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ROT OF SEED POTATO (*SOLANUM TUBEROSUM* L.) TUBERS AFFECTED BY STORAGE CONDITIONS AND STORAGE DURATION IN JOS, PLATEAU STATE, NIGERIA

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ABSTRACT
A study was carried out at the National Root Crops Research Institute (NRCRI), Potato Programme Kuru, Jos Plateau State, Nigeria (Longitude 08^{o}E 47l, Latitude 09^{o}N 441and 1,239 meters above sea level (msl)) during three seasons to investigate 'the rot of potato (*Solanum tuberosum* L.) seed tubersas affected by storage conditions and storage duration.' Five potato varieties (Nicola, Bertita, Diamant, BR63-18 and Roslin Ruaka) were stored for three durations (12, 24 and 32 weeks) in three kinds of stores (room temperature store (RTS), diffused light store (DLS) and air conditioned store (ACS). The experimental design used was completely randomized design in factorial combination of 5 potato varieties forming the main plots, three storage conditions and three storage durations constituting the split plots. There were 45 treatment combinations replicated 3 times. Weekly temperatures and relative humidity were recorded in each type of store.For percentage tuber rot, the result showed that all main effects were significant ($P<0.05$) except the main effect of variety and store type during season 2. All the varieties had similar percentage tuber rot except the variety Nicola which showed significantly lower tuber rot. RTS and DLS resulted in significantly higher tuber rot than the ACS. Tuber rot (%) was lowest at 24 weeks of storage in all the 3 seasons while 32 weeks of storage resulted in significantly higher rot than the other periods. All interactions were significant in the first cropping season, only the interaction of variety X storage duration was significant in the second cropping season, while inthe third cropping season, all interactions were significant except the interaction of store type X storage duration. For number of whole tubers left after storage, all the main effects and interactions were significant. Variety Nicola resulted in the highest number of whole tubers leftwhile Roslin Ruaka had the lowest tubers left in cropping seasons 1 and 2 and variety Diamant had lowest tubers left in cropping season 3. The number of tubers left decreased with storage period with the lowest number of tubers left after 32 weeks of storage. Tuber storage in ACS resulted in highest number of tubers left while RTS was lowest.The RTS and DLS characterized by higher temperature enhanced rot of tubers while the ACS with lower temperature reduced rot of tubers, it is therefore suggested that for prolong storage (8-9 months), the ACS should be used.

Keywords: *Potato, tuber rot, store type, storage period*

INTRODUCTION

Potato is the third most important food crop in the world after rice and wheat and more than a billion people eat potato world-wide (CIP, 2010).Over two thirds of the global production is eaten directly by human beings with the rest being fed to animals or used to produce starch (Struik and Wiersema, 1999). Storability or keeping quality of potatoes should be regarded as equally important as yield, disease resistance and quality during potato breeding and selection (Carli *et al*., 2010). Storability is one of the considerations that need to be evaluated before releasing any variety so that farmers are able to store their produce for a desired period of time at their farm under traditional storage conditions or in refrigerated storage infrastructures, depending whether the end-use is for fresh consumption, processing or planting as seed.

The aim of any type of storage is to minimise sprouting, respiration, evaporation and storage losses due to microorganism and to minimize all of this losses, it is necessary to create a low temperature environment e.g. cold store or a structure constructed in a way as to lower the room temperature appreciably (Okwonkwo *et al*., 1986; Owe Sonnewald, 2001).

An increase or decrease in potato storage temperature can be used to minimize disease development (Kibar, 2012). The pathogens enter the tuber through wounds caused during harvesting and handling e.g. desprouting. Struik and Wiersema (1999) suggested that the best protection against these diseases is proper handling, wound healing in storage and removal of infected tubers. They also reported that temperature has effect on the rate of wound healing and also on the growth of the disease causing agent (bacteria or fungi).They therefore suggested that temperature should be relatively high first to allow rapid wound healing and then should be lowered to reduce developmental rate of the disease. Most disease organism logarithmically increases their population growth at temperatures ranging from 4.4^{o}C to 26.7^{o}C. Lower temperature lessens the possibility of disease incidence during storage. High tuber loss due to dry rot (*Fusarium* spp) has been reported at high than low storage temperatures (Folsum *et al*., 1995). At temperatures above 10^{o}C the growth and development of disease organisms increase dramatically. Temperatures above 10^{o}C should be avoided during long- term storage. The hatching of flies is also inhibited below 10^{o}C, thus the presence of flies indicates that the temperature is too high somewhere in the storage and break down may become a problem.

The typical storage diseases include early blight, Fusarium dry rot, late blight, pink rot, pythium leak and silver scurf, bacterial soft rot is always a concern especially as a secondary invader to the primary diseases listed (Olsen and Brandt, 2013). Olsen and Brandt (2013) also observed that variety ‘Clear Water Russet’ and ‘Premier Russet’ potatoes had higher susceptibility to fusarium dry rot. Variety ‘Western Russet’ may have more early blight tuber lesionswhereas; silver scruf may plague ‘Russet Nurkotah’ more often. Disease development in storage will also be dependent upon storage temperature. Storing at lower temperature provides opportunity to potentially slow down the development of the diseases. Unfortunately depending upon variety and if they will be processed or not, lower storage temperatures may not be possible as a disease control tool.

Shortage of seed potato is usually an outcome of poor seed storage. In Nigeria as much as 40% seed loss has been recorded in farmers’ stores in 3 months of storage due to dry rot (*Fusarium* spp), soft rot (*Erwinia* spp) and high temperature (Okonkwo *et al*., 1986). This study is therefore aimed at evaluating the rot of seed potato as affected by storage conditions and storage duration under Jos Plateau conditions.

MATERIALS AND METHODS

The study consisted of two stages: multiplication of seed tubers in the field aimed at generating sufficient tubers for storage and storage of seed tubers.Five potato varieties viz: Nicola, Bertita, Diamant, BR 63-18 and Roslin-Ruaka were obtained and multiplied at the National Root Crops Research Institute (NRCRI) Kuru, Jos Plateau State, Nigeria (09° 44I N, 08° 47I E; 1,239m above sea level) during the 2010-2011, 2011-2012 and 2012-2013 seasons.

In storage, a completely randomized design in factorial combination of five potato varieties forming the main plots, three storage conditions and three durations constituting the split plots. There were 45 treatment combinations replicated 3 times. Each treatment was represented by 40 seed tubers.

Three types of stores were used: Diffused Light Store (DLS), Air conditioned store (ACS) and room temperature store (RTS) (Control) as described by Deshi et al. (2015). The conditions in the storage includes: temperature, relative humidity, and light. Thermo-hydrometers (Humidity and temperature data loggers were installed in each store room and was used to measure the temperature and relative humidity in each store on 6 hour period. Mean minimum and maximum temperature for each day was therefore calculated for each season and weekly mean was then calculated.

Each store had tubers of each variety stored for the same period. The tubers were stored for 12, 24 and

32 weeks in each type of store and then taken to the field for planting. Seed storage for 32 weeks was from rain fed harvest to rain fed planting (prolonged storage). Beukema and Van Der Zaag (1990) reported that in principle seed should be at least 3 months old before it is planted again and not older than 5-11 months (depending on the storage method and storage temperature).

The harvested tubers from seed multiplication were properly screened by physical examination to remove any diseased or damaged tubers. This was followed by seed selection (sizes of 30-40 mm grade) of each variety.The tubers were kept in an open room for two weeks for curing before storage.Mean weight of tubers for each variety were taken before storage. Tuber storage started at 3 weeks after harvest (August 26th, 2010; September 8th, 2011 and September 7th, 2012 in seasons 1, 2 and 3 respectively).

Observations were done fortnightly and the storage observations included:Number of rotted tubers/treatment and number of whole tubers left after storage.The storage data was subjected to analysis of variance (ANOVA) and the means were separated using least significant difference (LSD) using the mini tab software.

RESULTS AND DISCUSSION

The main effects of variety, storage duration and store type on percentage tuber rot were all significant ($P < 0.05$)during season 1 (Table 1). Variety Diamant had the highest number of rot(21.73%) although it was similar to BR 63-18 and Roslin Ruaka which had 18.03% and 18.33% respectively. Nicola resulted in significantly lower tuber rot of 2.23% (Table 1).Storage in RTS and DLS resulted in similar tuber rot of 19.4% and 18.55% respectively but storage in the air conditioned store resulted in significantly lower tuber rot of 7.13% (Table 1). Tubers stored for 12 weeks resulted in 18.05% rotted tubers. Storage for 24 weeks had significantly lower tuber rot of 4.15%. But tuber storage for 32 weeks resulted in the highest percentage tuber rot of 22.88% (Table 1).The interactions between variety and storage duration, variety and store type and storage duration and store type were significantly different ($P < 0.05$) (Table 1). In season 2, the main effect of variety with regard to tuber rot was not statistically different. The main effect of store type on percentage rot of tubers was not significant. While that of storage duration was significant. Storage of tubers for 12 and 24 weeks gave similar rotscompared with significantly higher rots (10.68%) recorded at 32 weeks (Table 1). Amongst the interactions only that of variety and storage duration was significant ($P<0.05$) (Table 1). During season 3, the main effects of variety, storage duration and store type were all significant ($P < 0.05$) with respect to tuber rot (Table 1). All the varieties resulted in similar rot of tubers except Nicola which had significantly lower rot of tubers (1.10%) (Table1). Storage in RTS and DLS resulted in similar rot of tubers (11.35% and 11.08% respectively), while storage in ACS resulted in significantly lower rot of tubers (8.48%).The rot of tubers was similar at 12 and 24 WOS (2.50% and 4.13%) but storage of tubers for 32 weeks resulted in significantly higher rot of tubers (24.23%) (Table1). The interactions of variety and storage duration and variety and store type were significantly different but the interaction of storage duration xstore type was not significantlydifferent ($P < 0.05$) (Table 1).

In season 1, the interaction of variety and store type on percentage number of rotted tubersrevealed that in the RTS, all the varieties had similar tuber rot except Nicola which had significantly lower tuber rot of 1.95%. In the DLS, the varieties were significantly different in respect of tuber rot. Diamant was the highest with 30% although it was similar with BR 63-18 which had 22.23% tuber rot. In the ACS, Roslin Ruaka resulted in the highest tuber rot of 13.05% although, this was similar to Bertita, Diamant and BR 63-18 (Table 2).

During season 3, the interaction of variety and store type on percentage number of rotted tubers showed that in the RTS, Diamant resulted in the highest rot of tubers (17.78%),in the DLS, Roslin Ruaka had the highest rot of tubers (12.78%) and in ACS, BR63-18 had the highest rot (15.28%), while Nicola had significantly lower rot (1.40%, 0.28% and 1.68% in the RTS, DLS and AC stores respectively (Table 2).

In season 1, the interaction of variety and storage duration on percentage number of rotted tubersshowed that at 12 weeks of storage, Roslin Ruaka had the highest tuber rot of 33.90% although this was similar to Diamant that had 28.90%. At 24 weeks of storage, tuber rot was similar in all the varieties. At 32 weeks of Storage, all the varieties had similar tuber rot except Nicola which had significantly lower tuber rot of 1.95% (Table 3).

In season 2, the interaction of variety and storage duration on tuber rot showed that at 12 and 24 WOS, all the varieties resulted in similar percentage rot of tubers. At 32 WOS, BR 63-18 resulted in highest rot of tubers (19.42%) although this was similar to Bertita, Diamant and Roslin Ruaka (Table 3).During season 3, the interaction of variety and storage duration on percentage number of rotted tubers showed that at 12 WOS, all the varieties resulted in similar rot of tubers. The same pattern was repeated at 24 WOS. At 32 WOS, BR 63-

18 had the highest rot of tubers (36.68%) although it was similar to Diamant and Roslin Ruaka while Nicola and Bertita resulted in significantly lower rot of tubers (1.10% and 14.23% respectively) (Table 3). Interaction of store type and storage duration on percentage number of rotted tubers was significant ($P<0.05$) only during season 1.At 12 weeks of storage, the room temperature store had the highest tuber rot of 20.15% although this was similar to DLS that had Rot of 19.58%. The ACS resulted in lowest tuber rot of 14.43%. At 24 weeks of storage, all the store types resulted in similar percentage tuber rot. At 32 weeks of storage, RTS and DLS resulted in similar tuber rot of 33.70% and 31.80% respectively while the ACS resulted in significantly lower rot of tubers with 3.08% (Table 4). The main effects of variety, storage duration and store types on mean number of whole tubers left after storage were significant during season 1 (Table 1). Nicola had the highest mean number of whole tubers (36.89) left after storage while Roslin-Ruaka had the lowest mean number of tubers (14.85) left after storage and the differences were significant (Table 1). Duration of storage significantly affected the mean number of tubers left after storage. More than thirty (30.24) tubers were left after 12 weeks of storage while 28.72 tubers were left after 24 weeks of storage. Storage for 32 weeks resulted in the lowest mean number of tubers left (18.72) (Table 1). RTS and DLS had significantly lower mean number of 22.75 and 21.52 tubers left respectively. Storage in ACS resulted in highest mean number of 33.41 tubers left (Table 1). The interaction between variety and storage duration, variety and store type and storage duration and store type were significantly different ($P < 0.05$) (Table 1).

In season 2, the main effects of variety, store type and storage duration with respect to mean number of whole tubers left after storage was significant ($P < 0.05$) (Table 1).Variety Nicola had the highest mean number of whole tubers left after storage (30.00) while Bertita had the lowest mean number of tubers left after storage (20.92) although it was similar to Roslin- Ruaka which had 21.81 whole tubers left after storage (Table 1).Storage of tubers for 12 weeks resulted in the highest mean number of tubers left after storage (38.53). 19.96 whole tubers were left after 24 weeks of storage while 14.69 whole tubers were left after 32 WOS (Table 1). Storage of tubers in diffused light store resulted in the highest mean number of whole tubers left after storage (34.02). 25.98 tubers were left after storage in the room temperature store, while 13.24 tubers were left after storage in the air conditioned store. All interactions were significant ($P < 0.05$) (Table 1).

During season 3, the main effects of variety, storage duration and store type were significant in respect to mean number of tubers left after storage (Table 1). Nicola resulted in significantly higher mean number of tubers left after store (39.11) while Diamant resulted in lowest mean number of tubers left after storage (31.93) although it was similar with Roslin Ruaka which had 32.19 (Table 1).The mean number of tubers left decreased with increased period of storage. 38.79 tubers were left after 12 WOS, 37.13 tubers were tubers were left after 24WOS and 27.61 tubers were left after 32 WOS (Table 1). The number of tubers left was significantly affected by type of storage. RTS resulted in significantly lower mean number of tubers left after storage (30.72%), this was followed by storage in DLS with 33.61 tubers left after storage while ACS resulted in significantly higher mean number of tubers lefty (39.20) (Table 1). The interaction of variety and storage duration, variety and store type and storage duration and store type were all significantly different ($P < 0.05$) (Table 1).

Interaction of variety and store type on mean number of tubers left after storage revealed that Roslin Ruaka had the lowest mean number of tubers (10.22) left in the RTS. In the DLS, Diamant and Roslin Ruaka resulted in similar and lowest mean numbers of tubers (10.96 and 9.00) left after storage respectively. In the ACS, Roslin Ruaka resulted in the lowest mean number of tubers (25.33) left after storage (Table 5).

During season 2, the interaction of variety and store type on mean number of whole tubers left after storage showed that Roslin-Ruaka resulted in lowest mean number of whole tubers left in the room temperature store after storage (17.33), although it was similar with Bertita which had 18.67 tubers left after storage. In the diffused light store, BR 63-18 resulted in the lowest mean number of whole tubers left after storage (30.67) although this was similar to Bertita that had 31.11 tubers left after storage. In the air conditioned store, all the varieties had similar mean number of tubers left after storage (Table 5).

In season 3, Nicola had the highest mean number of tubers left in the RTS (38.22) while Diamant had the lowest (22.67) although it was similar with Roslin Ruaka which had 27.89 tubers left after storage. The same pattern was repeated in the DLS. In the ACS, all the varieties had similar mean number of tubers left after storage (Table 5).

During season 1, the interaction of variety and storage duration on mean number of tubers left after storage revealed that after storage for 12 weeks Variety Nicola resulted in significantly higher ($P<0.05$) mean number of whole tubers left (37.78) while Roslin Ruaka had the lowest mean number of tubers (18.89) left. The same pattern was repeated after storage for 24 weeks and at 32 weeks (Table 6).

In season 2, all the varieties had a similar mean number of tubers left at 12 weeks of storage. At 24 weeks of storage, Nicola had the highest mean number of tubers left after storage (26.42). This was followed by BR 63-18 which had 24.22 tubers left after storage. Diamant had 19.11 tubers left after storage. At 32 weeks of storage, Nicola had the highest mean number of whole tuber left after storage (24.89). This was followed by BR 63-18 with 14.00 tubers left although this was similar to Diamant which had 13.67 tubers left after storage while Roslin-Ruaka and Bertita had significantly lower mean number of whole tubers left after storage 10.78 and 10.13 respectively (Table 6).

During season 3, the interaction of variety and storage duration on mean number of whole tubers left after storage showed that at 12 WOS, all the varieties had a similar mean number of tubers left. At 24 WOS, Nicola resulted in significantly ($P<0.05$) higher mean number of tubers left after storage (39.00) while Roslin Ruaka resulted in the lowest (35.67). At 32 WOS, Nicola was the highest (38.67) while Diamant had the lowest mean number of tubers left after storage (20.78) although it was similar with Roslin Ruaka which had 22.22 tubers left after storage (Table 6).

During season 1, the interaction of store type and storage duration on mean number of tubers left after storage revealed thatat 12 weeks of storage, ACS had the highest mean number of tubers (34.04) left while the DLS had the lowest mean number of tubers (26.37) left. At 24 weeks of storage, ACS resulted in the highest mean number tubers (34.12) left while the DLS had the lowest mean number of tubers (25.00) left. At 32 weeks of storage, RTS resulted in the lowest mean number of 10.90 tubers left (Table 7).

In season 2, theinteraction of store type and storage duration on mean number of whole tubers left after storage showed that at 12 weeks of storage, tubers stored in Air conditioned store and Diffused light store had significantly ($P<0.05$) higher mean number of whole tubers left after storage (39.72 and 39.03 respectively) while Room temperature store had a lower mean number of whole tubers left after storage (36.92).At 24 and 32 weeks of storage, Diffused light store resulted in highest mean number of whole tubers left after storage (36.72 and 26.23 respectively). This was followed by storage in Room temperature store while the Air conditioned Store had no tubers at 24 and 32 weeks of Storage due to fire disaster that razed down the store (Table 7).

In season 3, the interaction of store type and storage duration on mean number of whole tubers left after storage showed that at 12 WOS, ACS and DLS had similar mean number of tubers left (39.65 and 38.68 respectively) while RTS resulted in significantly lower mean number of tubers left (38.03). At 24 WOS, RTS and DLS had similar mean number of tubers left (35.48 and 36.81 respectively) while the ACS had significantly higher mean number of tubers left (39.09). At 32 WOS, ACS resulted in significantly higher mean number of tubers left (38.85) followed by DLS with 25.35 tubers left after storage while RTS had the lowest mean number of tubers left (18.64) (Table 7).

The differences observed amongst the varieties in percentage number of rotted tubers during seasons 1 and 3 might be attributed to their genetic variability. Ifenkwe and Nwokocha (1986) observed that the behaviour of potato (which is a living tissue) in storage is not only influenced by storage environment but also by genetic variability, agronomic practices during growth, pest and disease attacks. One of the factors evaluated to assess storability of a variety has been reported to be disease susceptibility (Carli *et al.,* 2010; Olsen and Brandt, 2013).Olsen and Brandt (2013) reported that while variety Clear water Russet and Premier Russet potatoes have a higher susceptibility to Fusarium dry rot, variety Western Russet may have more early blight lesions, whereas silver scurf may plague Russet Nurkotah more often.

The significant effect of store typeon percentage number of rotted tubers during seasons 1 and 3may be attributed to environmental conditions in the different store types. During season 1, the temperature range in the different store types was 15.70-31.57^{o}C, 15.14-28.04^{O}C and 14.20-24.19^{o}C in the RTS, DLS and ACS respectively. In season 2, the temperature range was 17.38-27.84^{o}C and 16.51-27.19^{o}C in the RTS and DLS respectively. The ACS was razed down by fire disaster. In season 3, the temperature range was 19.06-29.73^{o}C, 17.69-28.26^{O}C and 14.00-23.56^{o}C in the RTS, DLS and ACS respectively. The temperature in the ACS was appreciably lower than the other store types.

The observed interaction of variety and store type in percentage tuber rotmight be as a result of the differences in environmental conditions (e.g. temperature and relative humidity) of storage and genetic composition of the varieties. Each variety has been reported to have specific field and storage management conditions (Olsen and Brandt, 2013) and they differ in disease susceptibility (Carli *et al.*, 2010). Disease development in storage may also be dependent upon storage temperature. The higher temperature in the room temperature and Diffused light stores suggested why tuber rot was higher in those stores than the air conditioned store. Kibar (2012) observed that an increase or decrease in potato storage temperature can be used to minimize disease development. By reducing holding temperature many storage disease problems can be minimized. Struik and Wiersema (1999) reported that storage temperature has effect on rate of wound healing and also on the growth of disease causing agents (bacteria and fungi). Folsom *et al.,* (1995) found high tuber loss due to dry rot (*Fusarium* spp) at high storage temperature than low storage temperature. At temperatures above 10^{o}C the growth of disease causing organisms increases dramatically. High relative humidity >90% and high temperature >40^{o}C are favourable for development of silver scurf disease of potato (Merida and Loria, 1991). Irrespective of store type used tuber rot was lowest in variety Nicola suggesting that it had high storability irrespective of storage conditions.

Storage duration significantly affected tuber rot in all the 3 seasons. During season 1, tuber rot was high after 12 and 32 weeks of storage with 18.05 and 22.88% of rots respectively. During season 3 it was only high after 32 weeks of storage with 24.23% of rot. 32 weeks of storage (duration 3) was around the months of March, April and May when environmental temperature is high (See Appendix: meteorological data table). The high temperature might have favoured the growth of microorganisms that causes rot of tubers. Folsom *et al*., (1995) found higher tuber loss at high temperature than low temperature. 24 weeks of storage (duration 2) was during the cold harmattan winds of November, December and January (see meteorological data). The cold must have slowed down the activities of disease causing agents. Kibar (2012) observed that decrease in potato storage temperature can be used to minimize disease development.

The interaction of variety and storage duration on tuber rot observed might be attributed to varietal genetic variability, and physiological age which resulted from length of storage period. Tuber rot observed in the three storage durations were (18.05, 4.15 and 22.88 % at 12, 24 and 32 weeks respectively). The high loss at 12 weeks of storage might be as a result of the high moisture content of tubers at harvest and high relative humidity. The potato at harvest is about 80% water making its storage much more difficult than the grains with less than 20% moisture at harvest (Ifenkwe and Nwokocha, 1986). Storage losses of up to 30% in only two months of storage due to rots and loss of moisture have been reported (Williams, 1962 and Okonkwo *et al.*, 1986). Tuber rot reduced in all the varieties at 24 weeks of storage probably because 24 weeks of storage was during the cool harmattan wind (Months of December to February) when minimum temperature was between 11-15^{o}C (see Appendix: meteorological data 2011 and 2012. The high tuber rot at 32 weeks of storage observed might be that the period coincided with the months with high temperature (months of March to May).The significant interaction of store type and storage duration observed might be attributed to the environmental conditions in the store types at different storage periods. The period of harvest (August to September) was very wet and humid. As the months of storage progresses, it gets dryer especially during the harmattan period (November to February) and shortly before the rains set in, it gets very hot and humid (March to April) (see meteorological data). For prolonged storage, the use of air condition kept storage losses very low.The number of whole tubers left after storage varied significantly (P<0.05) with variety in all the 3 seasons. Nicola resulted in highest number of whole tubers left in all the 3 seasons, while Roslin Ruaka, Bertita and Diamant had the lowest number of whole tubers in seasons 1, 2 and 3 respectively. Each variety has been reported to have specific field and storage management conditions (Olsen and Brandt, 2013). This suggests reasons why some varieties stored well and others do not.

The number of whole tubers left varied significantly with store type in all the 3 seasons. Air conditioned store resulted in highest number of whole tubers left in seasons 1 and 3, while diffused light store had highest number of whole tubers left in season 2. The differences might be attributed to environmental conditions in the store types especially temperature. The highest number of whole tubers left in the air conditioned store was as a result of cooling which lowered the temperature reducing activities of microorganisms causing rot. During season 2, the air conditioned store was razed down by fire after 12 weeks of storage that may be the reason why DLS resulted in highest number of whole tubers left after storage.

CONCLUSION

Storage duration significantly affected the number of whole tubers left after storage in all three seasons. Storage for 12 weeks had the highest, followed by storage for 24 weeks, while 32 weeks of storage had the lowest number of whole tubers left, implying that the number of whole tubers left decreased with time in storage. As tubers are stored over time, losses are encored. The reduction in tuber number may be due to loss of tubers because of rots and diseases, insect and rodent pest attacks.

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Table 1: Effect of Variety as Affected by Storage Duration and Storage Type on Percentage Number of Rotted Tubers during the 2010 -2011, 2011-2012 and 2012-2013 (Seasons 1, 2 and 3 respectively) in Jos

Treatment	**Percentage number of rotted tubers (%)**			**Number of whole tubers left**		
Variety	Season 1	Season 2	Season 3	Season 1	Season 2	Season 3
Nicola	2.23c	2.03a	1.10b	36.89a	30.00a	39.11a
Bertita	14.83b	3.823a	7.38a	28.68b	20.92d	35.44b
Diamant	21.73a	6.03a	14.53a	19.86c	23.67c	31.93d
BR63-18	18.03ab	8.00a	14.08a	29.19b	25.67b	33.89c
Roslin-Ruaka	18.33ab	4.90a	14.35a	14.85d	21.81d	32.19d
LS	**	NS	*	**	**	**
LSD 0.05	5.83	7.38	9.30	1.09	1.05	1.62
Storage Duration (Weeks)						
12	18.05b	3.13b	2.50b	30.24a	38.53a	38.79a
24	4.15c	1.08b	4.13b	28.72b	19.96b	37.13b
32	22.88a	10.68a	24.23a	18.72c	14.69c	27.61c
LS	**	*	**	**	**	**
LSD 0.05	3.28	4.55	5.85	0.99	0.96	0.90
Storage Type						
Room temperature store	19.4a	4.523a	11.35a	22.75b	25.98b	30.72c
Diffused Light Store	18.55a	4.723a	11.08a	21.52b	34.02a	33.61b
Air conditioned store	7.13b	5.523a	8.48b	33.41a	13.24c	39.20a
LS	**	NS	*	**	**	**
LSD 0.05	3.38	2.08	2.20	1.31	1.04	0.72
Interaction						
Variety x storage duration	**	**	**	**	**	**
Variety x store type	**	NS	*	**	**	**
Storage duration x store type	**	NS	NS	**	**	**

Table 2: Interaction of Variety and Store Type on Percentage Number of Rotted Tubers

	Season 1			Season 3		
Treatment	Store type			Store type		
	RTS	DLS	ACS	RTS	DLS	ACS
Variety						
Nicola	1.95b	2.75c	1.95b	1.40b	0.28b	1.68b
Bertita	19.55a	19.10b	5.76ab	6.22b	6.55ab	9.33ab
Diamant	26.68a	30.00a	8.53ab	17.78a	11.10a	14.73a
BR 63-18	25.55a	22.23ab	6.30ab	15.28ab	11.68a	15.28a
Roslin Ruaka	23.33a	18.60b	13.05a	16.10a	12.78a	14.18a
$LSD_{0.05}$		8.03			9.75	

DLS. Diffused light store RTS. Room temperature store ACS. Air condition store

Table 3: Interaction of Variety and Storage Duration on Percentage Number of Rotted Tubers

	Season 1(2010-2011)			Season 2(2011-2012)			Season 3(2012)		
Treatment	Storage duration (Weeks)			Storage duration (Weeks)			Storage duration (Weeks)		
	12	24	32	12	24	32	12	24	32
Variety									
Nicola	4.18c	1.10a	1.95b	3.90a	0.52a	1.68b	1.10a	1.10a	1.10b
Bertita	11.10bc	5.78a	5.76ab	1.78a	0.90a	8.90ab	4.45a	3.45a	14.23b
Diamant	28.90a	5.18a	8.53ab	3.60a	1.26a	13.33a	3.05a	5.55a	35.00a
BR 63-18	12.23b	3.70a	6.30ab	2.50a	1.92a	19.42a	1.68a	3.90a	36.68a
Roslin Ruaka	33.90a	5.00a	13.05a	3.90a	0.83a	10.00ab	2.23a	6.68a	34.67a
$LSD_{0.05}$		8.03			10.58			13.50	

Table 4: Interaction of Store Type and Storage Duration on Percentage Number of Rotted Tubers During Season 1

Treatment	Storage duration (Weeks)		
	12	24	32
Store type			
RTS	20.15a	4.38a	33.70a
DLS	19.58ab	4.35a	31.80a
ACS	14.43b	3.85a	3.08b
$LSD_{0.05}$		5.63	

DLS. Diffused light store RTS. Room temperature store ACS. Air condition store

Table 5: Interaction of Variety and Store Type on Mean Number of Whole Tubers Left after Storage

	Season 1			Season 2			Season 3		
Treatment	Store Type			Store Type			Store Type		
	RTS	DLS	ACS	RTS	DLS	ACS	RTS	DLS	ACS
Variety									
Nicola	35.33a	37.22a	38.11a	37.52a	39.22a	13.22a	38.22a	39.33a	39.78a
Bertita	25.78b	24.36b	35.91ab	18.67c	31.11c	12.93a	31.47b	35.73b	39.11a
Diamant	16.33c	10.96c	32.30c	23.33b	34.33b	13.33a	26.67d	29.67d	39.44a
BR 63-18	26.07b	26.07b	35.41b	33.00a	30.67c	13.33a	29.33c	33.00c	39.33a
Roslin Ruaka	10.22d	9.00c	25.33d	17.33	34.78b	13.33a	27.89cd	30.33d	38.33a
LSD0.05	2.56	2.08	1.97						

DLS. Diffused light store RTS. Room temperature store ACS. Air condition store

Table 6: Interaction of Variety and Storage Duration on Whole Tubers Left in Storage

	Season 1(2010-2011)			Season 2 (2011-2012)			Season 3 (2012)		
Treatment	Storage duration (Weeks)			Storage duration (Weeks)			Storage duration (Weeks)		
	12	24	32	12	24	32	12	24	32
Variety									
Nicola	37.78a	37.11a	35.78a	38.63a	26.42a	24.89a	39.67a	39.00a	38.67a
Bertita	34.67b	33.42b	17.96b	38.53a	14.04d	10.13c	38.04a	36.98ab	31.29b
Diamant	25.33c	22.67c	11.59c	38.22a	19.11c	13.67b	38.44a	36.56b	20.78d
BR 63-18	34.52b	33.63b	19.41b	38.73a	24.22b	14.00b	39.11a	37.44ab	25.11
Roslin Ruaka	18.89d	16.78d	8.89d	38.63a	16.00d	10.78c	35.67b	35.67b	22.22d
$LSD_{0.05}$		2.04			1.97			2.19	

Table 7: Interaction of Store Type and Storage Duration onMean Number of Whole Tubers Left after Storage

	Season 1(2010-2011)			Season 2 (2011-2012)			Season 3 (2012)		
Treatment	Storage duration (Weeks)			Storage duration (Weeks)			Storage duration (Weeks)		
	12	24	32	12	24	32	12	24	32
Store type									
RTS	30.30b	27.04c	10.90c	36.92b	23.13b	17.82b	38.03b	35.48b	18.64c
DLS	26.37c	25.00b	13.20b	39.03a	36.72a	26.23a	38.68a	36.81b	25.35b
ACS	34.04a	34.12a	32.07a	39.72a	-	-	39.65a	39.09a	38.85a
$LSD_{0.05}$		1.88			1.67			1.44	

DLS. Diffused light store RTS. Room temperature store ACS. Air condition store