Evaluation of Zeolite Beads Technology for Drying Vegetable Seeds to low Moisture Content prior to Long-term Storage in Nepal

Khanal Arjun[1] Paudel Pratima[2]

1 Project Coordinator/Research Associate at Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED)
(E-mail: arjunkhanal15@gmail.com)
2 Data entry officer at Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED)
(E-mail: Paudelpratima10@yahoo.com)

Abstract

Seed drying beads are modified ceramic materials (aluminum silicates or "zeolites") that specifically absorb and hold water molecules very tightly in their microscopic pores. The beads will continue to absorb water until all of their pores are filled, up to 20 to 25% of their initial weight. Seven experiments were carried out using zeolite seed Drying Beads® to dry freshly harvested vegetable seeds to low moisture content. The beads were mixed with 1000 g of pea, 500 g of onion seeds and 100 g of tomato seeds in different ratios (the ratio of bead varies according to the beads moisture absorbing capacity and the moisture percentage of the seed), sealed inside moisture-proof bags or heat-sealed laminated aluminium foil packets and placed in temperature controlled environments for drying and/or storage. The desired moisture content of the seeds depends upon the size of the seeds, generally 4-6% for small seeds and 6-8% for large seeds. The experiment confirmed that the beads dry seeds within 3-5 days. The result demonstrated that bead has significant effect in lowering the moisture percentage and keeping the germination percentage constant for several years. It has been found that the seeds can be stored for several years, if seeds are treated with beads and are kept in air-tight containers.

Keywords: Zeolite beads, hygrometer, air-tight containers, seeds

Introduction

Background

Nepal is an agriculture based country. More than 68% of the people are engaged in agriculture. Seed storage may be a major problem in most part of the Nepal because the majority of the seed companies in Nepal are located in the tropics, where the combination of high temperature and high relative humidity causes rapid deterioration of seed quality. The relative humidity of the air for most of the period between harvest and planting often exceeds 75% and temperatures remain above 30°C, causing seeds to deteriorate rapidly. Seeds absorb water from the ambient air when they are stored in humid environments. These problems can be overcome by drying seeds to low moisture

contents using inexpensive hermetic containers and zeolite drying beads.

Seed drying beads are modified ceramic materials made up of aluminum silicates that specifically absorb and hold water molecules very tightly in their microscopic pores. The beads will continue to absorb water until all of their pores are filled, up to 16 to 24% of their initial weight. 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. The equilibrium will be raised after 24 hours when beads are kept in air-tight containers with zeolite beads. The beads can be re-used and regenerated by heating them at 200°C-300°C for 2 hours-3 hours to release the absorbed water. Desiccant drying in a closed container is often suggested as a low-technology method to reduce the moisture content of seed. Suitable desiccants include silica gel (sodium silicate), lithium chloride, calcium chloride, molecular sieve, charcoal and even other seed (Probert, 2003).

Advantages of bead drying

- Drying beads can dry seeds at ambient temperatures in moisture-proof containers.
- When seeds are dried and stored inside moisture-proof containers, they are also protected from molds, diseases (Xingping Zhang, Syngenta), insects and rodents.
- Seed quality is preserved for several years.
- Regeneration frequency is minimized in germplasm conservation programs.
- No need for cold storage to maintain seed viability.

Equipment needed

Any type of locally available air-tight container (plastic, metal can, etc.) of any size can be used. A gasket inside the cap may be needed to ensure air-tight conditions in plastic or metallic containers. An oven or other heat source is needed to regenerate the beads for reuse. This can be any type of oven capable of heating to over 200°C- 300°C. After heating for 2 to 3 hours, the beads should be cooled in a metal container for half an hour until they can be safely handled, then stored in a moisture-proof container.

For knowing the moisture percentage of the seed, moisture meter is required. Moisture meter can be identified with the help of hygrometer. Hygrometer gives the reading of relative humidity and temperature. From relative humidity and temperature, moisture percentage can be identified.

Objectives:

To determine the potential of the zeolite beads for drying and storage of different vegetable crops

Materials and methods

Two treatments (with beads and without beads) and 3 replications are used in each

treatment for the demonstration of bead technology. First moisture percentage of seed is calculated with the help of hygrometer for relative humidity and temperature. Then required bead quantity to bring down at required percentage level of seed (4-8% for small and large seeds) was also calculated with the help of hygrometer. The amount of beads required for lowering the moisture percentage of seed depends upon several factors: i) the water-holding capacity of the beads; ii) the quantity of seeds to be dried; iii) the initial seed moisture content; and iv) the final desired seed moisture content. The water-holding capacity of the beads can vary somewhat depending upon how they have been stored and handled prior to use. To determine their current water-absorbing capacity, a small quantity of beads can be weighed and then placed inside of a container with an open container of water, a wet sponge, or other water source. After leaving sealed for a day, the beads can be removed and weighed again. The final weight minus the initial weight is the weight of water absorbed, and dividing this value by the initial weight gives the water-holding capacity.

Bead water-holding capacity (%) = initial bead weight – final bead weight x 100
Initial bead weight

After knowing the moisture percentage of seed, bead capacity and the required beads to lower the moisture to desired level then bead was kept for 3-5 days with seed in air tight container. Similarly, after getting the desired moisture percentage the bead was removed from the air tight container after 3-5 days. In every three month interval, scouting as well as moisture percentage and germination percentage were checked. The germination percentages of the seed were checked in both at laboratory and in the field.

Seven experiments were carried out, between September 2012 and June 2014, as summarized below:

SN	Location	Crop	Variety	Seed used (Weight)	Bead used (weight)	Experiment Starting date
1	Sean Seed Company, Thankot, Kathmandu	Onion	Red Creole	500 gm	170 gm	13th March 2013
2		Pea	Sikkim Local	1000 gm	231 gm	13th Sep. 2012
3	Kathmadu Agro-concern, Lagankhel, Lalitpur	Onion	Red Creole	500 gm	190 gm	4th August 2013
4	National Seed Centre, Lagankhel, Lalitpur	Onion	Red Creole	300 gm	98 gm	9th August 2013
5	Chaudhary Group, Satdobato, Lalitpur	Onion	Red Creole	200 gm	59 gm	25th Sep. 2012

6	Gorkha Seed Company, Kalimati, Lalitpur	Tomato	Srijana	100 gm	19 gm	11th Sep. 2012
7	Ranagaun Farmer Group, Lele-7	Pea	Sikkim Local	400 gm	121 gm	25th Sep. 2012

Results:

1. **Sean Seed Company, Thankot, Kathmandu in Onion var. Red Creole**

The experiment was conducted for 15 months i.e. initiated in March 13, 2013 and final data was taken in June 13, 2014. There were two treatments (seed with beads and without beads) and three replications. For this experiment 500 gm of seed for each replication was used and was kept in hermatic container and the bag as control. 170 gm bead was kept in hermatic container and was removed after five days. During the experiment period, in every three month interval, scouting as well as moisture percentage and germination percentage were checked. The findings revealed that at the initial stage before start of experiment the germination percentage of onion seed was 81% but after the experiment it has been found that germination percentage of seed with bead was 83% and seed without bead was 7%. It has been found that the bead has significant effect in the storage of seed as well as keeping the germination percentage at constant level. It has been found that the germination percentage of seed is in decreasing order in seed without beads and at constant level in seed treated with beads. The result is illustrated below:

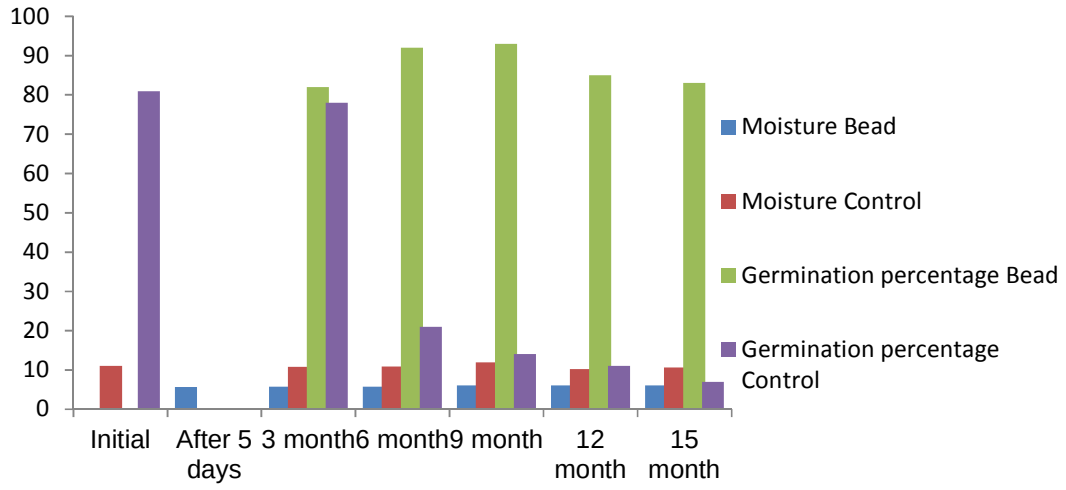

Fig. 1 Result of beads experiment in Sean Seed Company, Kathmandu in Onion

2. Sean Seed Company, Thankot, Kathmandu in Pea var. Sikkim Local

The experiment was conducted for 21 months i.e. initiated in September 13, 2012 and final data was taken in June 13, 2014. There were two treatments and three replications. For this experiment 1000 gm of seed for each replication was used and was kept in hermatic container and the bag as control. 231 gm bead was kept in hermatic container and was removed after five days. Similarly, during the experiment period, in every three month interval, scouting as well as moisture percentage and germination percentage were checked. The findings revealed that at the initial stage, before start of experiment the germination percentage of pea seed was 90% but after the experiment it has been found that germination percentage of seed with bead was 92% and seed without bead was 67%. The germination percentage of seed without bead is in decreasing order as the time increases. The result is illustrated below:

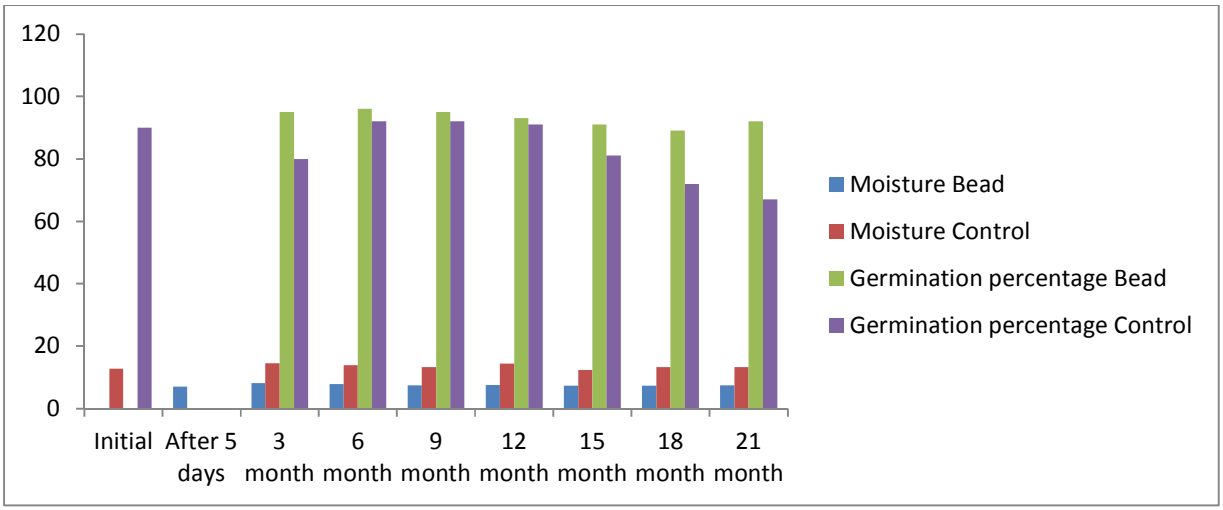

Fig. 2 Result of beads experiment in Sean Seed Company, Kathmandu in Pea

Fig. 3 Experiment conducted in Sean Seed Company at Kathmandu in Onion and Pea

3. Kathmandu Agro-Concern, Lagankhel, Lalitpur in Onion var. Red Creole

The experiment was conducted for nine months i.e. initiated in August 4, 2013 and final data was taken in May 4, 2014. For this experiment 500 gm of seed for each replication was used and was kept in hermatic container and the bag as control. 190 gm bead was kept in hermatic container and was removed after five days. Similarly, during the experiment period, in every three month interval, scouting as well as moisture percentage and germination percentage were checked. The findings revealed that at the initial stage, before start of experiment the germination percentage of onion seed was 70% but after the experiment, it has been found that germination percentage of seed with bead was 71% and seed without bead was 26%. The germination percentage of seed without bead is in decreasing order and the seed with bead treated is in constant level as the time increases. The result is illustrated below:

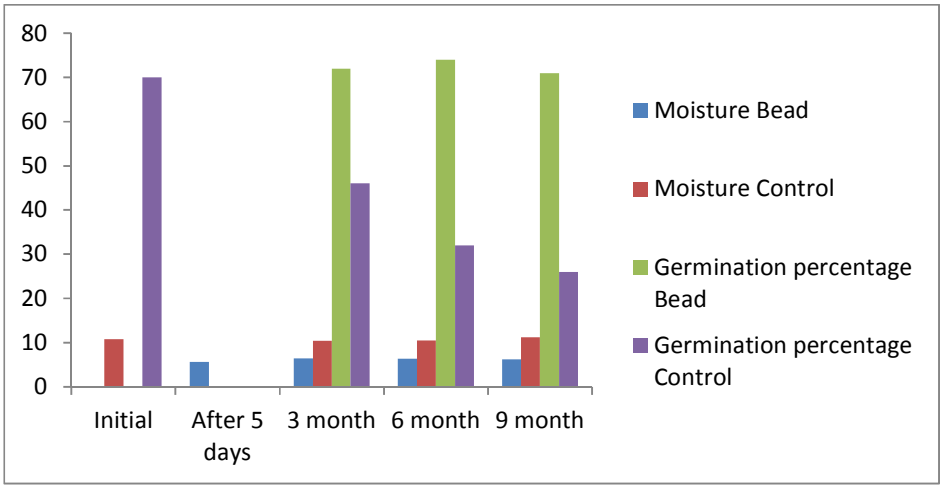

Fig. 4 Result of beads experiment in Kathmandu Agro-Concern, Lalitpur in Onion

4. National Seed Centre, Lagankhel, Lalitpur in Onion var. Red Creole

The experiment was conducted for nine months i.e. initiated in August 9, 2013 and final data was taken in May 9, 2014. For this experiment 300 gm of seed for each replication was used and kept in hermatic container as well as in the bag as control. 190 gm bead was kept in hermatic container and was removed after five days. Similarly, during the experiment period, in every three month interval, scouting as well as moisture percentage and germination percentage were checked. The findings revealed that at the initial stage, before start of experiment the germination percentage of onion seed was 81% but after the experiment, it has been found that germination percentage of seed with bead was 77% and seed without bead was 22%. The germination percentage of seed without bead is in decreasing order and the seed with bead treated is in constant level as the time increases. The result is illustrated below:

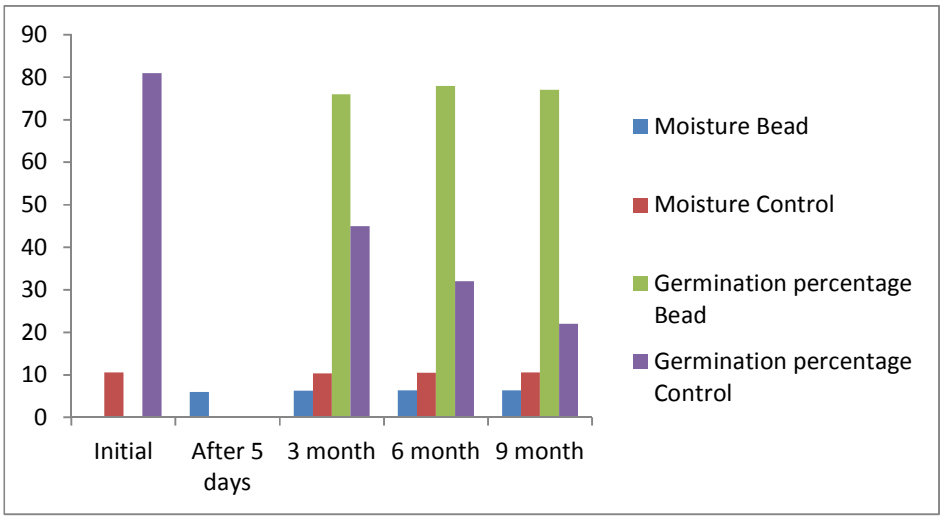

Fig. 5 Result of beads experiment in National Seed Centre, Lalitpur in Onion

5. Chaudhary Group, Satdobato, Lalitpur in Onion var. Red Creole

The experiment was conducted for 21 months i.e. initiated in September 25, 2012 and final data was taken in June 25, 2014. For this experiment 200 gm of seed for three replications was used and kept in hermatic container as well as in the bag as control. 59 gm bead was kept in hermatic container and was removed after five days. The study showed that at the initial stage, before start of experiment the germination percentage of onion seed was 77% but after the experiment, it has been found that germination percentage of seed with bead was 70% and seed without bead was 32%. The germination percentage of seed without bead is in decreasing order and the seed with bead treated is in constant level as the time increases. The result is illustrated below:

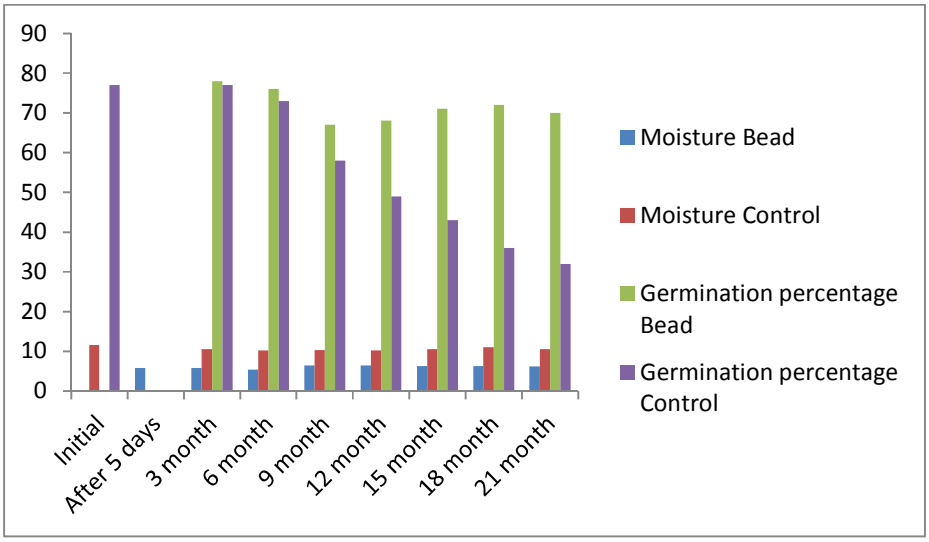

Fig. 6 Result of beads experiment in Chaudhary Group, Lalitpur in Onion

6. Gorkha Seed Company, Kalimati, Kathmandu in Tomato var. Srijana

The experiment was conducted for 21 months i.e. initiated in September 11, 2012 and final data was taken in June 11, 2014. For this experiment 100 gm of seed for three replications was used and kept in hermatic container as well as in the bag as control. 19 gm bead was kept in hermatic container and was removed after five days. The study showed that at the initial stage, before start of experiment the germination percentage of tomato seed was 92% but after the experiment, it has been found that germination percentage of seed with bead was 90% and seed without bead was 72%. The germination percentage of seed without bead is in decreasing order and the seed with bead treated is in constant level as the time increases. The result is illustrated below:

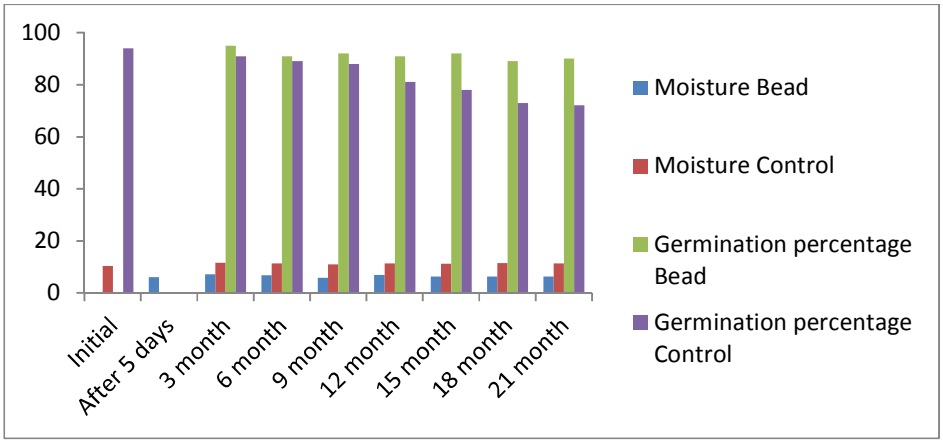

Fig. 7 Result of beads experiment in Gorkha Seed Company, Lalitpur in Tomato

Field performance of Tomato seeds from Gorkha Seed:

It has been found that the germination percentage of bead treated tomato seed was 90% and the seed without bead treated was 75%. The germination percentage of field as well as laboratory test was found same.

Fig. 8 Experimental seed tested in tray

7. Ranagaun Farmer Group, Lele-7, Ranagaun in Pea var. Sikkim Local

This experiment was carried out in farmers' group level of Lalitpur District. The experiment was conducted for 12 months i.e. initiated in September 11, 2012 and final data was taken in September 11, 2013. For this experiment 400 gm of seed for three replications was used and kept in hermatic container as well as in the bag as control. 121 gm bead was kept in hermatic container and was removed after five days. The study showed that at the initial stage, before start of experiment the germination percentage of pea seed was 78% but after the experiment, it has been found that germination percentage of seed with bead was 86% and seed without bead was 7%. The germination percentage of seed without bead is in decreasing order and the seed with bead treated is in constant level as the time increases. The result is illustrated below:

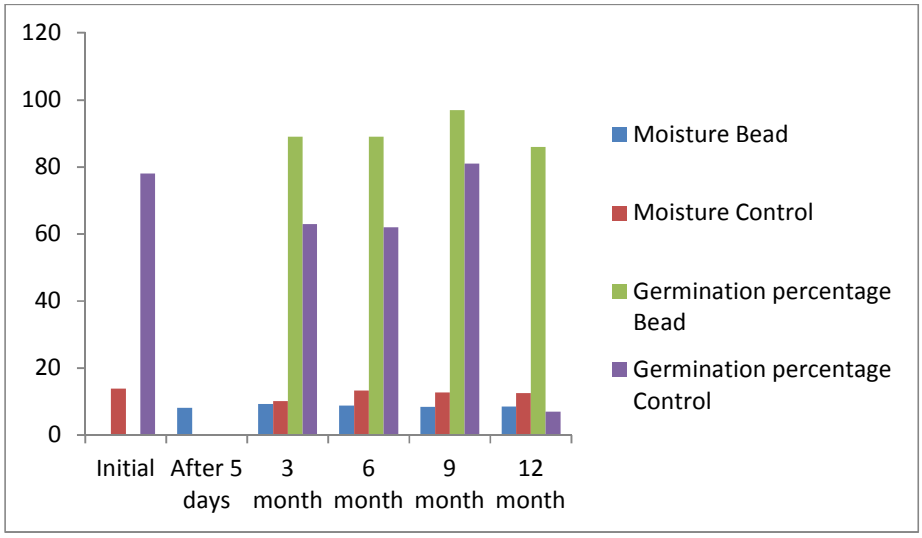

Fig. 9 Result of beads experiment in Ranagaun Farmers Group, Lalitpur in Pea

Discussion

It has been found that the importance of drying to extend the longevity of seed is undisputed. For the storage, it is recommended that seeds should be dried to moisture contents between 4-6% for small seeds and 6-8% for large seeds. For storing the seeds for longer duration without deteriorating the quality of seeds, zeolite beads are the best. It has been revealed from the study that the seeds are not able to take up moisture during storage by using air-tight containers, such as heat-sealed laminated aluminum foil packets (FAO/IPGRI, 1994). zeolite Drying Beads are becoming available around the world and are already being promoted as a new technology for drying horticultural seeds in a number of developing countries (UC Davis, 2009). When a bead-to-seed ratio of ½ or 1/3 was used, the seed moisture content was reduced to the desired moisture percentage level. It has also been found that the germination percentage of seed treated with beads was also at constant level while the seed without beads was in decreasing order as the time increases. Therefore, from the experiments it can be

concluded that the zeolite beads can be used for drying the seeds and can be stored in air-tight containers for several years without deteriorating the quality of seeds.

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