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The Impact and Analysis of Mechanical Factors of the Mechanized Unit on the Production of "Vigna radiata L." Crop

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Abstract

This study aims to know the effect of each of the forward speed factors and the depth of ploughing factor on the yield of Mung bean and some performance calculations of the tractor with the agricultural machine, which are as follows: (pull force, fuel consumption and slippage when conducting field operations). The average soil moisture content was (17.13%). Experiments were carried out using a split-plot system under a randomized complete block design with three replications. The depth of 18cm recorded the highest fuel consumption, the highest pull force and the highest slippage (17.82 l/ha, 13.21 kN and 7.97%), while the forward speed of the tractor was 17.12 km/h, the lowest fuel consumption was (12.06 l/ha). As for the production of the Mung bean crop, the depth of 18 cm and the forward speed of 4.03 km/h recorded the highest crop productivity rate of 15.97 kg/h.

Keywords:

Depth, pull force, speed, fuel consumption.

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Introduction

Mung bean "vigna radiata L." is an important leguminous plant from the Fabaceae family, which is used as a primary food source in Asia because it contains protein (19 to 29%), carbohydrates (62-65%), and fats (1-5%). Its plants are also used for feeding animals and improving soil characteristics (Al-Younis, 1993). In addition, it is characterized by its short growth period, the possibility of cultivation after harvesting field plants, and its productivity is low in Iraq compared to global production, as the crop suffers from a problem during flowering, which is a high percentage of fallen flowers, which leads to their falling and thus a reduction in production. (Ali et al., 1990). The selection of the compound machine is considered one of the very important matters that require high accuracy and is subject to important criteria because of its great role in achieving perfect quality during the implementation of the intended process, which is to prepare a suitable bed for the growth of the seed, and attention should be paid to the proportionality of the work of the compound machine with the used tractor. The effectiveness of the work of compound machines is related to the extent of the impact of these machines on working conditions and the type of production (Kovač et al., 2022), which reflects positively on reducing costs and increasing production per unit area (Hassan, 2012).

(Hameed & Jebur, 2023) Concluded by manufacturing and evaluating a combined machine for soil preparation and tillage cultivation, where this machine performs several operations in one pass, and the performance of the combined machine was tested at different forward speeds and different plowing depths, and the experimental results showed that each of the energy requirements (Khan & Siddiqui, 2024).The total costs are at their lowest values, and the crop yield is as high as possible through the use of the combined machine instead of using the traditional method, to reduce the number of times the machine passes over the agricultural soil, which reduces the risk of soil compaction and its impermeability to water(Haghighi & Far, 2014).

Tillage plays a major role in dismantling and turning the soil, as well as mixing it with the plants remaining on the surface, and this affects the physical properties of the soil such as bulk density, porosity, water and air movement through soil particles, soil resistance to penetration, surface hardening, and many other characteristics (Hillel, 2013; Amer, 2024).

Slippage is defined as the reduction in the forward speed of the tractor compared to the theoretical speed. The slip ratio is considered the most important criterion for agricultural tractors (Paul et al., 2020), and it expresses the percentage of power lost from the tractor. The maximum pull occurs in the tractor when the slip ratio is confined between 0 to 15 %, and the tractive efficiency decreases when the slip rate increases above 15% (ASAE, 2003; Zoerb & Popoff, 1967).

The use of installed machines in soil ploughing reduces the consumption of fuel (Dinesh, 2024). Obtaining the highest consumption of fuel during the agricultural process is one of the most important goals of good farm management (Bosco, 2016; Grisso et al., 2010; Jebur, 2018). Therefore, it is necessary to conduct a study on experimenting and testing the cultivation of the *vigna radiata L* crop in the combined machine.

Materials and Methods

An experiment was conducted to cultivate a crop "Vigna radiata L. " The combined machine was evaluated by attaching it to the agricultural tractor, and the original approval was obtained to conduct these practical experiments agricultural, to evaluate the performance of the combined machine (Aljuboury & Jebur ,2022). The field was designed to carry out the experiments of the research project through the use of three levels (main plate) for the front speed of the agricultural tractor (4.03, 5.86 and 7.12 km / h), while the depths were considered as (secondary plate) with two levels, which are (13 and 18 cm). New Holland tractor and International 966 were used in this work. Measuring instruments were a dynamometer, and fuel depreciation apparatus.

Parameter Measurement

Force of Pull (FB)

The tractor-pulling force was measured using a dynamometer as follows. (Jebur, 2018):

Nfb = B with load – A without load.

Where:

Nfb= Net force of pull, kN

Consumption of Fuel (Cf)

The perfect method for calculating the consumption of diesel fuel when conducting experiments in the field is the volumetric method, which depends on measuring a specific volume of fuel consumed through the use of a device shown in Figure (1). It was calculated as follows; (Hachim & Jebur 2022)

$FC = \left(\frac{V}{t}\right) \times 3 \cdot 6$ …………..1

Where:

F.C= Consumption of Fuel, l/h

V= Volume Consumption of Fuel, ml

t = second

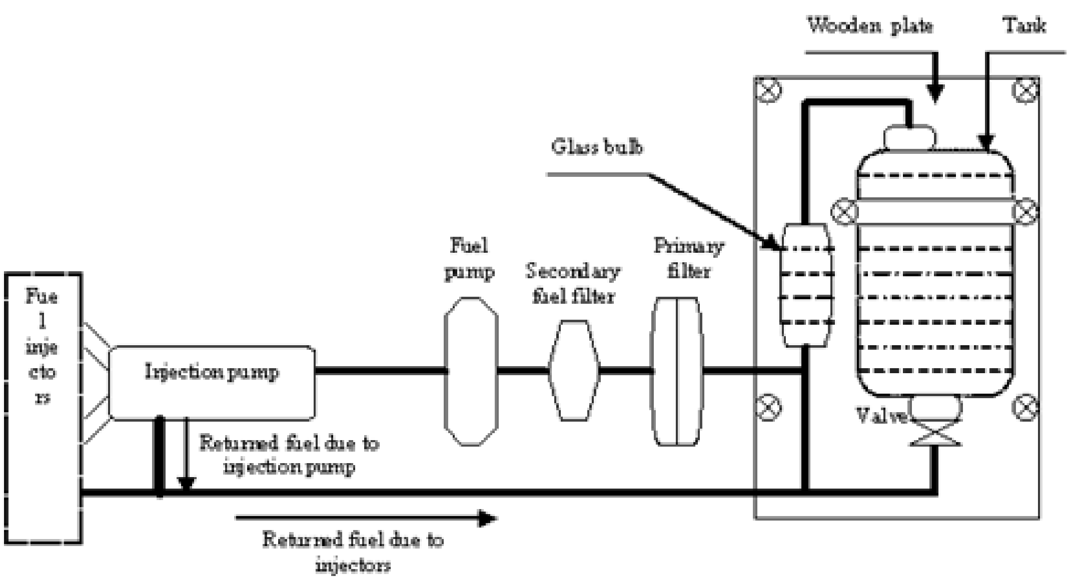

Figure 1. Schematic diagram showing the volumetric method

Tire Slip (Ts)

Calculated according to sources: (Mankhi & Jebur. 2022; Amer, 2019)

$$\boldsymbol{s = 1 - \frac{FS_2}{FS_1} \times 100 \;\ldots\ldots\ldots\ldots\ldots\ldots 2}$$

Where:

Fs1= speed of tractor without load, km/h.

Fs2= speed of tractor with load, km/h

Yield of the Seeds (kg/h)

Calculated by multiplying the seed yield per plant, which is calculated as the average seed weight of the twenty plants taken randomly, multiplied by the plant density, Al-Dabbagh & Al-Duleimi (2017).

Results and Discussion

Consumption of Fuel (Cf)

Table (1) demonstrates the effect of the machine speed of the tractor and depths on the consumption of fuel, where the tractor speed had a significant effect on the amount of exhaustion of fuel (Aljuboury & Jebur,2023). When the machine speed increased from 4.03 to 5.86 and then to 7.12 km/h, the consumption of fuel for each Unit area decreased from 15.97 to 13.10 and then to 9.74 l/ha, respectively, the reason for this may be because increasing the forward speed of the tractor leads to achieving a certain area in a shorter period, so it leads to reducing the amount of fuel consumption per unit area. These results agree with the results reached by Amin et al., 1992; Alloush, 2001). It is clear from table (1) the significant effect of the depths of the meadow on the exhaustion of fuel. When the depth of the meadow was increased from 13 to 18 cm, it resulted in an increase in the consumption of fuel for each Unit area from 10.68 to 15.18 l/ha. (Swain et al. 2022).

Table 1. Effect of the machine speed and depth on consumption of fuel (l/ha)

Average	**Depths, cm**		**Machine speed, km/h**
	18	**13**	
15.97	17.82	14.11	4.03
13.10	15.67	10.53	5.86
9.74	12.06	7.41	7.12
0.254	0.342		L.S.D = 0.05
	15.18	10.68	Average
	0.209		L.S.D = 0.05

Tire Slip (Ts)

Table (2) shows the effect of machine speed and deepness on tyre slip, where the speed of the tractor had a significant effect on the tyre slip. When the speed increased from (4.03 to 5.86, then to 7.12 km/h) the slip percentage increased from 3.77% to 5.20% and then to 7.35%, this is agreed with (Makawi & Jassim ,2023). It is also clear from Table (2) that the depths have a significant effect on the percentage of slipping, as by increasing the depth from 13 and then to 18 cm, the slip percentage increased from 5.04 to 5.83%.

Table 2. Effect of the machine velocity and deepness on slip (%)

Average	Depths, cm		Machine speed, km/h
	18	13	
3.77	4.01	3.52	4.03
5.20	5.52	4.87	5.86
7.35	7.97	6.73	7.12
0.135	0.187		L.S.D = 0.05
	5.83	5.04	Average
	0.102		L.S.D = 0.05

Force of Pull (FB)

Table (3) shows the effect of the machine speed and depths on the pulling force, where the speed had a significant effect on the pulling force, as it is clear from the table that the higher the speed led to the pulling force when the speed increased from 4.03 to 5.86 then to 7.12 then to km/h it led to an increase in the pull force from 10.22 to 11.54 and then to 12.11 kN. This is agreed with (Jebur and Himoud. 2018) and (Jebur, 2016). It is also clear from Table (3) that the depths have a significant effect on the pulling force, as by increasing the depth from 13 and then to 18 cm, the pulling force increased from 10.25 and then to 12.33 kN.

Table 3. Effect of the speed and deepness on the force of pull (kN)

Average	Depths, cm		Machine speed, km/h
	18	13	
10.22	11.12	9.31	4.03
11.54	12.65	10.42	5.86
12.11	13.21	11.01	7.12
0.159	0.204		L.S.D = 0.05
	12.33	10.25	Average
	0.121		L.S.D = 0.05

Yield of the Seeds (kg/ha)

Table (4) shows the effect of machine speed and deepness on the yield of the seeds. An increase of the depth (13, 18 cm) led to an increase in yield (1351, 1405 kg/ha) respectively. This is agreed with (Jebur, 2018).

Table 4. Effect of the speed and depth on the yield of the seeds (kg/ha)

Average	Depths, cm		Machine speed, km/h
	18	13	
1396	1432	1360	4.03
1376	1400	1352	5.86
1363	1384	1342	7.12
23.064	43.180		L.S.D = 0.05
	1405	1351	Average
	21.032		L.S.D = 0.05

Conclusion

We can conclude from this work that the ploughing depths have a significant impact on the evaluation of field science and the extent of its impact on the output of the yield of Mung bean, as well as the study of some performance characteristics of the agricultural tractor and its relationship to the forward speed of the tractor and the extent of its impact on plant productivity.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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