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Performance Testing of the Rotary Paddy Weeder with Different Angle of Blade

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***Abstract* – Rice (oryza sativa L) is an important crop which is being cultivated most extensively through the world and is considered as staple food crop of more than 60% of world's population. In India weed control is one of the major problems in rice cultivation according for a major share in the cost of cultivation. About 60 % of the cost of cultivation of the kharif crops goes in weed control alone. The cost of weeding can be substantially reduce by Introducing improve weeding tools. Six serrated blades were fixed on bush drum, shaft of diameter 2.5cm with axle of 1.1cm diameter. The blades was fixed with three different angels on the bush drum in different weeder, was 10º, 15º and straight. Its performance was compared with conventional manual weeding. Using it in wet field condition the field capacity of 80 to 85% during the operation. It was found that weeder with straight blade angles gave highest weeding efficiency other than two weeding methods.**

***Keywords* – Intercultural tool, Rotary Weeder, Weeder, Weed Management.**

I. INTRODUCTION

In India weed control is one of the major problems faced by the farmers for raising a crop. Weed competition is one of the prime yield limiting biotic constrains in rice which is grown in an area of around 44.97 million hectare annually with a production of 89.48 million tones. Weed control is essential so that crops could be grown profitably and other activities of man could efficiency. The cost of weeding can be substantially reduce by Introducing improve weeding tools. Rice (oryza sativa L) is an important crop which is being cultivated most extensively through the world and is considered as staple food crop of more than 60% of world's population. India is the third largest producers of groundnut in the world and accounts for about one-fifth of world's production (Anon, 2005-06). Manual weeding requires huge labour force and accounts for about 25 per cent of the total labour requirement (900-1200 man-hours/hectare) (Nag and Dutt, 1979). In India this operation is mostly performed manually with khurpi or trench hoe that requires higher labour input and also very tedious and time-consuming process. Moreover, the labour requirement for weeding depends on weed flora, weed intensity, time of weeding and soil moisture at the time of weeding and efficiency of worker. Often several weeding are necessary to keep the crop weed free. Reduction in yield due to weed alone is estimated to be 16-42 % depending on crop and location and involves 1/3 rd of the cost of cultivation (Rangasamy et al, 1993). Rice originated from hot humid tropics where monsoon rains and fluid water create environmental crisis for at least part of the growing session. The cultivation of rain feed rice is dependent on south – west monsoon. Being a tropical crop, rice requires high rain fall, humidity and requisite temperature. The paddy is cultivated in different field situation from upland to extreme lowland. The area under upper midland is about 25% of total paddy area a major portion of it 85% is an eastern states like Assam, Chhattisgarh, Madhya Pradesh, Eastern UP, West Bengal and Orissa. The remaining 15% is distributed in other state. The crop weed competition is greater in direct seeded line sowing of rice because the crop and weed seeds germinate simultaneously and they starts competing with each other of air, water, sunlight and nutrients. In India woman constitute 50.2% (Sony and varshney, 1984) of the agriculture work force. Woman is an entrepreneur as she plays an eminent role not only in agriculture but also in allied activities. In Chhattisgarh, woman labours played a significant role in the paddy cultivation (Marothia and Sharma 1985).

II. MATERIAL AND METHODS

Testing of Rotary Weeder
Field test

- Moisture content of soil
- Bulk density
- Speed of operation (km/h)
- Depth of cut (cm)
- Width of cut (cm)
- Theoretical field capacity (ha/h)
- Actual field capacity (ha/h)
- Field efficiency (%)
- Weeding efficiency (%)

Moisture content of soil: For the determining of the moisture content of the field five soil samples were collected randomly from each plot. The moisture content of soil sample was calculated by gravimetric method.

Moisture content = $\frac{\text{Weight of wet soil – Weight of oven dried soil}}{\text{Weight of oven dried soil}} \times 100$

$$M.C. = \frac{W_1 - W_2}{W_2} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (.1)$$

Where,
W_1=Weight of wet soil
W_2=Weight of oven dried soil

Bulk density: For determining the bulk density of soil of the test field

$$\gamma = \frac{M}{V}$$

$$= \frac{4M}{(\pi D^2)L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (.2)$$

M= Mass contain in core sample in oven dry soil
V= volume of cylindrical core sample
D= diameter of cylindrical core sample
L=length of cylindrical core sample

Measurement of speed of operation: For the manual weeder, the speed was measured by recording the time required to cover distance in one row by using the stop watch.

Measurement of depth of cut: Actual working depth of cut of the machine with different blades was measured in the field by observing the strip of the soil and weeds cuts in a row.

$$Speed\left(\frac{km}{h}\right) = 3.6 \times \frac{distance(m)}{time(s)} \quad \text{(.3)}$$

*Theoretical field capacity :*It was determined by taking the theoretical width observed by the weeder and the field coverage area that would be obtained if the weeder was operating continuously without interruptions.

Theoretical field capacity =SW/10 …………………(.4)

Where,
S= speed km/h
W= theoretical width, m

Actual field capacity: The weeder was continuously operated in the field for the specific time period. For calculating actual field capacity, the time consumed for actual work and that lost for the other activities such as turning and clogging of implement was taken in to consideration. The length and width of plot was measured and the area covered during the testing period was determined and expressed in ha/h.

$$S = \frac{A}{T_P + T_1} \quad \text{(.5)}$$

Where,
S=effective field capacity, ha/h.
A=area covered ha/h
T_p =productive time hour
T_1 =non productive time hour

Field efficiency: This given an indication of the time lost in the field and the failure and utilizes the full working width of the machine.

$$Fieldefficiency = \frac{effectivefieldcapicity}{teoreticalfieldcapicity} \times 100 \quad \text{(6)}$$

Weeding efficiency: The weeding efficiency of the weeder was calculated by counting the number of weeds present before weeding operation per unit area.

The weeds destroyed by the operation of weeder would include the weeds completely uprooted or buried in to the soil and those physically damaged.

$$weedingefficiency = \frac{noofweedpresentbeforeoperetion}{noweedpresentafteroperetion} \times 100$$

$$\eta = \frac{W_1 - W_2}{W_1} \quad \text{(7)}$$

Where,
η = weeding efficiency
W_1 = no. weeds count per unit area before operation
W_2 = no. weeds count per unit area after operation

Performance index: It measurement of performance of a weeder and is directly proportional to the area per unit time; the weeding efficiency and the quality of work are inversely proportional to the power required.

$$performanceindex = \frac{(fieldcapicity \times quality \times weedingefficiency)}{powerrequired}$$

$$P_I = \frac{F_C \times Q_1 \times \eta_W}{P} \quad \text{(.8)}$$

Quality of work done: This term refers to the qualitative assessment of the performance of the weeder in terms of complete removal weeds without causing damage of the crop. This may be expressed as follows:

$$Q1 = \left(1 - \frac{Pd}{Pt}\right) \times \eta_W \quad \text{(.9)}$$

Where,
P_t = total no plants per unit area before the weeding operation
P_d = total no of plants completely damaged in the same per unit area after the weeding operation
η_W = Weeding efficiency

Power used in weeding operation: The power used in the weeding operation was calculated by the following equation.

$$power = speed \times draft \div 75 \quad \text{(.10)}$$

$$p = \frac{s \times w}{75} \quad \text{(.11)}$$

Working depth of cut: The depth of cut of machine with different blades was measured in the field by measuring the depth of soil layer tilled by the blade in a row. This was done by the two scales, one placed in horizontal position on the ground and another in the tilled soil perpendicular to the first scale.

Working width of cut: The width of cut of the machine with different blades was measured in the field by observing the strip of the soil and weeds cut in a row. It was measured with the help of scale.

III. Results and Discussion

The field performance of weeder and its result were described. For this, the comparison between the three weeder with each other and with the traditional methods was compared. The performance of manually operated weeder and traditional method were expressed in terms of field capacity, weeding efficiency, time requirement, labour requirement of energy used and operation cost during operation.

Following three weeder were tested and their performance was compared with traditional method of hand weeding in this study.

1. Weeder 1 with blade angle 10º and float angle 150º
2. Weeder 2 with blade angle 15ºand float angle 150º
3. Weeder 3 with straight blade and float angle 150

Field Performance Test of Rotary Weeder

Study of weeds

Weed population: Weed population at 30 DAS and 45 DAS were studied. The common weed species were observed as Bristly star bur Acanthopermum hispidum

DC; spiny pig weed amaranths spinosus L; Goat weed Ageratum conyzoides l; dog weed cleome viscosia L; white cock's comb celosia argentia L; Euphorbia hirta L; Gripe weed phyllanthus niruri L; Day flower Commenlia banghalensis L; Wet land amaranth Alteranthera sessilis L.At the 30 DAS the intensity of the above mentioned weed flora in the testing of weeder was quite high. Minimum population of weeds was recorded at the stage of the crop of 45 DAS after one operation of weeding by weeders.

Weeding Efficiency: From the table 1 the weeding efficiency of the different method was significantly influenced in the weeding operation at 30 DAS. It reveals that the weeding efficiency (75.77%) was noted in the weeding operation by the weeder of 10º blades angle followed by (76.10) and (78.48) in the weeder with blade angle 15 and strength blade respectively. The highest weeding efficiency (93.6%) was found in the weeding operation in hand weeding. The highest weeding efficiency was found in the weeding operation of the hand weeding method as weeds were removed manually every weed was uprooted by hands. In case if the weeder, they were operated with in the row and only those weeds were removed which was grown in the row spacing and intra row weeds were left by the weeders causing minimum weeding efficiency. The weeding efficiency of the weeder and hand weeding was increased as the growth of the weeds was reduced by first weeding at 30 DAS.

Quality of work done: It was observed that some plants are damaged by the weeder. These damaged plants were counted and by the calculation The weeder was operated in the field by the man labour in the line sown paddy. During the operation the quality of work done was calculated and following result was given.

The quality of work done during weeding operation with different weeder and hand weeding method are given. It shows that the minimum quality of work done (80.22%) was observed by the weeder with the blade angle 15º followed by (80.49%) and (80.61%) by the weeder with blade angle 10º and straight blade respectively. While the maximum quality of work done among weeder was observed under the weeding operation of hand weeding (93.54%). However these result were coincide with the earlier research work done by Tewari et al. (1993) on field performance of weeding blades of manually operated paddy weeder.

Speed of operation : The speed of operation of weeding of the different weeder was observed and compared with each other and with the method of hand weeding. The speed of operation of the weeder during the weeding operation was observed that the speed of operation was found with the weeder with straight blades (0.83km/h) followed by (0.789km/h) with the weeder with blade angle 15º. As the straight blade weeder was worked without clogging result work coincidence with the finding of Tewari (1993).

Theoretical field capacity: It gives that the minimum theoretical field capacity (0.007ha/h) of the weeder with 15º blade angle. The maximum field capacity (0.0083ha/h) of the weeder with straight blades followed by (0.00789ha/h) the weeder with 10º blade angle.

Actual field capacity: The actual field capacity (0.0037ha/h) was minimum in the weeding method of hand weeding. The maximum actual field capacity (0.0068ha/h) of the weeder with the straight blades followed by (0.0066ha/h) of the weeder with blade angle 15º the actual field capacity (0.0062ha/h) of the weeder with the blade angle 10º.

Field efficiency: The field efficiency of the weeder with blade angle 15º was minimum (81.7%). The highest field efficiency was found during the weeding operation (84.5%) of the weeder with straight blade followed by the field efficiency (83.6%) of the weeder with blade angle 10º.

Performance index: The maximum performance index (21.92) was found in the weeder with straight blades followed by performance index(21.89) and (21.77) was found in the weeder with blade angle 10º and 15º respectively. Results work concedes with findings of Tiwari (1993).

CONCLUSIONS

- The manual operated rotary weeder was suitable for loosening the soil gently up to depth of 3.5 cm.
- Weeding efficiency was observed highest in the method of hand weeding (95.6%) followed by weeding of straight blade rotary weeder (86.48%). Lowest weeding efficiency was found in weeder with 1.
- The quality of work done was found to be highest in hand weeding (93.54%) fallowed by the weeder of straight blades was found to be (80.69%). The minimum quality of work don was found (80.22%) by the weeder of 15 degree blade angle. Maximum actual field capacity (0.0068 ha/h) was found with the weeder straight blades and minimum field capacity (0.0037ha/h) was found in the hand weeding.
- Maximum critical field capacity (0.0079ha/h) was absorbed with weeder of 10º blade angle (0.0079ha/h).
- Highest field capacity (77.9 %) was found in the weeder of straight blades and minimum field efficiency (74.5%) was found with weeder of 100 blade angle.
- Performance index was maximum with the straight blade weeder (21.92) and minimum with the weeder of 950 blade angle was found (21.77).

Table 1. Weeding efficiency of different method of weeding at 30 DAS

S. No.	Weeder	Weeding efficiency,%
1.	Weeder $_1$(10º)	75.77
2.	Weeder$_2$(15º)	76.10
3.	Weeder$_3$(straight)	78.48
4.	Hand weeding	93.60

Table 2. Weeding efficiency of different method of weeding at 45 DAS

S. No.	Weeder	Weeding efficiency,%
1.	$Weeder_1$ (10^o)	83.09
2.	$Weeder_2$ (15^o)	81.08
3.	$Weeder_3$(straight)	86.55
4.	Hand weeding	96.32

Table 3. Quality of work done with different methods

S. No.	Methods	No of plants before weeding	Plant damaged	Quality of work done,%
1.	$Weeder_1$	383	50	80.61
2.	$Weeder_2$	398	68	80.22
3.	$Weeder_3$	375	65	80.49
4.	Hand weeding	387	25	93.54

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