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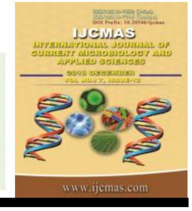

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Performance and Evaluation of Power Weeder, Wheel Hoe, Star Weeder under Dryland Conditions

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A B S T R A C T

Weeding consists of uprooting and removal of unwanted plants which grow in a filed with a cultivated crop competing with the crops for moisture and plants nutrients. Suitable mechanization technology is needed to reduce drudgery and to enhance time lines of operation. Hence a study was conducted to evaluate the performance of power weeder, wheel hoe and star weeder under dry land condition. Three weeders were initially evaluated in the dry land planted with maize with a plot size 20 m × 10 m with row to row spacing of 60 cm. Actual field capacities of power weeder, wheel hoe and star weeder were 0.0494 ha/h, 0.022 ha/h, 0.021 ha/h respectively. Field efficiencies of power weeder, wheel hoe and star weeder are 82.33%, 73.66%, 80.76% respectively. Power weeder has more field efficiency than other two weeders. Weeding efficiencies of power weeder, wheel hoe and star weeder are 78.4%, 74.0%, and 75.4% respectively. Power weeder has more weeding efficiency than other two weeders. Operational cost is more for power weeder and less for wheel hoe, star weeder compared to power weeder. Wheel hoe is having less efficiency and less cost of operation among the three weeders. Since drudgery involved during weeding is more compared to other weeders hence, it could be given less preference to weed when compared between power weeder and star weeder.

Introduction

Weeds, instead of harbouring insects, compete with the crop for water, light and plant nutrients and adversely affect the microclimate around the plant. In the absence of an effective control measure, weeds remove 30-40 % of applied nutrients resulting in significant yield reduction. Mechanical weeding is preferred considering the fact that manual weeding is time consuming, tedious and costly. Mechanical weeding is done either by power-operated weeders or manually operated weeders. Manual operated weeders have found acceptability due to their low cost but involves drudgery. Control of weeds requires lot of human labour, often several weeding are necessary to keep the crop weed free. Reduction in yield due to weed alone is estimated to be 16-42 % depending on crop and location and involves one third of the cost of cultivation (Rangaswamy *et al.*, 1993).

Delay and negligence in weeding operation affect the crop yield and the loss in crop yields due to weeds in upland crops vary from 40-60 per cent and in many cause complete crop failure. In India about 4.2 billion rupees are spent every year for controlling weeds in the production of major crops. At least 40 million tons of major food grains are lost every year due to weeds alone (Jagvir Dixit and lntikhab Syed, 2008). Therefore, timely weeding is very much essential for a good yield and this can only be achieved by using mechanical weeders which perform simultaneous job of weeding and hoeing and can reduce the time spent on weeding (man hours), cost of weeding and drudgery involved in manual weeding. Weeds decrease crop yields from 15 to 50% depending on species, density and weeding time through competition with main crop for light, water nutrition. It was accounted that losses due to weeds in main crops are more than 40 million tons per year. Experiments showed that competition of one kind of weed namely *Echinochloa crus-gali* in paddy fields reduced rice yield around 25%.

Common ways for controlling weeds include mechanical, chemical, biological and agronomical ones. Mechanical control, which is performed by hand and mechanical weeder have specific importance from agronomical and conformity with environmental condition points of view. Mechanical control not only eradicates weed between rows, but also softens superficial soil and enhances aeration of soil. Depending on weed density and species in the field, labor requirement for weeding varied between 10 to 15 persons per hectare in paddy fields. Row planting technology using rice transplanter and different grain drill machines, prepared the way for utilization of such plant protection machines as weeder in paddy fields (Tajuddin, 2009).Hence, a study was conducted to evaluate the performance of three weeders (power weeder, star weeder and wheel hoe) and their cost of operation was calculated to know the low cost and efficient weeder for dry land weeding (maize field).

Materials and Method

Study area

Power weeder, star weeder and wheel hoe (Figure 1) were evaluated for its performance in the Agricultural college farm, Bapatla, which is located at latitude of 15^0 58' N and $80^0$28' E longitude.

Three weeders were initially evaluated in the dry land planted with maize. Entire field was divided into equal number of plots of size 20m × 10m. Row to row spacing maintained was 60cm, with plant to plant spacing of 15cm. Weeding was done at age of 25 days of maize crop. Technical information of weeders was given in Table 1.

Speed of operation

Operational speed of weeders was calculated by fixing two poles, 20m apart in the test plot. The time required to travel the 20m distance was recorded to calculate the average value of time. From this time the effective field capacity has been estimated.

Actual field capacity

Time consumed for real work (t_p) and that lost for other activities such as turning at headlands, blade cleaning when clogging with weeds (t_c) was measured by stopwatch and recorded for calculation.

$$a = \frac{A}{(t_p + t_c)}$$

Where,

a = actual field capacity (ha/h)
A = area covered, ha
t_p= Productive time
t_c = Unproductive time, h

Theoretical field capacity

It is the rate of field coverage of the implement blade on hundred per cent of time at the rated speed and covering hundred per cent of rated width. It is given by formula

$$f = \frac{(W \times S)}{10}$$

Where,

f = theoretical field capacity (ha/h)
W= Width (m)
S= Speed of operation(km/h)

Field efficiency

Field efficiency is the ratio between actual field capacity and theoretical field capacity. This is calculated by using the following equation.

$$e = \frac{\text{Actual field capacity}}{\text{Theoretical field capacity}} \times 100$$

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 (500ml) before the testing at level condition. Fuel consumption was estimated by keeping the machine on a level platform and fuel was filled to full capacity mark. The amount of fuel required refilling the fuel tank again after one-hour continuous operation up to full capacity mark with help of measuring jar and fuel consumption per hour was calculated.

Weeding efficiency

Weeding efficiency was calculated by using the following formula:

$$e = \frac{(W_1 - W_2)}{W_1} \times 100$$

Where,

e = weeding efficiency, percent
W_1 =Number of weeds/m^2 before weeding
W_2 =Number of weeds/ m^2 after weeding

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:

$$q = \left\{ \frac{n_1}{n_2} \right\} \times 100$$

Where,
q= Plant damage in per cent,
n_1= Number of plants damaged in a 20 m row length after weeding,
n_2= Number of plants in a 20 m row length before weeding

Cost of operation

Cost of operation was calculated by considering depreciation, interest, housing, repair and maintenance, fuel cost and operator wages, for the power weeder where as for the wheel hoe, star weeder and traditional local tool only the operator wages are taken into consideration.

Results and Discussion

Speed of operation of power weeder, Star weeder and wheel hoe

Speeds of operation of three weeders were calculated by noting down the time required to cover 10 m of weeding length. Speed was calculated by calculating the average of three trails as shown in Table 2. The speed of operation of power weeder was more compared to star weeder and wheel hoe, because it was provided with petrol run engine which tills the soil with high rotating blades. Wheel hoe and star weeders are having almost same speeds of operations.

Actual field capacity

The actual field capacity of power weeder, star weeder and wheel hoe were observed as 0.0494, 0.021 and 0.022 ha/h, respectively. The power weeder observed as highest actual field capacity when compared with the star weeder and wheel hoe. The field capacity of star weeder and wheel hoe were depending on the pulling capacity of operator (Table 3).

Plant damage

The plant damage with the power weeder is 11 %, which is more compared to star weeder and wheel hoe. Wheel hoe is having highest plant damage when compared to star weeder (Table 4).

Weeding efficiency

Weeding efficiency was calculated by counting the number of weeds in 1 m^2 area before weeding and after weeding. Weeding efficiency of power weeder is 78.4 %, which is more compared to star weeder and wheel hoe (Fig. 2). Weeding efficiency of wheel hoe and star weeders are almost same.

Cost of operation

From Table 5, it was observed that cost of operation of power weeder was Rs. 2553 /ha. Where, wheel hoe was reported as less cost of operation, whereas drudgery is more in wheel hoe compared to power weeder and star weeder.

Table.1 Technical specifications of weeders

Parameters	Power weeder	Star weeder	Wheel hoe
Total length (cm)	120	138	169
Handle length (cm)	51	54	61
Wheel width(cm)	17	6	4
Cutting width (cm)	25	17.5	20.5
Wheel diameter (cm)	14	16	32
Weeder height (cm)	80	93	135
No. of blades	2	-	-
No. of teeth	6	-	-

Table.2 Speed of operation of power weeder, star weeder and wheel hoe

Replication number	Power weeder (kmph)	Star weeder (kmph)	Wheel hoe (kmph)
Trail 1	2.42	1.40	1.41
Trail 2	2.25	1.55	1.61
Trail 3	2.57	1.57	1.46
Average speed (kmph)	2.41	1.50	1.49

Table.3 Calculation of actual field capacity of power weeder, star weeder and wheel hoe

Type of weeder	**Area of the plot (Sq. m)**	**Time taken to cover an area of 200 sq. m (min)**	**Actual Field capacity (ha/h)**
Power weeder	200	24	0.0494
Star weeder	200	57	0.021
Wheel hoe	200	54	0.022

Table.4 Calculation of plant damage

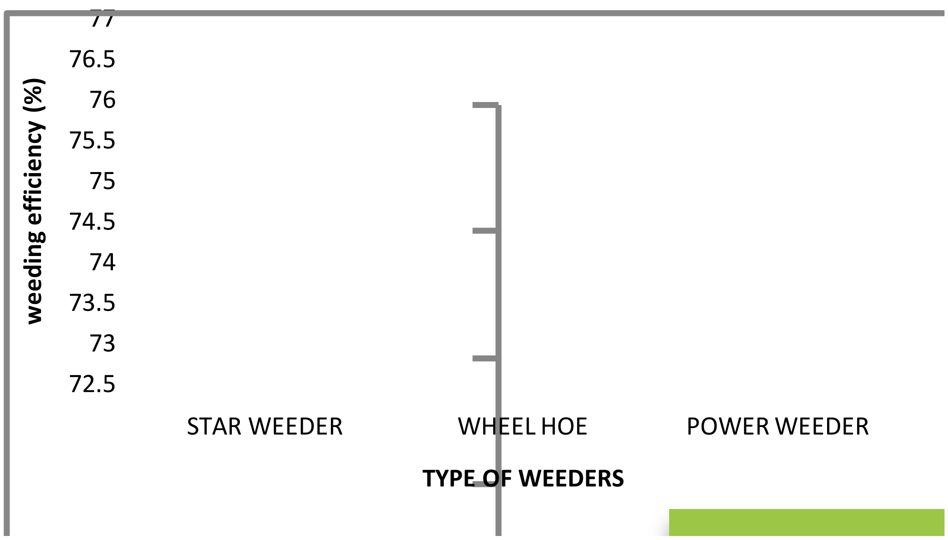
Types of weeders	Number of plants in 20 m row before weeding (n_2)	Number of plants in 20 m row after weeding (n_1)	Plant damage (%)
Power weeder	180	20	11.10
Star weeder	170	2	1.17
Wheel hoe	180	4	2.20

Table.5 Cost of operation of three weeders in dry land (Maize crop) weeding

Type of weeder	Cost of operation (Rs/ha)
Power weeder	2533
Star weeder	1785
Wheel hoe	1696

Figure.1 Star weeder, wheel hoe and power weeder

Figure.2 Weeding efficiency of power weeder, star weeder and wheel hoe



It is concluded that, field efficiency, weeding efficiency and cost of operation were more for power weeder under dry land weeding, when compared to other weeders. Even efficiency of power weeder is more; the cost of operation is a major constraint for small land holdings. Since the efficiency of power weeder and star weeder is not having much variation and also cost of operation of star weeder is less compared to power weeder. Hence it is advisable to work with star weeder and power weeder under small and higher land holding respectively. Wheel hoe is having less efficiency and less cost of operation among the three weeders. Since drudgery involved during weeding is more compared to other weeders hence, it could be given less preference to weed when compared between power weeder and star weeder.

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