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Effect of using Modified Subsoiler-Moldboard Plow on Some of the Soil properties and Broad Bean (*Vicia faba* L.) Growth and Yield Parameters

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Abstract: Field experiments were conducted in silty clay soil, to study the effect of using the modified subsoiler-moldboard plow (MSMP) on some soil properties (bulk density, penetration resistance and electrical conductivity) and on some of broad bean growth and yield parameters (emergency rate, plant height, frock number, pods number per plant, seeds number per pods, weight of 1000 seeds, and total yield). The experiment parameters were three depths of subsoiler as a part of MSMP (30,40 and 50cm) and two depths of moldboard as a part of MSMP (20 and 30cm). The results showed that increasing the subsoiler depth from 30 to 40 cm resulted in redusing the bulk density and electrical conductivity of the soil by 2.70 and 8.29%, respectively, while increased the growth and yield parameters by 10.17, 14.29, 33.43, 7.37, 21.46, 27.31 and 45%, respectively. Increasing the subsoiler depth from 40 to 50cm decreased the soil bulk density and electrical conductivity by 1.85 and 0.60% respectively, whereas the growth and yield parameters increased by 10.22, 37.50, 49.89, 93.13 35.34, 33.34 and 117.67% respectively. The increase of the moldboard depths from 20 to 30cm leaded to increase the growth and yield parameters by 23.16%, 24.70%, 67.46%, 57.51%, 34.38%, 20.33% and 68.16% respectively. The subsoiler and moldboard depths (50 and 30cm) gave the highest emergence rate, plant height, weight of 1000 seeds and yield by 71.61%, 109.42%, 111.01% and 407.46% compared with the shallow depths of subsoiler and moldboard plow depths (30 and 20cm respectively). The results revealed that the values of the soil properties decreased by 12.50%, 60.31% and 40.86%, respectively after tillage, whereas they increased by 17.35%, 250.68% and 169.09%, respectively before harvest.

Keywords: Broad bean, modified subsoiler-moldboard plow (MSMP), Soil properties, Growth and yield parameters.

Introduction

The broad bean is one among many seeded crops in the world. It contains high protein rate (26-34%). China produce about 2.7 million ton year^{-1}, while Ethiopia and Egypt produce 3.74 and 2.62 thousand ton year^{-1}, respectively. In Iraq the broad bean

production is very limited. The average yield is 1.76 ton year^{-1} for the years 1989 to 2002 (FAO, 2003). The lower production rate is related to soil management. Collins *et al.* (2005) indicated that tillage is the most important field process which improves soil properties and therefore, the broad bean seeds production.

De Giorgio & Fornaro (2004) also mentioned that the broad bean yield is highly affected by the tillage system. They found that the minimum tillage (5cm rotary tillage) gave greater yield while two-layer tillage became second. The two-layer tillage are (combined equipment – 50 cm subsoiling and 5 cm rotary tillage), conventional tillage (double-share plowing at 35-40cm depth, rotary tillage operations at 20 cm with disc plough, 5cm rotary tillage) and surface tillage (25cm five share plowing, 5cm rotary tillage) approximately of 2.37, 2.13, 1.98 and 1.82 ton/ha respectively.

The aim of this experiment is to study the effect of using the modified subsoiler-moldboard plow on some soil properties and growth and yield parameters of broad bean crop in silty clay soil.

Materials and Methods

The experiments were conducted in the field of Agriculture College, Basrah University, Iraq to study the effect of using the modified subsoiler-moldboard plow (MSMP) depths (three depths for subsoiler 30, 40, and 50cm and two depths for the moldboard (deep digger type which was width 45cm) 20 and 30 cm which were used with every depth of subsoiler) on some soil properties (bulk density, penetration resistance and electrical conductivity) and some of the broad bean crop parameters (emergency rate, plant height, frock number, pods number per plant, seeds number per pod, weight of 1000 seeds, and total yield) in silty clay soil. The soil properties are shown in table (1).

The broad bean seeds were sown in furrows using three seeds per hole. on one side of the furrow. The distances between the holes and the furrows were 20 and 70 cm, respectively.

The tri-super phosphate fertilizer (P_2O_5 46%) was added during sowing time using 120 kg ha^{-1} . The nitrogen fertilizer was added at rate of 120 kg ha^{-1} as urea (N 46%) in two application: at sowing time and after 40 days after planting. While, the potassium was added as K_2SO_4 (K_2O_2 50%) by at rate of 100 kg ha^{-1}.

The soil properties were measured three times (before tillage, after tillage and before crop harvest), while the growth parameters were measured during the growth period except the yield which was measured before crop harvesting. The randomized complete block design was used to analyze the experiment data.

Table (1): Some of the physical and chemical soil properties.

Depth (cm)	Bulk density (Mg/m^3)	Penetration resistance (kN/m^2)	Moisture content (%)	Electrical conductivity dS/m	Soil texture
0-10	1.08	1980	4.95	21.10	Silty clay
10-20	1.17	2248	5.50	13.43	
20-30	1.11	2078	7.41	12.93	
30-40	1.13	2280	7.42	13.08	
40-50	1.08	2675	7.79	14.47	
Average	1.11	2252.2	6.61	15.00	

Results and Discussion

1.Effect of the modified subsoiler-moldboard plow depths on soil properties

The results are shown in table (2). The subsoiler depth as a part of MSMP significantly affected the soil bulk density and electrical conductivity while it did not significantly affect the soil penetration resistance. The moldboard depth as a part of MSMP did not significantly affected the soil properties. Table (2) also showed that the soil bulk density and electrical conductivity decreased by 2.70 and 8.29% when the subsoiler depth increased from 30 to 40 cm, respectively and when the subsoiler depth increased from 40 to 50 cm these properties decreased by 1.85 and 0.60%, respectively. The results also showed that increasing the subsoiler depth from 30 to 50 cm decreased the above properties by 4.50 and 8.82%, respectively. This was because increasing the tillage depth increased the volume of the disturbed soil which resulted in greater clods collision and that reduced the clods sizes (smother soil). The soil pulverization decreased the soil bulk density in additional to that the tillage depth improved the soil drainage and soil leaching ability which helped in washing the soil salinity away from the plant roots zone and therefore, lowering the soil electrical conductivity (Siri-Prito *et al.*, 2007; Wang *et al.*, 2009).

Table (2): Effect subsoiler depth on soil properties.

Subsoiler depth (cm)	Soil properties	
	Bulk density (Mg/m^3)	Electrical conductivity (dS/m)
30	1.11	17.24
40	1.08	15.81
50	1.06	15.72
L.S.D.	0.04	0.66

Table (3): Effect subsoiler depth on soil properties for the averge soil depth 0-50cm.

Sampling period	Soil properties		
	Bulk density (Mg/m^3)	Penetration resistance (kN/m^2)	Electrical conductivity (dS/m)
Before tillage	1.12	2109.03	15.32
After tillage	0.98	837.11	9.06
Before harvest	1.15	2935.54	24.38
L.S.D.	0.04	278.90	0.54

2.Effect of the soil sampling time on the soil properties

The results showed that the sampling period significantly affected soil bulk density, penetration resistance and electrical conductivity. Table (3) showed that soil bulk density, penetration resistance and electrical conductivity decreased by 12.50, 60.31 and 40.86%, respectively after the tillage operation as compared with that before tillage. However, these properties increased

by 2.68%,39.19% and 59.14%, respectively before crop harvesting as compared with that before tillage operation. The above mentioned properties increased by 17.35%, 250.68% and 169.09%, respectively before crop harvesting as compared with that after tillage operation. That was because the tillage operation distribute soil and increased the soil porosity which on the other hand improved the soil drainage. However, after planting and irrigation the soil clods adhered to each other which resulted in lower soil porosity and that reduced the soil drainage ability (Wanas, 2006; Al-Nassar, 2015).

3.Effect of the interactions between the operating depths of the modified subsoiler-moldboard plow components and sampling period on the soil properties

The results showed that all interactions between depths of MSMP components and the soil sampling time significantly affected the soil bulk density, penetration resistance and electrical conductivity.

4.Effect the depth of subsoiler of MSMP on the plant growth and yield parameters

The results showed that the depth of subsoiler of MSMP significantly affected the seeds emergence rate, plant height, number of frocks, number of pods per plant, number of seeds per pod, weight of 1000 seeds and crop yield. Table (4) showed that increasing the subsoiler depth from 30 to 40 cm increased the above parameters by 10.17, 14.29, 33.43, 7.37, 21.46, 27.31 and 45%, respectively, while increasing the subsoiler depth from 40 to 50 cm increased the parameters by 10.22, 37.50, 49.89, 93.13, 35.34, 117.67%, respectively. However, increasing the subsoiler depth from 30 to 50 cm increased these parameters by even greater amount of by 29.44, 57.14, 100, 107.37, 64.38, 69.76, 215.63%, respectively. These increases in broad bean growth and yield parameters were due to the decrease in the soil bulk density and penetration resistance which improved soil drainage then reduced soil salinity in the roots zone and that positively affected the plant growth and yield parameters (Al-Issa & Samrah, 2007; Al-Nassar, 2015).

5.Effect of the moldboard depth of MSMP on plant growth and yield parameters

The results showed that the depth of the moldboard component of MSMP significantly affected the seed emergence rate, plant height, number of frocks, number of pods per plant, number of seeds per pod, weight of 1000 seeds and total yield.

Table (4): Effect subsoiler depth on plant parameters.

Subsoiler Depth (cm)	Plant parameters						
	Emergence rate (%)	Plant height (cm)	Number of frock (frock/plant)	Number of bods per plant (pod/plant)	Number of seeds per pod (seed/plant)	Weight of 1000 seeds (g)	Crop yield (ton/ha)
30	58.33	24.50	3.50	2.17	2.33	28.67	1.60
40	68.50	28.00	4.67	2.33	2.83	36.50	2.32
50	75.50	38.50	7.00	4.50	3.83	48.67	5.05
L.S.D.	1.71	2.82	1.05	0.74	1.00	4.37	0.92

Table (5): Effect the moldboard plow depth on the plant parameters.

Moldboard plow depth (cm)	Plant parameters						
	Emergence rate (%)	Plant height (cm)	Number of frock (frock/plant)	Number of bods per plant (pod/plant)	Number of seeds per pod (seed/plant)	Weight of 1000 seeds (g)	Crop yield (ton/ha)
20	60.44	27.00	3.78	2.33	2.56	34.44	2.23
30	74.44	33.67	6.33	3.67	3.44	41.44	3.75
L.S.D.	1.39	2.30	0.86	0.61	0.81	3.57	0.75

Table (5) showed that increasing the moldboard component operating depth from 20 to 30 cm increased the above parameters by 23.16, 24.70, 67.46, 57.51, 34.38, 20.33 and 68.16%, respectively, and that was because the mold board component of MSMP severely pulverized the soil clods, which improved the soil water retention ability. This resulted in greater plants roots distribution in the soil which increased nutrient elements absorption by plants. These factors positively increased the plant growth and yield (Soltanabadi *et al.*, 2008; Al-Nassar, 2015).

6.Effect of the interaction between the depth of the moldboard plow and the depth of subsoiler as components of the MSMP on the plant growth and yield parameters

The results showed that the interaction between the depths of the two components of MSMP (moldboard and subsoiler) significantly affected the seeds emergence rate, plant height, weight of 1000 seeds and total yield while it did not significantly affect number of frocks, number of pods per plant and number of seeds per pod.

Table (6) showed that depths of 50 and 30 cm for the subsoiler and moldboard gave the highest seeds emergence rate, plant height, weight of 1000 seeds and yield by 71.61%, 109.42%, 111.01% and 407.46% as compared for subsoiler and moldboard, respectively.

The supervision of the interaction of depths 50 and 30 cm for subsoiler and moldboard on the other depths was due to that they

Table (6): Effect of the interaction between MSMP components depths on plant parameters.

Depths of MSMP (cm)	Plant parameters							
	Emergence rate (%)		Plant height (cm)		Weight of 1000 seeds (g)		Crop yield (ton/ha)	
Moldboard / Subsoiler	20	30	20	30	20	30	20	30
30	51.67	65.00	21.33	27.67	27.33	30.00	1.34	1.86
40	67.33	69.67	27.33	28.67	36.33	36.67	2.04	2.59
50	62.33	88.67	32.33	44.67	39.67	57.67	3.30	6.80
L.S.D.	2.42		3.99		6.18		1.31	

encouraged the plant roots growth and distribution in the soil as well as the excess water moved down to lower layer of soil which reduced evaporation from the soil surface and that improved the soil enviroments then positively affected plants growth and hence the crop yield (De Giorgio & Fornaro, 2004; Al-Nassar, 2015).

Conclusions

1. The subsoiler depth of MSMP significantly affected the soil bulk density and electrical conductivity. As the subsoiler depth increased, the soil bulk density and electrical conductivity decreased, but it did not significantly affected the soil penetration resistance. However, the moldboard depth of MSMP had not any significant effect on soil properties.

2. The sampling time significantly affected the soil bulk density, penetration resistance and electrical conductivity. These values were decreased after tillage operation and were increased before crop harvesting.

3. The depths of MSMP components significantly affected seeds emergence rate, plant height, number of frock, pods per plant, seeds per pod, weight of 1000 seeds and yield. Increasing the depths of MSMP components increased the mentioned parameters. However the interaction between the depths of the components of MSMP significantly affected the seeds emergence rate, plant height, weight of 1000 seeds and crop yield. The interaction between the deeper depths of MSMP components gave the highest values.

Recommendations

1. To improve soil properties and broad bean growth and yield, MSMP is highly recommended. The depths recommended are 50 cm and 30 cm for the subsoiler and the moldboard respectively.

2. To obtained good board bean growth and higher yield, the soil should be disturbed during growth season.

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