`EFFECT OF STORAGE ENVIRONMENTS AND DURATION ON GERMINATION OF COWPEA (*VIGNA UNGUICULATA* (L.) WALP) SEEDS

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ABSTRACT

Seed storage is an integral aspect in crop genebank management and this is important to get adequate healthy and vigorous plant stands. The objective of this study was to investigate the effects of storage environments and duration on germination of cowpea seeds. Seeds of two cowpea (Vigna unguiculata L.) varieties, Ife Brown and SAMPEA 12 were used for the study. The seed samples from each variety were kept separately under ambient, short and medium term conditions for a period of one year using plastic containers as packaging materials. Electricity supply for minimum of ten hours was ensured in both short and medium term storage environments. Germination test was conducted on stored seed samples, which were drawn in four quarters i.e. May, August, November and February (2015-2016). The experiment was arranged in 2 x 3 x 4 factorial using complete randomization design (CRD) in three replication. Analysis of variance (ANOVA) revealed that effect of variety was significant ($P<0.05$) while effects of storage environment and storage period were highly significant ($P<0.01$) on germination of cowpea seeds. In addition, interaction effects of variety with storage environment and storage period with storage environment were highly significant ($P<0.01$) on germination of cowpea seeds. However, the non-significant difference observed between germination of cowpea seeds stored under the two coldrooms suggested that duration of power supply to coldrooms should be given priority. Furthermore, the observed significant interaction between storage period and environment suggested that in assessing germination of cowpea seed lot, storage conditions should be given prime consideration.

Keywords: Cowpea, Environment, Germination, Period, Storage

INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp) is one of the most important grain legumes, grown mainly in tropical and sub-tropical regions of the world. In Africa, the largest production comes from West Africa (Gbaguidi *et al*., 2013). Cowpea is cultivated primarily for its edible seeds in Nigeria moreover it is reputed as the highest producer in the world with about 850,000 tons (Ogbemudia *et al*., 2010). In addition to its importance as human food, the crop is also useful in enhancing soil fertility through symbiotic nitrogen fixation and the leaves and fodder also serve as animal feed.

Seed storage is the maintenance of high seed germination and vigour from harvest until planting and this is important to get adequate

healthy and vigorous plant stands. The quality of seed is a multiple concept encompassing genetic quality, seed health, physical aspects, germination and vigor. Germination capacity is a crucial aspect of seed quality therefore standard germination tests are used worldwide to determine the maximum germination potential of a seed batch under optimum conditions. Seed germination is the first critical stage in any plant life cycle and determines the optimal plant density and crop uniformity.

Seed deterioration and loss of viability are natural phenomenon during storage (Nasreen, *et. al.*, 2000), even under ideal storage conditions. However, proper storage conditions may effectively preserve substantial viability of seeds over a considerable period. Longevity of seed during storage could be influenced by several factors such as temperature and relative humidity of the storage environment, nature of the seeds, seed moisture content and storage periods. (Bonner, 1990; Onyekwelua and Fayose 2007; Pradham and Badola, 2008). Seed moisture content is the most important factor that influences seed longevity in any storage environment (O'Hare *et al*., 2001). High seed moisture content may reduce seed germination by promoting fungal growth and insect infestation (Bullerman *et al*., 1984). Nasreen *et al*. (2000) reported that there was decline in germination percentage of soybean seeds after two months in storage environment in seed with high (9.8%) and medium (7.7%) moisture content. Hence, proper seed drying to safe moisture level is recommended prior to the storage of seed lots. Temperature also plays an important role in determining the longevity of seeds. Tariq *et al*. (2005) reported that high moisture and temperature increased the infection of *Aspergillus flavus* and decreased the germination of soybean seed. Dawar and Ghaffar, 1992 had earlier reported increase in the incidence of *A. flavus* and aflatoxin B1 production in sunflower seeds due to high moisture content. Shelf life of seeds is also influenced by the relative humidity of the surrounding atmosphere. Due to the hygroscopic nature of seeds, there is exchange of moisture between the seeds and the surrounding air until equilibrium is attained between the seed and air moisture. This could result in rapid seed deterioration, especially where humid conditions are prevalent.

The National Center for Genetic Resources and Biotechnology (NACGRAB), located in Ibadan, Nigeria, is the national focal point for genetic resources conservation and utilization in Nigeria. NACGRAB holds over 300 accessions of cowpea in her gene banks and over the years, had been distributing cowpea accessions from her working collections to meet the requirements of researchers in the National Research System. However, the gene banks in NACGRAB were recently constrained by interruption in power supply, the primary requirement for cold storage of seeds. There is therefore a need for information on the influence of storage environments along with duration of storage on the viability of cowpea seeds. The objective of this study therefore was to investigate the effects of three storage environments namely, ambient (control), short term and medium term conditions at different periods of storage on germination of cowpea seeds.

METHODOLOGY

Seeds of two varieties of cowpea (Ife Brown and SAMPEA 12 with initial germination percentages of 90 and 88 %, respectively) were sourced from the gene banks of NACGRAB, Ibadan. The seeds were produced during the late growing season of 2014 at NACGRAB experimental farm in Ibadan. Five hundred grams of each of the accessions were drawn and further subdivided into three lots. Samples from each variety were kept separately in different storage environments including ambient, short and medium term conditions for one year using plastic containers as packaging materials. The materials were kept in the storage environments in February 2015. The stored seed samples were drawn at quarterly intervals starting from May 2015 to February 2016 which constituted four storage periods. Electricity supply was ensured for a minimum of ten hours daily in both short and medium term storage environments. Temperature and relative humidity of both short and medium term storage environments were taken daily but only daily temperature was recorded under ambient environment. One hundred seeds of each variety were drawn and evaluated for germination test in three replications. The experiment was arranged in 2 x 3 x 4 factorial in completely randomized design (CRD). At each of the four periods of germination testing, seeds were placed in germination plastic containers lined with four layers of tissue paper moistened with 15ml of distilled water. The containers were covered and placed in a germinating chamber at 25 ± 2°C. The seeds were kept moist every day for seven days. Germination counts were taken seven days after sowing according to International Seed Testing Association (ISTA) rules (ISTA 1995). Data on germination percentage were log transformed to ensure conformity to normality and subjected to analysis of variance (ANOVA) using Statistical Analysis Software, SAS Version 9.1 (SAS, 1990). However, since ANOVA did not detect any significant difference between transformed and untransformed values, untransformed values were hereby presented. Pertinent means were thereafter separated by the use of the least significant difference (LSD) at 0.05 level of probability using SAS software (SAS, 1990).

RESULTS

The results of the mean temperature ranges in the three environments, and mean relative humidity ranges in the short and medium term storage environments during the study were presented in Table 1. Temperature under ambient conditions ranged from 23 to 29.5^{o}C while that of the short term storage environment ranged from 15.07 to 22.59^{o}C. The lowest temperature value was observed under medium term storage environment which ranged from -4.18 to 4.12 ^{o}C (Table 1). The mean relative humidity ranges in short and medium term storage environments were 26.88 to 50.67 % and 42.72 to 72.10 % respectively (Table 1).

Table 1: Mean temperature (°C) ranges in the three storage environments and mean relative humidity (%) ranges in short and medium term storage environments at NACGRAB, Ibadan.

Storage environment	Temperature (^{O}C)	Relative humidity (%)
Ambient	23 to 29.5	---
Short term	15.07 to 22.59	26.88 to 50.67
Medium	-4.18 to 4.12	42.72 to 72.10

Analysis of variance showed significant variety (VAR) effect (P<0.05) on cowpea seed germination percentage. In addition, effects of storage environment (STR) and storage period (STP) on germination of cowpea seeds were highly significant (P<0.01) (Table 2). Highly significant (P<0.01) effects of interactions between variety and storage environment (VAR × STR) as well as storage period and storage environment (STP ×STR) on germination of cowpea seeds were detected (Table 2).

Germination percentage was 68.22% for SAMPEA 12 and 62.11% for Ife Brown variety (Table 3). The lowest mean germination percentage (46.75%) was recorded for seed samples under ambient conditions (Table 3). However, mean germination percentages for cowpea seeds stored under short term (75.75%) and medium term conditions (73.00%) were not significantly different (Table 3). In addition, mean germination percentages due to the influence of storage period were 91.22%, 73.22%, 49.89% and 46.33% for first, second, third and fourth period respectively (Table 3).

Table 2: Mean squares from the analysis of variance for the germination test on cowpea seeds at NACGRAB, Ibadan

Source of variation	df	Germination (%)
Rep	2	113.17ns
Variety (VAR)	1	672.22*
Storage Environment (ENV)	2	6150.50**
Storage Period (STP)	3	7991.33**
VAR x ENV	2	1337.39**
STP x VAR	3	242.59ns
STP x ENV	6	1515.17**
VAR x ENV x STP	6	271.54ns
Error	46	127.78
Total	71	805.27
R^2 (%)		0.90
CV		17.35
Mean		65.17

*, **, Significant at probability level of 0.05 and 0.01, respectively; ns = not sig

In addition, germination of cowpea varieties varied from one storage environment to another. Ife Brown variety (VAR1) had highest germination percentage (68.33%) under medium term storage conditions whereas SAMPEA 12 (VAR 2) had highest germination of 85.33% under short term storage environment (Table 4).

Table 3: Effect of variety, storage environment and duration in storage on seed germination of cowpea seed at NACGRAB, Ibadan

Factors	Seed germination (%)
A. Variety	
Ife Brown	62.11b
SAMPEA 12	68.22a
LSD	5.36
B. Storage Environment	
Ambient	46.75b
Short term	75.75a
Long term	73.00a
LSD	6.57
C. Storage Period	
Month 3	91.22a
Month 6	73.22b
Month 9	49.89c
Month 12	46.33c
LSD	7.58

Means with different letters within the column of the same factor are significantly different at P=0.05

Table 4: Germination of cowpea seeds as influenced by interaction of variety and storage environment at NACGRAB, Ibadan

Variety (VAR)	Storage Environment (ENV)	Germination (%)
VAR1	ENV1	51.83
VAR1	ENV2	66.17
VAR1	ENV3	68.33
VAR2	ENV1	41.67
VAR2	ENV2	85.33
VAR2	ENV3	77.67

VAR1= Ife Brown, VAR2= SAMPEA 12

ENV1=Ambient conditions, ENV2= Short term conditions, ENV3 =Medium term conditions

Table 5: Germination response of cowpea seeds as influenced by interaction of storage environment and period at NACGRAB, Ibadan

Storage Environment (ENV)	Storage Period (STP)	Germination (%)
ENV1	STP1	94.33
ENV2	STP1	91.33
ENV3	STP1	88.00
ENV1	STP2	62.00
ENV2	STP2	80.00
ENV3	STP2	77.67
ENV1	STP3	18.00
ENV2	STP3	61.67
ENV3	STP3	70.00
ENV1	STP4	12.67
ENV2	STP4	70.00
ENV3	STP4	56.33

ENV1=Ambient conditions, ENV2= Short term conditions, ENV3 =Medium term conditions
STP1=first storage period, STP2= Second storage period, STP3= Third storage period, STP4=Fourth storage period

Similarly, germination of cowpea seeds observed at each quarter varied with storage environment, for instance, at the first quarter, the highest germination percentage (94.33%) was observed under ambient (ENV1) conditions, but for the second and fourth quarters, the highest germination percentages were observed under short (ENV2) term storage conditions with respective values of 80.00% and 70.00%. However, highest germination percentage (70.00%) at the third quarter was observed under medium (ENV3) term storage conditions (Table 5).

DISCUSSION

Storability of seeds is determined by a wide range of factors such as genotypes, initial quality of the seed, seed moisture content, storage temperature, relative humidity and duration of storage. The mean temperature range under ambient environment was relatively higher compared to other two storage environments hence lowest mean germination percentage was observed for seed samples stored in this environment. The results corroborated with the findings of Chauhan and Nautical (2007) who reported lesser seed viability under room temperature than under low temperature storage for *Nardostachys jatamansi.* In addition, in this present study, a non-significant difference was observed between the germination percentages of cowpea seeds stored in the short and medium term storage chambers could be attributed to the fluctuation in electricity supply, which could have masked the anticipated differences. Nevertheless, these results still agree with the report of McDonald (1999) who stated that high temperature and relative humidity levels are the most prominent environmental factors with respect to the intensity and velocity of

deterioration in any storage environment. The germination of cowpea seed from this study depended on storage period. Germination significantly decreased with increase in storage period. This result agrees with that of Yilmaz and Aksoy (2007) who reported decrease in germination of *Rumex scutatus* with increase in storage period irrespective of different storage conditions.

In addition, the significant variety by storage environment interaction indicates that germination of the cowpea varieties varied from one storage environment to another. This suggested that restocking schedule in genebanks should be specific for each cowpea variety under the storage environment under consideration. Similar results were reported by El-Aidy *et al*. (2001) who reported that viability of cotton seeds during storage depended on varieties involved. Furthermore, the observed significant interaction between storage period and environment indicated that the germination of cowpea seeds drawn in each quarter varied with storage environment which corroborates the report of Soares *et al*. (1993). In addition, it also suggested that in assessing germination of cowpea seed lot, storage conditions should be given prime consideration.

CONCLUSION

This study led to the conclusion that there was differential response of germination of cowpea seed in the different storage environments, with lowest germination percentage observed for seed stored under ambient conditions. Also there was differential response of germination of cowpea seed to storage periods. Germination percentage of the cowpea seeds decreased with increase in duration of storage. However, there was no significant difference between the germination of cowpea seeds stored under medium and those in short term storage despite the different storage conditions. This suggests that duration power supply to the genebanks should be given priority in order to obtain anticipated differences from the cold environments. Furthermore, the observed significant interaction between storage period and environment suggested that in assessing germination of cowpea seed lot, storage conditions should be given prime consideration.

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