Evaluating the effect of tillage, irrigation, and organic fertilization systems on Some Growth and Yield Indicators of Cucumber Plants in Desert Soil

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Abstract

The experiment was conducted in Najaf province at the University of Kufa - Agricultural Research Station for the summer season of 2023 AD in a sandy loam soil, classified according to the modern American classification as sub-maximal to the level of Typical Torrifluvent according to the global classification to evaluate the effect of tillage, irrigation and organic fertilization systems on water consumption efficiency and some physical and chemical properties of desert soil and cucumber yield of the (Mansour) variety. The experiment included three main factors: first, the tillage system, with three levels of tillage (traditional tillage using a moldboard plow), reduced tillage (heavy disc harrow), and no tillage; second, drip irrigation, with two levels (surface drip irrigation and subsurface drip irrigation); and third, fertilization, with three levels (no organic fertilizer, polymer fertilizer, organic fertilizer, and organic fertilizer with polymer). The experiment was conducted using split-plot randomized complete block design (RCBD) The most important results were as follows: The traditional tillage treatment resulted in the highest cucumber plant height (118.10 cm). The plant had a leaf area of 148.00 cm^2, a fresh root weight of 26.57 g, an average harvest of 1.729 kg ha^{-1}, and a total yield of 13.00 kg ha^{-1} (ton ha^{-1}).The fertilization treatment combining organic fertilization and polymer addition significantly excelled the others, recording the highest values for most growth and yield traits. The subsurface irrigation treatment recorded the highest values for plant height (107.0 cm), leaf area (149.60 cm^2), fresh root weight (352.80 g $plant^{-1}$), and average harvest of 1.424 kg ha^{-1} (total yield). 11.393 kg ha^{-1}.bi- interaction treatments (organic fertilization, polymer addition, and conventional tillage), (organic fertilization, polymer addition, and subsurface drip irrigation), and (conventional tillage and subsurface drip irrigation) were significantly different and recorded the highest values for plant growth and yield indicators.The results also showed that the triple interaction treatments (no tillage, organic fertilization with polymer addition, and subsurface drip irrigation) and (conventional tillage, organic fertilization with polymer addition, and subsurface drip irrigation) were significantly excelled and recorded the highest values for most plant growth and yield traits.

Key word: subsurface drip irrigation, traditional tillage, polymer ,reduced tillage

Introduction

In desert regions, water is a vital natural resource and one of the most significant challenges facing sustainable agriculture, particularly in arid and semi-arid areas like Iraq, which relies primarily on groundwater. With increasing population pressures and climatic conditions, the need for smart and effective water resource management solutions has intensified, especially given the growing reliance on highly saline groundwater for agricultural irrigation in arid desert regions [4]Water scarcity is a major challenge for sustainable agriculture, particularly in arid desert regions. Drip irrigation systems have emerged as a technological solution capable of improving water use efficiency and reducing water loss by sensing the actual water needs of plants and precisely adjusting the amount applied. Among the systems used in agriculture are surface and subsurface drip irrigation. Surface and subsurface drip irrigation systems directly supply the plant's root zone and rely on water movement from the bottom up via capillary action and moisture tension. They are highly

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efficient because the water is contained within the root zone, which minimizes evaporation losses and reduces weed growth. The ability to inject fertilizers and pesticides directly into the plant roots mixed with the irrigation water further enhances the efficiency of subsurface drip irrigation, ranging from 85% to 95% [14].

This allows us to describe the efficiency of subsurface drip irrigation as excellent. Tillage is a crucial soil management process because deep, traditional tillage brings larger quantities of gypsum to the surface compared to shallow tillage [2]. To minimize this removal and create a suitable growing medium, specific tillage implements are used that achieve the lowest possible tillage depth [15]. This is known as shallow tillage. Choosing the right plow is essential for improving soil properties and determining the quality of tillage, which can lead to increased crop yields. Despite the numerous benefits of tillage, selecting the wrong plow can have negative consequences, such as soil compaction, increased permeability, and increased bulk density. Tillage techniques have diversified globally, with each soil type requiring a specific method and specific operations [1].The use of organic matter in nutrient-poor and chemically deficient soils is of particular importance, as organic matter has a biological effect on the soil through its direct impact on plants. It is an important source of nutrients, many organic acids, and various growth regulators. It also has an indirect effect by improving many of the soil's physical properties, such as porosity, permeability, water and air movement, increased moisture retention, and reduced bulk density. Considering all soil-building factors, the use of organic matter (plant and animal) has many advantages in increasing phosphorus availability by dissolving poorly soluble phosphorus compounds through the release of organic acids [11] These polymers also act as micro-reservoirs for nutrients and fertilizers, preventing nutrient leaching with irrigation water and allowing their balanced and regular release to meet the plant’s needs for longer periods, thus contributing to increased fertilization efficiency, improved soil physical properties, and an ideal moisture environment for plant root growth [18].This improves the growth of the cucumber plant (Cucumis sativus L.), which is of nutritional and medicinal importance to consumers. Therefore, attention should be paid to studying these crops and developing strategies, particularly by increasing their productivity and improving their quality. This research aims to evaluate the effect of tillage, irrigation, and organic fertilization systems on some physical and chemical properties of desert soil and cucumber yield.

Materials and Methods

Experimental Location and Field Soil Description

The experiment was conducted in Najaf Governorate at the University of Kufa - Agricultural Research Station during the autumn season of 2023 in a sandy loam soil, classified according to the modern American classification as sub-typical torrifluvent according to the international classification (Soil Survey Staff, 2006).

3-2- Soil Preparation

The soil was plowed using a moldboard plow, a disc plow, and left unplowed. The field was divided into 13m x 1m plots for each experimental unit, with a 1m spacing between plots. The total field area was 18m x 36m. Decomposed organic fertilizer (cow manure) was added according to the fertilization recommendations for the experimental units included in the research plan. Beforehand, random soil samples were taken from the 0-30cm topsoil in an X shape. After removing plant debris, the soil was air-dried, ground using a wooden mallet, passed through a 2mm sieve, and thoroughly mixed to homogenize it. Soil samples were taken from the rhizosphere of each experimental unit at the end of the experiment to estimate nitrogen, phosphorus, potassium, organic matter, soil moisture, temperature, salinity, and soil pH. These were

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used for chemical and physical analyses to study the soil, the results of which are shown in Table (1) as follows:

3-2-1 - Estimation of the Physical and Chemical Properties of the Soil Sample

Some physical and chemical properties of the study soil were estimated, as shown in Table (1). These properties were estimated according to the following methods:

3-2-2- Physical Analyses

1- Size Distribution of Soil Particles

The size distribution of soil particles was estimated using the pipette method, as described by [3]

2- Apparent Soil Density

This was estimated using the core sample method, as described by [3]

3-2-2- Chemical Analyses

1- Soil pH

This was estimated in a 1:1 soil:water extract using a pH meter, as described by [3]

2- Electrical Conductivity (EC)

This was estimated in a 1:1 soil:water extract using an EC meter, as described by [3]

3- Ion Exchange Capacity (CEC): Estimated by saturating the soil with 1.0 N calcium chloride solution at pH 7, followed by displacement with 1.0 N sodium nitrate solution according to the [10]

4- Organic Matter: Estimated by oxidation with 1.0 N potassium dichromate solution in the presence of concentrated sulfuric acid, followed by reverse tidylation with ferrous sulfate using diphenylamine assay, as described by [3]

5- Available Nitrogen: Estimated by extraction with potassium chloride solution (KCl2) (steam distillation using the method described by [3] as described in Bremner, using the Micro-Kjeldahl apparatus.

6- Available Phosphorus: Extracted soil phosphorus using 0.5 M sodium bicarbonate (NaHCO3) according to the Olsen method, then color-degraded using ammonium molybdate and acid. Ascorbic acid and available phosphorus were determined using a spectrophotometer at a wavelength of 882 nm according to the method described in [9].

7- Available Potassium: Available soil potassium was extracted using 1 M ammonium acetate, and the extracted potassium was then determined using a flame photometer according to the method described in [9].

Table (1) Some Chemical, Physical, and Biological Properties of the Study Soil

Properties	values	units	Source
pH 1:1	7.2	___	Methods mentioned in [9]
Electrical Conductivity (EC) 1:1	1.85	$DS.m^{-1}$	[9]
Organic Material O.M	10.3	$g.kg^{-1}$	Methods mentioned in [9[
available nutrient content			
Nitrogen	20	$mg.kg^{-1}$soil	The methods mentioned in [9[
Phosphorus	10.8		

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Potassium	154		
Soil separators			
Clay	12	%	The methods mentioned in [9[
silt	8		
Sand	80		
Soil texture	Sandy loam	——	——
Bulk density	1.46	Mg m̄³	
True density	2.63	g.cm³	
Porosity	39	%	
Weighted diameter index	0.7	mm	
Hydraulic conductivity	0.029	cm.min	
Soil penetration resistance	2	micapascal	
Lime	14.15	%	
Gypsum	0.5	%	
Bicarbonates	1.7	Mg.kg soil	
Carbonates	0	Mg.kg soil	
Irrigation water salinity	1.3	DS. m^{-1}	
Cation exchange capacity	8.6	mEq / 100 g	

3-3- Experimental Factors:

The experiment included three main factors:

First factor: Soil preparation system at three levels:

1. Traditional tillage (mold moldboard plow).

2. reduced tillage (heavy disc harrow).

3.Minimal tillage (no tillage)

Second factor: Drip irrigation method at two levels:

1. Surface drip irrigation.

2. Subsurface drip irrigation.

Third factor: Organic fertilization at three levels:

1. No organic fertilizer.

2. No organic fertilizer with polymer.

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3. Organic fertilization.

4. Organic fertilization with polymer.

3-4- Planting: Cucumber seeds of the (Mansour) variety were sown in rows within trays, with a spacing of 1 meter between rows and 50 cm between plants, at a rate of one row containing six plants per experimental unit. Two to three seeds were placed in each planting hole, and the plants were thinned to one plant each two weeks after emergence. Nitrogen fertilizer was applied at a rate of 250 kg N ha^{-1} in the form of urea (CO(NH2)2) 46% N, phosphate fertilizer at a rate of 100 kg P ha^{-1} in the form of triple superphosphate (Ca(H2PO4)2) 20% P, and potassium fertilizer at a rate of 100 kg K ha^{-1} in the form of potassium sulfate (K2SO4) 41% K, according to the Ministry of Agriculture's recommendations.

3.5. Irrigation Method: The plants were irrigated using surface and subsurface drip irrigation, with a spacing of 50 cm between emitters and 1 m between rows.

3-6- Growth Characteristic Measurements

3-6-1- Plant Height (cm)

The average plant height was measured for three plants randomly selected from each experimental unit, from the soil surface to the tip of the growing point (

3-6-2- Leaf Area (m^2 plant-1)

Six plants were randomly selected from each experimental unit, and the leaf area was measured (Elsahookie, 1985) using a digital planmeter.

3-6-3- Average Dry Weight of the Shoots (g plant-1)

The dry weight of the shoots was estimated for the randomly selected plants from each experimental unit. The plants were uprooted, excluding the roots, and the samples were dried in an electric oven at 75°C for 48 hours until completely dry (Hocking et al., 1997). 3-6-4- Yield Weight

3-6-5- Total Yield per Unit Area (Mg. ha^{-1})

The total yield for each experimental unit, from the first to the last harvest, was calculated cumulatively for the 4 m^2 experimental unit, totaling 13 harvests, from November 1, 2020, to January 17, 2021.

This calculation is based on the following equation:

Total Yield (Mg ha^{-1}) = Experimental Unit Yield × Cultivated Hectare

Area of Experimental Unit m^2

3-6-6- Harvest Index %:

The harvest index was calculated using the following equation: Harvest Index = (Crop Yield Weight) / (Biological Yield) × 100%

As reported by Al-Aboudi, 2016

Statistical Analysis:

The experiment was conducted using a randomized complete block design (RCBD) as a factorial experiment comprising 24 treatments with three replicates (2, 3, 4, 3), resulting in a total of 72 experimental units. The results were statistically analyzed using analysis of variance (ANOVA), and significant differences between the treatment means were calculated at the 0.05 level (Al-Sahouki & Wahib, 1990) using the Genestat statistical analysis software.

Results and discussion

4-21-Plant height (cm)

The results in Table (1) showed no significant differences in the tillage treatments. The traditional tillage treatment recorded the highest average height of cucumber plants, reaching 118.10 cm, while the no-till treatment recorded the lowest average height of plants, reaching 96.20 cm. The subsurface drip irrigation treatment also recorded the highest

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average height of plants, reaching 107.0 cm, while the surface drip irrigation treatment recorded an average height of plants, reaching 10.7 cm. The tables showed that fertilization had a significant effect on plant height. The treatment with organic fertilizer and polymer was significantly excelled, recording the highest average plant height of 133.80 cm, while the treatment without fertilization recorded the lowest average height of 82.10 cm. Regarding the dual interaction, the results showed no significant differences between tillage and irrigation. The treatment with traditional tillage and subsurface drip irrigation recorded the highest average height of 118.90 cm. The interaction treatment with traditional tillage, organic fertilizer, and polymer addition recorded the highest average height of 150.70 cm, while the interaction treatment with surface drip irrigation, organic fertilizer, and polymer addition recorded the highest average plant height of 136.4 cm. Table (1) also showed the excelledity of the interaction treatment with traditional tillage, organic fertilizer, polymer, and subsurface drip irrigation, giving the highest average height. The average plant height was 157.80 cm, while the lowest average plant height, 69.9 cm, was recorded in the no-till, no-fertilization, and subsurface drip irrigation treatment.

Table (1) Effect of tillage, irrigation, and organic fertilizer systems and their interactions on cucumber plant height (cm)

tillage systems (T)	Drip irrigation (I((I)	Fertilization (F(				**T * I**	
		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer		
no tillage	surface drip	69.9	91.9	102.2	119.3	95.8	
	Subsurface drip	73.3	85.2	110.2	117.8	96.6	
Traditional tillage	surface drip	93.9	90.6	127.2	157.8	117.4	
	Subsurface drip	100.2	95.7	135.9	143.7	118.9	
reduced tillage	surface drip	72.1	90.4	120.7	132.2	103.9	
	Subsurface drip	82.9	101.7	105.3	132.0	105.5	
			N.S	**LSD_{T*I*F} =**		**N.S**	**LSD $_{T*I}$ =**
average Fertilization (F(		82.1	92.6	116.9	133.8		
			6.8	**LSD_F =**			
T * f							
tillage systems (T)		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average tillage systems (T(**	
no tillage		71.6	88.6	106.2	118.6	96.2	
Traditional tillage		97.1	93.1	131.6	150.7	118.1	
reduced tillage		77.5	96.1	113.0	132.1	104.7	

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		15.7	**$LSD_{T*F=}$**		**N.S**	**$LSD_{T=}$**
I * F						
Drip irrigation (I(	No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average Drip irrigation (I((**	
surface drip	78.6	91.0	116.7	136.4	105.7	
Subsurface drip	85.5	94.2	117.1	131.1	107.0	
		= N.S	**LSD_{I*F}**		**= 7.1**	**LSD_{I}**

Leaf Area (cm2)

The results in Table (3) show that tillage has a significant effect on the leaf area of the plant. Tillage treatments were excelled, with no significant differences between them. The traditional tillage treatment recorded the highest average leaf area at 148.00 cm2, while the no-till treatment recorded the lowest average leaf area at 136.20 cm2. As for irrigation treatments, the subsurface drip irrigation treatment was excelled and recorded the highest average leaf area at 149.60 cm2, while the surface drip irrigation treatment recorded an average leaf area of 137.00 cm2. The tables also showed that fertilization had a significant effect on leaf area. The treatment with organic fertilizer and polymer was significantly excelled, recording the highest average leaf area of 193.90 cm², while the treatment without fertilization recorded the lowest average of 88.5 cm². Regarding the two-way interaction, the results showed no significant differences between tillage and irrigation. The treatment with traditional tillage and subsurface drip irrigation recorded the highest average of 155.50 cm². The interaction treatment with traditional tillage, organic fertilizer, and polymer addition recorded the highest average of 203.90 cm², while the interaction treatment with subsurface drip irrigation, organic fertilizer, and polymer addition recorded the highest average leaf area of 209.30 cm². The results in Table (3) also showed that the triple interaction between the experimental factors had a significant effect on the leaf area characteristic. In terms of leaf area, the interaction between traditional tillage + organic fertilizer and polymer + subsurface drip irrigation recorded the highest leaf area at 221.80 cm², while the treatment without tillage, without fertilization, and with subsurface drip irrigation recorded the lowest leaf area at 77.70 cm².

Table (3) Effect of tillage, irrigation, and organic fertilizer systems and their interactions on the leaf area of cucumber plants (cm²)

tillage systems (T)	Drip irrigation (I((I)	Fertilization (F(				**T * I**
		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	
no tillage	surface drip	79.2	104.5	172.0	170.1	131.5
	Subsurface drip	77.7	95.0	184.0	206.9	140.9
Traditional tillage	surface drip	89.0	98.8	188.2	185.9	140.5
	Subsurface	101.7	107.9	190.4	221.8	155.5

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	drip					
reduced tillage	surface drip	89.6	121.8	164.9	179.5	138.9
	Subsurface drip	93.6	130.4	187.0	199.2	152.5
			N.S	**LSD_{T*I*F} =**		**N.S** **LSD_{T*I} =**
average Fertilization (F(		88.5	109.7	181.1	193.9	
			8.0	**LSD_F =**		
T * f						
tillage systems (T)		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average tillage systems (T(**
no tillage		78.4	99.8	178.0	188.5	136.2
Traditional tillage		95.4	103.4	189.3	203.9	148.0
reduced tillage		91.6	126.1	175.9	189.3	145.7
			14.8	**LSD_{T*F}=**		**LSD_T= N.S** **11.3**
I * F						
Drip irrigation (I(		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average Drip irrigation (I((**
surface drip		85.9	108.4	175.0	178.5	137.0
Subsurface drip		91.0	111.1	187.1	209.3	149.6
			10.9	**LSD_{I*F}**		**5.9** **LSD_I=**

Fresh weight of vegetative growth (g)

The results in Table (4) show that tillage systems have a significant effect on the fresh weight of vegetative growth. The reduced tillage treatment recorded the highest average fresh weight of vegetative growth, reaching 389.20 g, while the no-till treatment recorded the lowest average fresh weight of vegetative growth, reaching 285.30 g. As for irrigation treatments, the subsurface drip irrigation treatment recorded the highest average fresh weight of vegetative growth, reaching 352.80 g, while the surface drip irrigation treatment recorded an average fresh weight of vegetative growth, reaching 349.40 g. The tables also showed that fertilization had a significant effect on the fresh weight of vegetative growth. The treatment with organic fertilizer and polymer was significantly excelled and recorded the highest average fresh weight of vegetative growth, reaching 559.80 g, while the treatment without fertilization recorded the lowest average, reaching 189.10 g. As for the dual interaction, the treatment of traditional tillage and subsurface drip irrigation recorded the highest average, reaching 436.30 g, while the interaction treatment of reduced tillage, organic fertilizer, and polymer addition recorded the highest average, reaching 678.40 g. Meanwhile, the interaction treatment between surface drip irrigation, organic

fertilizer, and polymer addition recorded the highest average fresh weight of vegetative growth, reaching 560.0 g. As shown in Table (4), the triple interaction between the experimental factors showed a significant advantage. The interaction between reduced tillage + organic fertilizer and polymer + surface drip irrigation resulted in the highest average fresh weight of the plant's vegetative parts, reaching 753.10 g. Conversely, the reduced tillage treatment without fertilization and subsurface drip irrigation resulted in the lowest average fresh weight of the plant's vegetative parts, at 147.20 g.

Table (4): Effect of Tillage, Irrigation, and Organic Fertilization Systems and Their Interactions on Fresh Weight (g) of Cucumber Plants

tillage systems (T)	Drip irrigation (I((I)	Fertilization (F(				**T * I**	
		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer		
no tillage	surface drip	170.2	187.2	428.2	407.3	298.3	
	Subsurface drip	156.0	212.7	301.1	419.7	272.4	
Traditional tillage	surface drip	146.6	263.3	355.0	519.4	321.1	
	Subsurface drip	270.4	281.5	537.8	655.6	436.3	
reduced tillage	surface drip	243.9	144.2	573.7	753.1	428.7	
	Subsurface drip	147.2	302.4	345.5	603.8	349.7	
			136.9	**$LSD_{T*I*F=}$**		**N.S**	**LSD $_{T*I=}$**
average Fertilization (F(		189.1	231.9	423.6	559.8		
			52.6	**$LSD_{F=}$**			
T * f							
tillage systems (T)		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average tillage systems (T(**	
no tillage		163.1	200.0	364.6	413.5	285.3	
Traditional tillage		208.5	272.4	446.4	587.5	378.7	
reduced tillage		195.5	223.3	459.6	678.4	389.2	
			111.2	**$LSD_{T*F=}$**		**N.S**	**$LSD_{T=}$**
I * F							
Drip irrigation (I(		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average Drip irrigation (I((**	
surface drip		186.9	198.2	452.3	560.0	349.4	
Subsurface drip		191.2	265.5	394.8	559.7	352.8	
			= N.S	**LSD $_{I*F}$**		**= 29.6**	**LSD $_{I}$**

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Dry weight of vegetative growth (g)

The results in Table (5) show that tillage systems have a significant effect on the dry weight of vegetative growth. The reduced tillage treatment recorded the highest average fresh weight of vegetative growth, reaching 56.87 g, while the no-till treatment recorded the lowest average fresh weight of vegetative growth, reaching 40.06 g. As for irrigation treatments, the subsurface drip irrigation treatment recorded the highest average fresh weight of vegetative growth, reaching 51.5 g, while the surface drip irrigation treatment recorded an average fresh weight of vegetative growth of 50.38 g. The tables also showed that fertilization had a significant effect on the dry weight of vegetative growth. The organic fertilizer and polymer treatment was significantly excelled and recorded the highest average fresh weight of vegetative growth, reaching 78.04 g, while the treatment without fertilization recorded the lowest average, reaching 28.1 g. As for the dual interaction, the traditional tillage and subsurface drip irrigation treatment recorded the highest average, reaching 64.26 g, while the interaction treatment of reduced tillage, organic fertilizer, and polymer addition recorded the highest average, reaching 93.22 g. Meanwhile, the interaction treatment between surface drip irrigation, organic fertilizer, and polymer addition recorded the highest average fresh weight of vegetative growth, reaching 78.58 g. As shown in Table (5), the triple interaction between the experimental factors showed a significant advantage. The interaction between reduced tillage + organic fertilizer and polymer + surface drip irrigation resulted in the highest average fresh weight of the plant's vegetative parts, reaching 104.30 g. Conversely, the reduced tillage treatment without fertilization and subsurface drip irrigation resulted in the lowest average fresh weight of the plant's vegetative parts, at 23.26 g.

Table (5): Effect of tillage, irrigation, and organic fertilizer systems and their interactions on the dry weight (g) of the vegetative parts of cucumber plants

tillage systems (T)	Drip irrigation (I((I)	Fertilization (F(				**T * I**	
		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer		
no tillage	surface drip	23.45	23.15	56.20	54.15	39.24	
	Subsurface drip	25.21	34.60	42.98	60.74	40.88	
Traditional tillage	surface drip	22.77	33.59	57.46	77.29	47.78	
	Subsurface drip	37.03	53.26	76.94	89.83	64.26	
reduced tillage	surface drip	41.76	24.45	85.98	104.30	64.12	
	Subsurface drip	23.26	43.01	50.08	82.15	49.62	
			12.93	**$LSD_{T*I*F=}$**		**8.93**	**$LSD_{T*I=}$**
average Fertilization (F(		28.91	35.34	61.61	78.08		
			4.99	**$LSD_{F=}$**			
T * f							

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tillage systems (T)	No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average tillage systems (T(**	
no tillage	24.33	28.88	49.59	57.44	40.06	
Traditional tillage	29.90	43.43	67.20	83.56	56.02	
reduced tillage	32.51	33.73	68.03	93.22	56.87	
		10.38	**$LSD_{T*F=}$**		**9.08**	**$LSD_{T=}$**
I * F						
Drip irrigation (I(	No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average Drip irrigation (I((**	
surface drip	29.33	27.06	66.55	78.58	50.38	
Subsurface drip	28.50	43.62	56.67	77.57	51.59	
		= 6.59	**LSD $_{I*F}$**		**= N.S**	**LSD $_{I}$**

Total Yield (kg.ha-1)

The results in Table (6) show that the farming systems did not show any significant differences between them. The traditional tillage treatment recorded the highest average total yield of 13.83 kg.ha-1, while the no-till treatment recorded the lowest average total yield of 7.647 kg.ha-1. As for the irrigation treatments, the subsurface drip irrigation treatment recorded the highest average total yield of 11.393 kg.ha-1, while the surface drip irrigation treatment recorded the lowest average total yield of 9.593 kg.ha-1. The tables also showed that fertilization had a significant effect on the total yield rate. The organic fertilizer and polymer treatment was excelled and recorded the highest total yield rate of 17.920 kg.ha-1, while the control treatment recorded the lowest total yield rate of 632. As for the dual interaction, the treatment of conventional tillage and subsurface drip irrigation recorded the highest rate of 14.953 kg.ha-1, while the interaction treatment of conventional tillage and organic fertilizer and polymer recorded the highest rate of 23.34 kg.ha-1. Meanwhile, the interaction treatment of subsurface drip irrigation and organic fertilizer and polymer recorded the highest total yield rate of 19.013 kg.ha-1. The triple interaction treatment showed no significant differences between them. The interaction treatment (conventional tillage, drip irrigation, organic fertilizer, and polymer) recorded the highest yield at 24.967 kg ha^{-1}, while the control treatment recorded the lowest total yield at 2.300 kg ha^{-1}.

Table (6) shows the effect of tillage, irrigation, and organic fertilizer systems and their interactions on the total yield (kg ha^{-1}) of cucumber plants.

tillage systems (T)	Drip irrigation (I((I)	Fertilization (F(				**T * I**
		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	
no tillage	surface	2.300	4.247	9.640	14.313	7.627

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	drip						
	Subsurface drip	2.673	4.440	9.913	13.627	7.660	
Traditional tillage	surface drip	5.480	7.073	16.593	21.707	12.713	
	Subsurface drip	5.873	8.053	20.933	24.967	14.953	
reduced tillage	surface drip	3.287	5.173	10.840	14.433	8.433	
	Subsurface drip	5.673	7.727	14.380	18.453	11.560	
			N.S	**$LSD_{T*I*F=}$**		**N.S**	**$LSD_{T*I=}$**
average Fertilization (F(		4.213	6.120	13.720	17.920		
			1.387	**$LSD_{F=}$**			
T * f							
tillage systems (T)		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average tillage systems (T(**	
no tillage		2.487	4.340	9.780	13.973	7.647	
Traditional tillage		5.673	7.560	18.760	23.340	13.833	
reduced tillage		4.480	6.453	12.607	16.447	10.000	
			4.600	**$LSD_{T*F=}$**		**4.660**	**$LSD_{T=}$**
I * F							
Drip irrigation (I(		No organic fertilizer	polymer	Organic fertilization	Organic fertilization with polymer	**average Drip irrigation (I((**	
surface drip		3.693	5.500	12.360	16.820	9.593	
Subsurface drip		4.740	6.740	15.073	19.013	11.393	
			= N.S	**LSD_{I*F}**		**= N.S**	**LSD_{I}**

Adding organic fertilizers plays a significant role in increasing growth rates and yields, improving the physical and chemical properties of the soil, and enhancing its moisture retention capacity. It also improves drainage, aeration, and gas exchange resulting from the activity of roots and microorganisms [3]

This excelled is attributed to the high organic matter content of cow manure, which provides plants with many essential nutrients. Furthermore, cow manure has the ability to chelate mineral elements from the soil, preventing their conversion into unavailable forms. Additionally, it raises the soil pH to 6.6, which is crucial for releasing micronutrients and making them readily available for plant uptake [13] Organic fertilizer also contains organic acids that have a direct effect on various enzymatic reactions and vital plant processes such as photosynthesis, respiration, and protein synthesis. Their effect is similar to that of plant hormones, leading to increased plant growth and creating optimal conditions for cell division and elongation [12] thus

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increasing plant height. The increase in leaf area can also be attributed to the role of cow manure in supplying plants with essential nutrients, including nitrogen, which is crucial for increasing leaf primordial formation. Furthermore, nitrogen plays a role in increasing the DNA and RNA content of plant tissues and in the synthesis of proteins important for stimulating cell division and increasing cell size. The important role that cow manure plays in preparing and improving the absorption of macro and micronutrients, which contribute to improving the permeability of cell membranes, resulting in various biochemical processes that promote plant growth and increase its resistance [5] or perhaps it is due to the content of the manure of nitrogen and zinc, which are important in building the amino acid tryptophan, which is the basic material in the manufacture of auxin IAA, which is important in increasing the expansion and elongation of cells and increasing the flexibility and plasticity of the cell wall, which contributes to increased growth. In addition, some elements enter directly into the composition of some important compounds such as cytokines, which are necessary in the process of photosynthesis and activating cell growth, and thus leads to an increase in leaf area. The high organic content of organic fertilizers increases the availability and absorption of nutrients, especially nitrogen This element plays a key role in amino acid synthesis and protein formation [6] It is essential in photosynthesis as it constitutes about 70% of the chlorophyll molecule. Nitrogen contributes to the formation of enzymes and coenzymes. Nitrogen works with zinc to synthesize plant hormones, particularly auxin IAA, which is synthesized endogenously and leads to increased elongation by stimulating cell division and multiplication. The amount of this hormone increases when nitrogen is readily available [16].The excelledity of surface and subsurface irrigation systems may be attributed to several factors that enhance nitrogen fixation and retention in the root zone. This type of irrigation delivers water directly to the root zone, reducing the effects of evaporation and deep seepage, both of which are beneficial to the absorption zone, the area containing available nitrogen (nitrates). Salt concentration in the water reservoir is higher when The periphery of the soil is more concentrated in the center, leading to salt concentration at the edge of the wet zone rather than in the center. This reduces stress on the roots and maintains the efficiency of the root zone. Furthermore, subsurface irrigation promotes a stable environment in terms of moisture and temperature, resulting in a longer and more concentrated supply of nitrogen. These factors combined contribute to increasing the amount of available nitrogen in the soil [17]

This is because subsurface drip irrigation is efficient in water transport and distribution, reducing salt accumulation in the slow-moving zone and minimizing potassium migration to deeper levels. This keeps potassium available to plants for longer periods. Furthermore, the capillary action in the topsoil layer reduces water loss and enhances cation exchange between the soil and the surface of clay particles and organic matter, thus improving soil stability. Additionally, the uniform distribution of moisture in subsurface irrigation reduces osmotic stress on roots, leading to better potassium uptake [5] Rapid and deep water penetration into the soil reduces evaporation and water loss. This efficient method increases nutrient availability to plants, particularly during flowering and fruiting, resulting in more flowers, larger flowers, and better quality and quantity of pods [7].

The excelledity of this irrigation system over other systems in terms of vegetative wet weight when using saline water is attributed to its precise water distribution and high efficiency in maintaining a constant moisture level. This method is suitable for the root zone, as the irrigation system provides the plant with a small but constant amount of water. This reduces irrigation stress and ensures continuous plant hydration, stimulating

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vegetative growth and increasing tissue hydration. Furthermore, this system reduces salt content in the root zone when using saline water. As a result of repeated irrigation, salts are removed from the root, maintaining cell activity and increasing water content. This leads to a higher total vegetative weight compared to subsurface drip irrigation [8].

Conclusions:

1- All studied traits exhibited the same behavior under different tillage systems. The response was similar but differed in magnitude, with traditional tillage being excelled for most of the studied traits.

2- The treatment with organic fertilizer and polymer fertilization significantly outperformed others, yielding the highest values for most growth and yield traits.

3- Subsurface irrigation also significantly outperformed others, recording the highest values for most of the studied traits.

4- The results showed that the triple interaction had a significant effect. The two interaction treatments consisting of (no tillage + organic fertilization with polymer addition + subsurface drip irrigation) and (traditional tillage + organic fertilization with polymer addition + subsurface drip irrigation) were significantly excelled and recorded the highest values for most of the plant's growth and yield traits.

References

[1] Allam, M., Radwan, S. M. A.,&El-Sikhry, E. M. (2020). Influence of conventional and reduced tillage systems on soil physical properties and maize yield. Egyptian Journal of Soil Science, 60(3), 291-305.

[2] Al-Majma'i, Ahmed Saleh. (2013). The effect of deep and short tillage systems on gypsum distribution and some physical and chemical properties of gypsum soils. Unpublished doctoral dissertation, College of Agriculture, Tikrit University, Iraq.

[3] Black, J. W., Duncan, W. A., & Shanks, R. G. (1965). Comparison of some properties of pronethalol and propranolol. *British Journal of Pharmacology and Chemotherapy*, *25*(3), 577.

[4] Food and Agriculture Organization (FAO). (2025). *The state of the world's land and water resources for food and agriculture: Smart solutions for sustainable agriculture*. Rome, Italy: FAO.

[5] Jensen, M. H. (2004). Hydroponics and organic amendments: Enhancing cell membrane permeability and biochemistry of greenhouse crops. Acta Horticulturae, (648), 19-27.

[6] Lazcano, C., Wade, J., & Horwath, W. R. (2021). The role of organic amendments in building amino acids and soil protein pools for sustainable crop nutrition. Soil Biology and Biochemistry, 156, Article 108221.

[7] Lei, Z., Wang, J.,&Zhang, Y. (2023). Surface and subsurface irrigation scheduling impacts on flowering, fruiting, and pod quality of legume crops. Field Crops Research, 291, Article 108785.

[8] Minamikawa, K.,&Makino, T. (2020). Alternating irrigation volume to mitigate salinity stress and preserve cell turgor in leafy vegetables. Environmental and Experimental Botany, 178, Article 104163.

[9] Page, A. L. (Ed.). (1982). *Methods of soil analysis. Part 2. Chemical and microbiological properties* (pp. 1159-pp).

[10] Papanicolaou, G. C. (1976). Some probabilistic problems and methods in singular perturbations. *The Rocky Mountain Journal of Mathematics*, 653-674.

[11] Rattan, B., Dhobale, K. V., Saha, A., Garg, A., Sahoo, L., & Sreedeep, S. (2022). Influence of

ISSN 2072-3857

inorganic and organic fertilizers on the performance of water-absorbing polymer amended soils from the perspective of sustainable water use efficiency. Soil and Tillage Research, 223, 105449

[12] Shaji, H., Chandran, V., & Mathew, L. (2021). Organic acids as biostimulators: Influence on enzymatic activities, photosynthesis, and hormone-like responses in plants. Physiology and Molecular Biology of Plants, 27(4), 731-743.

[13] Singh, M., Kumar, A.,&Gupta, S. (2020). Cattle manure amendments for micronutrient chelation and pH regulation in alkaline soils. Journal of Plant Nutrition, 43(12), 1845-1858.

[14] Sitharthan, R., Rajesh, M., & Elangovan, K. (2023). Automation and efficiency analysis of subsurface drip and localized irrigation systems. *Journal of Agricultural Water.*

[15] Szostek, M., Niemiec, M., & Sikora, J. (2022). Evaluation of the effectiveness of no-tillage systems in conservation agriculture. Soil Security, 7, 100062.

[16] Tian, D., Zhang, L., & Wang, H. (2022). Nitrogen-induced auxin synthesis and its effect on longitudinal cell division and vegetative growth. Annals of Botany, 129(5), 589-601.

[17] Wang, Q., Sui, J.,&Zhang, M. (2023). Subsurface vs. surface irrigation: Nitrogen retention dynamics and fruit water content relationships in dry regions. Agricultural Water Management, 277, Article 108104.

[18] Xia, W., Wang, Q., Yu, Q., Yao, M., Sun, D., Liu, J., & Wang, Z. (2023). Experimental investigation of the mechanical properties of hydrophobic polymer-modified soil subjected to freeze-thaw cycles. Acta Geotechnica, 18(7), 3623-3642

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