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Research Article

A SURVEY ON PERFORMANCE EVALUATION OF DIFFERENT TYPES OF WEEDER

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ABSTRACT

In Indian agriculture, it's a very difficult task to remove unwanted plants manually as well as using bullock operated equipments which may further lead to damage of main crops. More than 33 percent of the cost incurred in cultivation is diverted to weeding operations there by reducing the profit share of farmers. Every year in India, an average of 1980 Cr of rupees is wasted due to weeds. The country faces the total loss of 33% of its economy from Weeds. The Losses are due to some of the following reasons, total loss of 26% from Crop Diseases, total loss of 20% from Insects and Worms, total loss of 6% from Rats. Weeding control is done by: mechanical weeding, thermal weeding: flaming, biological control, chemical control, and by farming pattern. It has always been a problem to successfully and completely remove weeds and other innocuous plants. Invariably, weeds always grow where they are not wanted. After discovering that tools such as cutlass and hoes require high drudgery, time consuming and high labor force. This review paper is aim by carrying out the performance evaluation of different weeders such as manually operated and power operated which will help to minimize time consume, working fatigue and to reduce labor cost.

Keywords: *Weeder, Manual Weeder, Power Weeder, Weeding Efficiency, Field Efficiency*

INTRODUCTION

One third of the cost of cultivation is spent on weeding alone when carried out with the manual labour. The arduous operation of weeding is usually performed manually with the use of traditional hand tools in upright bending posture, inducing back pain for majority of labourers. The long growth cycle of the crop also passes through frequent rains and the weeds pose a serious problem. Losses caused by weeds in cotton ranges from 40-75 per cent depending upon nature and intensity of weeds. Though there are many agencies, which cause reduction in yield, the majority agency causing reduction are the weeds.

Paddy crop is widely accepted cereal for food and 95 per cent of world's paddy production by Asian countries only (Farahmandfar *et al*., 2009). Weeding in paddy is timely operation to be executed to get maximum yield otherwise weed will compete for the nutrients with crop. During early establishment, the weeds make 20-30 per cent of their growth while the crop makes 2-3 per cent of its growth. Manual weeding is one of the time and energy consuming operation in rice cultivation and also labour cost increasing tremendously from the last decade. Hence, cost of cultivation is getting increased every day.

Weeds are unwanted and undesired plants which grow among the field crops. It interfere and compete with main crop for their existence which causing serious yield loss by share in land, water, nutrients, sun light, and available CO_2 for main crop (Rao, 1999). 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 % of the total labour requirement (900–1200 manhours/hectare) during a cultivation season (Yadav and Pund, 2007). 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. Weeds compete with crop plants for nutrients and other growth factors and in the absence of an effective control measure, remove 30 to 40 per cent of applied nutrients resulting in significant yield reduction (Goel *et al.*, 2008). There is an increasing concern over the intra row weeder because of environmental degradation and growing demand for the weeding operation there is an increasing concern over the intra row weeder because of environmental degradation and growing demand for the food. Today, the agricultural sector requires non-chemical weed control that ensures food safety. Consumers demand high quality food products and pay special attention to food safety. The most common methods of weed control are mechanical, chemical, biological and cultural methods. Out of these four methods, mechanical weeding either by hand tools or weeders are most effective (Manjunatha *et al.*, 2014). But mechanical methods and intercultivation using agricultural implements are being practiced in many regions. Weeding with the indigenous tools of a 'khurpi' and a spade and with the improved tool (3-tine hoe) could be rated as 'moderately heavy' work. A 'khurpi' demanded less energy expenditure than a 3-tine hoe followed by a spade. For higher output, the order was spade, 3-tine hoe and 'khurpi' whereas, for weeding efficiency it was just the reverse.

MATERIALS AND METHODS

The following field tests were carried out in the research fields to evaluate the performance of the different weeders for weeding operation in this survey. The field tests were carried out to ascertain the following performance parameters:

1. Weeding efficiency
2. Field efficiency
3. Plant damage

The weeding efficiency of the weeders was calculated by the following equation (Remesan *et al.*, 2007):

Weeding Efficiency

$$\mathbf{W.E} = \frac{\mathbf{N1-N2}}{\mathbf{N1}}\mathbf{x100} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(1)}$$

Where,
WE is the weeding efficiency of the weeders (%),
N1 and *N2* are the number of weeds before and after weeding, respectively.

Field Efficiency

The field efficiency is the ratio of the effective field capacity to the theoretical field capacity and it is expressed in percent.

$$\text{Field efficiency} = \frac{\text{effective field capacity}}{\text{theoretical field capacity}} \text{x100} \quad \ldots\ldots\ldots\ldots \quad (2)$$

Plant Damage

Plant damage was calculated by counting the number of injured plants in sample plot and total number of plants in sample plot. The plant damage was calculated by following expression.

$$P_d(\%) = \frac{A}{B}\,\text{x100} \quad \ldots\ldots\ldots\ldots(3)$$

Where,
Pd = plant damage, %
A = No. of injured plants (cut or damaged) in sample plot
B = Total No. of plants in sample plot

RESULTS AND DISCUSSION

Based on the survey on various weeders these study comprises five (5) different Research papers namely: P1(Cono weeder), P2(W1=Single row conical weeder,W2= Two row conical weeder, W3= Rotary weeder,W4= Power weeder,W5= Hand weeding) P3(Khurpi,Push type cycle weeder, Power weeder), P4(Cono weeder), P5(manual operated single row weeder). The results of field performance evaluation trials of different weeders listed above were explained below:

Weeding Efficiency

Weeding efficiency was 83.4, 72.2, 80.3, 86.4, 82.4 and 88.8 respectively for Hand weeding, Cono weeding, Chemical weeding, Cono + Hand Weeding, Chemical + Hand weeding and Cono weeding + Chemical weeding. The increased soil contact and soil inversion capacity of Cono weeder add greater values to its higher weeding efficiency. Cono weeder gives better performance on initial stages of weed growth. If the weeds are matured the Cono weeder just rolls over the weeds with minimum uprooting and inversion. Chemical weedicide applied is Butachlore with 2.5 lit/ha dose. This is pre emergence weedicide. Weeds grown after application of Butachlore were measured. As reported by Karhale *et al*., (2015).

Damage Factor

The damage factor 0.76%, 4.1%, 0%, 4.16% and 0.54% and 4.04% for Hand weeding, Cono weeding, Chemical Weeding, Cono + Hand Weeding and Chemical + Hand weeding. The higher percentage damage in the case of Cono weeder due to the higher effective width of cut of weed rolls and uneven transplanting. Moreover, greater depth of cut and inversion of Cono weeder cause the uprooting of crop, which are extending to the row spacing (Karhale *et al.*, 2015).

Field Efficiency of Weeding Operations

For Cono weeder the field efficiency was 86.5%. The time loss independent of area, which is required for the operation, was about 4 h /ha. The time loss for turning was 1.83 h/ha for male subjects and 2.51 h/ha for female subjects for the same (Karhale *et al*., 2015).

Weeding Efficiency

Results showed that for each type of variety, there is a significant difference (P<0.01) between various methods. Amongst mechanical weeders (W1, W2, W3 and W4), the highest weeding efficiency (83.45%) was belonged to W4 and the lowest value (73.8%) was obtained in W3. The results also showed that for each type of mechanical weeder, the weeding efficiency in *Hybrid* variety was more than *Hashemi*. This may be due to differences in canopy pattern of the tested rice varieties in vegetative stage. *Hybrid* as a high-yielding variety grow straightly so that there is enough space between rows for operation of weeder and the operator is able to control better while weeding. On the contrary, because of plant shading in the local variety of *Hashemi*, the movement of machine would face difficulty. Generally, weeder efficiency depends on the weeder type, weed species and the weeding time. Different results have been reported about mechanized and hand weeding efficiency. Ramesan *et al.,* (2007) reported that the weeding efficiency of conical and rotary weeders were around to be 79 and 72.25%, respectively.

The weeding efficiency of modified IRRI conical weeder was 80% (Parida, 2002). Likewise, Subudhi (2004) reported that the efficiency of different types of hand operated weeders is between 76 to 91%, which is matched results of the current experiment Alizadeh *et al*., (2011).

Damaged Plants

Results indicated that the least percentage of damaged plants (0.13%) was obtained in hand weeding (W5), while the most one (4.14%) was registered in two rows conical weeder (W2). The power weeder caused less damaged plant, although it had high efficiency rather than other experimental weeders. The results also revealed that in each weeding method, the percentage of damaged plant in *Hashemi* variety was significantly (P<0.01) more than *Hybrid* (Alizadeh *et al.*, 2011).

Field Capacity and Field Efficiency

It was observed that among mechanical weeders, the most effective field capacity (Ce) (0.084 hah-1) belonging to W4 and W2 was in the second rate. Besides, the least Ce (0.0086 hah-1) was related to W5. There were no significant differences between the means of effective field capacity (Ce) in W1 and W3. The field efficiency, which indicates ratio of useful working time to the total working time was maximum in W4 and it was minimum in W2, however, there were no significant differences between the treatments. Also, the greatest working capacity (Wc) of 121.17 hha-1 was measured in W5. This could be attributed to lower Ce in hand weeding method. The Wc in the treatment of W1, W2, W3 and W4 were 52, 27.17, 45.06 and 11.78 hha-1, respectively. The weeding operation time in W1, W2, W3 and W4 was decreased by 57.07, 77.57, 62.8 and 90.27%, respectively as compared to hand weeding method. Different results were reported by other researchers. Field capacity of an IRRI modified hand operated weeder was 0.2 hah-1 (Parida, 2002). Tajuddin (2009) developed a power weeder and reported that the effective field capacity of weeder was around 0.75 hah-1 in Indian paddy fields. The effective field capacity of rotary weeder, conical weeder and hand weeding were found to be 0.021, 0.024 and 0.003 hah 1, respectively.

The field efficiency of rotary and conical weeders was 72.5 and 79% respectively (Remesan *et al*., 2007). Field performance of four types of hand-operated weeders were evaluated in India and results showed that the field capacity of these machines were varied from 0.17 to 0.89 hah-1 (Subudhi, 2004). As reported by Alizadeh *et al.*, (2011).

Field Performance Test Results

S/No.	Parameters		Observed Values			
			Test I	**Test II**	**Test III**	**Test IV**
1	Date of test		27/09/2012	28/09/2012	29/09/2012	29/09/2012
2	Duration of test, h		1.99	2.55	3.35	2.25
3	Average travel speed, kmph		1.66	1.99	1.75	1.82
4	Average depth of operation, mm		27.00	32.00	31.00	30.00
5	Average working width, mm	160	160.00	160.00	160.00	160.00
6	Percentage of plant damaged, %		0.00	1.00	1.50	1.50
7	Area covered, ha/h		0.02	0.02	0.02	0 0.018
8	Time required, h/ha		62.50	52.63	58.82	55.56
9	Field efficiency, %		59.23	59.38	60.71	62.07
10	Weeding efficiency, %		85.00	74.00	70.00	72.00
11	Average implement draft, kgf		13.00	16.00	13.80	14.80
12	Power requirement, kW (Ps)		0.08	0.12	0.09	0.10

Weeding Efficiency under Different Implements

The maximum weeding efficiency was observed with 'Khurpi' (95.05 per cent) followed by push type cycle weeder (92 per cent) and power weeder (89.5 per cent). Shekar *et al.*, (2010) also reported that the weeding efficiency was highest for khurpi than other weeder. The maximum weeding efficiency with 'Khurpi' was observed because of the capability of this hand tools to work between plant to plant spaces in a row. However, push type cycle weeder and power weeder cannot be used for closer plants. This may be the reason for low weeding efficiency (Kumar, 2014).

Field Efficiency under Different Implements

The average field capacity was found maximum for khurpi (91.5 per cent) followed by push type cycle weeder (85.4) and power weeder (71.25 per cent). The difference in field capacity of different tools/implements is because of the width of soil cutting parts and forward speed. Weeder due to its faster movement and its field efficiency compared to other weeder which are slow in speed. With 'Khurpi' is usually done by the operator in sitting posture and the forward speed is quite less, which accounts the minimum field capacity of 'Khurpi' during weeding operation (Kumar *et al.*, 2014).

Plant Damage under Different Implements

Higher percentage of plant injury was found in case of power weeder (2.5 per cent) followed by push type cycle weeder (1.02 percent) and khurpi (0.25 percent). The maximum percent of plant injury occur in power weeder due to higher speed of rotating blade, which when brought nearer to the plant during operation, caused injury to the plants by cutting either their roots or stem (Kumar *et al*., 2014).

Field Capacity

The field capacity of developed weeder was calculated by selecting a respective three plots of size 150 × 2 m. The weeder was operated in these plots and the different observations were recorded. The observations are presented in Table 1. The theoretical field capacity of the developed weeder was calculated about 0.0285 ha/h. The different paddy weeders developed by Behera (1996) has the field capacity ranged between 0.010 ha/h to 0.014 ha/h. Hence, we conclude that the developed groundnut weeder have more field capacity (0.016 ha/h) as compared to paddy weeders developed by Behera (1996). Field capacity is directly affected by cutting width and the physical condition of the operator. If the effective cutting width is reduced than field capacity is also reduced Bhavin *et al.,* (2016).

Table 2: Field Capacity of Manual Operated Weeder

Plot No	Area of Plot (m2)	Time to Cover this Area (min)	Field Capacity (ha/h)	Average (ha/h)
1	300	61.5	0.029	
2	300	63.0	0.028	0.0285
3	300	62.1	0.029	

Weeding Efficiency

The weeding efficiency test was performed on selected plot at the different locations. Average value of the weeding efficiency was found to be 80.42%. It can be concluded that the weeder is efficient because efficiency is more than 80% and also easy in operation. Weeder was calculated and it was about 1210.53. As in case of manually weeders for paddy crop, developed by Behera (1996), the maximum performance index was reported 1052.05. Wedding efficiency differs in every test codes located in the field. It depends on the root zone depth of weeds, shape of the blade, moisture content of soil at testing site and cutting depth of the weeder blades Bhavin *et al.,* (2016).

Conclusion

According to Karhale *et al.,* (2015) based on his finding:

The study revealed that the weeders and methods selected for the study has its own strengths and limitations. Cono weeder can be recommended in the early stages of weed growth as the better weeding efficiency, more turning of the soil and uprooting of weeds overrules the higher cost of operation. Cono weeder performed the task with comparatively higher field capacity, better performance index in the early stages of weed infestation. The field performance analyses have shown that Weeding efficiency as 72.2 % for Cono weeder with damage factor of 4.1% respectively.

The following conclusions were drawn from the results of Alizadeh *et al.,* (2011):

1) Among the tested weeders, the highest weeding efficiency and effective field capacity were registered in the power weeder.

2) The weeding operation time in single row conical weeder, two rows conical weeder, rotary weeder and power weeder was decreased by 57.07, 77.57, 62.8 and 90.27%, respectively compared to hand weeding method.

3) Weeding cost in single row conical weeder, two rows conical weeder, rotary weeder and power weeder was reduced by 15.7, 38.51, 22.32 and 48.70%, respectively compared to hand weeding method.

The results indicated that the average area covered was observed to be 0.16 to 0.019 ha/h. The required for intercultural operation of one hectare area was recorded as 52.63 to 62.5 h. The weeding efficiency by weed count method was recorded as 72.00 to 85.0 per cent. The percentage of plants damaged during the operation was recorded as Nil to 1.5 per cent. The draft required to operate the cono weeder was measured as 14.4 kgf, which is considered normal for one hour continuous operation by one unskilled labour.

According to Bhavin *et al.,* (2016) finding:

Test result indicates a clear view for adopting this design of manually operated row crop weeder because it is easy to operate and outcome of weeding efficiency is also satisfactory. The developed weeder can work up to 4.0 cm depth of operation with field capacity of 0.0285 ha/h. Higher weeding efficiency was obtained (i.e. up to 80.42%). The performance index of the developed weeder was obtained 1210.53. The draft requirement was 34.4 kg for 20 cm width of the weeder. Develop such type of weeder for row crop and assess functional suitability and weeding efficiency, to increase the productivity per unit area of small land holdings of farmers and considering their economic condition.

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