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Effect of Shade Curing on Post-harvest Loss of Big Onion (*Allium cepa*) Selection 'Dambulla Red' Stored under Ambient Conditions

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Abstract: Big onion is a highly demanded condiment in Sri Lanka that is characterized with high post-harvest losses. Curing is a major management practice that affects the post-harvest shelf life. Curing is not practiced by majority of farmers due to rainy weather condition prevail during the harvesting season. Hence, this experiment was carried out to test the effectiveness of shade curing to minimize the storage loses over field curing. Two treatments were used namely storage followed by shade curing and field curing. Physiological weight loss (PWL), Rotting Percentage (RP), Sprouting percentage (SP),Total Soluble Solids (TSS), and Total Post-harvest Loss (TPL) were recorded for three months duration. PWLwas significantly different ($P<0.05$) at1st, 2nd, and 3rd months after storage where PWL of shade cured and field cured onions after three months of storage were 8.04± 1.6 and 12.62±1.62 respectively. No significant difference was observed ($P>0.05$) for TSS, rotting percentage and sprouting. Results revealed that shade curing is important alternative practices to conventional field curing that minimizes the total post-harvest loss where it was 9.15% and 13.7% respectively.

Keywords: Big onion, Post-harvest loss, Shade curing, Storage

Introduction

Big onion is a highly demanded condiment in Sri Lanka where the total annual production is inadequate to fulfill the national requirement. Total annual requirement of big onion in Sri Lanka is around 240,000 MT (Presidential Task Force on National Food Production, 2015). However, the local production is around 53,603 MT (Ag Stat, 2019) which will adequate only for about three months of the year to feed the population. Due to the rainfall pattern of the country and day length requirement, cultivation of big

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onion is limited to Dry Zone (DZ) at *Yala* season from April to September (Sabaragamuwa *et al.,* 2011). Besides, a decreasing trend of extent under big onion cultivation was identified from 2014 to 2019 (Department of Census and Statistics, 2020). Post-harvest loss of onion under short term storage and ambient conditions is comparatively high and around 30-50% (Meththananda, 1992) where available local onions are further limited. Hence, identification of best post-harvest practices will account a huge importance to minimize post-harvest losses, retain farmers in the industry and reduce the gap between imports and local production.

Several factors can be identified behind post-harvest loss of onion; pre-harvest fertilizer application, pre-harvest fungal control, timing of cultivation, weather condition at harvest, improper curing, and improper storage condition. Among these factors, improper curing is one of the main factors behind high post-harvest loss in Sri Lanka. Curing is considered as an important practice that extends the post-harvest shelf life of big onion. It is a drying-out process that outer layer is dried to form a protective layer for prolonging the storage life. Curing of onion will produce an onion bulb that is resistant to disease causing organisms through proper sealing of the neck of the onion bulb, drying of roots, and drying of skin (Wright, 1997). Preventing the dormancy breakage and minimizing the water loss is important in onion storage where outer dry skin achieved by curing is important to control those them (Opara and Geyer, 1999). However, field curing is restricted under practical circumstances since harvesting of onion overlaps with North-East Monsoon where curing is not practiced under local condition. Hence, it leads to heavy post-harvest losses. An alternate curing technology is critically required to overcome the barriers in conventional field curing because of heavy rain prevail during the harvesting season. Shade curing may be a good alternative in this sense.

Hence this experiment was conducted with the objective of comparing the storage loss of onion bulbs subjected to shade curing and field curing.

Materials and Methods

Experimental Materials and Location

'Dambulla Red' onion selection, harvested at correct physiological maturity stage was used for the study. Experiment was conducted in National Institute of Post-Harvest Management, Anuradhapura. Onions were collected from a farmer field at Senapura, Anuradhapura Sri Lanka.

Experimental Treatments and Data Collection

Two different treatments were used for the study; shade curing, field curing (control). Shade curing was followed where onions were placed on a shade after harvesting and allowed to cure for 14 days. Foliage was removed only after the neck is completely sealed. For the control sample foliage was removed with a 1 inch neck length after field curing. Each treatment was triplicated. Samples were stored under ambient condition for three months and observed for losses. One layer of thickness was maintained in the storage. Loss of bulbs and chemical parameters were recorded in two week intervals to compare two treatments.

Physiological Loss in Weight (PLW) was calculated as cumulative % loss in weight based on the initial weight before the storage (Nath *et al.,* 2012;Kumara and Beneragama, 2020) as illustrated in equation (01).

$$PWL\ \% = (Pi - Pn) / (Po) \times 100 \qquad 01$$

Where, Pi = initial weight of bulb, Pn = weight of bulb at observation after storage

Rotting Percentage (RP) was calculated as given in equation (02). Rotted bulbs were removed after recording the weight to avoid cross contamination.

$$RP\% = (Pr) / (Pi) \times 100 \qquad 02$$

Where, Pr = Weight of the rotted bulbs

Sprouting Percentage (SP) was calculated as given in equation (03), where rotted bulbs were removed after recording.

$$SP\% = (Ps) / (Pi) \times 100 \qquad 03$$

Where, Ps= Weight of sprouted bulbs

Total Soluble Solids (TSS) Content

Onion samples were cut into small pieces and ground using mortar and pestle. The juice was extracted using a muslin cloth. TSS of extracted juices were measured by a temperature compensated digital refractometer (3810, Atago PAL-1) and expressed as a percentage. Finally, the Total Post-harvest Loss (TPL) of big onion was calculated after the storage period.

Data Analysis

Experiment was conducted as completely randomized design with three replicates. Parameters were analyzed with independent sample t-test. SPSS statistical software version 20.0 was used for statistical analysis.

Results and Discussion

PWL is significantly different ($P<0.05$) after one, two, and three months of storage where the mean PWL of shade cured onion after three months of storage was 8.04±1.6 and the mean PWL of field cured onion was 12.62±1.62 (Table 01). Hence, results reveal that shade curing is important alternative practices to conventional field curing that minimize the PWL thereby contribute to minimize the total post-harvest loss. Cured onion bulbs consist with one or more completely dried out skins which act as a barrier to water loss and dry off the onion neck (Gubb, & MacTavish, 2002). Hence, curing is important to minimize the shrinkage during post-harvest period and to minimize the fungal infections (Schroeder, & Toit, 2010; Downes, & Terry, 2010). According to Gubb, and MacTavish (2002)number of outer skins and the toughness of outer skin are important determinants of the postharvest shelf life that emphasize the need of curing where reduce the water loss.

Table 1: Physiological weight loss of two treatments during storage period

Treatment	Time (months after storage)		
	1	2	3
Field curing	5.20±.94	9.19±1.19	12.62± 1.62
Shade curing	2.66±.83	6.29±1.40	8.03± 1.60

Each vale represents mean Physiological Weight Loss ±SD of fifteen replicates

No significant difference was observed in TSS (P>0.05) between shade cured onions and the control where the means were 11.00 ± 1.06 and 11.13± 0.59 respectively after three months of storage period (Table 02).

Table 2: Total soluble solids of two treatments during storage period

Treatment	Time (months after storage)			
	0	1	2	3
Field curing	11.77±1.02	11.30±1.25	11.17 ±1.06	11.13±.58
Shade curing	12.43±.35	12.13±.64	11.13±1.40	11.00±1.06

Each value represents mean total soluble solids ±SD of three replicates

No significant difference (P>0.05) was observed in sprouting percentage between shade cured onions and the control where the means were 0.87±0.44 and 0.84±0.04 percentage respectively after three months of storage period. According to Msuya *et al,* (2005) sprouting loss is not severe prior to five months of storage period where it was not a severe loss even in this experiment.

No significant difference (P>0.05) was observed in rotting percentage between shade cured onions and the control where the means were 0.24±0.006 and 0.24±0.005percentage respectively after three months of storage period. Nega *et al.,* (2015) has conducted a study to find the effect of curing and top removal time on quality and shelf life of onion variety Bombay Red. According to his study bulbs cured for 10 days and none topped until 90 days of storage time has resulted the minimum PWL, rotting percentage and, sprouting percentage that implies the importance of top removal time on post-harvest storage quality and shelf life. Nevertheless, this research observed only the reduction of PWL by shade curing.

Sprouting percentage and rotting percentage are important parameters that determine the quality of onion bulbs and affect the marketability. Onion bulbs are in a dormancy stage at the harvesting where this dormancy stage varies depending on the genotype and storage conditions. However, in the dormancy period onions are sensitive to environmental changes where sensitivity is low at the early stage and it is high at the latter part (Sharma *et al.,* 2016). Hence, it is important to control the storage environment to delay the dormancy breakage. Though, controlling storage environment was not done for this experiment. Average relative humidity (RH) and temperature were ranged 57.2±8.32% and 33.84±1.79°C respectively sunny days. However, few rainy days were observed with maximum RH of 95%. Controlling of RH is a critical requirement for prolonging shelf life and reduces the post-harvest storage losses of onion to minimize disease incidences, prevent root growth and prevent removal of dried skins (Gubb, & Mac Tavish, 2002). According to the study conducted by Thamizharasi and Narasimham, (1990) a significantly low rate of microbial growth has been resulted between 60-65% relative humidity. Hence, future need of controlling the relative humidity in the storage should be highly emphasized.

Total Post-harvest Loss for the shade cured onion was 9.15% while for field cured onion was 13.7%. When considering the foliage removal, farmer practice is to remove foliage completely just after harvesting that constrains neck sealing and causes high microbial infections. Therefore, 2cm of neck length was allowed for the 'field curing' treatment while foliage was not removed for the 'shade curing' treatment. According to results no significant difference ($P>0.05$) of rotting percentage and germination percentage was observed between above treatments implies that neck cutting can be practiced by allowing an adequate length to support neck sealing.

Conclusions

Shade cured onion was resulted a low Total Post-harvest Loss (9.15%) compared to field cured onion (13.7%). Hence, shade curing can be considered as a better alternative for field curing that is constrained under unfavorable weather conditions during the harvesting season. However, controlling of relative humidity and temperature in the storage environment is highly important for further reduction of storage loss. Apart from that, possibilities for artificial curing should be further investigated.

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