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ASSESSMENT OF SIX STORAGE METHODS FOR SEED POTATO STORAGE IN NIGERIA

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ABSTRACT

Studies were carried out in 1997 and 1998 at Kuru, Jos Plateau, Nigeria to assess six storage methods for the storage of seed potato. The methods were: Storage in jute bags, perforated polythene bags, baskets, racks, crates and floor. Potato varieties used were Nicola (medium to long dormancy) and B7716-2 (short dormancy). The seed tubers were stored for six months during which daily maximum and minimum temperatures of the storage environment, and the relative humidity were recorded. Tuber weight loss, loss due to rots, sprout number and length per tuber at the end of the storage were also recorded. Results showed that only polythene bag reduced tuber weight loss, but resulted in highest tuber rots due to soft rot disease of potato. Poor light condition in jute bags encouraged the development of long and etiolated sprouts of seed potato. Sprout number per tuber was not affected by the storage methods. Varietal differences in tuber weight loss, sprout number and tuber rots were significant ($P \leq 0.05$). Due to dehydration, tuber weight loss increased by 37 percent during the six months storage. Based on the results obtained, storage is recommended in crates, racks and on floor of well-ventilated stores for short-term (4 months) storage, since these methods provided good ventilation of stored seed and tuber rots are low.

INTRODUCTION

Inadequate supply of seed potato to Nigerian farmers can be largely attributed to high losses of seed potato during storage. It has been reported that farmers lose as much as 40% of their stored seed within three months of storage due to poor storage conditions (Okonkwo, 2002). Such high losses make it difficult for farmers to meet their seed needs (Ifenkwe and Nwokocha, 1986). Because of the unfavourable storage conditions, farmers generally do not store seed potato for more than four months, except where refrigerated storage is possible (Okonkwo *et al.*, 1988). To conserve their seed, farmers who have facilities for irrigation grow potato in both rainy and dry seasons. Seed is planted as soon as it sprouts.

Several methods are available for seed potato storage. Booth and Shaw (1981) stated that the variety and quantity of seed potato to be stored, length of storage, climate of the area and the economic benefits of storage should be considered before selecting a storage method. Cold storage is the most ideal method for seed potato storage under tropical conditions (Okonkwo, 2002). Cold stores are however expensive to install and maintain, and most farmers cannot afford them. Moreover electricity is not available in most rural areas where potato is produced. Diffused light potato storage is practiced in many developing tropical countries (Booth and Shaw, 1981). The

store takes various forms depending on the local conditions. Basically it uses outside air for ventilation and it is designed to admit adequate diffused light into the store. Booth and Shaw (1981) reported that seed potatoes are stored in crates or shelves in the Philippines.

In Nigeria, farmers store seed potato in baskets, sacks while others spread their seed on the floor of any space in the family house or store (Okonkwo *et al.*, 1995). Other storage methods described by Burton (1989) include pit methods, delayed harvest and clamp method.

Most long-term storage methods used by farmers in Nigeria are not efficient. Consequently farmers frequently record high storage loss. The object of this study was to assess six methods of storage for seed potato storage under Nigerian conditions.

MATERIALS AND METHODS

This study was carried out at Kuru, Jos Plateau, Nigeria between September 1997 and February, 1998. Kuru (1350 meters above the sea level) is located between latitude 9.8°N and longitude 8.7°E. Six methods of seed potato storage namely Storage in jute bags, perforated polythene bags, racks, baskets, wooden crates and on the floor of a store were assessed to determine the best method for the storage of seed potato under Jos Plateau conditions. The study was set up in a diffused light potato store described by Nwokocha and Ifenkwe (1988). Two potato varieties used for the storage were Nicola (medium to long dormancy) and B7716-2 (Short dormancy). Six hundred seed tubers of each potato variety were used to assess each storage method. Each method of storage was replicated three times and the experimental design was randomized complete block. The seed was stored from September to February.

Seed tubers were weighed before storage and bi-weekly thereafter. Tuber rots and rat damage were recorded every week. At the end of the six months storage, tuber shrinkage score, final tuber number and weight, sprout number and length per tuber were also recorded. Daily maximum and minimum temperatures, relative humidity of the storage environment and the outside air were recorded. Monthly market survey of seed and ware potato prices were carried out at Bukuru and Bokkos, the major potato marketing centers on Jos Plateau to determine the economic benefit of seed potato storage.

RESULTS

Average maximum and minimum temperatures, and relative humidity of the storage environment from 1997 to 1998 are shown in Table 1. The temperatures in the diffused light potato store were lower than those of the outside air. Lowest minimum temperature and relative humidity were recorded between November and February each year (Table 1).

Table 1. Average Temperatures and Relative Humidity of Storage Environment and Outside Air (1996-98)

Month	Potato Storage Environment			Outside Ai		
	Temp. oC		%	Temp. oC		%
	Max	Min	R.H	Max	Min	P.H
January	26	14	45	28	9	37
February	25	13	47	32	13	38
March	28	16	46	34	18	45
April	32	18	59	33	17	58
May	30	16	65	36	16	75
June	31	15	75	31	15	81
July	28	14	87	31	14	91
August	29	13	90	32	13	86
September	26	16	91	29	16	79
October	25	17	61	31	17	69
November	26	16	58	33	12	42
December	25	13	44	27	10	38
Mean	27.6	15.08	64.0	31.4	14.2	61.5

Tuber Weight Loss

Loss of weight by seed tubers was significantly affected by the method of storage and potato variety stored and method of storage x variety interaction on tuber weight loss was also significant ($P \leq 0.05$). Weight loss of B7716-2 was 14.46% higher than that of Nicola. Only storage in perforated polythene bags significantly reduced seed weight loss (Table 2), but other methods did not. Tuber weight loss increased with duration of storage (Table 3). Highest weight loss due to dehydration occurred during the harmattan months of November to January when the relative humidity was low (Tables 1 and 3).

Table 2. Percentage Tuber Weight Loss as Affected by Method of Storage and Variety after 6 Months Storage (1997 and 1998)

Method of Storage	Potato Variety			
	Nicola	B7716-2	Mean	
LSD (0.05)				
	% Tuber Weight Loss			
Jute bag	43.48	44.93	44.20	
Polythene bag	34.22	34.60	34.41	
Rack	36.93	47.57	42.25	5.32
Basket	35.03	43.48	39.26	
Floor	32.27	48.19	40.23	
Crate	36.40	50.33	43.36	
Mean	36.39	44.85		
LSD (0.05)	4.64			

Table 3. Average Percentage Weight Loss of Seed Tubers as Affected by Duration of Storage

Month of Storage	Potato Variety	
	Nicola	B7716-2
	% Tuber Weight Loss	
September	3.6ed	8.4e
October	10.4d	16.6c
November	18.6c	21.5c
December	20.5c	30.8b
January	30.9b	41.1a
February	38.8a	46.8a
S.E.	3.8	5.1

a, b, c, d Values in the same column followed by different superscript are significantly different ($P \leq 0.05$).

Sprout Number and Length Per Tuber

Methods of potato storage did not significantly affect sprout number per tuber, but there were differences due to variety (Table 4). Nicola had more sprouts per tuber than B7716-2. Shortest sprout length was obtained from seed tubers stored in racks followed by perforated polythene bags (Table 5).

Tuber loss due to Rots

Storage of seed tubers in polythene bag resulted in highest tuber rot. This was followed by storage in basket (Table 6). There were significant differences due to Variety. About 25.8% more seed tubers of B7716-2 than Nicola were lost to rots during storage.

Market Prices Of Seed And Ware Potato

Table 7 shows the market prices/kg of seed and ware potato tubers at Bukuru and Bokkos, Jos Plateau in 1997 and 1998.

The result of the survey showed that potato prices were generally low between the months of July and September each year. Highest prices were obtained during the dry season months of November – April. The result also showed that seed potato is not available all months of the year. It is more available at the on-set of the planting season than in other months. Ware potato is

available in all months of the year. Ware potato prices are lowest during the peak harvest months (July to September) each year.

Table 4. Effect of Storage Methods and Variety on Sprout Number/Tuber after Six Months Storage

Method of Storage	Potato Variety*			
LSD(0.05)	Nicola	B7716-2	Mean	
Jute bag	3.92	3.00	3.46	
Polythene bag	3.78	3.13	3.46	
Rack	4.95	3.02	3.99	1.85
Basket	3.80	3.85	3.82	
Floor	4.78	2.80	3.79	
Crate	4.89	3.02	3.46	
Mean	4.35	3.14		
LSD (0.05)	1.03			

* Values are expressed as mean sprout number per potato tuber.

Table 5. Effect of Method of Storage and Variety On Average Sprout Length/Tuber (mm)

Method of Storage	Potato Variety			
LSD(0.05)	Nicola	B7716-2	Mean	
	Sprout Length/Tuber (mm)			
Jute bag	26.61	15.26	20.94	
Polythene bag	13.90	14.40	14.15	
Rack	12.45	13.34	12.90	2.73
Basket	16.37	12.15	14.26	
Floor	14.28	16.58	15.43	
Crate	13.09	17.94	15.52	
Mean	16.12	14.95		
LSD(0.05)	1.44			

Varietal differences on sprout length was not significant ($P \leq 0.05$).

Table 6. Effect of Method of Storage and Variety on % Tuber Loss due to Diseases (Soft Rots)

Method of Storage	Potato Variety			
LSD(0.05)	Nicola	B7716-2	Mean	
	% Tuber Rots			
Jute bag	1.23	30.64	15.94	
Polythene bag	2.29	36.08	19.19	
Rack	0.96	20.44	10.70	5.83
Basket	2.44	31.85	17.15	
Floor	1.71	25.78	13.75	
Crate	1.67	20.15	10.91	
Mean	1.72	27.49		
LSD (0.05)	4.66			

DISCUSSION

The two basic problems of potato storage in Nigeria are the high storage temperature and low relative humidity during the harmattan months of November to February (Okonkwo, 2002). A good storage method for seed potato should address these basic problems. Average temperature of the storage environment was 21°C. This temperature

is higher than the 10 – 15°C recommended for three months storage of seed potato (Booth and Shaw, 1981). High storage temperature increases the respiration of tubers and the consequent seed deterioration and degeneration in storage (Burton, 1989). Low humidity during the harmattan accelerates tuber dehydration with the consequent weight loss and even complete drying up. The result agrees with that of Okonkwo *et. al* (1988) which showed that tuber weight loss increased with duration of storage. It was also reported that seed tubers, which lost more than 30% of the fresh weight during storage, perform poorly in the field.

Table 7. Average Market Prices of Seed and Ware Potato Tubers in 1997 & 1998 at Bukuru and Bokkos Jos Plateau (₦/Kg)

	Bukuru				Bokkos			
	Ware		Seed		Ware		Seed	
Month	1997	1998	1997	1998	1997	1998	1997	1998
January	15.50	15.00	14.80	14.40	15.40	14.70	15.00	16.71
February	14.40	14.80	14.80	15.11	13.60	13.95	15.10	14.91
March	14.80	14.80	16.40	16.80	12.80	13.44	15.12	14.87
April	14.60	15.10	16.10	16.40	13.10	13.60	16.11	15.34
May	14.30	14.80	N.A	16.50	13.80	12.80	16.70	15.50
June	14.88	15.14	N.A	N.A	13.40	12.40	14.18	14.60
July	12.35	13.71	N.A	N.A	10.40	11.60	N.A.	N.A.
August	10.85	11.30	N.A	N.A	10.10	10.50	N.A	N.A
September	11.70	13.90	N.A	N.A	11.44	11.44	13.80	14.40
October	13.50	14.70	15.84	15.8	12.86	15.11	12.60	14.91
November	13.83	14.70	16.60	15.6	13.71	13.86	16.90	16.13
December	15.60	16.14	16.11	16.8	14.88	15.50	15.88	16.10
Mean*	13.85	14.49	15.80	16.05	12.79	13.03	15.35	15.36

N.A. = Not available. * = Mean of prices when seed is available.

The reduction in tuber weight loss by storage in polythene bags may be due to the restriction in the flow of air into the bag and trapping of moisture and heat released from respiration. At high temperature this property may be a disadvantage as tuber rots may occur. Other storage methods, which allowed free circulation of dry air, showed high tuber weight loss. Beukema and Zaag (1979) reported that sprouted and unsprouted tubers loose moisture in the ratio of 300:1. B7716-2 is a short dormancy variety. Early development of sprouts may be responsible for the higher tuber weight loss of B7716-2 than Nicola. Sprout number per tuber is influenced by tuber size and physiological age of the tubers. Varietal differences were also reported (Burton, 1989). Large tubers generally have more buds and develop more sprouts than small size tubers. Nicola produced more sprouts than B7716-2, but the storage methods did not significantly affect sprout number per tuber.

Sprout length is an indicator of light condition in the potato store. Poor light results in the development of etiolated sprouts, which are weak and easily break during handling. Light retards sprout growth and encourages the development of strong, dwarf and green sprouts (Beukema and Zaag, 1979). In this study, seeds stored on racks had the shortest sprouts, probably as a result of their exposure to diffused light. In jute bag storage, the tubers were in darkness and this may be responsible for the development of long sprouts. The effect of potato variety on sprout length was not significant ($p<0.05$).

Tuber rot during storage may be caused by poor ventilation, high storage temperature and poor quality of stored seed. Although storage in polythene bag reduced tuber weight loss, it gave the highest tuber rot. At high storage temperature, the polythene bag may have restricted the ventilation of the tuber stored in it. The heat, CO_2 and moisture released from tuber during respiration may not be removed fast enough and this could create a favourable environment for the growth of rot micro-organisms. This may account for the high rots of tubers stored in *polythene* bags. Over 90% of the rots were due to soft rot

disease caused by (*Erwinia spp.*. Poor ventilation of tubers stored in the basket and jute bags may have also contributed to the rots recorded.

Survey of market prices of ware and seed potatoes showed price fluctuations between period of high potato production (July to September) and the low production period November to January. Seed tubers are generally available in markets at the on-set of planting seasons and off market in some months (Table 7). Seed demand is greatest at the on-set of rainy and dry season planting (April – May and November – December). Seed prices are highest during these periods. Storage of seed potato should target the on-set of planting while ware tuber storage should target November – January period to maximize profit from the storage.

Based on the results obtained, seed tubers could be stored in crates, racks or on floor of a well-ventilated and lit store for a period of 4 months with less than 26% loss in seed weight. Although loss of seed weight due to dehydration was high in all the storage methods, better ventilation in the above three methods probably contributed to lower seed rots. Seed and ware tuber storage should target the periods of high market prices to maximize profit.

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