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Performance Evaluation of a Power Operated Wetland Weeders for Paddy

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A B S T R A C T

Generally farmers prefer manual weeding due to the lack of awareness about the mechanical weeder. But manual weeding is a most laborious and time consuming process. Nowadays mechanical weeders are being promoted to reduce drudgery, time of operation and to overcome the lack of labours problem. The study has been conducted on sandy loam and clay loam soils to evaluate the performance of two mechanical power weeders i.e., Garuda power weeder and Japanese power weeder. From the results, Garuda weeder has the highest weeding efficiency of 68.62 and 76.92 % and lowest plant damage of 24 and 13.33 % for sandy loam and clay loam soils. Japanese weeder has highest and lowest field capacities of 0.173 ha hr^{-1} for sandy loam soil and 0.067 $hahr^{-1}$ for clay loam soil. The performance index indicates that Garuda weeder and Japanese weeder is suitable for sandy loam and clay loam soils respectively.

Introduction

Rice is the staple food for more than half of the world's population. In paddy farming, weeds are competing with crops and it leads to decrease in yield. Weeds decline the crop yields from 15 to 50 percent influenced by the species, density and weeding period (Mirza *et al.*, 2009). So, timely weeding operation is essential for the paddy crop to control the weeds and to upturn the productivity. About 33 percent cost of cultivation is consumed on weeding alone when supported with the manual weeding. There are different types of weeding followed in paddy cultivation viz., chemical weeding, manual weeding, mechanical weeding. Chemical weeding uses weedicides to kill the weeds and it is a little costliest method. Manual weeding is an accurate weeding method which results in a complete removal of weeds. Manual weeding is a time consuming and higher labour requirement process (Mahilang *et al.*, 2017). Mechanical weeding is weed control technique that manage weed populations through remove, injure, kill, or make the growing conditions unfavorable for weeds. Efficient mechanical weeding for paddy is performed only on the System of Rice Intensification (SRI) methods of transplanted fields. It will not suitable for the conventionally transplanted fields. Keeping the above facts in view, selecting better weeder with region specific, commercially available two power weeders i.e., Garuda weeder and Japanese weeder were selected for performance evaluation under field conditions.

Materials and Methods

The study was conducted to evaluate the performance of two mechanical power weeders i.e., Garuda power weeder and Japanese power weeder. Both the weeders were evaluated for its performance during the weeding periods. The weeding was done at 20^{th} day after the transplanting of paddy in sandy loam soil at Tamil Nadu Agricultural University, Agricultural Engineering College and Research Institute, Kumulur(10°55' N and 78°49' E)and another trail was done in clay loam soil at Tamil Nadu Rice Research Institute (TRRI), Aduthurai (11°00' N and 79° 28'E) . The row spacing adopted in the field was 20 x 20 cm & 20 x 18 cm. Various parameters were selected to evaluate the performance of selected power weeders on field conditions. The parameters are

Effective Field capacity
Weeding efficiency
Plant damage efficiency
Fuel consumption
Performance index

The specifications of selected two row power weeders are given in table 1.

Effective field capacity

It is the machines ability to do a job in a field conditions. It includes the time for turning in headlands, blade cleaning time when weeds clogged to the blade. It is expressed in hectare per hour (ha h^{-1}).Effective field capacity is computed by using the formula (Keshavalu *et al.*, 2017).

$$EFC = A / T$$

Where

EFC – Effective field capacity (ha hr^{-1})
A – Area covered (ha)
T – Time taken to cover the area (h)

Weeding efficiency

It is the ratio between the number of weeds removed by the weeder to the number of weeds present before weeding. A plot of 1 x 1 m was marked in the field and the weeds were counted before and after the weeding process. It is expressed in percentage (%). Weeding efficiency is computed by using the formula (Sabaji *et al.*, 2014)

$$WE = ((W_1 - W_2) / W_1) \times 100$$

Where
WE - Weeding efficiency (%)
W_1 - Number of weeds present before weeding
W_2 - Number of weeds present after weeding

Plant damage efficiency

It is the ratio between the number of plants damaged by the weeder to the number of plants before weeding process. A plot of 1 x 1m was marked in the field and the plants were counted before and after the weeding process. It is expressed in percentage (%). Plant damage is computed by using the formula (Sabaji *et al.*, 2014).

$$PD = (P_1 - P_2) / P_1 \times 100$$

Where

PD - Plant damage (%)

P_1 - number of plants in $1m^2$ plot
P_2 - number of plants damaged after weeding

Fuel consumption

It is the quantity of fuel refilled in the tank after a period of time. Initially a fuel tank is fully filled with fuel, the machine is allowed to run for 1 hour and refill the fuel tank using a measuring jar. It is expressed in litres per hour ($l\ h^{-1}$).Fuel consumption is computed by using the formula (Keshavalu *et al.,* 2017)

$$FC = Q / T$$

Where

FC - Fuel consumption ($l\ h^{-1}$)
Q - Quantity of fuel refilled in the tank (l)
T - Total running time of an engine (h)

Performance index

It is the measure of machine performance how good the machine is adapted to a specific field condition with respect to power input. It is expressed in hectare per hp ($ha\ hp^{-1}$).Performance index was computed by using the formula (Sabaji *et al.,* 2014)

$$PI = (EFC \times (100 – PD) \times WE) / P$$

Where

PI - Performance index ($ha\ hp^{-1}$)
EFC -Effective field capacity (%)
PD - Plant damage (%)
WE -Weeding efficiency (%)
P -Power required to operate the weeder (hp)

Results and Discussion

Both the weeders were evaluated for its different evaluation parameters under different field conditions. The field operation of Garuda and Japanese power weeder is shown in figure 1 and 2. The results observed were as follows

Weeding efficiency

From the field trail, the weeding efficiency were observed as for sandy loam and clay loam soils were 68.62 and 76.92 % for Garuda weeder and 64.58 and 76.19 % for Japanese weeder respectively. The weeding performance of Garuda and Japanese weeder in clay loam soil is higher when compared to sandy loam soil due to soil consistency. This leads to the easy cutting and removal of weeds.

Plant damage efficiency

From the field trail, the Plant damage efficiency were observed as for sandy loam and clay loam soils were 24 and 13.33 % for Garuda weeder and 28 and 20 % for Japanese weeder. The plant damage efficiency of Garuda and Japanese weeder in clay loam soil is lower when compared to sandy loam soil due to soil consistency. This leads to the easy cutting action of blades to follow its trajectory, hence the weeders doesn't deflect from the passage line. So the efficiency of plant damage gets lowered.

Effective field capacity

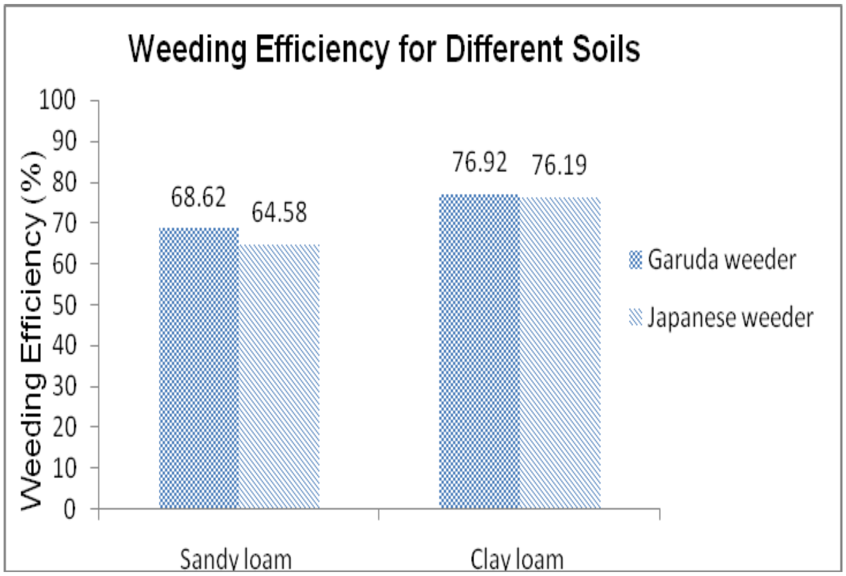
From the field trail, the effective field capacity were obtained as for sandy loam and clay loam soils were 0.160 and 0.090 $ha\ h^{-1}$ for Garuda weeder and 0.173 and 0.067ha $h^{-1}$for Japanese weeder. The effective field capacity of Garuda and Japanese weeder in clay loam soil is lower when compared to sandy loam soil due to field conditions. Field condition reduces the forward action of the weeders by not providing sufficient traction to the blades.

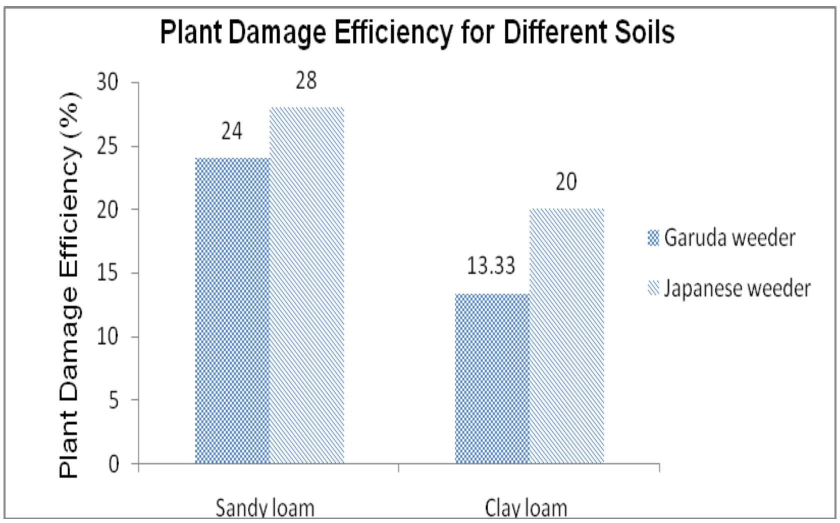
Table.1 Specifications of machine used in field trial

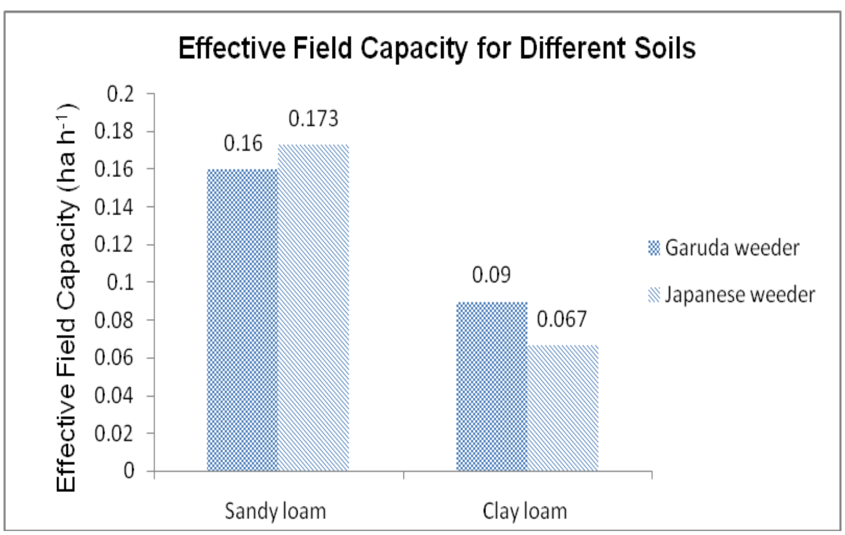
S.No	Description	Specifications	
		Garuda Weeder	**Japanese Weeder**
1	Model	Sharp Garuda 3PT 250	
2	Power, kW	1.4	1.4
3	Transmission type	Worm and wheel type gear	Worm and wheel type gear
4	Width of cut, m	0.4	0.4
5	Blade type	L type	Finger type
6	No. of rows	2	2
7	No. of blades on each flange	8	12

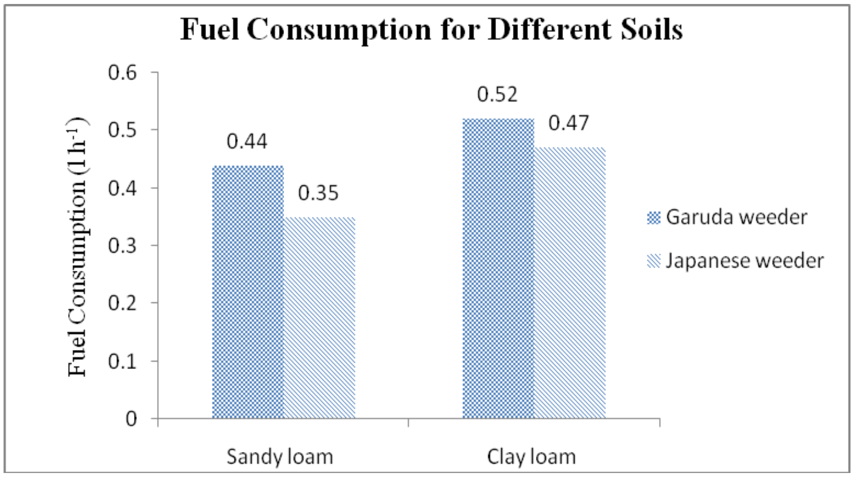
Fig.1 Field operation of Garuda weeder

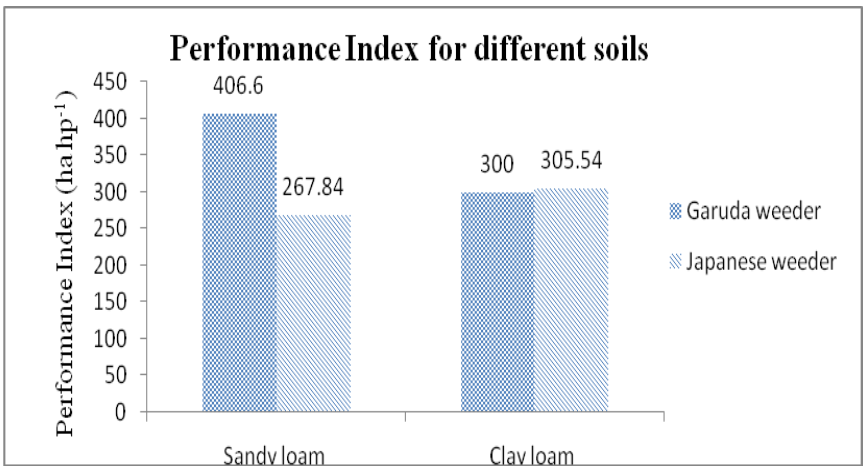
Fig.2 Field operation of Japanese weeder


Weeding Efficiency for Different Soils
Weeding Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
68.62
64.58
76.92
76.19
Garuda weeder
Japanese weeder
Sandy loam
Clay loam


Plant Damage Efficiency for Different Soils
Plant Damage Efficiency (%)
30
25
20
15
10
5
0
24
28
13.33
20
Garuda weeder
Japanese weeder
Sandy loam
Clay loam


Effective Field Capacity for Different Soils
Effective Field Capacity (ha h-1)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.16
0.173
0.09
0.067
Garuda weeder
Japanese weeder
Sandy loam
Clay loam





Fuel consumption

From the field trail, the fuel consumption were observed as for sandy loam and clay loam soils were 0.44 and 0.52lph for Garuda weeder and 0.35 and 0.47lph for Japanese weeder. The fuel consumption of Garuda and Japanese weeder in clay loam soil is lower when compared to sandy loam soil due to field conditions. Field condition reduces the forward action of the weeders by not providing the traction to the blades.

Performance index

From the field trail, the performance index were recorded as for sandy loam and clay loam soils were 406.60 and 300 ha hp^{-1}for Garuda weeder and 267.84 and 305.54ha hp^{-1}for Japanese weeder. The performance index of a Garuda weeder indicates that it is suitable for sandy loam soils and performance index of a Japanese weeder indicates that it is suitable for clay loam soils.

In conclusion, two power weeders were evaluated under two different soil conditions i.e. sandy loam and clay loam soil. Weeding efficiency, Plant damage, Fuel consumption, Effective Field Capacity and Performance Index were evaluated. From the results, Garuda weeder has the highest weeding efficiency of 68.62 & 76.92 %and lower plant damageof24 & 13.33 %for sandy loam and clay loam soils. Japanese weeder has highest field capacity of 0.173 ha hr^{-1} for sandy loam soil and in the clay loam soil it has the lower field capacity of 0.067 ha hr^{-1} due to the sinkage problem. The performance index of a Garuda weeder indicates that it is suitable for sandy loam soils and performance index of a Japanese weeder indicates that it is suitable for clay loam soils.

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