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Effect of Operational Parameters on the Performance of Walk behind Engine Operated Weeder for Upland Crops

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A B S T R A C T

Weeding is an important but equally labour intensive agricultural operation. Delay and negligence in weeding operation affect the crop yield and in many cases cause complete crop failure. Mechanical weed control not only uproots the weeds between the crop rows but also keeps the soil surface loose, ensuring better soil aeration and water intake capacity. A study was conducted in farmer's field at Tondamattur village of Coimbatore district to develop a walk behind engine operated weeder for upland crops and to analyse the effect of operational parameters on the performance of walk behind engine operated weeder. The weeding efficiency of the prototype weeder was determined by weed count method. The factorial analysis of the measured data was performed to assess the influence of the variables *viz.*, number of blades (N), rotational speed of weeding rotor (S) and depth of operation (D) on weeding efficiency. The main effects of number of blades (N), rotational speed of weeding rotor (S) and depth of operation (D) were significant at 1 per cent level of probability. But the effect of combination of rotational speed of weeding rotor (S) and depth of operation (D) was non-significant. The maximum weeding efficiency of 87.29 per cent was achieved with 4 number of weeding blades and 75 mm depth of operation at 250 rev/min rotational speed of weeding rotor.

Introduction

Dryland farming in India is major cultivation practice, especially in the areas coming under arid and semi-arid zones. Weed control is major problem in Indian agriculture and needs intensification to overcome the problem of labour availability and high labour wages. Weeding is an important operation to be carried out during the initial stages of crop growth especially for controlling the weeds competing with the crop, stirring the soil for aerating the crop root zones and for burying the weeds into the soil. Manual weeding requires large labour force and accounts for 25 per cent of the total labour requirement which is usually 900 to 1200 man-h/ ha (Nag and Dutt, 1979). Labour requirement for weeding depends on weed flora, weed intensity, time of weeding and efficiency of workers. Though manual weeding is considered to be the best, the undependable labour availability and escalating wages have given impetus to the development of mechanical weeding tools and machines.

Long handled star weeders and rotary type weeders are popular mechanical weeders in dry lands. Manually operated weeders have found acceptability due to their low cost

(Behera *et al.,* 2007). Mechanical weeders loosen the soil around seedlings, improve the physical properties of soil and reduce environmental pollution compared to chemical weed control method. Mechanical weed control is an effective approach to replace chemical and manual weed control (Jinwu *et al.,* 2014). Shridhar (2013) designed and developed a mechanical weeder made of two cutting mechanisms viz., primary cutting which is in front to loosen the soil and secondary cutting which is behind to accomplish weed cutting and lifting of weeds. He reported that field efficiency of the weeder was 81.2 per cent. Tajuddin (2009) developed a 2.2 kW petrol start kerosene run engine operated weeder for low land rice. The weeder was field tested in silty loam soil. The design forward speed of the weeder was 2.5 km h^{-1}. The theoretical field capacity and actual field capacity were 0.09 and 0.075 ha h^{-1} respectively with field efficiency and weeding efficiency of 83 and 89 per cent respectively. The cost of the machine was determined as Rs. 31,500. Cost of operation was calculated as Rs. 1,060 ha^{-1}.Keeping in view the above facts, a study was undertaken to develop a walk behind engine operated weeder for upland crops and to analyse the effect of the operational parameters on the performance of developed weeder under field conditions.

Materials and Methods

A prototype walk behind engine operated weeder was developed for upland crops. A vertical axis rotating weeding rotor with weeding blades attached on the periphery of circular shape rotor was selected as weeding tool. The forward speed of the prime mover was adjusted for 1.5 km h^{-1} by selecting the appropriate transmission ratios and controlling throttle lever to match the walking speed. The 4.1 kW petrol engine was selected as prime mover based on the power requirement of weeder. The power requirement of the prototype weeder was determined as 1.06 kW. The weeder was designed on basis of agronomic, soil and machine parameters. The conceptual drawing of developed weeder is shown in figure 1 and the technical specifications are presented in table 1.

The prototype walk behind engine operated weeder was evaluated in a farmer's field cultivated with okra crop with a spacing of 350 x 200 mm at Tondamattur village of Coimbatore district. The effect of operational parameters viz., number of blades (2, 3 and 4), rotational speed of weeding rotor (150, 200 and 250 revolutions per minute) and depth of operation (25, 50 and 75mm) on the performance of weeder was analyzed under field conditions.

From the analysis of the data collected randomly at different places in the field, the performance of the digger was evaluated in terms weeding efficiency. The weeding efficiency was determined during the field trials as follows.

To determine weeding efficiency, a quadrant of 300 x 300 mm was placed in the field at random and the number of weeds inside the quadrant was counted before and after weeding by machine. The weeding efficiency was calculated using the following equation (Remesan*et al.,* 2007).

$$e = \frac{(N_1 - N_2)}{N_1} \times 100$$

Where,

e = weeding efficiency, per cent

N_1 = number of weeds in the quadrant area before weeding

N_2 = number of weeds in the quadrant area after weeding

Results and Discussion

The effect of operational parameters viz., number of blades, weeding rotor speed and depth of operation on weeding efficiency of prototype weeder was analysed and results are presented below.

The measured values of weeding efficiency at selected levels of number of blades (N), rotational speed of weeding rotor (S) and depth of operation (D) are furnished in table 2.

At depth of operation of 25 mm (D1)

The relationship between weeding efficiency of weeder and rotational speed of the weeding rotor (S) with selected number of blades (N) at 25mm depth of operation is depicted in figure 2. It was observed that the weeding efficiency increased from 70.06 to 72.55 per cent at rotational speeds of 150, 200 and 250 rev/min when 2 number of blades were implied for weeding. The observation was mainly due to increase in rotational speed of weeding rotor which applied more shearing force to the soil as a result the weeding efficiency increased. The values of weeding efficiency for rotational speeds of 150, 200 and 250 rev/min at 3 numbers of blades were 72.3, 72.54 and 73.86 per cent respectively. Similarly the values of weeding efficiency with 4 numbers of blades were 76.25, 80.27 and 83.25 per cent respectively. As the number of blades increased the weeding efficiency also increased because the area covered for weeding per rotation of the weeding rotor will increase with increase in number of blades.

At depth of operation of 50 mm (D2)

The relationship between weeding efficiency of weeder and rotational speed of the weeding rotor (S) with selected number of blades (N) at 50 mm depth of operation is depicted in figure 3. It was found that the values of weeding efficiency were 70.2, 72.01 and 73.25per cent respectively for rotational speeds of 150, 200 and 250 rev/min with 2 numbers of blades. Weeding efficiency however interestingly decreased from 73.98 to 73.22 per cent at rotational speeds of 150 and 200 rev/min and then increased to 74.31 per cent at rotational speed of 250 rev/min with 3 blades in operation.

Values of weeding efficiency at 150, 200 and 250 rev/min with 4 blades in operation were found to be 78.12, 85.1 and 86.39 per cent respectively. The significant increase in the values of weeding efficiency were observed at 50 mm depth of operation compared to 25 mm depth of operation due to increase in number of weeds uprooted as the depth of operation increased.

At depth of operation of 75 mm (D3)

The relationship between weeding efficiency of weeder and rotational speed of the weeding rotor (S) with selected number of blades (N) at 25mm depth of operation is depicted in figure 4. It was observed that weeding efficiency increased from 71.2 to 73.08 per cent at rotational speeds of 150, 200 and 250 rev/min with 2 blades employed in weeding. The lower values of weeding efficiency were observed at rotational speed of 150 rev/min because of the increase in soil resistance with increase in depth of operation. Similarly the values of weeding efficiency observed at 150, 200 and 250 rev/min rotational speeds with 3 numbers of blades were 73.29, 74.25 and 76.05 per cent respectively. Weeding efficiencies of 79.26, 87.35 and 87.29 per cent were observed at 150, 200 and 250 rev/min rotational speeds with 4 blades in operation. The selected depth of 75 mm would uproot almost all the weeds as the depth of operation is more than the maximum root length of weeds observed in the field.

Table.1 Technical specifications of the developed prototype weeder

S. No.	Particulars	Values
1.	Overall length of the machine, mm	1980
2.	Overall height of the machine, mm	1160
3.	Overall width of the machine, mm	800
4.	Size of the engine, kW	4.1
5.	Diameter of the ground wheels, mm	750
6.	Ground clearance, mm	375
7.	Speed ratio from engine to ground wheels	300:1
8.	Speed ratio from engine to weeding rotor	9.6:1
9.	Maximum working width, mm	250
10.	Maximum working depth, mm	50
11.	Maximum number of blades on weeding rotor	4

Table.2 Weeding efficiency for different combinations of independent variables

S. No.	Treatment	N	S	D	Mean weeding efficiency, %		
					R_1	R_2	R_3
1.	$N_1S_1D_1$	2	150	25	65.55	63.43	72.66
2.	$N_1S_1D_2$	2	150	50	63.59	65.33	70.65
3.	$N_1S_1D_3$	2	150	75	65.20	67.30	71.20
4.	$N_1S_2D_1$	2	200	25	66.39	68.20	72.09
5.	$N_1S_2D_2$	2	200	50	64.80	69.36	72.01
6.	$N_1S_2D_3$	2	200	75	64.80	68.23	71.50
7.	$N_1S_3D_1$	2	250	25	68.90	69.32	74.07
8.	$N_1S_3D_2$	2	250	50	65.90	70.26	72.43
9.	$N_1S_3D_3$	2	250	75	68.05	73.78	79.98
10.	$N_1S_1D_1$	3	150	25	65.09	68.22	73.98
11.	$N_2S_1D_1$	3	150	50	67.84	72.32	76.09
12.	$N_2S_1D_2$	3	150	75	64.87	70.02	73.86
13.	$N_2S_1D_3$	3	200	25	67.55	69.51	76.09
14.	$N_2S_2D_1$	3	200	50	67.25	69.67	76.09
15.	$N_2S_2D_2$	3	200	75	68.22	70.32	73.33
16.	$N_2S_2D_3$	3	250	25	66.08	70.1	73.10
17.	$N_2S_3D_1$	3	250	50	66.97	73.91	70.07
18.	$N_2S_3D_2$	3	250	75	67.90	70.09	75.12
19.	$N_2S_3D_3$	4	150	25	70.28	73.65	78.2
20.	$N_3S_1D_1$	4	150	50	71.22	74.39	79.0o
21.	$N_3S_1D_2$	4	150	75	71.07	75.35	78.25
22.	$N_3S_1D_3$	4	200	25	74.32	77.05	81.74
23.	$N_3S_2D_1$	4	200	50	78.36	80.45	85.76
24.	$N_3S_2D_2$	4	200	75	81.21	84.33	86.35
25.	$N_3S_2D_3$	4	250	25	75.70	80.23	84.78
26.	$N_3S_3D_1$	4	250	50	79.88	82.54	86.39
27.	$N_3S_3D_2$	4	250	75	80.26	83.75	87.29

*R1, R2 and R3 represent replications

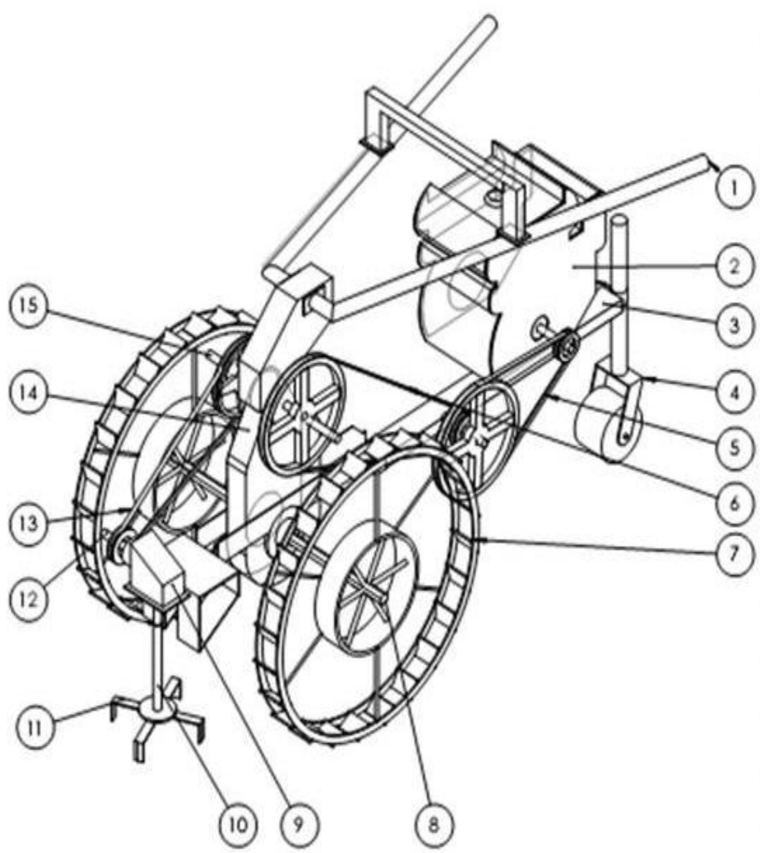
Table.3 ANOVA for weeding efficiency

S. No.	SV	DF	SS	MS	F
i.	Treatments	26	2237.20	86.04	49.23**
ii.	Number of blades (N)	2	1690.17	845.08	483.52**
ii.	Rotational speed of weeding rotor (S)	2	231.48	115.74	66.22**
iii.	Depth of operation (D)	2	41.68	20.84	11.92**
iv.	N × S	4	168.59	42.14	24.11**
iv.	S × D	4	14.81	3.70	2.11 NS
v.	N × D	4	44.23	11.05	6.32**
vi.	N × S × D	8	46.21	5.77	3.30**
vii.	Error	52	90.88	1.74	1
viii.	Total	80	3050.75	38.13	21.81

CV = 1.81 %   CD (0.05) = 0.82   CD (0.01) = 1.13

** Significant at 1 % level; * Significant at 5 % level; NS = Non Significant

Fig.1 Conceptual drawing of prototype walk behind engine operated weeder for upland crops



S. No.	Particulars
1	Handle
2	Engine
3	Base frame
4	Depth control wheel
5	Belt pulley drive (I reduction)
6	Belt pulley drive (II reduction)
7	Ground wheel
8	Hexagonal shaft
9	Bevel gear box
10	Weeding rotor
11	Weeding blade
12	Bevel gear input shaft
13	Belt pulley drive (III reduction)
14	Main gear box housing
15	Main gear box housing

Fig.2 Relationship between weeding efficiency and rotational speed of weeding rotor (S) for selected numbers of blades (N) at 25 mm depth of operation (D_1)

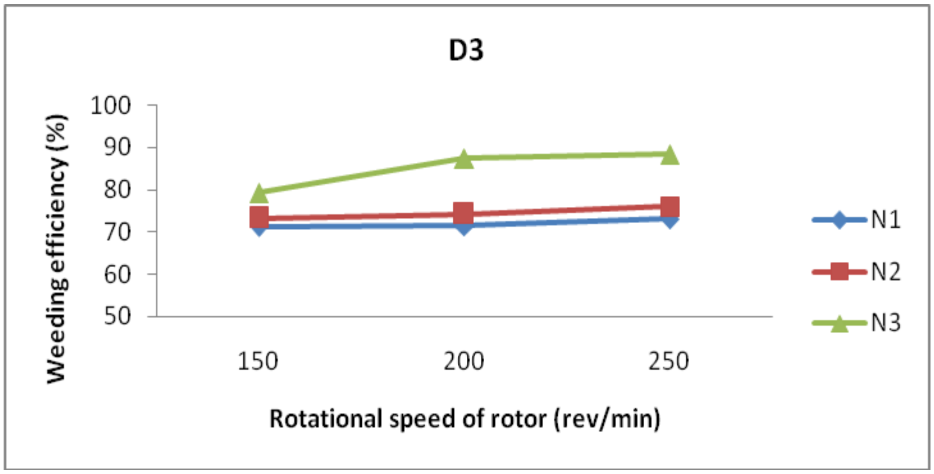


Fig.3 Relationship between weeding efficiency and rotational speed of weeding rotor (S) for selected numbers of blades (N) at 50 mm depth of operation (D_2)

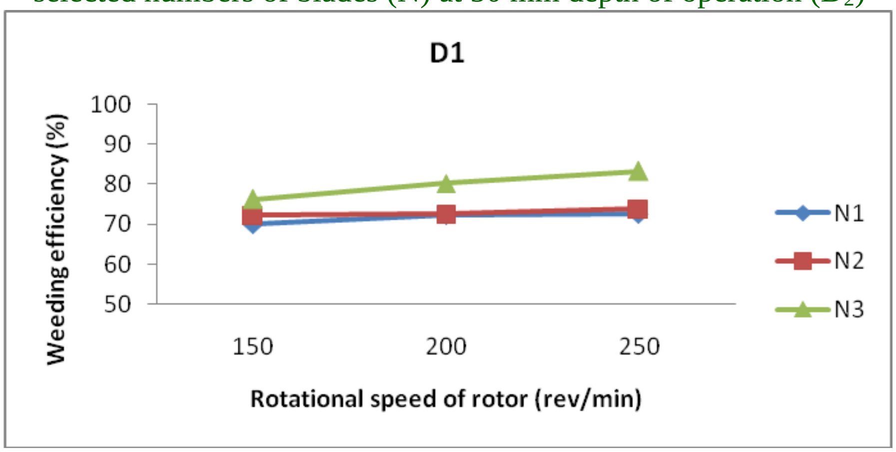
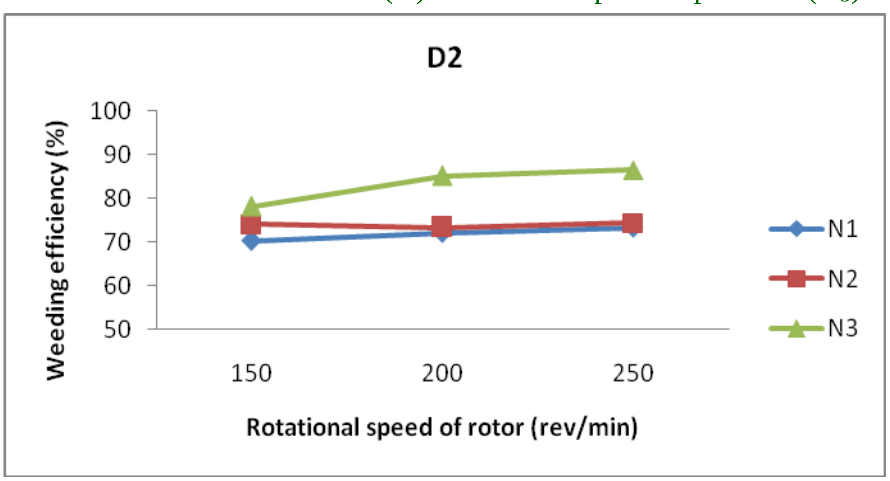


Fig.4 Relationship between weeding efficiency and rotational speed of weeding rotor (S) for selected numbers of blades (N) at 75 mm depth of operation (D_3)



The factorial analysis of the measured data was performed to assess the influence of the variables *viz.*, number of blades (N), rotational speed of weeding rotor (S) and depth of operation (D) on weeding efficiency.

The analysis of variance on weeding efficiency for the operation of weeder is furnished in table 3.

The main effects of number of blades (N), rotational speed of weeding rotor (S) and depth of operation (D) were significant at 1 per cent level of probability.

But the effect of combination of rotational speed of weeding rotor (S) and depth of operation (D) was non-significant.

In conclusion, a walk behind engine operated weeder for upland crops was developed from the optimized parameters and its field performance was evaluated for weeding in comparison with conventional method.

The effect of all the individual factors and the combined effect of different combinations of factors on weeding efficiency were statistically analysed.

The maximum weeding efficiency of 87.29 per cent was achieved with 4 number of weeding blades, 75 mm depth of operation at 250 rev/min speed of weeding rotor.

References

Gupta, J. P. and Pandey, K. P. 1996.Performance of rotary tiller tines under wetland condition. *Agricultural Mechanization in Asia, Africa and Latin America*, 27(1): 16-20.

Anonymous. 1998. Progress in irrigated rice research: selected papers and abstracts, International Rice Research Institute, 305.

Johnson D. E., Wopereisb, M. C. S., Mbodjb, D., Dialloc, S., Powersd, S. And Haefele, S. M. 2004. Timing of weed management and yield losses due to weeds in irrigated rice. *Field Crops Research*, 85: 31–42.

Behera, B. K., Swain, S. And Mohanty, S. K. 2007. Ergonomic evaluation of push-pull type weeders with women operators. *Journal of Agricultural Engineering*, 44(3): 39-43.

Dedousis, A. P. 2007. An investigation into design of precision weeding mechanisms for inter and intra-row weed control. Unpublished Ph.D. Thesis. Cranfield University, Silsoe.

Jinwu, W., Guixiang, T., Yongjun, L., Zhenwei, P. and Chunfeng, Z. 2014. Field experimental study on pullout forces of rice seedlings and barnyard grasses for mechanical weed control in paddy field. *International Journal of Agricultural and Biological Engineering*, 7(6): 1-7.

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