

# The effect of traditional storage methods on germination and vigour of maize (*Zea mays* L.) from northern KwaZulu-Natal and southern Mozambique

V. Govender\*, T.A.S. Aveling, Q. Kritzinger

*Department of Microbiology and Plant Pathology, University of Pretoria, Pretoria 0002, South Africa*

Received 31 July 2007; received in revised form 1 October 2007; accepted 4 October 2007

## Abstract

In sub-Saharan Africa, maize (*Zea mays* L.) is one of the most nutritional crops and proper storage of seeds continues to be a challenge for subsistence farmers. Storage fungi, which reduce seed quality, become active in seeds when moisture levels are 14% or higher and this is influenced by the way seeds are stored. The aim of the present study was to test germination and vigour of maize seeds that were subjected to traditional storage during 2005 and to test germination of the maize seeds after storage for one year under conditions of fluctuating temperature. A preliminary survey was conducted and maize samples (white and yellow) were collected from small-scale subsistence farmers in northern KwaZulu-Natal (South Africa) and Mozambique. Seeds that were left in the field to dry and seeds that were commercially treated with Celest® XL served as controls. Germination was measured according to the International Seed Testing Association (ISTA) rules. The maize that was left in the field (*NHS*) to dry gave 100% germination in 2005. The treated control had a germination of 94.0%. Seeds that were imbibed for 40 h had the highest percentage weight increase following rapid imbibition but four of the six samples maintained germination above 70% following slow imbibition. The conductivity of the solute was read following imbibition. Field stored maize had the lowest solute leakage (1181  $\mu$ S) and this correlated with the high percentage seeds with living tissue as indicated by the tetrazolium staining following rapid (94.4%) and slow (95.8%) imbibition. The number of fungi isolated from the samples reflected the initial condition of the samples with the fungicide treated control having the lowest percentage infection (11%), *NHS* had 33% and yellow maize that was stored on the cob and had with insect damage (*SIH*) had the highest, namely 71%. After the first set of experiments, samples were stored at 26–28 °C to simulate the fluctuating original storage conditions. A year later the samples were subjected to the standard germination test. The decline in seed viability during the storage period was exhibited by results of the standard germination test. Maize that was left in the field had a 74.7% decrease in germination while the sample stored in potato bag (*PHL*) and the treated control maintained germination above 80%. Two of the six samples failed to germinate. This study also showed that fungicide seed treatment is a viable option to maintain viability of the seeds, especially when the maize is to be stored until the next season.

© 2007 SAAB. Published by Elsevier B.V. All rights reserved.

**Keywords:** Germination; Maize; Seed treatment; Traditional storage

## 1. Introduction

Maize (*Zea mays* L.) is important as a source of energy and protein in the human diet throughout the world (Rehman, 2006). Proper crop storage plays an integral part in ensuring domestic food supply (Thamaga-Chitja et al., 2004) and that seed quality and vigour is maintained (Joao Abba and Lovato, 1999). Fluctuations in temperature, humidity and prolonged storage result in considerable nutrient losses (Shah et al., 2002). Despite significant

advances in food storage methods, many African and South African communities still rely on traditional storage methods for seed to be used as food and fodder (Olakojo and Akinlosotu, 2004; Thamaga-Chitja et al., 2004). Storage facilities not only offer the opportunity to provide a supply of food between staple crop harvests but farmers are able to improve farm incomes by storing crops and selling at premium prices when demand outstrips supply later in the post-harvest period (Florkowski and Xi-Ling, 1990). The most important factors that influence storage are temperature, moisture, carbon dioxide (CO<sub>2</sub>), oxygen (O<sub>2</sub>), grain characteristics, micro-organisms, insects, mites, rodents, birds, geographical location and storage facility structure (Jayas and White, 2003).

\* Corresponding author.

E-mail address: [velo@student.up.ac.za](mailto:velo@student.up.ac.za) (V. Govender).

Insect pests are one of the major organisms that are responsible for the decline in quantity, quality and germination potential of maize seeds in storage (Jayas and White, 2003). A common strategy in many African countries is to sell maize grains immediately after harvest, to avoid losses to insect pests (Olakojo and Akinlosotu, 2004). Farmers in sub-Saharan Africa generally store their un-husked maize on wooden posts (Thamaga-Chitja et al., 2004). In most situations, maize is traditionally left to dry in the fields prior to harvesting. Other storage structures include a traditional silo that is made of mud and twigs. This structure is relatively inexpensive but it is not airtight and often exposes the stored maize to harsh environmental conditions such as sun and rain (Olakojo and Akinlosotu, 2004). Other storage facilities include the use of iron tanks, re-used maize-meal sacks to store maize on the cob and in addition, polyethylene, polypropylene and cotton sacks are frequently used (Thamaga-Chitja et al., 2004).

In 1979, the Association of Official Seed Analysts' vigour committee defined seed vigour as "those seed properties, which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions" (Copeland and McDonald, 2001). Seed vigour is defined by the International Seed Testing Association (ISTA) as "the sum total of those properties of the seed that determine the level of activity and performance of the seed during germination and seedling emergence" (ISTA, 2006). Vigour testing involves direct tests (e.g. cold test) where an environmental stress is reproduced in the laboratory and the percentage and or rate of seedling emergence are recorded. In indirect tests (e.g. conductivity) other characteristics of the seed are measured, that have proved to be associated with some aspect of seedling performance (ISTA, 2006).

When dry seeds are plunged into water, they imbibe water rapidly in the first few minutes, followed by a slower phase of imbibition until they become fully hydrated (Copeland and McDonald, 2001). It is concluded that ultra-dry seed storage is beneficial for maintaining seed vigour and that starchy mobilization proceeds regularly during germination (Wang et al., 2005). During the early stages of imbibition the seeds leak solutes such as organic and inorganic ions, sugars, amino acids and even proteins into the surrounding medium. Depending on the condition of the seed this loss means the loss of intracellular constituents and often results in extensive embryo damage and even its death (Duke and Kakefuda, 1981; Copeland and McDonald, 2001). Conductivity of the soak water of the sample gives an estimate of seed vigour. Seed lots that have high electrolyte leakage that is, having high leachate conductivity are considered as having low vigour (Barton, 1961; Coolbear, 1995).

Proper and safe storage conditions are defined as those that maintain seed quality without loss of vigour for three years (Joao Abba and Lovato, 1999). The loss of quality of maize seeds is not only visually observed by the poor condition of the seeds (Hell et al., 2000) but also by the poor performance of this seed when it is planted for the next season (Bellon, 2001). Seeds cannot retain their viability indefinitely and after a period of time, the seeds deteriorate (Pascual et al., 2006). In a study conducted on wheat (*Triticum aestivum* L.), by Gilbert et al. (1997), it was shown that germination after storage at tem-

peratures  $-10$ ,  $2.5$  and  $10$  °C decreased with length of storage. This occurred because most of the stored seeds were infected with *Fusarium graminearum* Schwabe and although they were stored at an acceptable temperature ( $10$  °C) there were lowered germination percentages (Gilbert et al., 1997). Tekrony et al. (2005) studied the effects of storage of maize on germination and vigour in an "uncontrolled" warehouse and in a controlled environment, where the temperature and humidity were monitored. Their results showed that all seed lots had 87–99% germination prior to storage but a range in seed vigour as measured by the accelerated ageing test (ISTA, 2006). After eight months storage in the "uncontrolled" warehouse, the germination declined to 50–80% (Tekrony et al., 2005). Germination and vigour tests information can be used to make informed decisions regarding the value of different seed lots (Copeland and McDonald, 2001; Tekrony, 2003; ISTA, 2006).

The aim of the present study was to test germination and vigour of maize seeds that were subjected to traditional storage during 2005 and to evaluate the vigour of fungicide treated maize seed when stored for one year under conditions of fluctuating temperature.

## 2. Materials and methods

### 2.1. Collection of samples

Maize samples were obtained from small-scale subsistence farmers in Pongola and Kosi Bay area (northern KwaZulu-Natal, South Africa) and Ponto Molangane (southern Mozambique) in 2005 (Table 1). The quantity of the maize seeds that were stored by these farmers was enough to sustain those households that they were obtained from and most gave a small sample of their supply for this study. Of the seed that was kept for food, a small percentage was kept for planting the next season.

Maize that was left in the field to dry (NHS) [10 km from Nsalamanga High School — Kosi Bay area] prior to harvesting served as one of the controls. These seeds were in a good condition. The other control was seeds commercially treated with Celest® XL ([fludioxonil (25 g ai/L)+mefenoxam (10 g ai/L)] obtained from Syngenta (SA) Pty. Ltd, Midrand).

After collection, all samples were stored in plastic bags and brown paper bags (depending on the original storage condition), under cool conditions and transported back to the Department of Microbiology and Plant Pathology laboratories (University of Pretoria, South Africa) for tests. The moisture content of the seeds (11%) that were collected in 2005 was within the percentage acceptable for maize (10–14%) (ISTA, 2006). After the tests that were conducted in 2005, all seed samples were stored in the laboratory in brown paper bags at temperatures ranging from  $26$ – $28$  °C to simulate the conventional storage conditions that the seeds originally came from.

### 2.2. Standard germination tests

Standard germination tests were conducted on all samples according to the between-paper (BP) method of the International Seed Testing Association (ISTA, 2006). Due to the quantity

Download English Version:

<https://daneshyari.com/en/article/4521655>

Download Persian Version:

<https://daneshyari.com/article/4521655>

[Daneshyari.com](https://daneshyari.com)