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Performance evaluation of manual operated single wheel weeder for jute crop

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■ **ABSTRACT :** An experiment was conducted to evaluate the field performance of developed manual operated single wheel weeder at ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata. Various parameters such as field capacity, weeding efficiency, draft requirement and performance index of the weeder was measured during the test. The developed weeder can work upto 5.0-6.0 cm depth of operation with actual field capacity of 0.026 ha/h and field efficiency of 76.7 per cent. The draft requirement was 29.7 kg for 18 cm width of weeder. The weeding efficiency of the machine was found to be 81.65 per cent with performance index of 1123.01. The experiment also revealed that the weeding time requirement for single wheel weeder is much less than the manual weeding. It was easy to operate and most importantly involved less human drudgery during its operation.

■ **KEY WORDS :** Weeder, Weeding efficiency, Field capacity, Field performance

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Agriculture sector is the backbone of economy in India. Due to increasing in population day by day, it is required to produce more food and fibre to meet the demand. It can be achieved either by increasing the land under cultivation or by adopting modern farming technologies to enhance crop yield. The crop yield can be enhanced by using high yield variety seeds, proper agronomic practices and preventing yield loss due to factors like weeds, insects, pests, dieses etc. Among the factors, weed is one of the most important for contributing crop yield loss. The quality and quantity of crop yield depends upon effective and timeliness of weed removal from the field. Weeds causes highest annual yield loss of about 45 per cent compared to dieses (20%), insects (30 %) and pests (5 %) (Gupta *et al*., 2014). Depending on weed intensity, 20 to 30 per cent loss in yield is quite usual, if crop management practices are not followed properly (Gill and Kollar,1981).

Weeds are unwanted and undesired plants, which compete with the main crop in the field for space, water and plant nutrients and adversely affect the micro-climate around the plant and removes 30 to 40 per cent of applied nutrients (Behera *et al.*, 1996; Rao, 1999; Nojavan, 2001; Goel *et al*., 2008 and Yaghobi and Yousefi, 2008). Weeding involves one-third of the total cost of cultivation and accounts for about 25 per cent of the total labour requirement during a cultivation season (Rangaswamy *et al.*, 1993 and Yadav and Pund, 2007). Removal of weed at early stage of crop growth facilitates better crop yield. The initial 15 to 60 days after sowing of seed is

critical period for weed competition and the reduction in yield due to weed is around 16 to 42 per cent. Generally weeding operation is mostly performed manually with khurpi, which requires higher labour input and the work is very tedious and time consuming. Moreover, the labour requirement for weeding depends upon weed flora, weed intensity, time of weeding, soil moisture and efficiency of worker (Mukhopadhyay, 1992 and Bhavin *et al*., 2016). Timely weeding is one of the most important agricultural operations for increased production and is a major determinant in effective weed control (Igbeka, 1984). Weeds can be controlled by mechanical, chemical, biological and traditional methods. Among the different methods, weed control by mechanical method is the best with little or no limitation because of its effectiveness in keeping the soil surface loose by producing soil mulch, which results better aeration and runoff water conservation (Duraisamy and Tajuddin, 1999 and Manjunatha *et al*., 2014).

India is the largest jute producing and consuming country and it is mainly grown in Eastern and North Eastern part as a rain-fed crop. The cultivation area of jute crop is around 0.8 million ha with average production of 114 lakh bales of jute fibre. Around 3.5 - 4 million small and marginal farmers grow jute as cash crop with little resources on receipt of pre-monsoon showers. Since not much care is given initially for land preparation, the weed infestation remains high in the jute fields. Moreover, hot and humid climate and intermittent rain encourage profuse growth of weeds. Traditionally, jute farmers follow broadcast method of sowing and manual uprooting of weeds. Due to shortage of labour in peak seasons, weeding operation cannot be carried out within short period of 30-35 DAE of plants. Conventional manual weeding in jute field involves 40 per cent of total expenditure for jute cultivation and there is reduction in fibre yield upto 70 per cent under un-weeded situation (Ghorai *et al.*, 2013). The reduction in fibre yield due to weed competition under irrigate condition is upto the extent of 36 per cent and for rain-fed condition it is 87 per cent.

Taking the socio-economic factors of the jute farmers and nature of land holding,a low cost and light weight manual weeder is most suitable for mechanical weeding. The present study was under taken to evaluate the performance of single wheel weeder in field condition for line sown jute crop.

METHODOLOGY

Constructional details of weeder :

The main components of the push and pull forward type single wheel weeder consists of body frame, ground wheel, blade or tyne attachment frame (share type, hoe type and scraper) and handle (Fig. A). Considering the multi-purpose use of weeder in different soil conditions, the body frame was made with M S flat (1.25 x 0.6 mm) for its durability and to withstand the pressure exerted during its operation. The weeder operates on a cycle wheel (compact type) of diameter 40 cm for its easy operation in the field.The weeder can work with three types of blade *i.e*. 3-4 tines rake, scraper and share. Angle of the handle is variable as per the requirement of the operator and handle grip is made of 22 mm G I pipe and rubber grips are provided at both the ends of pipe for comfort handling. The elbow flex on angle of the weeder is kept at 110^0 to reduce the drudgery of operator. The overall dimensions of the weeder including handle are 53 cm width, 162 cm length and 92 cm height from the ground and its weight is 9.0 kg. Weeding operation is push and pull type in standing posture and removes weeds completely from its operational width of 18 cm. To avoid the accumulation of weeds ahead of tynes, the operator walks behind while using the tool.

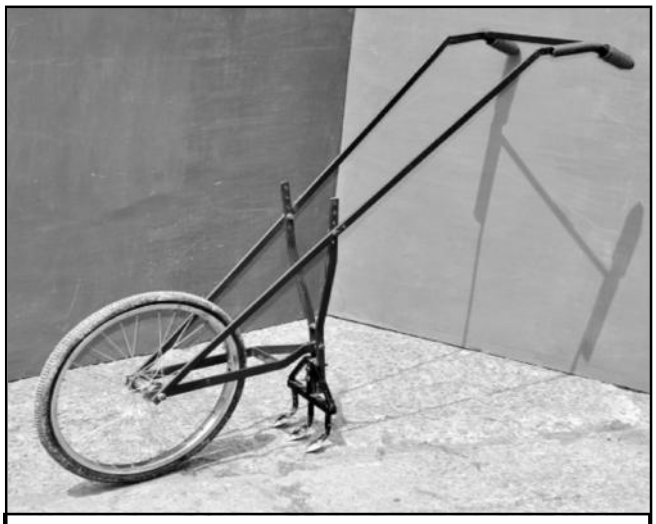

Fig. A : Single wheel weeder

Field performance of weeder :

The developed single wheel weeder was evaluated in ICAR-CRIJAF Farm, Barrackpore in the line sown jute crop of variety JRO-204 (Suren) in the month of

April during crop season 2016-17 (Fig. B). The jute was sown using the CRIJAF multi-row seed drill to maintain row to row spacing of 25 cm and plant to plant spacing of 5-7 cm along the row. The soil in the experiment site was sandy loam having sand, silt and clay in the ratio of 74.8, 13.2 and 11.8 per cent, respectively. The initial adjustment of the components was carried out in the machinery workshop. The test was conducted by selecting an area of 300 m^2 and sub-divided into three equal plots (length-50 m and breadth- 2 m each). The field tests were conducted at 15 days of crop age with height of plants ranging from 20-25 cm. The different performance test like speed of travel, field capacity, draft, weeding efficiency, power requirement and performance index were calculated.

Fig. B: Operation of single wheel weeder

Speed of travel :

For measuring speed of travel, a distance of 50 m was fixed and time to cover this distance is noted using stop watch in terms of meter per minute or meter per second.

Field capacity :

Field capacity of the weeder was measured with the actual area covered by the implement, based on total time consumed and width. Effective field capacity (ha/h) is given by :

$$EFC = \frac{A}{T_p + T_i} \quad \text{.....(1)}$$

where,

A = Area covered, ha

T_p = Productive time, h and

T_i = Non-productive time, h

Field efficiency is the percentage of time the machine operates at its full rated speed and width.

$$FE\ (\%) = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \quad \text{.....(2)}$$

Depth of weeding:

The depth of weeding plays an important role for the draft of weeder and it was measured in the field.

Draft of weeder:

The draft of the weeder is the soil resistance during its forward movement at rated width and depth.

$$D = W \times d_w \times R_s \quad \text{.....(3)}$$

where,

D = Draft of a weeder, kg

W = Width of cut, cm

d_w = Depth of cut, cm and

R_s = Soil resistance, kg/cm^2.

Weeding efficiency:

Weeding efficiency is the ratio of number of weeds destroyed to the number of weeds present before weeding in a unit area.

$$\text{Weeding efficiency}\ (\%), e = \frac{w_1 - w_2}{w_1} \times 100 \quad \text{.....(4)}$$

where,

w_1 = Number of weeds per unit area before weeding

w_2 = Number of weeds per unit area after weeding.

Plant damage:

The percentage plant damage during field operation was calculated using the following formula:

$$\text{Percentage plant damage} = (q/p) \times 100 \quad \text{.....(5)}$$

where,

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

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

Power requirement :

The power requirement for weeding operation was calculated by considering the parameters like draft and

speed of travel.

Power input (hp) = Draft (kg) x speed of travel (m/s)/75 ....(6)

Performance index:

The performance index of weeder was found using the following formula (Gupta, 1981) :

$$PI = \frac{a \times q \times e}{P} \quad \text{.....(7)}$$

where,

a = Field capacity, ha/h,

q = Plant damage factor, per cent (100-q),

e = Weeding index, per cent,

P = Power input, hp.

■ RESULTS AND DISCUSSION

The manually operated single wheel weeder is easy to operate due to small cycle wheel (compact) as its ground wheel and suitable for shallow weeding upto the depth of 5.0 cm. The developed weeder is not only suitable for jute crop but it can also be used for other line sown upland crops and vegetable crops, as row spacing can be adjusted. As far as physiological aspect is concern it is light in weight *i.e.* 9.0 kg and its handle height and angle of operation can be adjusted as per operator requirement.

The test was conducted by selecting a distance of 50 m and time for travel this distance was noted. Five readings of travel speed were recorded and average speed of travel was calculated and presented in Table 1. The average travelling speed was found to be 28.08 m/min.

The field capacity was measured by selecting three plots of size 50 x 2 m and observations were recorded while operating the weeder in these plots (Table 2). Actual field capacity of the machine was calculated in the experimental field by considering actual time requirement and area covered. At average speed of operation of 28.08 m/min, the field capacity of the weeder was found to be 0.026 ha/h and field efficiency of 76.7 per cent. Field capacity is affected by cutting width, moisture content of soil, weed intensity and physical condition of operator.

The weeding efficiency test was carried out on selected plot at the different locations. The average value of weeding efficiency was found to be 81.65 per cent. It can be concluded that the weeder is more efficient because efficiency is more than 80 per cent and also more comfortable to work with due to compact cycle wheel and small tynes (3 numbers).

The average draft of the weeder is 29.7 kg and it within the physical limit of the operator. The draft depends on the types of soil, effective cutting width and depth of cut. The working width of the weeder was 18 cm and depth of operation was kept as 5-6 cm throughout the experiment. The plant damage was observed to be 4.78 per cent due to better stability and control of weeder during its operation.The average power requirement for the developed single wheel weeder was estimated to be 0.18 hp. The performance index, which is a function of weeding index, field capacity, power input and plant damage was calculated to be 1123.01. The overall field performance of the weeder was presented in Table 3. It was observed that the developed weeder was not only suitable for jute crop but it could also be used for other crops as row spacing could be adjusted. The angle of penetration of blades can be changed as per the requirement.

Moreover, the time required for weeding one hectare area by single wheel weeder and *Khurpi* was observed as 38.5 h and 456 h, respectively. The cost of weeding

Table 1: Speed of travel of single wheel weeder

Sr. No.	Distance covered (m)	Time (min)	Speed (m/min)	Average speed (m/min)
1.	50	1.80	27.77	28.08
2.	50	1.77	28.24	
3.	50	1.79	27.93	
4.	50	1.76	28.40	
5.	50	1.78	28.08	

Table 2: Field capacity of single wheel weeder

Sr. No.	Area of plot (m^2)	Time to cover the area (min)	Field capacity (ha/h)	Average F.C. (ha/h)
1.	100	22.2	0.027	0.026
2.	100	25.0	0.024	
3.	100	21.4	0.028	

Table 3: Field performance of the single wheel weeder

Sr. No.	Description	Particular
1.	Effective width of cut	18 cm
2.	Number of runs required in between rows	1
3.	Depth of weeding	5-6 cm
4.	Draft requirement	29.7 kg
5.	Plant damage	4.78 %
6.	Power input	0.18 hp
7.	Performance index	1123.01

per unit area was calculated to be Rs. 1672.47/ha for the weeder against Rs. 19000.00/ha (two times manually) for conventional weeding. It can be observed that weeding by single wheel weeder is superior to that of conventional weeding using *Khurpi.*

Conclusion:

It can be concluded from above, that the performance of single wheel weeder is superior in terms of time and cost requirement to that of conventional weeding using *Khurpi*. It is easy to operate and the weeding efficiency is also satisfactory. It is suitable to use at 15-30 days of crop age in between rows and about 80 to 85 per cent weeds can be controlled. The rest 15 to 20 per cent of the weed flora has to be removed manually. Weeding with this tool reduces drudgery, reduces labour and cost requirement in line sown crops. There is a saving of Rs. 15000-17000/- per hectare following mechanical weeding in line sown crop. Moreover, as the tool is light in weight and easy to operate, women can operate the tool for weeding in line sown upland crops and vegetables.

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