Prolonging the shelf-life of seed potato tubers at farm level: Cold storage or Diffused Light Store?

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Abstract

Planting well sprouted potato tubers is key to achieving high yields. In the face of climate change, it is even more important to have well sprouted tubers to ensure a crop matures even when rains are low and erratic. A study was conducted in 2011-2012 at KARI-Tigoni to evaluate the behavior of common Kenyan potato varieties after cold storage (at 40C) and diffused light storage (DLS) for a period of up to eight months. Eight potato varieties commonly grown in Kenya and of different maturity periods were used. Five kilograms of each potato variety was put in the cold store or DLS store for a period of 8 months in 2011. These were replicated three times. After 8 months, data was collected on weight loss and general acceptability of seed tubers. During the long rains season (March-June) 2012, the tubers from the store were planted out at KARI-Tigoni. Data was collected on plant emergence and yields at harvest. All the cold-stored tubers were acceptable after eight months storage; the opposite was true for DLS-stored materials. However, the DLS stored tubers gave high yields than the cold-stored ones.

Keywords
Cold store; Diffuse light storage; Seed potato tubers
Introduction
In order to improve the quality of farm-saved seed, farmers are usually encouraged by extension staff and researchers to conduct positive seed selection to improve quality of the seeds. If such “clean seeds” are well-sprouted before planting, the on-farm yields can be improved substantially above the national yields of less than 10 t/ha particularly when complemented with adequate fertilizer and crop protection practices.

Seed potatoes previously distributed by the Agricultural Development Corporation (ADC) to farmers used to be sold following 7-9 months of cold storage (at 40°C and high relative humidity). However, this ceased when ADC collapsed in the late 1980’s. Since then, a regular supply of well sprouted seed potatoes ceased and farmers had to sprout their own seeds. Additionally, the commonly used pre-sprouting chemical “rindite” was withdrawn from the market in the 1990’s; since then, most farmers use freshly harvested tubers for planting leading to low yields. The diffuse light storage (DLS) technique developed by the International Potato Centre (CIP) can be used for seed storage for up to five or six months (Demo, 2002). DLS uses natural indirect light and good ventilation or air flow instead of low temperature to control excessive sprout growth and associated storage losses. Storage in DLS has been shown to delay physiological ageing of the tubers and to reduce apical dominance resulting in many, short and firm sprouts per tuber (CIP, 1985a). This translates into more stems and hence more yields since potato is a stem tuber. In addition, there are less storage losses from pests and diseases because the crop can be easily monitored. Generally, DLS is a low cost on-farm technique meant to store limited quantities of seed potatoes for a period: of 5-7 months. On the other had, cold storage is a high cost technique suitable for certified seed production; it can store seeds for a period of 9-10 months (Demo, 2002).

Research work funded by the former National Council for Science and Technology (NCST) (currently NACOSTI). was conducted to evaluate sprouting behaviour of commonly grown potato varieties after storage in cold store (40°C and 95% RH) and in naturally ventilated diffuse light store (DLS) for a period of up to 8 months.

Materials and Methods
Eight potato varieties (Table 1) were grown at KARI-Tigoni during March-June long rains season of 2011. The trial was a randomized complete design replicated three times. Each plot had five rows and each row had 10 plants giving a total 50 plants per plot. Plant spacing was 75 cm x 30 cm between and within the row respectively. The crop was managed according to the recommended practices for potato production in Kenya (KARI, 2008) Source: Crissman et al., 1993 After harvesting each replicate, the egg-sized tubers (35-45 mm in diameter) were selected and samples of 5kg each were put in net bags; the net bags were placed in crates in a diffused light store (DLS). The DLS had indirect light and ambient air conditions. It was made of wood with wide open spaces between the wood planks to allow in more diffuse light. In addition, some iron sheets on the roof had been replaced with transparent sheets to allow in more diffuse light. The inner side of the DLS was lined with netting to keep off insect pests and vectors. The floor was earthen to prevent temperature build-up.
Similar triplicate samples of potatoes were put in chitting crates and placed in a cold store (40C and 95% relative humidity). In both DLS and cold store, the seed tubers were stored for a period of eight months. Seed tubers from the cold store were placed at ambient temperature three weeks before planting in the field. The experiment was laid out as a split-plot design with storage method (cold store and DLS) as the main factor and the potato varieties as the sub plot.

The tubers were examined for tuber weight loss every four week (during the first 16 weeks of storage) and acceptability of tubers as seed after the eight month storage period. Acceptability of tubers as seeds is mostly affected by firmness (opposite of shrinkage) of the tubers after storage; the firmer the tubers were after storage, the more acceptable they are. Four panelists familiar with potato seed tuber quality used a 9-point scoring scale to evaluate the overall acceptability of the seed. On this subjective scale a score of 1 was the least acceptable while 9 was the most acceptable; a score of 5.0 and above was acceptable.

After eight months of storage, the seed tubers were planted out in the field at KARI-Tigoni during the March-June long rains season of 2012. The experimental design and crop management was as for the 2011. Field data collected included plant emergence. During harvest, data on tuber yield was taken from the middle 24 plants per plot.

**Results and Discussion**
Generally, Dutch Robjin experienced the least percentage tuber weight loss under cold storage (*Figure 1*). In addition, all varieties experienced significant (P≤0.05) differences in percentage tuber weight loss among the four evaluation times except for Dutch Robjin.

*Table 1* Potato varieties used in the study

Roslin Tana had the highest tuber weight loss 16 weeks after storage in the DLS (*Figure 2*). There were no significant (P≤0.05) differences in percentage tuber weight loss after 8, 12 and 16 weeks of storage in DLS for Kenya Sifa, Pimpernel, Tigoni, Asante and Desiree.
For Kenya Sifa, Pimpernel and Asante, there was no significant (P≤0.05) difference in percentage tuber weight loss between cold store and DLS after 16 weeks of storage (Figure 3).

Most varieties were unacceptable as seed after eight month storage under DLS (Figure 4). This could probably be due to excessive shrinkage. Because DLS was under ambient conditions as far as temperature and relative humidity are concerned, it is possible that the high air temperatures and low relative humidity normally experienced between August and February could have led to excessive shrinkage. In the contrary, almost all potato varieties were acceptable as seed after eight month storage in the cold room. This could probably be due to low respiration activities caused by low temperatures and low evaporation occasioned to high relative humidity in the cold store.

Percentage tuber weight loss between cold stored and DLS stored potatoes were almost similar 16 weeks after storage (Figure 3). However, after eight month storage, the potato vareities in the DLS were generally unacceptable as seed while the opposite was true for cold stored materials (Figure 4). This contradiction could have occurred in the later months of storage since percentage weight loss was determined for the first 16 weeks only. It is possible that low relative humidity and high temperature later during storage could have acacerlated shrinking of the tubers in the DLS. This is contrary to the controlled conditions in the cold room.
In the field, all varieties from both cold store and DLS had achieved 100% emergence 45 days after planting. Tubers stored in DLS emerged faster than the cold-stored ones. In addition, emergence varied with variety: Dutch Robjin, Tigoni and Asante emerged faster than the other varieties. The cold-stored tubers were generally very cold (40°C) and therefore took long to adapt to the field conditions hence longer time to emergence. In addition, cold-stored tubers had few long weak sprouts. These sprouts normally break during planting; the tubers have to resprout again hence taking longer to emerge. Therefore, cold-stored seed potato tubers need careful handling to prevent sprout breakage.

There were significant (P≤ 0.05) differences among potato varieties, between the storage methods and in variety x storage interaction in terms of total tuber yields (Table 2). In addition, the DLS stored tubers gave significantly higher mean yields (16.62 ton/ha) than the cold-stored ones (14.56 ton/ha). However, most of the varieties yielded far below the expected levels possibly because most tubers had aged during storage. In addition, severe late blight outbreak later in the season coupled with excessive rainfall may have depressed the yields for most of the varieties even further.

Table 2 Analysis of variance for tuber yields.

<table>
<thead>
<tr>
<th>Variety</th>
<th>DLS</th>
<th>Cold Store</th>
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<tbody>
<tr>
<td>Desiree</td>
<td>16.62</td>
<td>14.56</td>
</tr>
<tr>
<td>Dutch Robjin</td>
<td></td>
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<tr>
<td>Kenya Karibu</td>
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For Desiree, Dutch robjin and Kenya Karibu DLS stored material gave significantly high yields than the cold-stored materials; the opposite was true for variety Tigoni (Figure 5).

Figure 5 Tuber yields (ton/ha) of potato varieties planted during the 2012 long rains season

The higher yields from DLS-stored tubers could be due to their fast emergence as opposed to the cold-stored tubers. Therefore in the face of low and erratic rains occasioned by climate change, small-scale farmers are better off adopting the low-cost DLS technique to sprout their seed potato tubers. Such well-sprouted seed tubers are likely to establish early and yield well before the rains end.

Acknowledgement
The Authors are grateful to the National Council of Science and Technology for funding this work, and, Ministry of Agriculture, Mt. Kenya University and the Kenya Agricultural Research Institute for facilitating the study.

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