 0.05% also led to an increase in volumetric moisture content and a decrease in salt concentration compared to non-addition and zeolite addition treatments. The RDI-type drip irrigation pipe gave the highest values of plant height, dry weight of vegetation, leaf area and total yield, reaching 89.566 cm plant^{-1}, 144.435 gm plant^{-1}, 13.148 cm^2 leaf^{-1} and 78.213 Mg ha^{-1}, respectively, compared to the treatment of the drip irrigation pipe type (T-Tape). The perlite addition treatment recorded the highest values for plant height, dry weight of total vegetation, leaf area and total yield, reaching 92.725 cm plant^{-1}, 151.402 gm plant^{-1}, 14.150 cm^2 leaf^{-1} and 93.346 Mg ha^{-1} respectively, compared to zeolite addition treatments.

Keywords: Physical properties, Greenhouse, Soil, Pipes, Efficiency.

INTRODUCTION

The subsurface drip irrigation system is referred to as a system that supplies water directly to the plant's root area. This system reduces water loss and increases irrigation efficiency in distribution and homogenization [1], [2]. The subsurface drip irrigation system is useful in dry and semi-dry areas due to reduced water loss through evaporation, runoff, and deep filtration. The RDI system is a precise porous intelligent tube installed beneath the surface, which responds to naturally prevailing signals emitted by the roots of plants. All this is done without the use of controllers or sensors, one of its advantages is to release water when needed, perfect and accurate irrigation that tells one plant after another, virtually eliminates the loss of water due to evaporation and leakage, no smart controllers or timers, does not require calculating the rates of ET (evaporation knocked out) or flow rate calculations. The physical properties of the soil have a significant impact on agricultural use, and many research studies have demonstrated the positive impact of the addition of enhancers on soil qualities. The field of physics plays a particularly important role when it comes to soil construction, as it directly affects the hydrological properties of the soil. Different materials have been used to enhance the physical properties of the soil, including mineral materials such as (perlite, zeolite) [3].

In recent years, several research studies have been conducted to reduce water consumption in the agricultural sector, where many substances have been used in environments where water is scarce. Slow soil conductivity and nutrient content are low, fragile and rapidly filtered, such as perlite. A number of minerals have been used in a water-hungry environment and soil with low, nutrient-poor and highly easily filtered hydraulic conductivity, such as perlite, which has been ranked among the best agricultural modifications because it has high water absorption capacity and promotes soil ventilation, discharge and root ventilation [4]. Perlite is a small white grain with a size between 1 and 5 mm, originating from the heating of volcanic silica rocks to a temperature of 90-1000 ° C [5]. As a result of heating, granules increase in size from 4 to 20 times their original size, resulting in air vacuums that do not contain perlite and that can reach the roots of plants when necessary [6]. Mineral fertilizer has been widely used to enable crop production by bridging gaps between production and consumption, ultimately resulting in significant damage affecting natural environmental impacts and human health. So it's complementary to exploiting Fairly vital fertilizer mineral fertilizer in agriculture due to the abundance of safe food [7] zeolite is a soil enhancer that helps farmers and agronomists tackle many problems such as soil pollution. The zeolite metal is made up of hydraulic aluminum silicate materials formed by combining aluminum, silicon and oxygen with ground metals and alkali that form the metal frame. It contains open pores in the form of cavities, inside which there are channels that retain water, cateons and small particles. These pores are often called molecular sieves of constant and regular size, allowing the passage of small molecules and cations through them. Zeolite aluminosilicate metal attracts water molecules because it contains a proportion of aluminium, and some attract non-polar molecules when it is rich in silica. [8]. The aim of this research is study the adding of perlite and zeolite enhancer in some physical soil characteristics under protected agricultural conditions in Kirkuk governorate, by using two types of subsurface drip irrigation pipes, and comparing their performance in the efficient use of field water for the eggplant crop.

Materials and Methods

A field experiment was carried out in Petin Plastic to study the performance of two types of subsurface drip irrigation pipes by adding two types of soil enhancers and their impact on some of the physical properties of the soil and the efficient use of water for the eggplant crop under protected farming conditions in Kirkuk- IRAQ province during the autumn season **28\10\2023** at the research station of the Faculty of Agriculture - University of Kirkuk within coordinates Latitude 13″35˚23′ N, Longitude 36″ 44˚20 E. Split-split plots design under randomized completely block A design (RCBD) with three factors was used in this experiment. The factors were divided according to experiment design to:

- Main plots were type of drip irrigation pipe:

Drip irrigation pipe RDI [Responsive Drip Irrigation] type.

Drip irrigation pipe T-Tape type.

-Sup-plots were the type of conditioner:

Zeolite.

Perlite.

- Sup-sup plots were conditioner levels which:

0% (control).

0.5% of experimental unit weight.

Before field planting Soil samples were taken from depth of 0 – 30 cm, and then mixed, air dried, passed through a 2 mm holes diameter sieve, then analyses and measurements were conducted (Table 1).

Table 1. Some physical and chemical properties of pre-planting study soil for depths 0-0.30 m.

Properties		Value	Unit
Electrical conductivity [EC]		2.68	$dS.m^{-1}$
The potential of hydrogen [pH]		7.1	
Organic matter [OM]		37	
Calcium		6.3	$g\ kg^{-1}$
Gypsum		0.02	
Sand		400	
Silt		340	$g\ kg^{-1}$
Clay		260	
Texture class		Loamy	
Bulk density		1.45	$Mg\ m^{-3}$
Particle density		2.59	
Porosity		44.01	%
Saturated hydraulic conductivity		5.05	$cm\ h^{-1}$
Volumetric moisture at tensions [bar]	0.33	0.28	
	15	0.09	$cm^3\ cm^{-3}$
Available water		0.095	

The soil of the experiment was prepared under greenhouse conditions, and then it was tilled, crushed and levelled. The land was divided into six terraces with a width of 50 cm; a 75 cm distance was left between one terrace and another. The length of the terrace was 48 meters, and a line of drip irrigation system pipelines was placed along each terrace, which included drip pipes (T-tape) and filtering pipes (RDI) as shown in Figure (1).The compound fertilizer (NPK) with fertilizer formula of (15-15-15) according to the fertilizer recommendation [9], where nitrogen was added at a rate of 170 kg ha^{-1}; phosphorus was added at a rate of 160 kg P_2O_5 ha^{-1}. The potash was added at a rate of 120 kg K_2O ha^{-1}. Urea fertilizer was also used as a supplement to the recommendation of nitrogen in two batches, the first after 2-3 weeks of cultivation and the second before flowering, zeolite and perlite were added by mixing it with the soil with a width of 0.5 m and a length of 4 m and by 0.5% of the weight of the experimental unit at a depth of 0.3 m inside the soil profile.

A B

Figure 1. Types of subsurface drip irrigation pipes used in irrigation of aubergine crop in greenhouses (A T-Tape pipe, B RDI pipe).

An evaluation of the drip irrigation system was carried out before the start of cultivation to choose the best operating pressure to be adopted during the season, as some hydraulic parameters were measured for the drip and filtering irrigation systems:

2.4. Discharge of Dripper

One operating pressure (0.135) bar was selected during the evaluation process to measure the dripper discharge for both types of filtering and T-Tape, according to the volume of water received within 5 minutes, the measurement process was repeated three times at an operating pressure and for all selected lines and according to the discharge according to the equation mentioned by [10] as follows:

$$\mathbf{Q = v / t} \qquad \mathbf{(1)}$$

Q = Dripper's discharge (litre h^{-1}).
t = Operating time (h).
v = the volume of water received in the can (litre).

2.5. The Standard Deviation of Discharges (litre h^{-1})

The standard deviation of the discharges was calculated using the following equation [11]:

$$\mathbf{SD} = \frac{\sqrt{qn-n(qm)2}}{n-1} \qquad \mathbf{(2)}$$

SD = standard deviation of discharges (litre h^{-1}).
q_m = average of measured discharge (litre h^{-1}).
q_n = summation of drippers' discharges (litre h^{-1}).
n = number of drippers.

2.6. Coefficient of Manufacture Variation (CV%)

The coefficient of manufacture variation of drippers' discharge was calculated using the following equation [12].

$$\mathbf{Cv\ \% =} \frac{SD}{qm} \qquad \mathbf{(3)}$$

Cv = coefficient of factory variation (%).
SD = Standard deviation of discharges (litre h^{-1})
q_m = average of drippers' discharges (litre h^{-1}).

2.7. Variation of Emitter Flow (qvar)

The variance of dripper discharge along the irrigation line was calculated using the equation [13].

$$\mathbf{q_{var}(\%) =} \frac{qmax_{-}qmin}{qmax} \mathbf{\ x\ 100} \qquad \mathbf{(4)}$$

q_{var} = Dripper discharge variation (%).
q_{max} = Maximum dripper discharge (litre h^{-1}).
q_{min} = Minimum dripper discharge (litre h^{-1}).

2.8. Design Emission Uniformity (EU%)

Design emission uniformity was calculated using the following equation:

$$\mathbf{EU(\%) = 100} \left[1 - \left(\frac{1.27xCv}{\sqrt{n}}\right)\right] x \left(\frac{qm}{qm}\right) \qquad \mathbf{(5)}$$

2.9. Field Emission Uniformity (F.EU %)

Field emission consistency was calculated based on the following equation [13]:

$$\mathbf{F.EU\ (\%) = (\ 100 \times} \frac{qn}{qm}) \qquad \mathbf{(6)}$$

F.EU = Field emission uniformity.
q_m = average of drippers' discharges (litre h^{-1}).
q_n = average of drippers' discharges for the least quartile (litre h^{-1}).

2.10. Absolute Field Emission Uniformity(F.EUa)

The absolute field emission consistency value was calculated based on the equation mentioned in [14].

$$\mathbf{F.EUa\% = (} \frac{qn}{qm} + \frac{qm}{qx}\mathbf{)\ x\ 50} \qquad \mathbf{(7)}$$

F.EUa = Absolute field emission uniformity (%).
qx = Average dripper discharge for the higher price of drippers (litre h^{-1}).

q_n = average of drippers' discharges for the least quartile (litre h^{-1}).
The aubergine hybrid of the Jawaher cultivar was cultivated on (28/9/2023) in plastic dishes, then, it was transferred to the plastic house on (28/10/2023) and planted on the terrace in parallel order Irrigation was scheduled for all study treatments depending on the stage of crop 60 plants for the experimental unit if the distance between a plant and another is 0.4 m and the interval is 0.75 m between an agricultural line and another (total number of plants in the plastic house is 1440 plants and equivalent to 33,333 plant. hectares^{-1} growth using the evaporation basin, as a preliminary indicator for taking soil samples from the field and estimating the real remaining moisture in the soil by gravimetric method, this process is repeated until 50% of the water available to the plant is exhausted, then the actual soil moisture is determined when irrigating, the depth of water to be added to the soil (d) was calculated by applying the mathematical equation mentioned by [3].

d = (θfc - θpw) D **(8)**

d = The depth of water to be added (cm), which is equivalent to the actual water consumption (ETa).
θfc = Soil moisture at field capacity ($cm^3\ cm^{-3}$).
θpw = Soil moisture before irrigation ($cm^3\ cm^{-3}$).
D = Depth of the root zone (mm).

2.11. Measurement of Some Physical Properties

2.11.1. Bulk density and soil porosity (ρb)

The bulk density was estimated using paraffin wax according to the Blake method mentioned in [16]. The porosity was then calculated according to the following equation.

$$F = \left(1 - \frac{\rho b}{\rho s}\right) \times 100 \qquad (9)$$

If: -
F = Soil porosity (%)
bulck density ρb= (Mg M^3)
particle Density ρs= (Mg^{-3})

2.12.MeanWeightDiameter

Soil samples were taken to a depth of 0 to 0.3 m, sieving the soil with 4 and 9 mm sieves. Take 50 g of the remaining soil on the sieve 4 mm and put on filter paper and then put in a bowl (Petri dish) and moisten the property method for 6 minutes. Sieves with diameters of 0.3, 0.6, 1, 2 and 4 mm were placed on the Yoder device according to the method [18] then the device was turned on for 6 minutes according to [17] at a speed of 30 min-1 cycles, and according to the weighted diameter rate (M.W.D.) according to the equation that] proposed it [18].

$$\mathbf{M.W.D.} = \sum_{i=1}^{n} \bar{X}_i \times W_i \qquad \mathbf{(10)}$$

If:
MWD = weighted diameter rate (mm)
$\bar{X}_i$= Medium volume range of separated soil populations (mm)
Wi = Ratio of aggregate soil mass at any volume range to total dry soil mass (%).

Water efficiency (WUEF), or water unit productivity, is estimated to divide the total crop (kg ha^{-1} by the volume of water added (m^3 ha**-1** season), using the equation provided by [19] agencies: -

$$\textit{Field water efficiency } (kgm^3) = \frac{\textbf{Total result}(kgm.ha-1)}{\textbf{amount of water added}(m3.ha-1).} \qquad \mathbf{(11)}$$

The results were analysed statistically using the **SAS 2000** program for analysis of variance (F test), and the least significant difference **(LSD)** and the Dunkin' multi-range test were used to compare the different treatments included in the study

Results and Discussion

Figure 2 shows the hydraulic qualities of the irrigation system after the end of the season using two types of irrigation pipes (RDI and T-Tape). Analysis of the results from this table shows the impact of the drip irrigation system with two types of drops for some system-related qualities after the end of the agricultural season, the results show moral differences in the disposal of submarine drip irrigation missions, where the dotted RDI records lower value compared to the other dotted T-Tape type. (2.255). Also in the table there are moral differences in the difference factor as recorded (T-Tape) The highest value (0.0873) compared to RDI) was recorded the lowest value (0.0695) The source of the manufacturing difference is usually the result of a change in the internal path or in the design of the grid as a result of the existence of friction due to the nature of the manufactured material, and affected by a temperature [20] , increasing the variation in manufacturing may be the cause of some sediment accumulation in the pipes and therefore a blockage in the network of transmission and distribution of the system [21]. The reason for the decrease is the presence of sediment and salts, as well as the growth of lichens at bank openings as a result of use as indicated by [22] The table also showed regularity values of field emission that increased morally at drip drip irrigation type (RDI) highest value (97.01) compared to other point type (T-tape) recorded the lowest value (94.14) because the increase in operating pressure of the drip irrigation system leads to the steady and uniform output of water to the field, and the more regular the emission, the more ideal regularity and proximity to the optimal distribution of water throughout the field [23] The table also shows that the RDI dot has a higher value (96.96) than T-tape, which has a lower value (96.06).

Table 2. The effect of drip irrigation systems and two types of drips with the eggplant class (jewels - Dutch) on characteristic of the study.

No.	Measured properties	Dripper type		Calculated T value	P value
		RDI	T-Tape		
1	Water discharge (litre h^{-1})	0.7575	2.255	25.94	0.0001
2	*coefficient of variance [%] C.V	0.0695	0.0873	3.08	0.0216
3	Variation in flow [%] q_{var}	0.025	0.037	2.08	0.0829
4	Efficiency of water addition [%] EU	96.96	96.06	0.62	0.5559
5	*field emission uniformity [%] FEU	97.01	94.14	4.97	0.0025
6	Absolute field emission uniformity [%] FEUa	98.82	98.03	1.37	0.2202

* Refer to the existence of significant differences between the two averages.
The tabular value of the T-test corresponds to the degree of freedom 4 and the probability of 0. 05 = 2.77.
P Significant differences in T-test analysis at probability 0. 05.

Table 3. The condition of the dripper in light of the value of the coefficient of factory variation.

Efficiency of dripper	Manufacture variation coefficient CV%
Excellent	CV > 0.05
Average	0.07 > CV> 0.05
Below medium	0.11> CV> 0.07
Bad	0.15> CV > 0.11
Rejected	CV>0.15

Bulkdensity(mg-m^{-3}):

Table (4) shows the effect of the type of subsurface drip irrigation pipe, the type of improver and the level of its addition in the bulk density, as it is noted that there is no significant effect of the type of subsurface drip irrigation pipe in the values of bulk density and that the lowest value was at the RDI drip irrigation coefficients as it reached 1.552 mg m^{-3} while the highest value was 1.613 mg m^{-3} at the T-Tape type drip irrigation coefficients with a decrease of 3.78%. The reason for this decrease in bulk density values may be attributed to the fact that the method of humidification has differed when using the RDI type dripper, as the humidification was slow and exuded, so the effect of confined air decreased compared to rapid humidification when using a T-Tape dripper and this helped to reduce the severity of fracture of the soil groups and increase the stability of their gatherings, so they decrease

Table (4) Effect of Subsurface Drip Irrigation Pipe Type and Improver Type and Level of Addition on Bulk Density (Mg M^{-3}).

Pipe type	Conditioner type	Addition level		Pipe type × Conditioner type
		Control	0.5% addition	
T-Tape	Zeolite	1.702 a	1.667 ab	1.684 a
	Perlite	1.586 abc	1.496 c	1.541 b
RDI	Zeolite	1.595 abc	1.606 abc	1.600 ab
	Perlite	1.540 c	1.469 c	1.504 b
Pipe type x addition level		Addition level		Pipe type level
		Control	%0.5 Addition	
Pipe type	T-Tape	1.644 a	1.581 ab	1.613 a
	RDI	1.567 ab	1.537 b	1.552 a
Addition level average		83.675 a	1.605 a	1.559 a
Pipe type x addition level		Addition level		Conditioner type average
		Control	%0.5 Addition	
Conditioner type	Zeolite	1.648 a	1.563 ab	1.642 a
	Perlite	1.636 a	1.482 b	1.522 b

It is clear from Table (4) that there are no significant differences for the level of improver in the values of bulk density, but the addition coefficients gave the lowest value, reaching 1.559 mg M^{-3} compared to the non-addition coefficients in which the bulk density increased slightly and amounted to 1.605 mg M^{-3}, the reason for the decrease in bulk density may be attributed to the role of the level of the improver in the development of soil construction and increase porosity in size. The lowest bulk density value was 1.469 mg m^{-3} for interference treatment (irrigation of RDI with the addition of perlite enhancer at 0.5%). While B.

Total porosity (%):

Table (5) shows the effect of the type of subsurface drip irrigation pipe, the type of improver and its addition level on porosity. It is noted that there is no significant effect of the type of subsurface drip irrigation pipe on porosity values, and the highest value was in RDI drip irrigation treatments, reaching 40.735%. In comparison, the lowest value was 38.684% in T-Tape drip irrigation treatments. The same table also showed a significant effect of the improver type coefficients on the porosity values, as the perlite improver gave the highest value of 41.858% compared to the zeolite improver type, which gave the lowest value of 37.561%. The reason for the increase in the total porosity of the soil is that adding improvers to the soil may improve the shape of the soil pores, which leads to an improvement in the porosity of the soil, and increases the size of the voids between the soil particles. This is consistent with what Abdul Hassan [24], [25] reached. The reason for the increase in the total porosity of the soil by adding perlite may be attributed to its role in improving the soil properties by binding the soil particles and increasing its porosity, thus improving the soil structure. The results in

Table (5) show no significant differences in the level of improver addition, but the addition coefficients gave the highest value, reaching 40.995%, compared to the non-addition treatment, which reached 38.424%, in which the porosity increased slightly. The reason for the increase in porosity values may be attributed to the role of the improver addition level. The results of the same table indicate that there are no significant differences for the triple interaction between the type of drip irrigation pipe, the type of improver and the level of addition, but there were somewhat positive effects, and the highest value of porosity reached 43.448% for the interaction treatment (RDI irrigation with the addition of improver perlite at a level of 0.5%). While the highest value of porosity reached 33.652% for the interaction treatment (T-Tape irrigation and improver zeolite without addition).

Total porosity (%):

Table (5) shows the effect of the type of subsurface drip irrigation pipe, improver type and its addition level on porosity, as it is noted that there is no significant effect of the type of subsurface drip irrigation pipe on the porosity values, and that the highest value was in the RDI drip irrigation treatments, reaching 40.735%. In comparison, the lowest value was 38.684% in the T-Tape drip irrigation treatments. The same table also showed a significant effect of the improver type coefficients on the porosity values, as the perlite improver gave the highest value of 41.858% compared to the zeolite improver type, which gave the lowest value of 37.561%. The reason for the increase in the total porosity of the soil is that adding improvers to the soil may improve the shape of the soil pores, which leads to improving the porosity of the soil, and increases the size of the voids between the soil particles. This is consistent with what Abdul Hassan [27], [27] reached. The reason for the increase in the total porosity of the soil by adding perlite may be attributed to its role in improving the soil properties by binding the soil particles and increasing its porosity, thus improving the soil structure. The results in Table (5) show no significant differences in the level of improver addition, but the addition coefficients gave the highest value, reaching 40.995%, compared to the non-addition treatment, which reached 38.424%, in which the porosity increased slightly. The reason for the increase in porosity values may be attributed to the role of the improver addition level. The results of the same table indicate that there were no significant differences in the triple interaction between the type of drip irrigation pipe, the type of improver and the level of addition, but there were somewhat positive effects. The highest porosity value reached 43.448% for the interaction treatment (RDI irrigation with the addition of improver perlite at a level of 0.5%). While the highest porosity value reached 33.652% for the interaction treatment (T-Tape irrigation and improver zeolite without addition).

Table (5) Effect of sub-surface drip irrigation tube type and improved type in porosity%

Pipe type	Conditioner type	Addition level Control	Addition level 0.5% addition	Pipe type × Conditioner type
T-Tape	Zeolite	33.652b	38.648ab	36.150b
	Perlite	39.457ab	42.977a	41.217a
RDI	Zeolite	39.038ab	38.906ab	38.972ab
	Perlite	41.550a	43.448a	42.499a
Pipe type x addition level		Addition level Control	Addition level %0.5 Addition	Pipe type level
Pipe type	T-Tape	36.555 a	40.813a	38.684a
	RDI	40.294 a	41.177a	40.735 a
Addition level average		83.675 a	38.424 a	40.995 a
Pipe type x addition level		Addition level Control	Addition level %0.5 Addition	Conditioner type average
Conditioner type	Zeolite	36.345 b	38.777 ab	37.561 b
	Perlite	40.504 ab	43.213 a	41.858 a

Weighted diameter rate (mm):

Table (6) shows the effect of the type of subsurface drip irrigation pipe, the type of improver and its addition level on the weighted diameter rate, as it is noted that there is no significant effect of the type of subsurface drip irrigation pipe on the values of the weighted diameter rate, and that the highest value was in the drip irrigation treatments (RDI) as it reached 1.101 mm, while the lowest value was 0.928 mm in the drip irrigation treatments of the (T-Tape) type. The reason for the high values of the weighted diameter rate for irrigation treatments using the (RDI) drip pipes may be attributed to the fact that the drip irrigation process continues all the time (day and night) and according to what the plant needs, and with this mechanism, the wetting and drying cycles that negatively affect the soil structure and the stability of its aggregates are eliminated, as during irrigation, the soil expands, especially the clay containing the mineral montmorillonite. In contrast, the soil shrinks when irrigation is stopped, which is what happens when using irrigation pipes of the (T-Tape) type [28]. As shown in Table (6), there is a significant effect of the improver type coefficients on the weighted diameter values (mm), as the improver Perlite gave the highest value of 1.196 mm compared to the improver Zeolite type, which gave the lowest value of 0.833 mm. The reason for the high weighted diameter for the perlite addition coefficients may be attributed to the improvement of the soil structure and the increased soil moisture retention, which led to slow soil wetting and thus reduced the effect of the entrained air and reduced the initial breakage of the soil aggregates and increased the stability of the aggregates. This is consistent with what was concluded by [29].

Table (6) Impact of the type of subsurface drip irrigation tube and the type of enhancer and its level of addition in the weighted diameter rate (mm).

Pipe type	Conditioner type	Addition level		Pipe type × Conditioner type
		Control	0.5% addition	
T-Tape	Zeolite	0.655 c	0.784c	0.719c
	Perlite	1.020 bc	1.253ab	1.136ab
RDI	Zeolite	1.012bc	0.880bc	0.946bc
	Perlite	1.047bc	1.466 a	1.256a
Pipe type x addition level		Addition level		Pipe type level
		Control	%0.5 Addition	
Pipe type	T-Tape	0.838b	1.018ab	0.928 a
	RDI	1.029 ab	1.173a	1.101 a
Addition level average		83.675 a	0.933 a	1.095 a
Pipe type x addition level		Addition level		Conditioner type average
		Control	%0.5 Addition	
Conditioner type	Zeolite	0.834 b	0.832 b	0.833 b
	Perlite	1.033 b	1.359 a	1.196 a

Table (6) shows that there are no moral differences in the level of addition of the enhancement in the balanced diameter rate values. The additionally factors gave the highest value at 1.095 mm compared to non-additionality transactions in which the balanced diameter rate values decreased slightly and amounted to 0.933 mm. The results of the same table indicate positive but not moral effects of triple interference between drip irrigation tube type, enhanced type and additive level. The highest value of the weighted diameter rate was 1.466 mm for interference treatment (RDI irrigation by adding enhancer Berlite at a level of 0.5%). The minimum value of the weighed diameter rate was 0.655 mm for the overlap treatment (T-Tape irrigation and the improver Zeolite without addition).

Water efficiency (kg m^{-3}):

Table (7) shows the effect of the subsurface drip irrigation tube type and the type of enhancer and the level of its addition in water use efficiency values, A moral effect of the type of subsurface drip irrigation tube is observed in water efficiency values and the highest value is 17.462 kg m^3 in T-Tape drip irrigation transactions while the highest value in RDI drip irrigation transactions is 13.101 kg m^3, as shown in Table 3. (7) The moral effect of enhancement type factors on water efficiency values, as the enhancer gave Berlite the highest water efficiency value of 19.092 kg m^3 compared to the enhancer type Zeolite, which gave 11.472 kg m^3

Table (7) effect of subsurface drip irrigation tube type, enhancer type and additive level on water use efficiency (kg m^3).

Pipe type	Conditioner type	Addition level		Pipe type × Conditioner type
		Control	0.5% addition	
T-Tape	Zeolite	13.183 e	13.312e	13.247c
	Perlite	19.596 b	23.828a	21.677a
RDI	Zeolite	9.710f	9.683 f	9.696d
	Perlite	15.256d	17.756 c	16.506d
Pipe type x addition level		Addition level		Pipe type level
		Control	%0.5 Addition	
Pipe type	T-Tape	16.354b	18.570a	17.462 a
	RDI	12.483d	13.720c	13.101b
Addition level average		83.675 a	14.419 b	16.145 a
Pipe type x addition level		Addition level		Conditioner type average
		Control	%0.5 Addition	
Conditioner type	Zeolite	11.446 c	11.4977 c	11.472 b
	Perlite	17.391 b	20.792 a	19.092 a

It is clear from Table (7) that there are significant differences for the level of improver in the values of water use efficiency, as the addition coefficients gave the highest value, amounting to 16.145 kg m-3 compared to the non-addition coefficients in which the water use efficiency decreased to 14.419 kg m-3. The results of the same table indicate that there are positive but not significant effects of the triple interference between the type of drip irrigation pipe, the type of improver and the level of addition, and the highest value of water use efficiency was 23.828 kg m-3 for the interference treatment (irrigation T-tape by adding the improver perlite at the level of 0.5%). The lowest water use efficiency value was 9.710 kg m-3 for interference treatment (RDI irrigation and zeolite enhancer without additive).

Conclusion

In evaluating the pre-planting irrigation system, the RDI pipe gave the highest value for water emission uniformity (EU%), field emission uniformity (FEU%), absolute field emission uniformity (FEUa%), the lowest values for the factory variation coefficient (C.V%), the difference in discharge (q_{var}%), and the discharge average (qm) (litre hour^{-1}).

Irrigation using RDI pipes led to an increase in moisture content and a lower concentration of dissolved salts compared to T-Tape drip irrigation pipes. Also, (plant height, leaf area, dry weight of vegetative part, early yield and total yield) increased compared to the use of T-Tape drip irrigation pipes.

The addition of Perlite conditioners by 0.2% led to an increase in the volumetric moisture content of the soil and a decrease in the electrical conductivity values compared to the non-addition of conditioners and the Zeolite addition treatments. Also, (plant height, leaf area, dry weight of the vegetative total part, early yield and total yield) increased compared to the non-addition treatments and Zeolite addition treatments. The addition of Perlite conditioners by 0.2% led to an increase in the volumetric moisture content of the soil and a decrease in the electrical conductivity values compared to the non-addition of conditioners and the Zeolite addition treatments. Also, (plant height, leaf area, dry weight of the vegetative total part, early yield and total yield) increased compared to the non-addition treatments and Zeolite addition treatments

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دور استخدام بعض معززات التربة ونوع أنبوب الري بالتنقيط تحت السطح في بعض الخصائص الفيزيائية للتربة وكفاءة استعمال الماء من أجل نمو محصول الباذنجان وإنتاجه في ظل ظروف زراعية محمية.

ايهم صلاح محمد[1] **حسين ظاهر طاهر[2]**

وائل فهمي عبدالرحمن[3]

قسم علوم التربة والموارد المائية ،كلية الزراعة، جامعة كركوك،كركوك.

الخلاصة

نفذت تجربة حقلية في بيتين بلاستيكيين لدراسة اداء نوعين من انابيب الري بالتنقيط تحت السطحي بإضافة نوعين من محسنات التربة وتأثيرها في بعض الخصائص الفيزيائية للتربة وكفاءة استعمال الماء لمحصول الباذنجان في البيوت المحمية خلال الموسم الخريفي 2023 في محطة ابحاث كلية الزراعة – جامعة كركوك. تضمنت التجربة ثلاث عوامل رئيسة وهي نوع انابيب الري بنوعين الاول انابيب (T–Tape) والثاني انابيب نضح (RDI) ، العامل الثاني تضمن نوع المحسن (بيرلايت وزيولايت) والعامل الثالث مستويات الاضافة (بدون اضافة ، اضافة 0.5% من وزن الوحدة التجريبية) وتم استخدام تصميم القطع المنشقة بترتيب القطاعات العشوائية الكاملة (RCBD). جرى تقييم لمنظومة الري بالتنقيط قبل البدء بالزراعة وبلغت قيم كفاءة اضافة المياه EU% (96.96%) وانتظامية الانبعاث الحقلية FEU% (97.01%) وانتظامية الانبعاث الحقلية المطلقة FEUa% (98.82%) ومعامل الاختلاف المصنعي C.V% (0.0695%) والاختلاف في التصريف q_{var}% (0.025%)، ومعدل التصريف q_m لتر ساعة$^{-1}$ (0.7575 لتر ساعة$^{-1}$) مقارنة بقيمها قبل الزراعة. اعطى انبوب الري بالنضح (RDI) اعلى قيم للمسامية الكلية ومعدل القطر الموزون واقلها للكثافة الظاهرية حيث بلغت 40.735% و 1.101 مم و 1.552 ميكاغرام م$^{-3}$ على الترتيب، مقارنة بأنبوب الري بالتنقيط تحت السطحي T–Tape.سجلت معاملات اضافة البيرلايت اعلى قيم للمسامية الكلية ومعدل القطر الموزون واقلها للكثافة الظاهرية اذ بلغت 41.858% و 1.196 مم و 1.522 ميكاغرام م$^{-3}$ على الترتيب، مقارنة بمعاملات اضافة الزيولايت. واعطت معاملة مستوى الاضافة 0.05% اعلى قيم للمسامية الكلية ومعدل القطر الموزون والايصالية المائية المشبعة واقلها للكثافة الظاهرية بلغت 40.995% و1.095 مم و 4.851 سم ساعة–1 و 1.559 ميكاغرام م$^{-3}$ على الترتيب، مقارنة بمعاملات عدم اضافة المحسنات.

الكلمات المفتاحية : الصفات الفيزيائية، بيت بلاستيكي، تربة، أنابيب، الكفاءة.