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RESEARCH ARTICLE

Performance evaluation of manual operated single row weeder for groundnut crop

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ABSTRACT

An experiment was conducted to evaluate the field performance of developed manual operated weeder was carried out at Department of Farm Machinery and Power of College of Agricultural Engineering and Technology, Junagndh. Various parameters such as field capacity, weeding efficiency, draft requirement and performance index of the weeder were considered during the test. The developed weeder can work up to 4.0 cm depth of operation with field capacity of 0.0285 ha/h. highest weeding efficiency was obtained (*i.e.* up to 80.42%). draft requirement was 34.4 kg for 20 cm width of the weeder and the performance index of the developed weeder was obtained 1210.53 .

KEY WORDS : Weeder, Weeding efficiency, Field capacity, Field performance

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INTRODUCTION

India is a vast country having agriculture sector as the backbone of its economy. India has total land acquisition of about 329 Mha out of which 166 Mha (Sahay, 2008) of land is under cultivation. The population of India is more than 110 crore and is increasing day by day at an alarming rate. Hence, it is required to produce more food to meet the needs of growing population. This can be achieved only by either increasing the land under cultivation or by adopting the farming techniques which would increase the crop yields. As it is not possible to increase the land under cultivation, the left option is to increase the crop yield. The yield of crop can be increased by using HYV (high yield variety) seeds, using proper agricultural practices and by preventing yield loss due to natural factors like weeds, insects, rodents, etc. Out of these factors weeds is one of them and which is quite important. The qualitative and quantitative crop production depends upon the effectiveness and timeliness of weeding; as weeds are biggest crop enemy which causes 45 per cent of annual yield loss as compared to the disease as 20 per cent, insects as 30 per cent and pest as 5 per cent (Mungale, 2007). The losses due to weeds are Rs. 19800 million per year (Mukhopadhyay, 1992).

Weeds are unwanted and undesired plants which grow among the field crops. It interfere and compete with main crop for their existence which causing serious yield loss by share in land, water, nutrients, sun light, and available CO_2 for main crop (Rao, 1999). Weeds waste excessive proportions of farmers' time, thereby acting as a brake on development. Weeding is one of the most important farm operations in crop production system. Weeding is an important but equally labour intensive agricultural unit operation. Weeding accounts for about 25 per cent of the total labour requirement (900–1200 manhours/hectare) during a cultivation season (Yadav and Pund, 2007). In India this operation is mostly

performed manually with khurpi or trench hoe that requires higher labour input and also very tedious and time consuming process. Moreover, the labour requirement for weeding depends on weed flora, weed intensity, time of weeding and soil moisture at the time of weeding and efficiency of worker. Weeds compete with crop plants for nutrients and other growth factors and in the absence of an effective control measure, remove 30 to 40 per cent of applied nutrients resulting in significant yield reduction (Goel *et al.*, 2008). There is an increasing concern over the intra row weeder because of environmental degradation and growing demand for the weeding operation there is an increasing concern over the intra row weeder because of environmental degradation and growing demand for thefood. 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. The most common methods of weed control are mechanical, chemical, biological and cultural methods. Out of these four methods, mechanical weeding either by hand tools or weeders are most effective (Manjunatha *et al.*, 2014). But mechanical methods and intercultivation using agricultural implements are being practiced in many regions. Weeding with the indigenous tools of an 'khurpi' and a spade and with the improved tool (3-tine hoe) could be rated as 'moderately heavy' work. A 'khurpi' demanded less energy expenditure than a 3-tine hoe followed by a spade. For higher output, the order was spade, 3-tine hoe and 'khurpi' whereas, for weeding efficiency it was just the reverse.

In the Saurashtra weeding is done manually by hand sickle. Manual weeding is precise but requires about 250 man-hours to cover 1 ha land. Due to acute shortage of labour in peak seasons, weeding operation cannot be carried out within short duration. Moreover, the operation is cumbersome causing drudgery due to awkward posture of working to the operator. It induces back pain and may lead to musculoskeletal disorder (Rainbird and Neil, 1995). Tractors are used for interculturing and other light operations like spraying, dusting, etc. in the standing crops. Many times they are not suited for such operations due to higher weight and large turning radius which results in compact the soil and damage the standing crops. Moreover, the interculturing is an important operation for removing the weeds and to prevent their further growth. Generally, 2 to 4 interculturing operations are performed depending upon soil and plant conditions. Animal power is also plays an important role in mechanical control of weeds in Indian agriculture. Traditional animal drawn harrow made by the village artesian are widely used due to their simplicity of construction and lower in cost. Shallow tillage and weeding operation are practiced repeatedly in black soils with animal drawn straight blade harrow to remove the weeds during monsoon. The maintenance of the pair of bullock has also become costlier now-a-days. So, the use of animals in agriculture is declining day by day. Manually operated weeders available in India are not used in Gujarat, as they are not suitable for the region. Keeping in views the problem of weeds in row crops such as groundnut crop, faced by farmers, to requires modifications.

EXPERIMENTAL PROCEDURE

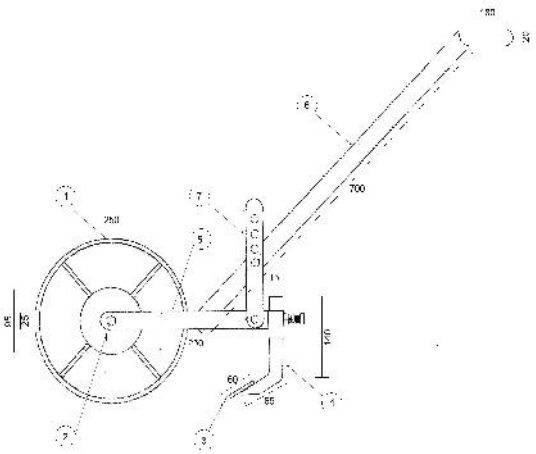
The constructional details, design and fabrication of different component of row crop weeder. The elevation and plan of the developed weeder is shown in Fig. A and Fig. B. The constructional details and main components of the weeder are ground wheel, ground wheel shaft, blade, prong, main frame and handle have been explained below. And also evaluate the performance of the developed manually operated row crop weeder in the field with respect to the row spacing, plant damage, efficiency of the weeder. The important observation like condition of the field, draft, power requirement, time required, work output, quality of work, travel speed and operation of weeder have been explained below :

Ground wheel :

There are two ground wheels. They are fabricated from mild steel bar of 12 mm diameter. The diameter of each ground wheel was kept 250 mm. The spokes are provided in the wheels for attaching the hub of 35 mm diameter with the help of washers with inner diameter of 35 mm and outer diameter of 95 mm.

Ground wheel shaft :

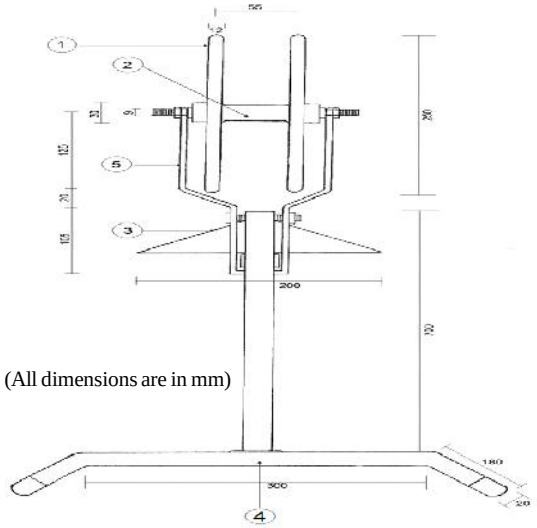
It is made of mild steel bar of 9 mm diameter and 160 mm length. The threads are provided on both the ends to fix



(All dimensions are in mm)

Elevation : 1. Ground wheel, 2. Ground wheel shaft, 3. Blade, 4. Prong, 5. Main frame, 6. Handle, 7. Adjusting support

Fig. A : Row crop weeder (elevation)



(All dimensions are in mm)

Plan : 1. Ground wheel, 2. Ground wheel shaft, 3. Blade, 4. Handle, 5. Main frame

Fig. B : Row crop weeder (plan)

the main frame.

Blade :

It is made of cast iron. It is V-shape with angle of 1250. It serves two purposes first to minimize the root damage and second provide sliding action so root may not stick to the blade. The width and length of the blade are 60 mm and 200 mm, respectively. The complete assembly of the cutting blade is shown in Fig. C. It is designed to work in the soil under the interaction of different soil forces. Therefore the metal selected is strong enough to sustain the prevailing forces, as well as to support the load of the implement. The blade is sharpen at the lower end so it can penetrate into the soil at proper angle and desired depth during weeding. The blade is attached to the prong at an angle of 1400.

(All dimensions are in mm)

Fig. C : Cutting blade assembly

Prong :

It is made of mild steel square bar and size of the bar is 200 × 15 × 15 mm. The blade is fixed at the one end of the prong and on the other end marks are provided at 10 mm, 25 mm, 40 mm and 55 mm from the top of the prong on back side to fix the nut so that desired depth can be obtain.

Main frame :

It is fabricated from two mild steel flat of 250 × 25 × 5 mm. It is bent in such a way that the outer ends of frame are kept at 110 mm and inner ends are kept at 35 mm. At outer end main shaft is bolted and at inner end provision of handle and adjusting support is made.

Handle :

It is most important part of the weeder. It is fabricated from the galvanized iron pipe of 700 mm length and 20 mm outer diameter. It is bent from both the sides with 180 mm at an angle of 400. The desired height of the handle from the ground surface is obtained with the adjusting support. The handle is joined to the main frame with the help of handle pipe. Rubber grips are provided at both the ends of pipe for comfort handling. The average weight and stature of weeder operator was 55.25 kg and 163.12 cm, respectively (Yadav and Pund, 2007), respectively.

Test condition :

The test condition of the field were considered like type of field, length and width of the field, area of the field, soil moisture content and soil type. The condition of weed is also taken in to consideration in terms of type of weed, root zone depth of weed, density of weed. The condition of crop is also considered in terms of variety, row spacing, age in days, plant population per meter square of area and height of plant.

Field performance of developed weeder :

Field test was carried out and the performance of the developed weeder was evaluated. Field Testing of the Weeder shown in Fig. D. The different performance test like speed of travel, field capacity, draft of weeder, weeding efficiency, power requirement and performance index were calculated.

Speed of travel :

For calculating the speed of travel, a distance of 150 m was fixed and the time to cover this distance is noted. For measuring the speed of travel, the implement was started well before the first pole marker and it was ensured that the speed was uniform throughout the marked space and then implement was operated in 150 m distance. A stop wa**t**ch was used to record the time taken by the implement to travel the marked distance during operation and the speed of travel was calculated in terms of meter per minute or meter per second.

Field capacity :

The field capacity of the weeder was calculated by fixing the area of 300 m^2 which has the 150 m length and 2 m width was recorded. The field capacity was determined in terms of hectare per hour (ha/h).

Depth of weeding :

The depth of the developed weeder was measured in the field and it was found 4.0 cm. This weeding depth (4.0 cm) is appropriate for shallow work. Measurement of depth of cut shown in Fig. E. The depth of weeding is a parameter, which plays an important role for the draft of the weeder.

Draft of the weeder :

In order to measure the draft of the weeder which was push type, the different parameters like soil resistance, width and depth of cut. Draft is an important parameter of the developed weeder and it must be within the physical limit of the operator. At experimental site soil type found Clay loam, moist. With using soil resistance in the range of 0.43 – 0.50 (kg/cm^2) (Wilkinson and Braunback, 1977).The draft was calculated by the following expression;

$$\mathbf{P = W \times d_w \times R_s}$$

where, P = Draft of the weeder (kg)

Fig. D : Field testing of the weeder

Fig. E : Measurement of depth of cut

W = Width of cut (cm)
d_w = Depth of cut (cm)
R_s = Soil resistance (kg/cm^2)

Weeding efficiency :

The weeder is tested on the same field to determine weeding efficiency . The weeding efficiency was calculated by the following mentioned expression and parameters;

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

where, e = Weeding efficiency (%)
W_1 = number of weeds before weeding
W_2 = number of weeds after weeding

Power requirement :

The power input required for weeding operation was calculated by considering the parameters like draft and traveling speed.

$$\text{Power input (hp)} = \frac{\text{Draft (kg)} \times \text{traveling speed (m/s)}}{75}$$

Plant damage :

The test was conducted to find out the per cent of the plant damage that taken place during the field operation. Yadav and Pund (2007).

The per cent plant damage was calculated by the following expression

$$\text{Percentage plant damage} = \frac{q}{p} \times 100$$

where, q= Number of plant damaged in 10 m row length after weeding
p= Number of plant damaged in 10 m row length before weeding

Performance index :

The performance index of the weeder was computed as; Gupta (1981)

$$PI = \frac{a \times e \times r}{P}$$

where, PI = Performance index
a = Field capacity of weeder (ha/ h)

e = Weeding efficiency (%)
r = Per cent plant damage
P= Power input (hp)

EXPERIMENTAL FINDINGS AND ANALYSIS

The findings of the present study as well as relevant discussion have been presented under the following heads :

Suitability of developed weeder :

The developed manually operated row crop weeder is easy to operate and suitable for shallow weeding up to the depth of 4.0 cm. The developed weeder is not only suitable for groundnut crop but it can also be used for other crops as row spacing can be adjusted. As far as physiological aspect is concern one can operate it easily as handle height and angle can be adjusted as per operator requirement.

Speed of travel :

It is very important parameter of the weeder performance evaluation. The test was conducted by selecting certain fixed distance say 150 m and the time was noted to travel this distance. Five readings of travel speed were taken and average travel speed was calculated and listed in the Table 1. The average travelling speed is 25.17 m/min. The increase in travelling speed of the operator reduces the walking time.

Table 1 : Speed of travel of manual operated weeder

Sr. No.	Distance covered (m)	Time taken (min)	Traveling speed (m/min)	Average (m/min)
1.	150	5.94	25.25	
2.	150	6.02	24.91	
3.	150	5.98	25.08	25.17
4.	150	5.91	25.30	
5.	150	5.92	25.33	

Field capacity :

The field capacity of developed weeder was calculated by selecting a respective three plots of size 150 × 2 m. The weeder was operated in these plots and the different observations were recorded. The observations are presented in Table 2. The theoretical field capacity of the developed weeder was calculated about 0.0285 ha/h. The different paddy weeders developed by Behera (1996) has the field capacity ranged between 0.010 ha/h to 0.014 ha/h. Hence, we conclude that the developed groundnut weeder have more field capacity (0.016 ha/h) as compared to paddy weeders developed by Behera (1996). Field capacity is directly affected by cutting width and the physical condition of the operator. If the effective cutting width is reduced than field capacity is also reduced.

Table 2 : Field capacity of manual operated weeder

Plot No.	Area of plot (m^2)	Time to cover this area (min)	Field capacity (ha/h)	Average (ha/h)
1	300	61.5	0.029	
2	300	63.0	0.028	0.0285
3	300	62.1	0.029	

Weeding efficiency :

The weeding efficiency test was performed on selected plot at the different locations. And the respective readings were noted and reported in Table 3. Average value of the weeding efficiency was found to be 80.42 per cent. It can be concluded that the weeder is efficient because efficiency is more than80 per cent and also easy in operation.weeder was calculated and it was about 1210.53. As in case of manually weeders for paddy crop, developed by Behera (1996), the

Table 3 : Weeding efficiency of manual operated weeder

Sr. No.	Area (m^2)	No. of weed before weeding (W_1)	No. of weed after weeding (W_2)	Weeding efficiency (%)	Average (%)
1.	0.9	60	12	80	80.42
2.	0.9	93	17	81.72	
3.	0.9	75	13	82.66	
4.	0.9	120	26	78.32	
5.	0.9	102	21	79.45	

maximum performance index was reported 1052.05. Wedding efficiency differs in every test codes located in the field. It depends on the root zone depth of weeds, shape of the blade, moisture content of soil at testing site and cutting depth of the weeder blades.

Draft of the weeder :

Draft is an important parameter of the developed weeder and it must be within the physical limit of the operator. The average draft obtained is 34.4 kg. Draft value depends on the types of soil, in which tool is used, effective cutting width and depth of cut. In manually operated weeder the tool works in a shallow depth so the soil resistance has a little impact on draft requirement of the tool. If the draft is to be reduced then we have to reduce the effective cutting width. Depth of weeding 4 cm was maintained during the testing. In the field, maximum weed root zone was found within 3-5 cm. If we reduce the depth then weeding efficiency can also be reduced and on the other side the weeding will not be proper because of less depth covered.

Power requirement :

The average power requirement for developed row crop weeder was estimated to be 0.19 hp and the complete data are presented in Table 5. If we want to reduce power value then one can reduce it by reducing effective width of cut and subsequently field capacity is also reduced.

Performance index :

After going through all detail tests, the performance index was prepared to know the overall performance of the weeder. It is the function of weeding efficiency, field capacity, power input and plant damage. During field test no plant damage was observed. The performance index of the developed weeder was calculated and it was about 1210.53. As in case of manually weeders for paddy crop, developed by Behera (1996), the maximum performance index was reported 1052.05. And also found that no plant damage during weeding operation.

Conclusion :

Test result indicates a clear view for adopting this design of manually operated row crop weeder because it is easy to operate and outcome of weeding efficiency is also satisfactory. The developed weeder can work up to 4.0 cm depth of operation with field capacity of 0.0285 ha/h. Higher weeding efficiency was obtained (*i.e.* up to 80.42%) The performance index of the developed weeder was obtained 1210.53. The draft requirement was 34.4 kg for 20 cm width of the weeder. Develop such type of weeder for row crop and assess functional suitability and weeding efficiency, to increase the productivity per unit area of small land holdings of farmers and considering their economic condition.

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