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Performance evaluation of self propelled rotary weeder

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■ **ABSTRACT :** Weed control is one of the most essential and expensive operation in crop production. The conventional methods of weeding *viz.*, manual and animal drawn involve drudgery, time loss and also increase the cost of operation. Manual weeding is common in Indian agriculture. It is the most widely used weed control method but it is labour intensive. The use of mechanical weeder will reduce drudgery and ensure a comfortable posture of the farmer or operator during weeding. This will resultantly increase production. Average depth and width of operation of developed machine was 14 cm and 110 cm, respectively. The performance evaluation of machine was calculated on the basis of three different engine speeds *i.e.* 2180, 2752, 2905 rpm and results showed that, field efficiency of 51.3, 64.96, 72.73 per cent was with fuel consumption of 0.81, 1.19, 1.68 lt./hr, respectively with weeding efficiency of 53.4, 63.73, 72.11 per cent. Thus, this weeder was found to be beneficial on the basis of weeding efficiency and operating time.

■ **KEY WORDS :** Performance, Self propelled, Rotary weeder

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The productivity of farms depends greatly upon availability and use of power on farms by the farmers. Agricultural implements and machines enable the farmers to employ the power for production purposes. Agricultural machines increase productivity of land and labour by meeting timeliness of farm operations and increase work output per unit time. Besides its contribution to multiple cropping and diversification of agriculture, mechanization also enables efficient utilization of inputs such as seeds, fertilizers and water (Singh, 2006).

In traditional method weeding is done manually. 'Khurpi' is handy tool used for this purpose. It is the most widely used weed control method but it is labour intensive, very slow, involving lot of drudgery. The use of mechanical weeder will reduce drudgery and ensure a comfortable posture of the farmer or operator during weeding. This will resultantly increase production. Mechanical method of weed control is the best with little or no limitation because of its effectiveness. The primary objective of row crop cultivation is to enhance the use of farm machinery for eliminating weeds from the crop land. The effect of this method is to promote plant growth and better quality crops (Mudakavi *et al.*, 1987).

There is an increasing interest in the use of mechanical inter-row weeders because of concern over environmental degradation and a growing demand for organically produced food. 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. Through the technical development of mechanisms for physical weed control, such as precise inter-and intra-row weeder, it might be possible to control weeds in a way that meets consumer and environmental demands (Hag and Islam, 1985).

Weeding is an important but equally labour intensive agricultural unit operation. There is an increasing interest in the use of mechanical intra-row weeders because of concern over environmental degradation and a growing demand for organically produced food. 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. Through the technical development of mechanisms for physical weed control, such as precise inter-and intra-row weeders, it might be possible to control weeds in a way that meets consumer and environmental demands (Pullen and Cowell, 1997; Fogelberg and Kritz, 1999; Kurstjens and Perdok, 2000).

Kepner *et al.* (1978) claimed that mechanical method of weed control is the best with little or no limitation because of its effectiveness. The primary objective of row crop cultivation is to enhance the use of farm machinery for eliminating weeds from the crop land. The effect of this method is to promote plant growth and better quality crops. However, the use of such machine is not common and the availability of a mechanical weeder is scarce.

To give farmer a better choice about the weeder so that, they choose weeder according to their need and its performance in the field, it was necessary to evaluate performance evaluation of developed self propelled rotary weeder. Moreover, after being equipped with related devices and tools it may be used to pump water, spray water and pesticides, implant seeds, threshing, cut tendrils, grind something etc.

■ METHODOLOGY

Constructional details :

Self propelled rotary weeder consisted of a 4- stroke diesel engine having displacement of 418 cc in the front portion assembly for using as a prime mover, operating at a rated speed of 3600 rpm as shown in Fig. A. The rotary weeder having overall dimensions (Length, height and width) of 1575, 1120, 1150 mm, respectively, having tilling width of 1050 mm. The rotary weeder was provided with eight set of blades consisting four blades mounted

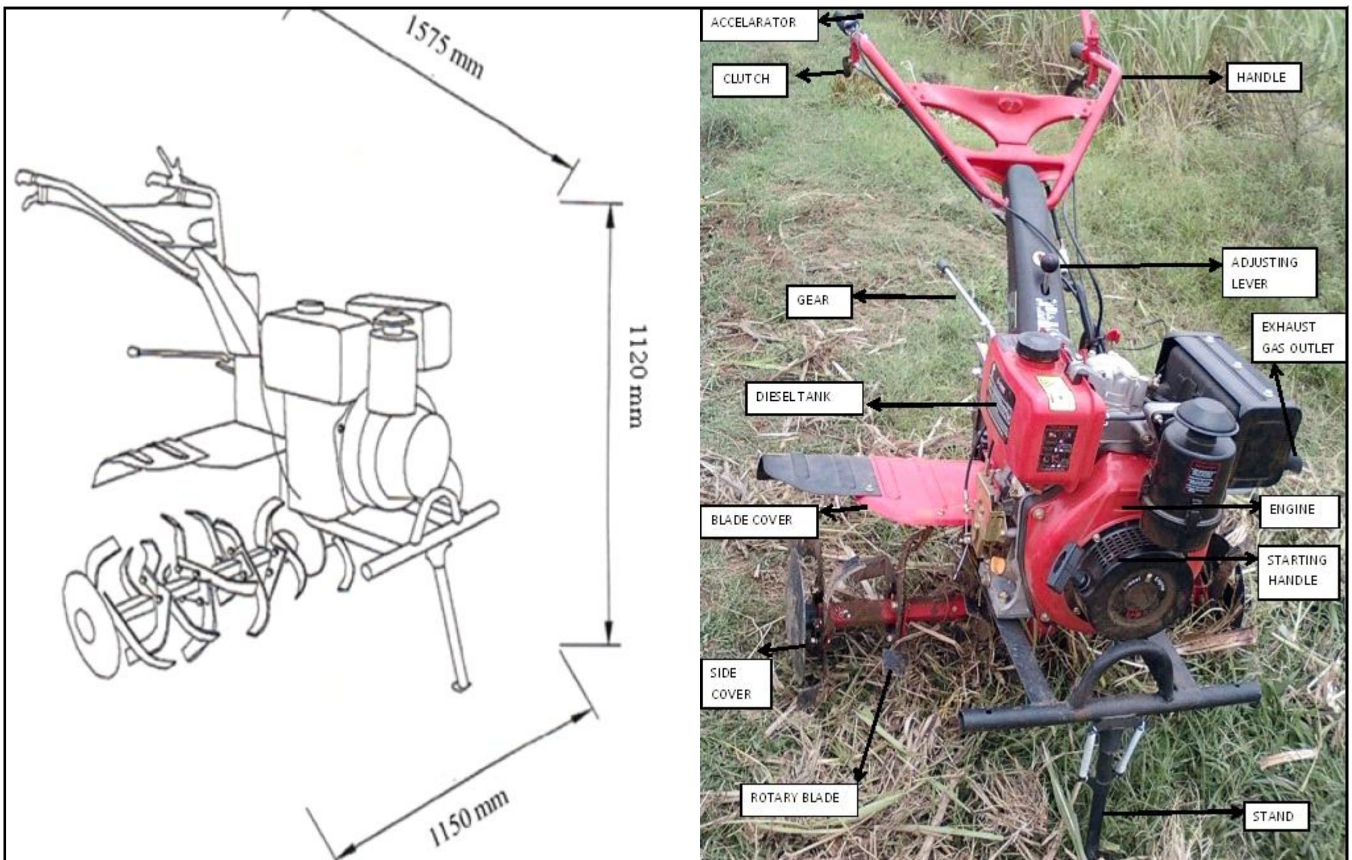

Fig. A : Schematic and pictorial view of the self propelled rotary weeder

Fig. B : Operation of self propelled rotary weeder in pomegranate and sapota crop field

on the hollow MS tube at a spacing of 140 mm. The power from engine was utilized for weeding purpose through the gear assembly. An adjusting lever was provided with four groves for shifting the position of handle as per the requirement of height of the operator. A safety clutch was provided at right hand for engaging/ disengaging the power from the engine to the rotary blades. The rotary weeder was provided with the two speeds *i.e.* high and low.

Performance evaluation :

The performance evaluation of the self propelled rotary weeder was conducted on the experimental field of pomegranate and sapota crop field (Fig. B) at Mahatma Phule Krishi Vidyapeeth, Rahuri, district Ahmednagar, India. The performance evaluation was conducted to investigate the effect of engine speed, forward speed on weeding efficiency and field efficiency.

Theoretical field capacity (*TFC*) :

It is the rate of field coverage of the implement based on 100 per cent of time at the rated speed and covering 100 per cent of its rated width. For calculating theoretical field capacity we first calculated the speed and width of the implement. The speed was calculated by recording the time required to travel 20m distance.

$$\text{TFC (ha/h}^{-1}) = \frac{\text{Width(m)} \times \text{Speed(m/hr)}}{10000} \quad ...(1)$$

Effective field capacity (*EFC*) :

It is the actual area cover by the implement based on its total time and its width.

Field efficiency (η) :

It is the ratio of the effective field capacity and theoretical field capacity express in per cent.

$$\eta = \frac{EFC}{TFC} \times 100 \quad .....(2)$$

Fuel consumption :

For fuel consumption, the tank was filled to full capacity before and after the test. Amount of refuelling after the test is the fuel consumption for the test.

Weeding efficiency :

1m × 1m plot was used for counting of weeds per square metre. Three trial plots of 1 m × 1m size were selected in cotton field for each weeder. Tests were conducted thrice and observation noted carefully. Averages of three observations were considered for calculation of performance parameters. The observations were recorded before and after the operation. The weeding efficiency was calculated by using formula, where w_1 is number of weeds before weeding operation and w_2 is weeds after operation.

$$\text{Weeding efficiency (\%)} = \frac{W_1 - W_2}{W_1} \quad .....(3)$$

Wear analysis :

Wearing is a general phenomenon in power rotary weeder that arises due to friction between soil and parts of machine. Wearing is observed mainly in rotary blades because it cuts the soil and penetrates into the soil. Mass of blades is taken before and after the performance operation. Difference in mass will give the wearing of blades.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of engine speed on weeding efficiency :

The effect of engine speed on weeding efficiency was determined by counting the number of weeds before and after using the developed weeder on the 3 blocks (replicated three times), for three engine speeds *i.e.* 2180, 2752, 2905 rpm with the help of Eqn. (3) and shown in Fig. 1. Detail records are presented in Table 1. The results showed weeding efficiency of 53.4, 63.73 and 72.11 per cent.

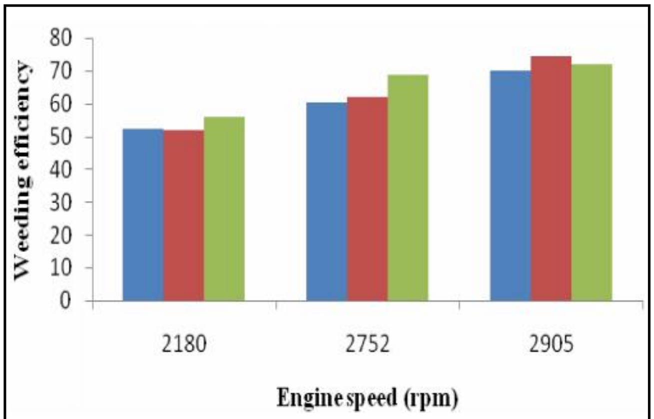

Fig. 1 : Effect of various engine speeds on weeding efficiency

Table 1 : Number of weeds removed and weeding efficiency for various engine speeds

Sr. No.	Engine speed (rpm)	Block	Weed density		No. of weeds removed	Weeding efficiency (%)
			Before weeding	After weeding		
1.	2180	1	212	101	111	52.3
		2	219	105	114	52.0
		3	202	89	113	55.9
2.	2752	1	305	121	184	60.3
		2	317	120	197	62.1
		3	379	118	261	68.8
3.	2905	1	217	65	152	70.0
		2	279	71	208	74.55
		3	302	85	217	71.85

Table 2 : Forward speed, field efficiency and fuel consumption for various engine speeds

Sr. No.	Engine speed (rpm)	Block	Forward speed (km/hr)	Area covered (ha/hr)	Field efficiency (%)	Fuel consumption (lt./hr)
1.	2180	1	1.2	0.077	50.7	0.82
		2	1.15	0.068	52.0	0.83
		3	1.19	0.071	51.2	0.78
2.	2752	1	1.5	0.112	65.0	1.13
		2	1.65	0.121	63.4	1.24
		3	1.82	0.139	66.5	1.2
3.	2905	1	2.8	0.232	72.3	1.68
		2	2.72	0.224	71.8	1.7
		3	2.68	0.228	74.1	1.73

Table 3 : Wear analysis of blades in self propelled rotary weeder

Blade	Mass of blade (g)		Difference in mass (g)	Result	
	Before operation	After 25.18 h of operation		% wear	Per hour wear
Blade 1	419.4	400.4	19	4.53	0.17
Blade 2	401.4	380.4	21	5.23	0.20
Blade 3	388.6	377.6	11	2.83	0.11

Effect of engine speed on field efficiency and fuel consumption :

The effect of engine speed on field efficiency and fuel consumption was determined by calculating EFC and TFC using the developed weeder on the 3 blocks (replicated three times), with the help of Eqn. (1 and 2) and shown in Fig. 2. Detail records are presented in Table 2. The results showed field efficiency of 51.3, 64.96, 72.73 per cent with fuel consumption of 0.81, 1.19, 1.68 lt./hr.

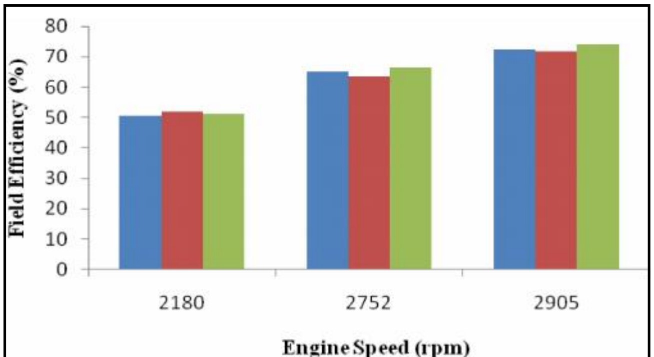

Fig. 2 : Effect of various engine speeds on field efficiency

Wear analysis :

The wear occurred during the weeding operation was determined by measuring the initial and final weights of blades after 25.18 hrs of weeding operation, and tabulated in Table 3. The hourly rate of wear of blades was found in the range of 0.11 to 0.20 per cent. Rathod *et al*. (2010) also worked on the development of tractor drawn inter-row rotary weeder.

Conclusion :

The results of the performance evaluation of the developed self propelled rotary weeder indicated that the engine speed influenced the weeding efficiency. It was observed that higher engine speed leads to higher weeding efficiency for three different engine speeds *i.e.* 2180, 2752, 2905 rpm, respectively. For these three engine speeds, it was observed that, higher engine speed led to higher field efficiency and fuel consumption. The machine operated at the field capacity of 0.07 to 0.22 ha/hr.

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