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Design, development and evaluation of a size grading machine for onion

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Abstract

Improvement of quality and value addition of agricultural produces has gained higher concern in recent times in Sri Lanka due to creation of new opportunities for sale of agricultural commodities in open market at competitive prices. Grading according to the sizes is an important value adding technique for most agricultural products. And also the price of the many agricultural products varies significantly according to their uniformity in size. Uniformity in size not only makes the produce more attractive to consumers but also improve its processing qualities. At present, size grading of most agricultural crops including big onion are carried out manually by crop collectors, whole sellers and retail sellers, most of farmers market their products without any grading. In Sri Lanka, persons engaging in post-harvest crop handling such as collectors, whole sellers, retail sellers, and farmers have less chance to use high technical and costly grading technique. And also local market survey reported, retail market price of the big onion bulbs are significantly varied according to its size. Hence, this research study attempted to design and development of a low cost size grading machine for size grading of big onion bulbs. Size grading machine was fabricated by cast iron and PVC tube and It was designed for grading of onion bulbs into three sizes i.e. small ($\phi < 4$ cm), medium ($4 < \phi < 6$ cm) and large ($\phi > 6$ cm). Grading machine was also fabricated to operate either by manual or electric motor. The machine was tested for grading efficiency/quality accordingly, machine performance was optimized. Optimized machine adjustments for its maximum performance were 3°inclined angle of the grading cylinder against horizontal axis and 15 rpm rotating speed of the grading cylinder. Maximum grading qualities/efficiencies under optimized machine adjustments for small, medium and large sizes were reported 84.47%, 93.46% and 90.14 respectively. The capacity of the grading machine was 630 kg/hour under the optimized operational conditions.

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Keywords: Size grading; onion; design; machine; evaluation; optimization

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1. Introduction

Apart from quantitative losses, quality deterioration and hence a reduction in the market value due to use of improper post harvest techniques are common in agricultural commodities in Sri Lanka. Improvement of quality and value addition of agricultural produce has gained importance in Sri Lanka in recent times due to creation of new opportunities for sale of agricultural commodities in the open market at competitive prices. This situation has resulted in a growing awareness and increased demand for better market quality among consumers. Improvement of product quality by grading according to the size will become even more important in the future for Sri Lanka, as well as most of the other countries, entering into international as well as regional trade agreements and thereby opening its market to the outside world. The price of many agricultural produce varies significantly according to their uniformity in size. Uniformity in size not only makes the product more attractive to consumers but also improve its processing qualities. Therefore, size grading of agricultural commodities to achieve uniformity in size is an important value adding technique to increase their market value.

Big onion (*Allium cepa*) is one of the major spice/vegetable cash crops, grown in Sri Lanka. The level of big onion production and prices shows an immense potential for increasing incomes of local farmers. Profit from big onion is greater than other major cash crops such as chilli and potato¹. Generally, it can be observed, that there is an appreciable difference in the market price of big onion according to the size of bulbs. Graded big onion bulbs according to their size fetches a higher price than the un-graded onions². Local farmers sell their produce to the market without grading. Hence, farmers are getting lower value for their produce. However, manual size grading of most crops are practiced by collectors, whole sellers and retailers and thereby, they make higher profit than farmers. In Sri Lanka, persons engaged in post harvest handling of crops have less chance to use high cost size separation techniques. Hence, this research study attempted to design, development and performance optimization low cost machine for size grading of big onion bulbs

2. Material and Methods

Big onion bulbs size grading machine, designing and fabrication works were carried out at research workshop, R & D Centre, Institute of Post Harvest Technology, Anuradhapura. Figure 1 is shown three dimensional view with its component of the big onion bulbs size grading machine and Figure 2 is shown engineering drawing of the size grader. The grading techniques and material use for fabricating the machine were selected to minimize the mechanical damage of big onion. Machine mainly comprise of grading cylinder made by PVC (tubes diameter 20mm), iron circle, feeding hopper and supporting frame. Front portion of the feeding hopper was adjustable. Grading cylinder consist two segments and four outlets. First segment was longer and it consist two outlets used for separation of small onion bulbs diameter less than 4cm. Second segment consist one outlet was used for separation of medium size onions bulbs diameter in between 4cm to 6cm and larger onion bulbs diameter more than 6cm were collected from the outlet located end of the grading cylinder. Lengths of the segments were 150cm and 100cm respectively. Soft wire mesh was used for fabrication of outlets and also PVC tubes were wrapped by rubber for the prevention of mechanical damaged for onion bulbs. A lever /handle was fixed for manual operation and also electric motor can be coupled by using pulley and belt mechanism if required for operating mechanically.

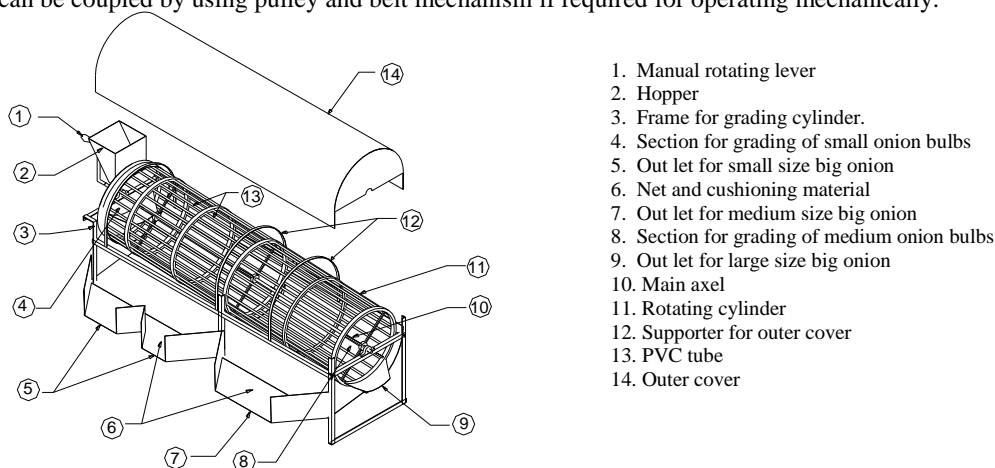


Figure 1: Three dimensional line diagram and component of the big onion size grader

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