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ORIGINAL ARTICLE

THE IMPACT OF PLOWING DEPTH AND SOIL MOISTURE ON SOME TECHNICAL INDICATORS AT USING DISK PLOW

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Abstract: An experiment was carried out in a field in Husayniyah sub-district of the Holy Karbala Governorate. The research included studying the impact of the plowing depth and soil moisture on some technical indicators when using the disc plow. The 80 hp New Holland tractor was used in this experiment. Two factors were studied, the first factor is the soil moisture (12-9%), (16-13%) and (20-17%) and the second factor was the depth of tillage (10-13) cm, (15-18) cm and (20-23) cm, which represented the secondary blocks. Bulk density, percentage of slippage and drawing force were studied. The field trials was conducted according to Split blocks in a randomized complete block design in three replicate. Consequences showed (according to the conditions of the experiment) that soil moisture of 17-20% outperformed in obtaining the lowest average bulk density of 1.25 g cm^{-3} whereas soil moisture of 12-9% recorded the lowest rate of slippage of 8.72% and the lowest rate of the net drawing of 1310.39 (kg.N). The plowing depth of 10-13 cm outperformed in obtaining the lowest average of bulk density of 1.25 g cm^{-3}, the lowest slippage percentage of 7.19%, and the lowest rate of net drawing of 1013.84 (kg. N). The results also showed that soil moisture of 9-12% and plowing depth of 10-13 cm outperformed in obtaining the best interaction in most of the studied traits.

Key words: Soil moisture, Depth, Traction force, Disc plow, Bulk density.

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1. Introduction

Generally, the plowing depth and soil moisture content were the most important factors that affected the tractor performance, to reduce power losses of tractor. Jebur (2016) indicated that the use of disk harrow recorded lowest rate of slip (4.898 %) and power losses (7.40 kW), compared with moldboard plough. Al-Rajaboo and Alsandooq (2012) stated that increasing the depths from 4 to 6 cm led to an increase in the percentage of slippage from 7.9 to 10.35% in regard to the first planting depth, and from 9.45 to 12.6% for the second depth. Mielke *et al.* (1986) found that the bulk density in the surface layer of 0-10 cm in a cultivated soil is lower than that of non-tilled soil. The moisture content is an influencing factor in resisting the drawing force. Marial *et al.* (2011) found that the drawing resistance increases when humidity is high or low thus the best traction force can be obtained when the moisture content laid between 13-20%. Roudhan (2012) stated that the drawing power increases with the increasing in the soil moisture content and vice versa. The aim of this study was to test and evaluate the effect of plowing depth and soil moisture content on tractor performance.

2. Materials and Methods

A field test was conducted in Al-Husayniyah district in the holy Karbala governorate during the year 2020-2021 on a plot of land of (7500 m^2) that is not cultivated in the previous season, and the soil was classified as

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Table 1: The physical and the chemical properties of the field.

Soil Sepertors gm kg^{-1}			Soil texture	PH	(EC) Decimensm	Total porosity (%)
Sand	Clay	Silt				
110	184	60	Silty clay	7.42	4.23	51

Table 2: Effect of the plowing depth and soil moisture on the bulk density (g/cm^{-3}).

Soil moisture (%)	Depth (cm)			Rate
	10-13	15-18	20-23	
9-12	1.29	1.31	1.36	1.32
13-16	1.24	1.28	1.33	1.28
17-20	1.22	1.24	1.28	1.25
L.S.D.%5		0.01		0.004
Rate	1.25	1.28	132	
L.S.D.5%		0.005		

silty clay. Table 1 shows the physical and chemical characteristics.

The research was carried out by a factorial experiment of split blocks design according to the randomized complete blocks by three replications [Al-Sahookie (1990)]. Two factors were used, the first was the soil moisture content in three levels (9-12%), (13-16%) and (17-20%), the second factor was the depth of tillage [(10-13), (15-18) & (20-23) cm]. The data obtained were collected and statistically analyzed according to the experimental design being used, and the differences between the parameters means were tested using the lowest significant difference (L.S.D) $p > 0.05$.

2.1 Studied traits

1. Bulk density (gm cm^{-3}): The bulk density was calculated according to the equation proposed by Black *et al.* (1965).

$$\rho b = Ms / Vt$$

where,

ρb : bulk density gm.cm^{-3}

Ms: Dry soil mass gm

Vt: total soil volume of cm^3

2. The slip (%): It was estimated using the formula by Macmillan (2002).

$$S_p = \left(V_t - \frac{V_p}{V_t} \right) \times 100$$

where,

S_p : Slip (%).

Vt: without load speed (km. h^{-1}).

Vp: with load speed (km. h^{-1}).

3. Net drawing power NDP (kilo. Newton): It was calculated by the equation used by Macmillan (2002).

$N_{dp} = B - A$

where,

N_{dp}: drawing force of the plow (kn).

B: the total drawing force of the plow during the plowing process (kn).

A: Rolling resistance force (kn).

3. Results and Discussion

3.1 Bulk density (gm cm^{-3})

Table 2 shows a presence of significant effects in the impact of the plowing depth and soil moisture on the bulk density, thus soil moisture had a significant effect on the bulk density. Whereby increasing moisture from 12-9 to 16-13 then to 20-17% led to a decrease in the bulk density from 1.32 to 1.28 and then to 1.25 g cm^{-3}, respectively. The reason for this may be due to the increasing in the soil moisture content, as a result for that caused a decrease in the expansion of soil particles that led to a decrease in the bulk density.

It is also obvious from Table 2 that there is a significant effect of the plowing depth and soil moisture on the bulk density. Whereby increasing the plowing depths from 13-10 to 18-15 and then to 23-20 cm, led to an increase in the bulk density from 1.25 to 1.28 and then to 1.32 g cm^{-3}. The reason may due to the fact that the increasing in load which is applied by the

Table 3: Effect of the plough depth and soil moisture content on slippage percentage (%).

Soil moisture (%)	Depth (cm)			Rate
	10 -13	15 -18	20 -23	
9-12	5.02	8.53	12.61	8.72
13-16	7.21	10.18	14.67	10.67
17-20	9.34	12.81	17.31	13.15
L.S.D.%5		1.75		1.09
Rate	7.19	10.51	14.86	
L.S.D.5%		1.09		

Table 4: Effect of the plough depth and soil moisture content on net drawing N_{dp} (kn).

Soil moisture (%)	Depth (cm)			Rate
	10 -13	15 -18	20 -23	
9-12	930.11	1320.34	1680.71	1310.39
13-16	980.21	1410.18	1752.53	1364.31
17-20	1131.21	1503.41	1883.31	1506.11
L.S.D.%5		32.28		18.28
Rate	1013.84	1411.31	1772.32	
L.S.D.5%		18.28		

adopted plow leads to compacting the soil, thus leads to an increase in the bulk density [Amer (2019)].

It is evident from the same table that the two-way interaction of the plowing depth and soil moisture, had a significant effect on the bulk density, whereby soil moisture of 12-9% and the depth of plowing 23-20 cm outperformed in obtaining the highest bulk density of 1.36 $g.cm^{-3}$. The lowest bulk density was 1.22 $g.cm^{-3}$ resulted from the interaction of the soil moisture of 20-17% and the plowing depth of 10-13 cm.

3.2 Slippage percentage (%)

Table 3 shows the presence of significant effects in the impact of the plowing depth and soil moisture content on the slippage percentage, whereby soil moisture had a significant effect on the slippage percentage, the increase in humidity from 12-9 to 16-13 then to 20-17% led to an increase in the slippage percentage from 8.72 to 10.67, then to 13.15%, respectively, The reason for this may be due to the conditions of the adhesion between the driving wheels of the adopted tractor and the soil, in other word the cohesion decreases thus, the percentage of slippage increases [Ahmed (2012)].

It is also cleared from the table that there is a significant impact of the plough depth and soil moisture content on the slippage percentage. When increasing the plowing depths from 10-13 to 15-18 and then to 23-20 cm, caused the slippage percentage to increase from 7.19 to 10.51 and then to 14.86%. The reason may be due to the increase in the depth of plowing caused an increase in the load on the plow as a consequence of the resistance resulted from an increase in the exposure surface of the shear, thus leads to an increase in the traction resistance, which in turn leads to an increase in the slippage percentage [Kazem and Jaber (2012)].

The same table shows the two-way interaction, the plowing depth and soil moisture, which had a significant effect in the percentage of slippage, as soil moisture 20-17% and the depth of plowing 23-20 cm obtained the highest slippage percentage of 17.31%, while the lowest slippage percentage was 5.02% that was resulted out of the interaction between the soil moisture of 12-9% and the plowing depth of 10-13 cm.

3.3 Net Drawing N_{dp} (kn)

Table 4 shows the presence of significant effects in respect of the impact of the plowing depth and soil moisture on the net Drawing, whereby soil moisture content had a significant impact on the net drawing. The increase in moisture from 12-9 to 16-13 and then to 20-17% led to an increase in net drawing from 1310.39 to 1364.31 and then to 1506.11 (kn), respectively. The reason for this may be due to the strength of the soil cohesion throughout the increasing in the moisture content, which leads to an increase in the net of the drawing [Aday *et al.* (2001)].

It is also obvious from the table that there is a

significant impact plough depth and soil moisture content on the net drawing, when increasing the plowing depths from 10-13 to 15-18, then to 20-23 cm, led to an increase in the net drawing from 1013.84 to 1411.31 and then to 1772.32 (kn). The reason for this due to the increase in the plowing depth leads to an increase in the load on the plow, which in turn results in an increase in the resistance that the plow may encounter, consequently leads to an increase in the net drawing [MaraKoglu and Carma (2009)].

The same table shows the two-way interaction, the plowing Depth and soil moisture content, which had a significant effect on the net drawing. Soil moisture of 20-17% and the depth of plowing of 23-20 cm obtained the highest percentage of net drawing, of 1883.71 kn. The lowest net drawing ratio was 930.11 kn, that resulted out of the interaction of soil moisture of 12-9%, and the plowing depth of 10-13 cm.

4. Conclusions and Recommendations

1. It is evident from the above results that with increasing soil moisture from 12-9 to 16-13 then to 20-17%, led to a significant decrease in bulk density and a significant increase in the percentage of slippage and net drawing.
2. Increasing plowing depth from 10-13 to 15-18 then to 23-20 cm led to a significant increase in bulk density, percentage of slippage and net drawing.
3. We recommend using soil moisture of 9-12 cm and soil moisture of 13-10% to obtain the best results in most of the traits.

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