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Research Article

Development of a Multipurpose Power Weeder

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Abstract: Paddy is grown in almost all states of India and the state of Odisha contributes 4.0 million hectares to rice cultivation practice. In India Rs. 4,200 million worth of crop is being lost every year due to weeds. There are many types of mechanical weeders available for vegetable crops with wide working width. These are not suitable for line sown paddy field. There is no such power weeder available which can work in both wet land and dry land condition. To eradicate these problems one power weeder was developed. The power requirement of the weeder was first calculated and found to be 1.1 kW. Hence, the available petrol engine of 1.33 kW with speed reduction of 34:1 was taken for fabrication of the weeder. Initially, three types of blade (L-type, C-type, hatchet type) were developed to see the efficacy of the blades. Each set of blade was fitted with the weeder and evaluated in line sown paddy in dry land as well as in transplanted paddy in wet land by attaching a suitable float and compared with the conventional weeding method. The highest weeding efficiency of hatched type blade was found to be 84.30% in wet land and 82.280 % in dry land, whereas the same for L-type blade and C type blade weeders were 72.83% and 62.79% in wet land and 71.03% and 63.67% in dry land at a soil moisture content of 14.5% respectively. The performance index of hatched shape, L shape and C shape blade weeder were observed to be 186.49, 117.70 and 125.15 in wet land and 190.81, 148.16 and 126.47in dry land at 14.5% moisture content respectively. At the same moisture content i.e.14.5%, the highest plant damage of 11.60% was observed with L type blades while the lowest plant damage of 4.0% was observed with hatchet type blade. The increase in heart rate (ΔHR) of 20.667 bpm was achieved for L type blade while the lowest of 18.667 bpm achieved in hatchet type blade at the same speed. It is concluded that the developed weeder with hatched type blade is most suitable for weeding in both wetland as well as dry land line sown paddy field. The cost of operation of the developed weeder was found to be Rs 177.10/h and Rs 4997/ha.

Key Words: power weeder, weeding index, plant damage, performance index.

INTRODUCTION

India is the second largest rice producing country in the world and represents about 10%(225 million)of the total world work force in agriculture(Nag &Nag,2004).To get the full benefit of mechanization, it is necessary to use proper weeding implements, which will reduce drudgery and cost of cultivation. In India Rs. 4,200 million worth of crop is being lost every year due to weeds (Natarajan, 1987). Weed control is becoming an expensive operation in crop production. Majority of Indian Farmers use hand-hoe for weeding which requires 40-60 labourers for weeding one hectare of land (Tajuddin and Job, 1997). In traditional method of rice cultivation, weeds are mostly removed from the field with manual process as they are seen more as a negative factor for crop growth. But in SRI weeds are seen as growth promoters when they are appropriately managed.

Now a days Govt. is giving more emphasize on line sowing. Govt. of Odisha provide 75% subsidy on seed drills and rice transplanters to increase production and productivity. But weeding is a major problem in line sown paddy crop. There are many types of mechanical weeders available for vegetable crops with wide working width. These are not suitable for line sown paddy field. Hence it is highly essential to develop a suitable power weeder for DSR condition. Though SRI power weeders are available for line transplanted paddy, these are not suitable for upland line sown crop. There is no such power weeder available which can work in both wet land and dry land condition. It is highly essential to develop a suitable weeder which can work in both transplanted rice in wetland as well as in line sown (DSR) in dryland condition. Hence the present study has been undertaken to develop a power weeder that can be used both in DSR in dry land as well as in transplanted rice in wet land condition.

MATERIAL AND METHODS

Experimental Site

The field experiments were conducted in the Agronomy main research farm, OUAT, Bhubaneswar in the district of Khurda, Orissa. The farm is located at 27 ^{0} 17′ N latitude and 85 ^{0} 45′ E longitude at an elevation of 35.0 m above mean sea level.

Selection of prime mover

Assumption:
S_R=soil resistance, kgf/cm^2 =0.43 kgf/cm^2
D=maximum depth of soil handle, cm =2.5 cm
W=Effective width of the cut, cm = 17X2=34 cm

V=Linear velocity of the tine at the point of contact with the soil, m/s
N = Revolution of tyne, rpm =170 rpm
D = diameter of tyne, cm=27.5 cm
The tip speed of the tine of the weeder was calculated by using equation

$$V=\frac{\pi DN}{60}$$
$$=3.14X27.5X170/60$$
$$=2.4 \text{ m/s}$$

Power required to dig the soil (Pd) was calculated by using the equation

$$P_d=S_R* d* W* V/75(hp)$$
$$=\frac{0.43*34*2.5*2.4}{75}$$
$$=1.169 \text{ hp}$$
$$=0.872 \text{ kW} \quad (1 \text{ hp}=0.746 \text{ kW})$$

- Taking efficiency of engine as 80%.

Total power requirement comes to
= (Power required, hp) / (Efficiency, %)
= (0.872/0.8)
= 1.09 kW

Design of Blades:

The interaction between soil and machines takes place at the blades thus by improving their geometry the power required and the size of machine will reduce.

• Blades are attached to a flange mounted on a rotating shaft usually by nuts & bolts.

• Types of blades

1)L-shaped Blades 2) C-Shaped Blades

3) Hatchet- Shaped Blades

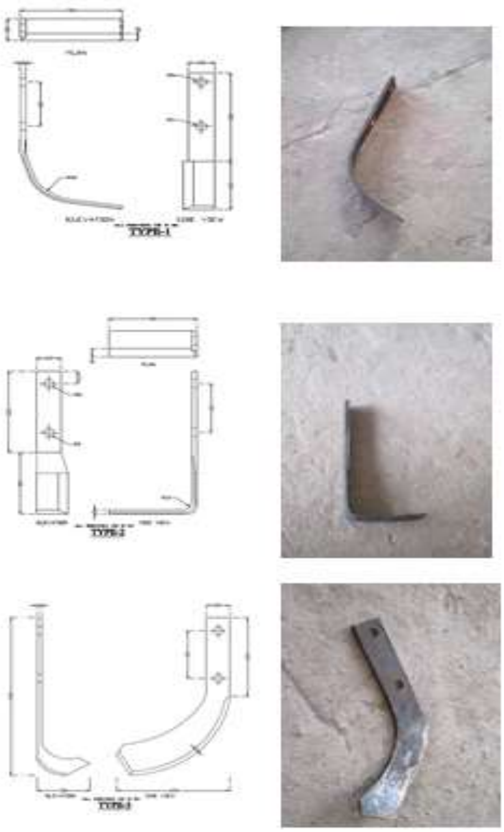

Fig 1 Type of blades (a) C type blade (b) L type blade (c) Hatchet type blade

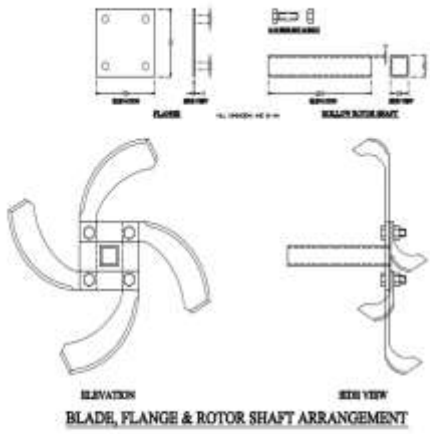

Fig 2: Rotor blade

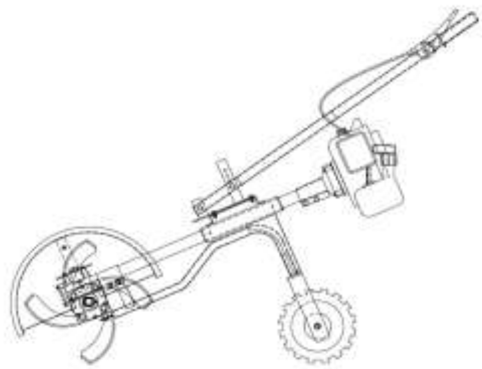

Fig 3: side view of the developed power weeder

Table 1: Specifications of Power weeder

Sl No	Specifications	Values
1.	Type of machine	Engine operated
2.	Dimensions in cm Length Width Height	 141.00 58.00 21.00
3.	Power	1.78 hp 2-stroke petrol engine (Maruyama, Japan),6500 rpm
4.	Weight, kg	20.4
5.	Type of float	PVC float (Sharp Garuda make)
6.	Number of rows	2
7.	Row spacing, cm	20
8.	Handle	
9.	Material and size	MS pipe, 25 mm dia.
10.	Position	Front of weeder
11.	Spacing between two handle, mm	580

Performance Evaluation

Prototype of power weeder was tested under

Both the field conditions i.e. dry land as well as wet land in sandy loam soil for its performance evaluation with different combinations of soil-machine parameters. A field was divided into three equal block sizes according to randomized complete block design. The power weeder was tested for 2 h in the field at each level of soil moisture content. The following performance indicators were calculated using the observed data in the field:

Weeding efficiency

Weeding efficiency is a ratio of the number of weeds removed by a weeder and the number present in unit area and is expressed as:

Weeding efficiency, (%)

$$e = \frac{W1 - W2}{W1} \text{ x } 100 \ldots (3)$$

Where,
W1 = Number of weeds before weeding, and
W2 = Number of weeds after weeding.

Plant damage

The percentage of plant damage that were caused due to operation of different weeders was determined by counting the no. of uprooted or damaged plants in a row and by using the relation

$$D = \frac{Q1 - Q2}{Q1} X100 \ldots\ldots (4)$$

Where,
Q1=no of plants in 10 m row length before weeding
Q2=no of plants in 10 m row length after weeding

Field capacity

Field capacity (ha/h) was computed by recording the area weeded during each trial run in a given time interval. With the help of stopwatch, time was recorded for respective trial run along with area covered.

$$TFC = \frac{\text{Width(W) mX Speed(V)km/h}}{10} \text{ (ha/h)} \ldots\ldots (5)$$

Performance index

The performance index of the weeder can be calculated by multiplying field capacity, weeding efficiency, plant damage percentage and dividing the result with the power input of the weeder.

$$P.I. = \frac{a \text{ X } q\text{X } e}{P} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where,
PI = Performance Index
a = Field Capacity of weeder, ha/h
e = Weeding efficiency, per cent
q= Plant damage factor = (100-% plant damage)
P = Power input, hp

RESULTS AND DISCUSSION

1. Performance of weeder in line transplanted paddy field

The developed weeder was evaluated at central farm OUAT during Rabi 2015.Each set of blade was fitted with the weeder and was operated in the field .The weeder was operated at three levels of speed. i.e. 1.42, 1.62, 1.78km/h for each set of blade. The parameters like actual field capacity, speed of operation, weeding index, plant damage, depth of operation, and change in heart rate of the operator were recorded and performance index were determined for three levels of working speed.

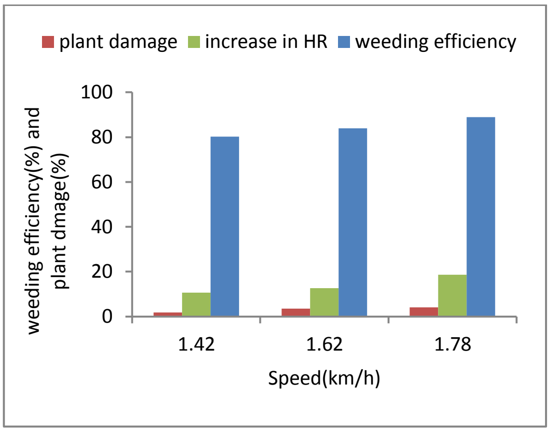

Fig. 5: Performance parameters of weeder as a function of speed

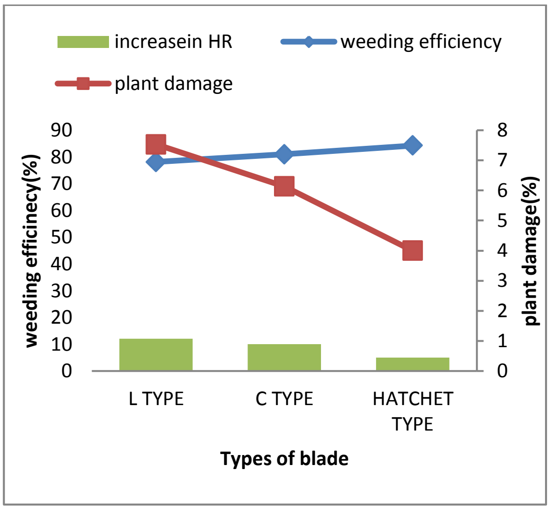

Fig. 6: Performance parameters of weeder with different types of blade

Performance of Different Types of Blade

Performance of the weeder with different types of blade is shown in Fig. 6. Highest weeding efficiency was recorded for hatchet-type blade (84.30%), and lowest for L type blade. In general the weeding efficiency increases with increase in speed for all three types of blade. The highest weeding efficiency of hatchet type blade may be due to the higher soil mass handling as well as cutting and burying of weeds in soil. Plant damage was 14.83%, 2.17% and 1.80 % for L-type, C-type and hatchet-type weeder, respectively. The minimum plant damage of hatchet types blade may be due to stable operation of the weeder because of its higher depth of cut and handling of more soil mass while the maximum plant damage in case of L type blade may be due to its lower depth of cut resulting higher vibration and unstable movement randomly in rows. Higher plant damage at higher speed may be due to the difficult to control the machine in a zigzag manner in rows. The weeder with different type of blade was operated by a healthy person aged about 28 years without any prehistory of diseases. The lowest ΔHR in case of hatchet type blade may be due to its lower vibration as compare to C type and L type blade causing lower exhaustion on the worker. The performance index of hatched shape, L shape and C shape blade weeder were observed to be 186.49, 117.70 and 125.15 in wet land.

2. Performance of weeder in line sown paddy field (Dry land)

The performance of the weeder was studied for three sets of blades at three levels of moisture content ranging from 9.8 to 14.5% and presented in Table 4.8 and Figure 4.4. Speed of the operation was kept constant (1.62km/h) for all three types of blades.

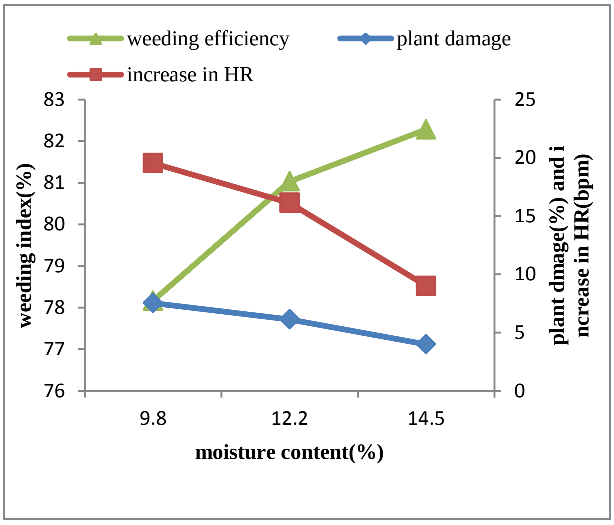

Fig. 5: Performance parameters of weeder as a function of soil moisture content

In general the percentage of weeding index increases with increase in moisture content for all three types of blade and for same moisture content (14.5%) ,the highest weeding index was achieved 82.280% for hatchet type blade while the lowest weeding index of 63.667% was achieved in C type blade.

This result also coincide with the result obtained by Sabaji *et al.* (2013).The weeding index increases with increase in moisture content as soil compaction was optimum at high moisture content which made weeds easily susceptible to mechanical shear. The highest weeding index of hatchet type blade may be due to higher soil mass handling as well as cutting and burying of weeds in soil. The percent of plant damage decreases with increase in moisture content for all three types of blade and the same moisture content (highest moisture content)i.e.14.5%,the highest plant damage of 11.60% was observed with L type blades while the lowest plant damage of 4.0% was observed with hatchet type blade.

The minimum plant damage of hatchet type blade may be due to stable operation of the weeder because of its higher depth of cut and handling of more soil mass while the maximum plant damage in case of L type blade may be due to its lower depth of cut resulting higher vibration and unstable movement randomly in rows. This result also coincide with the result obtained by Sabaji *et al* (2013).This is may be due to plant damage percentage was not significantly influenced by soil moisture content. The increase in heart rate (ΔHR) i.e. 10.667 bpm was achieved for L type blade while the lowest ΔHR (5.000 bpm) was achieved in hatchet type blade. The lowest ΔHR in case of hatchet type blade may be due to its lower vibration as compare to C type and L type blade causing lower exhaustion on the worker. Generally the percentage of ΔHR decreases with increase in moisture content for all three types of blade. This is may be due to that the blades penetrate in to the soft soil more easily that give less vibration resulting more comfort to the worker.

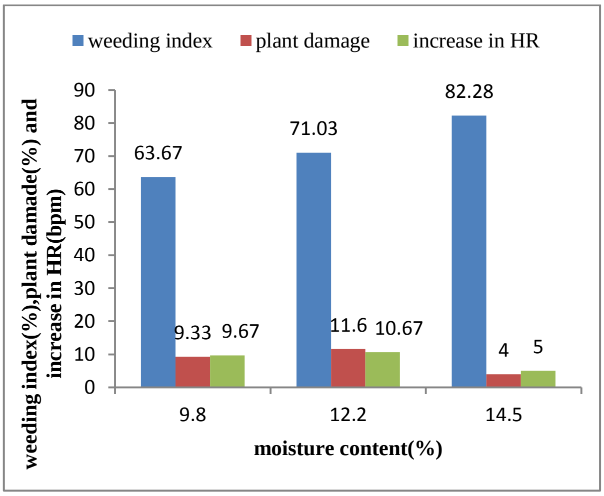

Fig. 6: Performance parameters of weeder with different types of blade

The highest performance index (190.81) was achieved in hatched type blade whereas lowest performance index (148.16) was achieved in L type blade. The maximum field capacity (0.043 ha/h) was achieved in hatched type blade as compared to other two.

CONCLUSIONS

A manually operated multipurpose power weeder operated by a1.33 kW engine and weighing 20.4 kg was designed and developed for weeding with minimum plant damage and power requirement for both wet land and dry land paddy filed. Hatchet-type of blades (length, cutting width and thickness of 200 mm, 50 mm and 5 mm, respectively) operated by rotor shaft was found to be superior among the three types with satisfactory weeding efficiency (83.40%) for wet land and 82.280% for dry land with minimal plant damage (4.03%) for wet land nd 4% for dry land. Machine performance in sandy loam soil indicated that with soil moisture increasing from 9.8 to 14.5 % (w.b), weeding efficiency increased from 78.17 to 82.28 per cent for hatchet type blade. The performance index of hatched shape, L shape and C shape blade weeder were observed to be 186.49, 117.70 and 125.15 in wet land and 190.81, 148.16 and 126.47in dry land at 14.5% moisture content respectively. The increase in heart rate (ΔHR) of 20.667 bpm was achieved for L type blade while the lowest of 18.667 bpm achieved in hatchet type blade at the same speed. It is concluded that the developed weeder with hatched type blade is most suitable for weeding in both wetland as well as dry land line sown paddy field. The cost of operation of the developed weeder was found to be Rs 177.10/h and Rs 4997/ha.

REFERENCES

1. Nag P.K &Dutt, P. 1979.- Effective of some simple Agricultural weeders with reference to physiological responses, Journal of Human Ergonomics; 13-2.
2. Olaoye, J.O. and T.A. Adekanye. "Development and Evaluation of a rotary power weeder." *Tillage for agricultural productivity and environmental sustainability – conference, held in Ilorin, Nigeria,* 21 – 23 February 2011, PP. 129-141.
3. Olawale, J.O. and Guntunde, P.O. 2006. Design of power weeder. Conference on International Agricultural Research and Development "Tropentag 2006" University of Bonn Germany.
4. Rangasamy KM, Balasubramanium and Swaminathan KR.1993. Evaluation of power weeder performance. *Agricultural Mechanisation in Asia*, Africa and Latin America, Vol(24) No(4): 16-18.
5. Tajuddin A, Karunanidhi R and Swaminathan KR.1991. Design development and testing of an engine operated blade harrow for weeding. *Indian Journal of Agricultural Engineering*. 1(2) 137-140.
6. Tajuddin A. 2006. Design, Development and Testing of Engine Operated Weeder. *Agricultural Engineering Today*.30 (5) 25-29.
7. Tewari VK, Datta RK and Murthy AS.1991. Evaluation of three manually operated weeding devices. *Applied Ergonomics*. 22(2) 3-6.
8. Tewari VK, Datta RK and Murthy AS.1993. Field performance of weeding blades of a manually operated Push-Pull weeder.Journal of Agricultural ngineeringRarch 55 2.
9. Umar B. 2003. Comparison of manual and manual-cum-mechanical energy uses in groundnut production in a semi-arid environment". *Agricultural Engineering International: the CIGR Journal of Scientific Research and Development* Manuscript EE 03 003 May 2003 1-11.
10. Varma MR, Tiwari RC and Agrawal A. 1991. Adoption and field evaluation of improved equipment to power tiller for sugarcane cultivation. *Journal of Agricultural Engineering* 48(9) 154-157.