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Performance evaluation of portable knapsack power weeder

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■ **ABSTRACT :** India is a vast country having agriculture sector as the backbone of its economy. A weed is essentially any plant which grows where it is unwanted or not required. A weed can be thought of as any plant growing in the wrong place at the wrong time and doing more harm to the farmer income. Several weeders are available which run by tractor or power tiller, these are large in size can not work for low inter row spaced crops. The portable knapsack power weeder is evaluated two different crops such as maize and chilliwith each blade (2, 4 and 6 blades per flange) combination. During the evaluation field capacity, field efficiency, weeding efficiency, plant damage, fuel consumption, performance index were evaluated. Actual field capacity of weeder for maize and chillicrop with 6 blades was 0.023 ha/hand 0.025 ha/h. Field efficiency of weeder for maize and chilli crop was 61.3 per cent and 66. 6.Weeding efficiency for maize and chilli crop was 89.3 per cent and 85.2 per cent. Plant damage for maize and chillicrop was 2.4 per cent and 3.30 per cent.

■ **KEY WORDS :** Knapsack power weeder, Field capacity, Field efficiency, Weeding efficiency, Plant damage, Fuel consumption, Performance index

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India is a vast country having agriculture sector as the backbone of its economy. India has total land acquisition of about 329 Mha out of which 166 Mha (Sahay, 2008) of land is under cultivation. Day by day Indian population growing. Hence, it is required produce more food to demand of the growing population. This can achieved by two ways they are either increasing the land under cultivation or by adopting the high farming technique which would increase the crop yield as per population demand. As it is not possible to increase the land under cultivation, another option is increase the crop yield.

A weed is essentially any plant which grows where it is unwanted or not required. A weed can be thought of as any plant growing in the wrong place at the wrong time and doing more harm to the farmer income. Weeds waste excessive proportions of farmers' time, thereby acting as a brake on development. Weeding is one of the most important farm operations in crop production system. Weeding is an important but equally labour intensive agricultural unit operation. Weeding accounts for about 25 per cent of the total labour requirement (900–1200 manhours/hectare) during a cultivation season (Yadav and Pund, 2007).

Indian agriculture is dominated by small farmers, having small land holdings for cultivation. The average size of the land holding declined to 1.15 ha in 2010-11 from 2.30 ha in 1970-71, and absolute number of operational holdings increased from about 70 million to 121 million. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020 and would be further reduced to a low of 0.32 ha in 2030. This is a

very complex and serious problem. At a conservative estimate, an amount of Rs. 100 billion is spent on weed management annually in India, in arable agriculture alone (Anonymous, 2011).

METHODOLOGY

The power weeder consists of the following components namely engine, flexible drive shaft, handle, worm gear box, rotor shaft, flanges, blades, blade cover, and transportation wheels etc.

Table A : Specifications of developed portable knapsack power weeder

Sr. No.	Specification	Value
1.	Number of engine cylinder	1
2.	Engine maximum power at 6500 rpm	1.25 kW
3.	Weeding width	25 cm
4.	No. of Blades per flange	2,4,6
5.	Rotor speed	185 rpm
6.	Weeding depth	3-5 cm
7.	Power transmission	Lightweight aluminum gear box
8.	Fuel tank capacity	0.9 L
9.	Fuel	Petrol mixed with lubricating oil (1 liter of petrol with 30 ml of oil)
10.	Material of blade	Spring steel –L-type blade
11.	Total weight	11 kg

Performance evaluation of developed weeder :

The field experiment was conducted at Rajasthan College of Agriculture (RCA) for maize crop and chilli crop at Sri. Mohanlal field opposite Sun Towers Roopsagar Road at new Adarshnagar Udaipur. In maize crop total area 600 square meters was taken and divided into 15 plots each of 5 meter length and 8 meter width and 5 replications were made with each blade (2, 4 and 6 blades per flange) combination. Similarly in chilli crop total area 855 square meters was taken and divided into 9 plots each of 19 m length and 5 m width and 3 replications were made with each blade (2, 4 and 6 blades per flange) combination. The following performance indicates were calculated using the observed data in the field.

Theoretical field capacity :

Theoretical field capacity of the machine is the rate

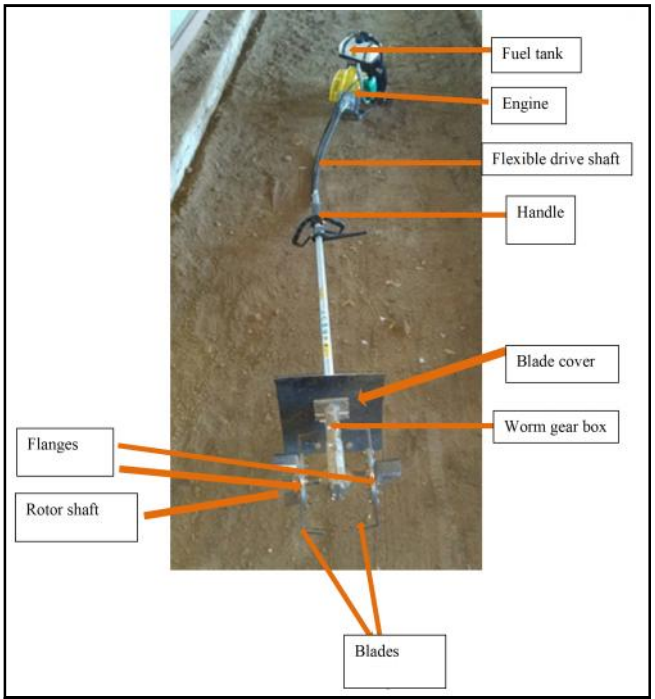

Fig. A : Portable knapsack power weeder

Fig. B : Testing in chilli field

of field coverage that would be obtained if the machine were performing for its theoretical width of the time at the rated forward speed and always covered 100 per cent of its rated width. It is expressed as hectare per hour and determined as follows (Kepner *et al.*, 1978).

$$\text{Theoretical field capacity, ha h}^{-1} = \frac{\text{Width (m) x Speed (km/h)}}{10}$$

Effective field capacity :

The effective field capacity of power weeder was computed by recording the area weeded during each trial run in a given time interval. It is dependent upon speed of operation. With the help of stopwatch, time was recorded for respective trial run along with area covered.

$$\text{Effective field capacity, ha h}^{-1} = \frac{\text{Area covered (ha)}}{\text{Time required (h)}}$$

Field efficiency :

Field efficiency is the ratio of effective field capacity to the theoretical field capacity, Expressed as percentage

$$\text{Field efficiency, per cent} = \frac{\text{Effective field capacity (ha h}^{-1})}{\text{Theoretical field capacity (ha h}^{-1})} \times 100$$

Weeding efficiency :

Weeding efficiency is the ratio between the numbers of weeds removed by power weeder to the number of weeds present in a unit area and is expressed as a percentage. The samplings were done by quadrant method, by randomly selection of spots by a square quadrant of 1 square meter (Tajuddin, 2006). Higher the value of weeding efficiency better is the weeder performance.

Fig. C : Chilli crop before weeding operation

Fig D: Chilli crop after weeding operation

$$\text{Weeding efficiency, per cent} = \frac{W_1 - W_2}{W_1} \times 100$$

where,

W_1 = Number of weeds counted in a unit area before weeding operation

W_2 = Number of weeds counted in same unit area after weeding operation

Plant damage :

Plant damage is the ratio of the number of plants damaged after operation in a row to the number of plants present in that row before operation. It was calculated by the following formula (Yadav and Pund, 2007). It is expressed in percentage.

$$\text{Plant damage (\%)} = 1 - \frac{Q}{P} \times 100$$

where,

Q = Number of plants in a 10 m row length of field after weeding

P = Number of plants in a 10 m row length of field before weeding.

Performance index:

Performance of the weeder was assessed through performance index (PI) by using the following relation as suggested by Srinivas *et al*. (2010).

$$\text{Performance index} = \frac{\text{FC x (100 – PD) x WE}}{\text{Engine power (hp)}}$$

Where,

FC = Field capacity, ha h^{-1}

PD = Plant damage, per cent

WE = Weeding efficiency, per cent.

Fuel consumption :

The fuel consumption has direct effect the economics of the power weeder. It was measured by top fill method. The fuel tank was filled to full capacity before and after the test. After completion of test operation, amount of fuel required to top fill again is the fuel consumption for the test duration. It was expressed in litre per hour.

$$\text{Fuel consumption} = \frac{\text{Fuel consumption, L}}{\text{Time, hr}}$$

Fig. E : Measurement of fuel consumption

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Actual field capacity :

The actual field capacity of the weeder with different blades in different crops was determined and shown in below graph.In maize crop, Row to Row spacing was 60 cm and the machine width of cut was 25 cm and maize crop field sown width wise (length 5m and width was 8 m) 3 passes required and 15 cm overlapping during the weeding in maize crop. In chilli crop, Row to Row spacing was 35 cm sown length wise (length 19 m and width 5 m) 2 passes required and 10 cm overlapping during the weeding in chilli crop. Hence less actual field capacity in maize and chilli crop. Higher the value of field capacity better was the machine performance. It was clear that the actual field capacity increased with increasing weeder forward speed. The actual field capacity of power weeder developed by (Rangaswamy *et al.*,1993) was 0.04 ha/h.

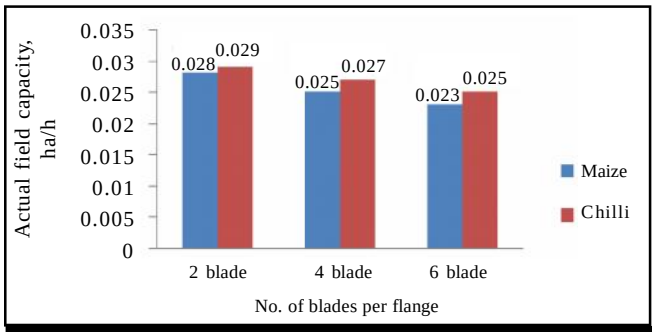

Fig. 1 : Effect of number of blades on effective field capacity by developed weeder

Field efficiency :

The field efficiency of the weeder with the different blades in different crop was determined.The data reveal that the maximum and minimum field efficiency of weeder for maize crop was 74.6 per cent with 2 blades and 61.3 per cent with 6 blades. Similarly, maximum and minimum field efficiency of weeder for chilli crop was 77.3 per cent with 2 blades and 66.6 per cent with 6 blades, respectively. The field efficiency depends on actual field capacity of weeder. Actual field capacity of weeder increases field efficiency increases and actual field capacity of weeder decreases field efficiency also decreases.

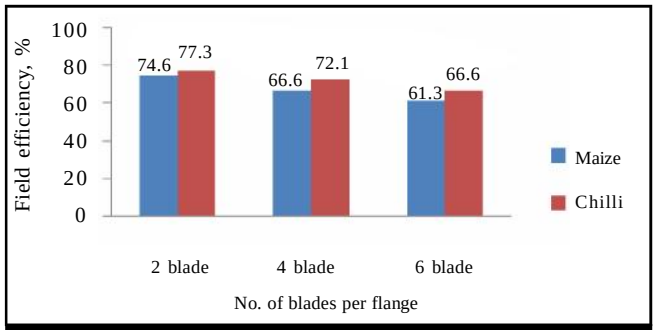

Fig. 2 : Effect of number of blades on field efficiency by developed weeder

Weeding efficiency :

The weeding efficiency for maize and chilli crop was measured in the field by diffrent blade combination shown in below graph. Maximum weeding efficiency was observed with 6 blades. In 6 blades, depth of cut increases and speed of weeder reduces, weeding efficiency increases whereas comparing with 2 blades depth of cut decreases and speed increases, weeding efficiency decreases. Maximum weeding efficiency was observed in 60 days maize crop whereas chilli crop with 30 days plants, more weeds present and lowest weeding efficiency (79.9 %) was observed. Weeding efficiency depends on the number of weeds presents in the crop. The power weeder has the capacity to till the soil to desired depth. Therefore, it works much better between two rows for control of weeds. The rotating blade of power weeder may cause damage to the plants if it is brought nearer to the rows. Considering this limitation of weeder, it gives lower weeding efficiency 89.3 per cent. The power weeder gives better performance even in later stages of weeding. It was clear that, as the depth of operation increases, the weeding efficiency increases.

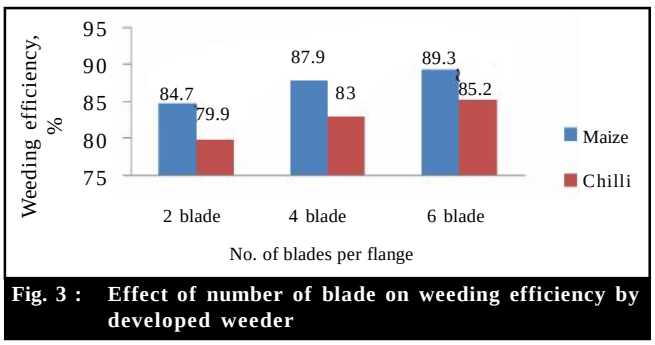

Fig. 3 : Effect of number of blade on weeding efficiency by developed weeder

Plant damage :

The plant damage for maize and chilli cropwas measured in the field by different blade combination shown in below graph. Maximum plant damage was observed with 2 blades as it runs with high speed and jerks. Comparing with 6 blades, rotor moving with low speed and depth of cut increases and no jercks was observed and thereby lower plant damage was observed. Plant damage was higher in chilli crop (30 days plant) and in maize crop (60 days plant) plant damage was low.

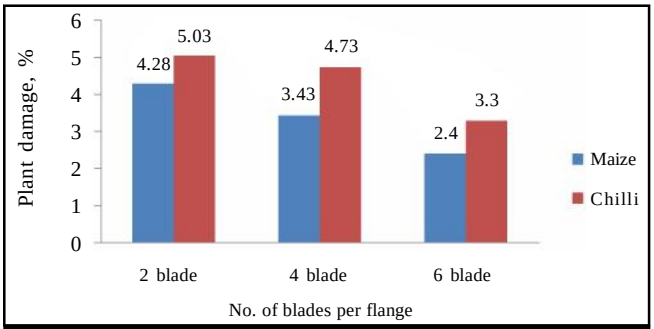

Fig. 4 : Effect of number of blades on Plant damage by developed weeder

Fuel consumption :

Fuel consumption of the power weeder was calculated by topping method and shown in below graph. The maximum fuel consumption was found in chilli crop with 6 blades as 0.76 l/h due to more depth of cut (4.60 cm) and minimum fuel consumption was found in maize crop with 2 blades as 0.61 l/h due to low depth of cut (3.36 cm).

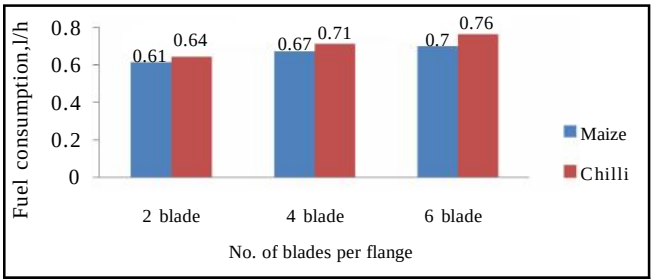

Fig. 5 : Effect of number of blades on fuel consumption by developed weeder

Performance index :

Maximumand minimum performance index of weeder for maize crop was 136 with 2 blades and 120 with 6 blades. Similarly maximum and minimum performance index of weeder for chilli crop was 132 with 6 blades and 123 with 2 blades.

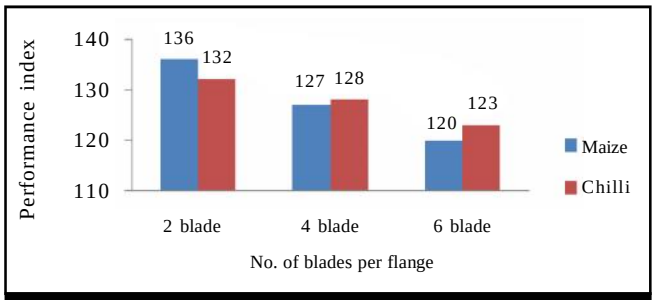

Fig. 6 : Effect of number of blades on performance index by developed weeder

Conclusion :

The performance evaluation of portable knapsack power weeder was weeding depth 5 cm with 6 blades and weeding efficiency 89.3 per cent and plant damage very less in 6 blades. Fuel consumption was high in 6 blades was 0.76 l/h. From above point of view 6 blades was preferred for weeding in dryland condition.

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