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The effect of plowing depth and distance between the two beds of furrows opener developed under different tillage systems on some soil physiology and sunflower crop growth.

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Abstract

The research was conducted in clayey loamy soil using two plowing systems (T1 chisel) and (T2 moldboard) and three depths of plowing D (10, 20, 30 cm) and three spacing between the two plates of each of the furrows opener (40, 50, 60 cm).) to study the effect of the developed furrows opener on the physical properties of the soil (bulk density and porosity) and the growth characteristics of the sunflower crop (plant height, , productivity,)

The furrows opener, when used after the moldboard plow, gave the highest height and the maximum quantity of the total seed yield of the plant, while the three mentioned traits recorded the highest increase at the maximum depth of the stalk (30 cm) and the largest spacing between the boards (60 cm) between the two plates of each of the three The furrows opener weapons, and the traits were affected (Plant height and total seed yield) were significantly affected by the bilateral and triple interactions between the study factors (tillage systems, machine depth, and the distance between the two plates) .

While it affected some of the physical soil characteristics represented by the bulk density of the soil and the total porosity of the soil, the sander recorded a decrease in the apparent soil density when used after the chisel plow, and also decreased with the increase in the depth of the machine and with the increase of the inter-distance between the boards of furrow opener, while the bilateral interference was recorded between systems Tillage and tillage depth had a significant effect, while the binary interactions between (tillage regimes spacing between the boards, plow depth, and spacing between the boards) and the triple interaction between the study factors (tillage regimes, plow depth, and spacing between the boards) had no significant effect on bulk density. The developed plow excelled when used after the chisel plow by recording the highest total porosity, which increased with increasing the depth of the machine and increasing the inter-distance, while the bilateral interference between the tillage systems and the depth of the machine had a significant effect, while the bilateral interactions between (the tillage systems and the inter-distance, the depth

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of the machine and the inter-distance) and the triple overlap between the study factors (tillage systems, machine depth and spacing between the boards) any significant effect on the total porosity of the soil.

Keywords: plowing systems, the depth of the machine (the depth of plowing), the distance between the furrow opener plates.

I. INTRODUCTION

Soil is used in agriculture as it is the main source of nutrients needed for plant growth. The soil that is used for cultivation varies (including but not limited to, among other characteristics, the percentage of moisture that the soil is supposed to hold) according to the variety of plants that can be grown in it. At the present time, the goal has become to improve the design of the machine in order to achieve the required reduction in the consumption of energy and materials, and on this basis new agricultural machines were produced in order to suit modern methods of agricultural production.

The is used before planting in order to form a cultivation for the purpose of planting crops that are grown on the mulch, such as sunflower, okra, cotton, etc. The furrows opener is at appropriate depths according to the type of plant, and the line of the mulch is perpendicular to the soil preparation operations to obtain a homogeneous distribution of soil and reduce the possibility of demolishing the mulch, and it is used after planting To dismantle the furrows after their purpose has expired, or to stir up the soil around the growing plants for the purpose of supporting them and forming a large root group. Machine Al-Sabbagh *et at (1990*). They differ according to the type of crop, its variety, its size, and the water needs, as well as the type of soil and the amount of slope. Young plants need small cultivars and vice versa. The cultivars are divided according to their shapes into two common types, which are the complete triangle shape. And the flat triangle at the base of the marshmallow, which indicated the standard dimensions of the marshmallows that meet the needs of most of the crops grown in Iraq (Al-Tahan *et at. 2000*)and ((Kepner et al. 1982).

Bulk density is a good indicator by which to judge the porosity of the soil, the extent of water and air movement, and the penetration of roots into the soil. Accordingly, it affects the productivity of the soil, and the Iraqi environment is considered one of the suitable environments for the production of sunflowers, but its productivity is still low, and the reason for this is due to the lack of interest in production factors. The most widespread method globally is cultivation on lines, but in the southern region of Iraq in particular, it is cultivated on ridge, because of its role in reducing the spread of salinity near the plants, which may be reflected in the improvement of production compared to cultivation on lines. In order to provide nutrients, increase the ability of the soil to retain water, and reduce the number of irrigations, the developed sprinkler was designed to open grooves of different dimensions.

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This research aims to study the effect of the interaction between furrows opener treatments (machining depth and angles of the tillers) and tillage systems in improving some physical properties of the soil and the growth and yield of the sunflower crop.

II- MATERIALS AND METHODS

The agricultural and mechanical experiment was conducted in Silt Loam soil as shown in Table (1). for the agricultural season 2022-2023. In one of the agricultural fields affiliated to the Agricultural Research Station - College of Agriculture - Karmat Ali, between latitude 30.47 north and longitude 47.80 east, , with an area of 1000 square meters.

1 . manufacturing of the Implement :

furrows opener developed designed and manufactured the angles between the two beds in the workshop of the Department of Agricultural Machinery and Machinery, College of Agriculture / University of Basra, to perform several functions of the appendices(Zoz et at., 2023).

First: Opening three furrows with one pass.

Second: The possibility of changing the distances between the two moldboard to control the width of the slider Third: The possibility of using it as a chisel plow at zero angle.

Fourth: The possibility of using it as a compound machine by adding other mechanical units.

Fifth: Reducing the time, effort and cost required to conduct agricultural operations.

Table (1): Primary physical, chemical and mechanical properties of the soil used in the experiments

NO	Properties	Units	Depth (cm)		
			٠-10	١٠ -20	20 – 30
1	Sand	gm kg−1	٢٠٨,٨١	١٩٧,٢٢	١٨٣,٦٨
	Silt		٥٧٦,٣٧	٥٨٦,٦٥	٦٠٩,٨٣
	Clay		٢١٤,٨٢	٢١٦,١٣	٢٠٦,٤٩
	soil texture		Silt Loam	Silt Loam	Silt Loam
2	bulk density	Mg m−3	٢,٦٢	٢,٦٤	٢,٦٤
	Particle Density		١,٤٤	١,٤٦	١,٤٧
3	Porosity	%	٤٥,٠٤	٤٤,٦٥	٤٤,٣٢

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4	moisture content	%	١٢,٤٦	١٥,٦٣	١٩,٠٩
5	penetration resistance	kN M^{-2}	٢٤٧٩	٢٦٤٨	٢٨٧٢
6	ECe	dS m^{-1}	١٢,٤١	١٣,٠٨	١٣,٦٣

The experiments conducted according to the -split plots according to the randomized complete block design (RCBD) with three replicates for each treatment that included dividing the land into two parts, during which two systems were used for plowing (chisel plow T1) and (mold board plow T2) with a depth of 25 cm for both systems, after which the developed furrow opener was introduced With three depths of the god (10, 20, and 30 cm) and with three distances between the two plates of each of the three furrow opener plates (40, 50, and 60 cm), so that the total is 54 treatments with a length of 5 m, with three furrows for each treatment to study the effect of the developed opener furrows In some physical characteristics of the soil (bulk density and percentage of soil porosity) and characteristics of growth and yield of sunflower crop,. The studied characteristics were measured as follows:

2. bulk density (ρb):

The bulk density of the soil was measured using the core sampler method, after the soil samples were dried in the oven at a temperature of 105 °C until the weight of the sample was fixed as in the method described by Black (1965), as in

$\rho b = MS$ / V the following equation …….. (1)

whereas :

ρb = bulk density of soil (g cm^{-3})

MS = mass of solid particles (g)

V = the total volume of the soil and represents the volume of the cylinder (cm^3).

3. Total porosity (F):

It was calculated through Equation (3) and according to the method presented and mentioned in (Black *et at*. 1983)

F = (1_ ρb / ρs)x100 .....(3)

whereas :

F = total porosity %

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4 . Plant height:

The average height of five plants from each experimental unit was measured in (cm) from the soil surface to the highest peak of the plant at the end of the season. (Al-Sahoki *et at*.,1996)

5 . total yield (productivity):

The amount of grain yield of the sunflower crop was calculated after separating the grains, which were collected in dry weight and cleaned of impurities, then weighed and then converted to (ton ha $^{-1}$).

IV - RESULTS AND DISCUSSION

Table (2) Analysis of variance table represented by the effect of individual study factors and their interactions on some physical soil properties and some characteristics of growth and yield of sunflower

SOV	DF	total porosity (%)	Bulk density(mg m^{-3})	Plant height(CM)	productivity (to/ ha)
r stratum	2	0.64	0.64	9.75	5.08
T	1	54.98*	63.99*	336.97*	42.69*
Residual	2	1.٦٢	1.63	0.45	1.35
D	2	203.01**	194.49**	269.62**	619.26**
T +D	2	0.54 ^{ns}	0.20 ^{ns}	2.75*	49.96**
Residual	8	0.68	0.68	0.56	0.45
W	2	23.00**	23.12**	117.67**	127.89**
T +W	2	1.98*	1.96*	1.76*	6.23*
	4	0.55 ^{ns}	0.55 ^{ns}	1.44*	13.22**
T+D+W	4	0.10^{ns}	0.10^{ns}	1.86*	16.17**
Residual	24				
Total	53				

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1. Bulk density:

Table (3) the results of the statistical data analysis shown in Table (2) indicate that there is a significant effect of the tillage systems on the bulk density. The value of the average bulk density of the soil decreased when using the plow in the soil that was plowed by the chisel plow (the first system), as it amounted to 1.2261 mg m^{-3}, while the bulk density increased when used in the part that was plowed by the moldboard plow (the second system), reaching 1.3159 mg m^{-3}, and the reason may be due to the role of the chisel plow and the nature of its work, which works to dismantle the soil without turning it over, which leads to Increasing the porosity of the soil and preserving its structural aggregation compared with the moldboard plow that works to demolish the soil agglomerations. Al-Mousa(2020) And AL- Khalidi(2023) In turn, they confirmed the low bulk density at the chisel plow and its superiority over the moldboard plow. And between table (3) and the results of the statistical data analysis shown in Table (2) there is a highly significant effect of the depth of the machine in the bulk density averages of the soil, where the inverse relationship between the depths of the machine and bulk density, as it decreased with increasing depth from 1.3783 to 1.2689 and then to 1.1658 mg m^{-3}When the depth increased from 10 to 20 and then to 30 cm, the reason may be attributed to the increased fragmentation of the soil at this depth and thus the bulk density decreased less than it was at the depths of 10 and 20 cm at which the machine produces less fragmentation and thus the soil aggregates maintain their structure Larger images when they are in the depths, and this agreed with Al-Nassar *et at.,(2015)* and Al-Jubouri *et at.,(2015)* indicated that increasing the depth works to increase the loose soil, and thus the bulk density decreases and its porosity increases. And the indication of the statistical data analysis table shown (2) and table (3) indicates that there are highly significant differences between the distance between the boards of furrow opener in the bulk density, where the bulk density decreases as the distance increases, as the maximum distance (60 cm) achieved a low value for the average bulk density of 1.2313, while it recorded The distance (50 cm) had a non-significant mean value of the bulk density from the maximum distance (60) which amounted to 1.2628 mg m^{-3}, while the highest bulk density was recorded with the least distance (10 cm) between the two extruders of the razor weapons, which amounted to 1.3189 mg m^{-3}. Perhaps the reason is due to the increase in the disjointed area as a result of the increase in the width of the marsh, which in turn led to the improvement of soil properties by recording a lower apparent density, and this is with Al-Nassar et at.,(2015) We note from the statistical contrast analysis table shown in Table (2) and Table (3) that there are significant differences in the average bulk density of the effect of the bilateral overlap between the tillage systems in which the plowshares were used and the distance between the boards of furrow opener, where the plow was superior when it was used with plowing by the chisel plow with the maximum A distance between the boards of furrow opener (60 cm), as it recorded 1.1793 mg m^{-3}, while it was recorded with the same system, but for the distances (50 cm) and (40 cm), values amounted to 1.2100 and 1.2889 mg m^{-3}, while it was recorded when used with the second system (The moldboard plow) with the least distance between the boards of furrow opener (40 cm), the maximum value of the bulk density reached 1.3489, and it decreased with the increase of the distance to (50 cm) and (60 cm), as it reached 1.3156 and 1.2832 mg m^{-3}, and the reason was The nature of the work of the two plows by which the soil was plowed, as the

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excavating plow works to overturn and break up the soil and demolish its structure, while the chisel plow works to break up and dismantle the soil without demolishing the soil aggregates and building it, which led when using the plow in this soil and distances between the boards of furrow opener and because The larger the disjointed area and the increase in the width of the paddle, all of these reasons led to a decrease in the bulk density values at the chisel and the maximum distance between the boards of furrow opener. The results of the variance analysis in Table (2) and Table (3) show that there are no significant differences for each of the bilateral overlap between tillage systems and machine depth, and the bilateral overlap between machine depth and the distance between the boards of furrow opener, and the triple overlap between tillage systems and machine depth and the distance between the two plates in bulk density for the soil.

Table (3) the effect of individual study factors and their interactions on bulk density

Tillage systems (T)	Depth (D) cm	The distance between furrow opener boards W (cm)			Between(T& D)
		W1	W2	W3	
T1	D1	1.3900	1.3100	1.296	1.3322
	D2	1.3067	1.2033	1.173	1.2278
	D3	1.1700	1.1167	1.0680	1.1182
T2	D1	1.4567	1.4200	1.3963	1.4243
	D2	1.3533	1.3100	1.2667	1.3100
	D3	1.2367	1.2167	1.1867	
LSD $_{0.05}$				NS	NS
					Medium D (cm)
Overlap between (D&W)	D1	1.4233	1.3650	1.3465	1.3783
	D2	1.3300	1.2567	1.2200	1.2689
	D3	1.2033	1.1667	1.1273	1.1658

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LSD $_{0.05}$		NS			0.02485
					Medium (T)
Overlap between (T&W)	T1	1.289	1.210	1.173	1.2261
	T2	1.348	1.315	1.283	1.3159
LSD 0.05		0.04082			0.04831
(cm) Medium W		1.3189	1.2628	1.2313	
LSD $_{0.05}$		0.02694			

2. The total porosity of the soil:

The results of the analysis of variance shown in Table (2) and Table (4) indicate the significant effect of the tillage systems on the total porosity of the soil with the superiority of the plow when used with the first system (chisel plow) by recording the highest total soil porosity of 53.31%, superior to that when used with the second system (mold plow), which recorded a rate of 50.16%, i.e. the amount of superiority was 3.15%. Perhaps the reason for this superiority is due to the decrease in bulk density when using the chisel with the improvement of soil construction, which was reflected positively towards the increase of the total porosity, which is inversely proportional to the bulk density. Similar to Al-Mousa(2020) and (AL- Khalidi.,2023). The results of the statistical analysis shown in Table (2) and Table (4) showed a highly significant effect of the depth of the machine on the total porosity of the soil, as the inverse relationship between them, whereby with increasing depth, the total soil porosity increased from 47.60 to 51.76, and then to 55.84% when the depth increased from 10 to 10. 20 and then to 30 cm, i.e. the percentage of increase was 4.16 and 1.08%, and the reason may be attributed to the decrease in the bulk density of the soil as a result of the increase in loosening of the soil by the sander. We note from the analysis table the statistical variation shown in Table (2) and Table (4) the effect is highly significant For the distance between the boards of furrow opener, the percentages of 52.05 and 49.91% were recorded for the distance between the boards of furrow opener, as the total porosity recorded its highest percentage at the distance (60 cm), amounting to 53.24%, while the records for the two distances (50 and 40 cm) amounted to 52.05 and 49.91%. Increasing the width of the marsh compared to the small cross-sectional area (40 cm), which led to a decrease in bulk density at this limit, which resulted in an increase in the total porosity of the soil with an increase in the distance between the two plates of the opener of the furrow, and these results were similar to Al-Nassar et at.,(2015) . It appears from the statistical analysis table shown in Table (2) and Table (4) that the bilateral overlap between the use of the separator in two leaving systems and the distance between the boards of furrow opener has a significant effect on the total porosity of the soil , where it recorded the highest porosity amounted to

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55.09%, and it reached with the same system and the two distances (50 and 40 cm) 53.92 and 50.92%, while it recorded when used after the moldboard plow lower values than it is in the first system, as it increased from 48.91 to 50.17 and then to 51.39 % when increasing the distance from 40 to 50 and then to 60 cm, and the reason may be that the chisel works to dismantle a larger and softer soil area, which decreases the bulk density and also increases the width of the meadow as a result of increasing the distance between the boards of furrow opener, which helped in increasing it. The results of variance analysis in Table (2) and Table (4) show that there are no significant differences for each of the bilateral overlap between plowing systems and machine depth, and the bilateral overlap between machine depth and the distance between the boards of furrow opener, and the triple overlap between tillage systems and machine depth and the distance between the two plates in bulk density for soil

Table (4) the effect of individual study factors and their interactions on the total porosity of the soil

Tillage systems (T)	Depth (D) cm	The distance between furrow opener boards W (cm)			Between(T& D)
		W1	W2	W3	
T1	D1	46.95	50.00	50.51	49.15
	D2	50.13	54.07	55.22	53.14
	D3	55.68	57.70	59.55	57.64
T2	D1	44.82	46.21	47.11	46.05
	D2	48.74	50.38	52.02	50.38
	D3	53.16	53.91	55.05	54.04
LSD $_{0.05}$				NS	NS
					Medium D (cm)
Overlap between (D&W)	D1	45.88	48.11	48.81	47.60
	D2	49.43	52.23	53.62	51.76

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	D3	54.42	55.81	57.30	55.84
LSD $_{0.05}$		NS			0.943
					Medium (T)
Overlap between (T&W)	T1	50.92	53.92	55.09	53.31
	T2	48.91	50.17	51.39	50.16
LSD 0.05		1.551			1.831
(cm) Medium W		49.91	52.05	٥٣,٢٤	
LSD $_{0.05}$		١,٠٢٧			

3- Plant height:

The results of the statistical analysis shown in Table (2) and Table (5) showed that there was a significant effect of the use of marijuana in more than one plowing system in terms of plant height, as we note its superiority when used after the second system (moldboard plow T2) by recording the highest height of the sunflower plant, which reached 110.88 cm, while a significant difference was recorded with the first system (moldboard plow T2), as it recorded the lowest height of 103.20 cm. Perhaps the reason is due to the use of the moldboard plow in plowing the land that was cultivated with another crop in the season that preceded the plowing season. When the soil was turned over, it improved the Nutrients of the soil absorbed by the roots, which helped to improve the growth of the plant and thus increase the height of the plant and do not agree with Al-Jubouri et at.,(2012) and AL-khaldi (2023)who found the superiority of chisel plow by registering the highest height of the wheat crop. It is noted from the statistical data analysis table shown its results In Table (2) and Table (5) there is a highly significant effect of the depth of the god on the height of the sunflower plant, as the height increased from 98.38 to 106.73 and then to 116.01 cm when the depth of the god increased from 10 to 20 and then to 30 cm, i.e. a maximum superiority Depth by recording the highest height of the sunflower plant, where the increase amounted to 8.35 and 10 cm, with a rate of 8.5 and 9.6%. Perhaps the reason for this superiority is due to the improvement of the physical characteristics of the soil, its high porosity and its low apparent density, which helped to assist in the absorption of nutrients by the roots that helped to grow This is in agreement with Muhsin *et at.,(2021)* and Al-Nassar *et at.,(2015)* . The results of the statistical analysis shown in Table (2) and Table (5) showed the highly significant effect of the distance between the boards of furrow opener in the characteristic of the height of the sunflower plant, as the largest distance between the boards of furrow opener was (60 cm) by recording the highest plant height of 114.98 cm, while The two distances (50 and 40 cm) recorded a

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significant decrease, when the plant height reached 106.73 and 99.41 cm, i.e. the amount of superiority was 8.25 and 7.35 cm, with a rate of 8.3 and 7.4%. Irrigation, which helped to wash the salts from the cedar and keep it away from the root zone of the plant whose roots spread and absorbed nutrients and retained more moisture, and this led to improved plant growth and thus an increase in its height with an increase in the size of the cedar, and this is what agreed with (Al-Khalidi ,.2023). The results of the statistical analysis shown in Table (2) and Table (5) indicate that there is a significant difference in ~~for~~ the effect of the bilateral overlap between the use of the plow with different plowing systems and the depth of the plow in the characteristic of the height of the sunflower crop, as the second interference between the second system ((moldboard plow) and the maximum depth (30 cm), recording the highest height of the sunflower plant at 120.39 cm, while the lowest height was recorded at the bilateral overlap between the first plowing system (chisel plow) and the lowest depth of the god (10 cm) at 95.57 cm. Perhaps the reason is due to the improvement of soil properties as a result of increasing Depth and as a result of the presence of the remains of previous plants through their overturning by the moldboard plow, which made it a soil improver. The results of the statistical analysis shown in Table (2) and Table (5) showed a significant effect of the bilateral overlap between the use of the plow in different plowing systems and the distance between the boards of furrow opener Among its weapons is the characteristic of the height of the sunflower plant, as the bilateral overlap between the use of the furrows opener after the second system ((moldboard plow) and the largest distance between the boards of furrow opener (60 cm) was superior by recording the highest plant height of 119.72 cm, while the lowest height was recorded when the bilateral overlap between the first system and The least inter-distance is (40 cm), as an average height of 96.57 cm was recorded. Perhaps the reason is due to the improvement of the physical characteristics of the soil as a result of the increase in the loosened area of the soil as a result of the increase in the cross-section of the meadow. The results appear in the analysis of variance table in Table (5). There is a significant effect of the interference between The depth of plowing and the distance between the boards of furrow opener in the characteristic of plant height, as we notice an increase in the average plant height from 91.97 cm when the overlap between the lowest depth (10 cm) and the lowest spacing between the boards (40 cm) to 125.17 cm when the bilateral overlap is increased to the maximum The depth is (30 cm) and the largest interstitial distance is (60 cm), and the reason may be due to the increase in the disjointed area when the depth is increased and the interstitial distance is increased, which leads to the improvement of its physical characteristics. We note from the variance analysis table in Table (2) that there is a significant effect of the triple overlap between the tillage systems, the depth of plowing and the distance between the boards of furrow opener in the plant height characteristic, and through the results shown in Table (5), we notice an increase in the average plant height when the triple overlap between the use of The furrows opener after the second system (moldboard plow) and the maximum depth of the plow (30 cm) with the largest distance (60 cm) by recording a height of 131.33 cm, while the triple overlap was recorded between the use of the mulching after the first system (chisel plow) with the lowest minimum plowing depth (10 cm) and the smallest spacing (40 cm) in which the lowest average height of the sunflower plant was recorded was 88.00 cm.

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Table (5) the effect of individual study factors and their interactions on plant height

Tillage systems (T)	Depth (D) cm	The distance between furrow opener boards W (cm)			Between(T& D)
		W1	W2	W3	
T1	D1	88.00	95.17	103.53	95.57
	D2	96.70	102.33	108.17	102.40
	D3	105.00	110.90	119.00	111.63
T2	D1	95.93	98.63	109.00	101.19
	D2	100.83	113.50	118.83	111.06
	D3	110.00	119.83	131.33	120.39
LSD $_{0.05}$				٤,٥٨٥	٢,١٦٦
					Medium D (cm)
Overlap between (D&W)	D1	91.97	96.90	106.27	98.38
	D2	98.77	107.92	113.50	106.73
	D3	107.50	115.37	125.17	116.01
LSD $_{0.05}$			3.310		1.752
					Medium (T)
Overlap between (T&W)	T1	96.57	102.80	110.23	103.20
	T2	102.26	110.66	119.72	110.88
LSD 0.05			٢,٥٦١		1.80
(cm) Medium W		٩٩,٤١	١٠٦,٧٣	١١٤,٩٨	

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LSD $_{0.05}$	٢,٠٩٦	

4- The total yield of seeds (productivity):

Table (6) indicated that there were significant differences in the effect of using the furrows opener with different plowing systems on the total productivity (total seed yield), as the machine was superior when used in the second system of tillage (moldboard plow) by recording the highest total seed yield of 1.716 t ha^{-1}. While it was recorded when used in the first system (chisle plow) a value of non-significant difference with the second system amounted to 1.601 t ha^{-1}, and perhaps the reason is due to the improvement of plant height as a result of the availability of nutrients necessary for the growth of the sunflower plant. Table (6) and table (2) show that there are significant differences due to the effect of the depth of the cutting on the total yield of seeds, as we notice an increase in productivity (total yield of seeds) from 1.334 to 1.656 and then to 1.986 t ha^{-1} when the depth of cutting increased from 10 to 20. And then to 30 cm, i.e. the amount of increase was 32.82%, and the reason may be due to the decrease in the bulk density of the soil, its increase in its porosity, and its decrease in its resistance, which led to the spread of plant roots, which helped the girls' ability to absorb sufficient nutrients, and this was agreed with Muhsin *et at., (2021)* and (Al-Khalidi ,.2023). Table (5) showed that there was a highly significant effect on the characteristic of the total seed yield, as we note that the maximum distance between the boards of furrow opener (60 cm) was superior to a productivity rate of 1.894 T H^{-1}, outperforming the two distances (50 and 40 cm), which were They recorded an average of 1.629 and 1.453 T H^{-1}. Perhaps the reason is due to the increase in the cross-section of the myrtle, which helped the roots retain moisture for a longer period with an increase in the loosened area of the soil and thus increased plant growth, which was positively reflected in productivity (the total yield of seeds), and this is what agreed with (Al-Khalidi ,.2023). Table (6) shows the highly significant effect of the bilateral overlap between the use of the plow in different plowing systems and the depth of the plow in the total yield of seeds, as we note the superiority of the overlap between the second system (the moldboard plow) and the maximum depth of the plow (30 cm), which was recorded at 2.144 T H^{-1}. It is superior to the interaction between the first system (chisle plow) and the maximum depth, where the productivity rate reached 1.828 ta ha^{-1}, with an increase of 14.73%. With depth, which helped to increase the productivity (total yield of seeds) of the sunflower plant. We note from Table (6) the significant effect of the bilateral overlap between the use of the furrows opener in different plowing systems and the inter-distance between the boards of furrow opener on the total seed yield, as the overlap between the second system (moldboard plow) and the largest spacing between the boards (60 cm) was higher. The average total seed yield reached 2.004 ta ha^{-1}, surpassing the two distances (50 and 40 cm) that were recorded (1.641 and 1.503 ta ha^{-1}), while the overlap between the first system (chisel plow) recorded the largest distance (60 cm). The total seed yield amounted to 1.784 ta ha^{-1}, meaning that the rate of increase was 10%, and the reason may be due to the fact that turning the soil by the chisel ~~digger~~ plow provided nutrients and the large cross-section of the meadows led to their abundance and the lack of competition between the plants for these elements, which benefits the Plant growth and thus increase productivity. Table (6) showed a highly significant effect of the

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binary overlap between the depth of the machine and the distance between the boards of furrow opener on the total seed yield (productivity), as the productivity increased from 1.135 ta ha^{-1} 2.380 ta ha^{-1} when increasing the bilateral overlap between The spacing and depth of the machine ranged from (40 cm) and (10 cm) to (60 cm) and (30 cm). The reason may be due to the improvement of plant growth as a result of the increase in the good qualities of the soil and its improvement through the decrease in its apparent density, the increase in its porosity, the decrease in soil salinity, and the decrease in soil resistance to penetration, which increased the process of washing the soil and the descent of salts to the lower depths, and the competition between plants for nutrients decreased as a result of the increase in the cross-section. This led to an increase in the productivity of the sunflower plant at a depth of 30 cm and spacing between the boards of 60 cm. The results of the statistical analysis shown in Table (2) and Table (6) showed that there were highly significant differences due to the effect of the triple overlap between the study factors (tillage systems, machine depth, and spacing between the boards) on the total seed yield (productivity), as we note from Table (6) the superiority of translocation at The triple overlap between the second system of plowing (the plow with the maximum depth of the plow (30 cm) and the largest spacing between the boards (60 cm) as it gave an average total seed yield of 2.743 ta ha^{-1}, while the lowest rate of productivity was recorded when the triple overlap between the first system (the plow The chisel) has the smallest depth (10 cm) and the smallest spacing (40 cm) with a capacity of 1.033 ta ha^{-1}

Table (6) the effect of individual study factors and their interactions on the total yield of seeds

Tillage systems (T)	Depth (D) cm	The distance between furrow opener boards W (cm)			Between(T& D)
		W1	W2	W3	
T1	D1	1.033	1.42	1.61	1.35
	D2	1.483	1.647	1.723	1.61
	D3	1.690	1.777	2.017	1.82
T2	D1	1.237	1.283	1.411	1.31
	D2	1.497	1.727	1.857	1.69
	D3	1.777	1.913	2.743	2.14
LSD $_{0.05}$				0.12	0.06
					Medium D (cm)

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Overlap between (D&W)	D1	1.31	1.35	1.51	
	D2	1.49	1.68	1.79	1.65
	D3	1.73	1.84	2.38	1.98
LSD $_{0.05}$		0.08			0.04
					Medium (T)
Overlap between (T&W)	T1	1.40	1.61	1.78	1.60
	T2	1.50	1.64	2	1.71
LSD 0.05		0.08			0.07
(cm) Medium W		1.45	1.62	1.89	
LSD $_{0.05}$		0.05			

IIV- CONCLUSIONS

From the experiments conducted, we conclude the following:

1- The developed furrows opener recorded superiority when used after the chisel (the first tillage system) in improving the physical properties of the soil by increasing its porosity and decreasing (the bulk density of the soil) compared to when it was used after the moldboard plow (the second tillage system), which is due to the economic benefit and the reduction of expenditures resulting from fuel energy and improve arable soil.

2- When used after the moldboard plow, the developed furrows opener was superior in all characteristics of growth and yield of sunflower (plant height, total seed yield) in comparison with the chisel plow.

3- The use of the developed furrow opener when increasing the depth from (10 to 30 cm) led to an increase in the improvement of the physical characteristics of the soil and the improvement of the characteristics of the growth and yield of sunflower (plant height, total seed yield (productivity). .

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4- When the distance between the two plates of each of the upgraded opener furrows weapons was increased from (40 to 60 cm), it led to an increase in the total soil porosity, plant height, total seed yield (productivity), and a decrease in (soil bulk density).

5- The best growth and yield characteristics of the sunflower plant (plant height, , total seed yield) were recorded when the three-way overlap between the use of the furrows opener developed after the moldboard plow and the maximum depth of the agricultural equipment (30 cm) and the largest distance between the two plates of the furrow opener (60 cm) superior to triple overlap between their use after the chisel plow with the least depth (10 cm) and the smallest spacing between the boards (40 cm), which is beneficial in terms of productivity.

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