

# Performance evaluation of concentric screen grader

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■ **ABSTRACT** : The machine main frame had dimensions 2000 mm × 1250 mm × 1000 mm, with a approximate cost of Rs. 45,000. The performance parameters such as actual capacity, grading efficiency of each grade, overall grading efficiency, damage loss and peel loss were studied in this work. The operating speed of the grader was maintained at constant speed 16 revolutions. The maximum grading efficiency of 96 and 62.3 per cent was found in onion and potato grading, respectively. The cost of the mechanical grading obtained was Rs. 30 per tonne. The ratio of cost for manual to mechanical grading worked out to be 12.45:1. During the performance test only peel loss was observed in onion grading while in case of potato grading more damage occurred. Therefore, this grading is only suitable for onion grading.

■ **KEY WORDS** : Fruit-vegetable grader, Screen grader, Onion, Potato

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India accounts for 10 per cent of total world production of fruits. India is large producer of onion and potato in the country, with high average production about 16813.0 MT and 45.34 MT, respectively. In Maharashtra production in onion is 15 lakh MT (Anonymous, 2014). About 30 to 35 per cent of the produce is wasted due to poor post harvest handling, lack of adequate transportation in time, improper storage facilities and poor processing techniques.

Grading of fruit and vegetables is an important operation done at the farm level. The separation based on a multiple parameters like size, shape, colour, weight, etc. Grading on the basis of size is essential preliminary to marketing of fruit and vegetables grown in commercial holding. In India the grading of agricultural production has not been introduced on farm level. At present, majority of farmers have to sell their produce in bulk without grading or fruit lot is separated on land with the help of labour of different age groups. The quality of processed product and cost of processing efficiency of

machine depend on uniformity in size and shape of raw material. Therefore, the study was carried out total performance evaluation of the grader for grading of onion and potato.

## ■ METHODOLOGY

The research work has been conducted in the Department of Agricultural Process Engineering, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The machine was concentric screen type grader. The speed of operation was constant speed which was measured by digital contact techo-meter ( range- 1 to 1000 rpm) and the grading efficiency, output capacity were determined for the onion. The machine consisted of main frame, power transmission unit, feeding unit, grading unit, collection unit. The slope of the grading frame was 10 per cent. The machine main frame having dimensions 2000 mm × 1250 mm × 1000 mm. In power transmission unit, one horse power motor and V-belt drive and pulleys connected with each other. The feeding unit

has length – 560 mm, width- 500 mm and height 100 mm.

### Grading and collection unit :

In this grading unit, three different sized concentric screens are used. The detailed dimensions of unit are given in Table A.

### Sample preparation :

The performance of the grader was evaluated by taking onion 50 kg. Under the evaluation, the speed of grader was constant *i.e.* 16 revolutions per min. The grading of sample was done on the basis of size and was graded into three different square mesh screen sized grades. The grades are classified into three different grades as, first grade - above 47 mm, second grade – between 38 mm to 47 mm and third grade-below 38 mm. There were three outlets or collection units for collecting the graded samples according to the grades. After completion of grading, the tubers were collected at each collection unit. The evenly numbered tubers were then counted and weighted and grading efficiency was estimated using following relationships.

### Grading efficiency :

Grading efficiency of the grader was estimated on the basis of known feed composition. Under known feed composition test, the onion/potato of different sizes were

selected. There were three collection units collecting the tubers separated according to commercial grade as well as the size group decided as, first grade – above 47 mm, second grade –between 38 mm to 47 mm and third grade – below 38 mm.

$$E_I = \frac{N_I - N_r}{N_t} \times 100 \quad \dots\dots(\text{Mangaraj } et al., 2009)$$

where,  $E_I$  is the grading efficiency with respect to grade first and  $N_I$  is the number of the tuber in grade first,  $N_r$  is the number of tubers rejected in first grade and  $N_t$  total number of tubers first in feed.

### Overall grading efficiency of the machine :

The overall grading efficiency of each tuber was estimated using following equation (Patel *et al.*, 2009).

$$E_0 = \frac{E_I + E_{II} + E_{III}}{3}$$

where,

$E_0$ = Overall grading efficiency

$E_I$ = Grading efficiency of I<sup>st</sup> grade.

$E_{II}$ = Grading efficiency of II<sup>nd</sup> grade.

$E_{III}$ = Grading efficiency of III<sup>rd</sup> grade.

### Damage percentage :

The damage percentage during grading at each grade was determined by visual observation. The graded tubers were stored in respect of damage due to abrasion and brushing and weight of total damaged tubers

Table A : Cost economics of onion grading			
Sr.No.	Method	Details	Cost (Rs.)
1.	<b>Manual grading</b>		
	Fixed charges	Nil	150 per day
	Variable charges	1 labour @150/day. Capacity 4 quintal/day	375 per tone
2.	<b>Mechanical grading</b>		
	Fixed cost		
	Depreciation	@10%, life 10 year, salvage value10%	4500
	Interest on investment	12%	5400
		Total	9900 per year
	Total fixed cost	Working days in year 90days, capacity of machine 11.54qt/hr <i>i.e.</i> 92.32 qt/day (one day is of 8 hr)	110 per day
	Variable cost		
	Repair and maintenance	@2%= Rs. 900	9
	Labour charges	1 labour @Rs.150/day	150
	Electricity	1kwh*8/unit	8
		Total	167 per day
	Total cost of grading by machine		(A+B)=Rs. 110+167=277 per day =Rs. 30.11 per tonne

collected at each collection unit was noted. The damage percentage was estimated using following relation (Patel *et al.*, 2009).

$$D_p = \frac{W_{d1} + W_{d2} + W_{d3}}{W_t} \times 100$$

where,  $D_p$  is the damage percentage, total weight of tubers;  $W_{d1}$ ,  $W_{d2}$ ,  $W_{d3}$  are the weight of damaged tubers collected at I, II and III collection unit, respectively.

### Actual capacity of grader :

The actual capacity was determined by noting the time required to grade 50 kg of onion and potato. The actual capacity ( $Q$ ) of the grader was estimated using the following equation (Patel *et al.*, 2009).

$$Q = \frac{\text{Total weight of graded sample (kg.)}}{\text{time (hr)}}$$

## RESULTS AND DISCUSSION

In general, grading capacity increased with the speed of grader. But the grading efficiency of grader increased with speed up to certain limit, after then it started decline. This is mainly due to the retention time required to the material, *i.e.* as the speed of grader is faster the time required to retain the material is very short and due to centrifugal force of the grader the material will pass to outlets without properly graded. The results were found for two materials *i.e.* for onion and potatoes. Fig. 1 shows the grading efficiency of onion and potato for each grade.

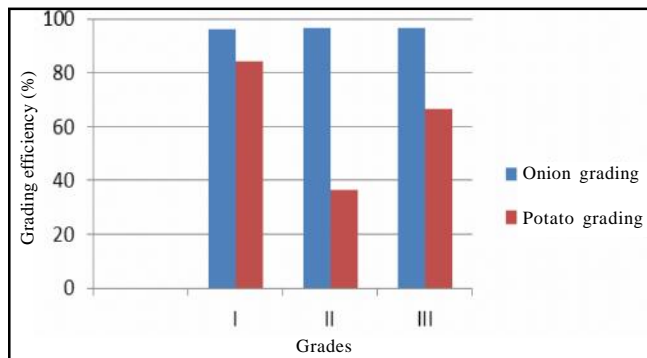


Fig. 1 : Grading efficiency of onion and potato for each grade

### Onion :

The overall grading efficiency of the grader for onion was found 96 per cent with minimum loss of 1 per cent. The actual capacity was found 1154 kg/hr. During onion grading; only outer dry peel loss occurred (less than 1%)

and no other damage like brushing or abrasion was observed as dry peels. Fig. 2 shows the collection of onion into three different grades.

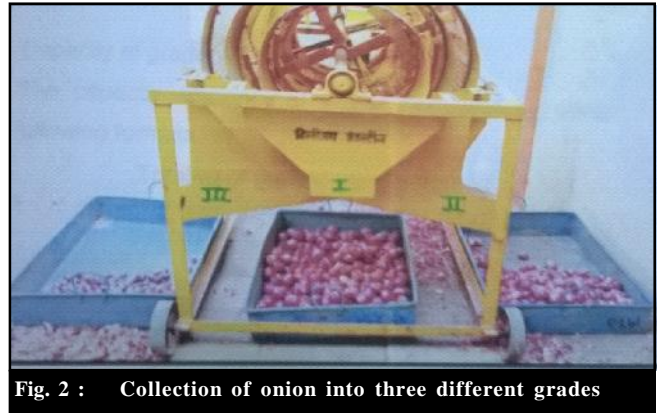


Fig. 2 : Collection of onion into three different grades

### Potato :

The overall grading efficiency of the grader for potato was found 62.3 per cent. The actual capacity was found 952 kg/hr. During grading, the damage occurred and the outer surface of the material due to its irregular shape and outlet angle was not suitable to roll down. Therefore, this grader is not suitable for the potato grading.

### Cost analysis :

The cost of onion grading was determined and shown in Table 2. The cost for manual grading was found to be Rs. 375 per tonne whereas the cost for machine grading was Rs. 30.11 per tonne. Ratio of cost for manual to mechanical grading: 375: 30.11= 12.45:1.

### Conclusion :

- The average grading efficiency of the grader for onion was found 96 per cent with minimum loss of 1 per cent. The actual capacity was found 1154 kg/hr.
- The average grading efficiency of the grader for onion was found 62.3 per cent. The actual capacity was found 952 kg/hr.
- The cost for manual grading was found to be Rs. 375 per tonne whereas the cost for machine grading was Rs. 30.11 per tonne. Ratio of cost for manual to mechanical grading: 375:30.11= 12.45:1.
- This grader is most suitable for onion grading.

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