

EFFECT OF POWER TILLER WEIGHT ON THE FIELD PERFORMANCE

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ABSTRACT

A power tiller having rated power of 6.71kW and weight of 350kg was tested to determine the optimum weight of power tiller for better tractive performance. The experiment was conducted in uncultivated land (silty loam, 12.66% m.c.(d.b.)). The maximum drawbar power was found to be 0.545kW with the present weight at the speed and slip of 0.344(m/s) and 31.5(%) respectively. With the addition of extra weight of 40kg at the speed and slip of 0.368(m/s) and 26.4(%) maximum drawbar power of 0.82kW was obtained. The draft at maximum drawbar power was 1.57, 1.62, 2.21, 2.06, 2.25 kN for the extra weight of 0, 20, 40, 60 & 80 kg respectively.

INTRODUCTION

Power tiller is now extensively used for farm mechanization especially in fragmented land. The efficient utilization of energy resources is one of the major factor of useful farm mechanization. Among all other agricultural operations for crop production, maximum power is utilized in the land preparation. Tractors and power tillers are used for this purpose. So, efficient use of fuel and labor can be achieved if these power units can be operated with better tractive performance.

In the Society of Automotive Engineers Cooperative Tractor Tire Testing Committee Report (1938), it was listed in the conclusion as: the most important factor affecting the drawbar pull is the load on the tire for a given soil; and tractor with high horse power to weight ratio have to travel faster to utilize the available power or use of extra load at lower speed. Burt *et al.* (1979) carried out test on selected pneumatic tires for various soil conditions and concluded that:

1. the performance of pneumatic tire is a function of both dynamic load and travel reduction.
2. at constant travel reduction, the tractive efficiency increases with the increase in dynamic load on compacted soil and decreases with the increase in

dynamic load on soils that have an uncompacted subsurface.

3. output power is non-linear with respect to both dynamic load and travel reduction.

Zoz (1972) mentioned that high load to power ratio is needed at low speed. Domier and Willans (1978) observed that optimum tractive efficiency is obtained at load to power ratio of 60kg/kW but at higher wheel speed in the range of 8-12km/h. Gee-Clough (1980) reported that at a forward speed of 6.4 km/hr the axle weight per unit axle power should be 1 for maximum tractive efficiency. Hossain (1991) studied the traction properties of power tiller with tire wheel and observed a load to power ratio of 70kg/kW and forward speed of 4km/hr at the maximum tractive efficiency of 46.4%. He mentioned that this load to power ratio was low at its low speed which caused poor performance compared to four wheel tractor. Hossain (1992) conducted an experiment on power tiller with cage wheel and observed that at a load to power ratio of 68kg/kW, maximum tractive efficiency is occurred at the speed of 3.5 to 4.2km/hr. This load to power ratio was low. He suggested that as in the case of power tiller an increase of speed may not be possible but an addition of extra weight would improve the tractive performance. It can be

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noted from the above citation that the weight of power tiller has a significant effect on the tractive performance.

Therefore, the present study was undertaken to determine the tractive performance of power tiller varying the extra weight on it to obtain optimum weight of power tiller.

METHODOLOGY

A power tiller equipped with YANMAR YC-7, 6.71kW (Continuous output at 2200 rpm) was used in the experiment. The weight of the power tiller was 350kg. The wheel diameter was 610mm and width 152mm. During the experiment, the gear position of power tiller was always kept in number 2L. To get constant engine speed, the throttle was always kept at the same position. The engine rpm was fixed at 2000. Tachometer was used to determine the engine rpm. Stop watch was used to determine the travel time. Tape was used to determine the travel distance. Number of wheel rotation was counted by giving a chalk mark on the wheel. Variable loads were fastened on experimental power tiller axle. The experiment was conducted on uncultivated land.

A plot of size 50m X 50m was selected. An idle power tiller with mold board plow was mounted behind the experimental power tiller to load the tiller. Draft force was increased slowly by gradual increase of the depth of plow. The weight of the power tiller was varied by adding extra weight on the power tiller axle from 0 to 80 kg at the interval of 20kg. To measure the draft, a pull type dynamometer was fixed between the experimental power tiller and the idle one. The data of pulling force, travel time and bout length for both load and no load condition of power tiller was recorded for each set of the extra weight addition.

Field performance was determined by using the following equations:

$$P_d = DV$$

$$S = \frac{V_0 - V}{V_0}$$

$$V_0 = \frac{L_0}{t_0}$$

$$V = \frac{L}{t}$$

$$W_d = W_a + W_e$$

$$C_T = \frac{D}{W_d}$$

Where, P_d = Drawbar power, kW

S = Slip, %

C_T = coefficient of traction

D = Draft, kN

V = Forward speed under load, m/sec

V_0 = Forward speed under no load, m/sec

L_0 = Distance measured under no load, m

L = Distance measured under load, m

t_0 = Time taken to advance distance to L_0 , sec

t = Time taken to advance distance L , sec

W_d = Dynamic weight, kN

W_s = Self weight of the power tiller, kN

W_e = Extra weight addition on the power tiller, kN

RESULTS AND DISCUSSION

Draft increases with the increase of the weight of power tiller. With self weight of power tiller maximum draft was found to be 1.96kN whereas with the extra weight addition of 80kg maximum draft obtained was 2.84kN. Drawbar power vs draft curves (Fig. 1) shows that drawbar power increases with draft upto a certain limit and then decreases. Draft at maximum drawbar power was 1.57, 1.62, 2.21, 2.06, 2.25 kN for the weight addition of 0, 20, 40, 60 & 80 kg respectively. Although maximum draft was found with 80kg extra weight but maximum drawbar power was observed with 40kg extra weight. Maximum drawbar power was 0.57, 0.58, 0.82, 0.78 and 0.77 kW at the extra weight of 0, 20, 40, 60 and 80 kg respectively. With the addition of extra weight drawbar power increase was 44%. Slip increases with the increase of draft (Fig. 2). With the increase of the weight of the tiller slip decreases for certain draft, say at draft 1.96kN slip was 51, 37, 26, 23.5, and 19.5% at the extra weight of 0, 20, 40,

60 and 80 kg respectively on uncultivated land. Only with the addition of 40kg weight on the power tiller slip decreases to almost half (from 51 to 26%) than that with no extra weight for the same draft of 1.96kN.

Figure 3 shows the extra weight vs maximum co-efficient of traction. The co-efficient of traction increases upto the 40 kg extra weight on power tiller. Beyond 40 kg the co-efficient of traction decreases. The maximum co-efficient of traction at 40 kg extra weight on power tiller was observed to be 0.72.

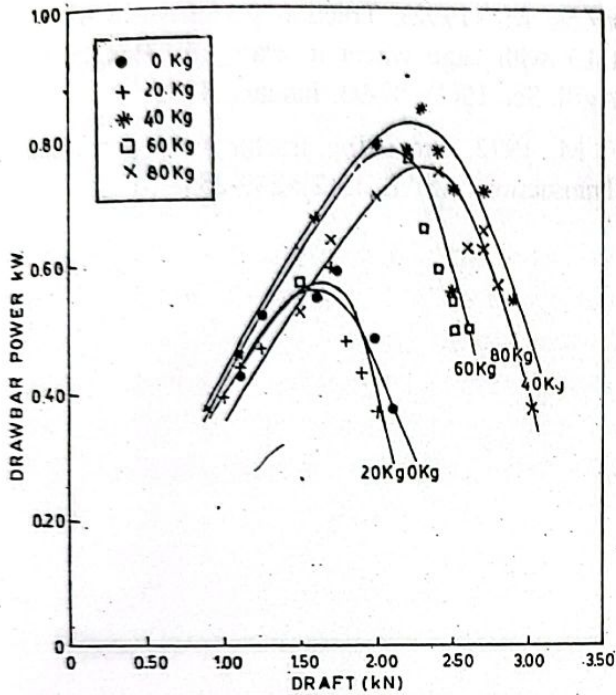


Fig.1 Relationship between Drawbar power & draft at different weight of power tiller in uncultivated land.

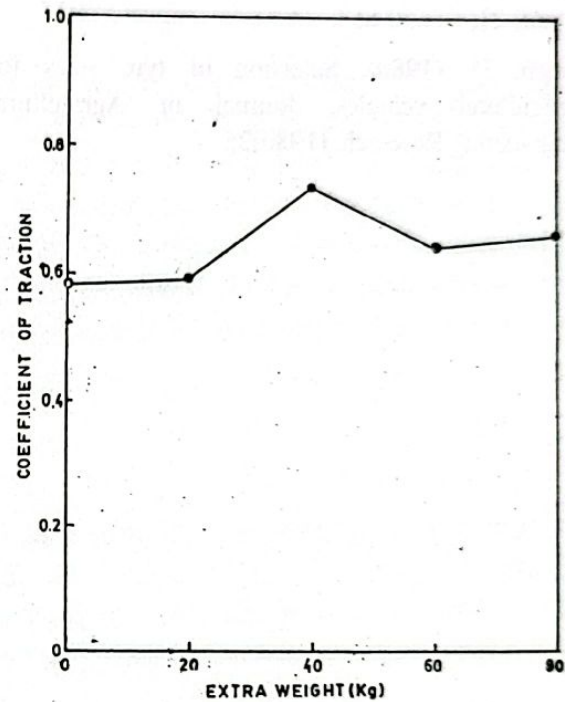


Fig.3 Load versus maximum coefficient of traction in uncultivated land.

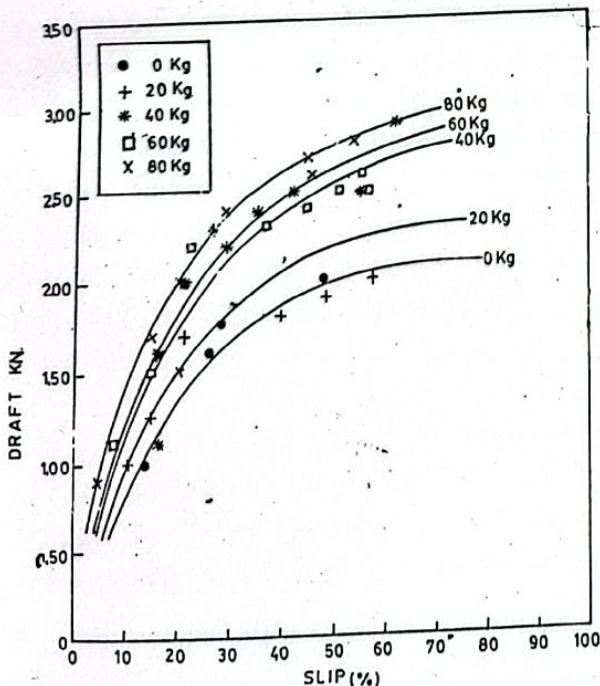


Fig.2 Relationship between slip & draft of different weight of power tiller in uncultivated land.

CONCLUSION AND SUGGESTION

Maximum drawbar power of the power tiller occurs at 40kg of additional weight on the power tiller during the operation in uncultivated land. With the extra weight of 40. kg on the power tiller slip decreases to almost half than that with no extra weight. Drawbar power and draft increased a maximum of 44% and 41% respectively with the addition of extra weight. Maximum drawbar power was found to be 0.82 kW. But still drawbar power is very low in comparison to its rated power. This may be due to the smaller size of the tire wheel. Use of water ballast tire wheel with higher section width will increase the weight of tiller and traction force and thereby drawbar power.

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