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Modification and Performance Evaluation of ANGRAU Power Weeder Developed by FIM Scheme for Paddy under SRI Cultivation

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ABSTRACT

Weed control is a major problem in System of Rice Intensification (SRI) cultivation. The field capacity of the present available weeders is less, which involves drudgery while operating and more time in field because of to and fro motion of the weeders. ANGRAU FIM developed a power weeder, which has higher field capacity and field efficiency. However, the ANGRAU FIM developed power weeder has less working width and does not have depth control provision. To solve this problem and to increase the weeding efficiency of the ANGRAU FIM power weeder it was modified at College of Agricultural Engineering Bapatla. The field performance was evaluated and compared with the performance of a cono weeder. The field capacity of the modified power weeder was found to be 0.0349 ha h^{-1} with a field efficiency of 79.74% at an average working depth of 4.8 cm. The field capacity of the cono weeder was found to be 0.0145 ha h^{-1} with a field efficiency of 73.03% at an average working depth of 3.1cm. Weeding efficiency was 84.58% and 68.97% respectively for power weeder and cono weeder. The plant damage by power weeder and cono weeder was 3.61% and 2.03% respectively. The cost of operation of the power weeder is 42.5% more than the cost of operation of the cono weeder.

Key words : Cono weeder, Power Weeder, SRI cultivation

Rice (*Oryza sativa*) is a crop of paramount importance. It is one of the most important staple food crops in many Asian countries. More than 90 % of rice is produced and consumed in Asian countries. In India it is grown in an area of 45.35 m. ha with a production of 99.15 m.tons (Directorate of Economics and statistics, 2008-2009) and in Andhra Pradesh rice is grown in an area of 4.38 m. ha with a production of 14.21 M.tons. Rice is a staple food for majority of the population in India. Global and domestic demand for rice is increasing with the ever growing population. There is a need for increasing rice production with less land and less water at affordable price to consumers. System of Rice Intensification (SRI) is a system of rice production in which synergistic interactions leads to higher grain yield. System of Rice Intensification is an improved method of rice cultivation developed in 1983 by Father Henri Laulani to overcome the problems of rice cultivation in predominately-acidic soils of Madagascar (Viraktamath, 2007). In this system, weeding is one of the most important and laborious operation, which leads to higher yields if performed in time. In spite of several advantages of SRI cultivation, the progress of SRI adoption is hindered by a major constraint, weed management (Giri and Punna, 2007). SRI is not adopted by the farmers for the second time due to four weeding operation need to be carried out days after transplanting in view of labour scarcity.

Absence of standing water provides a congenial environment for weeds to proliferate in SRI. Since the weeds grow more rapidly and abundantly in SRI due to intermittent wetting and drying, it is important to manage the weeds regularly. If proper weed control measures are not taken up then crop productivity decreases and timing rather than the frequency of weeding was a major determinant of effective weed control in rice production (Igbeka, 1984). There are several weed control measures such as manual, mechanical, and chemical methods. The principal demerit of chemical weeding is the loss of soil fertility and useful soil microorganisms are affected in long run. Manual weeding is done with conventional hand tools. Instead of weeding manually and throwing the weeds, there are several advantages of mulching the weeds into the soil by using improved weeding implements such as Cono weeder, Mandava weeder, Single or double wheel weeder, Kollur weeder, etc. ANGRAU FIM developed a power weeder, which has higher field capacity and field efficiency. However, the ANGRAU FIM developed power weeder which has less working width and does not have depth control provision.

Table 1. Technical specifications of modified power weeder

Sl. no	Particulars	Specifications
1	Engine	1.5 hp loona engine
2	Number of main wheels	2
3	Front wheel	1
4	Main wheel diameter	140 mm
5	Main wheel width	50 mm
6	Number of cutting blades on main wheel	8
7	Number of teeth on cutting blades of main wheel	4
8	Teeth height	30 mm
9	Front wheel diameter	110 mm
10	Front wheel width	80 mm
11	Number of cutting blades on front wheel	8
12	Number of teeth on cutting blades of main wheel	5
13	Teeth height	25 mm
14	Total working width	180 mm
15	Labour required	1
16	Weight after modification	20 kg
17	Total length	1500 mm

Table 2. Field Performance of cono weeder and power weeders.

	Cono Weeder				Power Weeder			
Days After Transplantation	Effective field capacity (ha/hr)	Field efficiency (%)	Weeding efficiency (%)	Plant damage (%)	Effective field capacity (ha/hr)	Field efficiency (%)	Weeding efficiency (%)	Plant damage (%)
12	0.0146	72.97	68.18	1.39	0.0357	80.35	81.31	3.33
24	0.0144	73.53	68.74	1.39	0.0345	79.06	84.04	3.33
36	0.0145	73.03	69.98	3.33	0.0346	79.8	88.41	4.17

Keeping all this points in view, an attempt was made to develop an existing ANGRAU FIM power weeder at College of Agricultural Engineering Bapatla.

MATERIAL AND METHODS

The field experiments were conducted to study the performance of modified power weeder against cono weeder for paddy crop in System of Rice intensification cultivation. Paddy variety ASP 003 was manually transplanted, with a spacing of 25 X 25 cm. The experiment consist of two treatments, viz weeding by modified power weeder and cono weeder each replicated thrice at 12, 24, 36 days after transplantation. The performance of weeders was evaluated as per RNAM 1983 test codes. The experiments were conducted in farmer's field at Gudavalli village, Cherukupalli mandal, and Guntur Dist A.P. A field of extent 1800 m^2 area was selected for the study. It was divided into 2 major plots of 900 m^2 one for power weeding and another for Cono weeding. Further 900 m^2 is divided into 3 plots of 300 m^2 for three replications. With the help of a marker lines are drawn across length and breadth of the field at 25 X 25 cm apart and twelve days old seedlings are manually transplanted, singly soon after they have two leaves, at the intersection of the lines. The seedlings are transplanted with their roots intact. Square pattern of planting grid is followed to facilitate weeding along length and breadth of field. Seedlings are precisely at a spacing of 25 cm X 25

Plate 1. Modified Power weeder

Plate 2. Cono weeder

cm and not allowed to transplant more than 2.5 cm depth.

Modification and Refinement of Power Weeder for SRI Cultivation

The existing power weeder consists of 1.5 hp loona engine, 2-litre capacity plastic petrol tank. The Main wheel has 140 mm diameter and 8 cutting blades of 4 teeth of 30 mm height and 50 mm width. The power transmission system consists of worm and worm gear arrangement. The rotary wheels rotated by the power transmission system of the engine. The working width of the weeder in the field is 100 mm. The front of the weeder is provided with the float and rear with MS angular to avoid sink age in the field.

Two M S plates of 480 X 25 X 5 mm were bent into L shape at a length of 250 mm. One end of both the M S plates were fastened to lower part of the handle of the weeder where it is bolted to the frame of weeder and at the other end two holes of 15 mm diameter were punched. This provision was made to facilitate the incorporation of a teethed wheel. A shaft of 10 mm diameter, 15 mm length was allowed to run through the holes which are mounted with a wheel of 11 mm diameter 7 cutting blades of 5 teeth, 25 mm height. And the width of the wheel is 80 mm. The float of the existing power weeder was replaced by the above wheel arrangement. And the rear M S angular was replaced by a castor wheel which prevents the weeder in bogging down and helps in depth adjustment. The modified power weeder is shown in Plate 1. After modification, the total working width of the weeder in the field is 180 mm. The technical specification of the modified power weeder is given in Table 1.

Cono weeder

It is suitable for weeding in wetland condition. It consists of two truncated rollers one behind other are fitted at the bottom of the long handle as shown in the Plate 2. The conical rollers have serrated blades on the periphery. A float provided in the front portion prevents the unit from sinking into the puddled soil. The unit consists of a long handle made of mild steel tube.

Research Plan

After completion of the modification of power weeder the field experiments were conducted. To evaluate the performance of the machine the following parameters had been considered. A day before weeding water was applied to field upto a level of 2 cm for easy movement of the weeders. Weeders were operated across length and breadth of the field.

Operational Parameters

Bulk density of soil (g/cc)

Soil samples were collected randomly from two replications of experimental plot with a core sampler. The length and diameter of core sampler were 75 mm and 70 mm respectively. Weight of each sample was measured and approximately 100 g soil from each sample was taken, weighed and kept in an oven at constant temperature of 105 ^{0}C till the soil sample attain constant weight and weight of the oven dried sample was taken. The bulk density of each sample was calculated by using the following relationship:

$$\text{Dry bulk density, } = \frac{\text{Dry weight of soil sample (g)}}{\text{Volume of soil sample (cc)}} \times 100$$

Effective working depth

The depth of the weeding was measured by measuring scale in different rows at different places. Average of five observations was taken as depth of weeding and expressed in cm.

Machine Parameters

Effective field capacity

It is the actual area covered by the implement, based on its total time consumed and its width. Effective field capacity was determined by using the following relationship.

$$\text{Effective filed capacity, ha h}^{-1} = \frac{\text{Total area covered}}{\text{Total time taken}}$$

The total time taken in above relationship includes time losses in turning, machine adjustment required during operation.

Field efficiency

Field efficiency is the ratio of effective field capacity to theoretical field capacity. It was determined by the following formula

$$\text{Field efficiency} = \frac{\text{Effective field capacity (ha h}^{-1})}{\text{Theoretical field capacity (ha h}^{-1})} \times 100$$

Theoretical field capacity is the rate of field coverage of the implement, based on 100 per cent of time at the rated speed and covering 100 per cent of its rated width.

The theoretical field capacity was determined using the following relationship

$$\text{Theoretical field capacity} = \frac{\text{Width (m) x Speed (km/h)}}{10}$$

Fuel consumption

The fuel consumption has direct effect on economics of the Power weeder. It was measured by Top fill method. The fuel tank was filled to full capacity before the testing at level condition. After completion of test operation, amount of fuel required to top fill again is the fuel consumption for the test duration. This observation was used for computation of fuel consumption in L/h.

Weeding efficiency

It is the ratio between the number of weeds removed by a weeder to the number present in a unit area and is expressed as percentage. The spots where such counts are taken were randomly selected and a square metallic frame covering area of one sq.m was used for sampling. The weeding efficiency was calculated by the following formula:

$$\text{Weeding Efficiency} = \frac{(W_1 - W_2)}{W_1} \times 100$$

Where, W_1= Weeds before weeding in 1 sq. m area of the field

W_2= Weeds after weeding in 1 sq. m area of the field

Plant damage

It is the ratio of the number of plants damaged in a row to the number of plants present in that row. It is expressed in percentage. The plant damage was calculated by the following formula:

$$Plant\ Damage(\%) = \left(1 - \frac{q}{p}\right) \times 100$$

Where q = number of plants in a 10 m row length of field after weeding

p = number of plants in a 10 m row length of field before weeding

RESULTS AND DISCUSSION

The machine was tested in the field. It was observed that the machine performance was satisfactory. However, there was little problem due to weight of engine and vibration. The machine has been tested in the field for its performance the parameters like effective field capacity, field efficiency, fuel consumption, weeding efficiency, plant damage, and cost of operation were calculated at 12 days, 24 days, and 36 days of transplantation.

The effective field capacity of the Power weeder obtained from the experiments varied between 0.0325 ha/h -0.0357 ha/h and the average effective field capacity of the Power weeder was 0.0349 ha h^{-1}. The effective field capacity of the Cono weeder varied between 0.0140 ha h^{-1} - 0.0149 ha h^{-1} and the average effective field capacity of the Cono weeder was 0.0145 ha h^{-1}. Field efficiency of the Power weeder varied between 77.60% - 81.73% and the average field efficiency was 79.74%. Field efficiency of the Cono weeder varied between 70.72 - 74.39% and the average field efficiency was 73.03%.

Fuel consumption of the Power weeder was calculated by "topping method". It was observed that the fuel consumption of the Power weeder varied between 0.557 L h^{-1} -0.635 L h^{-1} and the average fuel consumption was 0.599 L h^{-1}. The weeding efficiency of the Power weeder varied between 78.30 - 92.73% and the average weeding efficiency was 84.58%. The weeding efficiency of the Cono weeder varied between 57.58 - 77.61% and the average weeding efficiency was 68.97%. The plant damage caused by the Power weeder varied between 2.50-7.50 % and the average plant damage by Power weeder was 3.61%. The plant damage by Cono weeder varied between 2.5-5.0% and the average plant damage was 2.03%.

The cost of operation of the power weeder during the experiment was observed to be Rs1928/ ha, and the cost of operation of the cono weeder was Rs 1352/ha.

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