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Performance Evaluation of Manually Operated Basket Rotor Weeder for Maize Crop

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ABSTRACT

Agriculture is one of the most significant sectors of the Indian economy. The population of India was 1.332 billion in 2017 and estimated 1.807 billion by end of 2050. Hence it is required to produce more food to meet the needs of growing population. The yield of a crop can be increased by using high yield variety of seeds, or using proper agricultural practices and preventing yield loss due to natural factors like weeds, insects, and rodents etc. Out of these factors weed is one of impartment component which cause the serious damage to the crop yield, this include the decrease in crop yield, increase the cost of production, lower the quality of crop.Weed causes 20-30% loss in yield quite usual which might increase up to 80% if an adequate crop practice is not observed. By adopting the proper weed management technologies, additional national income of Rs 1, 05,036 cores per annum (NRCWS, 2007) can be recorded.

The present study was carried out by performance evaluation of manually operated basket rotor weeder with 1:1.5, 1:2 and 1:3 speed ratios with chain and sprocket system. The results of the manually operated basket weeder shows the weeding efficiency was 68.92, 81.93 and 75.47% with 1:1.5, 1:2 and 1:3 speed ratios. The plant damage was 1.666, 0.96 and 2.38% with 1:1.5, 1:2 and 1:3 speed ratios. The field efficiency was found to be 78.86, 83.92 and 60.36% with 1:1.5, 1:2 and 1:3 speed ratios. The cost of operation was 1600.56, 1516.96 and 2097 Rs ha^{-1} with 1:1.5, 1:2 and 1:3 speed ratios respectively.

Key Words: *Basketweeder, Speed ratios, Weed and Maize crop.*

Agriculture is one of the most significant sectors of the Indian economy. The population of India is 1.332 billion in 2017 and the National Commission on Population Government of India has estimated the increasing in population of 1.807 billion by end of 2050 (www.Indiastat.com, 2017). Hence it is required to produce more food to meet the needs of growing population. This can be achieved only either increasing the land under cultivation or by adopting the forming techniques which would increase the crop yields. Population is increasing whereas cultivable land is remains same; nevertheless cultivable land is decreasing due to urbanization. The agriculture sector of India has occupied 43% of India's geographical area and is contributing 16.1% of India's GDP. Agriculture still contributes significantly to India's GDP despite decline of its share in India's GDP.

The India has land of about 329 Mha out of which 156 Mha is cultivated land, 182 Mha of land is under cultivable and the net area sown is about 142 Mha (www.Indiastat.com, 2013-14). There are number of crops grown by the farmers. In India maize is regarded as a food crop which is grown in 9.26 Mha of area with a production of 23.67 MT. In Andhra Pradesh maize is grown in 1.0 Mha with a production of 4.24 MT. (Directorate of Economics and Statistics & Ministry of Agriculture, 2014-15).As it is not possible to increase the land under cultivation the left option is to increase the crop yield. The yield of a crop can be increased by using high yield variety of seeds, or using proper agricultural practices and preventing yield loss due to natural factors like weeds, insects, and rodents etc. out of these factors weed is one of important component, which cause the serious damage to the crop yield, this include the decrease in crop yield, impairment of crop quality, harbouring of plant pests and diseases, increase in irrigation costs,increase the cost of production, lower the quantity and quality of a crop.Weeds are unwanted and undesired which grows among the field crops which are interface and compete with main crop for their existence which cause serious yield loss by share in land, water, nutrients, sun, light and available carbon dioxide of crop.

As per the available estimates, weeds cause up to one third of the total losses in yield, besides impairing produce quality and raising cost of production (NRCWS, 2007). Due to weeds the yield reduction in the maizecrops ranges from 29-70% (Mani *et al.* 1968) and sometimes it can be high as 80-90% and can cause complete crop failure if adequate management practices are not followed effectively(Veerangouda*et al.* 2010).A study undertaken at DWSR suggests that proper weed management technologies, are adopted, which can result in an additional national income of Rs. 1, 05,036 cores per annum (NRCWS, 2007).

The status of land holding in context of Indian agriculture is reveals that the about 80% of land holdings were below 2 hectare area which is comes under small to marginal land holding. Most machines large in size and high initial investment it is not affordable for medium and small scale farmers. Keep the all above factors in the view a study under taken by performance evaluation of manually operated basket weeder for maize crop with three different speed ratios. During performance evaluation of equipment the following parameters were studied i.e. weeding efficiency, plant damage, effective field capacity, field efficiency and cost of operation.

MATERIAL AND METHODS

Performance evaluation of manually operated basket weeder

Weeding efficiency ($\sum$)

Weeding efficiency is the ratio of number of weeds before the operation to the number of weeds after the operation, a 1m × 1m plot was used for counting of weeds per square metre area. The weeding efficiency was calculated by using Eq.1 given by Shekhar *et al,* 2010.

$$\text{Weeding efficiency} \sum (\%) = \frac{W_1 - W_2}{W_1} \times 100 \quad \text{..... (1)}$$

Where,

$\sum$ = Weeding efficiency, %

W_1 = Number of weeds before weeding operation and

W_2 = Number of weeds after weeding operation.

Plant damage (P_d)

Plant damage was calculated by counting the number of injured plants in sample plot after the operation and total number of plants in sample plot before the operation. The plant damage was calculated by Eq. 2 given by Yadav and Pound, 2007.

$$\text{Plant damage } \mathbf{P_d}(\%) = \left\{1 - \left(\frac{q}{p}\right)\right\} \times 100 \quad \text{.....(2)}$$

Where

q = Number of plants in a 10 m row length after the operation,

p = Number of plants in a 10 m row length before the operation.

Effective field capacity (EFC)

Effective field capacity is the actual average rate of coverage by the machine, based upon the total field time. It is a function of the rated width of the machine, the percentage of rated width actually utilized, speed of the travel and the amount of field time lost during the operation. Effective field capacity is usually expressed as hectare per hour. It is calculated by using Eq. 3 given by Manjunatha*et al,* 2014.

$$\text{E.F.C (ha h}^{-1}) = \frac{A}{T_P + T_{NP}} \quad \text{..... (3)}$$

Where,

A = Area of coverage, ha,

T_P = Productive time, h and

T_{NP} = Non-Productive, h

Field efficiency (F_e)

Field efficiency is the ratio of effective field capacity to the theoretical field capacity, expressed as percentage. It was calculated using Eq. 4 given by Nageshkumar *et al,* 2014.

$$\text{F.E}(\%) = \frac{\text{E.F.C}}{\text{T.F.C}} \times 100 \quad \text{.....(4)}$$

Where,

E.F.C = Effective field capacity, ha h^{-1} and

T.F.C = Theoretical field capacity, ha h^{-1}

Cost economicsof manually operated basket rotorweeder

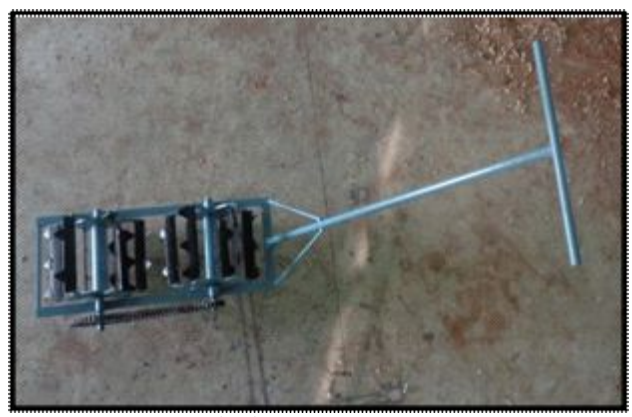

Fig 1. Basket weeder

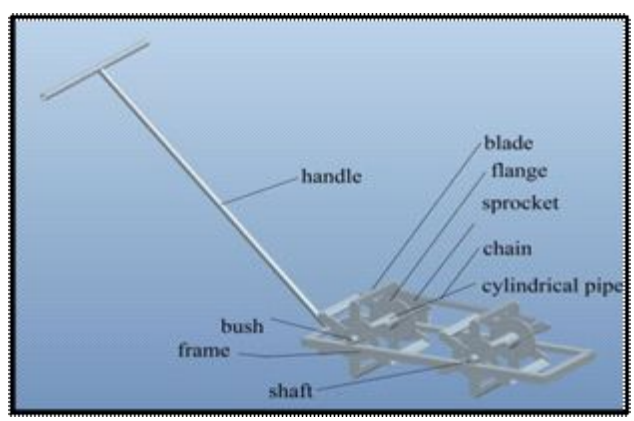

Fig 2. Basket weeder diagram in pro-e

Fig 3. Evaluation of basket weeder in maize crop

The cost evaluation of manual basket rotorweeder was determined by straight line method. Total cost of basket weeder was determined by adding both the net cost of material used for fabrication and labour cost for fabrication. Similarly, total cost of operation was calculated on the basis of fixed and variable cost.

RESULTS AND DISCUSSION

The performance evaluation of basket weeder was conducted at field located at College of Agricultural Engineering, Madakasira in terms of weeding efficiency, plant damage, effective field capacity, field efficiency at different moisture contents and operating cost of weeder with three speed ratios. The performance evaluation of the manually operated basket weeder was conducted as per RNOM test codes and results are discussed in the following sections.

Effect of moisture content on weeding efficiency

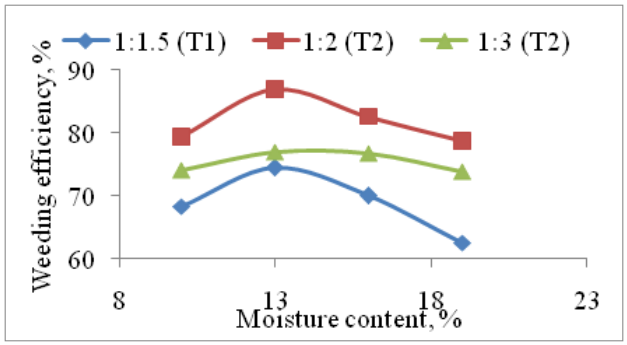

Fig 4. Effect of moisture content on weeding efficiency

Weeding efficiency was estimated by using Eq.1 and the mean weeding efficiency was found to be 75.44%. Among the treatment T_2 gave a best result of 81.93% with speed ratio of 1:2. The same was depicted in figure 4.

From the Table 1 the weeding efficiency indicated that there is a significantly different among the treatments T_1 and T_2 but between T_2 and T_3 there is a no significant difference among the treatments. The effect of moisture content on weeding efficiency of weeder is shown in Fig. 1. The moisture content is increased, the weeding efficiency is attain a maximum at 13% to 16% moisture content in all the treatments and then it is declined from 16% to 19% of moisture content in all the treatments. At optimum moisture content the weeding efficiency was reported maximum. Ojomo*et al.* (2012) studied the moisture contents of 10, 13, 16% and reported 13% to 16% was reported the maximum weeding efficiency.

Plant Damage

Plant damage was estimated by comparing the real damage occurred during the operation. It is estimated by using Eq. 2. The mean plant damage was found to be 1.671%. Among the treatment T_2 observed a less plant damage of 0.960% with speed ratio of 1:2. The same was depicted in figure 5.

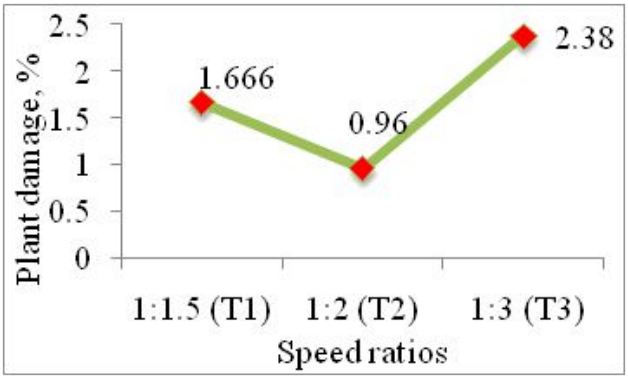

Fig 5. Plant damage at different speed ratios

Table 1. Average weeding efficiency of speed ratios

Treatments	R_1	R_2	R_3	R_4	Average Weeding Efficiency
01:01.5	68.42	74.54	70.07	62.65	68.92 [b]
1:02	79.41	86.95	82.61	78.77	81.93 [a]
1:03	74.13	77.03	76.81	73.91	75.47 [a]
CD (P=0.05)	-	-	-	-	4.5366
CV %	-	-	-	-	5.3738

Table 2. Plant damage

Treatments	Plant damage
01:01.5	1.666 [a]
1:02	0.960 [a]
1:03	2.38 [a]
CD (P=0.05)	NS
CV (%)	13.8844

From the Table 2 it is indicated that there is a no significantly different among the treatments, however the plant damage recorded highest with 1:3 treatment as 2.38% similarly with 1:1.5 it was 1.666% and lowest plant damage was found with 1:2 treatment as 0.96%. This is due to fact that chain and sprocket and blade causes damage to the plants while passing through rows and also damage occurred while turning of weeder due to insufficient land space for turnings.

Effective field capacity

Effective field capacity was estimated by using Eq.3 and the mean effective field capacity was found to be 0.01671 ha h^{-1}. Among the treatment T_2 gave a best result of 0.0188 ha h^{-1} with speed ratio of 1:2. The same was depicted in figure 6.

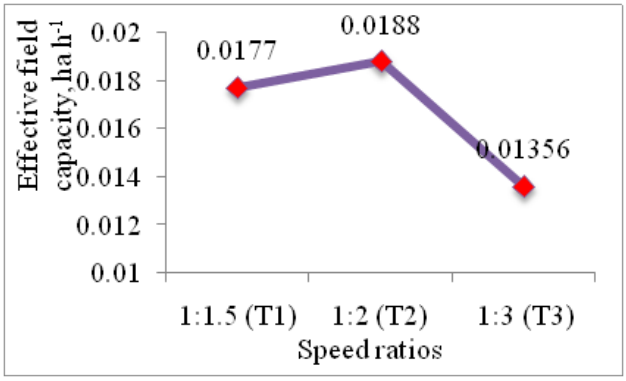

Fig 6. Effective field capacity at different speed ratios

Table 3. Effective field capacity

Treatments	Effective field capacity
01:01.5	0.0177[a]
1:02	0.0188[a]
1:03	0.01356[b]
CD (P=0.05)	0.001995
CV (%)	10.71357

From the Table 3 it is indicated that there is a significantly different among the treatments T_2 and T_3 but between T_1 and T_2 there is no significant difference, however the highest effective field capacity was found in T_2 treatment as 0.0188hah^{-1} followed by 0.0177hah^{-1} and 0.01356 ha $h^{-1}$with T_1 and T_3 treatments respectively.

Field efficiency

Field efficiency was estimated by using Eq. 4and the mean field efficiency was found to be 74.38%. Among the treatment T_2 gave a best efficiency of 83.92% with speed ratio of 1:2.Thesame was depicted in figure 7.

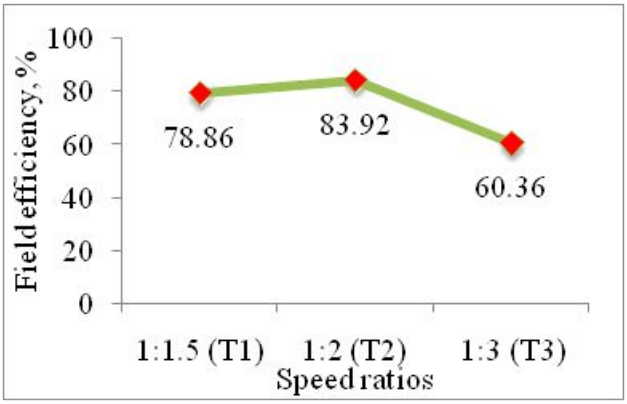

Fig 7. Field efficiency at different speed ratios

Table 4. Field efficiency

Treatments	Field efficiency
01:01.5	78.86[a]
1:02	83.92[a]
1:03	60.36[b]
CD (P=0.05)	8.84799
CV (%)	10.677

From the table 4 it is indicated that there is a significantly different among the treatments T_2 and T_3 but between T_1 and T_2 there is no significant difference, however the highest field efficiency was found in T_2 treatment as 83.92% followed by 78.86% and 60.36% ha $h^{-1}$with T_1 and T_3 treatments respectively.

Cost of operation

Operating cost of weeding was calculated by the fixed and variable cost of weeder and also cost of operations depends on the time required for completing the weeding operation.The mean cost of operation was found to be 1738.177 Rs ha^{-1}. The results was depicted in figure 8.

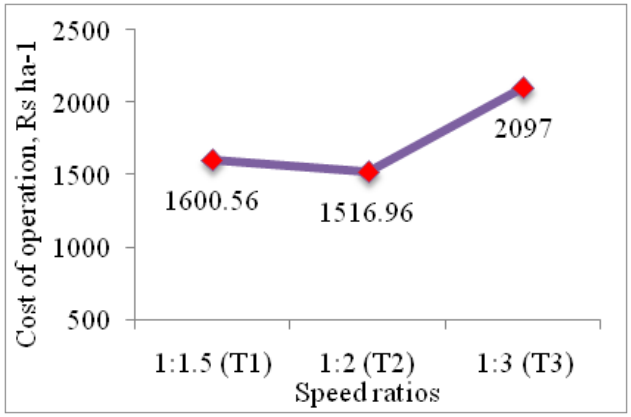

Fig 8. Cost of operation at different speed ratios

Table 5. Cost of operation

Treatments	Cost of operation
01:01.5	1600.56[b]
1:02	1516.96[b]
1:03	2097[a]
CD (P=0.05)	200.477
CV (%)	10.3528

From the table 5 it is indicated that there is a significantly different among the treatments T_2 and T_3 but between T_1 and T_2 there is no significant difference, the cost of operation with T_2 was recorded lowest as 1516.96Rs ha^{-1} similarly with T_1 as 1600.56Rs ha^{-1} and highest was found with T_3 speed ratio as 2097Rs ha^{-1}.

From the above performance evaluation of manually operated basket weeder the best speed ratio was found to be 1:2.

CONCLUSION

The following conclusions were drawn from the performance evaluation of basket rotor weeder.

1. The highest weeding efficiency was found as 81.93% in 1:2 speed ratio and lowest in 1:1.5 speed ratio as 68.92%, with 1:3 speed ratio it was 75.47% respectively.
2. The plant damage recorded highest with 1:3 speed ratioas 2.38% similarly with 1:1.5 it was 1.666% and lowest plant damage was found with 1:2 speed ratio as 0.96%.
3. The highest effective field capacity was found in 1:2 speed ratio as 0.0188 ha h^{-1} followed by 0.0177 ha h^{-1} and 0.01356 ha h^{-1} in 1:1.5 and 1:3 speed ratios.
4. The highest field efficiency was found in 1:2 speed ratio as 83.92% followed by 78.86% and 60.36% in 1:1.5 and 1:3 speed ratios.
5. The cost of operation with 1:2 was recorded lowest as 1516.96Rs ha^{-1} similarly with 1:1.5 is 1600.56Rs ha^{-1} and highest was found with 1:3 speed ratio as 2097Rs ha^{-1}.

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