EVALUATION OF SOME PERFORMANCE INDICATORS FOR THE TRACTOR (CASE JX75T)

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ABSTRACT

The experiments were conducted on farm of the Agriculture College, University of Basrah, in a silty clay soil with moisture content of 16%. The tractor used in this research was (CASE JX75T) tractor for studying and evaluating its agricultural performance. The parameters of study include three level of tillage depths (10, 15 and 20 cm) and four forward speeds (G=1.9, G= 2.44, G3= 3.25 and G= 4.33 km/h) by using randomized complete block design (RCBD) with a split plots. The results showed that the increase in forward speed from (1.9 - 4.33km/hr) led to a significant increased in drawbar pull and wheel slippage by the following percentages (33.33%-15.78%).The obtained results for the range of tests showed that the maximum effective field capacity 2.52 donum/h was obtained at 4.33 km/h travelling speed, while the fuel consumption 7.9 l/hr, required power 29.66 kW, and specific energy 19 kw.hr/don. Respectively the traveling speed and soil moisture , ploughing depth , the most important factors that affecting the effective field capacity and drawbar pull, fuel consumption, specific energy.

Keywords: drawbar pull, effective field capacity, fuel consumption, specific energy.

تقييم بعض مؤشرات الاداء للجرار (CASE JX75T)

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المستخلص

نفذت التجربة في احد الحقول الزراعية التابعة لكلية الزراعة جامعة البصرة في تربة طينية غرينية ذات محتوى رطوبي 16%. استعملت في التجربة الجرار نوع (CASE JX75T) لدراسة تقيم الاداء الحقلي للجرار، حيث تم استخدام محراث مطرحي قلاب بأعماق حراثة (10، 15، 20سم) وبأربع سرع امامية (km/h G1=1.9 ،G2= 2.44، G3=3.25، G4=4.33) صممت التجربة وفقا لتصميم الالواح المنشقة مع تصميم RCBD)، اذ خصصت القطع الرئيسية للسرع الامامية والقطع الثانوية لأعماق الحراثة. اظهرت النتائج ان زيادة السرع الامامية من (1.9-4.33 كم/ساعة) ادت الى زيادة معنوية بقوة السحب والانزلاق بنسبة (15.78% - 33.33%)، والنتائج التي تم الحصول عليها لمجموعة من الاختبارات اظهر ان باستعمال السرعة الامامية 4.33 كم/ساعة انتجت اعلى معدل الإنتاجية العملية 2.52 دونم/ساعة واستهلاك الوقود 7.9 لتر/ساعة والطاقة المطلوب29.66 kW واستهلاك النوعي للطاقة 19 كيلو واط. ساعة/دونم. بشكل عام السرعة الامامية للجرار ورطوبة التربة وعمق الحراثة من اكثر العوامل المؤثرة على الانتاجية العملية واستهلاك الوقود وقوة السحب والاستهلاك النوعي للطاقة.

الكلمات المفتاحية: الانتاجية العملية، استهلاك الوقود، قوة السحب، الاستهلاك النوعي

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INTRODUCTION

Agricultural tractor is one mechanical power sources used in operating machines for performing agricultural processes .The tractor deals with many factors, among them are the type of soil and forward speed. Tractive efficiency, tractive factors, tractive ability, slip and rolling resistance considered the best indicators to evaluate tractive performance for agricultural tractor. The agricultural tractor must provide a high tractive power as in ploughing. This involves a high efficiency transferring in engine power to tractive effort. Almaliki et al. (8) assessed the predictive capability of several configurations of ANNs for performance evaluating of tractor in parameters of drawbar power, fuel consumption, rolling resistance and tractive efficiency. Jebur et al**. (**11**)** indicated that the wheel slip increased with the increase in the traveling speed, while decreased by increasing the weight on the rear tractor wheels. When the soil is at the solid state (dry) the cohesion is high and therefore the soil strength and that resulted in greater thrust force and lower wheel slip and rolling resistance (18). But when the moisture content is high, the soil at the plastic state (wet) the soil cohesion is high but the wheel slip and the rolling resistance is high and that can cause greater power losses and that reduces the tractor traction efficiency. The soil cohesion is utilized by the contact area of the traction tires with soil (2, 3, 4, and 15). Almaliki et al. (7) revealed that the forward speed was the most influential parameter on Temporal, Area-specific and Specific Fuel Consumption (TFC, AFC and SFC) while the moisture content and tire inflation pressure effects were minor. Sahu and Raheman (17) indicated that the study on matching and field performance, the wheel slip increased with the increase in draft and implement system is necessary to decide matching implements for any tractor**.** Taylor et al. (19) showed that the range of slip is better which the tractive efficiency was optimized (9, 15) and out of this range the efficiency decreased in a clear way. Jebur et al**. (**12**)** 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. Mankhi and Jasim (13) the superior using of the tractor speed was 2.458 km/h and depth of tillage 10-15 cm in getting less pulling force, drawbar horse power and horse power losses due to slippage, the interaction between tractor speed 2.458 km/h and the depth of plowing 15-20 cm was superior the highest percentage of the pulling efficiency, we recommend to work at speed 2.458 km / h and the depth of tillage 10-15 cm to get less pulling force, drawbar horse power and horse power losses due to slippage**.** Younis (20) indicated that the performance of drawbar test has been measured the following data of forward speed, fuel consumption. The calculated data was the drawbar power, equivalent forward speed and drawbar pull. The maximum drawbar power affected by drawbar pull as showed (62.31-62.58 kW) at highest forward speed of (6.7-6.72 km/hr) respectively. Jebur (11) mentioned that, fuel consumption is a better indicator of energy requirement for each implement**.** Abraham et.al (1) indicated that the higher increasing in drawbar pull was measured during the tractor operation on the soil with higher moisture in comparison the soil with lower moisture level. In case of soil moisture 14% the increase in drawbar pull of tractor equipped with special wheels reached the value 17.2% in compare with standard tires. Using the special wheels on the same field with higher level of soil moisture 22% the increase in drawbar pull reached the value 36.1% in compare with standard tires. Sarhan (16) noticed that increase speed of the tractor leds to increase field capacity, fuel consumption and costs operation. Al-Hashimy (5) showed the first plowing depth (10cm) had significant superiority in comparison with second plowing depth (20cm) in recording lower slippage percentage (6.842 %), higher value of field efficiency (95.353%), lower value number of clod's >10 cm/m^2 (5.482 clod/m^2), lower value of unit energy requirements (158.596 kw.hr/ha). Khader (14) mentioned that, as the forward speed increased, the drawbar pull, specific energy, actual field capacity and fuel consumption were increased.

MATERIALS AND METHODS

The materials used in the experiment: Two tractors from the same Model (CASE JX75T) were used.

Table 1. The specifications of the used tractors

Tractor model	CASE JX75T
Engine	IVECO series 8000
Fuel	Diesel
The system of fuel combustion	Pressure
No. of Engine Cylinders	4 cylinders
Engine Displacement (Capacity)	3908 cm^3
Engine Power	55kW/75hp
Engine Max. torque	242Nm @ 1500rpm
Thrust type	4WD
Tractor weight	2575kg
Tire size	Front: (11.2-24) Rear: (16.9-30)
Made in	Italy - 2013

Moldboard Plow

Table 2. The specifications of the moldboard plow

Type	Deep digger
number of bottom	4
Working Width (m)	1.40
Weight (kg)	400

Fig. 1. Rear view of the moldboard

Methods of Work

The forward speed (theoretical speed) for tractor CASE JX75T was calculated by measuring the time required to distance 20 m on the straight asphalt street after 1500 rpm to stabilize engine speed and the operation was repeated three times of each forward speed using G1, G2, G3 and G4. Calculate the theoretical speed by using the following equation:

Vt = D / t …………… (1)

Where

Vt = theoretical speed (m/sec)

D = travelled distance (20 m)

t = the spent time in the distance of 20 m, (sec).

The actual forward speed for tractor CASE JX75T was measuring in the field. Where used with pull of the tractor (CASE JX75T) and moldboard plow. The engine speed for tractor (CASE JX75T) was stabilize on 1500 rpm, also, all the working depths and forward speed were stabilized. In addition, the time was measured for distance 20 m, and repeated the operation three times for all the working depths and all the forward speed. The draft force has been measured at the same time as the measurement of actual forward speed using the Dynamometer as a link between the two tractors. It was the process of measuring the draft force for all the working depths and all the forward speed. The draft force was calculated from the following equation (2):

Fig. 2. Measuring the tractive force

F = 0.8 + 0.44165 X ………….. (2)

Where

F = draft force (kN)

X = reading Dynamometer (bar)

The slipping of tractor was calculated according to the equation:

S = (Vt - Va) / Vt ………… (3)

Where

S = slipping (%)

Vt = theoretical speed (m/sec)

Va = actual forward speed (m/sec)

Effective Field capacity (E_{fc}):

The Effective Field capacity was calculated by using the following equation (10):

$$Efc = \frac{W \times V_a}{2.5} = don.h^{-1} \dots (4)$$

Ef.c : effective field capacity, fed/hr

W=machine with (m)
Va= actual forward speed (km/hr)

Fuel consumption (FC):

Fuel consumption per unit time was determined by measuring the volume of consumed fuel during ploughing or sowing time. It was calculated as follows (10):

$$FC = \left(\frac{V}{t}\right) \times 3.6 \ldots\ldots\ldots..(5)$$

Where

FC : rate of fuel consumption, l/h
V : volume of consumed fuel, cm^3
T : time, sec

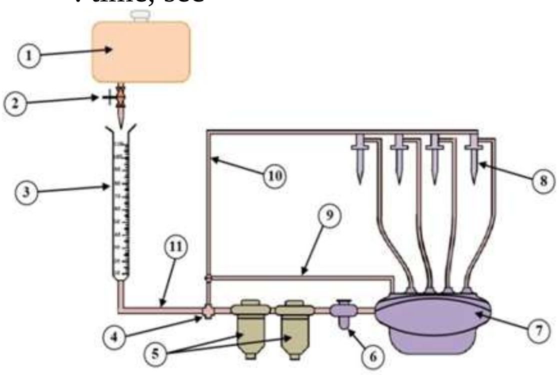

Fig. 3. fuel consumption system

1. Fuel tank 2. Fuel valve. 3. Graduated cylinder 4. Valve 5. Fuel filter 6. Helpful fuel pump 7.Feeding 8. Injections pump 9. Tube of excess from main fuel pump. 10. Tube of excess from injection. 11. Main plastic tube.

Required engine Power (R.E.P):

The required engine power was determined for each operation by using the following equation (10).

$$R.E.P = \left(Fc \times \frac{1}{3600}\right) \times \rho f \times L.C.V \times 427 \times \eta\text{th} \times \eta m \times \frac{1}{75} \times \frac{1}{1.36} \ldots.\ldots\ldots.(\mathbf{6})$$

Where

R.E.P: Power Requirements from Fuel consumption; Kw

F_c: Fuel consumption rate; L/h-------- ρ_f : Density of the fuel; kg/L (for diesel fuel = 0.85 kg/L)

L.C.V: Lower calorific value of fuel Kcal/Kg: (average L.C.V of diesel fuel is 10^4 kcal/kg)

427: Thermo–Mechanical equivalent; kg m/ kcal;

ηth : Thermal efficiency of the engine (assumed to be 40% for diesel engine);

ηm: Mechanical efficiency of the engine (assumed to be 80% for diesel engine).

Specific Energy (SE):

The specific energy (kW.h/fed) for a particular operation was calculated as follows (10):

$$\frac{R.E.P}{Efc} \ldots\ldots\ldots\ldots\ldots..(7)$$

R.E.P: power required for a particular operation, kW

Ef.c : effective field capacity, fed/h

RESULTS AND DISCUSSIONS

Relationship between tractive power for forward speed with slip: Fig. 4 shows the relationship between slip and tractive pull for four forward speeds (G1, G2, G3, and G4). Increasing of tractive pull led to increased slip for four forwards speeds. This is related to the increasing of speed and tractive power which related to the increasing of pull power, which accomplished by increasing of soil which increases slippage. The results showed that the increase in forward speed from (1.9-4.33 km/hr) led to a significant increased the drawbar pull and wheel slippage by the following percentages (15.78%-33.33%). The results showed that the effect of increased drawbar pull was greater than increased forward speed on slippage.

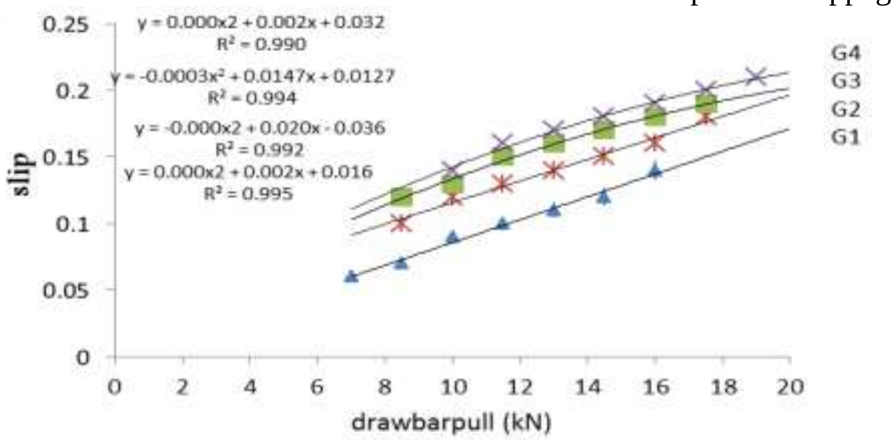

Fig.4. Relationship between Drawbar pull and slip for forward speed

The effective field capacity:
Results presented in Fig. 5 shows the effect of traveling speed and the effective field capacity. The effective field capacity increased with increasing of traveling speed. The results also showed that the maximum effective field capacity 2.52 don/hr was obtained at 4.33 km/h travelling speed. The less average for field capacity 1.6 don/hr in speed 1.9 km/h because the traveling speed is one of the basic factor for field capacity where the traveling speed comes extrusive with field capacity.

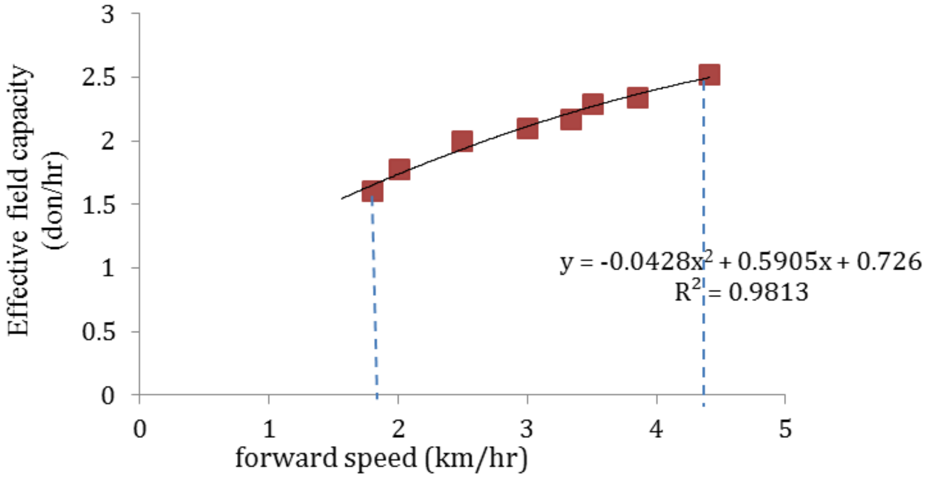

Fig.5. Effect of forward speed and Effective field capacity

Fuel consumption and drawbar specific fuel consumption: Results presented in Fig. 6 shows the effect of forward speed and fuel consumption and specific fuel consumption. The increasing of forward speed led to increasing trundling then increasing the required capacity for cutting certain distance then increasing fuel consumption to engine was increased, while the fuel consumption was decreased with the use increased by 43.03 % and the drawbar. Specific fuel consumption was decreased by 44.54 % when the traveling speed increased from 1.9 to 4.33 km/hr. The highest value of the fuel consumption was 7.9 l/hr at 4.33 km/hr traveling speed, in the meantime the drawbar specific fuel consumption was 0.61 l/kw.hr

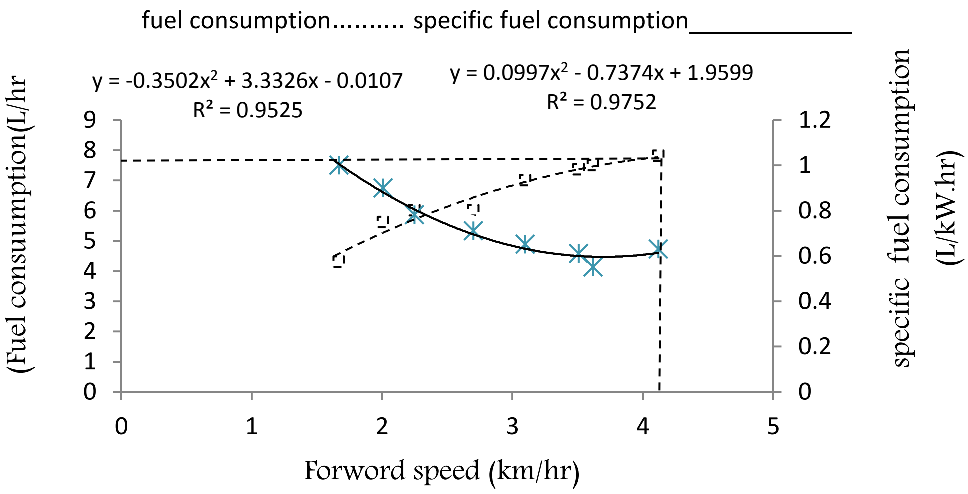

Fig. 6. Effect of forward speed and fuel consumption and specific fuel consumption

Required engine power and specific energy:
Results presented in Fig. 7 shows the effect of forward speed and required engine power and specific energy. It's obvious that by increasing the traveling speed, the required power was increased, and decreasing of specific energy wheels the required power was increased by 42.68% and the specific energy was decreased by 29.66% when the traveling speed increased (from 1.9 to 4.33 km/h). The highest value of the required power was 29.66 kW at 4.33km/h traveling speed, in the meantime the specific energy was19kW.h/don

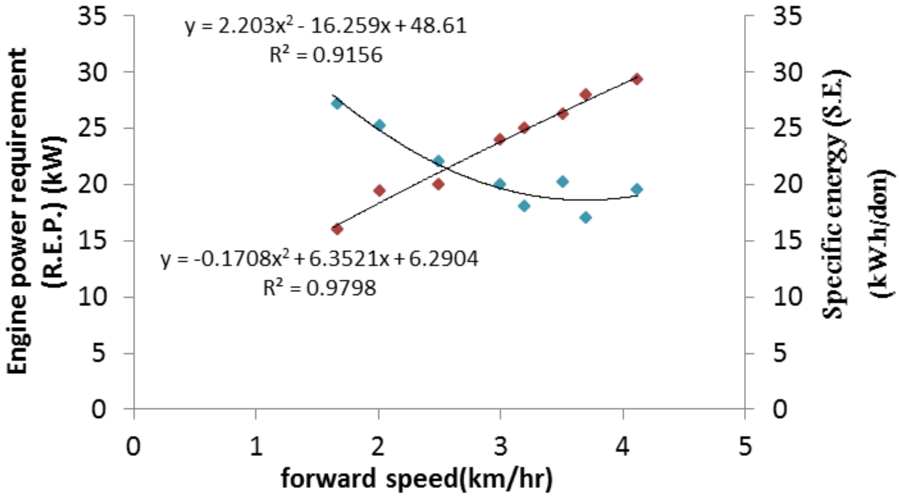

Fig. 7. Effect of forward speed and required engine power and specific energy

Forward speed and tillage depth with drawbar pull: Fig. 8 shows the effect of forward speed and four tillage depths on drawbar pull. The results demonstrated increased of drawbar pull with increasing forward speed and tillage depth. Drawbar pull increased by 15% when forward speed increased from 1.9 to 4.33 km/hr. while the effect of tillage depth was greater than forward speed on drawbar pull. Where drawbar increased by 30% when tillage depth increased from 10 to 20 cm. This is in assent with the findings of the Almaliki (6). He reported that the most influential factor in draft force is the tillage depth, followed by the forward speed and cone index.

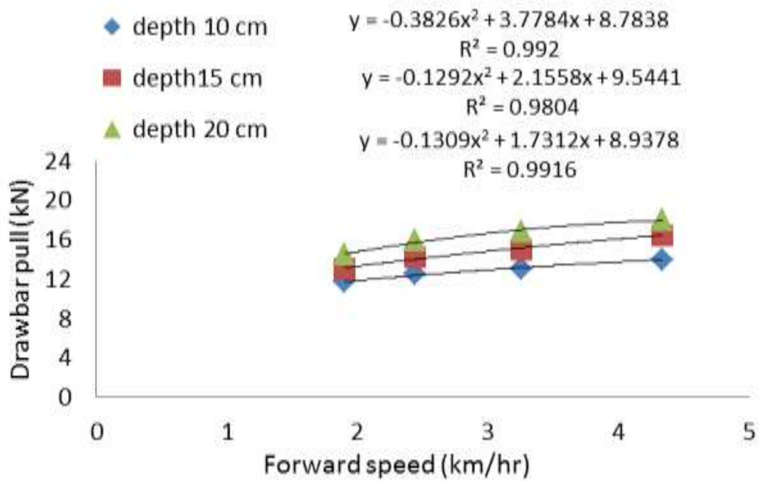

Fig. 8. Effect of forward speed and tillage depth on drawbar pull

The results illustrated that the most effect factors on drawbar pull and the specific energy were tillage depth and forward speed. Also the wheel slip of tractor increased with increasing in drawbar pull and traveling speed. The results indicated that the highest value of the required power was 29.66 kW which occurred at 4.33 km/h traveling speed, in the meantime the specific energy was 19 kW.h/fed. The use of at 4.33 km/h traveling speed produced the effective field capacity, fuel consumption, 2.52 don/h, 7.9 l/hr.

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