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Weed Management practice by Single Row Power Weeder for Rice crop

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Abstract
Weed control is important factor on crop growth and yield. There are different weed control method of rice cultivation for effective growth and yield. Mechanical weed control is helps to reduce the drudgery involved in manual weeding, it kills the weeds and also keeps the soil surface have moisture absorption capacity and loose soil aeration. Cost of labour are too high and availability is limited and therefore development of suitable mechanized weed control method is imperative. Power weeders are one step towards the standardization of practices, it has different variable rotational speed as per the need, having direction of movements, and it able to go one field to another. The purpose of power weeder is to kill weeds, minimum damages done to rice plants, cost effectiveness, low weight and easy to operate. The single row power weeder has less time consuming and significantly improves weeding efficiency as well as the quality of weeding. An experiment was conducted to trial the power weeder and its comparison against number of weeding with chemical weeding operation at 15 DAT, 25 DAT and at 35 DAT in Research farm, IGKV, Raipur. The test was carried out to assess the mechanical performance of the power weeder on the basis of number of weeding operation done by male and female workers. On comparison of male and female workers, male workers were more efficient than female worker. The actual field capacity of power weeder operated by male worker found as 0.05 ha/h with weeding efficiency of 80.95% and operated by female workers was 0.047 ha/h and 80.5% respectively. The operational speed of power weeder by male workers (i.e. 0.7 m/s) was more than the female workers (0.64 m/s). The grain yield with 3 weeding operation by single row power weeder was significantly high in comparison with other methods (viz. chemical weeding, 2 weeding, single weeding) as 48.74 qt/ha. Hence 3 weeding operation at 15, 25 and 35 DAT is economical for better production.

Keywords: Power weeder, weeding efficiency, chemical weeding, field capacity, operational speed, grain yield

Introduction
Rice (*Oryza sativa* L.) is a major cereal, which can be occupies 11% of world's crop area. Rice is a staple food for more than 60 % of the world population, especially in South and South-east Asia and Latin America. In India rice is cultivated in a very wide range of ecosystem.

The system of rice intensification (SRI) Is one such alternative, integrated and agro ecologically sound approach and system that claims to boost yield with fewer plants and fewer inputs resulting lower cost to farmers and saves 50 to 60 % of nutrient compared to conventional practice. Adoption of single row power weeder use in SRI plays a significant role in improving the growth, yield and economics of rice. Weed management with improved tools not only uproot the weeds between crop rows but also ensuring the better soil aeration. Rice is cultivated over an area of 3.67 m ha with the production of 5.56 million ton and productivity of 2.04t /ha (Anonymous, 2014) [1].

Weed control management is one of the most difficult tasks in agriculture. More than 33% of the cost incurred in cultivation is diverted to weeding operations there by reducing the profit share of farmers. A weed is essentially any plant which grows in the wrong place at the wrong time and doing more harm than good. 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.

In Chhattisgarh, rice occupies average of 3.6 million ha with the productivity of the state ranging between 1.2 to 1.6 t/ha depending upon the rainfall. The state is comprised with three agro-ecological zones i.e. Chhattisgarh plain, Bastar plateau and northern hill region of Surguja. These zones have huge variations in terms of soil topography, rainfall intensity and distribution, irrigation and adoption of agricultural production system and thus vary in the

productivity of rice in these regions. The crop weed competition is greater in direct seeded line sowing of rice because the crop and weed seeds germinate simultaneously and they start competing with each other for air, water, sunlight and nutrients. In this method of cultivation, it becomes difficult to keep the surface submerged throughout the crop growth period and hence it becomes favours for germination and growth of weeds. Weeding is one of the most important field operations and consumes 15% of total energy spent in crop production. Mechanical weed control reduces the drudgery involved in uprooting of the weeds. Moreover mechanical weeders besides killing the weeds loosen the soil between rows thus increasing air and water intake capacity. In Chhattisgarh, The weed control operations are mainly done by three methods such as biasi operation, hand weeding and using of herbicides. In biasi operation, weeds are removed by using an indigenous plough after 35-40 DAT. By hand weeding, weeds are removed by hand which is more effective but it is expensive, labour intensive as well as time consuming. Nowadays herbicide usage is increasing. But it has adverse effects on human health and environment. In order to assess the possibility of mechanization of the weeding operation, the power operated Single row power weeder is used in field conditions for better performance, effective weed control, minimum damages done to rice plants.

Materials and Method

The experiment was laid out in Factorial Randomized Block Design (FRBD) with single control and treatments were replicated thrice. The experiment structure is presented in table.

Test Cultivar of Rice: IR-64

IR 64 grain has good physical appearance and is a typical long-grain variety with high head rice yield (IRRI 1986). The crop matures in about 125-130 days, and having yield potential of 8.76 and 8.28 t/ ha.

Table1: Treatment factors details

Treatments
A. levels:- male and female operations
A_1: weeding operation by male workers
A_2: weeding operation by female workers
B. Factors:- weeding process
B_1: weeding at 15 DAT
B_2: weeding at 15 and 25 DAT
B_3: weeding at 15, 25 and 35 DAT
B_4: chemical weeding (pre-emergence oxadiargyl) + weeding at 15 DAT
B_5: chemical weeding (pre-emergence oxadiargyl) +weeding at 15 and 25 DAT
B_6: chemical weeding (pre-emergence oxadiargyl) +weeding at 15, 25 and 35 DAT
C. control
No weeding

Nursery preparation

The raised nursery bed was prepared with soil and FYM (2:1) and pre-germinated seeds @ 6 kg /ha were uniformly spread on the bed and covered with paddy straw for 2-3 days. It was watered by rose cans. At the time of transplanting seedlings were taken along with soil without disturbing root system.

Field preparation

The field was prepared by Ploughing and cross ploughing with the cultivator. The field was puddled in presence of 3-5 cm standing water and was leveled by planker. The marker was used to denote the spacing of 25 cm. × 25 cm.

Fig 1: Field preparation

Sowing

The 10 days old seedlings of only one seedlings/ hill was planted. Seedlings were carefully lifted with the seed, roots and soil from the nursery and transplanted one plant per hill within 15 to 30 minutes without plunging the plant in the mud ensuring of the root ends not turning upwards. The planting was done at a spacing of 25cm x 25 cm.

Fertilizer application

Recommended dose of P_2O_5 and K_2O *i.e.* 60:40 kg/ ha was applied through single Di ammonium phosphate and muriatic of potash, respectively. Nitrogen was applied in split doses at different growth stages. Full dose of P_2O_5, K_2O and $1/3^{rd}$ of N was applied as basal.

Fig 2: Fertilizer application

Weed Management Practices

Mechanical weed management

The weed management practices were adopted as per treatment. Under the treatment of mechanical weeding, weeds were controlled through power weeder running at one direction. The power weeder was run thrice at 15, 25 and 35 DAT.

Chemical weed management

Weed management techniques were adopted for weed control as per treatment. Herbicides oxadiargyl @80 g/ ha were used in the experiment as pre emergence to check the flush of weeds. Mechanical weeding was done at 15, 25 and 35 DAT, to check the flushes of weeds.

Fig 3: weeding operation

Fig 4: Chemical weeding

Harvesting, Threshing and Winnowing

Net area of plot was harvested manually by using sickle and the crop was left in the field for sun drying for two days and then bundled. After bundling, the produce was weighed plot-wise. Threshing was done by manual labours with the help of wooden sticks. The material threshed from each plot was kept separately and grain was separated from the chaff and straw by winnowing with the help of *supa*, after this the clean grains were weighed.

Machine Performance and Evaluation

Description of machine

An engine operated rice power weeder have power source of 2 hp, 6000 rpm, two-stroke petrol engine which is capable of providing the required power for weeding operation. The technical specifications of the engine are shown in Table.

Fig 5: Power weeder

Table 2: Technical specifications of the machine

S. No.	Specification	Value
1.	Number of cylinder	1
2.	Engine maximum power at 6000 rpm	2 hp
3.	Weeding width	140 mm to 250 mm
4.	No. of Blades	4 as per field condition
5.	Rotor speed	176 rpm
6.	Weeding depth	3 - 8 cm
7.	Power transmission	Light-weight aluminum gear box
8.	Fuel tank capacity	1.1 Litre
9.	Fuel	Petrol mixed with lub.oil
10.	Material of blade	Mild steel-L type blade
11.	Overall Dimension (LxWxH)	1345.8 x 573 x 1020 mm
12.	Total weight	14.5 kg

Machine performance parameters

Weeding efficiency

It is the ratio between the numbers of weeds removed by power weeder to the number of weeds present in a unit area and is expressed as a percentage. The samplings were done by quadrant method, by randomly selection of spots by a square quadrant of 1 square meter (Tajuddin, 2006) [9].

$$\text{Weeding efficiency \%} = \frac{W1-W2}{W1} \quad \text{…. (1)}$$

W1 = Number of weeds counted per unit area before weeding operation

W2 = Number of weeds counted in same unit area after weeding operation

Plant damaged

It is the ratio of the number of plants damaged after operation in a row to the number of plants present in that row before operation. It is expressed in percentage.

$$\text{Plant damage \%} = \left(1-\frac{q}{p}\right) \text{x100} \quad \text{….. (2)}$$

Where,

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

q = Number of plants in a 10 m row length of field after weeding.

Effective field capacity

Effective field capacity is the actual average rate of coverage by the machine, based upon the total field time. It is a function of the rated width of the machine, the percentage of rated width actually utilized, speed of the travel and the amount of field time lost during the operation. Effective field capacity is usually expressed as hectare per hour (Kepner *et al.*, 1978) [4].

$$EFC = A/(Tp+Ti) \quad \text{… (3)}$$

Where,

EFC = Effective field capacity, ha/h

A = Actual area covered, ha

Theoretical field efficiency

Theoretical field capacity of the machine is the rate of field coverage that would be obtained if the machine were performing its function 100% of the time at the rated forward speed and always covered 100% of its rated width. It is expressed as hectare per hour and determined as follows (Kepner *et al.*, 1978) [4].

$$TFC = \frac{W \times S}{10} \quad \text{... (4)}$$

Where,
TFC = Theoretical field capacity, ha/h
W = Width of cut, m
S = Speed of operation, Km/h

Fuel consumption
Fuel consumption has direct effect the economics of the power weeder. It was measured by top fill method. The fuel tank was filled to full capacity before the testing at leveled surface. After completion of test operation, amount of fuel required to top fill again is the fuel consumption for the test duration. It was expressed in litre per ha.

Crop observations
Plant population (per m^2)
The total numbers of plants were counted in an area of one square meter by a quadrate of 1 m^2 from randomly chosen places in each plot, before and after every weeding operation to observe plant damage percentage.

Weed population (per m^2)
Weed population per square meter was recorded randomly from each plot with help of 1 m^2 quadrate, after 15, 25 and 35 DAT. All the weeds present, in each plot were grouped under grasses, sedges and broad leaf weeds.

Plant height (cm)
The plant height of ten randomly selected plants from each plot was measured at 30, 60 DAT and finally at harvest. The height was measured in cm from ground level to tip from the longest leaf until the panicles emerged.

Number of tillers (per m^2)
Number of tillers per m^2 were counted at 30, 60 DAT and before harvest at five places already demarked with bamboo pegs in each plot and then mean was calculated.

Bulk density of soil
The bulk density of soil was determined by core cutter method. The core sampler of the soil of known volume was collected and weighed. The soil bulk density was determined as:

$$\text{Bulk density} = \frac{\text{mass of soil}}{\text{volume of soil}}$$

$$\rho = M/V \quad \text{… (5)}$$

Where,
ρ = Bulk density, g /cm^3
M = Mass of the soil, g
V = Volume of the soil, cm^3

Moisture content of soil
The moisture content of the soil was determined by oven drying method. In this, wet soil sample of known weight was kept in the thermostatically controlled oven at a temperature of 105 °C for 24 hours. The dried soil is again weighed and the moisture content is determined as:

$$W = \frac{Ww - Wd}{Ww} \quad \text{... (6)}$$

Where,
W = Moisture content, (% db)
W_w = weight of moist soil, g
W_d= weight of dry soil, g

Crop yield
The grain yield data was obtained by harvesting the crop manually from per plot (50 m^2) which was earmarked for data collection in the field. The crop was threshed and cleaned manually, and the grain so obtained was weighed to determine the crop yield.

Results and Discussion
Field Performance Test of Power Weeder
Operation speed
The operational speed of single row power weeder operated by male and female worker was 0.7 m/s and 0.64 m/s respectively.

Fuel consumption
Fuel consumption of the power weeder was calculated by topping method. The data revealed that there is no significant effect of male and female worker in fuel consumption at different stages of crop/ weeds. Average Fuel consumption of the power weeder operated by male and female worker was 0.64 l/h and, 0.68 l/h respectively.

Actual field capacity
The data reveal that the maximum field capacity was found in treatment A_1B_5 (0.051 ha/h), A_1B_5 (0.051 ha/h) and A_1B_6 (0.050 ha/h) at 15 DAT, 25 DAT and 35 DAT respectively. Result showed that there was significant different between numbers of weeding operation and also difference in working of male and female worker in actual field capacity.

Field efficiency
Field efficiency for different weeding operations is done by male worker, average field efficiency was (viz 72.6%, 72.48% and 70.55% at 15, 25 and 35 DAT respectively) and by female worker, average Field efficiency (viz. 66.27%, 66.16% and 63.95% at 15, 25 and 35 DAT respectively) are recorded. Results shows that there is significant difference in field efficiency of power weeder when weeding operation was done by male and female worker but there was no significant effect when number of weeding operation was changed.

Weeding efficiency
The data of weeding efficiency reveals that the average weeding efficiency at 15, 25 and 35 DAT was 80.65%, 80.71% and 82.01% respectively. It means that weeding efficiency of power weeder was not effect by number of weeding operation and also by male and female operators.

Plant Damaged (%)
Data indicated that the maximum plant damaged % for 15, 25 and 35 DAT was observed as 2.5%, 2.81% and 3% respectively under treatment A_2B_3 which showed that there was significant effect in plant damaged % with number of weeding operation and also due to the operator (male and female).

Comparative analyses of male and female workers
Comparison between male and female worker was analyzed based on mechanical parameters. The performance of male workers was comparatively more efficient then female workers. Result of different parameter with respect to male and female workers is shown in Table 3.

Table 3: Comparison between male and female worker

Parameters	Male Worker	Female Worker
Mechanical parameter		
Operation speed, m/s	0.70	0.64
Fuel consumption, l/h	0.64	0.68
Actual field capacity, ha/h	0.050	0.047
Field efficiency, (%)	72.22	65.85
Weeding efficiency, (%)	80.95	80.5
Plant damage %	1.48	2.14

Pre-Harvest Observations

Plant population (m^{-2})

Number of plants per square meter results showed that when weeding operation is done by male worker average plant population 15.81, 15.77 and 15.66 at 15, 25 and 35 DAT respectively and when weeding operation is done by female worker average plant population 15.67, 15.62 and 15.57 at 15, 25 and 35 DAT respectively are recorded. Maximum plant population (16.00) was observed in treatment combination A_1B_4, A_1B_3 and A_1B_5 at 15, 25 and 35 DAT respectively which showed that there is significance difference in plant population when number of weeding operation is increases.

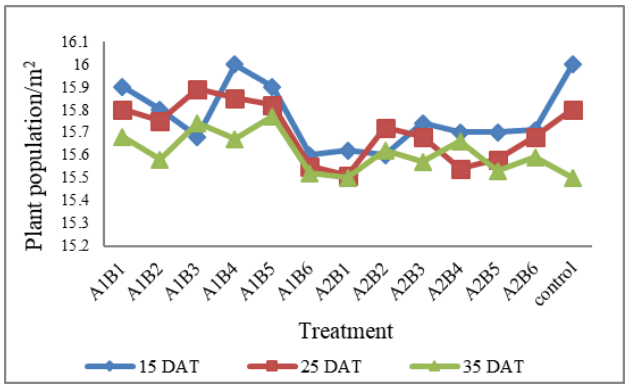

Fig 6: Plant population with different treatments

Plant height (cm)

The data reveals that different weed management practices affected the plant height at different growth stages at 30, 60 DAT and at harvest. The height of the plant goes on increasing as the age of the plant increases. At 60 DAT, maximum plant height was observed under the treatment of A_1B_3 (78.86 cm) and A_2B_3 (77.25 cm) by male and female worker respectively which showed that there was significance difference in plant height when number of weeding was increases and also significant difference in control vs. rest treatments.

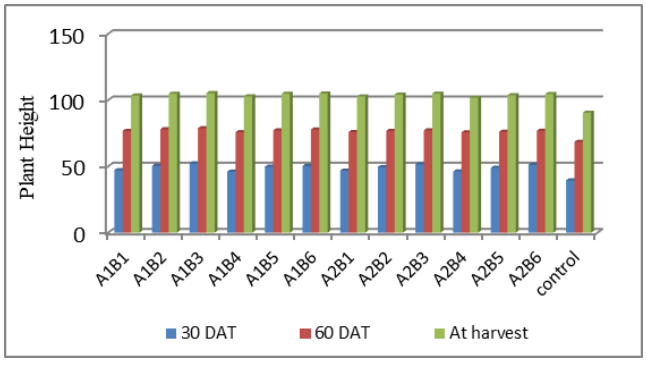

Fig.7: Plant height with different treatments

Number of tillers (m^{-2})

Number of total tillers/ m^2 of the plant go on increasing as the age of the plant increases. Results showed that when weeding operation is done by male worker average number of tillers/m^2 was 220.2, 225.25 and 235.45 at 30, 60 DAT and at harvest respectively and by female worker average Number of total tillers per m^2 213.9, 218.4 and 228.59 at 30, 60 DAT and at harvest respectively are recorded. Result showed that the number of tiller/m^2 was significance difference in control and rest treatments.

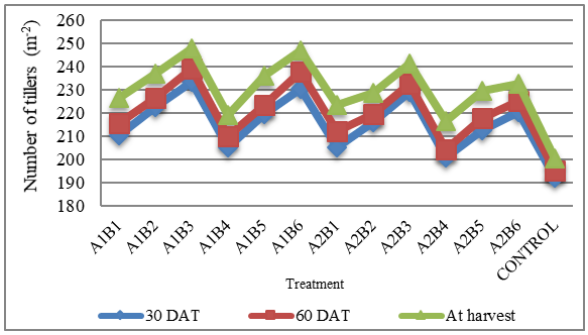

Fig 8: Number of tiller with different treatments

Post -Harvest Observations

Crop Yield

Crop Yield is obvious from the data that the maximum crop yield was found 48.78 q/ha at the treatment A_1B_3 in which three weeding operation was done by single row power weeder. The result showed that there was significant difference at different number of weeding operation and also difference in control and rest treatment but crop yield was no significant effect by operator (male and female).

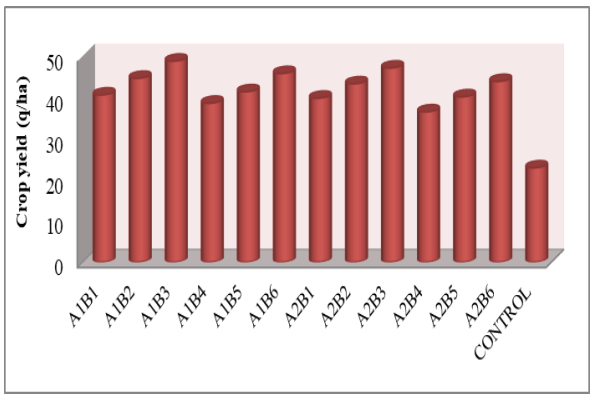

Fig 9: Crop yield

Conclusions

It was found that the performance of male workers was more efficient than female worker. The actual field capacity of power weeder operated by male worker found as 0.05 ha/h with weeding efficiency of 80.95% and operated by female workers was 0.047 ha/h and 80.5% respectively.

The field efficiency of power weeder operated by male workers and female workers was found as 72.22% and 65.85% respectively.

The operational speed of power weeder by male workers (i.e. 0.7 m/s) was more than the female workers (0.64 m/s) and Plant damage per cent by female workers was more as compared to male workers.

It was found that the grain yield with 3 weeding operation by single row power weeder was significantly high in comparison with other methods (viz. chemical weeding, 2 weeding, single weeding) as 48.74 q/ha.

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