Plant Archives Vol. 19 No. 2, 2019 pp. 3160-3164 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

INFLUENCE OF FUEL DIESEL TYPE, FORWORD SPEED AND TILLAGE DEPTH ON THE TRACTOR FUEL CONSUMPTION AND THE ENERGY UTILIZATION FOR DRAFT

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Abstract

A field experiment was conducted in silt clay soil to evaluate tractor fuel consumption and the energy utilization for draft. The experiment parameters are two fuel diesel types (magnetized and nonmagnetized), two forward speeds (G_1 and G_2 slow) and three tillage depths (10, 15 and 20cm). The results showed that the fuel consumption decreased from 2.52 to 2.06kg/hr when free fuel was used. However, the fuel consumption increased by forward speed and tillage depth. The values of fuel consumption are 2.09 and 2.49kg/hr for G_1 and G_2 respectively. While the values for the tillage depth of 10,15 and 20cm are 2.00, 2.17 and 2.70 kg/hr respectively. The results also showed that the magnetized fuel reduced the energy utilization draft, it gave value of energy utilization for draft amount of 4237.54 kJ/kg, while the nonmagnetized fuel gave values of 7228.11 kJ/kg. However, the energy utilization for draft increased from 5432.24 to 6033.41 kJ/kg as the forward speed increased from G_1 to G_2. As while as it decreased from 6914.58 to 5528.97 and 4754.93 kJ/kg with increasing tillage depth from 10 to 15 and 20cm.

Key words : Fuel consumption, energy utilization for draft, magnetic field, nonmagnetic fuel, tractor performance.

Introduction

The fuel consumption is used to evaluate tractor engine performance. It depends on many factors among them are the engine design, volume of air consumption, the fuel type and the load exposed on the engine (Aday, 2016). The effect of the magnetic on the fuel properties is through the interaction of the magnetic field with fuel molecules which increases the mixing of oxygen with fuel (Faris *et al.*, 2012). Mane and Sawant (2015) found that the fuel consumption decreased from 0.76 to 0.54 kg/hr when the magnetized fuel was used.

The load imposed on the energy represented by the draft force which depends on the tillage speed and depth. Aday *et al* (2009) found that increasing the tractor forward speed from 0.48, to 1.68 m/sec increased the fuel consumption by 38.57%, they also realized that the fuel consumption increased from 3.44 to 5.40 kg/hr as the depth increased from 2.5 to 7.5cm, as well as, Himoud (2018) found the fuel consumption was increased with increasing forward speed. While, AL-Hashimy (2012) mentioned the fuel consumption was increasing from 42.752 L/ha to 57.718 L/ha with increase the tillage depth from 10 to 20 cm respectively. Ruskin (1958) showed that the parahydrogen could be reactived (orthohydrogen) through magnetic stimulation, *i.e.* the application of the proper magnetic field changes the spin state of the hydrogen molecule.

These changes greatly enhance the energy of the atom and general fuel reactivity, *i.e.* the combustion efficiency. Al-Khaledy (2008) showed that the magnetized fuel lead to transferring hydrogen atoms in diesel fuel from stable state (parahydrogen) to unstable state (orthohydrogen) which causes higher fuel energy.

The utilization energy for the draft depends on draft power and the fuel consumption (Wong, 1978). But the draft power depends on draft force, where Aday (1997a) and Aday (1998) have reported that the greatest utilization energy for the draft was found at the optimum traction efficiency. Also, He found that the greatest utilization energy for the draft was exists at the middle of draft force range and corresponds to draft force of 12.5kN for the Massy- Ferguson and Zetor tractor (Antor 71) and 16kN for Antor 81. The draft force increased with

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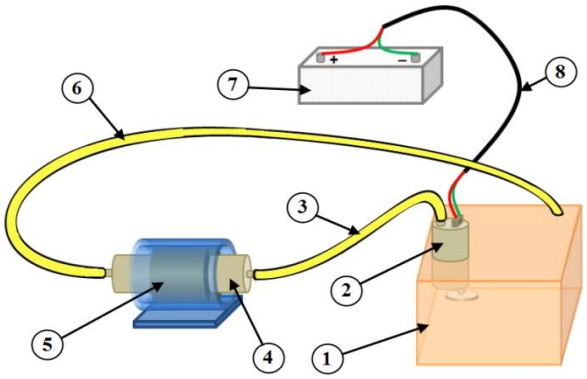
tillage speed and its depth, Aday (1997b). Moreover, Aday and Al-Musawi (2009) found that the higher utilization energy for draft begins after draft force of 12 kN and they also found that increasing the forward speeds from 0.4 to 0.58, and from 1.04 to 1.25 m/sec increased the utilization energy for the draft by 39.2, 42.7 and 69.4% respectively. This because the forward speed increased the draft force which to increase in the energy utilization for draft (Aday, 2016).

This research is aims to experience influence of magnetized diesel fuel, tractor forward speed and tillage depth on the tractor fuel consumption and the energy utilization for draft.

Experimental methods

The magnetizing the diesel fuel

The magnetizing fuel device was manufactured locally in the department of agricultural machine and equipment of agriculture collage, university of Basrah using magnetic intensity of 1200Causs, as showed in Fig. 1. This device was used in a laboratory to magnetizing the diesel fuel for 72 hours before using the fuel to conduct the experiments. The densities of the fuel were measured and they were 0.80 and 0.76g/cm^3 before and after magnetization respectively.

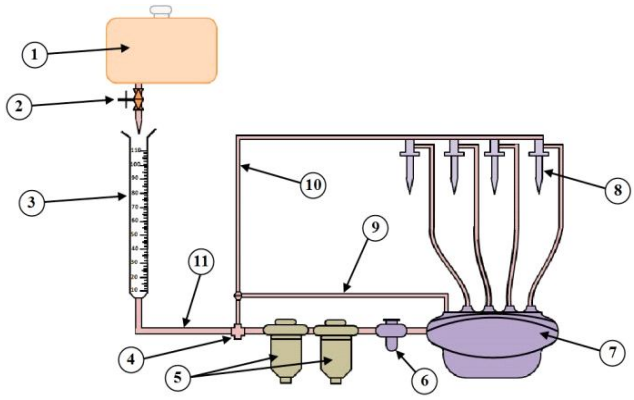


1. Fuel tank, 2. Fuel pump, 3. Transferring fuel pipe, 4. Transparent pipe, 5. Magnet,6. Fuel returning pipe to the tank, 7. Battery, 8.Electric cable.

Fig.1: magnetic fuel device.

Fuel Consumption System

The system was made in the department of agricultural machine and equipment of agriculture collage, University of Basrah Fig. 2. The system consists of a graduated cylinder and fuel tank. The graduated cylinder 3 receives the fuel from the fuel tank by amount of a plastic tube. A valve is fixed at the end of a plastic pipe to determine the fuel poured in the graduated cylinder. The graduated cylinder is connected to the feeding pump of the tractor fuel system. The excess fuel from the injectors and the fuel pump retain to the main plastic tube 11. All the fuel consumption system parts were attached to a wood board and the latter was fixed on the tractor engine side.



1. fuel tank, 2. fuel valve, 3. graduated cylinder, 4. Valve, 5. fuel filter, 6. feeding fuel, 7. fuel pump, 8. Injectors, 9. Fuel retain line, 10. the retain of the excess fuel for the injectors, 11. main plastic tube.

Fig. 2: Fuel consumption system.

Fuel consumption measurement

The fuel consumption by the tractor engine was measured for both fuel types (magnetized and nonmagnetized), two forward speeds and three tillage depths. The tractor fuel consumption was measured for a distance of 10m which represented experiment run. The graduated cylinder was filled with fuel for each run. The fuel consumption was measured for each run (10m) by recording the fuel levels in the graduate cylinder at the beginning and the end of the run. The time to move this distance was also recorded. The fuel consumption to move the distance of 10m is the difference between the two levels of fuel in the graduated cylinder (kg/time taken to move 10m in sec).

Determining Utilization energy for draft

The utilization energy for the draft was determined from the following equation (Wong, 1978).

$$ED = \frac{F * V_a * t}{F_t}$$

Where:

ED = the utilization energy for the draft (kJ/kg).

F = draft force (kN).

V_a = actual speed (m/sec).

t = time of the experimental run (sec).

F_t = quantity of fuel consumed for unit time (kg/sec).

Draft force measurement

The draft force was also measured by a load cell. The load cell attached to the draft bar of the front tractor, the other end of the load cell was connected to a cable which also attached to the front of the rear tractor which the implement attached to. This device was connected to a laptop for recording the readings.

The experimental field

The experiment was conducted in a field of agriculture collage – Bassrah university in a silt clay soil. The soil properties are shown in table 1, Two types of diesel fuel (Magnetized and nonmagnetized fuel) were used in this experiment, two tractor forward speeds (slow gears, G_1 and G-$_2$) as shown in table 2, and three operating depths (10,15 and 20 cm).

Two tractors used in this experiment. The tractors descriptions are shown in table 3. The first tractor was used to pull the second tractor which a moldboard plow was linked, the fuel consumption measuring system and load cell was fixed on first tractor.

Table 1: Soil physical properties.

Soil Depth (cm)	Soil Bulk Density (Mg/m^3)	Soil Moisture contains (%)	Soil Penetration Resistance (kN/m^2)	Soil Texture
0-5	1.34	13	986	Silt clay soil
5-10	1.29	15	4133	
10-15	1.21	18	4587	
15-20	1.24	21	4780	
Average	1.27	17	3621	

Table 2: Tractor forward speeds.

Tractor Gear (Slow Gear)	Theoretical speed (m/sec)	Average of actual speed(m/sec)	Engine speed (rpm)
G_1	0.36	0.24	1000
G_2	0.50	0.30	

Table 3: The properties of both tractors.

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

Experimental design

Split-split plot in randomized complete block design was used to carry out this experiment. The fuel types were put in the main plot, while the tractor speeds were put in the secondary plot while the tillage depths were put in sub secondary plot.

Results and Discussion

The effect of the fuel types, the tractor forward speeds and the tillage depths on the tractor fuel consumption

The magnetized diesel fuel significantly affected the fuel consumption (Fig. 3). However, the fuel consumption of magnetized fuel was higher than nonmagnetized fuel by about 18%. This was because the magnetic field altered H atom in diesel fuel from the stable state (parahydrogen) to a reactive unstable state (orthohydrogen), which means that the hydrogen molecule transferred from its para state to the higher energized ortho state (Al-Khaledy, 2008). In Ortho form a considerable reduction in inter-molecular forces takes place causing an increase in space between hydrogen atoms (Patel *et al*., 2014), and that lead to reduction in fuel density compared with nonmagnetized fuel (as a showed in experimental methods). The reduction in fuel density resulted in increased in fuel quantity injected in the engine cylinder and that resulted in greater fuel consumption. In addition, to that the magnetized fuel suffered from evaporation due to the high engine temperature and that was due to its low density. This problem resulted in higher fuel consumption of magnetizing fuel compared with nonmagnetized fuel.

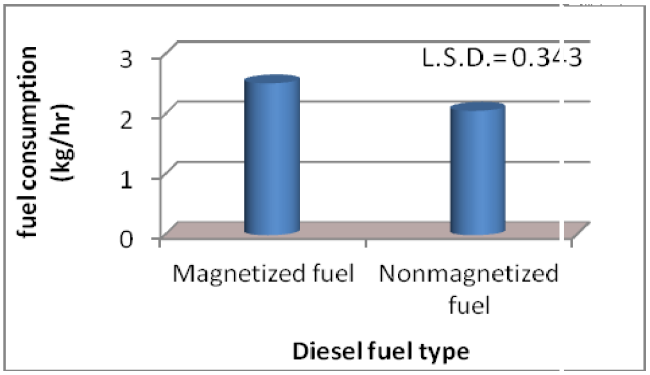


Fig. 3: Effect the diesel fuel types and the fuel consumption.

Fig. 4 showed that the forward speed of tractor has significantly affect the fuel consumption. It increased the fuel consumption from 2.13 to 2.75 kg/hr (29%) when the operating speed increased from G_1 to G_2. This was because the increase in the tractor forward speed required higher energy as well as the forward speed increased

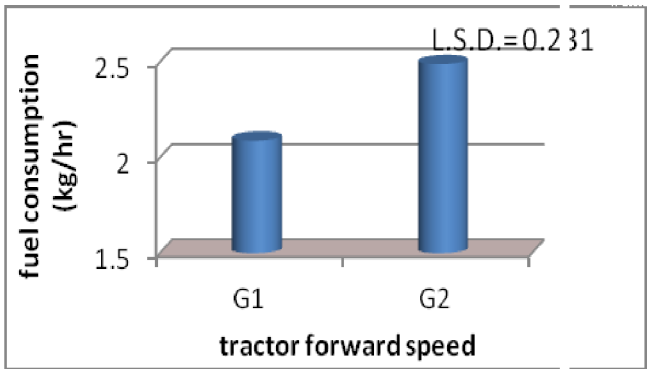


Fig. 4: Effect the tractor forward speed and the fuel consumption.

the load on the tractor engine which required more fuel to overcome the load (Awady *et al.,* 1996).

Fig. 5 showed that the operating depth significantly affected fuel consumption. The fuel consumption increased from 2.21 to 2.39 and 2.73 kg/hr with increasing the tillage depth from 10 to 15 and 20 cm respectively. The draft force also increased with the operating depth

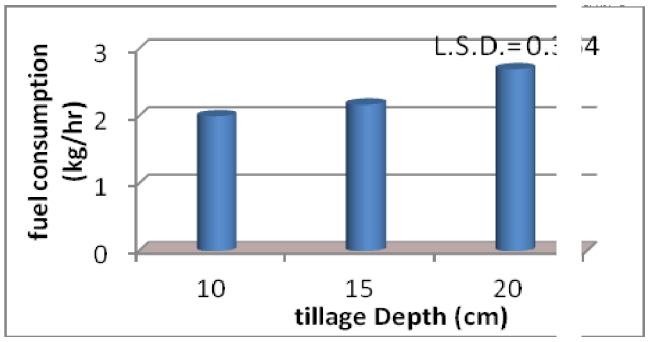


Fig. 5: Effect tillage depth and fuel consumption.

and that lead to high load on the tractor engine which required extra fuel to produce high power to overcome the load (Aday *et al.,* 2009).

The statistics analysis of the results showed that two and three parameters interaction had no significant effect on the fuel consumption.

The effect of the fuel types, tractor forward speeds and tillage depths on the utilization energy for the draft

Fig. 6 showed that the magnetized fuel significantly affected the utilization energy for the draft. The magnetized fuel reduced the utilized energy for draft lay 80% compared with that of nonmagnetized fuel and that was because the magnetized fuel consumption was greater than that of nonmagnetized for the same draft force.

Fig. 7 revealed that the forward speed of the tractor significantly affected the energy utilization for the draft.

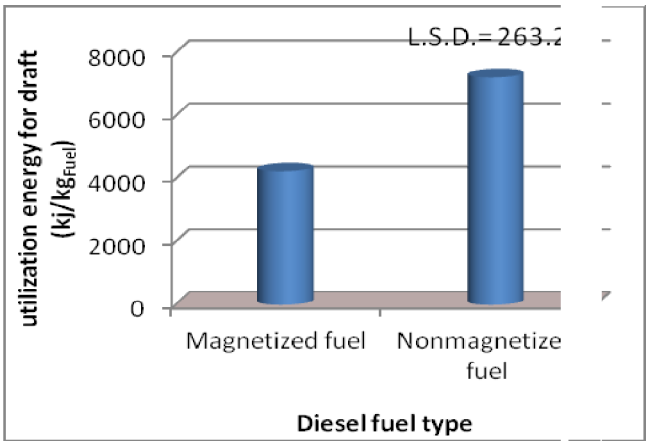


Fig. 6: Effect the diesel fuel types and the energy utilization for the draft.

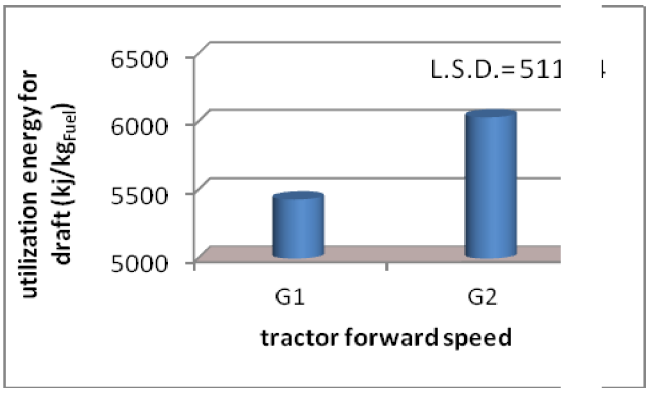


Fig. 7: Effect the tractor forward speed on the utilization energy for the draft.

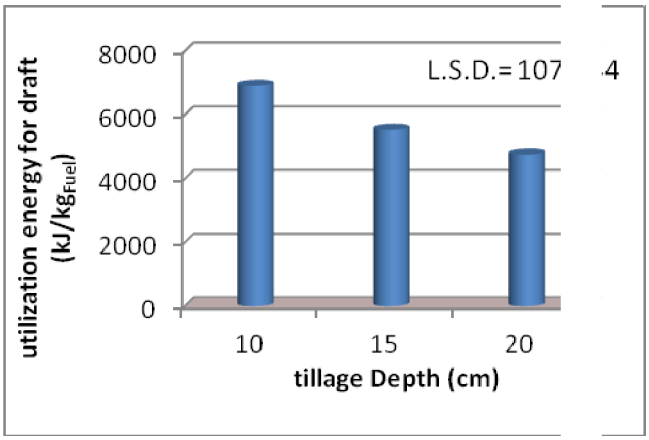


Fig. 8: Effect tillage depth and the utilization energy for the draft.

The energy utilized for draft increased from 4953.76 to 5514.87 kJ/kg (11%) as the tractor forward speed increased from G_1 to G_2.

Fig. 8 indicated that the tillage depth significantly affected the utilization energy for the draft. The utilization energy for the draft decreased from 6315.24 to 5051.44 and 4336.27 kJ/kg with increasing the tillage depth from 10 to 15 and 20 cm and that was because the draft force

increased with the operating depth by a rate lower than the increase in fuel consumption and that resulted in lower utilization energy for draft.

The statistics analysis of the results also showed that two and three parameters interaction in had no significant effect on the utilization energy for the draft.

Conclusions

1. Magnetizing the fuel lead to an increase in the fuel consumption and decrease in the utilization energy for the draft so that the tractor performance decreased appreciably.
2. The fuel consumption and utilized energy for draft increased with increasing tractor forward speed.
3. The fuel consumption and energy utilized for draft increased as the operating depth increased.

Recommended

To reduce fuel consumption and increase the energy used for draft a nonmagnetized fuel is recommended to be used.

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