Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 04, NO. 02, 2019
http://www.nilevalley.edu.sd

Research paper

Onion (*Allium cepa* L.) Bulb Storage in Improved Shaded and Aerated Store in River Nile State, Sudan

Abdelazim Mohamed Ali

Faculty of Agriculture, Nile Valley University, Sudan

Corresponding author: azimali58@yahoo.com

ABSTRACT

This study aimed to evaluate the storability of onion in improved shaded and aerated store in condition of River Nile State, Sudan. Dry onion of cultivar Red Baftaim collected from cultivation sites at Aliab during June 2018 and differentiated into small (50-100 g) and large size (100-280 g) bulbs. Storage started after two weeks curing, under straw shade, in three different sides of the store (North-eastern, the centre and South-western). Keeping material used were jute sacks, plastic boxes, plastic nets, baskets and the fifth part was left without containing material. Ten Kilograms of bulbs were weighed in the beginning of the storage period by early July to determine loss in weight of whole sample after 3 months as first experimentation. In the second experimentation five bulbs in each container were marked, their weight was registered every month to detect periodic trend for weight loss in each keeping material. Results revealed that bulbs kept in jute sacks showed the least sloping change in weight. All other containing material showed higher losses but in an inconsistent trend. While, bulbs stored in plastic boxes showed the highest rotting ratio. The storage side in the store showed no significant differences in trends and final evaluation of percentage losses. The last storing month showed sharper slope of bulb weight loss compared to the starting and the subsequent month, mainly in large size onions. Bulb sprouting was not observed in containers as well as on bulbs without containers.

Keywords: Onion, storability, improved store, keeping materials

تخزين البصل في مخزن مسقوف محسن ومفتوح للتهوية بولاية نهر النيل، السودان

عبد العظيم محمد علي

كلية الزراعة جامعة وادي النيل

هدفت هذه الدراسة لتقييم قابلية التخزين لصنف البصل المزروع بافطيم احمر تحت مخزن محسن تحت ظروف ولاية نهر النيل السودان. عينات الابصال تم جمعها من منطقة العالياب. وتم فرزها الي ابصال صغيرة (50-100 جرام) وكبيرة (100- 280 جرام). تم تخزين البصل بعد ان خضع لمعالجة لمدة اسبوعين في الحقل تحت ظل من القصب في يونيو 2018 في ثلاث مناطق في المخزن هي الشمال الشرقي ووسط المخزن والجنوب الغربي. حاويات التخزين التي استخدمت هي جوالات الخيش والصناديق البلاستيكية وشباك البلاستيك والمقاطف وترك الجزء الخامس ليخزن دون حاوية. تم تخزين عشرة كيلوجرامات من البصل في بداية التجربة وتم وزنها في نهاية التجربة لتقدير الفقد في الوزن بعد ثلاثة أشهر. كما تم ترقيم عدد خمس ابصال في كل حاوية وفي الجزء المخزون دون حاوية لتقييم التغير في الوزن. اوضحت النتائج ان جولات الخيش هي الاقل في الفقد الدوري وفي الوزن كما ان البصل المخزن في صناديق البلاستيك سجل النسبة الأعلى في تعفن الابصال. ولم تكن النتائج معنوية لا في الوزن النهائي ولا الشهري بين الجوانب المختلفة في المخزن كما ان الشهر الاخير سجل منحي كبير للفقد في وزن الابصال مقارنة مع الشهر الاول والثاني خاصة في الابصال الكبيرة. لم يلاحظ نموء للأبصال طوال مدة التخزين

كلمات مفتاحية: البصل، قابلية الخزن، مخزن محسن، حاويات التخزين

Introduction

Onion (*Allium cepa L.*) is one of the most important vegetable crops. It is grown commercially in nearly all parts of the world. Onion belongs to the family *Alliaceae*, genus *Allium* comprising about 500 species widely distributed in the northern temperate regions. Botanically it is a monocotyledonous cross- pollinated with 16 basic chromosomes number (2N). In Sudan it is considered as cool season vegetable crop. Onion has great economic importance due to its medicinal and nutritional values since ancient times and with worldwide production of storage (dry) onion as estimated in 2010 by 74.3 million tones. UK, Japan and Gulf countries are net importers, while leading exporters include India, Argentina, The Netherland, Spain, Mexico and Turkey (Brewister, 2008).

Northern states of Sudan are considered the best regions for onion production by virtue of having relatively cool, dry and long winter season which favors onion bulbing compared to other part of the country. The total area under the crop as estimated by Mohamedali in 2009 as 84000 hectares. Since then, onion production increased substantially specially in River Nile state. In the last years reports of the regional Ministry of Agriculture indicated that the River Nile state alone is now producing one million ton of bulb onion.

Red Baftaim cultivar dominates production at least in River Nile state due to its high productivity compared to other cultivars and the preferred cocking qualities that encouraged producers to expand its areas. However, it retained somewhat lower keeping qualities.

Major causes of onion losses during storage are; deterioration and loss of moisture, decomposition and loss of weight by respiration, onion rotting, contamination, onion sprouting and sun burn under direct sun condition. Storing requirement for onion is bound by the above mentioned problems. The crop requires two storing conditions; regarding temperature, relative humidity, light and storage atmosphere. Regarding temperature, two ranges are required (0-2 or 25-30) ^{0}C. Regarding humidity; most studies indicated that a store atmosphere of about 65–75% RH is required (Benkeblia *et al*., 2003; FAO, 2003; Banuu *et al*., 2014).

Warade *et al*. (1997) investigated the effect of different recommendations on storability of onion bulbs for six months under modified storage structure with bottom and central ventilation and observed that the modified storage structure had reduced losses 32 percent as compared to the conventional method (52%).

Like in similar conditions, most Sudanese onion producers bring onion directly to the market after harvest as the crop losses is great in traditional storing conditions. Proper storage facilities are very few and considered costly by farmers. The present storage capacities are inadequate and most of the available units has no trained personal. Marketing of the entire stock within one or two month of harvest usually pull prices to be very low then after, the rise in prices is rapid and sometimes elevated extraordinary when it is out of farmer hands, leading to frustration among producers as well as consumers. Hot and dry summer conditions at harvest and unexpected rains and flooding usually worsen farmer ability for proper traditional storage (Musa *et al*., 1973; Musa, 1999; Ahmed *et al*., 2015).

To improve the situation, the regional ministry of agriculture and the Japanese Agency for International Cooperation in their (CADAPIS) project desired to change this situation by establishing appropriate storage structures for onion with minimal cost to farmers, together with small dehydration units. Successful implementation was carried out at Aliab Agricultural scheme. The aim of this study is to evaluate the storability of onion in improved shaded and aerated Store.

Material and Methods

Onion bulbs samples (of cultivar Red Baftaim) were collected from cultivation sites at *Aliab* during June 2018. The bulbs were obtained after two weeks curing under straw shading in ambient environmental conditions in farmer field. Bulbs were differentiated into small (50-100 g) and large size (100-280 g) bulbs to be stored in three different sides of the store, North-eastern, the centre and South-western. The store (15x30m) is shaded with insulated iron sheets left by steel shafts and bordered by 1.3 cement wall. Bulb storage was conducted on shelf raised by one meter from the store flooring (Plate.1 and 2). Keeping material used were jute sacks, plastic boxes, plastic nets, baskets and the fifth part was left without containing material. Ten Kilograms of bulbs were weighed in the beginning of the storage period by early July to determine loss in weight of whole sample after 3 months as first experimentation. In the second experimentation five bulbs in each container were marked, their weight was registered every month to detect periodic trend for weight loss in each keeping material. In this sample, rotten bulbs were registered as percentage compared to initial sample number. Monthly average temperatures and relative humidity are illustrated as metrological climate indicators for the region (Table 1 and Fig. 1). The first experiment was arranged in a randomized block design, while, the other was arranged as split plot. Probability and LSD were presented as derived by computer statistical package SAS.

Plate (1) Store from outside

Plate (2) Store from inside

Table (1): Aliab weather temperatures in centigrade

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature	23	25	27	32	35	35	33	33	35	32	27	24
Avg. Max Temperature	31	33	36	41	43	43	41	40	42	40	36	32
Avg. Min Temperature	15	16	18	23	27	27	27	26	27	25	21	16

Source: https/www.weather atlas.com/en/Sudan/Atbara climate

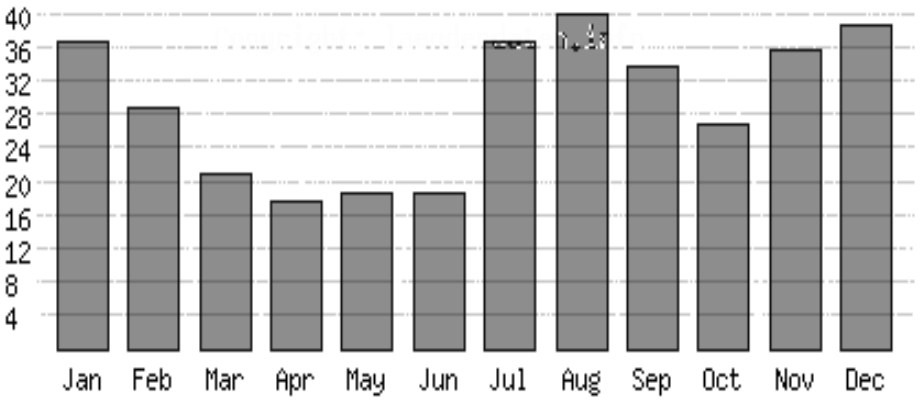

Fig. (1): Relative humidity (%) during the year in Aliab region
(Source: https/www.weather atlas.com/en/Sudan/Atbara climate)

Results

As indicted in table (2) Jute sacks resulted in the least significant percentage loss in weight in both large and small size bulbs (28.0 and 19.3 % respectively) followed by plastic nets and storing onion in plastic nets or without keeping material. While plastic box resulted in the highest percentage weight loss (62.7 and 63.3 % in large and small bulbs respectively).

Table (2): Percentage loss in weight per container after 90 days

Keeping material		**Jute sacks**	**Plastic net**	**Plastic box**	**Basket**	**Without**
Percentage loss in weight	**Large size bulbs**	28.0	33.3	62.7	50.3	32.7
	Small size bulbs	19.3	33.3	63.3	44	37.3
	Average	23.7	33.3	63	47.2	35
CV %	26.65					
P	***					
LSD bulb size	25.57					
LSD container	13.22					

LSD: least significant difference at stated confidence level (*=95% ** = 99% *** > 99%)

Regarding trend for individual bulb deterioration, as reflected in table 3A and 3B, significant differences between containers with regard to detected periodical loss in weight on both large and small bulbs observed. Bulbs kept in jute sacks showed the least sloping change in weight. All other containing material showed higher losses but in an inconsistent trend. While, bulbs stored in plastic boxes showed the highest rotting ratio (Table 4**)**. No single sprout was observed over bulbs in all

containers as well as on bulbs without containers. The storage side in the store showed no significant differences in trends and final evaluation of percentage losses. The last storing month showed sharper slope of bulb weight loss compared to the starting and the subsequent month, principally in large size onions.

Table (3A): Large size onion loss in weight through time (g)

Container type	Loss in weight (g)				
	Side	**Starting**	**After 30 days**	**After 60 days**	**After 90 days**
Without	North east	178.8	154	148	83
	Centre	144.6	136	133.2	76
	South west	183.2	182	149	71
	Mean	**168.87**	**157.33**	**143.40**	**76.67**
Basket	North east	180.8	174	134.4	98.2
	Centre	164.4	156.6	140.2	57.5
	South west	140.6	138	132	88.6
	Mean	**161.93**	**156.20**	**135.53**	**81.45**
Jute sack	North east	182.6	172.8	162.6	144.6
	Centre	178	171.2	170.2	158
	South west	162.2	156	154.4	142.3
	Mean	**174.27**	**166.67**	**162.40**	**148.29**
Plastic net	North east	109.4	105	100.8	80.75
	Centre	165.8	147	138.8	81
	South west	123.6	117.6	117.2	113
	Mean	**132.93**	**123.20**	**118.93**	**91.58**
Plastic box	North east	125.8	119.6	113	97.6
	Centre	119.6	115.2	104.2	57.3
	South west	189	167.8	146.8	131
	Mean	**144.8**	**134.20**	**121.33**	**92.28**
P side			NS	NS	NS
P container			**	***	***
P interaction			NS	NS	NS
LSD container			26.08	21.61	33.18

LSD: least significant difference at stated confidence level (*=95% ** = 99% *** > 99%)

Table (3B) Small size onion loss in weight through time (g)

Container type	Side	Bulb weight (g)			
		Starting	After 30 days	After 60 days	After 90 days
Without	North east	77.6	79	58.6	32.4
	Centre	78	67	49	34
	South west	73.8	62.4	59	26
	Mean	**76.47**	**69.47**	**55.53**	**30.8**
Basket	North east	92	88.2	76.4	71
	Centre	90.4	85.2	72.2	45.7
	South west	88.4	85.4	83	70.2
	Mean	**90.27**	**86.27**	**77.2**	**62.32**
Jute sack	North east	67.8	63.8	60.8	59.2
	Centre	78.4	77	73.8	68.5
	South west	66.8	63.8	62.6	61.2
	Mean	**71**	**68.2**	**65.73**	**62.97**
Plastic net	North east	79.8	62.2	58	36
	Centre	83.6	73.2	70.2	65
	South west	68.4	65.4	61.2	53.6
	Mean	**77.27**	**66.93**	**63.13**	**51.53**
Plastic box	North east	88.6	84.6	76.4	51.6
	Centre	106.4	93.2	86	76.6
	South west	62.6	59.8	53	37.5
	Mean	**85.87**	**79.2**	**71.8**	**55.23**
P side			NS	NS	NS
P container			*	NS	*
P interaction			NS	NS	NS
LSD container			14.29		20.85

LSD: least significant difference at stated confidence level (*=95% ** = 99% *** > 99%)

Table (4): Percentage of rotting bulbs in each batch (20 bulbs per split treatment)

Container type	Side	After 30 days		After 60 days		After 90 days	
		Small bulbs	Large bulbs	Small bulbs	Large bulbs	Small bulbs	Large bulbs
Without	North east	0	0	0	5	5	5
	Centre	0	0	0	0	0	5
	South west	0	0	0	0	0	5
Basket	North east	0	0	5	0	10	5
	Centre	0	0	0	0	5	5
	South west	0	0	0	0	5	5
Jute sack	North east	0	0	0	0	0	0
	Centre	0	0	0	0	5	0
	South west	0	0	0	0	0	0
Plastic net	North east	0	0	10	0	10	0
	Centre	0	0	0	0	0	5
	South west	0	0	0	0	0	0
Plastic box	North east	0	0	10	0	15	5
	Centre	0	0	0	0	0	5
	South west	0	0	0	0	0	0

Discussion

Although not like perishable crop, onion is a semi-perishable crop with relatively high moisture content. The storability is relatively low. Hence, 30-50% postharvest losses were reported during short term storage under room conditions. As reported by Musa *et al*. (1973) very high percentage (>50%) of losses is expected in long term storage (more than 5 months) under condition of Sudan.

Perfect bulb storage depends on acquaintance with the scientific facts about bulb dormancy and the pathology of diseases of stored bulbs. Excessive water loss from bulbs and microbial infection of the inner fleshy scales usually hindered by the dry intact skin of the onion bulb. It also prevents postharvest injuries. During the maturation of bulbs the outer scales lose water and form thin, dry skins that wrap the bulb, as stated by Brewister (2008). In this concern, attractive and intact skins are essential for high-quality onions preservation. Therefore, knowledge of how to produce and maintain sound and attractive skins is important for the onion to be kept in good condition for longer periods. Controlling factors of pre-harvest and post-harvest operations will yield best storage results. In the store, high relative humidity will reduce moisture loss but at high temperatures will increase product rotting and may induce sprouting. Intermediate temperatures (5-20) in presence of humidity will enhance sprouting. Low humidity usually preferred to reduce fungal growth and rotting, but will enhance shriveling and water loss. According to this background, factors are complicatedly interrelated.

In this study bulbs were kept under shade at high summer temperatures and 20-40% RH. Observation revealed that water loss and shriveling with individual bulb were more prominent in bulbs stored without containing material due to lower % RH, in the vicinity of the individual bulb, than always bulb need to preserve its protective skin. Onion skins usually adsorb and evaporates water from the surroundings atmosphere till reach equilibrium with the water vapour pressure in their adjacent environment. Skin water content depends primarily on RH of the surrounding vicinity and, on temperature at a given RH. However, increasing humidity in the bulb atmosphere to 65–70% RH is sufficient for hygroscopic equilibrium irrespective of temperature to keep reasonable skin flexibility and avoids dampness to extent of encouraging microbial rotting. Although kept in good ventilation, bulbs stored without keeping materials performed more loss of weight compared to other kept in containers. Water loss might be more excessive leading to continuous scale removal under low RH as at this condition skins seems to be less flexible and tend to torn apart. Such interpretation was explained by Brewister (2008) and Sabaragamuwa *et al*. (2011). On the other hand, containers can keep more humidity around bulb surroundings, however, this condition seemed to enhance rotting and decay as stated by Swee-Sauk *et al*. (2002), this was clearly manifested on bulbs kept in plastic boxes. The ability of jute as cellulose fiber to attract humidity and keep bulb surrounding somewhat humid and somewhat ventilated may favored it over other containing materials under this type of stores.

Conclusion:

Compared to other bagging materials, under the improved shaded and aerated store, the jute sacks showed the least losses and the least sloping change in bulb weight during short storage period (3-4 months). Onion bulb losses in such conditions usually caused by desiccation and /or rotting rather than bulb sprouting.

Acknowledgement:

The paper was written due to a project supported by the Japanese Agency for International Cooperation (JAICA). The author wish to thank the JAICA administration office in Sudan for their financial support and encouragement.

References

Ahmed, A. D.; Elkashif, M. E.; Elamin, O. M. and Mahmoud, H. I. (2015). Comparison of cold and traditional storage methods on the storability of selected onion (*Allium cepa* L.) cultivars. Gezira J. of Agric Sci., 13 (1): 17-34

Banuu, Priya E. P.; Sinja, V. R.; Alice, R. P. J. S.; Shanmugasundaram, S. and Alagusundaram, K. (2014). Storage of onion- review. Agri. Review, 35 (4): 239 – 249.

Benkeblia, N.; Onodera, S. and Shiomi, N. (2003). Effect of Temperature and Storage Time on fructosyl transferase Activities (1-FFT and 6G-FFT) in Onion Bulb Tissues. Soil and Plant Sci. 53: 211-214, Taylor & Francis.

Brewster, J. L. (2008). Onion and other vegetable Alliums (2nd Edition). Oxford, UK.

FAO (2003). Onions: Post-Harvest Operation. Author: Linus U. Opara. Edited by AGST/FAO: Danilo Mejía, PhD, FAO (Technical).

Mohamedali, G. H. (2009). Onion in Sudan, production, storage and breeding. Agricultural Research Corporation, Sudan (in Arabic).

Musa, S. A. (1999). Effects of environment, packing material and cultivar on the storability of onion (*Allium cepa* L.). MSc thesis, University of Gezira, Sudan.

Musa, S. A.; Habish, H. A.; Abdalla, A. A. and Adlan, B. B. (1973). Problems of onion storage in the Sudan. Tropical Sciences, 15:319-327

Sabaragamuwa, R. S.; Dharmasena, D. A. N. and Mannaperuma, J. (2011). Optimization of Environmental Parameters for Short-term Storage of Big Onions and Evaluation of the Feasibility of Controlled Environmental Storage. Tropical Agricultural Research, Vol. 22 (4): 356 – 366.

SAS (2003). SAS institute corporation. SAS/STAT User's Guide, Version 9.1.

Swee-Sauk, K. O.; Chang, W.; Wang, J; Shering, S. and Shanmugasndaram, S. (2002). Storage variability among short day onion cultivars under high temberatures and high relative humidity and its relationship with disease incidence and bulb characteristics. Journal of American society of horticultural sciences. 127(5): 848-854.

Warade, S. D; Desale, S. B. and Shinde, K. G. (1997). Studies on storage of onion bulbs. Journal of Maharashtra Agricultural Universities, 22(3): 336.