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Development and evaluation of manually operated sprocket weeder

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ABSTRACT : A manually operated sprocket weeder was developed and evaluated for its performance. Various parameters such as weeding efficiency, plant damage, field capacity, draft and power input of the weeder were considered during the test. The sprocket weeder was developed by using inexpensive bicycle components. The major parts of the weeder consisted of the front portion of a bicycle namely handle bar, front axle, sprocket, wheel hub, fork and galvanized iron pipe. V-shaped blade made from hardened steel was attached to the fork with the help of U-clamp which is adjustable. The results showed that, the weeding efficiency of the sprocket weeder was found to be 94.5 % with a field capacity of 0.032 ha/h with a time saving of 84 per cent. The cost of operation was found to be Rs. 375/ha with a saving of 79.16 per cent compared to traditional method. It was also observed that, there was no plant damage while carrying out the weeding operation with the sprocket weeder.

KEY WORDS : Field capacity, Manual weeder, Plant damage, Weeding efficiency

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Ever since man started growing crops, he had come up with the problems of weeds, which are undesirable growth of a farm. Farmers and researchers are putting up a combined front to tackle the menace of weeds (Rajshekar, 2002). A weed is defined as "any plant growing where it is not wanted" (Anderson *et al.*, 1996). Weed is usually characterized by rapid growth, and it typically replaces other more desirable plants. Weeding and hoeing is generally done 15 to 20 days after sowing. Depending upon the weed density, 20 to 30 per cent loss in grain yield is quite usual which might increase up to 80 per cent if adequate crop management practice is not observed as reported by Goel *et al.* (2008).

In India about 4.2 billion rupees are spent every year for controlling weeds in the production of major crops. At least 40 million tonnes of major food grains are lost every year due to weeds alone (Singh and Sahay, 2001). Therefore, timely weeding is very much essential for a good yield. There are four general methods for weed control *viz*. physical, cultural, mechanical and biological. Mechanical weeding is preferred to chemical weeding because weedicides application is generally expansive, hazardous and selective. Besides, mechanical weeding keeps the soil surface loose by producing soil mulch which results in better aeration and moisture conservation (Duraisamy and Tajuddin, 1999).

Some researchers have carried out a study on development and evaluation of manual weeders in order to control the weeds with low cost and effective for marginal farmers who are affordable to maintain bullocks. Yadav and Pund (2007) developed and evaluated manually operated weeder. They reported that, the weeding efficiency of the developed weeder was satisfactory and it was easy to operate. The developed weeder could work up to 30 mm depth with field capacity of 0.048 ha/hr and higher weeding efficiency was obtained up to 92.5 %. Soil moisture of 11.63 per cent was found to be optimum for weeding in groundnut crop and the cost of operation of developed weeder at this soil moisture content was found to be Rupees 244.00 as against Rupees 2450.00 per hectare in conventional method of weeding by using trench hoe (Goel *et al.*, 2008).

There are many types of hand weeders available in India. All the available weeders are region specific to meet the requirements of soil type, crop grown and cropping pattern. Therefore, effort has been made to develop the manual operated sprocket weeder and to evaluate its performance.

■ METHODOLOGY

Manually operated sprocket weeder was developed by using inexpensive bicycle components. The major parts of the weeder consist of the front portion of a bicycle, namely handle bar, front axle, sprocket, wheel hub, fork and galvanized iron pipe. One end of the galvanized iron pipe was attached to the handle bar with the help of nut and bolts; another end was welded to the fork. Two numbers of bicycle sprockets with the diameter of 180 mm were attached to the wheel hub and it was fitted on the fork with the help of axle. A piece of mild steel flat was welded on the fork and U-clamp was provided on the M.S flat for weeding tool attachment. A V-shaped blade made from hardened steel was welded on the tyne and it was attached to the fork with the help of U-clamp. The height of the handle at an angle of 36^0 with horizontal was 930 mm. The height and angle can be adjusted as per the need of operator to suit his posture. The detail specification of sprocket weeder was provided in Table A.

Table A : Specifications of manually operated sprocket weeder

Sr. No.	Parameters		Description
1.	Overall dimensions, mm		
		Length	1400
		Width	570
		Height	930
2.	Weight, kg		4.5
3.	Diameter of bicycle sprocket, mm		180
4.	Diameter of wheel hub, mm		30
5.	Length of G.I pipe, mm		800
6.	Length of bicycle fork, mm		550
7.	No. of weeding elements/tynes		1

The manually operated sprocket weeder was tested in the field condition (Fig. A) to evaluate its performance and the following results were analysed and compared with traditional method (Khurpi). Three trail plots of 15 x 15 m size were selected in groundnut field and replicated thrice. Soil samples were collected from each test plots with the help of soil sampling auger and analysed by standard gravimetric method. Moisture content on dry basis has been calculated from the formula :

Fig. A : The weeding operation by sprocket weeder

$$\text{Soil moisture content (\% dry weight basis)} = \frac{W_1 - W_2}{W_2} \times 100$$

where,

W_1 - Weight of wet soil sample, kg

W_2 - Weight of the oven dried soil, kg.

Cone index is an indication of soil hardness and is expressed as force per square centimeter required for a cone to penetrate into soil. Cone index in the soil varies with cone apex angle and area of cone bottom. A standard cone penetrometer was used to determine the cone index. Bulk density is the mass after oven drying of soil of a unit volume. For measurement of bulk density of soil, cylindrical core samples of soil from at least three randomly selected locations were taken. Then the diameter and length of cylindrical soil sample were measured. The core sample was kept in hot air oven maintained at 105°C for 8 hours. Then the weights of cooled soil samples were noted down. The bulk density of soil sample was determined by using following expression.

$$\text{Bulk density of soil sample} = \frac{M}{V}$$

where,

M = mass of oven dried core soil sample, g

V = volume of cylindrical core sample, cc.

The draft required by the weeder was calculated by using following expression

$$D = W \times d_w \times Rs$$

where,

D =Draft of a weeder, (kg)

W = Width of cut, (cm)

d_w =Depth of cut, (cm)

Rs = Soil resistance, (kg/cm^2).

The power input required for weeding operation was calculated by considering draft and travelling speed by using following equation

$$\text{Power (hp)} = \frac{(D \times S)}{75}$$

where,

D = Draft, kg

S = Travelling speed, m/sec.

Number of weeds in 1 m^2 area was counted before operation and number of weeds left after operation were recorded and average of such three readings were counted and taken for calculating the weeding efficiency by the following expression (Padole, 2007).

$$\text{Weeding efficiency, (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

where,

W_1= number of weeds counted before operation, per square meter

W_2= number of weeds counted after operation, per square meter.

Plant damage was calculated by counting the number of plants in 10 m row length before weeding and number of the plant damaged in 10 m row length after weeding. The plant damage was calculated by following expression (Yadav and Pund, 2007).

$$\text{Plant damage}, (\%) = (1 - \left(\frac{q}{p}\right) x\, 100)$$

where,

q = number of plants in a 10 m row length after weeding

p = number of plants in a 10 m row length before weeding.

For calculating effective field capacity, the time consumed for actual work and lost for other activities were recorded by using stop watch. The following expression was used to calculate the effective field capacity of the weeder:

$$\text{E.F.C.} = \frac{A}{T_p + T_1}$$

where,

E.F.C. = effective field capacity, ha/h

A = area, ha

T_p = productive time, h

T_1= non productive time, h.

RESULTS AND DISCUSSION

The groundnut crop was about 30 days old at the time weeding having a row-row spacing of 400 mm. The average soil moisture content of the soil was 10.2 % at the time of weeding. The average plant population per square meter area was 20 and average height of plant was 25 cm. The field trials were conducted as per RNAM and BIS test codes and procedures and results are given in Table 1. The following treatments were selected for conducting field evaluation trials.

T_1 = Weeding by using hand khurpi

T_2 = Weeding by using sprocket weeder.

Field capacity:

The average operating speed was found to be 18 m/min. The field capacity of the developed weeder was found out to be 0.032 ha/h, which was higher compared to hand weeding by Khurpi with a field capacity of 0.005 ha/h (Table 1). Garg and Sharma (1998) also reported that area coverage with wheel and hoe in wheat crop was 0.36 ha/day which was much faster than 'Khurpi' 0.064 ha/day. The field capacity of this developed weeder was also superior as compared to traditional method. The wide difference in field capacity of different tools/ implements is because of the width of soil cutting parts *i.e.* blade of the implement as well as forward speed. Besides having the larger operating area, sprocket weeder facilitates the worker to provide easy push and pull action to the implement as compared to khurpi. Apart from this by using khurpi, operator will be in sitting posture and the forward speed is quite less, which accounts the minimum field capacity of 'Khurpi' during weeding operation.

Table 1 : Field performance of the manually operated sprocket weeder

Sr. No.	Description	Traditional method (Khurpi) T_1	Sprocket weeder T_2
1.	Soil moisture content, % (db)	10.9	10.2
2.	Bulk density before operation, g/cc	1.40	1.41
3.	Bulk density after operation, g/cc	1.38	1.37
4.	Cone index before operation, kg/cm^2	1.24	1.27
5.	Cone index after operation, kg/cm^2	1.14	1.15
6.	Weeding efficiency, %	96	94.5
7.	Plant damage, %	0.67	Nil
8.	Effective working width, cm	15	30
9.	Average working depth, cm	2.5	4.0
10.	Draft requirement, kg	--	30.0
11.	Effective field capacity, ha/h	0.005	0.032

Table 2 : Cost economics comparison of developed weeder and Khurpi

Sr. No.	Particulars	Traditional method (Khurpi) T_1	Sprocket weeder T_2
1.	Cost of operation, Rs/h	9	12
2.	Cost of operation, Rs/ha	1800	375
3.	Saving in cost when compared to treatment T_1 (%)	---	79.16
4.	Saving in time when compared to treatment T_1, (%)	---	84.00

Weeding efficiency and plant damage:

The average weeding efficiency for the developed weeder was found to be 94.5 %, which shows that the weeder is efficient (Table 1). It was observed that, the weeding efficiency depends on shape of blade, moisture content of the soil at testing plot and cutting depth of the weeder blade. The weeding efficiency by using Khurpi was found to be 96 % which was at par with sprocket weeder. The maximum weeding efficiency with 'Khurpi' was observed because of the capability of this hand tools to work between plant to plant spaces in a row. No plant damage was observed in developed weeder whereas for Khurpi it was found to be 0.67%. The plant damage with Khurpi was occurred while working between plant to plant spaces.

Draft and power requirement:

The draft and power requirement are the important parameters for the development of weeder and they must be within the physical limit of the operator. The average draft and power requirement the weeder were found to be 30 kg and 0.12 hp, respectively. The power requirement was little bit higher because of higher width of cut. Further, it was concluded that if one want to reduce the power requirement, reduction in effective width of cut is needed which subsequently reduces the field capacity of the weeder.

Cost economics:

The values of cost of operation in terms of Rs./h and Rs./ha, savings in cost and time of weeding operation using the hand khurpi and sprocket weeder are presented in Table 2. The cost of operation of developed weeder and by traditional method was found to be 375 Rs./ha and 1800 Rs/ha, respectively. As weeding is a labour consuming process and because of minimum field capacity of Khurpi, the cost of operation of khurpi for weeding was maximum.

Conclusion:

The sprocket weeder can be easily fabricated by farmers themselves with low cost by using inexpensive bicycle materials. The weeding efficiency of the sprocket weeder was found to be 94.5 %. The sprocket weeder could work up to 4 cm depth. No plant damage was occurred during weeding operation with the sprocket weeder. The field capacity of the sprocket weeder was found to be 0.032 ha/h. The saving in time and cost was 84 % and 79.16%, respectively. It can be operated easily by farmers or unskilled labours. It is most economical and effective for marginal farmers who are affordable to maintain bullocks.

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