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Research Article

FIELD PERFORMANCE OF DIFFERENT WEED CONTROL PRACTICES IN PUDDLED FIELD DRUM SEEDED RICE

JAYA PRAKASH R.[1*], ANAND BABU D.[2], ARAVIND REDDY G.[3] AND RAMANA C.[4]

[1,2]Department of Farm Machinery and Power, College of Agricultural Engineering, Acharya N. G. Ranga Agricultural University, Bapatla, Andhra Pradesh, India
[3]Department of Farm Machinery and Power, Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, India
[4]Department of Farm Machinery and Power, College of Agricultural Engineering, Acharya N. G. Ranga Agricultural University, Madakasira, Andhra Pradesh, India
*Corresponding Author: Email-jayacae08@gmail.com

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Abstract- Weeding is one of the critical stages in rice cultivation which affects yield and quality of rice. The success of direct wet seeded rice crop is dependent upon efficient weed control. The present study was conducted to evaluate the field performance of different weed control measures such as manual weeding, chemical weeding and weeding with mechanical weeders like cono weeder and two row power weeder to find out the best economical weed control method in direct seeded rice sown by drum seeder with 20 cm row spacing. The highest field capacity was found 0.06 ha /h with the field efficiency of 70.98 per cent at an average speed of 2.09 kmph for power weeder whereas the field capacity of 0.01 ha /h with the field efficiency of 76.56 per cent at an average speed of 0.83 kmph for conoweeder by mechanical weeding. The fuel consumption for power weeder was observed that 9.25, l/ha. The highest weeding efficiency was found to be 100 per cent with the zero per cent plant damage for manual weeding followed by 90.26 per cent with 1.33 per cent plant damage for cono weeder 90.38 per cent for chemical weeding and 87.58 per cent with 2.63 per cent plant damage for power weeder respectively. Significantly higher grain yield (5949 kg/ha) were realized when manual weeding was employed as weed management option, however this was at par with cono weeding (5645 kg/ha) and significantly superior over weeding with power weeders (5416 kg/ha) and herbicides (5442 kg/ha). Among the all weeding methods the lowest operating cost of 747.12Rs/ha was associated with power weeder and the highest operating cost with 5390.63Rs/ha pertained to manual weeding. Based on the obtained results the weeding cost in power weeder, cono weeder and chemical weeding was reduced by 86, 70 and 73 per cent respectively compared to manual weeding method.

Keywords- Mechanical weeding, Manual weeding, Chemical weeding

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Introduction

Rice is important cereal crop of the world and nearly more than half of the population subsists on it. In Asia where 95% of the world's rice is produced and consumed, it contributes 40 to 80% of the calories of Asian diet [3]. India is the largest grower of rice in the world and it occupies the largest cropped area of 44.2 M ha with a total production of 87.5 Mt and an average productivity of 1.9 t/ ha. However, it ranks second to China in terms of production [1].

Weed growth is a major problem for wet land crops particularly in cereal crops like rice and wheat, causing a considerable lower yield [4]. Production of rice increased due to increase in weed control cost. High weed infestation is a major constraint for broader adoption of direct sowing of rice. Yield losses from weeds in direct seeded rice ranges from 20-88 % in India, 40-100 % in South Korea and 35-56 % in Philippines [6]. The success of direct wet seeded rice is dependent upon efficient weed control. 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 i.e. pulling by hand tools. Instead of weeding manually and throwing the weeds, there are several advantages of mulching the weeds into the soil by using mechanical weeders. The present study was conducted to find out the best economical weed control practice among different weed control practices such as manual weeding, chemical weeding and weeding with mechanical weeders like cono weeder and two row power weeder by evaluating field performance and cost economics in direct seeded rice sown by drum seeder with 20 cm row spacing.

Material and Methods

The field experiments were conducted to study the field performance of different weed control practices in puddled drum seeded rice and compare the yield and economics of operation for different weed control practices at Farm Implements and Machinery Scheme and Agricultural Research Institute of Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad during *kharif* 2013.

Details of various weed control practices used in puddled field drum seeded rice

The field performance of different weed control practices such as manual weeding, chemical weeding and weeding with mechanical weeders like cono weeder and two row power weeder in direct seeded rice sown by drum seeder with 20 cm row spacing was carried out. The details are given as follows.

Traditional method of weeding

Weed removal is one of the major activities in agriculture. Traditional method of weeding was done by manual labour. Manual control involves either by pursuing with hands or hand held tools to remove or uproot weeds. This was economical when the plenty of agricultural labours available in India, but at present day

situation getting required number for weeding is very difficult and expensive.

Chemical weeding

The weeding operation was done with Nominee gold (Bispyribac Sodium) in chemical weeding. The dosage of weedicide 250 ml/ ha was used at post emergence after 15-20 days from the date of sowing [2]. Chemical control with the use of herbicides involves the weeds can control either by speeding up, stopping or changing the plant's normal growth patterns by drying out the leaves or stems or by making it drop its leaves. This method of application can provide the most effective and time-efficient for managing the weeds. Chemical method of weed control is more eminent than manual and mechanical methods.

Mechanical weeding

Mechanical weeding was done with cono weeder and power weeders and the figures of cono weeder and power weeder with schematic representation were shown in [Fig-1] and [Fig-2] and the specifications of cono weeder and power weeder were shown in [Table-1] and [Table-2] respectively.

Salient features of cono weeder

The cono weeder is used to remove weeds and spread as mulching on soil by to and fro motion between rows in paddy crop efficiently. The cono weeder consists of two rotors, float, frame and handle. The rotors are truskated cone and serrated strips are welded on the surface along its length. The rotors are mounted in tandem and in opposite orientation. The float, rotors and handle are joined to the frame. The float controls working depth and does not allow rotor assembly to sink in the puddle field. The cono weeder is operated by pushing and pulling action. The orientation of rotors create a back and forth movement and till the top 3 cm of soil.

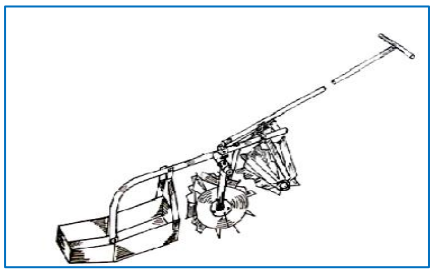

Fig-1 View of manual cono weeder with schematic representation

Table-1 *Specifications of manual cono weeder*

Sl. No.	Descriptions	Details
1	Power Source	Manually operated
2	Number of operators	One person
3	Type of operation	Push and pull motion
4	Operating condition	Water must be more in the field at the time of weeding
5	Number of rows	Single row
6	Weight, kg	6
7	Width of operation, mm	140-160
8	Number of cones	2
9	Number of blades on each cone	12 (6 no. plain and 6 no. serrated blades)
10	Thickness of blades, mm	2
11	Size of float(L x W x H), mm	320 x 120 x 65
12	Float angle, degrees	21

Salient features of power weeder (Garuda weeder)

The power weeder consists of a transmission system, engine, and rotors with blades. The rotary wheels rotated by the power transmission system of the engine. The weeder is provided with float in between two rows to avoid sink age into the field. The total length of the machine is 1470 mm. and the weight (including float) is 17 kg.

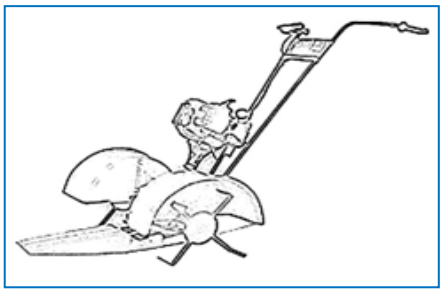

Fig-2 View of power weeder (Garuda weeder) with schematic representation

Table-2 *Specifications of power weeder (Garuda weeder)*

Sl. No.	Descriptions	Details
1	Model	3PT250
2	Engine	P H25, 1.75hp
3	Overall Dimensions, mm	1470 x 735 x 830
4	Fuel type	Petrol (with 2T oil)
5	Weight, kg	17
6	Rotavator	Centre Drive
7	Speed, rpm	300
8	No. Of Blades	8
9	Weeding Width, mm	150(STD)
10	Suitable row spacings, mm	200, 250 and 300

Field performance various weed management practices

During the experiment, the parameters like speed of operation, effective field capacity, theoretical field capacity, and field efficiency, fuel consumption, weeding efficiency, effective working depth and plant damage were recorded by using the following standard equations. Moreover, the data on crop parameters like number of hills per square meter, tillers per square meter, panicles per square meter, panicle weight, test weight and grain yield were recorded. The field performance of cono weeder and power weeder during operation was shown in [Fig-3] and [Fig -4] respectively.

Fig-3 View of field performance of cono weeder

Fig-4 View of field performance of cono weeder

Speed of operation, kmph
To determine the speed of operation, mark the length of 5 m and the machine was operated in the marked run length. A stop watch was used to record the time for the machine to traverse the marked run so that the speed of travel was computed in m s^{-1}.

Effective field capacity, ha/h
Effective field capacity was measured by the actual area covered by the machine, based on its total time consumed and its width. Effective field capacity was determined by the following relationship.

$$\text{Effective field capacity, ha } h^{-1} = \frac{Totalareacovered,\ ha}{Totaltimetaken,\ h}$$

Theoretical field capacity, ha/h
Theoretical field capacity is the rate of field coverage of the machine, 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 by using the following relationship.

$$\text{Theoretical field capacity, ha } h^{-1} = \frac{Width(m)XSpeed(km/h)}{10}$$

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

$$\text{Field efficiency, \%} = \frac{Effectivefieldcapacity,\ (ha/h)}{Theoreticalfieldcapacity,\ (ha/h)} \text{ x } 100$$

Fuel consumption, l/ha
The fuel consumption has direct effect on economics of the machine. The fuel consumption was measured by top fill method. The fuel tank of the machine was filled at its full capacity. The machine was run in the field at constant speed. After completion of the operation, the fuel was refilled in the tank up to the top level. The quantity of refilled fuel was measured by measuring cylinder. This observation was used for computation of fuel consumption in l h^{-1} and l ha^{-1}.

Weeding efficiency, %
It is the ratio between the numbers of weeds removed by a weeder to the number present in a unit area and is expressed as percentage. A square metallic frame of 1 square meter was randomly cast in the test field and the number of weeds included in the frame was counted before and after weeding. The weeding efficiency was calculated by the following formula [7].

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

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

Effective working depth, cm
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.

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 [5].

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

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

Cost analysis:
The cost analysis was done by using the straight-line method. The total cost of operation of the machine in Rs.h^{-1} was estimated by considering the fixed cost and operational cost of the machine by making following assumptions. The cost of operation was based on the prevailing market rates during the season and location.

Fixed cost:
Fixed cost includes depreciation, interest, housing, insurance and taxes.

Depreciation
It is the loss of value a machine with the passing of time.

$$D = \frac{C - S}{L\,H}$$

Where,
C = Capital cost
D = Depreciation, Rs. /h
S = Salvage value, 10 per cent of capital
H = Number of working hours per year, and
L = Life of machine, year

Interest
Interest was calculated on the average investment of the machine taking into consideration the value of in first and last year.

$$I = \frac{C + S}{2} x \frac{i}{H}$$

Where,
I = interest per year
i = interest rate per year, per cent
C = Capital cost

Housing, insurance and taxes
Housing, insurance and taxes taken as the 1 per cent of the initial investment of the machine.

Operating cost:
Operating cost includes fuel cost, lubricants, repairs, maintenance, and other costs.

Fuel cost
Fuel cost was calculated on the basis of actual fuel consumption of the machine.

Lubricants
Cost for lubricants was taken as 30 % of the cost of fuel consumption.

Repairs and maintenance
Cost of repairs and maintenance was taken as 10 per cent of the initial investment of the machine.

Other costs
It includes wages for operator, labour cost based on the prevailing market rates per day of 8 hours.

Results and Discussion
Based on field experiments conducted during *kharif* 2013, the performance evaluation of different weed management practices (power weeder, cono weeder, manual weeding and chemical weeding) were conducted in puddled drum seeded rice for 20 cm row spacing. The results for operating parameters were recorded that the highest field capacity was found 0.06 ha h^{-1} with the field efficiency of 70.98 per cent at an average speed of 2.09 kmph for power weeder whereas the field capacity of 0.01 ha h^{-1} with the field efficiency of 76.56 per cent at an average speed of 0.83 kmph for cono weeder by mechanical weeding. The fuel consumption for power weeder was observed that 9.25, lha^{-1}. The highest weeding efficiency was found to be 100 per cent with the zero per cent plant damage for manual weeding followed by 90.26 per cent with 1.33 per cent plant damage for cono weeder 90.38 percent for chemical weeding and 87.58 per cent with 2.63 percent plant damage for power weeder respectively. The results for operational parameters of different weed management practices were furnished in [Table-3].

Table-3 *Operating parameters of various weed management practices.*

Sl. No.	Observations	Power weeder	Cono weeder	Manual weeding	Chemical weeding
1	Number of rows	2	1	-	-
2	Effective working width, m	0.4	0.2	-	-
3	Speed, kmph	2.09	0.83	-	-
4	Theoretical field capacity, ha/h	0.08	0.02	-	-
5	Area covered, ha	0.007	0.007	0.007	0.007
6	Total time taken, h	0.12	0.55	2.00	0.06
7	Effective field capacity, ha/h	0.06	0.013	0.003	0.125
8	Field efficiency,%	70.98	76.56	-	-
9	Fuel consumption, l/ha	9.25	-	-	-
10	Number of persons required, man-h/ha	16.82	78.36	287.50	8.00
11	Weeds before weeding in 1 sq.m area of the field, w1	153	154	118	156
12	Weeds after weeding in 1 sq.m area of the field, w2	19	15	0	15
13	Weeding efficiency, %	87.58	90.26	100.00	90.38
14	Effective working depth, cm	4.80	3.20	-	-
15	Plant damage, %	2.63	1.33	-	-

In puddled drum seeded rice, different weed management practices significantly not influenced hills and panicles/m^2, panicle weight and test weight whereas tillers m^2 and grain yield were significantly affected. The hill number varied from 29.7 (power weeder) to 32.6 (manual weeding) whereas numerically higher panicles (477 m^{-2}) were recorded in manual weeding. Significantly higher tillers (522 m^{-2}) and grain yield (5949 kg/ha) were realized when manual weeding was employed as weed management option, however this was at par with cono weeding (5645 kg ha^{-1}) and significantly superior over weeding with power weeders (5416 $kgha^{-1}$) and herbicides (5442 $kgha^{-1}$). The yield and yield attributes were shown in [Table-4].

Cost analysis
The items for evaluating and comparing weeding costs in mechanical, manual and chemical weeding methods are illustrated in [Table-5]. In mechanical weeders, the cost of machine operation is the sum of fixed cost and variable costs. In manual weeding and chemical weeding, the total cost of operation is related to the labour cost. Among the all weeding methods the lowest operating cost of 747.12 $Rsha^{-1}$ was associated with power weeder and the highest operating cost with 5390.63 $Rsha^{-1}$ pertained to manual weeding. Based on the obtained results the weeding cost in power weeder, cono weeder and chemical weeding was reduced by 86, 70 and 73 per cent respectively compared to manual weeding method.

Table-4 *Yield and yield attributes as influenced by various weed management methods.*

Sl. No.	Observations	Various weed management methods			
		power weeder	cono weeder	manual weeding	Chemical weeding
1	Number of hills / m^2	29.7	31.3	32.6	32.4
2	Number of tillers/ m^2	460	499	522	485
3	Number of panicles/ m^2	427	445	477	428
4	Panicle weight, g	2.63	2.6	2.47	2.67
5	Test weight, g	12.17	12.21	12.22	12.33
6	Grain yield, kg/ha	5416	5645	5949	5442

Table-5 *Weeding cost in various weed control methods.*

Sl. No.	Observations	Power weeder	Cono weeder	Manual weeding	Chemical weeding
1	initial cost (C), Rs.	45000	1400	-	-
2	salvage value (S), Rs.	4500	140	-	-
3	life of the machine (L), years	6	4	-	-
4	working hours per year (H), h	500	250	-	-
5	Total fixed cost, Rs/ha	355.89	136.04	-	-
6	Number of labours required , man-h/ha	16.83	78.37	287.50	8.00
7	Labour cost, Rs/h	18.75	18.75	18.75	31.25
8	Cost of chemical/ha, Rs.	-	-	-	1200
9	Fuel cost, Rs/ha (Rs.72/l)	39.58	-	-	-
10	Total variable cost, Rs/ha	391.23	1491.29	5390.63	1450.00
11	Total cost of operation, Rs/ha	747.12	1627.34	5390.63	1450.00
12	Cost reduction compared to manual weeding, %	86	70	Base	73

Conclusions
Based on the experimental results, the following conclusions are drawn.

1. The highest field capacity was found 0.06 ha h^{-1} with the field efficiency of 70.98 per cent at an average speed of 2.09 km h^{-1} for power weeder whereas the field capacity of 0.01 ha h^{-1} with the field efficiency of 76.56 per cent at an average speed of 0.83 kmph for cono weeder by mechanical weeding. The fuel consumption for power weeder was observed as 9.25, lha^{-1}.
2. The highest weeding efficiency was found to be 100 per cent with the zero per cent plant damage for manual weeding followed by 90.26 per cent with 1.33 per cent plant damage for cono weeder 90.38 per cent for chemical weeding and 87.58 per cent with 2.63 per cent plant damage for power weeder respectively.
3. Significantly higher grain yield (5949 kg/ha) was realized with manual weeding and followed by cono weeding (5645 kg/ha) and significantly

superior over weeding with power weeders (5416 kg/ha) and herbicides (5442 kg/ha).

4. Among the all weeding methods the lowest operating cost of 747.12 $Rsha^{-1}$ was associated with power weeder and the highest operating cost with 5390.63 $Rsha^{-1}$ pertained to manual weeding.
5. Based on the obtained results the weeding cost in power weeder, cono weeder and chemical weeding was reduced by 86, 70 and 73 per cent respectively compared to manual weeding method.

Conflict of Interest: None declared

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