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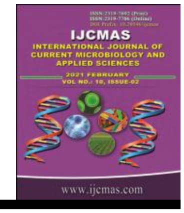

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Performance and Evolution of Touchi Gurma Weeder with Developed Self-propelled Power Unit

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ABSTRACT

Keywords

Self-propelled, Power weeder, Rotary weeder, Power unit, Weeder, Paddy, Tauchi gurma weeder

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Weeds are the major reason for economic losses in paddy production. Despite advances made in weed control, they continue to cause serious crop losses. Presently in Eastern Madhya Pradesh, majorly weeding in machine transplanted paddy fields was done by manually operated touchi gurma which is labor-intensive and time-consuming. A self-propelled power unit is developed at the workshop of CAE, JNKVV, Jabalpur, powered by the Honda engine of 1.3 (hp) petrol engines. The objective of this research to do performance and evaluation of Touchi gurma with and without self-propelled power unit. It was found that the self-propelled power unit with Touchi gurmahas a field capacity of 0.0167ha/h with 91% weeding efficiency and 77.65 % field efficiency. Similarly, for manually operated Touchi gurma has afield capacity of 0.0099 ha/h with 81.49 % weeding efficiency and 80 % field efficiency. Among the two weeders, man-hours are required for a hectare field is59.35 man-h/ha for a self-propelled unit with a Touchi gurma as compared with a manually operated Touchi gurma i.e., 100.20 man-h/ha. The operational cost of weeding was maximum in manually operated Touchi gurma of 3131.25 Rs/ha as compared with self-propelled unit Touchi gurma of 1871.25 Rs/ha.

Introduction

Rice (*Oryza sativa L.)* is a staple food for more than 60% of the world population. Asia holds the share of 90% from worlds rice production and utilization (FAO 2014). India holds 2nd place in rice production and share added about 21.65% of total rice production of the world. In India, rice is cultivated in an area of 43.19 million hectare, annually with a production of 163.70 million tonne and yield of 3790 kg/ha (Agricultural Statistics at a Glance 2018). In Madhya Pradesh rice is grown in an area of 2.06 million hectares with production of 4.12 million tonne with yield of 2026 kg/ha. Weeds are major reason for economic losses in crop production. The estimated yield loss due to weed about 16-42 % based on type of crop and location and in terms of cultivation cost it was estimated about one-third of the total cost of cultivation (Rangasamy *et al.*, 1993). Technologies based on resource conservation are becoming progressively important in rice system because these technologies will increase net profit of farmers and cut the production cost (Singh *et al.*, 2016). Mechanical weeding reduces competition with weed and improves root growth by increasing soil aeration and root pruning which ultimately results in an increased number of tillers per plant (Vijayakumar *et al.*, 2006).In Madhya Pradesh paddy the transplanting was done by rope line method. Early maturing varieties should be planted at a spacing of 20x20 cm and medium and late varieties should be planted at a spacing of 25x25cm. In this method at early stage of paddy crop, there is chances for increasing the weed infestation. For this, often use Tauchi Gurma. Touchi gurma is a manually operated mechanical weeder having the working width of 100 cm for manually operated weeders high energy required to perform weeding operation in wet land. It is also concluded that manual method of weeding operation requires more time and also increase the physiological response of the worker. Therefore, the operator cannot operate for a longer period of time without fatigue. The objective of this research was to performance and evaluation touchi gurma weeder with and without developed self-propelled power unit.

Materials and Methods

Rotary weeder (Touchi Gurma)

It is also known by name of Touchi gurma as shown in Figure 2.1, the weeder consists of the following components; handle, frame, handle and float joint pipe, blade, float, blade holding shaft and nut bolt. Table 2.1 Reveled that the overall length of weeder ls 1550 mm, width of 540 mm and height from the ground surface is 1020 mm. The weight of weeder is 3.4 kg. It consists of two rotary units with working width of 80 mm. The diameter of hands is 14 mm. Thickness of blade is 2 mm. The size of float is 460 mm in length, 120 mm width and 25 mm height. The figure 4.2 depicted the view of rotary weeder

Table 2.1 shows the specification of different parts of the rotary weeder with their material of construction

Self-propelled power unit

A self-propelled power unit is developed at the workshop of CAE, JNKVV, Jabalpur, with the power by the Honda engine of 1.3 (hp) petrol engines. It is a compact low weight machine, self-propelled with a positive drive system by using a chain and sprocket system. It consists of a frame, handle, engine, wheel, cono weeder, chain, sprocket, bearing hub, throttle system, etc. The engine operated at 5000 (rated rpm), however, at 1/3 throttle position the speed was found to be 1800 rpm at no-load condition. Overall dimensions developed self-propelled power unit was shown in figure 2.2. The brief specifications of the self-propelled power unit in table 2.2.

Machine parameters

Travel speed (km/h)

To determine the travel speed of the machines during weeding operation, the time required for covering 10 m row length was recorded. Three measurements were recorded in each operation and the average value was calculated. A digital stopwatch was used to record the time in seconds to cover a 10 m distance by weeders. The sensitivity ofthe stopwatch is 0.01 seconds.

Effective working width (mm)

The effective width of the weeder shall be the effective width of the weeding. In the case of weeder having provision for width adjustment, the minimum and maximum width shall be measured. The working width of the developed weeder was 150 mm but it was found that the effective width was a little less than the theoretical actual width. To measure the actual width of the weeding, a measuring tape of 5 m length was used.

Theoretical field capacity (ha/h)

Theoretical field capacity is the rate of field coverage that would be obtained if the weeder was operating without interruptions. It is based on theoretical width and speed. The theoretical field capacity was calculated by using the formulae.

$$\text{Theoretical field capacity (ha/h)} = \frac{\text{Width of the implement (m) x Speed of operation (km/h)}}{10} \quad (3)$$

Actual field capacity (ha/h)

The actual field capacity is the actual average rate of field coverage. It includes turning losses, choking, making adjustments, etc. It is recorded in hectare/hour.

The actual field capacity was calculated as per the following equation:

$$\text{Actual field capacity (ha/h)} = \frac{\text{Actual width of field coverage (m) X Length of field coverage (m)}}{\text{Time for covering total area (h) X 10000}} \quad \ldots(4)$$

Field efficiency (%)

The field efficiency was calculated using equation:

$$\text{Field efficiency (\%)} = \frac{\text{Actual field capacity (ha/h)}}{\text{Theoretical field capacity (ha/h)}} \times 100 \quad \ldots(5)$$

Weeding efficiency (%)

To determine the weeding efficiency at four places of each plot a frame of 1 × 1 m was thrown in the field randomly and the numbers of weeds were counted before and after weeding operation. The weeding efficiency of the weeders was calculated by the following equation (Remesan *et al.*, 2007):

$$WE = \frac{N1 - N2}{N1} X\ 100 \quad \ldots(6)$$

Where,

WE= Weeding efficiency of the weeder (%);
N_1 = Total number of weeds before weeding.
N_2 = Total number of weeds after weeding.

Draft measurement

Draft is defined as the horizontal vector of the pull, parallel to the line of motion. The S-type load cell was used to measure the draft. Which could measure the draft up to the range of 1000 kg & least count of load cell was 0.01 kg.

As the load cell was fitted horizontally in the line of pull, therefore, it gave the value of draft directly in kgf. Load cell was placed between power tiller and power unit. Power tiller pulled the power unit at a speed of 2.5 km/h.

Fuel consumption (l/ha)

Fuel consumption was measure by using the top up method. The fuel tank was filled to full capacity before and after test. Amount of refueling after the test was recorded. The measuring flask capacity of 1 liter was used to measure the fuel.

$$\text{Fuel consumption} = \frac{\text{Fuel consumption (ml/s)}}{\text{Area covered } (m^2/s)} \times 10 \quad \ldots(7)$$

Cost of operation

In order to compare weeding cost, fixed and variable cost were calculated.

Fixed costs

In this study, fixed costs like costs of insurance, taxes and shelter are considered negligible.

Depreciation

This cost mirrors the reduction in worth of a machine with use (wear) and time (obsolescence). While actual depreciation would rest on the sale price of the machine after its use straight-line method was used to calculate the depreciation value.

$$D = \frac{P-S}{L} \qquad \ldots(8)$$

Where,

D = depreciation cost, average per year;
P = cost price of the machine;
S = residual value of the machine; and
L = useful life of the machine in years.

The depreciation value per hour can be assessed by dividing D by the number of hours the machine is anticipated to be utilized in a year. Residual value (S) of the machines may be taken as 10 % of the Actual cost price.

Interest

An annual charge of interest was calculated taking 12 percent of average purchase price as basis. Average purchase price was calculated using the formula given below.

$$A = \frac{P+S}{2} \qquad \ldots(9)$$

Where

A = average purchase price;
P = purchase price of the machine; and
S = residual value of the machine.

Variable cost

Variable costs include fuel, lubricant, repair and operator costs and are directly related to the amount of work done by the machine. Repair cost for the weeders was considered 5% of purchase value and lubricant cost was accounted to be 3% of fuel cost (Remesan *et al.*, 2007).

Fuel

The actual fuel consumption in each treatment was observed and estimation was done accordingly.

Wages and Labour charges

The cost of labor was estimated to take the prevailing rate of □ 22.87 per hour or □ 250 per day.

Results and Discussion

Field performance of weeder (manual and power operated touchi gurma)

Details of the performance evaluation conducted for touchi gurma attached with developed power unit (T1) and manually operated touchi gurma (T2) are shown.

Performance and evaluation of weeders

Table 3.1 revealed that the mean value of the effective field capacity of T_1 andT2were found to be 0.0167 and0.0099 ha h^{-1} respectively. The maximum field capacity (i.e.0.0167ha h^{-1}) was obtained with T_1 treatment followed by T_2 (i.e. 0.0099 ha h^{-1}). power unit with touchi gurma (T_1) the operational speed is more than manually operated touchi gurma weeding method. Among the two methods the power unit with touchi gurma had highest field capacity because of its operational speed. The statistical analysis of data revealed that the two treatments differ significantly for the field capacity. The mean value of field efficiency of T_1 and $T_{2\ were}$ found to be 91 and 80 percent respectively. The field efficiency, which indicates ratio of useful working time to the total working time, was obtained maximum in T_1 (91 %) treatment and minimum in T_1 (80%) treatment. Similar findings was reported by Parida (2002), Tajuddin (2009), Remesan *et al.,* (2007). The travel speed of the two treatments is presented in Table3.1. The result revealed that the higher travel speed was found in power unit with touchi gurma i.e., 2.36 km h^{-1} and lowest travel speed in manually operated touchi gurma i.e., 1.55 km h^{-1}.

Figure 3.3 revealed the weeding efficiency of T_1 andT2and were found to be 77.65 and 81.49 respectively. The highest weeding efficiency with T_2 may be due to and fro-motion in manual touchi gurma operation.

Draft of the power unit with weeders

From the experiment, it is found that the draft of the power unit with and without weeder attachment was 19.179 and9.475 kgf. The actual draft required for weeder attachment i.e.,touchi gurma was 9.704kgf. A similar opinion was also reported by Anantachar *et al.,* (2013).

Table.2.1 Brief specification of rotary weeder

Sl.No	Particulars	Dimensions
1	Overall dimension (L x B x H), mm	1870 x 460 x 950
3	Working width, mm	80
4	Number of rotors	2
5	Height of Handle from Ground	950
6	No. of blade in rotor	serrated blade - 6
7	Blade thickness, mm	1.6, 2
8	Width of handle	460
9	Size of Float (L x B x H), mm	160 x 90 x 35

Table.2.2 Brief specification self-propelled power unit

Sl.No	Details	Particulars
1	Overall dimension (L x B x H), mm	1650 x 200 x 1150
2	Weight in kg	20
3	Height of Handle from ground, mm	1050
4	Width of handle, mm	460
5	Speed of operation, km/h	2.5
6	Size of float (L x B x H), mm	150 x 200 x 100
7	Diameter of ground wheel, mm	400

Table.3.1 Field performances of Power unit attached Touchi Gurma (T1) and manually operated touchi gurma (T2)

SI No.	Performance Parameter	Result	
		T1	T2
1	Theoretical field capacity (ha/h)	0.01824	0.0124
2	Effective field capacity (ha/h)	0.0167	0.0099
3	Field efficiency (%)	91	80
4	Operating speed (km/h)	2.36	1.55
5	Weeding Efficiency (%)	77.65	81.49

Table.3.5 Labour required in different weed control methods (man-hha^{-1}) and cost of operation (Rs/ha)

Treatments	Labour required (man-h/ha)		Cost of operation		
	Weeding (man-h/ha)	Labour time saving (%)	Labour cost (Rs/ha)	Operation cost(Rs/ha)	Operation cost saving (%)
Hand weeding*	166.5	Base	5203.12	5203.12	Base
T1	59.88	64.03	1871.25	2725.25	47.62
T2	100.20	39.81	3131.25	3131.25	39.82

Fig.2.1 Pictorial view of manual rotary weeder

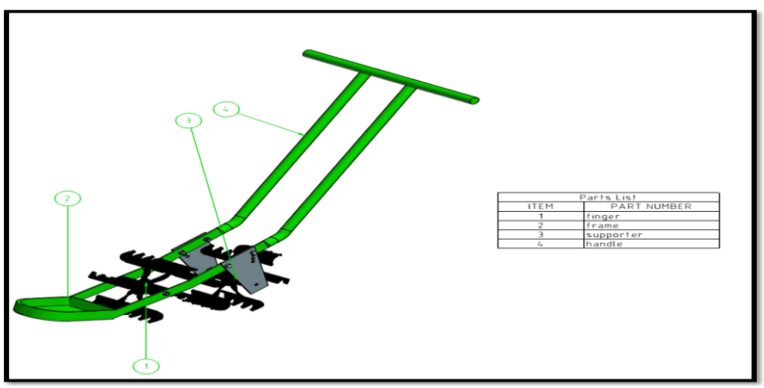


Fig.2.2 Orthographic view of power unit with rotary weeder (touchi gurma)

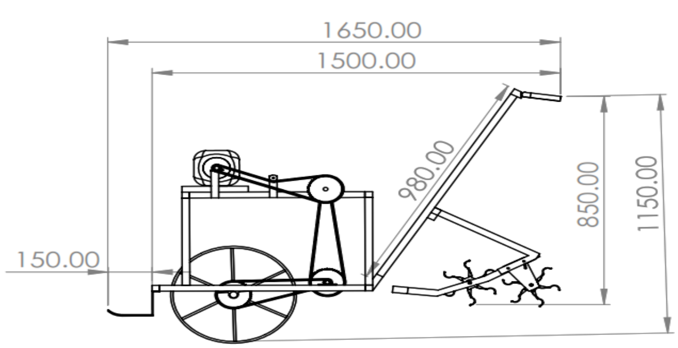
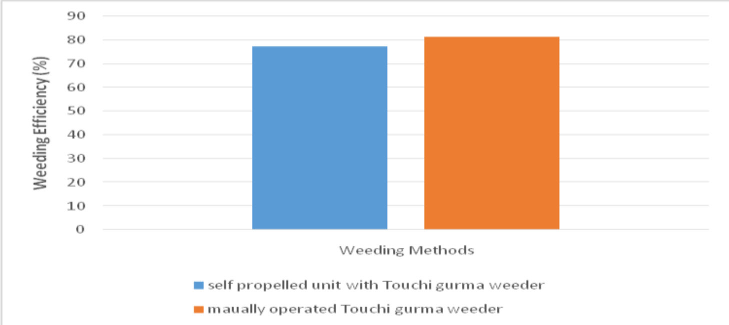


Fig.3.1 Weeding efficiency of weeding methods



Labour requirement and cost of operation in different weeding methods

Table 3.2. shows that the total manual working hours and cost of weeding operation of different weeding methods. The time required for controlling the weeds by Manual weeding method taken as base period and calculated the labor-saving for different mechanical methods. Table 3.2reveals that the time saving was a maximum of 64.03 % for the T1 (power unit with touchi gurma) and a minimum of 39.81 % for the T2 (manually operated touchi gurma).The operating cost of T1 andT2 was 2725.25 and3131.25 Rs/ha respectively.

Fuel consumption

It is evident from the experiment that the fuel consumption in weeding operation by the power unit with touchi gurma at the speed of 2.28 km/h was found to be 6.5 l/ha.

In conclusions the performance of the developed self-propelled unit with touchi gurma was compared with the manually operated touchi gurma. The different mechanical parameters were measured which include field capacity, field efficiency, travel speed, labor required, weeding efficiency, cost of operations.

Amongst the two weeders (i.e., power unit with touchi gurma and manual touchi gurma) field capacity was found to be maximum i.e., 0.167 ha/h for power unit with touchi gurma and a minimum of 0.0099 ha/h for manual touchi gurma.

Amongst the two weeders (i.e., self-propelled and manual) field efficiency was found higher in self-propelled unit touchi gurma having 91% which is higher than the manual operated touchi gurma of 80%.

Minimum manual work hours required for controlling the weed were related in self-propelled unit with touchi gurmai.e.,59.88 man-h/ha as compared with manually operated touchi gurmai.e.,100.20 man-h/ha.

The operational cost of weeding was maximum in manually operated touchi gurma of 1871.25 Rs/ha as compared with self-propelled unit touchi gurma of 3131.25 Rs/ha.

The draft was found in self-propelled unit touchi gurma having 9.04kgf.

The result indicates that self-propelled unit touchi gurma contributes maximum efficiency with least fatigue.

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