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Design and fabrication of farming weeder and cutter under single operating mechanism

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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 common weeder for paddy and maize. There is no such weeder available which can work in both wet land and dry land condition. To eradicate these problems a weeder was developed. 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 paddy field and L-type blade 82.36% in maize field, 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 126.47 in 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 (Δ HR) 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 blade is most suitable for weeding in both wetland as well as dry land line sown paddy field.

Keywords: 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. 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. 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. 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 emphasis on line sowing. Govt of Odisha provide 75% subsidy on seed drills and rice transplanters to increase production and productivity. But weeding

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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 weeders are available for line transplanted paddy, these are not suitable for upland line sown crop. There is no such weeder available which can work in both maize land and riceland 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 dry land condition. Hence the present study has been undertaken to develop a weeder that can be used both in DSR in dry land as well as in transplanted rice in wet land condition [1-5].

LITREATURE REVIEW

RajvirYadav et.al-Development and Ergonomic Evaluation of Manual Weeder, To increase the productivity per unit area of small land holdings and considering the economic condition of Indian farmers, it is quite necessary to have suitable agricultural implements which farmers can use and also allow them to use for custom hiring.

MonalishaSahu et.al-Development of a Multipurpose Power Weeder, There are many types of mechanical weeders available for vegetable crops with wide working width. These are not suitable for line sown paddy field.

Satish Kumar et.al- Performance Evaluation of Developed Manually Operated Rotary Weeder for Vegetable Crops, Weeding is one of the major control operations in the vegetable crops. The traditional method of weed control is to remove the

weed manually by a Khurpi or Spade. This is a very time consuming process.

MATERIAL AND METHODS

Experimental Site

The field experiments were conducted in the village located in bhavani in the district of Erode, TamilNadu. The farm is located 11.4469° N, 77.6840° E [6].

Selection of prime mover

Assumption

SR=soil resistance, kgf/cm² =0.43 kgf/cm²
 D=maximum depth of soil handle, cm =2.5 cm
 W=Effective width of the cut, cm = 17X2=34 cm

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 [7].

- 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

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:

$$\text{Weeding efficiency, (\%)} e = \frac{w_1 - w_2}{w_1} \times 100 \dots (3)$$

Where,

W1 = Number of weeds before weeding, and

W2 = Number of weeds after weeding.

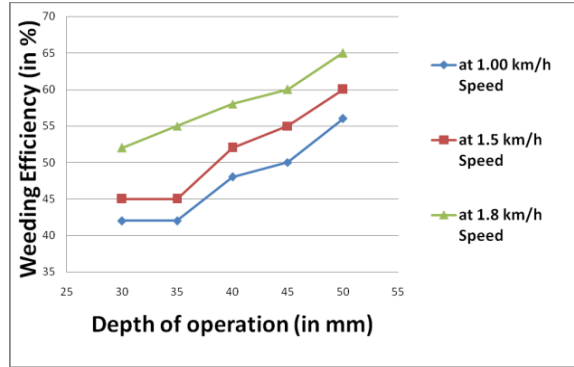


Fig. 1

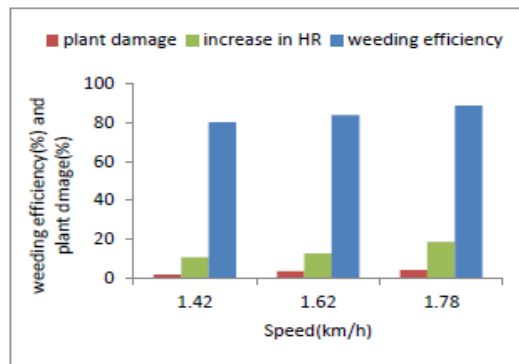


Fig.2

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 [9, 10].

$$D = \dots\dots(4)$$

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 [8].

$$TFC = (ha/h) \dots\dots (5)$$

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. = \dots\dots\dots\dots\dots\dots (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, h

CAD DESIGN

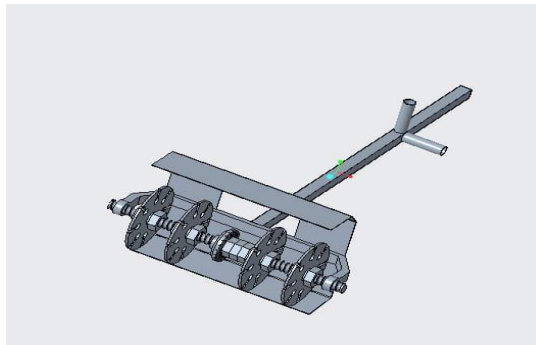


Fig.3

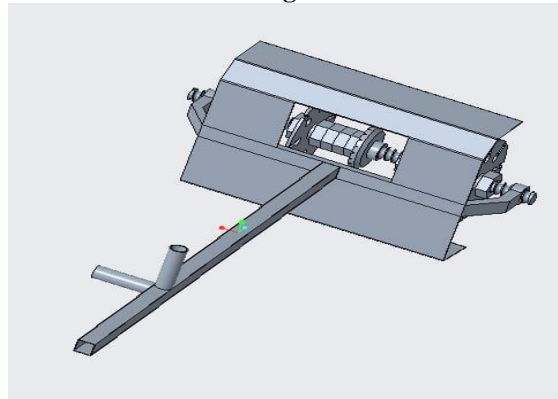


Fig.4

PHOTOGRAPHIC VIEW



Fig.5 Top View



Fig.6 Side View

RESULTS AND DISCUSSION

Performance of weeder in line transplanted paddy field

In the developed weeder, Each set of blade was fitted with the weeder and was operated in the field

The weeder was operated at constant speed. i.e. 1.42km/h for 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.

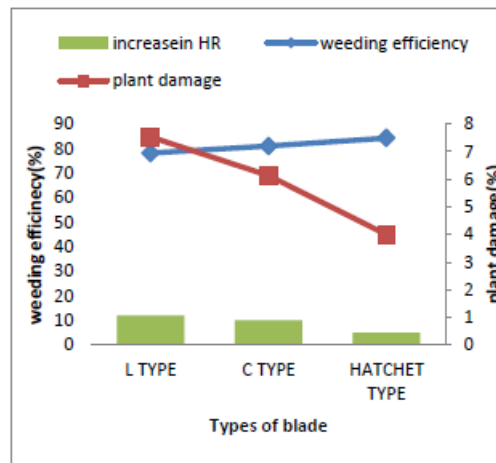


Fig.7

Effect on weeds

The major weed species present in the experimental field were Echinochloa colonum (44.92%), Digitalis on giflora (5.31%), Dactyloctenium aegyptium (3.11%), Cyperus rotundus (4.55%) and the annual broad leaved

weeds constituted 39.64% of the total weed population comprising of Parthenium hysterophorus (27.77%), Digeria arvensis (4.40%), Trianthema portulacastrum (3.60%). The weed density recorded in the various treatment plots at 45 DAS revealed that atrazine 0.5 kg/ha.

Design of Blades

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Table 1. Effect of different weed control treatments on weed density, weed dry weight, grain yield and economics

Treatments	Weed density (No./m ²)		Weed dry weight (kg/ha)		Grains per cob	Grain yield (kg/ha)	WI (%)	B:C ratio
	25 DAS	45 DAS	25 DAS	45 DAS				
Weeding with Crescent hoe (25 and 45 DAS)	2.6 (396.7)	2.4 (255.0)	2.3 (186.7)	2.8 (693.3)	430	4059	25.23	2.08
Weeding with Multiweeder (25 and 45 DAS)	2.5 (286.0)	1.8 (62.0)	2.2 (173.3)	2.2 (140.0)	438	4615	14.99	2.39
Weeding with Wheel hoe (25 and 45 DAS)	2.4 (235.3)	1.7 (52.7)	2.2 (166.7)	2.1 (113.3)	484	4814	11.33	2.60
Weeding with Rotary peg weeder (25 and 45 DAS)	2.5 (315.3)	1.9 (69.3)	2.3 (186.7)	2.6 (353.3)	449	4345	19.97	2.18
Hand weeding twice (25 and 45 DAS)	2.3 (206.7)	1.7 (46.3)	2.2 (166.7)	2.0 (106.7)	513	5227	3.72	2.40
Atrazine 0.5 kg/ha as pre-emergence+ HW at 45 DAS	2.1 (111.3)	1.6 (34.7)	2.2 (140.0)	2.1 (114.7)	457	5429	0.00	2.87
Unweeded control	2.7 (458.0)	2.6 (439.3)	2.5 (293.3)	3.3 (2133)	380	3125	42.24	1.95
LSD (P=0.05)	0.1	0.1	0.1	0.1	37	188		NA

NA - Not analysed
Values in parenthesis are original values

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 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.

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.

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 Sabajiet *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 Sabajiet *al.* (2013). This may be due to plant damage percentage was not significantly influenced by soil moisture content. The increase in heart rate (Δ HR) i.e. 10.667 bpm was achieved for L type blade while the lowest Δ HR (5.000 bpm) was achieved in hatchet type blade. The lowest Δ HR 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 Δ HR 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.

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 1.33 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 field. 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 82.28% for dry land with minimal plant damage (4.03%) for wet land and 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 126.47 in dry land at 14.5% moisture

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