Studying the effect of a new tillage system on some yield attributes of sunflower crop (*Helianthus annuus*. L)

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Abstract---The study was conducted during the Autumn season 2021 in one of the fields of the College of Agriculture - University of Basra, Karmat Ali site, in a silty clay soil by using a multi-purpose tillage machine. by split-blocks system according to a completely randomized design of a factorial experiment It included three factors: Three plowing depths (30, 40 and 50 cm), two rotary speeds of the rotary plow blades(250 and 300 rpm^{-1}) give two levels of soil pulverizing, and three distances between the two opener furrows (35, 40 and 45 cm) give three different widths of furrows, And its effect on some yield attributes of sunflower, which included: weight of 1000 seeds, seed yield, percentage and oil yield. The results showed a significant increase in Weight of 1000 seeds, total seeds yield and oil yield, with an increase in the plowing depth from 30 to 50 cm, a low rotational speed of 250 rpm, and an increase in the distance between the boards of opener furrows from 35 to 45 cm.

Keywords---Plowing depth, weight of 1000 seeds, seeds yield, Oil percentage, oil yield.

Introduction

Sunflower (*Helianthus annuus* .L) is one of the oil crops that widely cultivated in Iraq for the purpose of extracting oil for use in food and soap production. Its seeds contain a high percentage of oil up to 50%, and it also contains important vitamins (A, D and E). It is also of great importance in feeding livestock and poultry because it contains a high percentage of protein up to 35% and a high percentage of fatty acids ranging from between 85 - 91 % [9 & 10]. The productivity of this crop is still below the level of ambition, which requires studying the factors related to soil and crop service in order to increase its productivity[3]. Several studies have indicated that deep plowing affects the increase in the depth of the roots, improving their ability to absorb water and nutrients, and increasing plant productivity[3]. Also, the rotational speed of the rotary plow It is one of the factors affecting the degree of soil pulverizing, its bulk density and porosity. Increasing the speed increases the softness of the soil and its bulk density and decreases its total porosity. This negatively affects on the growth of the plant, which leads to a decrease in yield. Irrigation water consumption in ridge and furrow planting depends mainly on the wide of furrow and the furrow profile as well[7]. The design parameters of the furrow opener such as the share rake angle and wing shape and angle strongly affect the shape of the ridge profile. showed [2] In his study evaluation the field performance of manur subsoil laying machine and its impact on some growth parameters of sunflower crop, an increase in plant yield from 720.30 kg ha^{-1} to 2234.75 kg ha^{-1} by increasing the depth of the machine from 20 to 50 cm. As was mentioned[5] that the increase in the depth of the meadows led to an increase in the width of the meadows using the movable of boards openers furrows from 6, 9.5, 10.5 and 12 to 13.5 cm, the width of furrows increased from 20.9, 24.3, 25.7, 27.3 to 28.8 cm, which led to a significant increase in the yield of maize plant from 7175, 6847, 7096, 7205 and 7360 kg ha^{-1} respectively. The study aims to know the effect of the depth of plowing, the degree of soil fragmentation and the width of the cross-section of the furrow by using the modern tillage machine on some characteristics of yield of sunflower crop.

Materials and Methods

The experiment was carried out in one of the fields of the College of Agriculture - University of Basra - Karma Ali site in the northwest of Basra Governorate during the Autumn season 2021 in a silty clay soil (Table 1), by the method of factorial within split block according to a completely randomized design(RCBD) with three repetitions[6].The plowing depths (30, 40 and 50 cm) occupy the longitudinal strips within each block, while the two different speeds of the rotary plow (250 and 300 rpm^{-1}) and the widths of boards of the opener furrows (35, 40 and 45) cm are distributed randomly within each block, where each blick contains 18 treatments with two furrows per transaction, so the number of trial units is 108 units. To study the effect of a new tillage machine (Fig. 1) on some characteristics of the sunflower crop which included (Weight of 1000 seeds, seeds yield, percentage and oil yield). The results were collected and analyzed according to the design used, and the means of the transactions were tested using the least significant difference (LSD) method at the 0.05 level. The experiment factors are

coded as follows: Tillage depths, codes D_{30}, D_{40}, D_{50}, plow speeds S_{250}, S_{300}, and furrows widths, codes W_{35}, W_{40}, W_{45}.

Table 1
Physical characteristics of the soil

Plowing depth (cm)	Moisture content (%)	Bulk density (Mg m-3)	Porosity (%)	Ec (Decimens m^{-1})	Soil resistance penetration (kN m-2)
0-20	.49118	1.35	49.057	.62914	2824.850
20-40	23. 515	1.38	47.925	.50311	2593.020
40-60	29.732	1.31	50.792	.28013	2863.710
Average	23.912	1.38	49.258	12.137	2760.052
Soil texture: Silty clay	Clay (g kg-1)	Silt (g kg-1)	Sand (g kg-1)	Irrigation water salinity Decimens m^{-1})(	2.731
	310.724	486.057	203.219		

Fig (1). New tillage machine

Fig (2). Experiment field (flowering stage)

Agricultural Operations

The field of the experiment was prepared for the cultivation of the sunflower crop on the furrows, where the soil leveling was carried out by f the plank leveling machine, after that the experiment was carried out according to the design of the experiment by using the new plowing machine. furrows opened with a length of 27 m and was divided into 108 experimental units, each unit with a length of 3 m. irrigated the field, slander irrigation, and then planted the sunflower crop (Aqmar variety) on one side of the furrow in the Autumn season on 7/8/2021 after a test for the germination rate, which was 96%, The distance between one furrow and the other is 75 cm, and the distance between another hole is 20 cm, with 3 seeds per hole, and a depth of 3 cm. The field was irrigated at a rate of 12 watering throughout the growing season, according to the requirements of the plant and weather conditions. Nitrogen fertilizer was added at an amount of 200 kg ha^{-1} in the form of urea (46% N) and in two batches, the first after emergence and the second when the flower buds appeared And super phosphate at a rate of 100 kg ha^{-1} at once before planting. The thinning process was carried out 15 days after planting, and the grafting process was carried out two weeks after planting. The grasses and weeds were removed manually after the plants reached a height of 70 cm to reduce competition for the necessary growth factors. Irrigation was stopped when signs of maturity appeared for a period of 15 days, and the plants were harvested on 11/15/2021. Ten plants were randomly taken from each experimental unit to measure the mean of yield characteristics of the plant.

Measuring some characteristics of the sunflower yield

Ten plants were taken from each treatment at random and the following traits were measured:

Weight of 1000 seeds: The seeds were collected from the ten plant heads taken from each experimental unit and the weight of 1000 seeds was calculated from them to find an average weight of 1000 seeds (gm).

Seed yield (ton h^{-1}): The total yield of the ten plants that were taken randomly from each experimental unit was extracted after adjusting its moisture to (11%), then it was calculated on the basis of seed yield per hectare.

Oil percentage: A random sample was taken from each treatment to estimate the oil content in the seeds using Soxhlet device and based on the dry weight of the seeds according to the method mentioned in [1].

Oil yield (ton.h^{-1}): It was calculated from the following equation:

$$\text{Oil yield (ton.ha}^{-1}\text{)} = \text{percentage of oil(\%)} \times \text{seed yield(ton.ha}^{-1}\text{)}$$

Results and Discussion

Effect of tillage depths on some yield attributes of sunflower crop

Through the results of the statistical analysis shown in the table(2), notice that there are significant differences($P < 0.05$) between the average weight of 1000 seeds, the total seed yield, and oil yield with effectt of the depth of plowing, and comparing the averages of the Transaction averages find that deep plowing of 50 cm recorded the highest average for the aforementioned traits amounted to 57.912 g, 2.302 ton h^{-1}, and 1.041 ton h^{-1} respectively. while medium plowing with a depth of 40 cm and shallow plowing with a depth of 30 cm recorded the lowest rate was reached 53.933 48,784 g, 1.829 1.390 ton h^{-1}, and 0.820, 0. 620 respectively. This is because the increase in the depth of plowing made of dismantle the soil and break up the solid layer that prevent the growth and spread of the roots of the plant, which results in a decrease in the bulk density of the soil as a result of the increase in the volume of disassembled soil, as well as its increased porosity and improved aeration conditions, which led to a good spread of the root system of the plant. In increasing the efficiency of absorption of water and nutrients necessary for growth by its root bristles, and this led to stimulated on fashioning a highly efficient vegetative group in the manufacture of food and its transfer to the seed germination sites and fashioning seeds full of pulp with a good weight compared to the seeds resulting from the treatments of shallow plowing depths. This is what[12] found in his study Effect of organic manure and tillage depths on sunflower production It was found that there is a significant increase in the average weight of 1000 seed and the total seed yield of the sunflower crop when increasing the depth of the organic fertilizer application machine from 10 to 20 and 30 cm for both study sites (Shatt Al Arab and Qurna). While there was no significant difference in the percentage of oil due to the change in the depth of the plowing**.**

Table (2)
Effect of tillage depths on some yield attributes of sunflower crop

Tillage depths (cm)	Weight of 1000 (gm)	Seed yield (ton ha^{-1})	Oil percentage (%)	Oil yield (ton.ha^{-1})
D_{30}	48.784	1.390	44.67	0.620
D_{40}	53.933	1.829	44.89	0.820
D_{50}	57.912	2.302	45.22	1.041
LSD	0. 624	0.071	NS	0.040
The means show significant difference at 5% N.S: Means no significant difference				

Effect of the speed of the rotary plow plades on some yield attributes of sunflower crop

The results shown in table(3) It shows significant increase(P < 0.05) in the average weight of 1000 seeds, the total seed yield, and the oil yield by effect of the speed of the rotary plow blades, where the average weight of 1000 seeds, the total seed yield and oil yield increased from 51,354 g, 1.665 ton ha^{-1} and 0.748 ton ha^{-1} to 55,732 g, 2.015 ton ha^{-1}, and 0.907 ton ha^{-1} respectively when the rotary speed of the blades was reduced from 300 to 250 rpm. The reason for this is due to the quality of soil friability, its low bulk density, It increased the efficiency of the salts washing process, and aeration at low speed compared to high rotational speed, which created a good bed for seed germination and their emergence and wide spread of plant roots capable of meeting the plant's need for water and nutrients necessary for growth, which reflected positively. On the vegetative growth represented by a large leaf area and efficient in carrying out the process of photosynthesis, which effectively contributed to the process of transferring food from its sources to its estuaries represented with heads and their seeds filled with pulp, which increased the rate of seed weight, the total yield of seeds, and oil yield. This is what referred to[4]. In their study on effect of In their study of the effect of the number of pulverizing times and the tractor forward speed on the growth and yield of the bean(*Vicia faba.* L), where the weight of 100 seeds and the total yield of the plant increased when pulverizing is once time compared to the increase of the pulverization of soil by using the double disc harrow with two passes and three passes. As for the effect of the rotational speed of the rotary plow blades on the oil percentage, it was not significant.

Table (3)
Effect of the speed of the rotary plow plades on some yield attributes of sunflower crop

Speed of the rotary plow plades (rpm)	Weight of 1000 (gm)	Seed yield (ton ha^{-1})	Oil percentage (%)	Oil yield (ton.ha^{-1})
S_{250}	55.732	2.015	44.96	0.907
S_{300}	51.354	1.665	44.89	0.748
LSD	0.318	0.029	NS	0.018
The means show significant difference at 5% N.S: Means no significant difference				

Effect of the distance between two opener furrows plates on some yield attributes of sunflower crop

When comparing the mean values of the treats of the weight 1000 seed, the total seeds yield, and oil yield, find significant differences(P < 0.05) between these averages due to the effect of changing the distance between the two plates of the two opener furrows, as shown in the table(4), where the average weight of 1000 seed, total seed yield and oil yield increased from 49.972 g, 1.638 tons ha^{-1} and 0.731 tons h^{-1} to 53,580 g, 1.832 tons ha^{-1}, 0.823 tons ha^{-1}, then to 57,077 g, 2.050 tons ha^{-1}, 0.927 tons ha^{-1}, by increasing the distance between the two plates of the two opener furrows from 35 to 40 and then 45 cm respectively. This is due to the increase in the cross-sectional area of the furrows, which is led to provided a greater amount of moisture to the plant than it is in the furrows with areas of medium and small width sections, which encouraged the growth of a dense and widespread root system capable of meet the needs of the plant from water and the necessary nutrients during the different stages of growth. This was reflected positively in increasing the leaf area and the efficiency of the process of transferring manufactured foodstuffs to the heads, which led to an increase in the diameter of the head and its well-filled seeds, which increased their average weight, thus increasing the total seed yield and oil yield. This is what[8] found when studying them effect of furrow cross section on water use efficiency of corn and yield, where they found an increase in the yield of maize with an increase in the width of the furrows section. While the effect of the change in the distance between the two plates of the two opener furrows on the oil percentage was not significant.

Table (4)
Effect of the distance between two opener furrows plates on some yield attributes of sunflower crop

Distance between two opener furrows plates(cm)	Weight of 1000 (gm)	Seed yield (ton ha^{-1})	Oil percentage (%)	Oil yield (ton.ha^{-1})
W_{30}	49.972	1.638	44.61	0.731
W_{40}	53.580	1.832	44.94	0.823
W_{45}	57.077	2.050	45.22	0.927
LSD	0.390	0.036	NS	0.022
The means show significant difference at 5% N.S: Means no significant difference				

Effect of the interaction between the depth of tillage and the rotational speed of the rotary plow blades on some yield attributes of sunflower crop

When comparing the average values of the means of the weight 1000 seed, the total seed yield and the oil yield, find significant differences(P < 0.05) between these means whith effect of the interaction between the depth of plowing and the rotational speed of the new plowing machine, as shown in the table(5), where observed that the deeper plowing50 cm exceeded when The low rotational speed 250 rpm^{-1} achieved the highest average weight of 1000 seeds, seed yield and oil yield of 60,913 g, 2,641 ton ha^{-1} and 1.194 ton ha^{-1} compared with the shallow

and medium depths of 30 and 40 cm at high rotational speed of 300 rpm^{-1}, which achieved The lowest rate for the aforementioned traits was 46.942, 52.210 g, 1.256, 1.776 ton ha^{-1}, and 0.558 0.796 ton h^{-1}, respectively. The reason is due to the improvement of the physical properties of the soil, as deep plowing reduced the bulk density and increased its porosity and water conductivity, in addition to that the rotational speed of the rotary plow blades which worked to break up the soil appropriately particles in a manner appropriate to plant growth, root penetration and expansion in the soil, which contributed to providing the requirements for growth from water and the necessary nutrients, which encouraged the formation of a good vegetative group represented by increasing the leaf area capable of intercepting the largest amount of light, which contributed to improving the efficiency of photosynthesis and transferring dry matter from its manufacturing sites to its estuaries, which was positively reflected on the growth of the plant, for represented with increasing the diameter of the head. The number of seeds in it and the proportion of filled seeds, which increased the average weight of 1000 seeds and the seed yield and oil yield. While the effect of the interaction on the oil percentage was not significant.

Table (5)
Effect of the interaction between the depth of tillage and the rotational speed of the rotary plow blades on some yield attributes of sunflower crop

Tillage depths (cm)	Rotational speed of the rotary plow blades(rpm)							
	Weight of 1000 (gm)		Seed yield (ton ha^{-1})		Oil percentage (%)		Oil yield (ton.ha-1	
	S_{250}	S_{300}	S_{250}	S_{300}	S_{250}	S_{300}	S_{250}	S_{300}
D_{30}	50.626	46.942	1. 524	1.256	44.78	44.56	0.682	0.558
D_{40}	55.656	52.210	1.881	1.776	44.89	44.89	0.844	0.796
D_{50}	60.913	54.910	2.641	1.963	45.22	45.22	1.194	0.888
LSD	0.552		0.050		NS		0.031	
The means show significant difference at 5% N.S: Means no significant difference								

Effect of the interaction between the depth of tillage and the distance between two opener furrows plates on some yield attributes of sunflower crop

The results shown in the table(6) showed a significant increase($P < 0.05$) in the average weight of 1000 seeds, the total seed yield and the oil yield with the change in the depth of plowing at all parameters of the distance between the two plates of the plates of the two opener furrows. However, the largest plowing depth of 50 cm and the large interlayer distance of the opener furrows 45 cm recorded the highest rate for the mentioned traits amounting to 61.797 g, 2,640 ton ha^{-1} and 1,201 ton ha^{-1}, respectively, while the shallow depth of 30 cm and the small distance between the two plates of the furrows. 35 cm, were recorded the lowest average for the mentioned traits was 45,766 g, 1,260 ton ha^{-1} and 0.558 ton ha^{-1},

respectively. The reason for this is due to the improvement of the physical properties of the soil such as a decrease in its bulk density and an increase in the efficiency of the salt washing and aeration process as a result of the increase in the depth of plowing compared to the surface plowing., which encouraged the growth of a dense and widespread root system capable of fill the plant's water and nutrient needs during the different growth stages.This was positively reflected in the increase in leaf area and the efficiency of the process of transferring the treated nutrients to the heads which resulted in an increase in the diameter of the head and its well filled seeds resulting in an increase in its average weight and thus an increase in the weight total seed yield and oil yield. While there was no significant difference between the averages of the oil percentage due to the effect of changing the depth of plowing and the distance between the two boards of the two opener furrows.

Table (6)
Effect of the interaction between the depth of tillage and the distance between two opener furrows plates on some yield attributes of sunflower crop

Depth of tillage (cm)	The distance between two opener furrows plates(cm)											
	Weight of 1000 (gm)			Seed yield (ton ha^{-1})			Oil percentage (%)			Oil yield (ton.ha^{-1})		
	W_{30}	W_{40}	W_{45}	W_{30}	W_{40}	W_{45}	W_{30}	W_{40}	W_{45}	W_{30}	W_{40}	W_{45}
D_{30}	45.766	48.714	51.872	1.260	1.392	1.518	44.33	44.50	45.17	0.558	0.618	0.685
D_{40}	50.363	53.874	57.561	1.689	1.804	1.992	44.67	45.00	45.00	0.754	0.811	0.896
D_{50}	53.786	58.153	61.797	1.965	2.300	2.640	44.83	45.33	45.50	0.881	1.042	1.201
LSD	0.676			0.062			NS			0.039		
The means show significant difference at 5% N.S: Means no significant difference												

Effect of interaction between rotational speed of the rotary plow blades and the distance between the two opener furrows plates on some yield attributes of sunflower crop

The results in the table(7) show that there is no significant($P < 0.05$) difference between the average weight of 1000 seed, the total seed yield, the oil percentage and oil yield due to the effect of the interaction between the rotational speed of the rotary plow blades and the distance between the two plates of the two opener furrows.

Table (7)
Effect of interaction between rotational speed of the rotary plow blades and the distance between the two opener furrows plates on some yield attributes of sunflower crop

Distance between the two opener furrows plates(cm)	Rotational speed of the rotary plow blades(rpm)							
	Weight of 1000 (gm)		Seed yield (ton ha^{-1})		Oil percentage (%)		Oil yield (ton.ha-1	
	S_{250}	S_{300}	S_{250}	S_{300}	S_{250}	S_{300}	S_{250}	S_{300}
W_{30}	52.213	47.730	1.8100	1.4671	44.78	44.44	0.810	0.652
W_{40}	55.610	51.550	1.991	1.673	44.89	45.00	0.894	0.753
W_{50}	59.372	54.782	2.245	1.854	45.22	45.22	1.017	0.838
LSD	NS		NS		NS		NS	
The means show significant difference at 5% N.S: Means no significant difference								

Effect of the interaction between depth of tillage, the rotational speed of the rotary plow blades, and the distance between two opener furrows plates on some yield attributes of sunflower crop

The results in the table(8) showed that there were significant differences($P < 0.05$) between the average weight of 1000 seeds and the total seed yield by the effect of the interaction between the depth of plowing using the modern plowing system and the rotational speed of the rotary plow blades and the distance between the two opening plates, where the average weight of 1000 seed and the total yield of seeds increased with the increase in the depth Plowing from 30 to 40 and then to 50 cm at both rotational speeds 250 and 300 rpm and for all distances between the two openers of furrows 35, 40 and 45 cm, However, the highest rate of the two mentioned characteristics was recorded at a depth of 50 cm, a slow rotational speed of 250 rpm, and a large interfacial distance of 45 cm for the two plates of opener furrows, which amounted to 65.119 g and 3.026 ton ha^{-1}, respectively, while the two depths were 30 and 40 cm at a high rotational speed of 300 rpm, and at the distance between plates of opener furrows 35 and 40 cm, the lowest average for the two previously mentioned characteristics was reached 43.707, 47.289, 48.791, 51.797 g, 1.1667, 1.238, 1.615, and 1.766 ton h^{-1} respectively. The reason for this is that the increase in the depth of plowing and the decrease in the rotational speed have led to an improvement in the properties of the soil, as its bulk density decreased and its porosity, aeration and water permeation through it increased, which improved the process of water movement and gas exchange and increased the efficiency of salt washing far away from zone of the roots spread, in addition to a good bulverisation of the soil, In addition, the increase in the distance between the two panels of the two opener furrows increased the cross-sectional area of the furrows, which provided a greater amount of irrigation water than what is in the small and medium furrows. This contributed to increasing the penetration of the roots and their spread in the soil and increasing their ability to absorb water and nutrients necessary for the growth of the crop and achieving a high seed yield. As for the percentage and oil yield, they were not significantly affected by the change in the plowing depth, rotational speed and the distance between the two plates of the two opener furrows.

Table (8)
Effect of the interaction between depth of tillage, the rotational speed of the rotary plow blades, and the distance between two opener furrows plates on some yield attributes of sunflower crop

Depth of tillage& The rotational speed& The distance between two opener furrows plates						
Weight of 1000 (gm)						
D & S & W	S_{250}			S_{300}		
D	W_{30}	W_{40}	W_{50}	W_{30}	W_{40}	W_{50}
D_{30}	47.825	50.138	53.915	43.707	47.289	49.829
D_{40}	51.935	55.951	59.081	48.791	51.797	56.041
D_{50}	56.878	60.741	65.119	50.693	55.564	58.474
LSD	0.956					
Seed yield (ton ha^{-1})						
D & S & W	S_{250}			S_{300}		
	W_{30}	W_{40}	W_{50}	W_{30}	W_{40}	W_{50}
D_{30}	1.353	1.547	1.672	1.166	1.238	1.364
D_{40}	1.764	1.8430	2.038	1. 615	1.766	1.946
D_{50}	2.311	2.585	3.026	1.619	2.016	2.253
LSD	0.088					
Oil percentage (%)						
D & S & W	S_{250}			S_{300}		
	W_{30}	W_{40}	W_{50}	W_{30}	W_{40}	W_{50}
D_{30}	44.67	44.67	45.00	44.00	44.33	45.33
D_{40}	44.67	45.00	45.00	44.67	45.00	45.00
D_{50}	45.00	45.00	45.67	44.67	45.67	45.33
LSD	NS					
Oil yield (ton.ha^{-1})						
D & S & W	S_{250}			S_{300}		
	W_{30}	W_{40}	W_{50}	W_{30}	W_{40}	W_{50}
D_{30}	0.604	0.690	0.752	0.512	0.545	0.618
D_{40}	0.788	0.829	0.917	0.720	0.794	0.875
D_{50}	1.039	1.162	1.382	0.722	0.921	1.020
LSD	NS					
The means show significant difference at 5% N.S: Means no significant difference						

Conclusions

From the results of the study, conclude that increasing the plowing depth to 50 cm with the modern plowing system, the slow rotational speed of 250 rpm for the rotary plow blades, and the large distance between two plates of the two opener of furrows 45cm has a positive effect on increasing growth and productivity of the sunflower crop, while the effect of surface tillage, high rotational speed and the small cross-sectional area of the furrows negatively affects on the growth and productivity of the plant.

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