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EVALUATING THE EFFICIENCY OF A MANUALLY OPERATED WEEDER FOR SUSTAINABLE AGRICULTURE AND WEED CONTROL IN INDIA

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Article Info

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Abstract

As a country with a predominantly agriculture-based economy, India faces the challenge of effectively managing weeds in agricultural operations. A manually operated weeder, designed for use by a single individual, was developed to address this issue. This study assesses the weeder's performance considering factors like field capacity, weeding efficiency, plant damage, operator speed, and field moisture content. Experiments were conducted in two fields, revealing a peak weeding efficiency of 81.8% and a minimum plant damage of 4.39%. The study determines that the weeder's efficiency is influenced by the operator's speed, with increased speed resulting in reduced weeding efficiency.

Introduction

Sustainable agriculture has become a major concern across the globe due to the increasing pressure on natural resources and the need to ensure food security for the growing population. One of the major challenges faced by farmers in India is the management of weeds, which significantly affect crop productivity and quality (Gupta et al., 2013). The use of herbicides has been the most common method of weed control, but it poses numerous environmental and health hazards (Kaur et al., 2017). Therefore, there is an urgent need to explore alternative weed management strategies that are effective, economical, and environmentally friendly.

In this context, mechanical weeding has emerged as a potential solution for sustainable agriculture and weed control. Mechanical weeding involves the use of various tools and machines for the physical removal of weeds from the crop fields (Rao et al., 2019). One such tool is the manually operated weeder, which is a simple, easy-to-use, and cost-effective option for small and marginal farmers in India (Bhosale and Raut, 2018). The manually operated weeder can be operated by a single person, requires minimal maintenance, and has been found to be efficient in controlling weeds in various crops such as rice, wheat, and maize (Dwivedi et al., 2016). However, there is limited research on evaluating the efficiency of a manually operated weeder for sustainable agriculture and weed control in India.

Therefore, the primary objective of this study is to evaluate the efficiency of a manually operated weeder for sustainable agriculture and weed control in India. Specifically, the study aims to assess the impact of manually operated weeder on weed density, weed biomass, crop yield, labor requirement, and cost of weed control. The

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findings of this study will contribute to the existing knowledge on alternative weed management strategies and support the promotion of sustainable agriculture in India.

In recent years, several studies have been conducted on mechanical weeding and its potential benefits for sustainable agriculture. For instance, Chauhan and Mahajan (2014) reported that mechanical weeding is an effective method for controlling weeds in rice fields, and it can significantly reduce the use of herbicides. Similarly, Kumar et al. (2016) found that the use of a mechanical weeder in wheat fields resulted in lower weed density and higher crop yield compared to the conventional method of hand weeding. These studies highlight the potential of mechanical weeding for sustainable agriculture and weed control.

However, there is a scarcity of research on the efficiency of manually operated weeders, especially in the context of Indian agriculture. A study by Bhosale and Raut (2018) reported that a manually operated weeder was efficient in controlling weeds in rice fields, but the study did not consider other crop types and did not provide a comprehensive evaluation of the weeder's efficiency. Furthermore, most of the existing studies on mechanical weeding have focused on the use of power-operated machines, which may not be suitable for small and marginal farmers in India due to their high cost and maintenance requirements (Rao et al., 2019).

This study aims to fill the research gap by evaluating the efficiency of a manually operated weeder for sustainable agriculture and weed control in India. The findings of this study will provide valuable insights for policymakers, researchers, and farmers to promote alternative weed management strategies and contribute to the achievement of sustainable agriculture goals in India.

Material and methods:

After developing manually operated weeder how it actual work is described here,

Experimental site

The study was conducted at Research Farm Jalgaon (Jamod). The field was carefully selected for conduction of the study. Developed manually operated weeder is operated for cutting of weed.

Material required

The following material is used for determining the different methods.

1. Measuring tape:

The long measuring tape is required for measuring the different dimension of developed weeder. **2. Stop watch:** Stop watch was required for calculating the speed of operator and also required to calculate theoretical speed of operator. Because the speed of operator is also affected by the weeding efficiency.

3. Weighing balance:

Weighing balance was required to record observations of weight of soil for calculating moisture content of soil.

4. Moisture boxes:

The aluminum moisture boxes were used for calculating the moisture content of soil.

5. Electric oven:

Electric oven is required for calculating moisture content of soil. It is important to calculate moisture content because it is affected by weeding efficiency.

Performance and evaluation of manually operated weeder 1. Moisture Content

Moisture content for soil sample is computed on dry basis. For measurement of soil moisture, take core samples of wet soil from at least three different locations randomly selected in the test plot. Record the weight of wet soil sample. Place the sample in hot air oven maintained at 105^0 C for at least 24 hrs. At the end of 24 hrs, place the sample for cooling in the in desiccators and note the observations of weight again. Calculate the soil moisture using the following formula (Veerangouda *et al.,* 2010).

$$Soil\ moisture\ \%\ (dry\ basis) = \frac{Wieght\ of\ wet\ soil\ sample\ (g) - Weight\ of\ dry\ soil\ sample(g)}{Weight\ of\ dry\ soil\ sample(g)} \times 100$$

2. Speed of operator:-

Speed of operator was calculated by putting two pole at two end of the field, opposite in direction. The operator travelled from starting point to end point. The observation of time required and distance travelled was recorded. The speed of operator was calculated by ratio of distance travelled to time required (Olaoye *et al.,*1990).

$$S = \frac{d}{t}$$

Where,

S = Speed of operator (m/s) d = Distance travelled by operator (m) t = Time required to travel (sec)

3. Actual field capacity

The actual field capacity is the actual rate of coverage by the implement. The total time required to complete the operator was recorded and actual field capacity was calculated as followed by (Kumar *et al.,* 2014).

$$Actual\ field\ capacity = \frac{A}{T}$$

Where,

A = area covered by machine, m^2

T = time taken by machine to cover area A, s

4. Theoretical field capacity:-

The theoretical field capacity is the rate of field coverage that would be obtained if implement were performing its function 100% of the time at the rated speed and always covering 100% of its rated width. Field capacity was calculated by following expression (Kumar *et al.,* 2014).

$$\text{Theoretical field capacity} = \frac{S \square W}{10}$$

Where,

W = Width of Machine, m

S = Speed of operator, m/s

5. Field efficiency

Field efficiency is the ratio of actual field capacity and theoretical field capacity. It is expressed in percentage by following expression (Kumar *et al.,* 2014).

$$Field\ efficiency = \frac{\text{Actual field capacity}}{\text{Theoratical field capacity}} \times 100$$

6. Weeding index:-

Weeding index is the ratio between the numbers of weeds removed by a weeder to the number of weeds which were present in one unit area before starting operator (Goel *et al.,* 2008).

$$\text{Weeding index} = \frac{W1 - W2}{W1} \times 100$$

Where,
W1 = Number of weeds before weeding
W2 = Number of weeds after weeding

7. Plant damage:-

Plant damage was calculated by counting the number of injured plants in sample plot to the total number of plants in sample plot. Plant damage was calculated by following expression (Kumar et al., 2014)**.**

$$Pd = \frac{A}{B} \times 100$$

Where,
Pd = plant damage, %
A = No. of injured plants (cut or damaged) in sample plot
B = Total no. of plants in sample plot.

Findings and analysis:

This experiment was conducted at the Research Farm of C.A.E.T Jalgaon (Jamod). The observations were recorded at field conditions. Experiment was conducted by plotting number of field for noting the observations for speed of operator, actual field capacity, theoretical field capacity, field efficiency, moisture content of soil, bulk density, weeding efficiency. The above observations were analysed and results were computed. From the results suitable conclusions were drawn and are discussed in the following sections.

1. Moisture content of soil

The test was carried out in two different field (A &B). Soil sample is collected from the field and kept in the digital electrical oven for calculating the moisture content of soil sample. The result of this is shown in table 1

Table 1: Moisture content of soil in field A and field B

Sr no.	**A (%)**	**B (%)**
1	13.40	11.15
2	13.13	11.88
3	12.37	11.34
4	13.86	11.11
5	12.25	11.11
Average	13.00	11.15
Total average = 12.25		

From the Table 1, it is observed that the average moisture content of field A is 13 % and the field B average moisture content is 11.15 %. This infers that the field A has high moisture content than field B. The total average moisture content of soil is 12.25 %.

2 Performance and evaluation of manually operated weeder

Table 2: Effect of moisture content on speed of operator and field efficiency for field A

Sr no.	**Moisture content (%)**	**Speed of operator (m/s)**	**Field efficiency (%)**
1	13.40	0.40	66

2	13.13	0.43	62.85
3	12.37	0.47	61
4	13.86	0.39	73.84
5	12.25	0.49	58
Average	11.50	0.44	64.34

Plate 1. Performance and evaluation of manually operated weeder

The relationship between moisture content, speed of operator and field efficiency is presented in the table 2. The result shows that average speed of operator in field A is 0.44 m/s and field efficiency in field A is 64.33%. From the above table it is observed that when the speed of operator was increased, the field efficiency decreased. This states that the relation between the speed of operator and the field efficiency is inverse. When the moisture content of soil increases then speed of operator decreases and vice versa. But when moisture content of soil increases then field efficiency is increases due to decrease in speed and vice versa.

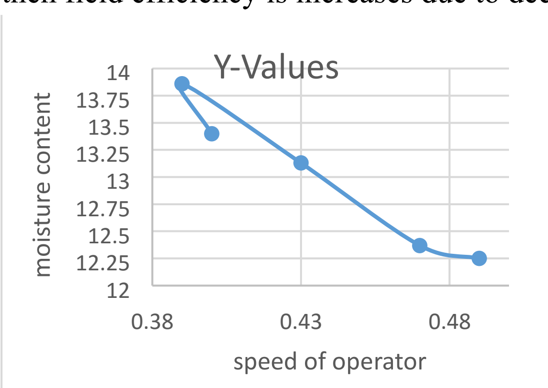


Fig 1: Effect of moisture content on speed of operator in field A

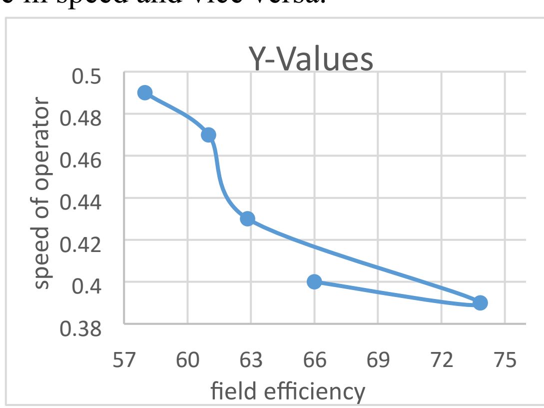
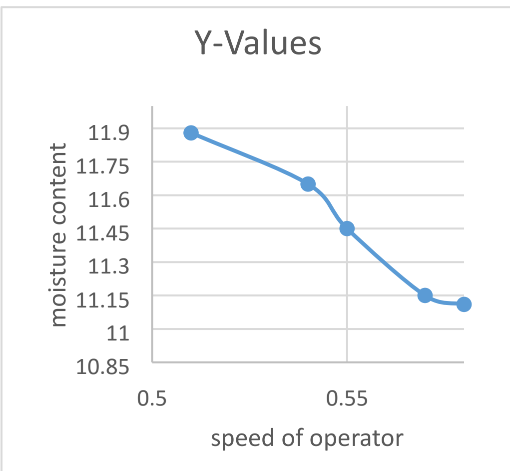


Fig 2: Effect of speed of operator on field efficiency in field A

Table 3: Effect of moisture content on speed of operator and field efficiency in field B

Sr. No.	Moisture content (%)	Speed of operator (m/s)	Field efficiency (%)
1	11.15	0.57	60
2	11.88	0.51	66
3	11.74	0.55	64
4	11.11	0.58	58
5	11.65	0.54	65
Average	11.50	0.55	62.6

From Table 3, it is seen that the speed of operator decreased when field efficiency was increases and also depicted in fig 4. The average speed of operator in field B is 0.55 m/s and average field efficiency in field B is 62.6 %. The highest field efficiency 66 % obtained at 11.88 % moisture content. Hence, in field B, 11.88 % moisture content is best for weeding efficiency.



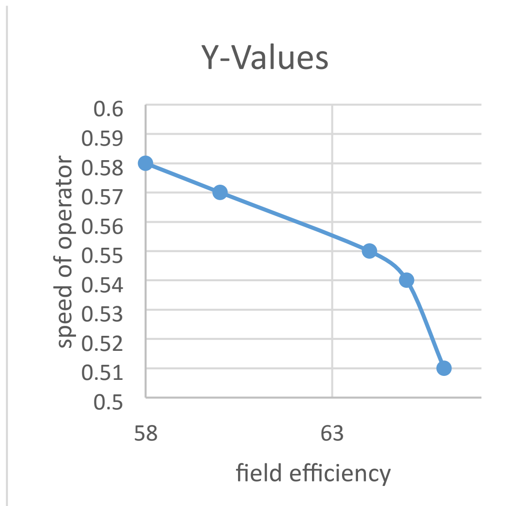


Fig 3: Effect of moisture content on **Fig 4:** Effect of speed of operator on speed of operator in field B field efficiency in field B

Table 4: Effect of moisture content on speed of operator and weeding efficiency in field A

Sr no.	Moisture content (%)	Speed of operator (m/s)	Weeding efficiency (%)
1	13.40	0.40	84
2	13.13	0.43	81
3	12.34	0.47	79
4	13.86	0.39	88
5	12.25	0.49	77
Average	13	0.43	81.8

From the table 4 it is observed that when moisture content in field A is decreased the speed of operator is increases and vice versa. But when moisture content in field increases then weeding efficiency was observed to be decreased due to increase in speed of operator and due to some other reason. The average speed of operator in field A is 0.43 m/s average weeding efficiency of field A 81.8 % and 13.40 % moisture content of soil gives best condition for weeding efficiency.

Table 5: Effect of moisture content on speed of operator and weeding efficiency in field B.

Sr. No.	**Moisture content (%)**	**Speed of operator (m/s)**	**Weeding efficiency (%)**
1	11.15	0.57	76
2	11.88	0.51	68
3	11.74	0.55	71
4	11.11	0.58	79
5	11.65	0.54	74
Average	11.50	0.55	73.6

When moisture content in field B is increased then speed of operator is observed to be decreased and vice versa as shown in Table 5. The average speed of operator in field B is 0.55 m/s, average of weeding efficiency is 73.6 %. It is found that the weeding efficiency is decreased when speed of operator is increased and vice versa. The highest weeding efficiency 79 % is obtained at 11.11 % moisture content. Hence 11.11 % moisture content is the best condition for weeding efficiency in field B.

Recommendations and Conclusion:

The moisture content of soil in field A was 13 % and moisture content of 11.5 % in field B. In field A, the highest speed of operator was 0.49 m/s and average speed of operator was 0.044 m/s whereas in field B highest speed of operator was 0.58 m/s and average was 0.55 m/s. Total average of speed of operator in field A and B was 0.49 m/s. Highest actual field capacity in field A was 0.11 m/s and average field capacity was 0.096 ha/hr. In field B average field capacity was 0.092 ha/hr and the total average actual field capacity in both A and B field was .081 ha/hr. In field the 13.86 % moisture content is best field efficiency, because at 13.86 % moisture content the highest field efficiency 73.84 % was obtained. The 13.86 % moisture content was also suitable for weeding efficiency because at 13.86 % moisture content the highest weeding efficiency 88 % was obtained. The highest field efficiency is 73.84 % and the average field efficiency of field was 64.34 % and for field B was 62.6 %. The total average of both field A and B was 63.47 %. The average plant damage was 4.39 % and in field B it was 4.43 % but the total average plant damage in both field A and B was 4.41 %. The highest weeding efficiency was 88 %. The average weeding efficiency in field A was 81.8% and for field B was 73.6 % but the total average weeding efficiency in both field A and B was 77.7 %. Therefore, weeding efficiency of field is depending on speed of operator when speed of operator is a increases then weeding efficiency is decreases.

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