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Technique increasing depths of tillage in some characteristics by using moldboard plow

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ABSTRACT
One of the basic tasks in agricultural mechanization technology is to reduce energy consumption in agricultural operations, especially in tillage. Experiment was conducted in fields of Al- Bada in Iraq season 202**4**. This research studied, soil disturbed volum, practical productivity, and tractive efficiency. Best indicator involved three levels of tractor speeds (2.70, 3.4**0** ,3.78 km. hr^{-1}) and three levels of tilt depths (18, 22, 27) cm. Factorial experiments under (RCPD) with three replications was used in this study. It was verified superiority tractor velocity 3.78 $km.h^{-1}$ gets highest value soil disturbed volume which amounted 100.9$m^3.hr^{-1}$and higher practical productivity 0.813 $ha.hr^{-1,}$ while velocity 2 .70 $km.hr^{-1}$ gets less tractive efficiency **63**.**2**3 %, tillage depth 18 cm gets lowest percentage of tractive efficiency 62.11%, depth tilled 27 cm by using moldboard plow gets highest value in soil disturbed volume 98.19$m^3.hr^{-1}$ and practical productivity 0.843 $ha.hr^{-1}$. Interaction between tractor speed 3.78$km.hr^{-1}$ with tillage depth 27 cm was superior in getting the highest (S. D. V)100.9$m^3.hr^{-1}$. practical productivity 0.907 $ha.hr^{-1}$ and higher tractive efficiency 72.00%.

تكنولوجيا زيادة اعماق الحراثة في بعض الخصائص باستعمال المحراث المطرحي القلاب

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الخلاصة

من المهام الأساسية في تكنولوجيا المكننة الزراعية تقليل استهلاك الطاقة في العمليات الزراعية وخاصة في أعمال الحرث. اجريت التجربة في حقول البدعة في العراق موسم 2024. تضمن البحث دراسة الصفات التالية حجم التربة المثار والإنتاجية العملية وكفاءة السحب. أفضل مؤشر تضمن ثلاثة مستويات لسرعات الجرار (2.70، 3.40، 3.78 كم. ساعة-1) وثلاثة مستويات لأعماق الحراثة (18، 22، 27) سم. تم استخدام التجارب العاملية تحت تصميم القطاعات العشوائية الكاملة (RCPD) بثلاثة مكررات في هذه الدراسة. تم التحقق من تفوق سرعة الجرار 3.78 كم. ساعة$^{-1}$ في الحصول على أعلى قيمة لحجم التربة المثار وبلغت 100.9 م3. ساعة$^{-1}$ والإنتاجية العملية 0.813 هكتار. ساعة$^{-1}$، بينما السرعة 2.70 كم. ساعة$^{-1}$ حصلت على اقل كفاءة سحب 63.23 %، عمق الحراثة 18 سم حصل على أقل نسبة كفاءة سحب 62.11%، وعمق الحراثة 27 سم وباستخدام المحراث المطرحي القلاب حصل على أعلى قيمة لحجم التربة المثار 98.19 م3. ساعة$^{-1}$ والإنتاجية العملية 0.843 هكتار. ساعة$^{-1}$. تفوق التداخل بين سرعة الجرار 3.78 كم. ساعة$^{-1}$ وعمق الحراثة 27سم في الحصول على أعلى حجم تربة مثار100.9 م3.ساعة$^{-1}$. الإنتاجية العملية 0.907 هكتار. ساعة$^{-1}$ واعلى كفاءة سحب 72.00%.

الكلمات الافتتاحية: السحب –عمق العمل –الجرار – الانتاجية

INTRODUCTION

One of the important technological requirements for soil preparation equipment is that it performs many operations at different soil depths under different tractor speed loads. Determined by conditions of use for each type of this equipment. Using modern mechanization to increase agricultural production, reduce the time required and speed completion of work. (Alkaab. 2024; - Alkaab., and W. AH Al-Sheikh. 2024) some agricultural technical requirements are regulated, such as regulating different depths of plowing, working width, degree of soil disintegration and fragmentation, depending on working part of each type of tillage equipment (Abdul-Kreem, 2017; Isaak, M. (2011). Despite the many modern technologies in the field of using agricultural machinery and implement to prepare the soil for planting in order to provide suitable conditions for seed germination, it is not without side effects that may lead to compaction of the soil and poor aeration (Alsaady,2013; Ghali,2019; Azawi et al.). Choosing the appropriate machine, especially in process tillage, has a fundamental and major role in the success of any agricultural operation (Kareem and Sven, 2019; Abdullah and Rahman 2019; AL Nuaimi. 2020).

Each soil has characteristics that require the use of tillage equipment suitable for its type, and the mold board plow one of the most efficient types of plows in preparing the soil and achieving the goals of correct and successful agriculture (Al-Janobi et al., 2020). According (Silas and Raymond ,2020; Jyoti et al., 2019) mold board plow cuts lift and turns the furrow slice, buries trash and crop residue, aerates soil control weeds, provides good seed beds for better germination. It must be used at appropriate tractor speeds, depths, and soil moisture conditions. (Isaak et al., 2024; Al-Abdali, 2000) found increase tractor velocity from (2.63 ,4.79 to 6.94) km.hr^{-1} decrease tractive efficiency because of high of slippage percentage in

high velocity. Increase tillage depths from 15,20 to 25 cm increase tractive efficiency (74.9, 78 .1 to 78.9) %. Explain (Al-Ani et al., 2004) increase in the tractive efficiency values from (63.8 to 65.3 to 65.8) % when the plowing depth of the moldboard plow was increased from (15 to 20 to 27) cm traction linear force draft or pull resulting from torque applied to tractor tires. According (Kim et al.,2020; Aday and Al-Musawi 2009) the reason for this was attributed to increase in force resistance capacity which represents one component tractive efficiency. (Asae ,2003) effective productivity is actual amount of work done which would be done if not time were lost It depends on working width, practical speed, depth of plowing, and technical and organizational condition of the machines (Al-Tahan et al., 1995; Ghofran, 2022). According (Al- Hashimi ,2012) higher tractor practical speeds from 1.93, 2.99 to 4.88 cased high productivity (0.144, 0.227 to 0.376) ha. Hr^{-1}. (Jassim, 2018) explained below when working with a greater plowing depth and stabilizing tractor speed, this leads to a decrease in practical productivity, reason is due to an increase in traction force and slippage percentage, thus a decrease in productivity. Soil disturbed volume means that a lot of work has been done, and it increases with depth of tillage, and is accompanied by a higher in fuel consumption (Mankhi, 2012). In a study mentioned (Amer ,2017), superior moldboard plow in obtaining highest average practical productivity, amounting to 0.26 hectares/hr^{-1}, compared to disc plow, which obtained 0.22 hectares/hr. The reason is due to large design width of moldboard plow.

Considering the importance of great effect of practical speed tractor and different types of plowing depths on some mechanical properties of machine and soil properties to prepare suitable cultivation conditions using suitable plowing machines, the research aims to study effect of three levels of tractor speed, (2.70, 3.40 and 3.78)$km.hr^{-1}$ and three plowing depths of (18, 22 and 27)cm on some of studied indicators, which are the volume of soil stirred, practical productivity and tractive efficiency of using mold board plow.

Aim of this research study effect increasing depths of tillage in some characteristics by using moldboard plow.

MATERIALS AND METHODS

Field experiment was conducted in one of field Al-Bada area north of Dhi Qar Iraq season2024. Factorial experiments under complete randomized block design. with three replications in this experiment. First factor tractor velocity at three levels 2.70, 3.40 and 3.78km.hr-1 on the secondary plot, three levels tillage depths, (18, 22, and 27 mm) on main plot. the research included 3*3**3= 27 experimental units. Using moldboard plow working width 75 cm and length 150 cm, width 97 cm and high plow 110cm. Limited working width by hydraulic device was controlled by using control lever. A stopwatch was used to determine the time required to cover the distance (30 m). After recording the required data, following calculations were performed to measure theoretical speed, practical speed, practical productivity, and soil disturbed volum according to the equations shown below.

Field tools were used to implement the experiment, where measurements were taken during implementation for theoretical velocity and time, and readings were taken after implementing experiment for remaining characteristics. An electronic stopwatch was used to measure time, a 10-meter measuring tape to measure the coefficients, a long ruler to measure

ground coefficients and depths, and indicators were used to know beginning and end of each replicate and to know limits of experiment.

Figure (1) mold board plow using in experiment

Studied attributes

Vt: theoretical speed km.hr^{-1}

$$Vt = \frac{D}{Tt} \times 3.6$$

D: Length of the plowing line (m)

Tt: The theoretical time without load (seconds)

$$PT = 0.1 * Wt * Vt$$

PT: Theoretical productivity (ha.hr^{-1})

WT: design working width of the plow (m)

VT: Theoretical speed (km.hr^{-1})

$$P..P = 0.1 * Wp * Vp * St$$

p.p: practical productivity (ha.hr^{-1}) ……(Kepner et al., 1982)

Wp: practical working width of the plow (m)

Vp: practical speed (km.hr^{-1})

$$S.P.V = Pp * Dp$$

S.D.V: soil disturbed volume (m^3.hr^{-1})….. (Bukhari et al., 1988)

p.p: practical productivity (m^3.hr^{-1})

D.p: soil depth field (m)

Tractor specifications

Engine type	Direct injection Diesel
Number of cylinders	6
Internal cylinder diameter	100mm
Power stroke order	1-3-4-1
Maximum power	142hp
Engine revolution	2500 r.ma
Type of cooling	Water
Number of speeds	12
Origin	France
Model	2010 n

Plow specifications

Number of moldboards	3
Type	Cylindercal
Working width	75 cm
Length	140 cm
Height	110 cm
Total weight	160 kg

RESULTS AND DISCUSSION

Table 1. shows effected the tractor velocity, tilt depths, and interactions between them in soil disstuebed volum gets high value which amonted 100.9 $m^3.hr^{-1}$ in grouned speed 3.78 km $.hr^{-1}$ and less value 85.5 $m^3.hr^{-1}$in velocity 2.70 km $.hr^{-1}$, increasing velocity from 2.70 to 3.40 and then to 3.78 km $.hr^{-1}$laed an increase in S.D.V from 85.5 to 96.2and then 100.9 $m^3.hr^{-1}$. Because higher tractor speeds lead to less time to achvment work by using moldboard plow whith a large working depth. This supported by (Al-Badria and Al-Hadithi, 2011; Isaak, M. and Ahmed, M.A.) (2009).

Increaing tillage depths from (18,22 to 27)cm it causes an increase S.D.V from (90.6 ,94.1 to 98.1) $m^3.hr^{-1}$. Reason may be due to existence of a direct relationship between the tillage depth and the volume of soil stirred, as increasing depth leads to an increase in load on tractor, which leads to an increase in wheel slippage and thus an increase in the values of volume soil stirred volum. Interaction between velcity 3.78 $km.hr^{-1}$ and tillage depth 27 cm gets heightes value which amonted 102.5 $m^3.hr^{-1}$.

Table 1 Effect of tractor speeds,tillage depths and interactions between them in soil disturbed volum $m^3.hr^{-1}$.

Tractor speed	**Tillage depths (cm)**			
Km.hr^{-1}	**18**	**22**	**27**	**Average speeds**
2.70	79.2	85.2	93.1	85.5
3.40	93.1	96.4	98.9	96.2
3.78	99.6	100.6	102.5	100.9
0.31		0.54		LSD
	90.6	94.1	98.1	Average depths

Look at (Table 2) indicators to effected tractor velocity, and tillage depths, and the interactions between them in practical productivity. Increasing velocity from 2.70 to 3.40 and 3.78 km .hr^{-1}caused an increase in practical productivity from (0.637 to 0.772 and 0.813) ha.hr^{-1}, because increasing velocity will due to increase velocity in process tillage by used moldboard plow being one of factors in calculating practical productivity. Among the important factors that helped increase practical productivity were maintaining largest working width, highest practical speed, and reducing wasted time. This result agrees the finding by (Mankhi, 2012).

Shaw (Table 2) impact tractor velocity and tillage depths in practical productivity, as it is noted that increasing tillage depths from (18 to 22 and then to 27) cm leads to increase production from (90.6 % to 94.1 and 98.1) h ha.hr^{-1}. interaction between higher velocity 3.78 km.hr^{-1} and depth moldboard plow 27 cm gets heights average practical productivity which amounted 0.907 ha.hr^{-1}.

Table 2 Effect of tractor speeds, tillage depth and interactions between them in practical productivity ha.hr^{-1}.

Tractor speeds	Tillage depths (cm)			Average speeds
km.hr^{-1}	18	22	27	
2.70	0.507	0.633	0.770	0.637
3.40	0.703	0.760	0.853	0.772
3.78	0.677	0.857	0.907	0.813
0.096		N.S		LSD
	0.629	0.750	0.843	Average depths

It was verified the superiority tractor velocity 3.78 km .hr^{-} gets higher tractive efficiency which amonted 68.89 % while the loss value 63.23 % gets in first velocity 2.70 km.hr^{-1} (Table 3) because increasing tactor speeds will caused increase movement resistance which lade to increase tractive force and slippage precentage which caused a decrease tractive efficiency values by using moldboard plow. This agrees with the outcomes of Al-Ani et al.,2004.

Table 3 as it is noted that using tilt depth from (18, 22 and 27) cm lead to gets tractive efficiency from(62.11, 65.89 to 68.55 %) . the interaction between tractor speed 3.78 km.hr^{-1} and tillage depth 27 cm gets heghtes value which amonted 72%.

Table 3 Effect of tractor speeds,and tillage depths and the interactions between them in tractive efficiency %.

Tractor speeds km.hr^{-1}	**Tillage depths (cm)**			**Average speeds**
	18	**22**	**27**	
2.7	60.00	62.67	67.00	63.23
3.4	62.33	64.33	66.67	64.44
3.78	64.00	70.67	72.00	68.89
1.40		2.43		LSD
	62.11	65.89	68.55	Average depths
		1.40		LSD

CONCLUSIONS

From the above results, groaned velocity 2.70, 3.40and 3.78 km.hr^{-1}gets effected in soil disturbed volume from 85.5 to 96.2 and then 100.9 m^3.hr^{-1} by used moldboard plow with large working width. Highest practical productivity in tractor speed 3.87 km.hr^{-1} which amounted 0.813 ha.hr^{-1} while the tilt depth 27 cm superior in all studied properties gets S.D.V. 98.1 m^3.hr^{-1}, practical productivity 0.843 m^3.hr^{-1} and tractive efficiency 68.55%. Therefore, we recommend using a tractor speed 3.78 km.hr^{-1} and tillage depth 27 cm by used mold board plow.

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