Journal of Agricultural Engineering and Technology (JAET)
JAET - CIGR Section VI Special Issue:
Innovation & Technologies for Sustainable Agricultural Production & Food Sufficiency
JAET, June, 2019. Vol. 24(2):35-43
Published by the Nigerian Institution of Agricultural Engineers (NIAE).

Print ISSN: 014-2222, Electronic ISSN: 2651-558X
www.jaet.com.ng

CONSTRUCTION OF STORAGE STRUCTURES FOR ONION BULBS FOR FOOD SECURITY

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ABSTRACT
The impacts of climate change on natural disasters, infra-structure and livelihood, infers that the implementation of climate change adaptation strategies in developing countries needs to be practically addressed. Among other factors, inter-annual rainfall variations, excessive rainfall which causes flood and drought cause great stress to the farming activities, crop production and crop yield. During these periods there is food scarcity due to lack of storage infrastructure that can make food to be available throughout the year. Large quantities of harvested produce are wasted due to deterioration during the peak of harvest. To ensure food security and to reduce wastage, the adoption of an effective storage condition is necessary. This paper presents the analysis to set up proper storage medium for onion bulbs to make the crop available when it is off season. A storage shed was constructed and some storage cabinets were kept inside for storing onions and compared with open storage of onion bulb on concrete floor. The storage shed was built with concrete blocks and covered with corrugated iron sheet. The storage cabinet was constructed with wood which was divided into three portions and the sides were covered with thin wire mesh. The onion bulbs were measured, graded into small, medium and big sizes and arranged in each portion (A, B and C) of the cabinet, respectively. The temperature and relative humidity inside the storage medium were measured three times daily. Analysis of variance was used to determine effect of storage period on weight of the onion bulbs. The comparison of open storage and storage was done using T-test analysis. The area of the entire storage shed was 25 m2 and each storage cabinet was 2.25 m2 and each portion of the cabinet was 0.25 m2.The diameter of the onion bulbs ranged from 3.2 to 5.98 cm (small), 6.01 to 7.09 cm (medium) and 7.39 to 9.27 cm (large). The result of experimental values showed that the rate of deterioration varies with the sizes of the onion. Analyses of variance results indicated that moisture (weight) loss increased as storage period increased. The rate of deterioration of onion bulbs in storage cabinet is minimal. The effect of temperature and relative humidity is significant at 95 % confidence level on stored products which necessitates the prolonged shelf life. The designed wooden storage cabinet for homestead storage of onion bulb is recommended for domestic use to ensure food security and safety.

Key words: Onion bulb, storage cabinet, food security, weight loss, climate change

1 INTRODUCTION

1.1 Agronomy of Onion

Onion *(Allium cepa)* is an edible bulb composed of a fleshy tight concentric leaf based having a pungent odour and taste, it is a bulbous plant cultivated worldwide as a vegetable, a cool season biennial onion of Asiatic origin and belonging to the plant order lilalies. The Onion is grown for its edible bulbs other species are leek, garlic, welsh onion and shallot (Brewster, 1994). Onion is

the queen of the kitchen (Selvaia, 1976), the onion is preferred mainly because of its green leaves immature and mature bulbs are either eaten raw or cooked as a vegetable, its varieties are classified mainly according to pungency (mild or pungent) or use (dry bulb of green bunching). Bulb may be white, red or yellow. They generally have a papery outer skin over a fleshy, layered inner conie used worldwide for culinary purposes; they come in a wide variety of forms and colours (KTBL, 1993).

In this light of the day, hybrid varieties with increased disease resistance, longer storage life and improved quality are rapidly displacing older varieties; Texas, New York and California are important producing status (Bruce et al., 1991). Onion (Allium cepa) in general sense can be used for any plant in genius but used without qualifias usually mans. It is also called the garden onion (usually but not exclusively the bulbs) are edible with a distinctive strong sweetened by cooking.

The underground bulbs, like lily, are priced around the world for the magic it makes in multitude of dishes with its pungent flavor and odour. There are two main classification of onion, green onion (also called scallions) and dry onion which are simply matured onions with a juicy flesh covered with dry papery skin. Dry onion comes in a wide range of sizes, shapes and flavours, among those that are mild flavoured are the white or yellow Bermuda onion which is usually yellow skinned from August to May and red or Italian onion which is available year round. The primary center of origin of onion is central Asia with secondary centre in Middle East and the Mediterranean region, from these centers, onion has spread widely to many countries of the world. Onion is different from other edible species of Alliums for its single bulb and is usually propagated by true botanical seed. (Dahlgren et al., 1985). Onion is one of the oldest cultivated vegetables and has been in cultivation for more than 4000 years, the earliest records came from Egypt, where it is cultivated at the time of the old kingdom. Carvings of onions can be seen on the walls of pyramids in the 3rd and 4th dynasties. A global review of major vegetables show that onion ranks second to tomatoes in area under cultivation. (Dahlgren et al., 1985)

1.2 Climate Change and its Impact on Onion Bulb Availability in Nigeria

There was problem of flood in Nigeria in 2010 which eroded onion plants and bulbs away and this led to loss of products. In other words, there is a lot of wastage of onion due to deterioration when the product is at the peak of harvest. During the off season there is scarcity of onion bulb and the available ones are expensive. These problems arise from improper storage methods or lack of storage facility for onion bulbs. This study is targeted to getting a suitable storage medium and condition to make the product available at cheaper cost throughout the year in Nigeria. Therefore, proper storage of onion bulbs will encourage farmers for more production and this will improve the economy of the nation. The aim of this work is to construct an underground pit and shelves for storing onion bulbs and determine effect environmental factors on the deterioration rate of the onion bulbs,

2.0 Research Methodology

The materials used for the construction of the underground storage pit and shelves were such that could make it to be easily maintained, repaired, and obtained at relatively lower costs. The materials used are such that can withstand humidity, heat and prevent rodent attack. Some of the materials used are cement, sand, gravel, wood, wire mesh net and corrugated iron sheet.

2.1 Design consideration of the storage pit

Some factors were considered in the design of storage pit of onion bulb in order to produce high quality and large quantity of products to be dried. The factors considered are as follows:
The availability and cost of materials required (relatively cheaper than imported ones),
Ease of operation
Can be operated by one person
Size of the shelves and storage structure
Ease of Maintenance
Safety

2.2 Description of the underground pit

The underground pit consists of the following: foundation, wall, roof, floor and shelves. The foundation of the pit was made; a piece of land was pegged to give a rectangular shape of 3 m by 3 m. This was sited and constructed at the workshop of the Department of Agricultural Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The foundation was dug until sub soil was got. The concrete was pounded in the trench, and then five layers of block were laid and join together by mortar from foundation to make the underground pit with 1 m depth. The floor was filled with a concrete mixture of ratio 1:3:6. The floor was reinforced to ensure adequate strength and firmness. The overall materials were; 16 bags of cement, 155.5 kg of sand and 352 kg of gravel. The wall support was constructed with 3 by 4 hard wood and the four sides were covered with chicken net and mosquito net to prevent insect and rats from entering the barn and also allow free movement of air in the barn. The roof is covered with galvanized sheets and the areas of the roof and storage pit are 2 m2 and 9 m2, respectively. Figures 1and 2 show the design diagrams of the storage shed. The storage cabinet was made of wood divided into three portions with chicken wire mesh net. The cabinet is rectangular in shape, with length of 0.5 m, thickness of 0.5 m and breath of 0.5 m. Fig. 3 shows the storage cabinet constructed.

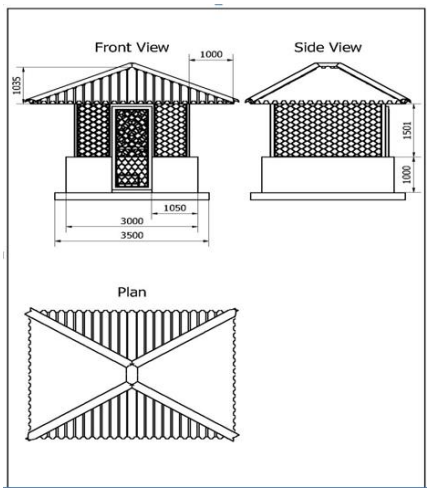

Fig. 1: Plan of the storage shed

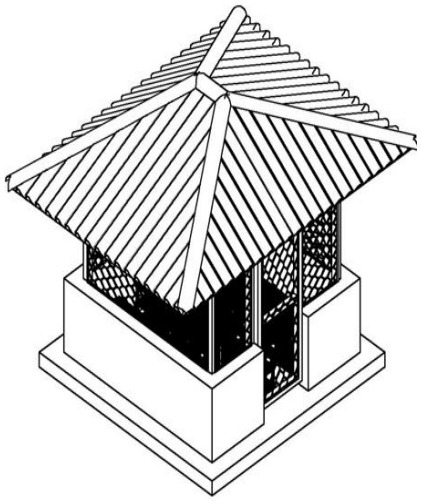

Fig.2: Design of storage shed for onion bulbs

Fig. 3: Storage cabinet for onion bulbs

2.3 Sample Preparation and Measurement of Onion bulbs

Some onion bulbs were purchased from Sabo market in Ogbomoso. The onion bulb sampling experiment was carried out and the onions were grouped into three different sizes; small, medium and large. A vernier caliper was used to measure the width of the samples. The diameter of the onion bulbs ranged from 3.2 to 5.98 cm (small), 6.01 to 7.09 cm (medium) and 7.39 to 9.27 cm (large). The grading of sample was necessary to compare the rate of deterioration among the different sizes.

Ninety onion bulbs were arranged on each portion of the cabinet; thirty small onions, thirty medium onions and thirty large onions as shown in Figure 4. The onions were checked carefully for damages and ensure that their body covers were intact (unremoved) before storage. The onions were arranged randomly on the storage cabinet and not touching one another. The temperature was taken three times daily inside the room at 7:00am, 12 noon and 6:00pm, each onions were labeled and the weight were taken before storage and at the end of the week for a period of eight weeks(two months). The significant losses were being determined using T-test and also the effect of the week and losses were determined using analysis of variance (ANOVA).

Figure 4: cabinet storage of onion bulbs

3.0 Results and Discussions

The results of the average weight loss of onions are presented in Fig. 5. It was observed that the weights of the onions reduced as the weeks advanced for the period of 2 months. The

environmental factors which were wet bulb temperature, dry bulb temperature and relative humidity played a significant role in the weight loss and deterioration of the onions. It was observed that there was weight loss in the onions as the weeks progressed. The variance in the weight of onion is due to the hygroscopic nature of the crop; so when it increases it has absorbed moisture and when it decreases it loses moisture as presented in Table 1.

From the Fig 5.1 it was observed that there were more weight losses in the onions as the weeks progressed. The variance in the weight of onions is due hygroscopy, that is when it increases it absorbes moisture and when it decreases it loses moisture. From Table 2, It was observed that the F calculated (3.558676 and 8.636586) is greater than the F critical (2.591094 and 3.633716), this implies that there is a great significance in the weeks and the losses, hence making all the environmental factors have an effect on the small, medium and big size of the onions. Figure 5.2, 5.3 and 5.4 shows that small onions, medium onions and big onions results have the same pattern because each one has its losses increasing by the week. Further investigation was carried out on the result using the T-test statistical analysis. Table 3, 4 and 5 shows the confident limit of the small, medium and big onions at 95%.

From Table 3, the value of t-stat ($1.01142E^{-05}$) is less than tcritical one-tail and t Critical two-tail (1.795883691 and 2.200986273) respectively. This implies that there is a significant difference. Table 4 shows that the value of t-stat (-1.66907E-06) is less than t Critical one-tail and t Critical two-tail (1.745884219 and 2.119904821) respectively. This implies that there is no significant difference. Table 4 shows that the value of t-stat (-1.34821E-06) is less than tcritical one-tail and t Critical two-tail (1.745884219 and 2.119904821) respectively. This implies that there is no significant difference.

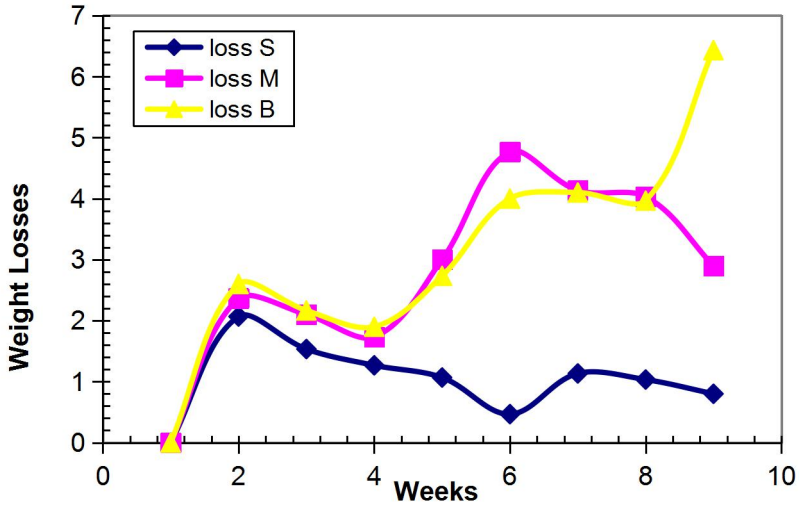

Fig. 5.1 Graph of weeks against weight losses for all the three sizes of onions

Table 1: Analysis of variance of the weeks and losses of the three sizes of onion

Source of Variation	Sum of Square	Degree of freedom	Mean of Square	F Calculated value	P-value	F standard value
Weeks	26.45926	8	3.307407	2.754189	0.040264	2.591094
Losses	22.11654	2	11.05827	9.208595	0.002182	3.633716
Error	19.21383	16	1.200864			
Total	67.78963	26				

The regression equation for loss S = - 19.1 - 0.094 WK - 0.000 WT + 0.456 DT + 0.100 RH

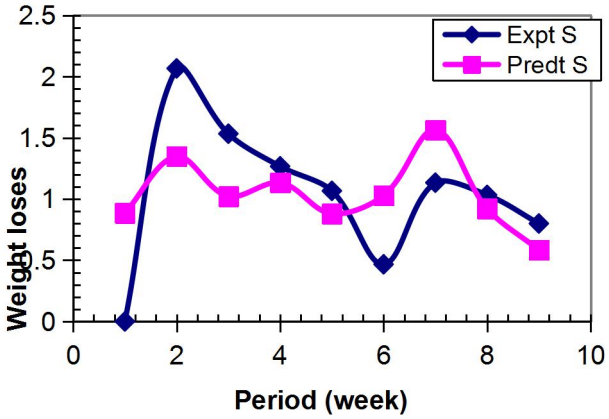

Fig. 5.2 Graphical comparison of experimented and predicted results for small onions

The regression equation for loss M = - 18.6 + 0.424 WK + 0.584 WT - 0.035 DT + 0.073 RH

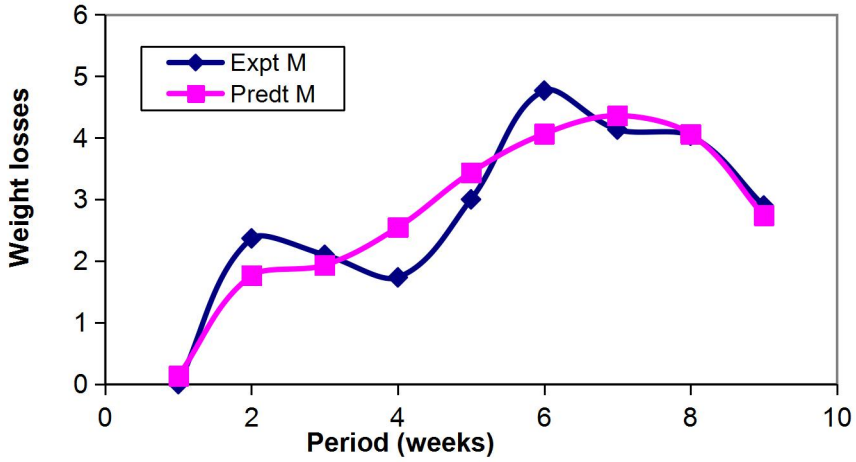

Fig. 5.3 Graphical comparison of experimented and predicted results of medium onion

The regression equation for loss B = - 6.9 + 0.387 WK + 0.033 WT + 0.377 DT - 0.034 RH

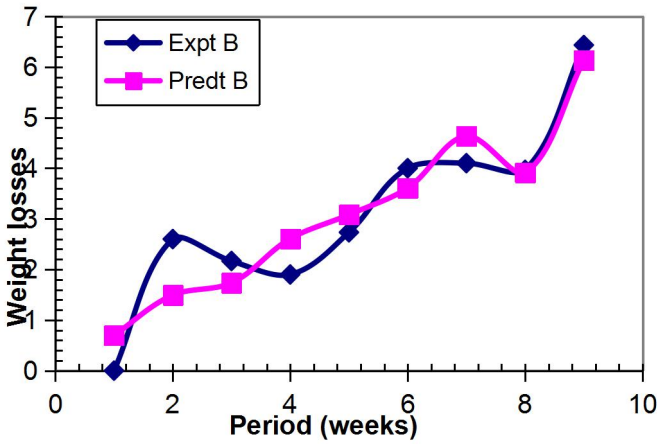

Fig. 5.4 Graphical comparison of experimented and predicted result of big onion

Table 2: T-test analysis results for experimented and predicted values of small onions

	Experimented values of Small	Predicted values of Small
Mean	1.040741111	1.040738889
Variance	0.35327171	0.081192757
Observations	9	9
Hypothesized Mean Difference	0	
Degree of freedom	11	
t Stat	1.01142E-05	
P(T<=t) one-tail	0.499996056	
t Critical one-tail	1.795883691	
P(T<=t) two-tail	0.999992111	
t Critical two-tail	2.200986273	

Table 3: T-test analysis results for experimented and predicted values of medium onions

	Experimented values of Medium	Predicted values of Medium
Mean	2.781481111	2.781482222
Variance	2.108641988	1.879829919
Observations	9	9
Hypothesized Mean difference	0	
Degree of freedom	16	
t Stat	-1.66907E-06	
P(T<=t) one-tail	0.499999345	
t Critical one-tail	1.745884219	
P(T<=t) two-tail	0.999998689	
t Critical two-tail	2.119904821	

Table 4: T-test analysis result for experimented and predicted values of big onion

	Experimented value of Big	Predicted value of Big
Mean	3.1	3.100001111
Variance	3.247219694	2.86561904
Observations	9	9
Hypothesized Mean Difference	0	
Degree of freedom	16	
t Stat	-1.34821E-06	
P(T<=t) one-tail	0.49999947	
t Critical one-tail	1.745884219	
P(T<=t) two-tail	0.999998941	
t Critical two-tail	2.119904821	

4.0 Conclusions

Ninety onion bulbs (small, medium and big) were stored at room temperature for a period of eight weeks (two months). The weight loss of each onions were studied against the week and the environmental conditions. The results showed that each onions has its own experimented and predicted value and has a significant difference at 95% confident limit and the rate of deterioration onions varies with the size of the onion bulbs. The onions stored in cabinet had high rate of deterioration than those stored in storage shed built with underground pit filled with sawdust. Therefore, storage shed is recommended for storing onion bulbs for food security.

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