Design and Development of Manually Operated Disc Weeder for Garlic Crop

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ABSTRACT
Weeding is an important operation for increasing the productivity of farm. For small land holdings and considering economic condition of Indian farmer, manual operated weeder is most suitable. The major Garlic producing states of India are Madhya Pradesh, Gujarat, Uttar Pradesh, and Rajasthan which produce 80% of the country's garlic. In garlic weeding operation is done manually by khurpi and wheel hoe. Manual weeding is precise but requires about 900- 1200 man-hours/hectare. Due to acute shortage of labour in peak seasons, weeding operation is difficult to carry out within short stipulated. With regard to this, a manually operated weeder was developed and tested. The weeding disc was made from iron plate and circular with a diameter of 30mm outer diameter. The desired height of the handle from ground surface is obtained with the adjusting and fixed with nuts & bolt at 0.961 m height. The developed garlic disc weeder was tested under different moisture % present in soil

KEYWORDS
Garlic, Disc weeder, Weeding

1. INTRODUCTION
India is primarily an agricultural country. The major occupation of the Indian rural people is agriculture, and both men and women are equally involved in the process. Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. About 54.6 % of the population is engaged in agriculture and allied activities (Census 2011), and it contributes 17.4 % to the country's gross value added. Besides, agriculture is an important source of raw materials for industrial production and serves as a huge market for industrial products. As per the land use statistics 2013-2014, the total geographical area of the country is 328.7 million hectares, of which 141.4 million hectares is the reported net sown area and 200.9 million hectares is the gross cropped area, with a cropping intensity of 142%. The net irrigated area is 68.2 million hectares and the gross cropped area in India is 194.4 million hectares (59.14 % of the total geographical area).

Mechanization is the replacement of old and traditional tools or equipment by modern tools with the view of reducing (saving) time, labor costs, and energy. This is the basic principle of mechanization. The overall level of farm mechanization in India is 40-45 percent. The garlic family is Amaryllidaceae and the botanical name *is* Allum sativan Linn. India is the second

largest producer of garlic in the world after China. It is grown and used as a spice or condiment throughout India. According to the National Horticulture Research and Development. Foundation (NHRDF), India's garlic area, production, and productivity were 3.16 lakh ha, 1.61 MT, and 5.08 t/ha in 2017–2018 (NHRDF, 2020). As per the Directorate of Onion and Garlic Research (DOGR), there is a need to increase garlic production to 1.79 million tones and the productivity of garlic in India. In India, the annual loss due to weeds in food grains is about 82 million tonnes and commercial crops are about 52 million tonnes (P.K. Singh, 2013). Weeding is a timeconsuming and labor-intensive operation that accounts for approximately 25% of total labor required (900-1200 man-hours/hectare) (Yadav and Pund, 2007).

As far as Indian scenario is concerned, more than 75% of farmers belong to small and marginal land holdings. Because average Indian farmers' economic conditions are poor, they cannot afford large-scale automatic labor-free mechanization of their farms. In this agriculture sector, out of the different field operations, weeding is an important operation to be performed by the farmer to protect cultivated crops from weeds and unwanted plant. The growing concern to control agricultural products is increasing speedily in many developing countries like India. The quality and quantity of crops yield depends upon effective and timeliness of weed removal from the field. Weeds causes highest annual yield loss of about 45 % compared to 3 dieses (20 %), insects (30 %) and pests (5 %) (Gupta et al., 2014). Depending on weed intensity 20-30 % loss in yield quite usual, if crop management practices are not followed properly (Gill and Kollar, 1981). Weeds are unwanted and undesired plants, which compete with the main crop in the field for space, water & plant nutrients and adversely affect the micro-climate around the plant and removes 30-40 % of applied nutrients (Behera et al., 1996; Rao, 1999; Nojavan, 2001).Manual weeding can give hygienic weeding but if a strenuous is process (Biswas, 1990).

2. MATERIALS AND METHOD

2.1 EXPERIMENTAL SITE

The study was conducted in sku , situated at 25.4137o North latitude and 81.8491o East longitude with an altitude of 95.097 meter above mean sea level. This district lies in the southern part of the state in the genetic plain and adjoining Vindhyan Plateau of India. The operational field meant for study was selected from the demonstration/research field of faculty

2.2 CLIMATE AND WEATHER CONDITIONS

The climate is typical version of a humid subtropical climate that is common to cities in north-central India. Prayagraj experiences three seasons: hot dry summer, cool dry winter and warm humid monsoon. The summer seasons lasts from April to June with the maximum temperatures ranging from 40o C (104o F) to 45o C (113o F). Monsoon begins in early July and lasts till September. The winter season lasts from December to February. The average rainfall of the district is 960 mm and the monsoon season is spread between July-September.

2.3 PERFORMANCE EVALUATION OF FABRICATED MACHINE

Study on the field performance was carried out to obtain actual data on over all machine performance and work capacity in the actual field conditions. The weeding operation was carried out in row. sown garlic at row - row spacing of 15 cm. The plant and weed population was counted before and after the operation. The machine performance parameters such as weeding efficiency, Plant damage, Actual field capacity, Theoretical field capacity, field efficiency of the weeder were determined as follows

2.4 FIELD TEST

2.4.1 FIELD PARAMETER

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 into consideration in terms of type of weed, root zone, depth of weed, and density of weed. The condition of crop is also considered in terms of variety, row spacing, plantpopulation per meter square of area and height of plant.

2.4.2 SPEED OF OPERATION

To determine the travel speed of the machines during weeding operation, the time required for covering 10 m row length was recorded. Data were recorded in each plot at different place at different level of moisture content in soil and average value was taken. A digital stop watch was used to record the time in seconds to cover 10 m distance by weeder. (RNAM procedure).

Speed(km/h) =Distance (m)/time(s)×3.6

Table:2.1 Selected anthropometric and strength data of Indian agriculture workers.

S.No.	Parameters	Male (N=236)			Female (N=236)		
		Mean	Percentile Value		Mean	PercentileValue	
			5th	95th		5th	95th
	Anthropometric data						
1.	Age, years	29.7	19.0	50.0	33.5	20	50
2.	Weight, kg	51.6	42.0	63.0	45.6	35.5	59.3
3.	Stature, cm	164.6	155.3	174.6	151.3	142.7	159.7
4.	Eye height, cm	154.9	144.8	164.7	141.2	132.4	149.7
5.	Acromial height, cm	137.2	128.4	146.2	126.2	118.2	133.9
6.	Elbow height, cm	104.7	97.5	111.4	96.0	89.9	102.3
7.	Lliocrystale height, cm	97.7	90.3	105.0	91.3	84.2	98.3
8.	Metacarpal III height, cm	70.2	64.5	76.2	65.3	60.1	71.0
9.	Grip diameter(inside), cm	5.3	4.6	6.0	4.8	4.3	5.4

	Strength data						
10.	Hand grip strength(right) N	416.9	254.1	588.6	226.6	98.1	342.4
11.	Push strength (both hands)	256.0	172.7	351.2	183.4	126.5	246.2
12.	Leg strength (height sitting, N	395.3	267.8	559.2	258.0	165.8	361.0
13.	Torque strength both hands (standing), N	208.0	154.0	265.9	166.8	115.8	220.7

Table:2.2 Brief specification disc weeder

S.No.	Details	Particulars
1.	Overall dimension (L x B x H) , (mm)	927 x 100 x 961
2.	Weight in (kg)	12
3.	Width of roller (mm)	100
4.	Diameter of roller (mm)	150
5.	Height of handle from ground , (mm)	950
6.	Length of handle (mm)	1000
7.	Diameter of disc (mm)	127
8.	No. of disc	8
9.	Space between disc (mm)	25
10.	No. of bearing	6
11.	Dimension of bearing 6001RS (mm)	12 x 28 x 8
12.	Diameter of shaft (mm)	10
13.	Length of shaft (mm)	160

3. RESULT AND DISCUSSION

3.1 GENERAL

This chapter deals with the results and discussion for design development and performance evaluation of the developed manually operated disc weeder with from mechanical point of view. A testing was conducted at the Department of Agriculture engineering, SKU Chhatarpur(M.P)

3.2 DETAILS CONSIDERATION FABRICATION OF DISC WEEDER

Disc weeder is developed at workshop of SKU Chhatarpur. It is medium range weight machine. It consists of base frame, handle, disc etc. This disc weeder can be used as a single push type operation.

3.3 DESIGN OF FRAME

The base frame was constructed hollow square pipe made up of Mild steel. The length of the frame 355mm & width of the frame 140mm. The base was designed to support handle, wheel & weeding disc. The handle, wheel, disc were attached to the base frame with the help of supporting M.S. plates, rod, nuts and bolts. When the operator pushes the weeder b/w the crops row, the wheel moves following it the disc penetrates into the soil. The disc at the pointcut and uproots the weeds. The way weeding operation is done

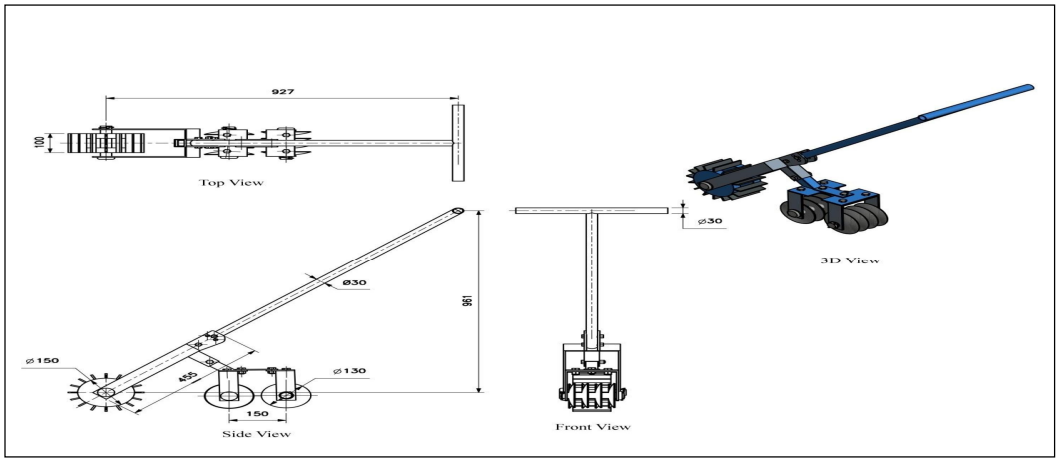

Fig: 3.1 Orthographic view of Disc weeder

Fig: 3.2 Pictorial view of Disc weeder

3.4 OPERATIONAL SPEED

The operational speed of weeder is different at different moisture content. The average operational speed of weeder at less than 5%, 5-10 %, 10-15 %, 15-20% moisture content is 1.9 km/h, 1.7 km/h, 1.5 km/h, 1.4 km/h.

Table:3.1 Field capacity and field efficiency of disc weeder (at <5% and 5-10% moisture content

S.No.	Replication	At <5% moisture content			At 5-10% moisture content		
		TFC (ha/h)	EFC (ha/h)	FE %	TFC (ha/h)	EFC (ha/h)	FE %
1.	R1	0.20	0.0185	92.36	0.20	0.0167	83.60
2.	R2	0.20	0.0181	90.46	0.20	0.0166	82.88

Table: 3.2 Field capacity and field efficiency of disc weeder (at 10-15% and 15-20% moisture content)

S.No.	Replication	At 10-15% moisture content			At 15-20% moisture content		
		TFC (ha/h)	EFC (ha/h)	FE %	TFC (ha/h)	EFC (ha/h)	FE %
1.	R3	0.20	0.0150	75.06	0.20	0.0141	70.56
2.	R4	0.20	0.0148	73.94	0.20	0.0138	69.07

3.5 WEEDING EFFICIENCY

The result of weeding efficiency at different moisture content in soil was analyses in tabular form as shown in table given below. The graphical representation is shown in figure.

Figure: 3.3 Before Weeding (1m x 1m)Figure: 3.4 After Weeding (1m x 1m)

Table: 3.3 Weeding efficiency of disc weeder (at <5% and 5-10% moisture content)

S.No.	Replication	At <5% moisture content	At 5-10% moisture content
		Weeding Efficiency (%)	Weeding Efficiency (%)
1.	R1	89.33	90.67
2.	R2	88.39	89.66

Table: 3.4 weeding efficiency of disc weeder (at 10-15% and 15-20% moisture content

S.No	Replication	At 10-15% moisture content	At 15-20% moisture content
		Weeding Efficiency (%)	Weeding Efficiency (%)
1.	R3	87.50	82.86
2.	R4	85.88	80.56

4. CONCLUSION

- To increase per unit area of small land holding of farmers and considering their economic condition. It is quite necessary to have suitable agricultural implements by which farmers can use.
- This manually operated disc weeder is also useful for 15 cm above wide row crops.
- With regard indicated a clear view for adopting this design of manually operated disc weeder for garlic crop, because it is easy to operate and outcome of weeding efficiency is also satisfactory. It is suitable to use at 15 -20 days of crop age in b/w about 15 cm.
- Test result indicated a clear view for adopting this design of manually operated disc weeder for garlic crop, because it is easy to operate and outcomes of weeding efficiency are also satisfactory.
- The higher Weeding efficiency was obtained (i.e. up to 90.67 %) at 5-10 % of moisture content.
- The higher disc weeder could work upto 2.5cm depth.
- No plant damage was occurred during weeding operation with disc weeder.
- The higher field capacity of the disc weeder was found to be 0.0185 ha/hr and field fficiency 92.36 % at < 5% of moisture content.
- Weeding with this machine reduces human drudgery, reduces labour, reduce time etc.
- It is most economical and effective for marginal farmer.
- The overall performance of weeder was satisfactory.

4.1 SUGGESTION FOR FUTURE WORK

- For removing stucked soil between Disc, scrapper can be attached as modification.
- It will be modified for multi crops as well as vegetables.
- Front Disc can be adjusted as modification.

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