International Journal of Plant & Soil Science

20(6): 1-6, 2017; Article no.IJPSS.38518
ISSN: 2320-7035

Effects of Storage Conditions and Duration on Seed Germination of Okra (*Abelmoscus esculentus*)

Olosunde Adam[1*], Aladele Sunday[1], Olubiyi Mayowa[1], Afolayan Gloria[1] and Olajire Olabisi[1]

[1]National Center for Genetic Resources and Biotechnology, Moor Plantation, Ibadan, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author OA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AS, OM, AG and OO managed the analyses of the study, literature searches and also involved in overall planning and supervision of the experiment. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2017/38518
Editor(s):
(1) Nasima Junejo, Department of Forest Production, Faculty of Forestry, Universiti Putra Malaysia, Selangor, Malaysia.
Reviewers:
(1) Jayath P. Kirthisinghe, University of Peradeniya, Sri Lanka.
(2) Shui Shiozaki, Osaka Prefecture University, Japan.
Complete Peer review History: http://www.sciencedomain.org/review-history/22514

Short Communication

Received 30th November 2017
Accepted 21st December 2017
Published 29th December 2017

ABSTRACT

Okra (*Abelmoschus esculentus*) is an important crop grown mainly for its pods which are used either fresh, canned or dried and ground as powder. It is a good source of vitamins A, B, C and also rich in protein, minerals and iodine. However, conservation of okra seed for long term use especially for the purpose of crop improvement in Nigeria is still a big challenge. The objective of this study was to carry out preliminary investigation on the influence of storage conditions and duration on seed germination of okra seeds. Freshly harvested and processed seeds of three okra accessions (NGAE-96-011, NGAE-96-0060 and NGAE-96-0062-1) were packaged inside well-covered plastic containers and kept in three storage environments namely, ambient (control), short and medium term chambers. The laboratory experiment was conducted at the seed testing laboratory of NACGRAB between February and November 2015. One hundred seeds of each accession were subjected to germination test in three replicates at three-month intervals. The experiment was arranged in 3 x 3 x 3 factorial using completely randomized design (CRD). The results of analysis of variance (ANOVA) revealed that effects of accession and storage duration as well as interactive effect of storage conditions by duration were significant (P<.01) on germination

**Corresponding author: E-mail: olosundam@yahoo.com;*

of okra seeds indicating that there were differential germination response of okra seeds to accession and storage duration. Moreover, the significant interactive effect of storage conditions and duration indicates that duration of okra seed in storage and storage conditions should be given prime consideration in determining germination status of okra seeds in order to avoid wrong conclusion on okra seeds germination potential.

Keywords: Germination; storage; conditions; periods; okra.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moech) belongs to Family *Malvaceae*. It is originated in tropical Africa and grown mainly for its pods which are used either fresh, canned or dried and ground as powder. It is a good source of vitamins A, B, C and also rich in protein, minerals and iodine [1,2]. It has also been reported that okra mucilage application serves as a plasma replacement or blood volume expander [3]. In addition, okra has been reported to contain about 86.1% water, 2.2% protein, 0.2% fat, 9.7% carbohydrate, 1% fiber and 0.8% ash [4].

Seed storage is an integral aspect in crop genebank management and this is important to get adequate healthy and vigorous plant stands. There are several factors influencing the longevity of seed in any storage environment. These include genotype of the seed, initial seed quality, seed moisture content, temperature and relative humidity of the storage environment and storage periods [5,6,7]. Simic et al. [8] reported that within the same plant species, different varieties may exhibit different storing abilities either from genetic variations or other external factors. Seed moisture content is the most important factor that influences seed longevity in any storage environment [9]. Hence, seed must be dried to safe moisture level before storage. However, unfavourable storage conditions, particularly high temperature and relative humidity contribute to accelerating seed deterioration [10]. High relative humidity and temperature cause high moisture content in seeds and result in low germination at the end of storage [11]. Duration of seed storage can be another factor causing seed deterioration due to natural seed aging event that takes place. Since seed is a living entity, if storage period is prolonged, it may result to natural seed aging process and chemical changes thus causes seed deterioration. Proper storage conditions are therefore important in retaining substantial viability of seed over a considerable storage periods.

The germination capacity of any seedlot is a crucial aspect of its quality. Germination is defined as the process in which seeds begin to uptake water, followed by elongation of the embryo and penetration of the radical through the endosperm and seed coat [12]. The Association of Official Seed Analysts [13] defined seed germination as 'the emergence and development from the seed embryo of those essential structures which, for the kind of seed in question, are indicative of the ability to produce a normal plant under favourable conditions'. Seed germination therefore forms the first critical stage in any plant life cycle and determines the optimal plant density and crop uniformity.

Proper conservation of okra seed is important so as to provide seed supply for planting purpose and create a guarantee of this natural resource for the purpose of breeding. In Nigeria, one of the conservation strategies of genetic resources was the establishment of The National Centre for Genetic Resources and Biotechnology (NACGRAB) located in Ibadan. The Centre has over 400 accessions of okra seeds stored in both short and medium term storage chambers. However, conservation of germplasm in the genebanks of NACGRAB is of recent being confronted with some challenges such as interruption in power supply which often results to fluctuation in temperature and relative humidity in the short and medium term storage chambers. Information on storage periods of okra seed at present storage conditions is therefore necessary to ensure proper conservation strategy of okra seeds. This would also furnish additional information for okra seed producers. The present study was therefore designed to investigate the effect of storage conditions and duration germination of okra seeds.

2. MATERIALS AND METHODS

2.1 Genetic Materials and Location of the Experiment

Three accessions of okra seeds (NGAE-96-011, NGAE-96-0060 and NGAE-96-0062-1) with

about 12% moisture content were used in the study. The materials were randomly selected among the accessions harvested and processed during the late season of 2014 and stored in one of the genebanks of The National Centre for Genetic Resources and Biotechnology (NACGRAB). The laboratory experiment was conducted at the seed testing laboratory of NACGRAB between February and November 2015.

2.2 Seed Storage and Measurement Temperature and Relative Humidity

Five hundred grams of each of the accessions were drawn and further subdivided into three lots. Samples from each accession were kept separately in different storage environments including ambient, short and medium term conditions for nine months using plastic containers as packaging materials. The materials were kept in the storage environments in February 2015. Electricity supply was ensured for a minimum of ten hours daily in both short and medium term storage environments. The temperature ranges for the ambient, short and medium term storage environments during the conduct of the experiment were 24.0 to 29.5°C, 15.1 to 22.6°C and -4.2 to 4.1°C respectively while the relative humidity in short and medium term storage chambers ranged from 26.88% to 50.67% and 42.72% to 72.10% respectively.

2.3 Experimental Design

The experiment was arranged in 3 x 3 x 3 factorial using completely randomized design (CRD) in three replications. The three factors were accessions of okra, storage environments and storage periods. The stored seed samples were drawn at quarterly intervals starting from May to November 2015 which constituted three storage periods and evaluated for germination test.

2.4 Standard Germination Test

The standard germination test was conducted using sterilized riverbed sand as substratum. The sand was sieved with 2 mm sieve to ensure uniform particle size. Seed germination was assayed by placing 100 seeds per replication in sand inside plastic trays and covering with moist sand up to about 2 cm level. These trays were kept at room temperature of about 26 ± 2°C for 14 days. Germination percentages were determined by expressing the number of seedlings in a replicate that emerged 14 days after planting as a percentage of the number of seeds planted. 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 [14]. 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.

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

The analysis of variance (ANOVA) revealed that effects of storage duration (STD) and interaction of storage conditions by duration were highly significant ($P < .01$) while effect of accession was also significant ($P = .05$) on germination of okra seeds (Table 1). Differential response to germination due to the effect of accession indicates that genetic constitution plays significant role in the germination potential of okra seeds. Several author had similar reports on different species of crops. Tame and Elam [15] reported significant difference in germination of soybean varieties. Similar results was reported by Omar et al. [16] where highly significant differences were observed among the tested cultivars of wheat for all the characters studied. Also, there were differential germination responses of okra seed to storage duration. The germination declined as the storage period increased.

The interactive effect of storage conditions and duration indicated that germination response of okra seed lot at each period varied with the conditions of the storage environment. This finding is in agreement with that of Sultana et al. [17] who reported that germination of stored okra seeds decreased gradually with increase storage period irrespective of containers used in carrying out the study. Some authors also had similar reports for other species of crops. For instance, Verma and Tomer, [18] reported that seed germination, emergence rate and seedling establishment decreased as storage period of Brassica (*Brassica campestris*) seeds increased. Yilmaz and Aksoy [19] also reported decrease in germination of *Rumex scutatus* with increase in storage time irrespective of different storage conditions.

Table 1. Mean squares from the analysis of variance for laboratory germination test on okra seed conducted at the Seed Testing Laboratory, NACGRAB, Ibadan

Source of variation	DF	Mean squares of germination (%)
Replication	2	96.3ns
Accession (ACC)	2	284.8ns
Storage chamber (ENV)	2	23.8ns
Storage period (STD)	2	4589.7**
ACC*ENV	4	54.6ns
ACC*STD	4	70.2ns
ENV*STD	4	385.6**
ACC*ENV*STD	8	25.6ns
Error	52	109.9
Total	80	223.7
R%		0.7
CV		23.5
Mean		**44.6**

**, **, Significant at probability level of .05 and .01, respectively; ns = not significant*

3.2 Germination Performance of *A. esculentus* as Influenced by Accession and Storage

The germination percentage for accession NGAE-96-0062-1 was significantly higher (48.3%) than that of accessions NGAE-96-011 and NGAE-96-0060 with mean germination percentages of 42.1% and 43.6% respectively (Table 2). Also, effect of storage period was highly significant on germination of okra seeds. Although, there was no significant decrease between the mean germination percentages at third (54.1%) and sixth (50.2%) month in storage however germination percentage decreased significantly at ninth (29.7%) month in storage (Table 2). In addition, germination of okra seeds was significantly affected by the combined effect of storage conditions and duration (Table 2).

In this study, accession NGAE-96-0062-1 seemed to possess better storability quality compared to accession NGAE-96-011 and NGAE-96-0060. The decrease of the seed germination was more pronounced at ninth month in storage.

The mean seperation of interactive effect storage conditions and duration revealed that at three months in storage, germination values of 55.3%, 52.2% and 54.7% were observed for okra seeds stored under ambient, short and medium term chambers respectively (Table 3). Similarly, at sixth month in storage, the germination values were 54.9%, 47.1% and 48.4% were observed for okra seeds stored under ambient, short and medium term chambers respectively (Table 3). However, the germination values significantly decreased at ninth month in storage irrespective of the storage environments used in this study with respective values of 21.1%, 37.6% and 30.4% for the materials stored in the ambient, short and medium term chambers respectively (Table 3). The highest germination values (37.6%) was observed from okra seed stored under short term storage conditions at the end of ninth month in storage which was the last storage duration for this study.

Table 2. Comparison of means for accessions, storage conditions and storage periods on seed germination of okra at NACGRAB, Ibadan

Factors	Seed germination (%)
A. Accession	
NGAE-96-011 (ACC1)	42.07b
NGAE-96-0060 (ACC2)	43.56a
NGAE-96-0062-1 (ACC3)	48.30a
LSD	5.73
B. Storage chambers	
Ambient (ENV1)	43.78a
Short term (ENV2)	45.63a
Medium term (ENV3)	44.52a
LSD	5.73
C. Storage duration	
3 months (STD1)	54.08a
6 months (STD2)	50.15a
9 months (STR3)	27.70b
LSD 0.05	5.73

Means with different letters within the column of the same factor are significantly different at P=.05

Table 3. Germination of okra seeds as affected by the interactive effect of storage conditions and periods at NACGRAB, Ibadan

Storage environment	Storage duration	Mean germination (%)
ENV1	STD1	55.3
ENV2	STD1	52.2
ENV3	STD1	54.7
ENV1	STD2	54.9
ENV2	STD2	47.1
ENV3	STD2	48.4
ENV1	STD3	21.1
ENV2	STD3	37.6
ENV3	STD3	30.4

ENV1= ambient, ENV2= short, ENV3= medium
STD1= for 3 months, STD2= for 6 months, STD3 = for 9 months

The highest germination percentage at the last period of the experiment was observed on okra seed stored in short term chamber followed by the medium term. Hence, in assessing germination of okra seed, storage conditions and duration should be given prime consideration in order to avoid wrong conclusion on germianation potential of a particular accession.

4. CONCLUSION

It can be concluded from this study that interactive effect of storage conditions and duration affected germination of okra seeds. The highest germination value at the end of the last period was observed on materials stored in the short term storage chamber followed by that of medium term storage chamber. Hence, there is need to optimize cold room conditions in order to achieve the anticipated differences for short and medium term storage. This could be easily achieved by increasing the duration of electricity supply to the cold rooms so as to reduce fluctuation in temperature and relative humidity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Qayyum S. A varietal trial on okra (*Hibiscus esculentus L.*) cultivars. Pak. Agric. 1990;7(4):55-78.
2. Malik MN. Vegetable crops in horticulture. National Book Foundation Islamabad, Pak. 2nd Edition. 1996;504-505.
3. Onunkun O. Evaluation of aqueous extracts of five plants in the control of flea beetles on okra [*Abelmoschus esculentus* (L.) Moench.]. 2012;5(Supplementary):62–67.
4. BARI (Bangladesh Agricultural Research Institute). Annual progress report of okra cultivation. Bangladesh; 2010.
5. Bonner FT. Storage of seeds: Potential and limitations for germplasm conservation. Forest Ecology and Management. 1990;35(1-2):35–43.
6. Onyekwelua JC, Fayose OJ. Effect of storage methods on the germination and proximate composition of *Treculia africana* seeds. In Proceedings of the International Conference on Agricultural Research for Development, University of Kassel-Witzenhausen and University of Göttingen, Tropentag; 2007.
7. Pradhan BK, Badola HK. Seed germination response of populations of *Swertia chirayita* following periodical storage. Seed Technology. 2008;30(1):63–69.
8. Šimic B, Popoviæ R, Sudaric A, Rozman V, Kalinovic I, Cosic J. Influence of storage condition on seed oil content of maize, soybean and sunflower. Agriculturae Conspectus Scientificus. 2007;72(3):211-213.
9. O'Hare T, Bagshaw J, Johnson WLG. Storage of oriental bunching onions. Post-harvest handling of fresh vegetables. In: Proc. of a workshop held in Beijing, China, 9-11 May; 2001.
10. Heatherly LG, Elmore RW. Managing inputs for peak production. In H. R. Boerma, & J. E. Specht (Eds.), Soybeans: Improvement, Production and Uses (3rd Ed.). 2004;451-536.
11. McCormack JH. Seed processing and storage. Principles and practices of seed harvesting, processing and storage: An organic seed production manual for seed growers in the Mid-Atlantic and Southern U.S.; 2004.
12. Bewley JD, Black M. Seeds: Physiology of development and germination. New York, Press; 1994.
13. Association of Official Seed Analysts. Rules for testing seeds. AOSA, Ithaca, NY; 2009.
14. SAS/STAT *User's Guide* Version 6, 4th Edition. SAS Institute, Cary, North Carolina, USA; 1990.
15. Tame VT, Elam Y. Effect of storage materials and environmental conditions on germination of percentage of soybean (*Glycine max* (L) Merr) seeds in Yola, Nigeria. International Journal of Agricultural Sciences and Natural Resources. 2015;2(4):90-94.
16. Omar AM, Sorour FA, El-Sayed SA, Naywa ES. Effect of storage periods, cultivators, environments and package materials on germination, viability and seedling vigour of wheat grains. Journal of Plant Production, Monsura University. 2012;3(b):1075-1087.
17. Sultana R, Salahuddin M, Chowdhury M, Islam M, Akhter K. Effects of container and duration of storage on the quality of okra

(*Abelmoschus esculentus*) seeds. The Agriculturists. 2016;14(1):63-72.

18. Verma SSU, Tomer RPS. Studies on seed quality parameters in deteriorating seeds in Brassica (*Brassica campestris*). Seed Science and Technology. 2003;31:389-396.

19. Yilmaz DD, Aksoy A. Physiological effects of different environmental conditions on the seed germination of *Rumex scutatus* L (*Polygonaceae*). Erciyes Üniversitesi Fen Bilimleri Enstitüsü Dergisi. 2007;23(1-2): 24-29.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22514