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Evaluation of Different Mechanical Weed Control Methods in Rice Field

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ABSTRACT

A field experiment was conducted to evaluate different mechanical weed control methods in rice field by using three types of mechanical rice weeders *i.e.,* single row cono weeder (T_2), single row mandwa weeder (T_3) and two row power weeder (T_4) were compared with hand weeding (T_1). The results revealed that among the mechanical weeders, the highest weeding efficiency (88.62 %) was obtained with T_4 and the lowest value (78.67 %) with T_2. The average of damaged plants in mechanical weeders was obtained as 3.78 , 2.83 and 1.76 per cent, in T_4, T_2 and T_3 treatments, respectively as compared to 0.11 per cent in hand weeding. The highest effective field capacity of 0.064 ha/h was measured with T_4 and the corresponding lowest values of 0.017 and 0.012 ha/h were obtained with T_3 and T_2, respectively. The weeding cost was reduced by 34.9, 53.9 and 49.65 per cent in T_2, T_3 and T_4 , respectively as compared to T_1. Among the four treatments, highest grain yield of 43.6 q/ha was recorded in T_4 followed by 37.5q/ha, 36.75q/ha and 34.04 q/ha in treatments T_3, T_2 and T_1 ,respectively. Among the tested weeders T_4 showed a proper field performance.

Key Words: Cost of cultivation, Drudgery, Field performance, Weeder, Yield.

INTRODUCTION

Weed control is one of the most difficult tasks in agriculture that accounts for a considerable share of the cost involved in agricultural production. Reduction in yield due to weed alone is estimated to be 16-42 per cent depending on crop and location and involves 1/3 rd of the cost of cultivation (Raosaheb *et al*, 2020). Weeding and hoeing is generally done 15-20 days after sowing. The weed should be controlled and eliminated at their early stage. Depending upon the weed density, 20-30 per cent loss in grain yield is quite usual which might increase up to 80 per cent if adequate crop management practice is not observed. Rice and groundnut are very sensitive to weed competition in the early stage of growth and failure to control weeds in the first three weeks after seeding reduce the yield by 50 per cent (Sridhar, 2013). 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 (Nagesh Kumar *et al*, 2013).

The nutrient uptake by the weeds was found to be directly related with weed population and inversely related with grain yield (Dubey *et al*, 2013). In India about 4.2 billion rupees are spent every year for controlling weeds in the production of major crops. At least 40 Mt of major food grains are lost every year due to weeds alone (Kishore Kumar *et al*, 2018). Therefore, timely weeding is very much essential for a good yield and this can only be achieved by using mechanical weeders which can reduce the time spent on weeding (man-h), cost of weeding and drudgery involved in manual weeding. Mohanty *et al* (2010) in his study on cono weeder indicated that the grain yield significantly increased (13.6 to 14.2%) under weeding by cono weeder at 10 DAT, 20 DAT and 30 DAT in SRI method of rice cultivation against manual weeding.

Weeding is an important but equally labour intensive agricultural unit operation. Weeding accounts for about 25 per cent of the total labour

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requirement during a cultivation season (Basavaraj *et al*, 2016). The most common methods of weed control are mechanical, chemical, biological and cultural methods. Chemical method of weed control is more prominent than manual and mechanical methods. However, its adverse effects on the environment are making farmers to consider and accept mechanical methods. Researcher claimed that herbicides can reduce the labour requirement tremendously, but there was inconsistency in their performance. So, mechanical method of weed control is the best with little or no limitation because of its effectiveness. Out of these four methods, mechanical weeding either by hand tools or weeders are most effective in both dry land and wet land. Mechanical weed control not only uproots the weeds between the crop rows but also keeps the soil surface loose, ensuring better soil aeration and water intake capacity (Upendar *et al*, 2018). Manual weeding can give a clean weeding but it is a slow process. Chanakyan *et al* (2017) evaluated wet land power weeder and results indicated that effective field capacity, field efficiency, plant damage and fuel consumption was observed as 0.065 ha/hr, 78.9 per cent, 84.8 per cent, 4.12 per cent and 16.9lt ,respectively. In the testing of push type cono weeder by Anantachor *et al* (2018) results indicated that field capacity was in the range of 0.016 to 0.019 ha/hr with weeding efficiency in the range of 72.16 to 85.5 per cent. Nowadays, finding the suitable methods of weed control has been aimed beside the consideration of environmental hazards, reducing cost and drudgery with higher yield. Therefore, the objective of this study was to evaluate field performance of different mechanical weeders available in Odisha and compared to hand weeding for developing appropriate mechanical control practice in the paddy fields.

MATERIALS AND METHODS

The study was conducted in five locations of Mayurbhanj district of Odisha by KVK, Mayurbhanj-1 in the form of on farm trial (OFT). The treatments consisted of T_1 - control treatment, where three hand weeding ware accomplished,T_2 - application of mechanical weeding without engine power-1 (Cono weeder), T_3 - application of mechanical weeding without engine power-II (Mandwa weeder) and T_4 - power mechanical weeding (SRI power weeder). The experiments replicated in five locations and the high yielding rice variety of MTU 7029 was chosen in the experiment. Paddy seedlings were transplanted in line with the help of rope in rows with row spacing of 25 cm and hill to hill spacing of 16 cm. Weeding was done in between the rows and first weeding was done at 20 days after transplanting (DAT) when height of weeds were about 3-5 cm. Subsequent weeding was done at 30 and 40 DAT. All the weeders were tested in similar field conditions with same procedures. The size of each experimental plot was 200 m^2. The type of soil was found to be sandy loam (sand: 73.7-76.9 %, silt: 13.6-14.1 %, clay: 12.7-13.4 %) with bulk density of 1.65 to 1.69 g/cm3. Working speed of weeders were kept within the range of 0.9 to 1.10 km/hr. Agricultural workers free from cardiac and other aliments were selected for operating the weeders. Test was carried out as per RNAM test code (1985). The experiments replicated five times and were laid out in randomized block design (RBD) and the experimental data (yield) obtained was analyzed statistically using analysis of variance (ANOVA).The specification of experimental weeders is mentioned in Table 1 and Table 2.

Table 1. Specification of Cono and Mandwa weeders.

Detail	Cono weeder	Mandwa weeder
Length, mm	2040	1500
Nominal width, mm	194	150
Working width, mm	125	120
Weight, kg	6.1	5.1
Height of handle from ground level, mm	1120	1000
Width (Handle), mm	500	460

Table 2. Technical specifications of Power Paddy Weeder.

Sl. No.	Particular	Specifications
1.	Weight, kg	17
2.	Vertical height, mm	850
3.	Width, mm	720
4.	Power, hp	1.5
5.	Type of weeder	Rotary
6.	Blade shape	L type
7.	No. of blades per rotor	4
8.	Row spacing, mm	Adjustable 220, 240, 260 and 300
9.	Width of weeding rotor, mm	150, 140 and 130 variable by changing the blade

For all the treatments the average actual field capacity, weeding efficiency and plant damage were recorded and performance indices were calculated to compare the performance of weeders. Different test parameters were calculated as per the formula depicted below.

Theoretical field capacity

Theoretical field capacity was calculated with standard formula as suggested (Anon, 1985). Theoretical field capacity

$$\text{(ha/h)} = \frac{\text{Working width} \times \text{speed}}{10} \quad \text{.....(1)}$$

where, Working width in m and speed in km/h

Effective field capacity

Effective field capacity is an average output of the weeder per hour and calculated from the following formula (Anon, 1985).

Effective field capacity

$$\text{(ha/h)} = \frac{\text{Area covered by weeder}}{\text{Total time taken} \times 10000} \quad \text{.....(2)}$$

Where, Area covered in m^2 and total time in hr

Field efficiency

It is the ratio of effective field capacity to theoretical field capacity and expressed in % (Anon, 1985).

$$\text{Field efficiency (\%)} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100 \quad \text{..... (3)}$$

Weeding efficiency

It is calculated by using the following formula (Anon, 1985).

$$\text{Weeding efficiency (\%)} = = \frac{W1 - W2}{W1} \times 100 \text{.. (4)}$$

Where, W_1 = Number of weeds/m^2 before weeding, W_2 = Number of weeds/m^2 after weeding. Higher the value weeding efficiency means the weeder is more efficient to remove the weeds.

Plant damage

Plant damage per cent is measured by using following relation (Anon 1985).

Plant damage (%) = {1- (Q/P)} x 100 …… (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

RESULTS AND DISCUSSION

Grain Yield

Result (Table 3) indicated that the treatment means differ significantly and grain yield of rice was significantly influenced by different methods of mechanical weed control and T_4 (Power paddy weeder) had its most significant effect on yield performance standpoint, which was 43.6 q/ha in its highest peak with 27.8 per cent increase over local check . T_3 (Mandwa weeder) was ranked as second influential with 37.5 q/ha with 9.9 per cent increase over manual weeding. In addition, under T_2 (Cono weeder) and T_1 (Hand weeding) treatments, 36.8 q/ha and 34.1 q/ha of yield recorded respectively and there is a 7.9 per cent increase in yield in treatment

Table 3. Comparison of experimental treatments on yield

Treatment	R1	R2	R3	R4	R5	Mean
T_1	32.4	33.7	36.4	35.8	32.2	34.1
T_2	37.1	36.5	38.5	38.1	33.8	36.8
T_3	38.3	35.1	36.7	37.9	39.5	37.5
T_4	44.5	45.2	42.1	43.5	44.9	43.6

CD at 5 % = 2.65, SEM ± = 1.15, CV=5.03

T_2 against treatment T_1. The results were close conformity with findings of Mohanty *et al* (2010). This may be due to better aeration of top horizon of the soil and the regeneration of newer roots due to the pruning effect by power weeder.

Field capacity and cost of weeding

Comparative performance of power weeder, mandwa-weeder and cono-weeder in line transplanted rice (25cm x 16 cm) at 20, 30 and 40 days after transplanting indicated the average field capacity of 0.064, 0.017 and 0.012 ha/hr, respectively which is almost similar to findings obtained by Chanakyan *et al* (2017) and Anantachar *et al* (2018). The cost of weeding of the above weeders per hectare were being Rs.1578/-, Rs.1445/- and Rs. 2040/- , respectively. Whereas in case of control treatment cost of weeding per hectare derived as Rs. 2520/-, Rs. 3150/- and Rs. 3780/- at 20, 30 and 40 DAT with 0.0067 ha/hr field capacity. Thus the weeding cost was reduced by 34.9, 53.9 and 49.65 per cent for T_2, T_3 and T_4 , respectively as compared to control *i.e.,* hand weeding. It was also evident that, the minimum time duration of performed action for controlling weeds was related to T_4 (16 man-hr/ha) and maximum time for T_1 (149 man-hr/ha).

Weeding efficiency

The results also revealed that among all weed control methods, the highest weeding efficiency (98.34 %) was obtained with treatment T_1 and among the mechanical weeders, the highest weeding efficiency (88.62 %) was obtained with T_4 and the lowest value (78.67 %) was measured with treatment T_2. The results confirmed the test conducted by Chanakyan *et al* (2017) and Anantachar *et al* (2018).

Plant Damage

The average of damaged plants in mechanical weeders was obtained as 3.78, 1.76, 2.83 per cent in case of power weeder (T_4), mandwa weeder (T_3) and cono weeder (T_2) respectively compared to 0.11 per cent in hand weeding (T_1).

CONCLUSION

The performance analysis results demonstrated that mechanized weeding can produce large reductions in the weeding costs and significant reductions in labour time, whereas hand weeding

Table 4. Comparison of experimental treatments on field performance.

Treatments					
	Mean				
	Field capacity (ha/hr)	Cost of weeding (Rs./ ha)	Weeding efficiency (%)	Average damaged plant (%)	Labour requirement (man-hr/ha)
T_1	0.0067	3150	98.34	0.11	149
T_2	0.012	2040	78.67	2.83	83
T_3	0.017	1445	81.54	1.76	58
T_4	0.064	1578	88.62	3.78	16

reached the best efficiency in weed control. The study could conclusively identify weeding operation, as one of the major factors which can pose a great influence on crop yield.

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