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EFFECT OF DIFFERENT TILLAGE SYSTEM ON SOME SOIL PHYSICAL PROPERTIES AND CROP YIELD OF BARELY (*HORDEUM VULGARE*)

Talal Jaber Abd Al Khanfous
Department of Filed Crops, College of Agriculture and Marshes, University of Thi-Qar, Iraq
Email: talal@utq.edu.iq

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Abstract:

The study was conducted at the Station of agricultural Research in the College of Agriculture and Marches, University of Thi- Qar, during the 2017-2018 and 2018-2019 seasons to study the impact of various tillage systems on certain physical properties of soil, yield, and components of barley. The treatments included various tillage systems which are moldboard plow(T1), chisel plow (T2) , moldboard plow with one pass of disc harrows (T3), chisel plow with one pass of disc harrows(T4), moldboard plow with three passes of disc harrow (T5), chisel plow with three passes of disc harrow (T6), and no tillage (T7). These treatments were arranged using a randomized complete block design (R.C.B.D) with three replications. The data were analyzed using the Genstat program, and mean comparisons were performed using the least significant difference (LSD) test. The results indicated a significant effect of tillage systems and year on the parameters studied. The treatment (T3) outperformed the other treatments in enhancing soil physical properties, yield, and components of barley crop.

Keywords: Soil, Physical Properties, Tillage Systems, Barley Crop

INTRODUCTION:

The selection of agricultural machinery is critical for the realization of sustainable agriculture. Effective management and the appropriate selection of machinery significantly contribute to cost reduction and the mitigation of challenges in field operations, while also enhancing production and safeguarding the environment from pollution (Dahab et al., 2007) .Tillage practices are frequently regarded as limiting factors for crop production in clay soils (Bashir et al., 2015). Rashidi and Keshavarypour (2007) indicated that the method of tillage has a substantial impact on the physical properties of soil. Specifically ,treatment CT(moldboard plow followed by two passes of disc harrows) presented the highest percentage of moisture content (19.6%), recorded the lowest bulk density of (1.41 g m^{-3}), and the lowest penetration resistance (560 kPa). In contrast, treatment NT(no tillage) recorded the lowest moisture content (16.8%), the highest bulk density (1.52 g m^{-3}), and the highest penetration resistance (1250 kPa).

The various tillage systems demonstrated differing effects on the soil physical properties such as bulk density, moisture content , and total porosity, which in turn influenced the growth and productivity of sunflower crops (Sessiz et al., 2008). Soil tillage , coupled with increased traffic in agricultural area, contributed to greater soil compaction and consequent reduction in crop yield. As result, the choice of tillage equipment affected soil bulk density and total porosity in the 0-10 cm layer, as well as increasing penetration resistance of soil at a depth of 30 cm. Notably, an increase in penetration resistance of soil exceeding 1.53 MPa was associated with reduced plant dry matter and maize productivity (Junior et al ., 2016).

Tillage systems evidently influence the soil physical properties, such as soil bulk density an percentage of moisture content , necessitating environmental modifications to create optimal conditions for enhanced crop production (Mohamed et al., 2017). Tillage is recognized as a vital tool for management, improving soil physical properties, and fostering the growth and productivity of crop. The productivity of crops and the characteristics of soil are significantly affected by tillage operations (Alam et al., 2014). However, there is a paucity of studies examining the impact of various tillage practices on soil properties and barley crop productivity (Lopez et al., 2019). Therefore, the primary objective of study was to evaluate the effect of different tillage systems on selected soil physical properties and the productivity of barley crop.

MATERIALS AND METHODS:

EXPERIMENTAL SETUP:

The experiment was performed to assess the impact various tillage systems on the soil physical properties and productivity of barely crops during the growing seasons of 2017-2018 and 2018-2019. The study was carried out at Agricultural Research Station in College of Agriculture and Marshes, University of Thi-Qar , focusing on clay soil. Table 1 provides an overview of the physical and chemical characteristics of the field crop.

Table 1.The physical and chemical properties of soil experiment.

Soil depth (cm)	Partial size (%)			Texture class	Bulk density (Mg m^{-3})	Particle density (Mg m^{-3})	Field capacity (cm^3 cm^{-3})	EC (ds m^{-1})	pH	Organic carbon (%)
	sand	Silt	clay							
0-15	6.0	36.8	57.2	clay	1.43	2.60	0.34	2.04	7.32	0.80
15-30	5.4	34.4	60.2	clay	1.46	2.62	0.36	2.36	7.35	0.54

The experiments were conducted using a randomized complete block design (RCBD) with three replications. The experimental plot size was 5.0 meters in length and 4.0 meters in width. A 2-meter buffer zone was maintained between the experimental plots to prevent interference. All treatments were applied to the same land plots during the 2017-2018 and 2018-2019 farming seasons. The tillage treatments included moldboard plow (T1), chisel plow (T2), moldboard plow with one pass of disc harrows (T3), chisel plow with one pass of disc harrows (T4), moldboard plow with three passes of disc harrows (T5), chisel plow with three passes of disc harrows (T6), and no tillage (T7). These treatments are described in Table 2. Barley crop, local variety, was sown on October 1st in each season. Crop management operations, including weeding, pest control, and irrigation, were carried out as per recommendations. NPK fertilizer was applied according to the recommended quantities. Harvesting operations were performed at the beginning of the fourth month.

Table 2. Tillage treatments of experiment.

Treatment	Description
T1	Moldboard plow.
T2	Chisel plow.
T3	Moldboard plow and one pass of disk harrow.
T4	Chisel plow and one pass of disk harrow.
T5	Moldboard plow and three pass of disk harrow.
T6	Chisel plow and three pass of disk harrow
T7	No Tillage

The Studied Variables:

The following soil physical properties were measured at harvest:

1- Soil Moisture Content:

The soil moisture content was assessed using the method that described by Black et al. (1965). Soil samples were taken using an auger at (0-15) cm and (15-30) cm of soil depths at the end of the growth season. The samples were then dried in an oven at a temperature of 105°C for 24 hours. The moisture content was calculated as the ratio of the weight of water (Pw) to the weight of dry soil.

2- Bulk Density:

The bulk density of soil was estimated using core sampling method . the soil samples collected from depth of 0 to 30 cm . The bulk density was calculated using Equation (1) after the samples were drying in an oven at a temperature of 105°C for 24 hours, in accordance with the methodology described by Black et at., (1983). The results are presented in Table (1).

$Bd = \frac{MS}{Vt}$.....(1)

Where:

Bd: bulk density (Mg m^{-3})

MS: mass of dry solids (Mg)
Vt: total volume of Soil (m^{-3})

3- Total Porosity:

The porosity calculated by using equation (2) which is described by Black et at., (1983).

$$P(\%) = 1 - \frac{Bd}{Bds} \times 100 \quad \text{.....(2)}$$

Where:
%P: Total Porosity (%)
Bd: Bulk Density of the soil

Bds: soil particle density (Mg m^{-3}).

4- Soil Penetration Resistance:

The electronic cone penetrometer (HUMBOLDT) was utilized to measure soil penetration resistance , commonly referred to as the cone index.

5- Barley Yield and Components:

The following barley yield and components were studied: number of spikes per square meter, number of grains per spike, weight of 1000 grains, and total yield.

Experimental Design:

The experiment analyzed by using a randomized complete block design (RCBD) with three replications, resulting in 21 experimental units. The statistical analysis of the data was performed using the Genstat software. Mean comparisons were conducted using the least significant difference (LSD) test at a significance level of 0.05.

Results and Discussion:

Soil Physical Properties:

1.1. Moisture Content (%):

The highest soil moisture content (21.91%) was detected in treatment (T3), which was significantly different from treatments (T5), (T6), and (T7). The lowest soil moisture content (13.43%) was recorded in the untilled soil (T7). Therefore, the plowing treatment with moldboard plow and one pass with disc harrows showed a 63.14% increase in soil moisture content compared to untilled soil. Refer to Table 3 for details.

2.1. Bulk Density:

The lowest bulk density value (1.27 g cm^{-3}) was recorded in treatment (T3), that was significantly different from the other treatments. The treatment (T7) was observed highest bulk density (1.40 Mg m^{-3})). Therefore, the plowing treatment with moldboard plow and one pass with disc harrows resulted in 92.85% lower bulk density compared to untilled soil. Refer to Table 3 for details.

3.1. Total Porosity (%):

The highest total porosity (51.59%) was observed in treatment T3. The lowest total porosity (46.69%) was recorded in the untilled soil (T7), which was not significantly different from treatments T6 and T5. Therefore, the plowing treatment with moldboard plow and one pass with disc harrows resulted in a 10.49% increase in total porosity compared to untilled soil. Refer to Table 3 for details.

4.1. Soil Penetration Resistance:

The lowest soil penetration resistance value (731 KN) was recorded in treatment T3, which was significantly different from the other treatments. The highest penetration resistance of soil was observed in the untilled soil (T7) which is equal (976 KN). Therefore, the plowing treatment with moldboard plow and one pass with disc harrows resulted in 25.10% lower soil penetration resistance compared to untilled soil. Refer to Table 3 for details.

Table 3. Effect of barley-based cropping systems on soil bulk density and soil porosity following barley harvest under conventional and conservation tillage practices.

Tillage system	Soil bulk density (Mg m^{-3})		Percent porosity (%)	
T1	1.31 a	**2017-2018**	49.94 ab	**2017-2018**
T2	1.29 a	1.32	50.57 a	
T3	1.27 a	**2018-2019**	51.59 a	**2018-2019**
T4	1.31 a	1.34	50.06 ab	
T5	1.38 b	**LSD**	47.96 bc	**LSD**
T6	1.39 b	**N.S**	46.94 c	**N.S**
T7	1.40 b		46.69 c	

LSD	**0.067**		**2.563**	
	Soil moisture content (%)		**Soil penetration resistance (KN)**	
T1	18.18 b	**2017-2018**	861.33 c	**2017-2018**
T2	17.69 bc	17.27 b	853.17 c	878.50 b
T3	21.91 a	**2018-2019**	731.00 a	**2018-2019**
T4	19.19 b	17.53 a	820.17 b	848.33 a
T5	16.61 cd	LSD	924.00 d	LSD
T6	15.83 d	**0.813**	876.67 c	**13.454**
T7	13.43 e		976 e	
LSD	**1.521**		**25.171**	

5-1. Barley Yield and Components:

The results in Table 4 showed that treatment T3 outperformed other treatments, recording the highest number of spikes per square meter, number of grains per spike, weight of 1000 grains, and total yield for both growing seasons. Treatment T4 followed closely behind T3 in terms of yield components. The lowest values were recorded in treatment T7.

Table 4. The impact of different tillage system on yield of Barely.

Treatments	**Number of spikes m^{-2}**		**Number of grains in the spike**		**Weight of 1000 grains (g)**		**Grain yield (ton h^{-1})**	
	2017 2018	2018 2019	2017 2018	2018 2019	2017 2018	2018 2019	2017 2018	2018 2019
T1	342 b	371 a	57 c	63 bc	34 bc	37 c	2.36 b	2.74 bc
T2	305 c	344 b	55 c	61 c	30 c	34 c	2.34 b	2.58 c
T3	368 a	389 a	65 a	69 a	42 a	45 a	2.89 a	3.07 a
T4	350 b	374 a	61 b	65 b	38 ab	41 b	2.45 b	2.80 ab
T5	261 d	308 c	51 d	56 d	25 d	26 d	2.05 c	2.29 d
T6	231 e	282 d	51 d	55 d	23 d	25 d	1.99 c	2.15 de
T7	204 f	241 e	50 d	55 d	18 e	23 d	1.56 d	1.89 e
LSD	**15.12**	**21.64**	**3.39**	**3.08**	**4.43**	**3.39**	**0.20**	**0.27**

CONCLUSION:

From Table 3, it is evident that treatment T3 excelled in improving soil physical properties. It resulted in decreased the soil bulk density and penetration resistance of soil, increased moisture content, and total porosity compared to the other treatments. The reason behind this is that single pass plowing decreased bulk density which in turn increased soil porosity while reducing soil penetration resistance; this situation is more beneficial for plant growth as compared to no-tillage or repeated tillage which diminishes size of aggregates and compacts them. This particular result has been confirmed by Gassem et al. (2006) and Al Banna et al. (2011), who also found evidence supporting the positive effects of appropriate soil tillage and inversion practices on reducing bulk density and enhancing soil porosity. Additionally, from Table 4, it is evident that treatment T3 outperformed other treatments in terms of barley yield and its components for both growing seasons. This can be attributed to the significant improvement in soil physical properties, as shown in Table 3. The moldboard plow played a significant role in enhancing soil physical properties, leading to improved growth and yield of barley. The combined effect of the moldboard plow and single pass tillage reduced the soil bulk density, penetration resistance of soil, and increased soil porosity, thus improving the physical,

chemical, and biological properties of the soil. These favorable conditions provided the highest yield and yield components compared to the other treatments, particularly when compared to increased frequency of tillage, which further fragmented soil aggregates and reduced soil porosity. As a result, this negatively affected the yield and components of barley crop.

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