Weed Management practice by Single Row Power Weeder for Rice crop

Shubham Pandey, AK Verma and Animesh Chandravanshi

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 weeder 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 weeder 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.

<table>
<thead>
<tr>
<th>Table1: Treatment factors details</th>
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<tr>
<td><strong>Treatments</strong></td>
</tr>
<tr>
<td>A. levels:- male and female operations</td>
</tr>
<tr>
<td>A1: weeding operation by male workers</td>
</tr>
<tr>
<td>A2: weeding operation by female workers</td>
</tr>
<tr>
<td>B. Factors: - weeding process</td>
</tr>
<tr>
<td>B1: weeding at 15 DAT</td>
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<tr>
<td>B2: weeding at 15 and 25 DAT</td>
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<tr>
<td>B3: weeding at 15, 25 and 35 DAT</td>
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<tr>
<td>B4: chemical weeding (pre-emergence oxadiargyl) + weeding at 15 DAT</td>
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<tr>
<td>B5: chemical weeding (pre-emergence oxadiargyl) + weeding at 15 and 25 DAT</td>
</tr>
<tr>
<td>B6: chemical weeding (pre-emergence oxadiargyl) + weeding at 15, 25 and 35 DAT</td>
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<tr>
<td>C. control</td>
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<tr>
<td>No weeding</td>
</tr>
</tbody>
</table>

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.

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 P₂O₅ and K₂O 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 P₂O₅, K₂O and 1/3rd of N was applied as basal.

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.

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.

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

| Table 2: Technical specifications of the machine |

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].

\[
\text{Weeding efficiency } \% = \frac{W_1 - W_2}{W_1} \times 100 \quad \ldots (1)
\]

\(W_1\) = Number of weeds counted per unit area before weeding operation
\(W_2\) = 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.

\[
\text{Plant damage } \% = \left(1 - \frac{q}{p}\right) \times 100 \quad \ldots (2)
\]

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].

\[
\text{EFC} = \frac{A}{(T_p + T_i)} \quad \ldots (3)
\]

Where,
\(\text{EFC}\) = 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].
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 m²)
The total numbers of plants were counted in an area of one square meter by a quadrat of 1 m² from randomly chosen places in each plot, before and after every weeding operation to observe plant damage percentage.

Weed population (per m²)
Weed population per square meter was recorded randomly from each plot with help of 1 m² quadrat 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 m²)
Number of tillers per m² 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:

\[ \rho = \frac{M}{V} \]  

Where,
\( \rho \) = Bulk density, g/cm³
\( M \) = Mass of the soil, g
\( V \) = Volume of the soil, cm³

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:

\[ W = \frac{W_w - W_d}{W_w} \]  

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 m²) 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 A₁B₁ (0.051 ha/h), A₁B₃ (0.051 ha/h) and A₃B₃ (0.050 ha/h) at 15 DAT, 25 DAT and 35 DAT respectively. Result showed that there was significant difference 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 A₁B₁ 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

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

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 of 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 of 15.67, 15.62 and 15.57 at 15, 25 and 35 DAT respectively are recorded. Maximum plant population of 16.00 was observed in treatment combination A₁B₄, A₁B₃ and A₁B₅ at 15, 25 and 35 DAT respectively which showed that there is significance difference in plant population when number of weeding operation is increases.

**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 A₁B₃ (78.86 cm) and A₂B₃ (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.

**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 A₁B₃ 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).

**Number of tillers (m⁻²)**

Number of total tillers/m² 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/m² 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 m² 213.9, 218.4 and 228.59 at 30, 60 DAT and at harvest respectively are recorded. Result showed that the number of tiller/m² was significance difference in control and rest treatments.

**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.
References