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Development and Performance Evaluation of Solar Operated Power Weeder

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Abstract - *A solar operated power weeder was developed to reduce dependency on fossil fuel, harmful emissions and cost of operation. The developed weeder was tested on maize crop having row to row spacing of 600 mm. Three different width of cutting blade (50, 60 and 70 mm) were selected with two, three and four number of blades per flange to evaluate its performance. The operational width of developed weeder was 240 mm and blade penetrated into soil up to the depth of 35 mm. Maximum field capacity and weeding efficiency was found to be 0.175 ha/day and 88.03 per cent, respectively. Minimum plant damage was 1.96 per cent and the average performance index obtained was 841.*

Key Words: Solar, Power weeder, Fossil fuel, Emissions, Performance

1. INTRODUCTION

Ever since independence, Indian agriculture has continuously provided structural support to the economy. Agriculture continues to be the most important sector of Indian economy providing employment and livelihood to nearly about 115.5 million families (Shamrao, 2011). Despite significant improvement in crop productivity, the agricultural yield is found to be lower per unit area for most of the crops (Deshpande, 2017). Weeds continue to be an important constraint in crop production. Weeds have the potential to seize resources that were provided for the nourishment of crops. Which further affects the growth of plants and crop production. Weed management has always been a challenging and tiring job. Weed control methods changes with farm size, availability of working labours, weeds and crop type. There has always been an improvement in weed management practices with the advancement in technology which usually aim to reduce drudgery during operation and manufacturing cost of machine. Power weeders which are commonly used these days are engine operated and depends on fossil fuel for its operation. Fossil fuel when burnt emits greenhouse gases which are harmful for the health and environment. On the other hand, price of gasoline is increasing day by day which ultimately increases the operating cost of machine which seems to be unaffordable for small scale farmers.

There has always been a need to switch over to alternate solution for the fossil fuel to avoid energy crisis in near future. And as we all are aware about the environmental hazard and climate change for which air pollution also plays a very major role. That is why it has become very important to search for an alternative which is environmentally friendly and cost effective. Using renewable energy can reduce the use of fossil fuels, which are major sources of carbon dioxide emissions. Wind, solar and hydroelectric systems generate electricity with no associated air pollution emissions.

Solar energy is more practical type of energy due to its plentiful availability and it is derived directly from the sun. It is an important, clean, cheap and abundantly available renewable energy which is inexhaustible in nature and are freely available in adequate quantities in almost all part of the world

2. MATERIAL AND METHODS

2.1 Description of developed solar operated power weeder

The solar operated power weeder consisted of solar panel, DC motor, worm gearbox, rotor shaft, flanges, blades, frame, handle, blade cover, wheels.

2.2 Working principles

Solar energy was the main source of power for the developed weeder. A 160 W solar panel was used to harvest solar energy and it works on the principle of photo-voltaic effect which converts sunlight into

electrical energy. The electrical energy developed was further transmitted to 150 W DC motor which was responsible for the conversion of electrical energy into mechanical energy. The output shaft of DC motor was connected to worm gear box in order to achieve the desired rpm. Output rpm of worm gear box was gained by the rotor shaft which further helped the cutting blades to perform their desired work. Cutting blades were attached to the rotor shaft with the help of flanges.

Fig -1 Developed solar operated power weeder

2.3 Experimental details

Various experiments were conducted to determine the field capacity, weeding efficiency, plant damage and performance index.

Table -1 Research plan for field testing of solar operated power weeder

Sl. No.	Particulars	Levels
Independent variables		
2.	Number of blades per flange	2, 3 & 4
3.	Cutting width of blade	50, 60 and 70 mm
Dependent variables		
1.	Field capacity, ha/day	
2.	Weeding efficiency, per cent	
3.	Plant damage, per cent	
4.	Performance index	

2.4 Performance evaluation of solar operated power weeder

2.4.1 Field capacity

Field capacity was calculated by recording the area covered in hectare per day.

$$\text{Field capacity, ha/day} = \frac{Area\ covered\ (ha)}{Time\ required\ (day)}$$

2.4.2 Weeding efficiency

It was calculated by using the following formula (Yadav and Pund, 2007).

$$\text{WE, per cent} = \frac{W_b - W_a}{W_b} \times 100$$

Where,
WE = weeding efficiency, per cent
W_b = Number of weeds counted in a unit area before weeding operation
W_a = Number of weeds counted in same unit area after weeding operation

2.4.3 Plant damage

It was calculated by using the following formula (Yadav and Pund, 2007).

$$\text{Plant damage} = \frac{P_b - P_a}{P_b} \times 100$$

Where,
P_a = Number of plants in a given area of field after weeding
P_b = Number of plants in a given area of field before weeding

2.4.4 Performance index

The performance of the weeder was evaluated by the performance index (PI) by using following relationship (Srinivas et al., 2010).

$$PI = \frac{FC \times (100 - PD) \times WE}{MP}$$

Where,
PI = performance index
FC = Field capacity, ha/h
PD = Plant damage, per cent
WE = Weeding efficiency, per cent
MP = motor power, hp

Fig -2 Maize crop before weeding operation

Fig -3 Maize crop after weeding operation

3. RESULTS AND DISCUSSION

The developed machine was tested in maize crop with different number of blades at different cutting width of blade. The results obtained from the evaluation of the machine are discussed in the following sections.

3.1 Field capacity

Maximum field capacity was observed for 50 mm cutting width of blade working with two number of blades per flange and minimum was observed for 70 mm cutting width of blade working with four number of blades per flange.

Table –2 Effect of number of blades on field capacity

Field capacity, ha/day			
Treatment	Cutting width of blade		
	50 mm	60 mm	70 mm
2 blades	0.175	0.171	0.162
3 blades	0.170	0.163	0.149
4 blades	0.158	0.145	0.141

3.2 Weeding efficiency

The maximum and minimum weeding efficiency of developed solar operated power weeder was 82.47 per cent and 88.03 per cent, respectively.

Table -3 Effect of number of blades on weeding efficiency

Weeding efficiency, per cent			
Treatment	Cutting width of blade		
	50 mm	60 mm	70 mm
2 blades	82.47	84.69	86.72
3 blades	83.93	85.59	87.5
4 blades	86.41	86.87	88.03

3.3 Plant damage

The observation showed that maximum and minimum plant damage by the developed weeder for maize crop was 3.03 and 1.961 per cent, respectively.

Table -4 Effect of number of blades on plant damage

Plant damage, per cent			
Treatments	Cutting width of blade		
	50 mm	60 mm	70 mm
2 blades	2.703	3.03	2.679
3 blades	2.703	2.151	2.02
4 blades	2.128	2.083	1.961

3.4 Performance index

Maximum and minimum performance index of weeder for maize crop was 895 with 2 number of blades and 773 with 4 blades per flange, respectively. But, the main purpose of weeder is to provide higher weeding efficiency with minimum plant damage. Thus, three number of blades per flange was recommended instead of two number of blades per flange.

Table -5 Effect of number of blades on performance index

Performance index			
Treatment	**Cutting width of blade**		
	50 mm	**60 mm**	**70 mm**
2 blades	873	895	862
3 blades	879	863	810
4 blades	837	778	773

4. CONCLUSIONS

- Field capacity of developed weeder was observed highest for 50 mm cutting width working with two number of blades i.e., 0.175 ha/day.
- Weeding efficiency of developed weeder was observed highest for 70 mm cutting width working with four number of blades i.e., 88.03 per cent.
- Plant damage of developed weeder was observed highest for 60 mm cutting width working with two number of blades i.e., 3.03 per cent.
- After several experiments the average performance index calculated was 841.
- After several observations weeder with three number of blades per flange was recommended in terms of weeding efficiency and plant damage.

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