A Study of The Work of The Flap Plow in Silty Loam Soil (Mould Board Plow)

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ABSTRACT
This study was carried out in one of the agricultural fields affiliated to the University of Basra in the year 2022, where the study included the use of the tractor type (Massey Ferguson MF 375) with the rotary cultivator at different speeds, as well as the use of different depths to study the effect of this on silty clay soils. In this experiment, the effect of two factors was studied. They are the plowing depths (0.13, 0.185, 0.235 m) and the plowing speed of the tractor with the tipper plow, which ranged from (0.977, 1.347, 1.805 m/sec) in the studied technical indicators, which included practical productivity, the real efficiency of the symptoms, soil resistance to penetration, and the percentage of slip. The research was carried out according to the randomized complete block design and with four replications using the practical experiment method, where the statistical results and differences tests were analyzed in a manner with the least significant difference at the level of (0.05). To the decrease in the practical productivity and field efficiency of the plows with an increase in soil resistance to penetration and the percentage of slippage, and the plowing depth exceeded 0.15 meters over the plowing depths (0.235, 0.185) meters in achieving the highest rate of practical productivity with the highest field efficiency of the plow, as well as achieving the lowest soil resistance rate For penetration with the lowest anti-overturning ratio, while increasing the practical speed of the plow from 0.997 to 1.347 m/sec and then to 1.805 m/ sec led to an increase in practical productivity with a decrease in the field efficiency of the plow as well as an increase in soil resistance to penetration with an increase in the slip percentage.

1. Introduction

Tilling is one of the main processes that take place on the soil to break the surface layer and create suitable conditions that allow water and air to penetrate (Th.Tahir & A H. Jarad, 2017). The beginning of the third millennium is marked not only by the rapid development of transport and small energy but also by the continuing growth of the anthropogenic impact of piston engines on the environment (Al-Maidi *et al*., 2019). Usually, farmers conduct subsoiling using conventional subsoilers (Askari *et al*., 2016).

At present, there is widespread combined agricultural equipment, which performs many agricultural operations with one passage (Taha & Taha, 2019).While the flip plow works to penetrate and cut the soil slice horizontally, then separate it from the mother soil, and then raise the top of the crumbled section (Altalabani, 2010) . Tractive efficiency, tractive factors, tractive ability, slip and rolling resistance considered the best indicators to evaluate tractive performance for agricultural tractor (Himoud, 2018). (Jebur *et al*., 2013) indicated that the traveling speed and the weight on the rear tractor wheels were the most important factors that affecting the drawbar pull and the specific energy. Diesel engines are one of the main sources of energy for mobile vehicles and can also be used as stationary or mobile power sources (Al-Maidi *et al*., 2018).

Humans used stone pieces to dig the ground and place seeds at the beginning of the cultivation process, relying on human energy directly, as the agricultural machinery developed through the ages, and animals were used to pull the plow and manage the water-wheels in the irrigation process to reduce muscular effort on the farms as well as increase field productivity. And break it up and overturn the surface layer of the earth and replace it with a new layer of the lower soil layers. Therefore, this type of plow is called a (turing plows). During the performance of this process, most of the plant debris and any other material is buried under the furrow slide, and these plows need to have a stronger traction capacity than the excavator plows (Almaliki *et al*., 2016).

This type of plow is more common abroad, and the subtractive plow leaves the soil surface uneven when plowing, so additional operations are needed from leveling the soil surface to prepare these seeds, thus increasing the cost and he rose (Al-Suhaibani, S. A. *et al*., 2010). Diesel engines are one of the primary sources of energy for mobile vehicles and can also be used as stationary or mobile power sources [8]. The tillage is the largest consumable energy of the tractor (Almaliki, 2018).By evaluating the effects of plowing depth and forward speed on the traction force of the tipper plow, disc plows and excavator on sandy clay soils, the results showed significant effects of the forward speed and plowing depth on the traction force of all the studied plows.

Where it is noticed during the process of turning the groove slice, the slice moves aside a certain distance, leaving an open cavity or trench, which is called the groove. When performing the next operation, the groove fills another new groove slice, but leaves another groove uncovered, and the secondary plowing operations break up the groove slices into small parts that fill the existing large air spaces. One of the factors affecting the percentage of slippage when plowing is the depth of plowing, which in turn increases the load on the pull shaft, which makes the size of the cut soil larger, and then the bulk density increases and the porosity of the soil decreases. The percentage of slippage is affected by the increase in the moisture content of the soil, as well as The dept (Al-Jarrah & Muthanna, 2011) of plowing, and the reason is that when the humidity is high, the cohesion between the soil particles increases, which increases the slip rate (Jebur, 2016).

The subtractive plow is slower in performance and more expensive than the digging plow. Also, the subtractive plow buries the most fertile surface layer at the bottom of the field, to show instead a less fertile layer from the ground. Live rain plows are used on clay or yellow soils devoid of salts, especially when it is necessary to turn the soil surface or bury the remains of previous crop plants. The number of bodies ranges between (2-4) and sometimes more, depending on the capacity of the used tractor. In his study (Al-Jarrah & Muthanna, 2011), he explained a soil with a clay texture and an apparent density of (1.22 µg m-2), and he used two types of plows, four process speeds, and different depths (15-20 cm) and (20-25cm). 15 and 20) in most of the studied traits, including the slip percentage%.

Table (1) Tractor specifications

Type of tractor	**Massey Ferguson 375 (2wd,75hp)**
Engine Power at 2200 rpm	75 (B.S) HP
Torque at 1400 rpm	290 Nm
PTO Power at rated	69.5 hp*
PTO Power at 540 rpm	63.0 hp
No. of Cylinders	4
Bore	101mm
Stroke	127 mm (5.0 in)
Gross Weight	2355 Kg
Wheel base	2170 mm
Overall Length	3670 mm

Table (2) mould board plow specifications

Models	MT 202 (H)
Max.depth	25 cm
Tractor compatibity	60 plus Hp
Linkage category	11

2. Methodology

The experiment was conducted in Basra Governorate in 2022 using an experiment according to randomized complete block design and with four replications to study the effect of two factors:

Picture No. (1)

The speed of the tractor: the speed of the tractor included (1.805, 1.347, 0.977) m/sec, where the theoretical speed is measured after operating the tractor with the tipping plow in the field designated for the experiment, and the plow almost touches the ground, taking into account the distance (15 m) from the start The field and stability at the theoretical required speed for the remaining (60 m) Where it was shown (Peça *et al*., 2010) that different results are obtained when the tractor operates at high speeds. After that, the practical speed is calculated by operating the tractor with the tipping plow and the plow in plowing state, according to the depths (0.13, 0.185, 0.235 m), leaving a distance of (15 m) from the beginning of the field, and the practical time is calculated for each depth (second) using a stopwatch For the actual plowing distance, which is (60 m), then the practical speed is calculated from the following law:

1. $$Vp = \frac{S}{Tp} \quad (1)$$

Where: Vp: is the practical speed of the tractor (m/sec)

S: is the actual distance length (60 metres)

Tp: process time (seconds)

Plowing depth: Three soil depths were used, which are (0.13, 0.185, 0.235 m) respectively, using the aforementioned speeds and calculating the time for each of these depths. The Studied Traits Are:

Practical Productivity: Practical productivity depends on the actual speed of the tractor (Vp), as well as on the actual working width of the plow (w), which is measured by a tape measure in meters. (Abdulaziz, 2006) concluded that it is the factors that increase the practical productivity of the puller during plowing. Practical speed, but it Negatively affected when increasing the degree of smoothing after plowing, which in turn causes an increase in the slip percentage. Practical productivity is checked on the coefficient of exploitation of time (Ft), which is approximately (0.7) for plows for dumpers.

$$Ppr = w.Vp. \quad (2)$$

Where: Ppr = actual practical productivity (m2/sec)

w = Actual working width of plow (meters)

Vp = practical tillage speed (m/sec)

Ft = time utilization factor (unit/sec).

Field Efficiency Of Tillage:

Emphasize (Al-Ani & Najm, 2010) Increasing the plowing depth and using the four-rotary plow from 15 to 20 and then to 27 cm had a significant effect on practical productivity and slippage rate. clear up (Al-Nama & Al-Jubouri, 2011) showed that the plowing depth of 10-15 cm was signific antly superior to the depth of 15-20 cm and gave the lowest slippage rate of 6.99% and the highest value in practical productivity of 0.842. Dunum. hour -1. Where the width of the plow design was measured with a tape measure, which is the distance between the right end to the left end of the working part of the plow, for the purpose of calculating the theoretical productivity of the plow from the following equation:

$$Pt = Wd.Vt \tag{3}$$

Where: Pt = theoretical productivity of the plow (m2/sec)

Wd = Designated working width of plow (meters)

Vt = theoretical velocity (m/sec)

After extracting the theoretical productivity, the field efficiency of the plow is calculated by dividing the practical productivity by the theoretical productivity from the following equation:

$$Fe = \frac{Pp}{Pt}.100\% \tag{4}$$

Where: Fe = field efficiency of the plow (%)

Pp = practical productivity of the plow (m^2/sec)

Pt = theoretical productivity of the plow (m^2/sec)

Soil Resistance To Penetration:

Soil resistance to penetration depends on several factors, including (drawing force, plowing acceleration, depth) as well as on the type and condition of the soil (moisture content, cohesion) and this was confirmed by (Amponsah *et al*., 2014) in a study conducted in Ghana on alluvial soil. The relationship between tractor wheel slip and soil moisture content. The results show that when the soil moisture content changed from 12% to 22%, the wheel slip increased from 10% to 20%. And also by (Jebur & Alsayyah, 2017) in a field experiment conducted in one of the experimental fields of the College of Agriculture - University of Baghdad in clay soil, and the soil resistance to penetration can be calculated from the following equation:

$$S.R = \frac{Ft}{Dp.Cp} \tag{5}$$

Where: S.R = Soil Penetration Resistance (kn/m^2)

Ft = pulling force (kN)

Dp = plowing depth (m)

Cp = breadth of tillage (m)

The traction force is calculated by linking the driving tractor (MF 375) to the driven tractor (MF 285s) carrying the dumper plow, taking into account the rolling resistance of the driven tractor and three levels of air pressure, which has a gearbox in neutral position and connects the load cell) between the driven tractor and the driven tractor to measure the drag force when working in the field and for each depth and speed, and they found (Schreiber & Kutzbach, 2008) a high correlation between the drag force and slip. Through it, the force required for the pull is calculated, which represents the rolling resistance of the tractor. As for the sliding, it is calculated from the following equation:

$$S = \frac{Vt - Va}{Vt} \tag{6}$$

Where: S = Slip

Vt = theoretical velocity (m/sec)

Va = practical velocity (m/sec)

As for the plowing width, it is calculated from the following equation:

$$Cp = Nb.0.35 \tag{7}$$

Where: Cp = breadth of plowing depth (m),

Nb = number of bodies

Slippage Percentage:

He has reached (Al-Nemah & Al-Fartousi, 2012) in their study to evaluate the performance of a mechanized unit and to know the effect of plowing depth and practical speed on the characteristic of the slip percentage. It was clear from the obtained results that the slip rate was It (54 and 41%) increased when the process speeds increased from (2.81 and 4.47 km. hr^{-1}) This is confirmed (Mankhi & Jasim, 2012). The theoretical speed and the

practical speed can be calculated through which the slip percentage can be calculated through the following equation:

$$\partial = \frac{Vt - Vp}{Vt} \tag{8}$$

Where: ∂ = slip percentage (%)

Vt = theoretical velocity (m/sec)

Vp = practical speed (m/sec)

3. Results and discussion

Table (3) shows the effect of the plowing depth and the practical speed of the tractor on the practical productivity, as the results of the statistical analysis showed significant differences for the plowing depth at the level of (0.05), where the plowing depth exceeded (0.13 m) in achieving the highest practical productivity rate of (1.716 m2/s).) while the depth of plowing (0.235 m) recorded the lowest rate of productivity, which amounted to (1.101 m2/s). It is also clear from Table (3) that the practical speed of the tractor had a significant effect at the level of (0.05), when the practical speed of the tractor recorded (1.805 m/sec), the highest practical productivity rate of (1.568 m2/sec), while the practical speed of the tractor recorded (0.977 m/sec). The lowest practical productivity rate (1.282 m2/sec) .

Table (3) Effect of some plowing depths and tractor speed on practical productivity

studied trait	plowing depth (m)	Tractor working speed (m/sec)			rate
		0.977	1.347	1.805	
Practical throughput (m^2/sec)	0.13	1.536	1.677	1.936	1.716
	0.185	1.28	1.408	1.597	1.428
	0.235	1.03	1.102	1.172	1.101
L.S.D 0.05-	0.1543				0.096

rate L.S.D 0.05-		1.282	1.395	1.568	
		0.111			

Table (4) shows the bilateral overlap between the plowing depth (0.13m) and the practical speed (1.805m/sec) in recording the highest practical productivity value of (1.936m2/sec), while the interference was recorded at the plowing depth (0.235m) and the practical speed of the tractor. (0.977 m/sec) is the lowest currency productivity and its amount is (1.013 m2/sec). The reason for this is that the practical speed is one of the variables of the equation for obtaining practical productivity and that the practical speed is directly proportional to the practical productivity.
Table (4) shows the effect of traction speed and depth and the interaction between them on the field efficiency of the subtractive tipping plow. In the table, it is shown that the speed of the tractor had a significant effect on the field efficiency of the plow. When the speed of the tractor increased from (0.977 to 1.347, then to 1.805 m/s), the field efficiency decreased from (77.424 to 76.626, then to 75.297%), respectively. The reason for this is due to the low exploitation coefficient time. It is also clear from the same table that the depth had a significant effect on the field efficiency of the plow. The field efficiency decreased from (80.316 to 76.528, then to 72.771%) with an increase in the plowing depth from (0.13 to 0.185, then to 0.235 m), respectively. The depth was accompanied by a decrease in the practical speed, which is considered one of the most important factors involved in practical productivity, which led to a decrease in field efficiency. As for the bilateral overlap between the speed of the tractor and the depth, it had a significant effect on the field efficiency of the plow, where the bilateral overlap between the speed (0.977 m/sec) and the depth (0.13 m) was superior in obtaining a field efficiency of 81.351%, while the lowest field efficiency It was 71.772%, resulting from the overlap of the tractor speed of 1.805 m/sec and plowing depth of 0.235 m.

Table (4) Effect of some plowing depths and tractor speed on the field efficiency of the plow %

studied trait	plowing depth (m)	Tractor working speed (m/sec)			rate
		0.977	1.347	1.805	
Field efficiency of plow %	0.13 0.185 0.235	81.351 77.275 73.648	80.592 76.391 72.895	79.012 75.108 71.772	80.318 76.258 72.771
L.S.D 0.05-		0.312			0.194
rate		77.424	76.626	75.297	
L.S.D 0.05-		0.224			

It is clear from Table (5) that there is a significant effect of the depth of plowing on the soil resistance to penetration, as the depth of plowing (0.13 m) gave the lowest rate of soil resistance to penetration, reaching (95.548 kn/m), while the highest rate of soil resistance to penetration was at the depth of tillage (0.235 meters), where It reached (176.745 kn\m). The table also showed that the depth of plowing (0.13 m) and the practical speed (0.977 m/sec) led to recording the lowest rate of soil resistance to penetration, which was (13.666 kn/m), while the plowing depth of 0.235 meters and the practical speed (1.805 m/sec) recorded the highest rate. Soil resistance to penetration, which amounted to (205.029 kn/m). The table also shows that the practical speed of the tractor had a significant effect at the level of (0.05), where the practical speed exceeded (0.977 m/sec) in recording the lowest rate of soil resistance to penetration, which amounted to (113.043 kn/m), while the practical speed of the tractor recorded (1.805 m/sec) the highest rate of soil resistance. Soil penetration reached (162.715 kn/m). The reason for this may be attributed to the fact that by increasing the practical speed and depth of plowing, and then increasing the bulk density, it leads to an increase in the soil resistance to penetration.

Table (5) Effect of some plowing depths and tractor speed on soil penetration resistance (kn\m)

studied trait	plowing depth (m)	Tractor working speed (m/sec)			rate
		0.977	1.347	1.805	

Soil penetration resistance (kn\m)	0.13 0.185 0.235	86.131 110.951 142.048	96.922 144.501 183.152	103.593 179.523 205.029	95.548 144.991 176.743
L.S.D 0.05-		32.534			20.278
rate		113.043	141.525	162.715	
L.S.D 0.05-		23.415			

Table (6) shows the effect of the depth of plowing and the practical speed of the tractor on the percentage of slipping. The results of the statistical analysis showed that there is a significant effect of the depth of plowing at the level of (0.05), where the depth of plowing exceeded (0.13 meters) in recording the lowest percentage of slipping, which amounted to (15.139%), while The plowing depth (0.235 meters) recorded the highest slip percentage (26.455%).

The table also shows that the practical speed of the tractor had a significant effect at the level of (0.05), as the practical speed of the tractor excelled (0.977 m/sec) in recording the lowest percentage of slipping and was (19.58%), while the practical speed of the tractor gave (1.805 m/sec) the highest percentage of slipping. It amounted to (22.633%), and the reason for this is that the increase in practical speed has led to an increase in the load on the plow as a result of increasing the plow weapon’s cutting of the soil and then reducing the bond between the tractor wheels and the soil and thus increasing the slip rate.

Table (6) Effect of plowing depth and tractor speed onf yhgv the slip percentage (%)

studied trait	plowing depth (m)	Tractor working speed (m/sec)			rate
		0.977	1.347	1.805	
Soil penetration resistance (kn\m)	0.13 0.185 0.235	13.666 19.984 25.091	15.553 22.753 26.569	16.198 23.997 27.706	15.139 22.244 26.455
L.S.D 0.05-		1.026			0.639
rate		19.58	21.625	22.633	
L.S.D 0.05-		0.738			

4. Conclusion and future scope

It is clear from the above that plowing at a depth of 0.13 meters achieved the highest production rate than plowing depths (0.235, 0.185) meters in order to achieve the highest practical productivity rate with the highest field efficiency of plowing, and it also achieved the highest productivity rate of plowing. As well as the lowest rate of soil resistance to penetration with the lowest rate of resistance to overturning,

While increasing the practical speed of plowing from 0.997 to 1.347 m/s and then to 1.805 m/s led to an increase in practical productivity with a decrease in plow field efficiency, as well as an increase in soil resistance to penetration with an increase in the slip rate.

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