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In-ground post maturity storability of five local sweetpotato varieties

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Abstract

Two experiments are described in which prolonged post maturity storability of sweetpotato (*Ipomoea batatas* L.) was studied between 1990 and 1992 at Namulonge Agricultural and Animal Production Research Institute (NAARI). Five commonly grown local varieties Tanzania (TZ), Tororo 1 (TOR 1), Tororo 3 (TOR 3), Kawogo (KA) and Kyebandula (KY) were harvested at 4, 5, 6, 7, 8, 9 and 10 months after planting (MAP). The harvest date (HD) for optimum storage root yieldsfor for varieties TZ, TOR 1, KA and TOR 3 were at 8 MAP while that for KY was 9 MAP. Varieties KA and KY attained their optimum fresh root yield at 10 MAP while varieties TOR 3, TOR 1 and TZ attained theirs at 7, 8 and 8 MAP, respectively. Storage root quality varied among varieties and deteriorated with time for all varieties. The magnitude of weevil damage increased with increase in in-ground storage period, but remained relatively stable after 9 MAP. The different varieties correlated differently but not significantly with the level of weevil damage except TZ (r= -0.88*). The dry matter content percent (DMC %) varied among varieties and was negatively but non significantly correlated with rainfall. In-ground post maturity period had no significant effect on root cooking quality, taste and texture. However, the optimum HD is crucial if optimum economic yield is to be achieved.

Key words: Harvest date, in-ground storage, *Ipomoea batatas*, yield, quality, weevil.

Introduction

Sweetpotato (*Ipomoea batatas* L) is an indispensable crop in all parts of Uganda except in the relatively drier areas. It is the third major non-grain starchy staple after banana (*Musa spp*) and Cassava (*Manihot esculenta* Crantz). The crop is grown almost by every farm household for both cash and home consumption (Vanegus and Bashaasha, 1991). The crop has gained commercial status and is one of the main sources of income.

The predominant mode of harvesting among subsistence farmers is piecemeal (Bashaasha et al., 1995). Piecemeal harvesting is a traditional practice that creates room and provides a loose soil environment for smaller storage roots to enlarge for the next piecemeal harvest. It thus guarantees consumption of fresh roots throughout the year. Usually only enough storage roots are harvested for a meal as sweetpotato roots are perishable and cannot store for long after harvesting. Research to prolong the fresh root life after harvest is being conducted by the Natural Resource Institute (NRI) in collaboration with the Sweetpotato program at Namulonge and the Post Harvest Program at Kawanda Agricultural Research Institute. While the endeavor is in progress there is need to develop short term strategy to circumvent the problem of fresh root storage.

In-ground, post maturity storage is the common method of keeping storage roots fresh among both commercial and subsistence farmers. It is essentially a post-maturity storage of fresh storage roots on the living plants in the field until they are required for consumption or sale. Commercial farmers often keep the sweetpotato crop in the field until they establish a ready market and transport to avoid post harvest losses. Yet Bashaasha et al. (1995) reported that more than 90% (n=350) of the farmers interviewed had no knowledge of the maturity periods of the various local sweetpotato varieties they grow. This problem is compounded by the fact that maturity periods vary with cultivars and environmental conditions under which they are grown.

External signs of maturity such as yellowing of the leaves is not true for all varieties. Onwueme (1978) reported that early harvesting results in low yields and if the crop is left in the ground for too long the roots become fibrous, unpalatable and are prone to attack by the sweetpotato weevils and various rots. However, roots on the same plant do not mature at the same time since rooting does not occur at the same time. Whole sale harvest is therefore economical only if optimum harvest dates for optimum root yields and quality are known by the farmer. The knowledge of the optimum maturity period and the additional period of post-maturity in-ground storage of a given sweetpotato variety is essential as it may help commercial farmers in particular to decide when to plant in order to harvest at a time of high market demand as well as evade periods of weevil infestation. It may also guide subsistence farmers to choose which variety to grow and have either a prolonged or shorter piecemeal harvest to ensure continuous consumption of fresh storage roots.

This study was therefore designed to establish the optimum maturity period and post-maturity in-ground storability for selected long and short term local sweetpotato varieties.

Materials and methods

The field experiments were conducted between 1990 and 1992 at Namulonge Agricultural and Animal Production Research Institute (NAARI). NAARI lies at 0° 32' N, 32° 35' E and at 1128 m above sea level. It has a mean annual rainfall of 1270 mm spread between March and December with peaks in May and August. The soil type is predominantly sandy clay loam.

Five commonly grown local sweetpotato varieties Tanzania (TZ), Tororo 1 (TOR1), Tororo 3 (TOR3), Kawogo (KA) and Kyebandula (KY) were studied at harvest dates (HDs) beginning at 4 months after planting (MAP) and continued at monthly intervals until 10 MAP.

The sweetpotatoes were planted in single rows in pure stand at a spacing of 30 cm between plants within rows on ridges 1 m apart. The field was tractor ploughed, disk harrowed and ridged. The main plot size was 30 m x 40 m, and the subplot size was 6 m x 6 m. Varieties TOR1, TZ, KA and KY were grown in the 1990-1991 season but TOR1 was substituted with TOR3 in the 1991-1992 planting due to shortage of planting materials. TOR 1 and TOR 3 have similar morphological and yield characteristics although TOR 3 is relatively tolerant to the sweetpotato virus complex disease. TZ is a short term maturing variety (3-4 months) while the rest are medium to long term (5-6 months) maturing varieties. The experiment was arranged in a randomized complete block design with four replications. Sweetpotato varieties formed the main plots and HDs, the sub-plots. Destructive sampling for root development study began at 2 MAP. For the short term variety TZ, harvesting began at 4 MAP and continued on monthly intervals until 8 MAP (4 months post-maturity). Harvesting of the other varieties began at 6 MAP and continued on monthly intervals until 10 MAP, (4 months post-maturity). The crops in the outer most ridges and those within one meter from both ends of the plot were used as border crops.

The number of plants harvested per plot was recorded. Fresh storage root yield per plot were measured using a 25 kg weighing scale. The storage roots were sorted out into marketable and non-marketable root sizes and counted. Weevil damage was assessed on a score scale of 1, 3, 5, 7 and 9, where 1= no damage, 9= severe damage. The magnitude of root rots and losses due to rodents and theft were estimated. Samples of clean storage roots were taken from each plot, washed, sliced and fresh weight recorded and dried at 70°c until constant dry weight was achieved to determine the dry matter content (DMC). Data were statistically analyzed using MSTATC package. Where necessary some of the data were logarithmically transformed.

Table 1. Effects of harvesting dates on the yield and yield components of sweetpotato 1990/1991 cropping season

Harvesting dates MAP	Attributes: Number of marketable roots $plot^{-1}$	Number of non-marketable roots/plot	Total yield ($t\ ha^{-1}$)	Weevil damage (score)
(Four varieties)				
6	1.17^{b}	0.58^{bc}	17.00^{d}	0.64^{b}
7	1.02^{ab}	0.43^{c}	21.97^{c}	1.17^{d}
8	1.24^{a}	0.64^{bc}	31.57^{a}	2.83^{a}
9	1.20^{a}	0.90^{ab}	24.91^{b}	4.58^{a}
10	1.17^{b}	1.05^{a}	21.81^{c}	3.83^{b}
CV	44.7%	25.8%	38.8%	29.04%
LSD (0.05)	0.38	0.31	0.54	0.65
One variety (Tanzania)				
6	0.50^{c}	1.15	8.79^{d}	1.0^{c}
7	0.76^{bc}	0.84	20.05^{cd}	1.0^{c}
8	1.20^{b}	0.65	35.82^{bc}	2.5^{b}
9	1.19^{b}	0.61	41.65^{ab}	2.5^{b}
10	1.83^{a}	1.05	57.16^{a}	6.0^{a}
CV	26.99%	34.6%	34.88%	32.18%
LSD(0.05)	0.45	ns	17.57	1.28

Means within a column not followed by the same letter differ significantly at 5% probability level.
ns = not significant

Results and discussion

Number of marketable and non-marketable storage roots

Results of the 1990-1991 cropping season (Table 1) indicated that the number of marketable roots differed significantly among the various HDs. However, the 1991-1992 season results (Tables 2 and 3) showed that there was highly significant difference among varieties but HD had no significant effect on number of marketable storage roots. The number of non-marketable roots was significantly different among HDs except for variety TZ during 1990-1991 cropping season. Number of marketable roots differed among the varieties during the 1991-1992 cropping season.

Differences in time of root development and rate of root enlargement among different varieties partly explain the significant differences in the number of marketable roots at various harvest dates. The number of marketable roots increased with time as young storage roots continued to enlarge to attain marketable size. After the storage root initiation development phase has elapsed (8-9 MAP), no further increase in number occurred. This agrees with observations by Low and Wilson (1974) observation that root development begins 4 weeks after planting (WAP) with most of it occurring 4-7 WAP, followed by root enlargement and no new roots formation.

Storage root yield

Total yield for the 1990-1991 cropping season was significantly different among the varieties and HDs. The variety x HDs interaction effect was highly significant. This simply indicates that root yields among varieties were influenced by HDs. In 1991-1992 cropping season, total yields were significantly different among varieties and harvesting dates.

Optimum mature root yields were attained at 8 MAP for varieties TZ, TOR 1, and 9 MAP for KA in the 1990-1991 cropping season.

During the 1991-1992 cropping season, varieties KA and KY attained their optimum mature storage root yield at 7 MAP, while TZ and TOR 3 attained at 8 and 7 MAP, respectively (Table 4). There was apparent decline in yield with prolonged post maturity in ground storage during both cropping seasons and the decline was more pronounced in the varieties KY and KA with 72% and 57.7% yield loss, respectively. Decline in yield was only 13.2% and 34.6% for variety TZ and TOR 3, respectively.

Table 2. Yield and yield components of four sweetpotato varieties tested, 1991/1992 cropping season

Sweetpotato variety	Attributes			
	Number of marketable roots plot^{-1}	Number of non-marketable roots plot^{-1}	Total yield (t ha^{-1})	Weevil damage (score)
TZ	0.86^{b}	2.0^{a}	15.04a	4.6^{a}
KA	0.34^{c}	0.74^{c}	5.27b	1.8^{c}
TOR 3	1.04^{a}	1.48^{b}	13.43a	3.8^{b}
KY	0.38^{c}	0.78^{c}	4.5b	2.3^{c}
CV	0.88%	1.69%	3.58%	35.3%
LSD(0.05)	0.133	0.36	2.08	0.55

Means within a column not followed by the same letter differ significantly at 5% probability level
* = Not significant at 5% probability level

Table 3. Effects of harvesting dates on the yield and yield components of sweetpotato 1991/1992 cropping season

Harvesting dates MAP	Attributes			
	Number of marketable roots plant^{-1}	Number of non-marketable roots plant^{-1}	Total yield (t ha^{-1})	Weevil damage (score)
6	1.04a	1.01	7.82^{b}	2.25^{b}
7	1.08a	1.91	9.52^{ab}	2.62^{b}
8	1.04a	1.08	10.79^{a}	2.50^{b}
9	1.05a	1.19	9.38^{ab}	3.87^{a}
10	1.04a	1.12	10.30^{a}	4.37^{a}
CV	0.88%	1.69%	3.58%	3.05%
LSD(0.05)	ns*	ns	2.01	0.275

Means within a column not followed by the same letter differ significantly at 5% probability level.
* = Not significant at 5% probability level.

The variety KA and KY suffered more because they are moderate to long term and usually mature when sweetpotato crops are scarce and expensive, therefore, the decline is attributed to theft, root rot and rodents.

Storage root yields for the 1991-1992 were lower than the 1990-1991 season by 54%, 72.5% and 76.7% for TZ, KA and KY, respectively. This may partly be attributed to differences in rainfall amount and distribution during the experiment. During the 1990-1991 season, the mean monthly rainfall was 83.2 mm compared to 94.52 mm during the 1991-1992 growing season. During 1991-1992 season, much of the rain was received between March and June which coincided with the second phase of the sweetpotato crop growth. According to Woolfe (1992), this is a phase of extensive vine growth and roots are initiated but too much rain may encourage more vegetative growth at the expense of root initiation and development.

The sweetpotato weevil is the major pest of sweetpotato. The two most important weevil species found in Uganda are *Cylass puncticollis* (Bohe) and *Cylas brunneus* (Fabr.), (Sweetpotato Program Annual Report, 1993). Results indicated that their infestation of storage roots was significantly different among HDs and varieties (Tables 1, 2 and 3). The weevil infestation increased with increase in post-maturity in-ground storage period with a peak at 9 and 10 MAP for 1990-91 and 1991-92 season (Figures 1 and 2). During the 1990-1991 season, increase in intensity of weevil damage were observed when harvesting was delayed by 5-8 MAP for TZ, 7-10 MAP for TOR1. Varieties KY and KA showed some tolerance and had low weevil damage(Table 2).

Weevil damage in TOR1, KA and KY increased with a decrease in rainfall amount except in TZ in 1990-91 when weevil damage increased with increase in rainfall. In 1990-91, weevil damage to TZ storage roots began at 5 MAP when rainfall was relatively low and the damage continued to increase with rainfall because the weevils were already well established in the storage roots. This was also true of variety TOR 3 in 1990-92 season. In KA and KY in particular, weevil damage began during the decline in rainfall and continued to increase with further decrease in rainfall. In 1990-91 and 1991-92, rainfall peaks were achieved at 6 and 8 MAP of crop growth. This may probably explain the low weevil damage during the two seasons. However, weevil damage was more severe in 1990-91 than in 1991-92 season because rainfall was lower in 1990-91 than 1991-92 between 8-9 MAP (Figures 1 and 2). This observation agrees with those of Low and Wilson (1974) and Ramessy and Muthukrishnam (1980) that weevil incidence is correlated negatively with rainfall amount and distribution. The results also agree with findings of Villamayor (1987) that weevil infestation increased as the date of harvest was delayed for 3-5 MAP. The most susceptible variety was TZ followed by TOR 3, while KA and KY showed some tolerance to weevil attack. Field observations have shown that varieties TZ and TOR 3 have relatively long necks which at maturity tend to protrude out of soil, a characteristic that favors the weevils which gain access to storage roots through the exposed necks.

If only relatively clean and marketable root size were considered marketable, then the optimum post-maturity storage period for variety TZ would be between 6-8 MAP; TOR 3, 6-7; KA, 9-10 and KY, 8-9 MAP.

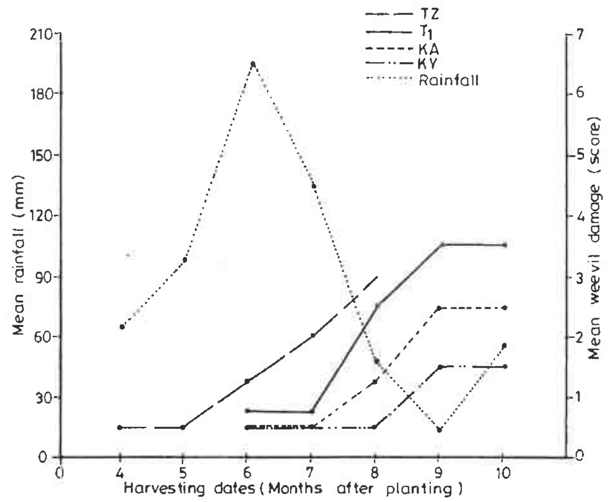

Fig. 1. Varietal response to weevil infestation in relation to rainfall, 1990-1991 season

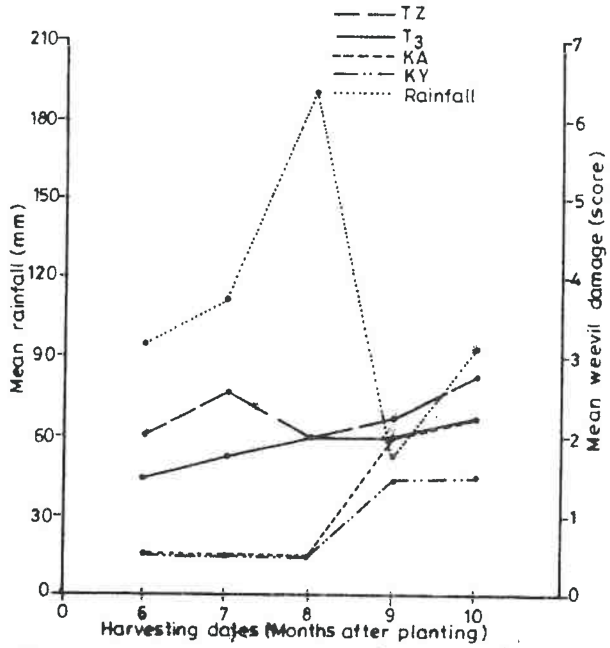

Fig. 2. Varietal response to weevil infestation in relation to rainfall amount 1991-1992 season

Table 4. Yield (t ha^{-1}) of four sweetpotato varieties at various harvesting dates 1991/1992 cropping season

	Harvesting dates (MAP)					
Variety	6	7	8	9	10	Mean
TZ	11.3	12.9	14.8	14.6	11.1	12.9
TOR 3	10.4	17.7	11.3	11.7	13.7	13.0
KA	4.7	14.2	4.6	6.2	7.7	7.4
KY	2.0	9.8	6.6	7.2	7.7	6.6
Mean	7.1	13.7	9.3	9.6	9.8	9.9
CV	3.58%					
LSD(0.05)	2.01					

This is because at these HDs, TZ, TOR3, KA, and KY had 52%, 70.75%, 80.5% and 68.4%, respectively of their storage roots marketable with low weevil damage score, ranging from 3 - 4. This is particularly important for commercial farmers who may derive good returns to investment. On the other hand, if storage root size (edible size) was considered regardless of weevil damage at different HDs, then the consumption of TZ and TOR 3 would both be as long as 10 MAP. This is feasible because storage roots of edible sizes would be piecemeal harvested before weevil infestation. Nicole and Ocitti p'Obwoya (1993) concluded that piecemeal harvesting results in accumulated weevil free yields which do not differ significantly from the yields at the optimum HD. The different varieties were correlated but not significantly with level of weevil damage except variety TZ (r=-0.88).

This indicates that TZ was most affected during the period of little rainfall and therefore was the most susceptible to weevil infestation.

Dry matter accumulation

Dry matter accumulation in storage roots expressed as dry matter content percent (DMC %) varied among varieties and HDs as illustrated in Figure 3. DMC % was not influenced by rainfall for all varieties.

According to Woolfe (1992) the average DMC in sweetpotato is approximately 30% but varies very widely depending on such factors as cultivar, location, climate, day length, soil type, incidence of pests and diseases and the cultivation practices. Spence and Humphries (1972) observed that less total dry matter per unit area was produced in a wet regime. There were variations in this study but they were not significant (Figure 3).

Conclusion

From the results of the studies, it can be concluded that the optimum harvest dates of various sweetpotato varieties are different. It is therefore very important for a farmer to know the optimum maturity periods of the varieties he grows if maximum economic yield and prolonged piecemeal harvest are to be achieved.

For short term varieties like TZ the most appropriate HD for commercial purposes would be at 6 MAP, while for medium term varieties like TOR 1 and TOR 3, the most appropriate HD for commercial purposes would be at 7 MAP. For long term varieties like KA and KY, the most appropriate time of harvesting for whole sale would be at 8 MAP. Piecemeal harvesting may begin as early as 3 MAP for TZ, TOR 1 and TOR 3; and 5 MAP for KA and KY.

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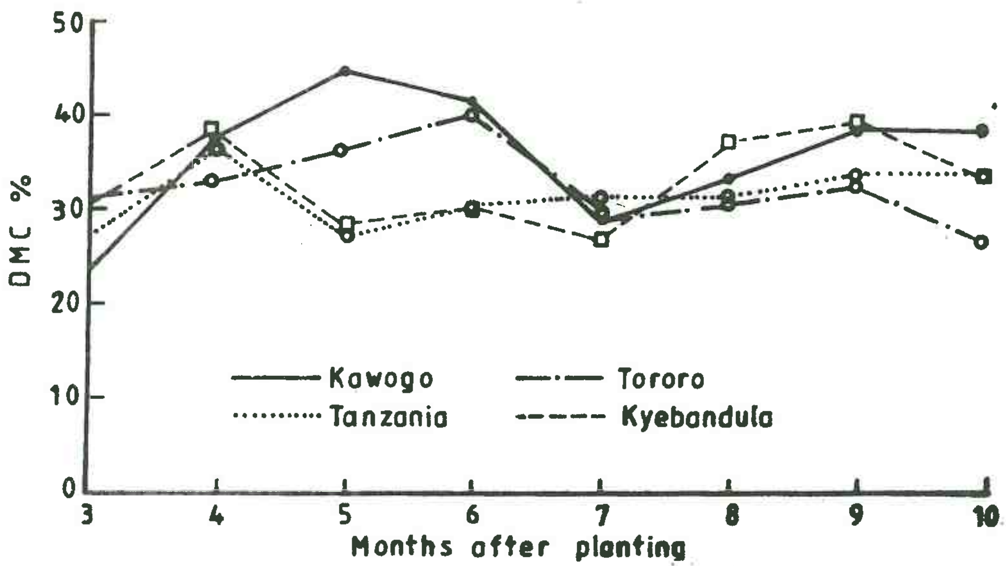

Fig. 3. Changes in DMC percentage of four sweetpotato varieties

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