Performance Evaluation of Onion Grader

Anand Mishra[1*], Sanjeet Kumar Jha[2], and Shreemat Shrestha[3]

*Corresponding author's Email: anandhansy@yahoo.com
[1, 2, 3]Agricultural Engineering Division, Khumaltar, Lalitpur, Nepal

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Abstract: Onion is one of the important vegetable crops. A global review of area and production of major vegetable crops shows that the onion ranks third in area and production. Onion is one of the important condiments which are widely used all the year round in Nepal. Grading of onion is done on the basis of size and shape and is important for marketing of uniform high quality products. Manual grading takes long time to do the grading process and hence labor charges is high. This study was conducted with an objective of the performance evaluation of grader at Agricultural Engineering Division. The onion was purchased from the local market. The grading machine is simple in design which is manually operated. The size, weight, and percentage of onion received at individual size openings B varies from 3.39-3.68 cm, 25.71-27.95 g, and 0.60-0.80%, respectively. The size, weight, and percentage of onion received at individual sieve opening C varies from 4.43-4.72 cm, 36.87-42.93 g, and 6.20-7.80%, respectively. The size, weight, and percentage of onion received at individual sieve openings D varies from 5.23-5.33 cm, 59.10-63.99 g, and 52.40-57.20%, respectively. The size, weight, and percentage of onion received at outlet of grader which as denoted by E varies from 5.67-6.03 cm, 78.17-89.25 g, and 34.20-41.40%, respectively. The grading capacity varies from 0.20-0.22 kg sec^{-1}. The grader shows better results in terms of size of onion. However, we saw few onions of size C and D was received from the outlet point of grader which is denoted by E. Therefore, we concluded that there is still room for some modifications in the grader. We recommend reducing the slope of the grader which will allow the product to travel for longer period of time inside the cylinder of grader and better results can be expected. In addition, some modifications on sieve openings are necessary for the better results in the future.

Keywords**:** Postharvest handling, Onion, Grading capacity, Size of onion, Weight of onion

1. Introduction

Onion (*Allium cepa L.*) is one of the important vegetable crops worldwide. A global review of area and production of major vegetable crops shows that the onion ranks third in area and production [1]. Onion is one of the important condiments which are widely used all the year round in Nepal. It is rich source of phosphorus, calcium and carbohydrate [2]. The area, production, and productivity of onion in Nepal was 20,070 ha, 2,38,590.7 t, and 11.9 t ha^{-1}, respectively [3]. This production fulfilled around 41.15% of national demand and remaining 58.85 % demand is fulfilled by importing fresh or chilled and dry onion from other countries. In Nepal, based on the domestic production and import from other countries, the per capita consumption of onion in fiscal year 2018/19 was 12.86 kg which was lower than the average annual consumption 30.7 kg per person across the world [2]. The demand of onion is year round but it is grown seasonally only [4].

Grading plays a vital role in the food processing industries. Grading of fruits and vegetables is one of the most important operations which adds the value to the product and gives better income to the growers of fruits and vegetables. Manual grading is time consuming process and it requires huge amount of labors. Manual grading is also affected by non-availability of labors during peak seasons [5]. Manual grading is less efficient and inconsistent as human perception varies from one another. It is also laborious job and causes muscle fatigue and stress to the farmers. In manual grading, huge amount of energy is invested and the product is handled for number of times which results in increasing of wastage

and may decrease marketing value [6]. Mechanical grading saves time and money. It is gaining popularity in large scale marketing to fetch higher prices. Good mechanical grading equipment can do grading of product based on various criteria like size, shape, weight, colour etc. [7]. Gunathilake *et al*., (2016) [8] reported that there is an appreciable difference in the market price of big onion according to the size of bulbs. Big size of graded onion bulbs fetches a higher price than the un-graded onions [8].

Many researchers designed and fabricated grader such as Roy *et al*., (2005) [9] fabricated a potato grader with oscillating sieve. The average capacity of the grader was 2030 kg hr^{-1} in the laboratory and 1500 kg hr^{-1} in the field. Similarly, Ghanbarian *et al*., (2010) [10] reported a potato grader could grade products in three sizes: small (below 50 g), medium (50 to 80 g), and large (above 80 g) with gradation accuracy of 74% and mechanical damages of 5.5%. Hossain *et al*. (2013) [11] reported that capacity of the grader was 1.3 ton hr^{-1} with 95% grading efficiency.

The mechanical graders operated by electricity are expensive and sometimes beyond the purchase capacity of Nepalese famers. The manually operated grader is usually less costly and can be purchase by Nepalese farmers. The quality of processed product and cost of processing efficiency of machine depend on uniformity in size and shape of raw material. This study was carried out with an objective of performance evaluation of grader for grading of onion.

2. Material and Methods

2.1. Experimental site

This research work was conducted at the Agricultural Engineering Division, Khumaltar, Lalitpur.

2.2. Information about grader and data collection

The machine consisted of main frame, feeding unit, grading unit, collection unit. The slope of the grader was about 8 per cent. The grading of sample was done on the basis of size and was graded into three different sized grades. The grades are classified into three different grades as, first grade (big size onions) which was denoted by D, second grade (medium size onions) which was denoted by C, third grade (small size onions) which was denoted by B and finally oversized onions were collected from the outlet point which was denoted by E. 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. Ten kilograms of onion was purchased from the local market. Performance evaluation of grader was done at the three speeds of grader, i.e. 17 revolutions per min., 20 revolutions per min., and 22 revolutions per min. The revolution per minute was measured by digital techo-meter. The size (diameter) of graded onion was measured by vernier caliper. The weight of grader onion was measured by weighing balance. Fig. 1 shows photographic view of grader.

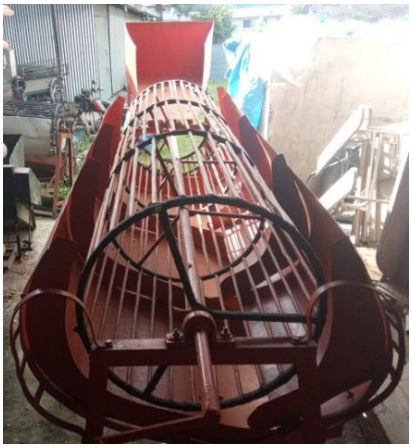

Fig. 1: Photographic view of grader

2.3. Measurement of grading capacity

The grading capacity was determined by noting the time required to grade 10 kg of onion. The grading capacity of the grader was determined by using the following formula as suggested by Cochran and Cox (1975) [12].

Grading capacity (kg sec^{-1}) = Total weight of grader sample (kg.) / time (sec)

Percentage of onion received at individual sieve openings (%) = mass of onion collected from individual sieve openings (kg) / total mass of onion (kg)*100.

3. Results and Discussion

3.1. Size, weight, and percentage received at individual sieve openings and outlet point E of grader

Table 1 shows size, weight, and percentage received at individual sieve openings and outlet point denoted by E of grader at 17 rpm. The size of onion at openings C and D were 4.57 ± 0.23 cm and 5.33 ± 0.36 cm, respectively. The weight of onion at openings C and D were 42.93 ± 3.76 g and 59.72 ± 8.92 g, respectively. The percentage of onion received at individual sieve openings C and D were 6.20% and 52.40%, respectively.

Table 1: Size, weight, and percentage of onion received at individual sieve openings and outlet point of grader at 17 rpm

Parameters	Sieve openings C	Sieve openings D	Outlet point of grader denoted by E
Size of onion (cm)	4.57 ± 0.23	5.33 ± 0.36	5.78 ± 0.41
Weight of onion (g)	42.93 ± 3.76	59.72 ± 8.92	78.17 ± 14.81
Percentage received at individual sieves openings (%)	6.20	52.40	41.40

Table 2: Size, weight and percentage of onion received at individual sieve openings and outlet point of grader at 20 rpm

Parameters	Sieve openings B	Sieve openings C	Sieve openings D	Outlet point of grader denoted by E
Size of onion (cm)	3.68 ± 0.14	4.72 ± 0.19	5.27 ± 0.16	6.03 ± 0.37
Weight of onion (g)	27.95 ± 2.09	40.84 ± 4.23	59.10 ± 5.18	89.25± 13.30
Percentage received at individual sieves openings (%)	0.60	6.20	55.40	37.80

Table 2 shows size, weight, and percentage received at individual sieve openings and outlet point denoted by E of grader at 20 rpm. The size of onion at openings B, C, and D were 3.68 ± 0.14 cm, 4.72 ± 0.19 cm, and 5.27 ± 0.16 cm, respectively. The weight of onion at openings B, C, and D were 27.95 ± 2.09 g, 40.84 ± 4.23 g, and 59.10 ± 5.18 g, respectively. The percentage of onion received at individual sieves openings B, C, and D were 0.6%, 6.20%, and 55.40%, respectively.

Table 3 shows size, weight, and percentage received at individual sieve openings and outlet point denoted by E of grader at 22 rpm. The size of onion at openings B, C, and D were 3.39 ± 0.21 cm, 4.43 ± 0.27 cm, and 5.23 ± 0.31 cm, respectively. The weight of onion at openings B, C, and D were 25.71 ± 5.14 g, 36.87 ± 4.60 g, and 63.99 ± 8.02 g,

respectively. The percentage of onion received at individual sieves openings B, C, and D were 0.8%, 7.80%, and 57.20%, respectively.

Table 3: Size, weight and percentage of onion received at individual sieve openings and outlet point of grader at 22 rpm

Parameters	Sieve openings B	Sieve openings C	Sieve openings D	Outlet point of grader denoted by E
Size of onion (cm)	3.39 ± 0.21	4.43 ± 0.27	5.23 ± 0.31	5.67 ± 0.37
Weight of onion (g)	25.71 ± 5.14	36.87 ± 4.60	63.99 ± 8.02	79.25± 10.54
Percentage received at individual sieves openings (%)	0.80	7.80	57.20	34.20

3.2. Effects of grader rpm on grading capacity

Table 4 shows the effect of grader rpm on grading capacity. The grader was tested at the rpm of 17, 20, and 22. The grading capacity at 17 rpm was 0.20 kg sec^{-1}. Similarly, the grading capacity at 20 rpm was 0.21 kg sec^{-1}. The grading capacity at 22 rpm was 0.22 kg sec^{-1}. There were no losses in onion except some onion cover was seen during grading of onion.

Table 4: Effect of grader rpm on grading capacity

S. N.	Grader (rpm)	Grading capacity (kg sec^{-1})
1	17.0	0.20
2	20.0	0.21
3	22.0	0.22

4. Conclusions

In this experiment we conducted the performance evaluation of grader. The size, weight, and percentage of onion received at individual sieve opening C varies from 4.43-4.72 cm, 36.87-42.93 g, and 6.2-7.8%, respectively. The size, weight, and percentage of onion received at individual sieve opening D varies from 5.23-5.33 cm, 59.10-63.99 g, and 52.4-57.2%, respectively. The grading capacity varies from 0.2-0.22 kg sec^{-1}. The grader shows better results in terms of size of onion. However, we saw few onions of size C and D was received from the outlet point of grader which is denoted by E. Therefore, we concluded that there is still room for some modifications in the grader. We recommend reducing the slope of the grader which will allow the product to travel for longer period of time inside the cylinder of grader and better results can be expected. In addition, some modifications on sieve openings are necessary for the better results in the future.

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