Journal homepage www.jzs.univsul.edu.iq
Journal of Zankoy Sulaimani
Part-A- (Pure and Applied Sciences)

Effect of the added weight on the rear wheels and inflating pressure in agricultural Tractor type (New Holland 2WD) on the performance of Mold Board Plow in terms of some mechanical & physical properties of the soil

Fawzy F. Khorshid

Faculty of Agricultural Science-Sulaimani University, Bakrajo Street, Sulaimaniyah-Iraq

Email: fawzy.shwany@yahoo.com

Article info

Original: 10 July. 2015
Revised: 7 September. 2015
Accepted: 8 September. 2015
Published online: 20 March. 2016

Key Words:

Added weights to the wheels

Wheels bulge pressure

Mechanical Properties

Soil Physical Properties

Triple Mold Board Plow

Abstract

Experiment was conducted in one fields of Agricultural Sciences College in Sulaymaniyah University with Silty-clay soil in order to study the effect of different weights added to the rear wheels for agricultural tractor type New Holland 2WD, with the effect of pressure bloating of rear wheels on the performance of triple Mold Board in terms of some properties represented by: The amount of fuel consumption, plowing practical speed, Slippage percent, soil penetration resistance, covered soil volume, number of clods which have a diameter more than 10 cm. Split- plot design used in this research under randomized complete block design RCBD, where added weights factor on rear wheels wear put in the main plots represented by two levels which are without weights and added weights by 100 kg per each rear wheel, While bloating pressure factor of the wheels has been developed in sub plots by three levels included 80, 100 and 120 Kpa. The results showed that the added weight had a significant effect on all studded properties except of fuel consumed amount. While bloating pressure factor of the wheels was significantly difference in the level 80 Kpa on 100 Kpa level, which in turn significantly differs on the third level 120 Kpa in all studied properties. As to the interaction between the factors, the weights 200 kg factor with bulging pressure wheels 80Kpa recorded best significant effect on the rest of interactions in all studded properties except in fuel consumed property which the differences between the factors was In favor for the factor without weights with the bulging pressure wheels 80 Kpa, as the results showed that there is no significant differences between number of interactions for all studded properties in the experiment except soil penetration resistance property, where was significant differences between its levels.

Introduction

As the agricultural tractor is the main source of mechanical power in the field, whether moving on rubber wheels or crawler to provide various agricultural equipment with Required power in the field Perfectly, the interest in providing optimal conditions for their work is the basis for the success various agricultural operations and reflect positively on increasing the equipment productivity and the production of agricultural crops in quantity and quality, Considering lower costs as much as possible by taking into account the technical and scientific aspects when exploiting agricultural tractor in the field, This is done through many processes to prepare the tractor to work in an optimal scientific manner to reach the desired goal, for that *[2]* noted the possibility of optimization in the performance of agricultural tractor to become ready to work in different conditions by controlling rear wheel inflation pressure. *[9]* Referred that the tire pressure and the load inflicted on the tractor wheels seen as easy standards management which plays an important role in improving the plowing operations and reduce slip which involves the loss of power to a large extent, and this side affects the fuel consumption and time Required to plow the soil. *[16]* shows the possibility of measuring the amount of fuel consumed by the engine either by measuring the fuel level in the tank before and after the test procedure, but there are some errors in this way, especially when the time and area of the test is little, or by using fuel graduated cylinder putted on main line fuel system between the tank and the fuel injection pump. It is known that slip leads to an increase in the amount of fuel consumed in the performance of any agricultural operation, as well as an increase in consumption, wheels, and wheels tread, Also an increase in the time it takes for an agricultural operation, according to the proportion of the amount of slip. So it is necessary to reduce the value of a slippage into minimal to be of great benefit in reducing the earlier mentioned damages as well as sabotage of the soil physical properties. On the other hand *[1]* Indicates to the actual need to a reasonable proportion of slippage as a damper for the repercussions and shocks that may occur in the field as a result of the sudden load of the engine or the hitch points because of the obstacles that this ratio does not exceed 15% as a maximum extent permitted allowed in wheeled tractors. The results of [11] showed that the addition of standard weights or water to the tractor rear wheel led to a significant increase in raised soil size and bulk density when plowing while there was no significant effect of these factors on the fuel consumption indicator. Soil compaction has large impact on the performance of many agricultural operations, particularly tillage operations as facing exceptional work during Plows resistors in these soils as may be caused big problems such as knives damage and the difficulty of penetrating of plow knives into the soil and reach the required depth. Soil compaction causes back to many factors including the use of heavy machinery or add weights on tractor axes as well as tire inflation pressure, all which lead to increase hanging weight on area unit weight , and this was confirmed by *[12]* They noted the existence of a relative relationship between load inflicted on the axis of agricultural tractor back and size or bulging tire pressure and must be put correct combination of these two factors, according to the process of agricultural and soil conditions because of its great impact on the optimal tractor performance of different agricultural operations. *[17]* Refer that the increase in the size of tires must be accompanied by a decrease in tire pressure to prop up and support a certain load on the axis of agricultural tractor. This is supported by *[7]* and *[15]* later where they said that this measure will also provide improved drag performance and reduce the proportion of soil deformation of the fact that the soil compression point of contact center under the wheels directly, which is almost equal to inflation pressure, in addition to the pressure of the tires on soil shear strength or hardness. And here comes the role and purpose of this study, which focused on the effect of the added weight on the rear wheels and inflated pressure in agricultural tractor type Massey Ferguson on the performance of the triple Mold Board plow in terms of some mechanical properties and physical indicators of the soil.

Materials and method

A field experiment was conducted in one of the Faculty of Agricultural Sciences of the University of Sulaymaniyah fields in Silty-clay soil at rates of 43.6% clay, silt 51.13% and sand 5.27% while the proportion of organic matter which amounted to 2.32% and the moisture content when performing the experiment 16%. Agricultural tractor type New-Holland 70 hp used in this research with Front Drive ,diesel engine with four-stroke and four direct injection, and the tractor total 2575 kg, the weight on the rear axle 1770 kg and rear tires size have been 16.9 / 14-30 pressure inflating of 1.1 kg / cm^2. Tilling was done in this experiment by using three bottoms Mold Board plow weight of 300 kg and a work width of 105 cm. The experiment was executed according to a split-plot design under randomized complete block design (RCBD) with three replications .least significant differences (L.S.D) was used to compare means of treatments at 0.05 level., Main plot included added weights factor: without weights and 200 kg at the rate of 100 kg per wheel, while sub plots included tires inflating pressure factor with three levels of 80,100 and 120 Kpa, The tractor with a plow in the experiment field Been running without plowing to calculate the theory speed and reached 6.46 km/hr. note that this speed was within the recommendations mentioned by *[1]*,while the practical speeds was calculated during tillage operation with M.B plow for all treatments in this experiment on the same elected theoretical speed, the experiment Characters was calculated as follow:

- Estimating amount of fuel used in the experiment (L / ha): As indicated by the *[16]* using a graduated cylinder installed on the main line system of fuel between the tank and fuel injection pump. The data that were obtained was in ml / Unit of experiment area then converted to liter / ha by using the following mathematical equation that *[3]* depended on:

$$FC = \frac{F.V \times A}{We \times d} \times Fe \quad \text{.....(1)}$$

Where:

FC= The amount of fuel consumed (L/ha)

F.V= fuel consumed volume (ml)

A= Hectare area (m^2)

We= work width (m)

D= distance of plowing line

Fe = field efficiency (%) where it was assumed for this experiment 80%. Said *[18]* that the value of the efficiency of field operations for tillage range (75-90%).

- The practical speed (km/h): Measured by calculating the time it takes to plough distance of experimental unit length m/s and then convert the data into km/h by the equation:

$$Vp = \frac{D}{} \times 3.6 \quad \text{.....(2)}$$

Tp

Where:

Vp= practical speed (Km/hr)

D= tillage distance (m)

Tp= the takes time for ploughing an experiment unit distance(sec)

- Wheel slip (%): Is a mismatch between the length of the linear distance to the circumference distance for fixed number of tractors wheel revolutions in, Usually linear distance relatively be less than the wheel circumference, Slip ratio was calculated according to the adopted way by the *[7]*:

$$S = \frac{Vt - Vp}{Vt} * 100 \quad \ldots\ldots\ldots\ldots (3)$$

Where:

S= percentage of slip (%)

Vt= theoretical speed (Km/hr)

Vp= practical speed (Km/hr)

-Soil covered volume (m^3/hr) : Was calculated as the way adopted by the *[13]* according to the following equation:

$$S.C.V = Cp \times D \times 2500 \quad \ldots\ldots\ldots\ldots (4)$$

Where:

S.C.V= Soil covered volume (m^3/hr)

D= actual tillage depth (m)

Cp = the productivity of the plow was calculated according to the following equation *[10]* and *[4]*:

$$Cp = \frac{A}{T} \quad \ldots\ldots\ldots\ldots (5)$$

Where:

A= experiment unit area that has been plowing (ha)

T= time it takes to plow experimental unit per hour

- Number of clods with a diameter greater than 10 cm/m ^{2}: *[6]*. Said that The appearance of tillage is one of the most important indicators by which to determine the efficiency of tillage equipment in creating the appropriate sense of the seed shrine. for express to the number of soil clods that diameter bigger than 10 cm that referred to the tillage appearance used wired sieve area of 0.5 m^2 ,where the distance between wire and other was 10 cm. the number of clods × 2 calculate for the purpose of expressing the number of clusters per square meter.

- Soil penetration resistance (Kpa): measured by using dynamic soil penetrometer in three random locations for each experimental unit, particularly in soils under tractor tires line and then took the average of those readings.

Result and discussion

1-The effect of added weight (Kg) :

Table (1) show the existence of a significant effect of weighting factor in all the Characters except amount of fuel consumed, where note that adding 200 kg weight on the tractor wheels the slippage percent decrease from 12.32% to 9.58% because increase in actually weight on the wheels make touches space between the wheel with the soil largest and thus slip decrease which lead to increase in plowing practical speed and rate of operating soil volume this is what *[4]* refer to that adding weights to the wheels lead to increase contact between the wheel and the soil which play role to reduces the losses in power lost by slippage that reflect positively on increasing the productivity of the plow in the same period time. The table (1) also indicates that the addition of weights on the rear wheels led to a significant increase in the soil penetration resistance character from 1240.89 Kpa to 1297.67 Kpa This is reached by the *[8]*. The reason for this is due to the increase weights lead to soil compaction and difficult to penetrate by the plow,-and this was supported by *[19]* when he studded effect of two types of soil, tire inflation pressure, tire size and added weights he said when tire inflation pressure was constant bulk density and penetration resistance increased with increasing in added weight on the axis of the tractor.

Table – 1: Effect of added weight on the characters.

Factor (A) Kg	Fuel consumption L/ha *	Practical speed Km\hr	Tire slippage % *	Soil penetration kpa *	Soil covered volume m^3/hr	No. Soil clod diameter *
Control	18.72	5.62	12.32	1240.89	945.65	7.84
200	18.53	5.80	9.58	1297.67	975.14	6.40
LSD 5 %	**0.3614**	**0.0349**	**0.5434**	**24.306**	**5.8604**	**0.4466**

*****Least values are the best values

2- Effect of tire inflation:

From Table (2) can be seen that the tractor tire inflation pressure significant effect between the treatment means in all of the characters, the best results were in favor of the treatment of pressure inflating 80 Kpa, namely: 17.52, 5.90, 8.09,1071.17, 991.20, and 5.67 for characters: the amount of fuel consumed , practical speed, slip percentage, penetration resistance, soil cover volume, and the number of clods that diameters more than 10 cm respectively. The reason for this is that low pressure inflation for tire led to the increased surface area in contact wheel with the ground and thus a decrease in the proportion of wheel slip, which in turn led to a reduction in fuel consumed quantity and an increase in the tractor practical speed, which in turn increased the soil covered volume of the unity of time, these results are agree with the findings of the *[9]* and *[2]*, As well as with *[13]* when he referred that there is a provision in the consumed fuel by 0.27 gallons / acre an average of 20%, as well as an increase in the soil covered area using a disc plow by 0.67 acre / hr an average of 5.7%. Also from the table (2) we note that the increase of pressure iflating the soil resistance to penetration has increased significantly from 1071.17 Kpa at 80 Kpa tire pressure to 1290.83 Kpa at a pressure of 100 Kpa, which in turn has increased significantly to 144 Kpa at tire pressure 120 Kpa, also increased the number of soil clods that diameters larger than 10 cm significantly from 5.67 to 7.10 and then to 8.60 when the inflating pressure of 80 has increased to 100 and then to 120 Kpa respectively. The reason for this is due to the increase in soil compaction by increase tire inflation pressure and thus increasing the value of bulk density that leading to a conglomerate soil in the form of large synagogues of the plowed soil surface.

Table – 2: Effect of tire inflation on study characters.

Tire pressure Kpa	Fuel consumption L/ha *	Practical speed Km\hr	Tire slippage % *	Soil penetration kpa *	Soil covered volume m^3/hr	No. Soil clod diameter *
80	17.52	5.90	8.09	1071.17	991.20	5.67
100	18.63	5.71	10.98	1290.83	960.11	7.10
120	19.72	5.53	13.78	1445.83	929.88	8.60
LSD 5 %	**0.4426**	**0.042**	**0.6656**	**29.768**	**7.1775**	**0.5469**

*****Least values are the best values

3- The effect of interaction between weight factor and inflating pressure of the traits

Table (3) refer to the presence of significant differences between the interacting means of added weight and tire inflating pressure, with increasing the interacting means value increased significantly all studied character values and the best one was when weight treatment 200 kg interact with inflating pressure 80Kpa treatment for the characters: practical speed, wheel slip, soil covered volume, and the number of clods that diameters larger than10 cm, which values was: 5.98 L / ha, 6.74%, 1005m3 / hr and 5, respectively, these results are consistent with the findings of the *[9]* and *[5]*. While the best value for fuel consumption and soil covered volume characters happened when the treatment without added weight interacted with the treatment inflating pressure 80Kpa, which were 17.07 L/ha and 1024.00 kpa respectively.

Table – 3 Effect of interaction between added weight on the rear wheels and tire inflating pressure

Interaction Added weight& Tire pressure	Fuel consumption L/ha *	Practical speed Km\hr	Tire slippage % *	Soil penetration kpa *	Soil covered volume m^3/hr	No. Soil clod diameter *
Cont. & 80Kpa	17.07	5.81	9.44	1042.00	976.64	6.34
Cont. & 100 Kpa	18.78	5.63	12.25	1264.00	946.40	8.18
Cont. & 120Kpa	20.31	5.44	15.26	1416.67	913.92	9.00
200Kg & 80Kpa	17.97	5.98	6.74	1100.33	1005.76	5.00
200Kg & 100Kpa	18.49	5.79	9.70	1317.67	973.82	6.02
200Kg & 120Kpa	19.14	5.63	12.30	1475.00	945.84	8.20
LSD 5 %	**0.626**	**0.0604**	**0.9412**	**42.099**	**10.151**	**0.7735**

From the above table, we conclude that the best results will be achieved when the added weight on the rear wheels of the tractor was 200 kg With rear wheels inflating pressure 80 Kpa for its best results and for all studied indicators Except fuel consumption and soil penetration resistance. So the study recommends using these levels of the studied factors to achieve better productivity of the desired results and to reflect on the positive results of plant characters and yield later.

References

[1] AL-Banna, Aziz Ramo "*Soil tillage equipment*" The Ministry of Higher Education and Scientific Research, the University of Mosul, the Faculty of Agriculture and Forestry. (1990).

[2] Hamoud, Majid Ahmed "*Effect of rere tire inflating pressure and forward speed on the fuel consumption for anter tractor*" Egyptian Journal of Agricultural Engineering, Vol. 6 Issue (1), pp. 686-694, (80). (2009).

[3] AL-Jarrah, Nuri al-Muthana Abdul Malik "*Loading tractor with two types of plows and measuring specific fuel consumption effects under rain-fed conditions*" Master Thesis, Department of Agricultural mechanization. Agriculture and forestry collage. University of Mosul. Iraq. (1998).

[4] Abbouda, Sirelkatim K., Hasan A. AL-Hashem and Mohamed O. Saeed "*The effect of some operating parameters on field performance of a 2wd tractor*" Scientific Journal of King Faisal University (Basic and Applied Sciences) Vo.(2), No.(1). (2001).

[5] Abu-Hamdeh, N. H., Al-Widyan M. I. "*Effect of axle load, tire inflation pressure, and tillage system on soil physical properties and crop yield of a jordanian soil*" American society of agricultural engineers Vol. 43(1): 13-21. (2000).

[6] AL-Hashimy, Laith A. Z. "*The effect of disc tilt angle, tillage speed and depth on some of machinery unit technical and energy requirements parameters*" The Iraqi Journal of Agricultural Science, 33 (1) : 131-143. (2012).

[7] Ageikin, I. S. "*Off-the-Road Wheeled and Combined Traction Devices: Theory and Calculation*" New Delhi, India: Amerind Publishing Co. (1987).

[8] Botta, G. F, Jorajuria D. and Draghi L. M. "*Influence of the axle load, tyre size and configuration on the compaction of a freshly tilled clayey soil*" Journal of Terra mechanics, Vol (39): 47–54. (2002).

[9] Damanauskas, Vidas Algirdasm, Janul Evičius. & Gediminas Pupinis "*Influence of Extra Weight and Tire Pressure on Fuel Consumption at Normal Tractor Slippage*" Journal of Agricultural Science, Vol.(7), No.(2). (2015).

[10] Hunt, D. R. "*Farm power and machinery management*" 8th Edition, Iowa, The Iowa State University. (1983).

[11] Jasim, Abdulrazzak, A., Al- shujairy and Tahseen A. Dila "*The Effect of Added Weights to Rear Wheels of Tractor, Plow Type and Tillage Depth on Fuel Consumption, Soil Disturbed Volume and Soil Bulk Density*" 5th Scientific Conference of College of Agriculture -Tikrit University From 26 to 27 April (2011).

[12] Lamande, M. and P. SchjOnning " *Transmission of vertical stress in a real soil profile: Part II. Effect of tyre size, inflation pressure, and wheel load*" Soil and Tillage Res. 114(2): 71-77. (2011).

[13] Lancas, Kleber, P. Upadhyaya, Shrini Muluneh, Sime K. and Sayedahmad Shafii "*Overinflated tractor tires waste fuel, reduce productivity*" California agriculture, Vol. (50), No (2)**.** (1996).

[14] Mari, G. R., F. A. Chandio, N. Leghari, A. G. Rajper and A. R. Shah "*Performance Evaluation of Selected Tillage Implements Under Saline- Sodic Soils American-Eurasian*" J. of Agric. & Environ Sci.,10 (1) : 42 – 48. (2011).

[15] Misiewicz, P. A., T. E. Richards, K. Blackburn, J. L. Brighton, M. J. Hann, and R. J. Godwin"*Techniques for estimating contact pressure resulting from loaded agricultural tyres*" ASABE, Paper No. 083511. St. Joseph, Mich. (2008).

[16] Natsis, A., G. Papadakis and J. Pitsilis "*The Influence of Soil Type, Soil Water and Share Sharpness of a Mouldboard Plough on Energy Consumption, Rate of Work and Tillage Quality*" J. Agric.Ing. Res. Vol.(72), 171-176. (1999).

[17] Plackett, C. W.. *The ground pressure of some agricultural tyres at low load and with zero sinkage*. J. Agric. Eng. Res. 29(2): 159-166. (1984).

[18] Roth, L. O., F. R. Grow and G. W. A. Mahony "*An introduction to agricultural engineering*" AVI publishing company, INC., Oklahoma State University. (1977).

[19] Way, Thomas R., Kishimoto, Tadashi, Torbert, H. Allen, Burt, Eddie C., Bailey and Alvin C."*Tractor tire aspect ratio effects on soil bulk density and cone index*" Journal of Terra mechanics, Vol (46) : 27–34. (2009).