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Effect of Tillage Depth and Manure on Growth, Oil and Protein Content in Seeds of Sunflower (*Helianthus annuus* L)

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Abstract: The field experiments were carried out at the Agricultural Research Station of the College of Agriculture, University of Basrah, with the objective to determine the effect of plowing depth and adding Manure at the silty loam soil, on growth, yield, and oil and protein content of sunflower. The experiment was laid out in full Randomized Complete Block Design, of a factorial experiment, three tillage depths (40, 50, and 60cm) and two levels of the manure (0 Mg ha^{-1}, 40 Mg ha^{-1}). The depth of tillage and adding the manure significantly increased the vegetative growth, yield, oil and protein content. The depth 60cm superior in registering the highest values of the studied characteristics compared to the treatment of non-adding the manure on the height of the plant, stem diameter, leaf area, seeds yield per unit area, the weight of 100 seeds and the oil content increased by 18.37, 51.36, 6.95, 38.98, 21.44, 11.32% respectively, while the content of the protein was decreased with increased depth of tillage from 40 to 50 and 60 cm in both the treatments with superiority of the manure treatment. The depth 60cm increased the protein content by 26.26% by adding manure treatment compared with no addition of manure.

Keywords: Depth tillage, Manure, Sunflower

The agro ecosystem in arid or semi-arid regions depends to a large extent on the availability of organic matter in the soil for the good production of various crops. The degradation of agricultural lands the decline in their productivity, especially in irrigated lands, reaches a percentage close to half of the cultivated area as a result of mismanagement such as repeated plowing operations in the same way and not exploiting the wastes from the previous crops, or not having crops which works to improve the soil (Kushwaha et al 2001). Watson et al (2002) indicated that the desired goal from growing crops concentrates mostly on the increase of yield. At the same time, the economic aspect must be taken into account and production inputs should be reduced conservation of the natural resources and the importance of environmental awareness gain. Preserving the environment acquire plowing practices are required to increase agronomic stability and productivity while enhancing the environment and for this sustainable and conservation tillage are becoming increasingly attractive because clearly reduces production cost relative to traditional plowing (De Vita et al 2007). Traditional tillage practices and sweeping of crop remnant can lead to a dwindling in soil organic matter content due to swift decomposition and depletion of topsoil rich in organic matter, which adversely affects soil properties. The use of conservative plowing practices has increment due to this practice's potential in reducing soil erosion, conserve soil humidity, and ameliorating soil structure. In semi-arid conditions, conservative plowing may reduce the evaporation of water from the soil and increase crop biomass, thus the accumulation of organic matter in the soil.Organic matter has a vital role in preserving the soil in a good way and increasing its productivity. However, agricultural production consumes most of the organic matter from the soil and thus the soil deteriorates over time, unlike lands covered with natural vegetation. This is because agricultural production depends on plowing soil, which speeds up the decomposition of organic matter, and this makes the soil lack basic organic materials for the growth and production of crops, and reduces the soil's ability to hold water and nutrients, thus reducing, its productivity. Plowing depths impact in the physical and chemical properties of soil and then affect plant growth and crop production. Dismantling of soil by means of deep-tillage systems improves water infiltration, internal drainage, and aeration in the soil increases root depth, intensity, and development; and allows for deeper fertilizer placement (Diaz-Zorita 2000, Strudley et al 2008). Traditional agricultural operations involve repetitive processes and this may lead to loss of organic matter, which leads to soil degradation and lower soil quality (Peigne et al 2007). Therefore, need to preserve or increase the amount of organic matter in the soil whenever possible because of its role in increasing production, availability of nutrients depleted by crops, and increasing

biological activity. Botta et al (2006) observed cone penetrometer resistance was reduced and sunflower yields increased following deep tillage operations. Subsoil compaction caused changes to the root system of sunflower that affected shoot growth and crop yields, although the sunflower crop is suited to a wide range of agro-ecological zones with a wide range of temperatures, soil types, and rainfall patterns. The addition of nitrogenous fertilizers and animal wastes has a clear effect on the growth and production of sunflower, biological yield components and oil content. Soil fertility is considered one of the most important factors determining the yield of sunflower crops, who also noted that nitrogen deficiency in general is the most important nutritional determinant that limits sunflower production. The goal of the experiment was to demonstrate the impact of the plowing depths and adding manure by implement plowing and adds manure in the growth and yield of a sunflower plant and the oil and protein content it seeds.

MATERIAL AND METHODS

The field experiments were carried out at University of Basrah, located between the 29.078° and 31.18° N and arc lengths of 46.35° and 48.31° E, in texture silty loam soil classified as hyperthermic, fine clayey mixed typic torrifluvents calcareous, some soil properties (Table 1).

Tillage process and adding manure: The experiment was carried out using a compound implement for soil tillage and the addition of manure produced in Agricultural Machines and Equipment Department, University of Basrah. The implement consists of two moldboard plows and two subsoiler plows. The depth of the plows can be changed by changing the plows' attachment points on the frame through a set of holes on the leg of each plow. In this experiment, the depth of the moldboard plows was fixed at 30 cm and three depths of the subsoiler plows (10, 20 and 30 cm) to obtain the total depth of tillage required. In relation to the depth of the plowing, for example, the depth of plowing is 40 cm, due to the depth of the moldboard plows are 30 cm and the depth of the subsoiler plows are 10 cm. At the top of the implement, there is a manure tank equipped with a mechanism to disperse the manure in the slot that the plows operate under the soil surface, in addition to adding the manure to the cultivated soil between the plows, through three gates in the rear side of the manure tank. The implement was provided with three excavator plows and provided wings on the plowshares of feet to increase the mixing of manure and soil fragmentation.

Soil test and preparing the field: Soil samples were collected from the experiment site for depths d_1 (0-10), d_2 (10-20), d_3 (20-30), d_4 (30-40), d_5 (40-50), and d_6 (50-60) cm, and sieved by 2 mm sieve, to compute some soil properties (Peign´e et al 2007) (Table 1). The plowing carried out by implement for three depths 40, 50, and 60cm once without manure and another with adding manure for 40 Mg ha^{-1} cows excrement used as fertilizer organic (Table 2). After the plowing, the field was divided into experimental units in the form of basins with a length of 10m and a width of 1m and leaving a distance of 1m between one basin and another, a chemical fertilizer was added before planting according to the fertilizer recommendation. Sunflower seeds were planted with 3 seeds per hole and a distance of 25 cm between one hole and another. The crop was irrigated using drip irrigation,

Table 1. Physical and chemical properties of the experimental soil

Properties	Unit	Soil depth (cm)					
		(d_1)	(d_2)	(d_3)	(d_4)	(d_5)	(d_6)
Sand	g kg^{-1}	200.51	139.15	173.74	151.89	162.61	67.69
Silt		599.97	612.74	610.87	653.17	600.45	628.18
Clay		199.52	248.11	215.39	194.94	236.94	304.13
Texture		Silty loam	Silty loam	Silty loam	Silty loam	Silty loam	Silty clay loam
Penetration resistance (cn)	kN. m^{-2}	1250	1280	1340	1404	1500	1506
Real density (ρs)	Mg. m^{-3}	2.61	2.61	2.62	2.65	2.65	2.65
Bulk density (ρp)	Mg. m^{-3}	1.20	1.21	1.23	1.25	1.30	1.30
Total porosity (f)	%	54.02	53.63	53.05	52.83	50.94	50.94
EC	dS. m^{-1}	7.69	9.50	11.89	14.67	15.72	18.17
Total carbonate	g. kg^{-1}	339.12	338.41	316.51	300.35	290.45	280.11
Organic mater	g. kg^{-1}	12.46	12.15	11.41	6.33	3.42	1.03
pH		7.23	7.63	7.79	7.80	7.80	7.80
CEC	Cmolc. kg^{-1}	29.21	30.12	29.11	28.32	27.50	27.11

as the irrigation system was installed using drip tubes with two tubes in each basin separated by a distance of 70 cm. The process of thinning the plants was carried out after 15 days and leaving one plant in each hole.

Collection of data: Before harvesting the crop, random samples were taken to measure the height of the plant, the number of leaves. The leaf area was calculated using the Portable Laser Leaf Area Meter CI202, stem diameter at the surface of the soil and diameter of the sunflower head ere also estimated. After harvesting the crop, random seed samples were taken to measure the weight of 100 seeds. Protein content and the percentage of oil were estimated using the Soxhlet on the basis of dry weight (Reeves 1997).

Experiment design and analysis data: The experiment was arranged in a randomized complete block design with factorial layout with three replicates. Three plowing depths (40, 50 and 60 cm) was main factor and two levels of manure (0 and 40 Mg ha^{-1}) sub factor. All data were subjected to analysis of variance using the Gen stat 14 Statistics software.

RESULTS AND DISCUSSION

Effect of Tillage Depth

Vegetative growth: All vegetative growth parameter significantly increased when the tillage depth increase (Table 3). The plant height increased by 9.22 and 7.54%, stem diameter 20.99 and 14.05%, number of leaves 7.95 and 9.20%, the leaf area 145.75, 12.88% and head diameter by 11.09 and 12.77%, respectively, when the depth of tillage increase from 40 to 50 and 50 to 60cm. This increase occurred as a result of improving the physical properties of the soil, such as low bulk density, penetration resistance, and increased total porosity, and soil moisture content (Botta et al 2006, Jabro et al 2010, Adeyemo and Agele 2010). Aikins and Afuakwa (2010) reported that plant shoot development was dependent on root development and increased with depth of tillage, leading to the more vegetative growth of plants.

Seed weight and yield: The effect of tillage depth in the yield and the weight of 100 seed was significant and the yield increased by 35.68 and 15.62%, the weight of 100 seed d by 25.57 and 17.05% when the plowing depth increased from 40 to 50 and 50 t0 60cm respectively (Table 4). The may be due to vegetative growth for sunflower plants which lead to result of increased accumulation of proteins and store the excess reserve food in the seeds. Warren et al (2006) and Khan et al (2015) observed the deep plowing increased the yield due to an increase in the availability of soil nitrogen and uptake by the plant of the nutrients that are required for optimum plant growth.

Oil and protein content: The significant difference was observed in the oil content and protein for seed sunflower. The oil content increased by 11.61 and 9.96 % while protein content decreased by 2.95 and 7.65% when plowing depth increased from 40 and 60cm (Table 4). The may be due to improvement the soil's physical properties and increase its holding water and increment soil moisture (Sornpoon and Jayasuriya 2013, Aday et al 2018). This caused an increase in oil content and decrease protein content. Oraki et al (2011) observed that well irrigated fields treatments of sunflower generally had the highest oil content and the least protein contents.

Effect of Manure

Vegetative growth: There was significant increase in the height of the plant, stem diameter, number of leaves, and leaf area and head diameter of the sunflower plant with application of cattle manure compared to the non-addition treatment (Table 3). The height of the plant, stem diameter,

Table 2. Physical and chemical characteristic for manure

EC (dS. m^{-1})	pH	Total carbon g. Kg^{-1}	Total nitrogen g. Kg^{-1}	C=N ratio	Organic matter g. Kg^{-1}	Potassium g. Kg^{-1}	Phosphorus g. Kg^{-1}	Density Mg. m^{-3}
13.25	6.42	210.69	17.37	12:13	363.22	10.44	7.16	0.59

Table 3. Effect of plowing depth and manure on growth, qualitative and yield of sunflower

Treatments		Height of plant (cm)	Diameter of stem (cm)	Number of leafs	Area of leaf (cm^2)	Diameter of head (cm)	Yield of seed (g m^{-2})	Weight of 100 seeds (g)	Oil content (%)	Protein content (%)
Manure levels	M_0	146.70	1.56	24.22	5207.5	16.33	394.2	5.54	34.67	14.80
	M_{40}	184.00	2.43	30.44	5680.2	20.67	509.4	6.40	38.89	16.57
LSD (0.01)		6.37	0.035	1.189	5.08	0.945	12.44	0.243	0.531	0.009
Tillage depth (cm)	40	151.8	1.6667	25.17	2620.8	16.50	345.3	4.81	33.00	16.38
	50	165.8	2.0167	27.17	6440.6	18.33	468.5	6.04	36.83	15.91
	60	178.3	2.3000	29.67	7270.2	20.67	541.7	7.07	40.50	14.78
LSD (0.01)		7.80	0.043	1.456	6.22	1.157	15.23	0.297	0.650	0.010

the number of leaves, and the leaf area, and head diameter increased i by 25.42, 55.76, 25.68, 9.07, and 26.57% respectively. Earlier workers mentioned the addition of the fertilizer organic in soil lead to improve physical and chemical properties as well as the availability necessary nutrients for the growth of the plant and increased the biomass. (Chenu et al 2000, Hasanzade 2002, Khan et al 2010, Braz and Rossetto 2010).

Yield and the weight seed: The addition of manure resulted in a significant .increased in the yield and the weight 100 seed (Table 3). The yield increased by 29.22% and the weight of 100 seed increased by 15.52% in comparison with control (Table 4). This may be due to the increase in vegetative growth and the availability of readymade nutrients for the plant as a result of adding manure and available integrated nutritional levels for manure and chemical fertilizer may be possible due to available soil, nitrogen and plant requirements at different stages of growth, indicating that the mineral nitrogen content of the organic nutritional level was less than that of the chemical fertilizer at the beginning of growth when the demand is low, but at the productive growth stages, the absorption continues for a longer time because of the continuous mineralization process, also decrease of the soil bulk density, the increase of the water storage capacity and aggregate stability (Mooleki et al 2004, Munir et al 2007, Gryndler et al 2008). This lead to increased yield is increased uptake of elements NPK. The uptake of NPK also improved with the application of the manure and manure + NPK (Yang et al 2004, Meena et al 2018).

Oil and protein contents in seeds: The results showed a significant increase in the oil and protein percent with addition the manure (Table 4). The sunflower oil content increased by 12.17% when application the manure. This can due to beneficial wide range of nutrients in the manure improving soil productivity, such NPK which might have improved sunflower plant growth and higher production of carbohydrates in plants and transfer to seeds and easy uptake of other nutrients like sulfur which has been to influence fatty acid formation processes on oil crops (Hasanzade 2002, Ghalavand et al 2011, Rasool et al 2013). Ghalavand et al (2011) observed that higher organic nutrition levels exhibited the highest levels of oil content and as the nitrogen accessibility increased. Moreover, the findings of each of Manikandan and Thamizhiniyan (2016) and Kinama et al (2018) showed that the organic fertilizer was found to be more efficient than inorganic fertilizer over control improving phytochemical constituents in sunflower and content of the oil. The content of the protein in sunflower seeds was increased by adding manure to the soil by 11.95% compared with no addition. This increase was as a result of the continued release of nitrogen during the growth periods of the plant, this agreement with Basu et al (2008) also mentioned that the largest amount of protein content for integrated treatments was with mineral and organic fertilizer.

Effect of interaction between adding manure and depths of tillage: There was a significant effect of the interaction between the addition of manure and the depth of tillage in all of the studied characteristics, except the number of leaves and the head diameter were not significantly affected (Table 3). Fertilization treatment was superior in registering the highest values of the studied characteristics compared to the treatment of non-adding the manure. There were significant differences for the interaction between the addition of manure and the depth of tillage (Table 5). The depth 60cm recorded the high value of the height of the plant, stem diameter, leaf area, seeds yield per unit area, the weight of 100 seeds, and the oil content, they were increased by 18.37, 51.36, 6.95, 38.98, 21.44, 11.32% compared with same depth in the treatment of non-adding manure, while the content of the Protein was decreased with increased depth of tillage from 40 to 50 and 60 cm in both the treatments with superiority of the manure treatment. In the depth 60 cm the protein content increased by 26.26% for adding manure compared with no manure. This because to the improved soil physical properties and the increase in the spread of the roots in addition to providing the appropriate humidity for the growth and production of sunflowers (Borghei et al 2008, Adeyemo and Agele 2010).

Table 5. Interaction between adding manure and depths of tillage on growth, qualitative and yield of sunflower

Treatments		Height of plant (cm)	Diameter of stem (cm)	Number of leafs	Area of leaf (cm^2)	Diameter of head (cm)	Seed yield ($g\ m^{-2}$)	Weight of 100 seed (g)	Oil content (%)	Protein content (%)
OM_0	40	128.3	1.27	NS	2357.0	NS	318.3	4.58	30.33	16.05
	50	148.3	1.57	NS	6239.4	NS	411.0	5.66	35.33	15.30
	60	163.3	1.83	NS	7026.1	NS	453.3	6.39	38.33	13.06
OM_{40}	40	175.3	2.07	NS	2884.6	NS	372.3	5.03	35.67	16.71
	50	183.3	2.47	NS	6641.8	NS	526.0	6.42	38.33	16.51
	60	193.3	2.77	NS	7514.2	NS	630.0	7.76	42.67	16.49
LSD (0.01)		11.03	0.0193		8.79		21.54	0.421	0.920	0.015

CONCLUSIONS

The growth of vegetative sunflower increased with increasing depth of plowing and adding the manure. The weight of seeds and oil content increased and protein decreased when depth increase.

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