*International Journal of Agriculture and Environmental Research*

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

# EVALUATION OF DESICCANTS ZEOLITE BEADS TECHNOLOGY FOR DRYING FOUR SEED CROPS (GREEN GRAM-*VIGNA RADIATA L.*, ONION-*ALLIUM CEPA L.*, *AMARANTHUS L.*, TOMATO- *LYCOPERSCON ESCULENTUM L.*) AND THEIR EFFECT ON SEED STORABILITY AND QUALITY

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**DOI: https://doi.org/10.51193/IJAER.2024.10209**

Received: 09 Apr. 2024 / Accepted: 17 Apr. 2024 / Published: 26 Apr. 2024

## ABSTRACT

The Physiological quality of the seed is challenged by processing and handling methods especially drying methods, packaging materials, storage method used and time. A comparable study was conducted to evaluate influences of different seeds' drying methods, packaging materials and storage period on tomato, green gram, onion and amaranth. A Randomized complete Block Design (RCBD) factorial experiment with four factors (crop types, seed storage period, packaging materials and drying methods (4 x 4 x 2 x 2) resulted in a combination of 32 treatments used. Results revealed that there was highly significant difference (P<.001) among treatments over seed qualities. It was observed that seeds dried with zeolite beads and stored with air tight container had good seed quality over seeds dried under sun and stored with cloth bag. Seed dried using zeolite beads and stored with airtight container except amaranth showed higher germination percentage (green gram 74), (onion 87) and (tomato, 80), field emergence percentage (green gram 70), (onion 83) and (tomato 79) and vigour index I (green gram 1070), (onion 987) and (tomato, 1122) compared to germination percentage of sundried seeds stored with cloth bag (green gram 18), (onion 64), (tomato, 60), field emergence percentage (green gram 15), (onion 61), (tomato, 58) and vigour Index I (green gram 226), (onion 653), (tomato, 768) after 18 months of storage.

**Keywords:** Desiccants, Zeolite beads, Seed drying, Seed storability, Seed quality, Green gram (*Vigna radiata* L)

  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

## 1.0 INTRODUCTION

Agricultural crop production highly depends on quality seeds. The longevity of seeds during storage is highly sensitive to relative humidity and temperature [3]. Generally, the duration of seed viability (germination capacity) in storage is reduced by half for every 1% increase in Moisture content (fresh weight basis) or 5% increase in temperature [3],[11]. This principle implies that seed storage life can be enhanced considerably by lowering both moisture and temperature. The maintenance of seed viability, tissue and cell morphological integrity, and genetic material stability may be possible with the use of ultra-dry storage technologies in agriculture and forestry [24]. However, moisture content is the key factor that can be lowered for successful seed storage in tropical countries. Cold storage is expensive and difficult to maintain because the electricity supplies are often inconsistent and unreliable. In addition, seeds that are dried to low moisture contents are more tolerant of storage at warm temperatures. However, even prolonged sun drying in high humidities cannot reduce seed moisture content to safe moisture content for assurance of long-term viability. Seeds are hygroscopic in nature, and their MC change in response to the relative humidity (RH) of the air surrounding the [2]. Seed storage is major problem in most part of Tanzania because the majority of the seed companies/farmers are located in the tropics, where the combination of high temperature and high relative humidity is obvious, which causes rapid deterioration of seed quality. The relative humidity mostly exceeds 75% and temperatures remain above 20°C between harvesting and next planting, causing seeds to deteriorate rapidly. Generally, seeds are dried under the sun, if the crop is harvested during rainy season or under cloudy atmosphere which is very difficult to dry the seed to low moisture content suitable for longer storage unless mechanized drying equipment are employed. In such climates high temperature and humidity combine to cause rapid deterioration of seeds under ambient storage conditions result in poor quality seeds such as poor stand establishment, lower productivity and disincentive to invest in improved seeds.

Therefore, there is a need for low cost drying methods to be used as alternatives of such expensive seed drying equipment. In order to maintain safe moisture content of seed for storage and during storage, a well-designed drying technique/method that suits for all categories of seed producers located in different climatic zones is of paramount important. As an alternative desiccant drying technology, seed drying using zeolite beads are modified ceramic materials (aluminum silicates or "zeolites") that specifically absorb and hold water molecules very tightly in their microscopic pores. When placed in an enclosed space like a plastic or metal container, the beads will remove water from the air, creating and maintaining a very low humidity environment. Seeds placed into a container with the beads will lose water due to the low air humidity, and will continue to do so until they come to equilibrium. Hence, desiccant-based drying simply transfers the water in the seed to the drying beads through the air without the need

  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

for heating. Beads can be enclosed in a porous bag or container within the hermetic container with the seeds for convenience in separation.

## 2.0 MATERIAL AND METHODS

The experiment was conducted at Agricultural Research Institute, Tengeru in Tanzania. The freshly harvested seeds of green gram, onion, amaranths and tomato with different moisture contents were collected and dried using zeolite beads in a ratio of 1:1 (100g seeds: 100g zeolite beads) and under sun ($25^0$C, RH 80%). Both drying methods took 72hrs for drying seed. The dried seed using zeolite beads and sun were stored using cloth bag and airtight container for (18) eighteen months. Seed quality testing was conducted at the interval of (6) six months. Seeds of four seed crops (4) green gram, onion, amaranths and tomato seed with varying moisture contents were used to asses effect zeolite beads, drying technology and storage materials on seed storability and seed quality under ambient conditions.

### 2.1 Drying and storage methods

Seeds with initial moisture content, green gram 11.62%, and onion 9.82%, amaranths 21.44% and tomato 15.55% were both dried under sun and using zeolite beads. A zeolite beads with a ratio of (1:1) was used for drying seed in airtight plastic containers for seventy two hours (72hrs). The beads were enclosed in a porous bag into the hermetic container with the seeds for convenient separation. The beads were subsequently removed and regenerated separately by heating at a temperature >200°C in an oven for 2 hours to release the absorbed water.

Sun drying involved drying of amaranths, green gram, onion and tomato seeds by spreading in a thin layer on ground at a temperature of $25\pm1^oC$ and a relative humidity of about 80% for seventy two hours (72hrs), with duration of 8 hours in a day.

After seed drying hundred (100) grams of seeds in each crop were replicated three times and kept in airtight containers and cloth bags for 18 months under ambient conditions. Data were recorded at the interval of six (6) months by adopting the standard procedures as detailed below.

### 2.2 Collection of Experimental Data

#### 2.2.1 Moisture content (%)

Moisture content was determined using the constant high-temperature oven method according to [8]. Seed samples were thoroughly mixed by placing the opening of the nylon container against the side of a similar empty container and pouring the seeds back and forth between the two containers for about 1 minute. Three subsamples were drawn from different parts of the container with sample and then mixed to form a working sample of 5 g. The process was repeated to obtain a duplicate working sample.

Green gram seed were grounded to coarse powder and two samples of 5g each were dried in an oven at 130ºC for an hour. Two samples of onion seed of 5 grams each were dried in an oven at 104ºC for an hour. For tomato and amaranths seed, 5 grams of two seed samples were dried in an oven at 130ºC for an hour. Containers and their lids were weighed and recorded as M1, then containers were filled with samples and labeled M2. After filling and weighing the containers and their lids with samples, were rapidly placed into an oven. After drying period, the containers with their lids were placed into a desiccator for thirty minutes to cool; the containers with lids and dried sample were weighed and recorded as M3. The moisture content was calculated as follows.

$$\text{Moisture content (M. C)} = \frac{\text{Loss of weight}}{\text{Initial weight}} \times 100 = \frac{M2 - M3}{M2 - M1} \times 100$$

Hereby: M1 Weight in grams of the container and its cover.

M2 Weight in grams of the container, its cover, and its contents before drying,

M3 Weight in grams of the container, its cover, and its contents after drying.

**2.2.2 Germination percentage**

Germination test was conducted on pure seed fraction using 100 seeds in four replicates following sand method. The sand was sieved into 2mm and sterilized at $150^0$C using an oven. The seed samples were placed in the germination chamber at $25^0$Ctemperature and $90 \pm 3$ per cent relative humidity [8]. The germinated seeds were evaluated into normal, abnormal seedlings and dead seeds on 7th, 8th, 12th and 14th day after planting for green gram, amaranths, onion and tomato respectively. The germination per cent was calculated based on the number of normal seedlings evaluated.

**2.2.3 Vigour index 1**

The vigour index was calculated by adopting the method suggested by [1] and were expressed as the whole number.

  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

Seedling Vigour Index I (SVI-I) = Germination (%) x Seedling length (cm)

**2.2.4 Field emergence percentage**

Twenty five seeds in four replications were taken randomly for each treatment and planted in a well prepared media in a plastic container. Seeds were sown equidistantly and watered to maintain the optimum soil moisture for emergence. The number of normal seedlings emerged three centimeters above the soil surface were counted on 15$^{th}$ day after sowing and expressed as field emergence in percentage [10].

**2.3 Statistical analysis**

A Randomized complete block design factorial experiment with four factors (crop types, seed storage period, packaging materials and drying methods-4 x 4 x 2 x 2) resulted in 32 treatments combination were used. Data obtained were analysed by using Analysis of Variance (ANOVA) technique [6]. Standard error of difference was calculated for each treatment effect and critical difference (CD) was calculated at 5 percent probability level to compare the mean difference among the treatments using GenStat 16$^{th}$ edition computer statistical software.

**3. RESULTS AND DISCUSION**

**3.1 Effects of zeolite beads on seed drying and storage on seed quality**

**3.1.1 Moisture content percentage**

Seeds with initial moisture content, green gram 11.62%, Onion 9.82%, Amaranthus 21.44% and Tomato 15.55% before drying and storage using desiccants zeolite beads had a remarkable effect on seed moisture content and maintenance of seed viability and vigour during (18) eighteen months of seed storage.

Seeds dried using zeolite beads in airtight container observed lowest moisture content after 72 hours of seed drying and maintained lowest moisture throughout storage period (Figure 1). Zeolite beads reduced the moisture content from 11.62 to 7.13% green gram, 9.82 to 5.76% onion, 21.44 to 11.48% Amaranth and 15.55 to 5.76% tomato seeds. In the present study zeolite beads dried both seeds to lower moisture, this may be due to highly polar surface within the pores which is main driving force for moisture adsorption from the seeds, similar results on zeolite beads was reported by [14] who dried soya bean to 8.56 % moisture content using silica gel and store in pearl pet jars for six months. [21] used zeolite beads to dry mung bean seeds from 10-6% moisture content. [13] dried tomato seeds using desiccant zeolite beads seed ratio (1:1) from 17 to 4.4 % thereby seed viability and vigour can be extended for a long period.

  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

Seeds dried under sun and stored in cloth bags, moisture per cent keep fluctuated with environmental conditions (Figure 2) the open sun dried method and cloth bag storage led to moisture content fluctuation as seeds were exposed to external relative humidity and temperature in order to equilibrate with surrounding environment. The change in seed moisture during storage in cloth bag might be the reason responsible for faster seed deterioration through its effect on cell membrane, the loss of structural integrity of membrane upon dehydration of seeds and its retention affect viability of seeds. Similar result was found by [9] and [17].

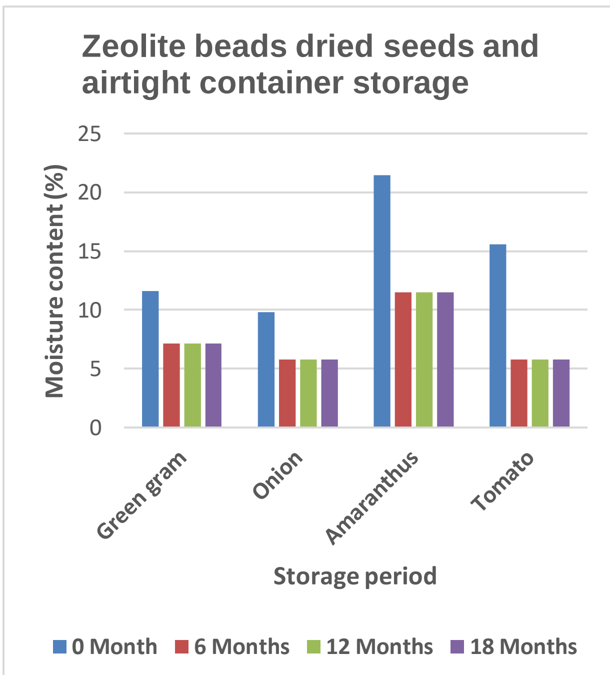


**Figure 1:** Moisture content seeds dried with zeolite beads and stored in airtight container

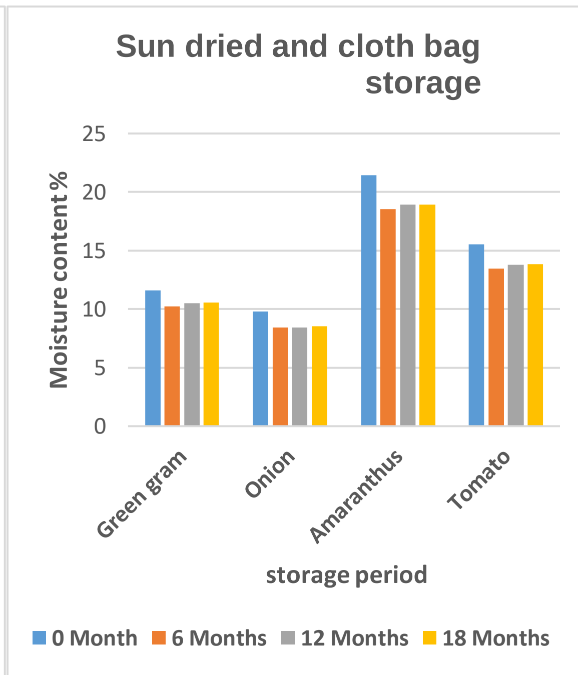


**Figure 2:** Moisture content seeds dried under sun and stored in cloth bag

### 3.1.2 Germination percentage

Viability of many seeds is reduced by half within six months under ambient storage conditions [20]. This is in line with a study by [12] who finds that seeds stored under ambient conditions (16–30 C and 30% RH) deteriorate at a faster rate and have lower germination and vigor as compared to those seeds stored under closed conditions for 27 months. Henceforth, it is very crucial for seed moisture and storage temperature to be kept low to improve storability. [4] 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% Relative humidity respectively showed a rapid decrease in viability of bean seed (Phaseolus vulgaris) and went below the accepted levels after one month of storage. In the current study, except amaranthus, when green gram, Onion, and tomato seeds were dried to a moisture content of 7.13%, 5.76%, and 5.76% with zeolite beads respectively, the germination per cent was not statistically influenced and ageing of seeds is minimized at low moisture during storage.

The seed deterioration which results to poor germinability and vigour during storage is inevitable. Reduction of quality during storage is mostly caused by relative humidity, temperature and storage containers [16]. The present study revealed that the initial germination were 94%, 92%, 91% and 88% for green gram, onion, amaranthus and tomato respectively. Except amaranthus, a high significant effect on seed germination percentages was observed using desiccants zeolite beads (**Table 1**). Seeds dried and stored in airtight container with desiccants zeolite beads maintained high germination percentage throughout the storage period as follows green gram (74%), (**Plate 1**) Onion (88%), Amaranthus (91%) and tomato (80%) (**Figure 3**). The retention of high seed viability might be due to lowering of seed moisture at ultra dry conditions during storage which resulted to low seed respiration and maintenance of cell membrane. Similar results was reported by [21] drying of mung bean seeds using zeolite beads to 6%, low moisture content and hermetic storage delayed loss of seed viability at ambient temperature and maintained germination above 90% compared to cloth bag 79% after nine months of seed storage.

Except Amaranthus, seeds dried under sun and stored in cloth bag recorded lowest germination percentage after 18 months of storage (**Figure 4**) i.e. Green gram 18%, Onion 65%, Amaranthus 90%, tomato 61% This is mainly because of higher and fluctuating moisture content during storage period. This is in accordance with the findings of [7] in cowpea, [19] in brinjal.

*International Journal of Agriculture and Environmental Research*

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

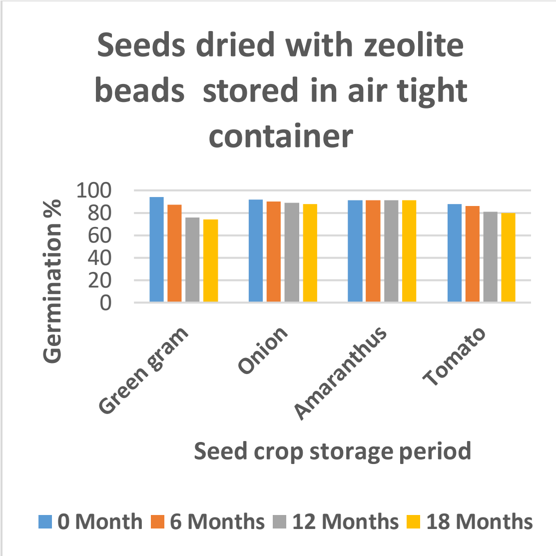


**Figure 3:** Germination percentage seeds dried with zeolitebeads stored in airtight container

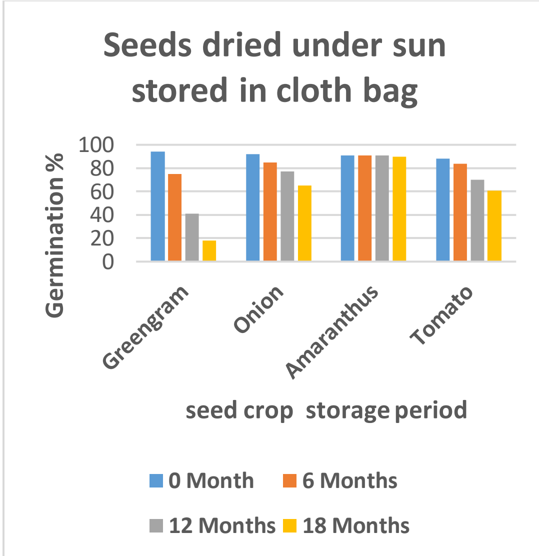


**Figure 4**: Germination percentage seeds dried under sun stored in a cloth bag

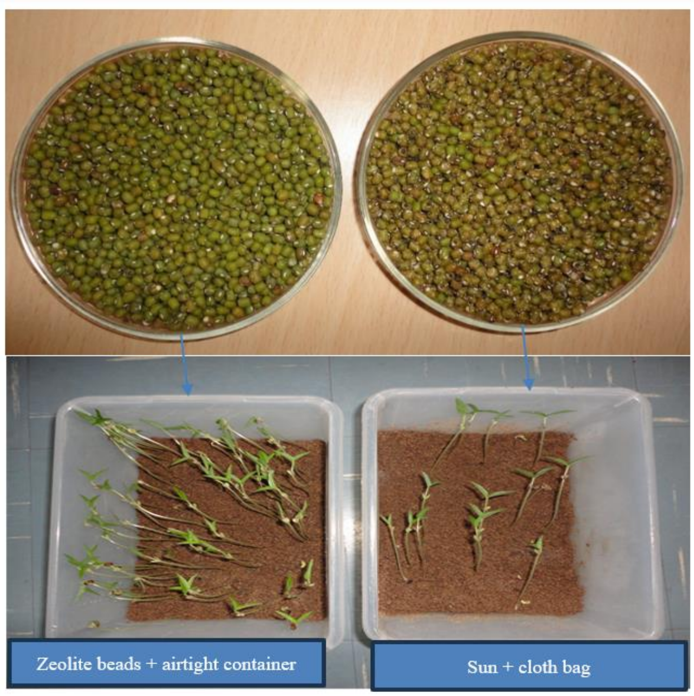


**Plate 1: Germination percentage of green gram seeds after 18 months of storage, (left) seed dried with zeolite beads and stored in airtight container, (right) seeds dried under sun stored in cloth bag.**

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

### 3.1.3 Seedling Vigour Index 1

Seedling vigour is an important parameter in assessing seed quality. In the current study, seedling vigour as reflected in root and shoot length was higher in seeds dried using zeolite beads and stored in airtight container which recorded higher seedling vigour index I (Plate 2), compared to seeds dried under sun and stored in a cloth bag. Lower moisture maintained in a airtight container might be responsible for higher germination, seedling length and seedling vigour index as reported by [24] in lab lab seeds after six month of seed storage, [15] reported higher vigour index of 1097 in chilli seeds after 9 months of storage. In addition [18] reported that onion seeds were dried with silica gel to 5.3% seed moisture content and stored in polythene bag maintained higher vigour index I of 474 after 20 months of seed storage compared to cloth bag 413.


**Plate 2: Tomato seedling showing vigorous growth for seeds dried with zeolite beads and stored in airtight container (Left) and for seeds dried under sun and stored in cloth bag (Right)**

  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

### 3.1.4 Field emergence percentage

High quality seeds lead to higher plant population with healthy and uniform seedlings. In the current study, seeds dried and stored with zeolite beads took significantly less days to 50 per cent of emergence as compared to seeds dried under sun and stored in a cloth bag. Seeds dried with zeolite and stored in airtight container revealed higher seedling quality with respect to germination, vigour index and field emergence. These are in accordance with the findings of [5] who observed higher field emergence of 75% for soybean seeds dried to safer moisture content and stored in impervious poly-line jute canvas compared to previous jute canvas (71%) after one year of storage, also [22] observed higher field emergence of 81% for rice seeds stored in airtight container with zeolite beads after 16 months.

**Table 1: Effects of zeolite beads on seed drying and storage on seed quality**

| Treatment combination | Germination | Emergency | Index-I |
|---|---|---|---|
| Amaranthus Sun dried & stored in cloth bag 0 | 91.33n | 90.67q | 1187lm |
| Amaranthus Sun dried & stored in cloth bag 6 | 90.67mn | 89.67opq | 1200lm |
| Amaranthus Sun dried & stored in cloth bag 12 | 90.67mn | 88.67no | 1203lmn |
| Amaranthus Sun dried & stored in cloth bag 18 | 90lmn | 88mn | 1167kl |
| Amaranthus Zeolite beads Dried & Stored in airtight container 0 | 91.33n | 90.33pq | 1187lm |
| Amaranthus Zeolite beads Dried & Stored in airtight container 6 | 90.67mn | 90.67q | 1188lm |
| Amaranthus Zeolite beads Dried & Stored in airtight container 12 | 90.67mn | 89.33op | 1179klm |
| Amaranthus Zeolite beads Dried & Stored in airtight container 18 | 91mn | 90.33pq | 1186lm |
| | | | |
| Green gram Sun dried & stored in cloth bag 0 | 93.67o | 93.33r | 1477p |
| Green gram Sun dried & stored in cloth bag 6 | 74.67f | 72.33g | 1177klm |
| Green gram Sun dried & stored in cloth bag 12 | 40.67b | 38.33b | 537b |
| Green gram Sun dried & stored in cloth bag 18 | 18.33a | 15.33a | 226a |
| Green gram Zeolite beads Dried & Stored in airtight container 0 | 93.67o | 92.67r | 1477p |
| Green gram Zeolite beads Dried & Stored in airtight container 6 | 87.33j | 85.67l | 1364o |
| Green gram Zeolite beads Dried & Stored in airtight container 12 | 75.67fg | 70.67f | 1097hi |
| Green gram Zeolite beads Dried & Stored in airtight container 18 | 74f | 70.33f | 1070h |
| | | | |
| Onion Sun dried & stored in cloth bag 0 | 91.67n | 90.33pq | 1125ij |
| Onion Sun dried & stored in cloth bag 6 | 85.33i | 80.67j | 1027fg |
| Onion Sun dried & stored in cloth bag 12 | 77g | 75.33h | 842e |
| Onion Sun dried & stored in cloth bag 18 | 64.67d | 61.33d | 653c |
| Onion Zeolite beads Dried & Stored in airtight container 0 | 91.67n | 90pq | 1125ij |
| Onion Zeolite beads Dried & Stored in airtight container 6 | 90.33mn | 89.67opq | 1093hi |
| Onion Zeolite beads Dried & Stored in airtight container 12 | 89.33klm | 87.33m | 1013fg |
| Onion Zeolite beads Dried & Stored in airtight container 18 | 87.67jk | 83.67k | 987fg |
| | | | |
| Tomato Sun dried & stored in cloth bag 0 | 88.33jkl | 87.67mn | 1243n |
| Tomato Sun dried & stored in cloth bag 6 | 85.67i | 83.67k | 1187lm |

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

| | | | |
|---|---|---|---|
| Tomato Sun dried & stored in cloth bag 12 | 70.33e | 68.67e | 982f |
| Tomato Sun dried & stored in cloth bag 18 | 60.67c | 58.33c | 768d |
| Tomato Zeolite beads Dried & Stored in airtight container 0 | 88.33jkl | 87.33m | 1243n |
| Tomato Zeolite beads Dried & Stored in airtight container 6 | 84.33i | 83.67k | 1214mn |
| Tomato Zeolite beads Dried & Stored in airtight container 12 | 80.67h | 79.33i | 1143jk |
| Tomato Zeolite beads Dried & Stored in airtight container 18 | 80.33h | 79.33i | 1122ij |
| **P-Value** | **<.001** | **<.001** | **<.001** |
| **CV** | **1.2** | **0.8** | **2.1** |
| **Mean** | **81.27** | **79.5** | **1084** |
| **S.E** | **0.981** | **0.6473** | **23.29** |
| **LSD** | **1.601** | **1.0565** | **38.02** |

## 4. CONCLUSION

Therefore, from experiment it can be conclude that zeolite beads drying of seeds to lower moisture content prior storage is the one of an ideal method to store seeds for longer period in an air tight container without seed quality reduction. Zeolite beads have professed advantages over other desiccants, which include that they have higher regeneration capacity, greater affinity for water, particularly at low humidity. Also, the present results also indicated that green gram, Onion, and tomato seeds drying by zeolite beads has reduced its moisture content to a desired level also maintained better seed quality parameters throughout the storage period. Hence, it is a suitable technology to low volume seeds, seed companies (either public or private) and seed banks to store precious seed material as well as plant genetic resources for a longer period.

## REFERENCES

[1] Abdul-Baki A A and Anderson J P (1973) Vigour deterioration in soybean by multiple criteria. *Crop Science*. 13: 630-637.

[2] Arjun Khanal (2014) Evaluation of zeolite beads technology for drying vegetable seeds to low moisture content prior long term storage. *International Journal of Research* (IJR) Vol 1: 140-149

[3] Ellis R H and Roberts E H, (1980) Improved equations for prediction of seed longevity. *Ann. Botany*. 45: 13-30.

[4] Eliud, R., Muasya R., & Gohole, L. (2010). Longevity of Bean (Phaseolus vulgaris) Seeds Stored at Locations Varying in Temperature and Relative Humidity. *Journal of Agriculture, Pure and Applied Science and Technology*, 5, 60-70.Technology, 5, 60-70.

[5] Girase V S, S hende V D, Dumbra A D, Shaikh R S (2006) Effect of packaging on germination and storability of soybean seeds under ambient conditions. *Seed Research*. 34(2) 202-204.

  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"


[6] Gomez K A, Gomez A A. Statistical procedures for agricultural research, 2nd edition, A Willey International Science Publication, New York (USA). 2010, 20-29.

[7] Hillary M.B, Alimatu O.S, James Y.A (2016) Influence of seed storage techniques on germinability and storability of cow peas (*Vigna Unguiculata L*) Walp*). Journal of Agricultural Sciences* 8(10) ISSN 1916-9752

[8] International Seed Testing Association (ISTA) (2021). International Rules for Seed Testing. Bassersdorf.

[9] Khatri N, Pokhrel D, Pandey B.P, Pant K.R, Bista M. (2019) Effect of different storage materials on the seed temperature, seed moisture content and germination of wheat under farmers field conditions of Kailali district Nepal. *Agricultural Sciences and Technology Journal* 11(4): 352-355

[10] Manjunata S N 2007 Effect of polymer coating on storability of chilli (*Capsicum annuum* L.) seeds, *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences Dharwad, India.

[11] Miller B M and Lawrence C (1998) Seed production Principles and Practises. CBS Publishers & Distributors. New Delhi. 132-133.

[12] Nagaveni, P.K. (2005) Effect of Storage Conditions, Packing Material and Seed Treatment on Viability and Vigour of Onion Seeds. Ph.D. Thesis, UAS, Dharwad, India.

[13] Nassari P J, Keshavulu K, Manohar Rao K, Chandra Shekar Reddy, Amtul Raheem (2014) Post-harvest drying of tomato (Lycopersicon esculentum Mill) seeds to ultra low moisture safe for storage using desiccant (zeolite) beads and their effects on seed quality *American Journal of Research Communication*, www.usa-journals.com. 2014, 2(4)

[14] Nethra N, Rani K, Gowda R, Prasad, Rajendra S, Narayanaswamy S. (2016) Effect of packaging and dessicants on storability of soya bean seeds. *International seed testingAssociation* 44(1): 207-211.

[15] Ninganna, J.S. Hilli and B.S. Vyakaranahal (2018) Effects of Ultra-Dry storage of Chilli seeds. *International Journal of current microbiology and Applied Sciences*. 7 (12): 2743-2751

[16] Ninganna J.S Hilli and B.S. Vyakaranahal (2019) Effects of dessicants on seeds quality of brinjal during ultra-dry storage. *The Pharma Innovation Journal*. 8 (1): 71-73

[17] Quais M K, Jahan S, Haque M M, Khan M R (2013) Variation in seed quality of radish preserved in different storage containers. *Bangladesh Journal of Agriculture Research* (38): 545-552.

[18] Padma V and Reddy M B (2000) effect of seed moisture and packaging material on onion seed longevity. *Seed Research*. 28 (2): 171-175.

[19] Padma V and Reddy M B (2002) Storage of brinjal seed under ambient conditions at two moisture levels. *Journal of Research ANGRAU*. 30 (2): 6-10.


  

ISSN: 2455-6939

Volume: 10, Issue: 02 "March-April 2024"

[20] Panda B B, Mohapatra S, Mallik S, Acharya P (2010) Effect of Tamarind seed mucilage on rheological properties: Evaluation of suspending properties. *International Research Journal of Pharm. Sci*. 1, 8–10.

[21] Razia Sultana, Keshavulu S, Lakshimi prasad A, Peetambar D, Kent J.B (2021) Dessicant drying prior to hermetic srorage extends viability and reduces bruchid (*Callosobruchus chinensis L*.) Infestation of Mung bean (*Vigna radiata (L.)* R. Wilczek) seeds. *Journal of stored products Research* 94 (2021)

[22] Sudha Rani M, Rajasri M, Rao P.S (2015) Effect of Desiccant (Zeolite) beads on Storage Life and Quality of Rice Seed (Oryza sativa L.). *Journal of Rice Research* 8(2).

[23] Wawrzyniak M.K, Michalak M, Chmielarz P, (2020). Effect of different conditions of storage on seed viability and seedling growth of six European wild fuit woody plants. *Annals of Forest Science* 77(2): 1-20

[24] Yahaya A M, Sinniah U R, Misran A (2022) Seed quality of Lab lab beans (*Lab labpurpureus L*) as influenced by drying methods and storage temperature. *Agronomy Journal* 12. 699. http://doi.org/10.3390/*Agronomy* 12030699

  