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Influence of Seed Storage Techniques on Germinability and Storability of Cowpea (*Vigna unguiculata* (L) Walp)

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Abstract

This study was set to investigate the germinability and storability of the newly released cowpea genotypes and secondly the influence of different storage materials under ambient storage condition on seed vigour and germination over time. The experiment was laid in a Split-split plot design with four replicates. The main plot was duration (0, 30, 60 and 90 days), while Storage material (polyethylene bag, cotton bag and glass container) was sub plot and the four cowpea genotypes were sub-sub plot. Results from the study showed that irrespective of the cowpea genotypes and storage material used, percentage vigour and germination were significantly affected with time in storage. Seeds stored in cotton bags had the least percentage vigour (57%) and germination (65%) while the highest was recorded for seeds stored in air-tight glass containers. Among all the cowpea genotypes studied, Hewale was found to have poor storage abilities. For better storage of cowpea seeds for a period exceeding 3 months, it is preferable to use glass containers or black polyethylene bags even under ambient condition to maintain seed vigour and germinability.

Keywords: cowpea, seed longevity, seeds storage, storage material

1. Introduction

Although seed quality is governed by their genetic make-up, the quality of seeds however, is deteriorated during storage (Barua et al., 2009; Al-Yahya, 2001). Thus, seed storage and retention of seed viability has always been an important consideration in agricultural production. Most seeds have been reported to be hygroscopic in nature, and tendency of absorbing environmental moisture during storage is high (Copeland & McDonald, 1995). Poor storage condition gives rise to deterioration of seed quality and the resultant loss of viability.

During storage, seed quality can remain at the initial level or decline to a level that may make the seed unacceptable for planting purpose. Several environmental factors have been reported to affect seed viability during storage (Rindels, 1995). Some of the factors that affect the longevity of seeds in storage could be the genotype of seed, initial seed quality, storage conditions, and moisture content among others. Within the same plant species, different varieties may exhibit different storing abilities either from genetic variations or other external factors (Simic et al., 2007). However, irrespective of the initial seed quality, unfavourable storage conditions, particularly air temperature and relative humidity contribute to accelerating seed deterioration (Heatherly & Elmore, 2004). High relative humidity and temperature cause high moisture content in seeds and result in low germination at the end of storage (McCormack, 2004).

In Ghana, most smallholder farmers store their seeds in various containers/materials including: pieces of cloth, black polyethylene bag, clay pots, plastic containers, mostly under ambient conditions (Bortey et al., 2011). This results in loss of seed viability over a short period of time depending on the type of crop seed (Barua et al., 2009; Bortey et al., 2011). Additionally, several studies have indicated the effect of storage containers/materials on the quality of seeds in terms of germination and viability over a period of time. A study conducted by Bortey et al. (2011) indicated that tomato seeds stored in piece of cloth and tin containers resulted in low percentage germination and vigour compared to seeds stored in glass containers. However, it has been reported that the intensity of quality decreasing of stored seed under different storage techniques differ among plant species and within plant species (Al-Yahya, 2001; Guberac et al., 2003). Thus, the choice of material/container used in storing seed is crucial in ensuring that the quality of seed is maintained during storage. Moreover, since the effect of these storage materials on the quality of seeds of different crops may vary, it is important to investigate and establish the most suitable storage material and condition for various food crop seeds. This would provide seed producers, breeders and farmers information on how to maintain the integrity of the seed during storage.

This study was set to investigate the storability of the newly released cowpea genotypes and secondly the influence of storage techniques on seed germinability and storability. Specifically, to investigate the influence of different storage materials under ambient storage condition on seed vigour and germination of the newly released cowpea genotypes.

2. Materials and Methods

The investigation was carried out at the Seed Technology Unit Laboratory of CSIR-Crops Research Institute (CSIR-CRI), Kwadaso. Seed samples were collected from the Legumes Division of CSIR-CRI, Fumesua approximately 3 weeks after harvesting. Four genotypes of cowpea seed samples used for the study comprised *Hewale, Vidiza, Asomdwoe* (newly released) and *Asenetapa* (old variety), all unpigmented seed coat. Seed samples were initially stored in a cold room for after harvesting before it was sampled for the experiment. Seed samples were stored in polythene bag (black), Cotton bag (cloth), and Air-tight glass-bottle (Kilner jar) and kept under ambient storage conditions for storage.

2.1 Monitoring of Storage Condition

Data on relative humidity and temperature was recorded for the storage period under ambient condition using an analogue SeedBuro Hygrometer. Both temperature (degree Celsius) and percentage relative humidity were recorded three times during the day for the entire study period. The average, minimum and maximum temperatures and relative humidity at the end of the storage period were computed. Before seeds were kept in the various containers, initial seed quality characteristics including percentage seed moisture (SMC), 1000 seed weight, seed germination percentage (SGP), percentage seed vigour and dead seeds were recorded. Seed samples were taken every 30 days from the various containers and the above stated seed quality characteristics recorded for 90 days.

2.2 Determination of Seed Germination Percentage (SGP)

Seed germination was tested on four 50 seed replicates for all treatments. Each replicate was set to germinate at 25± 2 °C on top of Non-toxic Paper towel, moistened and placed in a plastic seed box (Figure 1). Germination, judged by the appearance of the radicle, was counted daily up to 8 days. At the final count, the number of normal and dead seedlings was assessed. The SGP was calculated as follows:

$$\text{SGP (\%)} = \frac{\text{number of germinated seeds}}{\text{Total seed number}} \times 100 \tag{1}$$

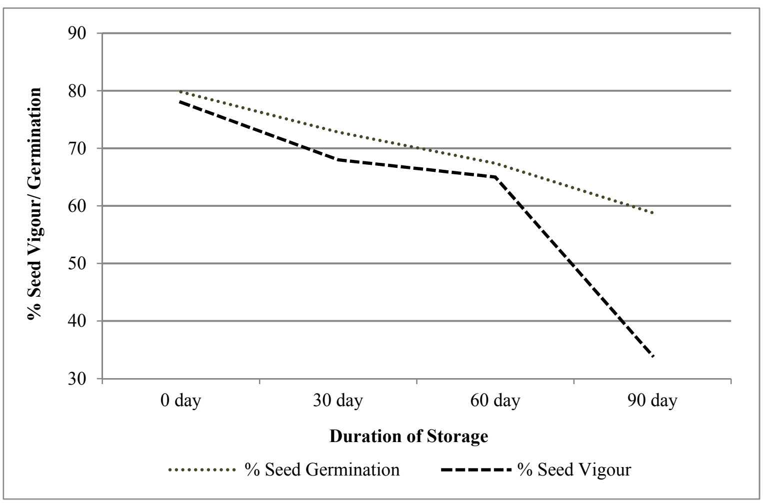

Figure 1. Effect of storage duration on percentage seed vigour and germination

2.3 Determination of Percentage Seed Vigour

The Percentage Seed vigour was calculated by dividing the number of seeds that germinated at first count after 5 days by the total number of seeds sown.

2.4 Seed Moisture Content (SMC)

SMC determined by the high constant temperature oven method at 130 °C for one hour according to International Seed Testing Association (ISTA, 2007) procedures. 15 g of seeds was milled to a coarse texture after which two replicates of 5 g of the coarsely milled cowpea was weighed and put in aluminum analytical container (9 mm in diameter). After the oven reached 130 °C, the seeds in the container were put in the oven for drying. After 1 hour drying, seeds were immediately removed and kept in a desiccator containing silica gel for cooling. Seeds were re-weighed and the weight difference was used to compute the seed moisture content using the formula: SMC (%) = $(M_2 - M_1)/M_2 \times 100$ where M_1 is seed sample weight after drying, M_2 is seed weight before drying. Maximum tolerance was 0.2 between replicate.

2.5 1000 Seed Weight

For 1000 seed weight determination, eight replicates of 100 seeds were counted and weighed on a sensitive balance and average weight was multiplied by 10.

2.6 Experimental Design and Analysis

The experiment was laid in a Split-split plot design with four replicates. The main plot was duration (0, 30, 60 and 90 days), while Storage material (polyethylene bag, cotton bag and glass container) was sub plot and the four cowpea genotypes were sub-sub plot. A total of 192 samples consisting of 48 treatment combinations replicated four times were prepared. Analysis of variance (ANOVA) and least significant difference (LSD) at 5% were utilized to analyze the data using SAS (2007 ed.).

3. Results

The storage condition was relatively warm with an average temperature and humidity of 32 °C and 81% respectively.

Table 1. Storage condition, Initial Seed Moisture Content and 1000 seed weight (g)

Storage condition	Minimum	Maximum	Average
Temperature, ºC	28	34	32
Relatively Humidity (%)	74	88	81

Seed of cowpea genotypes used for the study had initial seed moisture contents ranging from 9% to 10.7%. While *Asetenapa* recorded the least per cent seed moisture, Asomdwoe had the highest per cent seed moisture (10.7%). *Asomdwoe* was observed to be small seeded compared to the other genotypes. It recorded the least 1000 seed weight of 136 g while *Videza* recorded 169 g.

Table 2. Initial Seed Moisture Content and 1000 seed weight (g)

Cowpea Genotypes	Initial Moisture Content	1000 Seed weight (g)
Hewale	9.8	149.4
Videza	10.4	169.5
Asomdwoe	10.7	136.3
Asetenapa	9.0	162.5

3.1 Effect of Storage Duration on Percentage Seed Vigour and Germination

Highly significant difference ($P < 0.001$) was observed among the various storage time on percentage seed vigour and germination. Germination and seed vigour percentage was found to decrease with the increase in storage duration (Figure 1). The mean percentage seed vigour and germination irrespective of storage containers (polythene bags, cotton bags and glass containers) and genotype was found to decrease continuously from initial 78 to 34 % and 79.8 to 58.8 % after 9 months storage respectively (Figure 1).

3.2 Effect of Storage Material and Duration on Seed Percentage Germination

Storage material significantly ($P < 0.001$) affected the percentage of seed vigour and germination. Highly significant ($P < 0.001$) difference was observed in mean vigour and germination percentages among cowpea genotypes stored in different storage materials. The seeds stored in glass containers which had the highest vigour

(63.7%) also had the highest germination percentage (72.5%), followed by seeds stored in polyethylene bags (black) which had vigour percentage of 63% and mean germination percentage of 71.7% (Figure 2). The lowest percentage seed vigour and germination was recorded by seeds stored in cotton bags (57%) and 65% respectively. The results also indicate that there was a strong positive correlation (r = 1.00) between percentage seed vigour and germination percentage (Table 3).

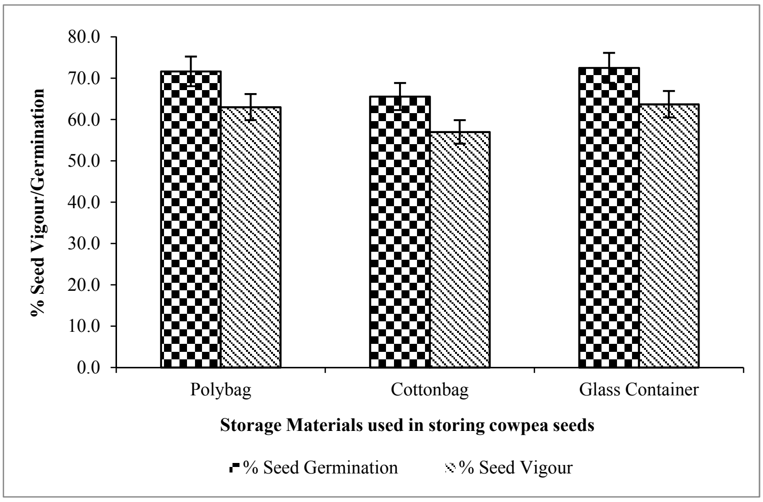

Figure 2. Effect of Storage materials on seed percentage vigour and germination

Table 3. Correlation coefficients (r) of physiological and physical traits of cowpea genotypes after 90 days storage

	%Germ	%Vigour	SMC	Seed_Wt
% Germ				
%Vigour	1.0000			
SMC	0.3877	0.3877		
Seed Wt	0.2428	0.2428	-0.4157	

3.3 Performance of Cowpea Varieties in Storage of Time

Varietal differences during storage in the present study were highly significant (P < 0.001). Among the newly released varieties, *Hewale* stored poorly, irrespective of the packaging material and storage condition. *Hewale*, decrease from 75% germination initially to 67% below acceptable minimum germination within 30 days of storage and further decreased sharply at 60 days of storage to 47%. On the other hand, *Videza* and Asomdwoe performed better in storage compared to an old cowpea variety, *Asetenapa* up to 60 days in storage. It was however, observed that all varieties fell below minimum percentage seed germination for cowpea at day 90.

3.4 The Combined Effect of Storage Material, Crop Genotype and Duration on Percentage Seed Germination

It can be deduced from Figure 3, that combined effect of storage material cowpea genotype and storage time were highly significant (P < 0.001). All cowpea genotypes irrespective of the storage materials declined in germination percentage over time. Consistently, cotton bags used in storage also performed poorly among the storage materials. Similarly, the genotype *Hewale*, irrespective of the storage material and duration of storage decreased in percentage germination. The lowest percentage germination of 22% was recorded at 90 days in cotton bag.

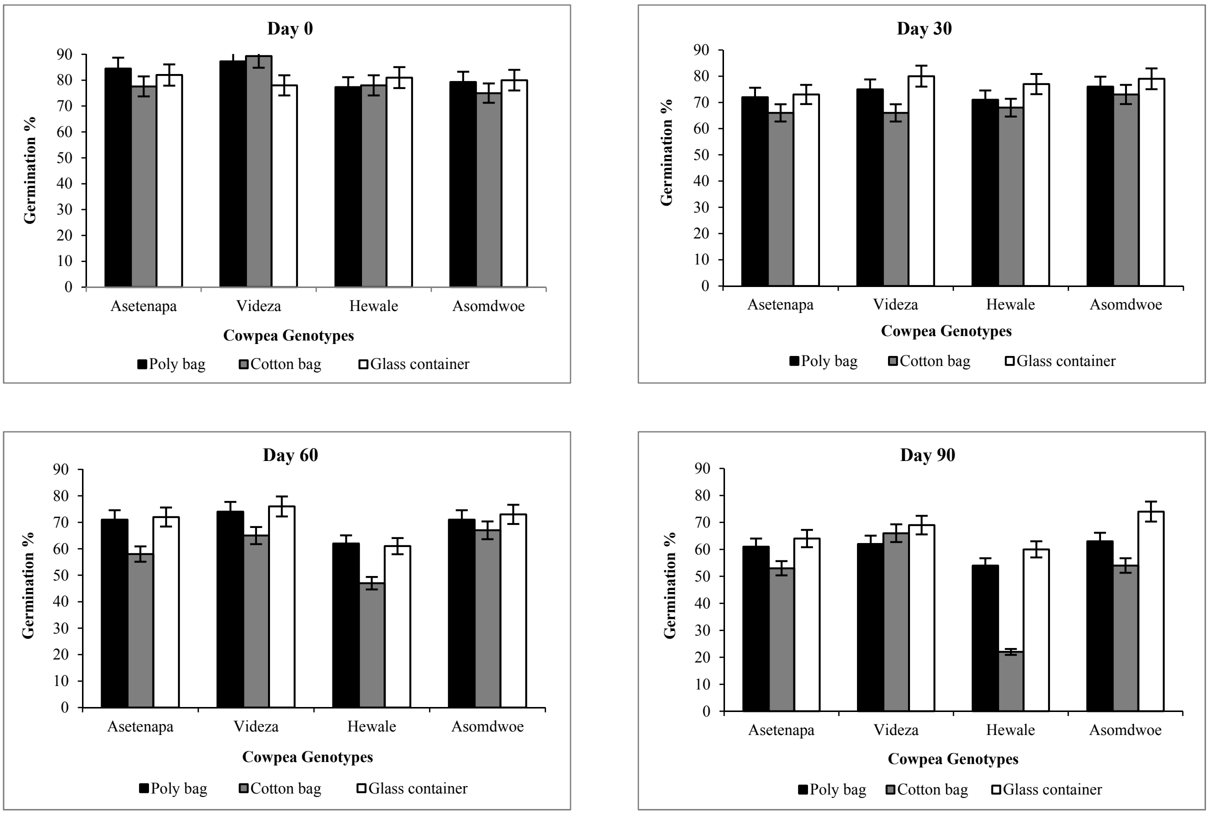

Figure 3. Combined effect of storage material, genotype and duration on percentage germination

4. Discussion

4.1 Effect of Storage Duration on Percentage Seed Vigour and Germination

Across the cowpea genotypes studied, percentage seed vigour and germination reduced over time during storage (Figure 1). This observation could be attributed to the relatively high storage conditions (temperature and relative humidity) recorded during the period of storage as indicated in Table 1. The combined effect of temperature and seed moisture content and relative humidity of storage conditions are main known factors influencing seed deterioration and viability loss. These factors are applicable irrespective of the seed type as observed in the present study. Eluid et al. (2010) in studying the effects of temperature and relative humidity on the viability of bean seeds stored under stockists store condition observed that seeds stored under mean maximum temperature and relative humidity of 30.8 °C and 80.1% respectively showed a rapid decrease in viability of bean seed (*Phaseolus vulgaris*) and went below the accepted levels after one month of storage.

Further, it is generally known that seed deterioration is inevitable but the rate can be reduced when the key storage factors such as temperature and humidity during storage are well managed (Ellis & Roberts, 1981; Rindels, 1995; Adetumbi, 2009). With the exception of *Hewale* genotype, which maintained good germination up to 30 days, the cowpea genotypes in the present study were able to store up to 60 days still with relatively good germinability but was short below acceptable levels according to Ghana Seed regulation standards. Thus, as observed by other authors (Pradhan & Badola, 2008; Adetumbi et al., 2011; Kamara et al., 2014), it can be re-emphasized that irrespective of the initial seed quality, unfavourable storage conditions, particularly air temperature and relative humidity contribute to accelerating seed deterioration (McCormack, 2004; Heatherly & Elmore, 2004).

4.2 Effect of Storage Material on Percentage Seed Germination

Seed stored in cotton bag under ambient temperature and humidity recorded the lowest vigour and germination percentage after 60 and 90 day period irrespective of variety. However, seeds stored in polyethylene bag and air-tight glass container recorded high seed vigour and germination percentage. This present studies are in line with reports of Asiedu and Powel (1998), Bortey et al. (2011) and Kamara et al. (2014). The author reported that seeds stored in humid and warm environments tend to absorb moisture from the surroundings, leading to increased seed moisture content until equilibrium is established. Gurmit and Hari (1992) also made similar observation and indicated that seeds stored in vapour proof containers maintain the desired quality of seeds for longer periods than moisture pervious containers like cotton bags. When there is minimal gas exchange between the storage material and surrounding environment, biochemical activities reduces and that could reduce the rate of deterioration in seeds.

4.3 Cowpea Genotype Performance in Storage Over Time

Seed deterioration is a serious problem in developing countries where seeds are stored in places usually without a proper control of humidity and temperature. Generally, all cowpea seed genotypes fell below minimum seed germination percentage of 70% according to the Seeds (Certification and Standards) Regulations of Ghana after 90 days of storage (Figure 4). The various released cowpea genotypes stored significantly different. Among the newly released genotypes, *Asomdwoe and Videza* stored well up to day 60 but comparable to the old *Asetenapa* genotype while *Hewale* stored poorly in terms of percentage seed germination at day 60. Differences in the storage potential of cultivars within a species have also been reported in grain legumes as being associated with seed-coat pigmentation. To corroborate with this assertion, the findings of Asiedu and Powell (1998) in Cowpea (*Vigna unguiculata* L. (Walp)), Abdullah et al. (1993) in *Phaseolus vulgaris* and Mugnisjah et al. (1987) in soybean, reported that soybean cultivars having unpigmented seed coats deteriorated more rapidly during storage than cultivars with pigmented seed coats. In the present study however, all cowpea varieties had light coloured or unpigmented seed coat. This may rule out the influence of seed coat colour or pigmentation on the longevity of the cowpea genotypes studied. This notwithstanding, the rate of seed ageing depends on the physiological status and genetic constitution of the seeds as well as on the capacity of a cultivar to withstand ageing conditions (Priestly, 1986; Kalpana & Madhava Rao, 1995). Progressive loss in seed quality attributes occurred with ageing in all varieties but at a faster rate with the *Hewale* genotype. The observed reduction in percentage seed germination over time could also be linked to the reduction in enzyme activity within the seed Iqbal et al. (2002), Ruzrokh et al. (2003), and Demirkaya et al. (2010).

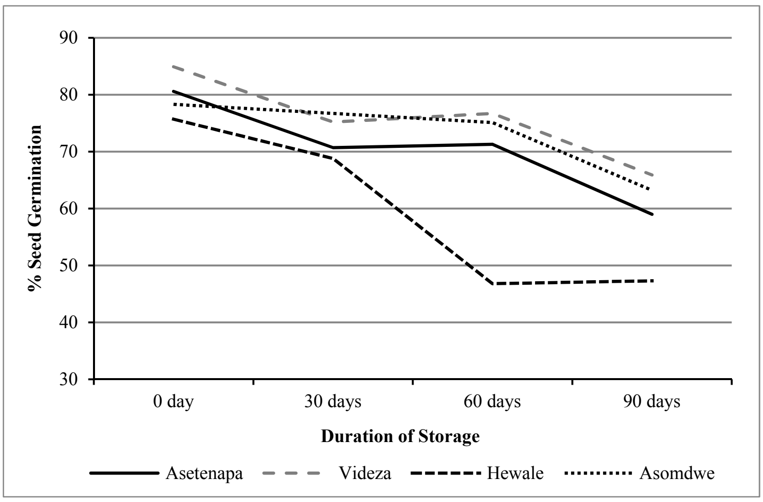

Figure 4. Performance of Cowpea genotypes in storage over time

5. Conclusion

Results from the present study suggest that cowpea genotype differences affect germinability and storability; that each genotype behaved differently during storage. It further indicates that glass containers and polyethylene bags are suitable seed storage materials for cowpea compared to cotton bags. The storage material significantly affected the quality of seed in terms of percentage vigour and germination.

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