*Research Journal of Recent Sciences* ISSN 2277-2502
Vol. **3(10),** 48-52, October **(2014)** *Res.J.Recent Sci.*

# Traditional Method of Storing Pigeonpea (*Cajanus cajan* L.) Seeds Using Red Soil

**Ganesh K. Jaganathan* and Baolin Liu**
Institute of Biothermal Technology, University of Shanghai for Science and Technology, Shanghai 200093, CHINA

**Available online at: www.isca.in, www.isca.me**
Received 18th November 2013, revised 28th February 2014, accepted 27th March 2014

## Abstract

*Post-harvest storage of pigeonpea (Cajanus cajan.* L*) seeds is susceptible to insect infestation, therefore seed viability deteriorates rapidly during storage and cause considerable economic loss. In the present investigation, we studied the effects of a traditional method using red soil in storing pigeonpea seeds over two years. Seeds at the time of collection germinated to 85 ± 6.9%. Results of seed storage experiments showed that 58 ± 8.1% of seeds coated with red soil were viable after 6 months and 44 ±7.9% of the seeds germinated after 12 months of storage. Sun-dried seeds stored under laboratory condition germinated only to 14 ± 5.7% and 4 ± 3.4% after 6 and 12 months respectively. However, after one year of storage the number of viable seeds is very low and no statistically significant difference in germination (P>0.05) was observed between red soil coated and sundried seeds stored in room temperature. We observed seeds coated with red soil were completely dry, a reason attributable to less insect infestation. Given its easy use and better efficacy compared to solar heating method reported previously, we expect this cost-effective technique will serve as a reliable way for storing pigeonpea seeds.*

**Keywords:** *Cajanus cajan*, Post-harvest seed storage, red soil, Storage pests, traditional method.

## Introduction

Traditional banking of seeds between growing seasons has been the key factor driving agricultural advancements[1,2]. Several methods have been developed to store seeds effectively, because unconventionally processed and stored seeds are often infected by insects and prone to fungal attack, thus hastening the seed deterioration time[3,4]. As a general estimate, poor storage techniques alone contribute up to 10% of the stored seed loss in the tropics[5]. The techniques available for seed storage are quite varied but selection of a particular method largely depends on the effectiveness and cost of the given method. Although recent developments in using chemical substances for pest-control[6] have proven to assist long-term storage of seeds, such techniques are not yet readily available to small-scale farmers.

In reality, small-scale farmers, especially from developing countries rely heavily on traditional seed storage methods that can be easily used to store seeds at least until the subsequent sowing season. In spite of several time-tested methods being practiced for centuries, considerable attention for authenticating these ethnic storage methods has only begun recently. In Meghalaya, India, for example, grains of paddy, wheat and maize have been traditionally stored in specific structures mostly made of bamboo[3]. Dhaliwal and Singh[7] explored the usage of indigenous storage structures (e.g. *Bukhari, Bharola, Kupp*) by farmers in Punjab, India. Similarly, the use of biological and physico-chemical agents (obtained from plants) benefiting the pest management of various stored grains employed by the people of Tirunelveli district of Tamil Nadu, India has also been documented[8]. However, this is not an exhaustive list and there are numerous other storage methods that are still being used around India. Yet, knowledge of those techniques is highly restricted to indigenous people, thereby limiting its wider usage.

Pigeonpea (*Cajanus cajan* (L.) Millisp) is the most extensively cultivated legume in India, Myanmar, Nepal, East Africa, Malawi, Uganda, some parts of South and Central America and the Caribbean[9-11]. Recently, this crop cultivation invaded China and its cultivation area increased from 50 ha in 1999 to over 100,000 ha by 2006[10]. Pigeonpea is mainly cultivated for its seeds which is consumed world-wide because they are nutritious, have high-protein content (21%) with high protein digestibility (68%) and high dietary fibers[12]. It acts as an important protein supplement to cereal-based diets in many of the protein-deficient tropical countries[13]. Besides consumed as food, leafs of pigeonpea serves as an excellent fodder for live-stock animals, stems are an important source of domestic fuel and thatching roofs and fencing fields[10].

Although over 90% (25.23 million tons produced from 24.0 million hectares) of the world's pigeonpea is produced in India, the average kg $ha^{-1}$ productivity is far below the average productivity of world [14,15]. The success of pigeonpea cultivation relies immensely on sowing high quality seeds. The use of low quality seeds is potentially a problem not only because seed germination will be poor, but also germinating seeds will be prone to pest attack. Because pigeonpea is generally cultivated during *Kharif* season[16], seeds harvested must be stored for at least a minimum period of six to nine months before sowing in a subsequent growing season. Currently, methods for storing pigeonpea seeds from the time of harvest to sowing are lacking and approximately 14.5 percent of pigeonpea production is lost during post-harvest handling[17]. It has been estimated that about 30-40 percent of the postharvest loss occurs during the seed storage stage[17]. In particular, seeds are largely infected by pests within months when stored at ambient conditions posing additional risk to seed storage. Given the increase in food demand for pigeonpea in the last two decades, there is an urgent need for storing seeds[10,17]. Especially, the viability of the stored seeds is crucial if the storage is for sowing purpose. In this article, we investigated the efficacy of a cost-effective traditional storage method that could be useful for pigeonpea seed storage. We duplicated the technique used by farmers (sometimes the seeds are randomly investigated in the lots stored by farmers), thus there is no rationale behind selecting the particular species or red soil.

## Methodololgy

Pigeonpea plants were grown in a ploughed field (20m x 20m) near Coimbatore, Tamil Nadu, India, from previously harvested and stored seeds. Seeds were sown on 12-July-2010 and watered every two to three days, except the third week of July and second week of August- where heavy rain supplemented the water requirement for the plants. Pod collection began on first week of Nov- 2010, after the completion of seed maturation phase, which is evident from the visual change of pod color (from green to pale brown). The collected pods were ripped open by hand and seeds were spread on a cotton cloth for 2-3 hours. Each pod contained three to five seeds. A total of 5000 seeds were selected, counted manually and used in further experiments. Four lots of 100 seeds were immediately sown in 1% agar water taken in sandwich boxes. We scored germination on every third day for a period of 28 or 32 days and germinated seeds were removed during every counting session. Rest of the seeds in the seed lot was dried under shade conditions for two days. During drying, diurnal and nocturnal temperature remained close to 30˚C and 20˚C respectively and direct sunlight was completely avoided.

We split the seeds in to two groups namely control and experimental. After drying, seeds (n=2300) in control group were stored in closed glass bottles and seldom exposed to air. For experimental group, the procedure consisted of following steps. The topography of the study area incorporates several soil layers with red soil as the second layer from the top. We dug out the top layer and extracted red soil. Using a fine mesh we sieved the soil to remove the stone materials and any additional debris. We mixed the sieved soil and seeds (≅ 2:3). We then added water and thoroughly mixed the contents so that soil coated seeds completely. The soil-coated seeds were then dried under shade for one week and stored at identical condition to the control. After stored for 6 months in room temperature, seeds from control and experimental group were retrieved for germination. We used 400 (100 X 4) seeds of each group and germinated as above. Subsequent seed retrieval took place every 6 months, until no seeds in both groups germinated, but only results of two years are reported.

Percentage of seed germination was expressed as mean ± S.D. A t-test was conducted to compare the means of control and experimental group.

## Results and Discussion

At the time of harvest, 85.2 ± 6.9% of seeds germinated indicating the higher germinating ability of seeds. However, most farmers do not directly sow seeds after harvest. Instead, pigeonpea is grown during the drought season as the tap root system can successfully absorb the moisture and nutrients from the soil [10]. Furthermore, pigeonpea cultivation rejuvenates the soil by releasing soil-bound phosphorous, fixation of atmospheric nitrogen, recycling of soil nutrients, addition of organic matter and other nutrients[18]. Therefore, pigeonpea is traditionally cultivated as an intercrop with sorghum and cotton. The life-span of the crop is variable according to the cultivator, but generally ranging from 150 to 280 days[6]. As the search continues for decreasing the life-span duration of many crops to meet the steady rise in global food requirement, several pigeonpea (hybrid) varieties are commercially available that are capable of growing between 90 and150 days[18]. The seeds used in the present study completed life-cycle around 120 days.

Our results suggest that red soil could act as a protective agent in preventing the pigeonpea seeds from fungal growth and insect attack. Pigeonpea seeds coated with red soil can be kept viable and free from major insect/pest for 1 year, whereas sun-dried seeds stored in glass bottle were affected by insects within two to three months of storage and viability decreased significantly (figure.1). Seeds collected in Nov-2010, coated with red soil resulted in 58% viability when tested after 6 months on May-11 (figure.1). It should be noted, however, that seed deterioration is significantly ($P<0.05$) faster in control seeds compared to experimental group (figure 1 compare experimental group line with control group). When seeds stored for 1 year were germinated, red soil treated seeds had 44% germination, compared to 4% in control seeds ($P<0.05$). Since sowing begins in June of every year, higher viability at this time could encourage farmers to use this method for seed storage. Furthermore, the growing seedlings from control group were severely infected by insects compared to experimental group, thus leading to excessive plant loss. Results also showed no statistically significant difference between control and experimental group ($P>0.05$) after 18 months of storage (figure.1). Our complementary study, which involved sowing seeds in field after each storage time, also revealed a similar (slightly higher) germination percentage (data not shown). In particular, excavation of red soil treated seeds that had failed to germinate showed physical damage, e.g. seed coat cracking, after water absorption.

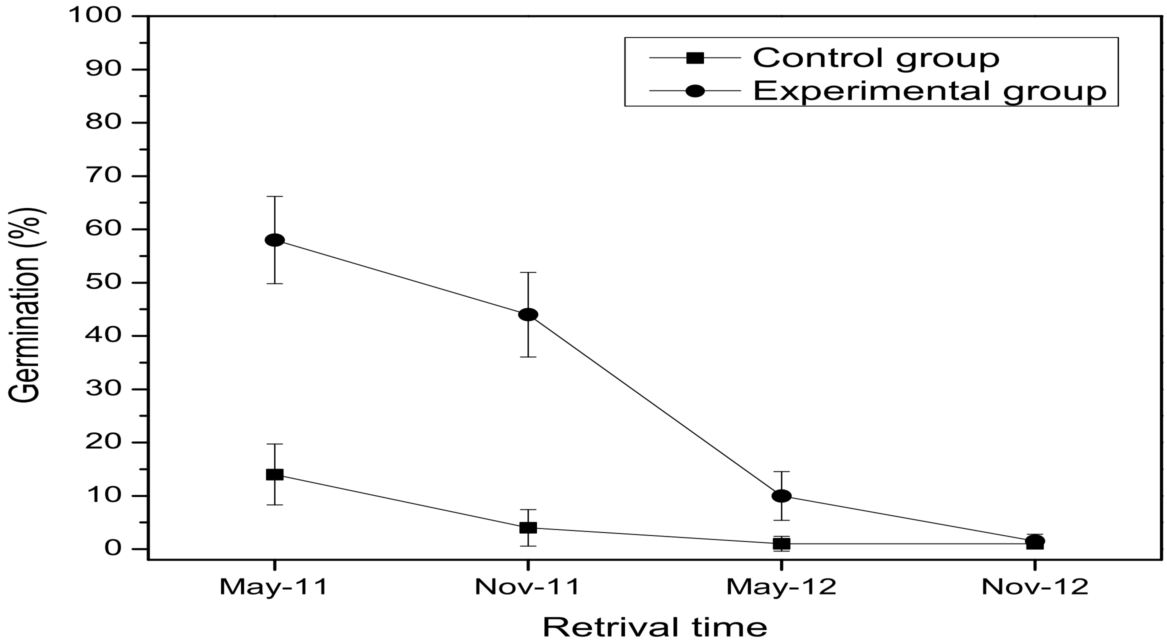


**Figure-1**
**Percentage of pigeonpea seeds germinated after different storage time. Seeds were harvested on November 2010. Seeds in control group were simply stored at room temperature. Seeds labeled as experimental group were coated with red soil and kept in ambient condition. Error bars indicate the standard deviation**

Several insects have been reported to blemish pigeonpea seeds[19,20], but the most common are Diptera *(Melanagromyza sp.)* and Bruchids (*Callosobruchus spp*.)[21,22]. Many of the insects attacking pigeonpea seeds are sporadic and hence may not be noticed as pests, but contribute greatly to seed impairment. In some villages of Maharashtra, farmers store pigeonpea seeds in wooden planks and use aluminium phosphide capsules and gamaxine for fumigation to protect the ant and beetle infestation[17]. Alternatively, some farmers store seeds in gunny bags. In both the cases, the seeds were kept moist. It is well known that increased moisture content of the stored seeds is conductive for fungal growth [17]. We observed that the seeds coated with red soil were completely dry (random moisture content measurements ranged between 8% and 14% on the fresh weight basis) and therefore the substratum for laying larvae or growth for insects was not provided, a reason that might explain the higher viability after storage. This explanation is further supported by the results of **C**hauhan and Ghaffar[21], who reported simple solar heating of pigeonpea [cultivator (ICPL 87119)] seeds controlled Bruchids growth. They stored seeds in transparent plastic bags and kept the bags in direct sunlight. The continued solar exposure trapped heat inside the polythene bags (a process analogous to green-house effect), hence the temperature inside the bags rose to 65˚C during the day. The higher temperature experienced by the seeds inside the plastic bags must have kept seeds dry thorough out storage. It was observed that 42% of the stored seeds germinated after 41 weeks. However, coating pigeonpea seeds with redsoil is an equally important alternative technique.

The use of biological products as a plant and seed insecticide has a long history and the interest to understand the efficacy of these methods have revitalized recently both in India and globally[3,7,23,24,25,26,]. These methods are extremely useful in controlling pest and holding viablity of seeds. More importantly these methods are highly eco-friendly, in comparision to the several other seed storage methods being used in commercial distribution of seeds[25,26,6]. Our ongoing survey documenting such traditional methods to date has recorded 28 different methods of seed storage that are mostly applied on commonly cultivated plants, e.g. maize, corn *etc.* The choice of selection and wider usage of those methods by farmers on a global scale will only considered feasible after careful experimental investigations.

## Conclusion

The experiments reported here demonstrate coating pigeonpea seeds with red soil is an efficient storage method. This technique of coating pigeonpea seeds with red soil has been practiced since immemorial in Tamil Nadu, although pigeonpea is only cultivated here on small area but on regular basis [10]. It is essential to point out that the same technique has been employed for storing *Vica faba*. However, the longevity, pest growth during storage and germination after storage of this crop awaits further investigation. The chemical properties of red soil contributing the viability of both species also demand additional studies. Given its easy usage and effectiveness compared to solar heating method proposed by **C**hauhan and Ghaffar[21], most small-scale farmers could consider using this inexpensive method.

## References


**1.** Van Dooren T., Banking Seed: Use and Value in the Conservation of Agricultural Diversity, *Science as Culture.,* **18**, 373-395 **(2009)**

**2.** Baniya B., Subedi A., Rana R., Tiwari R.K., Chaudhary P., Shrestha S., Tiwari P,. Yadav R., Gauchan D. and Sthapit B., What are the processes used to maintain genetic diversity on-farm, Agrobiodiversity conservation on-farm: Nepal's contribution to a scientific basis for national policy recommendation D. Gauchan, BR Sthapit and DI Jarvis, eds., IPGRI, Rome, Italy, 20-23 **(2003)**

**3.** Jeeva S., Laloo R.C. and Mishra B.P., Traditional agricultural practices in Meghalaya, North East India, *Indian Journal of Traditional Knowledge,* **5**, 7-18 **(2006)**

**4.** Sashidhar R., Ramakrishna Y. and Bhat R.V., Moulds and mycotoxins in sorghum stored in traditional containers in India, *Journal of Stored Products Research.,* **28**, 257-260 **(1992)**

**5.** Gwinner J., Harnisch R. and Mück O., Manual of the prevention of post-harvest grain losses, GTZ Germany, 1996 **(1196)**

**6.** Isman M.B., Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world, *Annual Review of Entomology.,* **51**, 45-66 **(2006)**

**7.** Dhaliwal R. and Singh G., Traditional food grain storage practices of Punjab., *Indian Journal of Traditional Knowledge.,* **9**, 526-530 **(2010)**

**8.** Kiruba S., Jeeva S., Kanagappan M., Stalin S.I. and Das, S.S.M., Ethnic storage strategies adopted by farmers of Tirunelveli district of Tamil Nadu, Southern Peninsular India, *Journal of Agricultural Technology.,* **1**, 1-10 **(2008)**

**9.** Mula M. and Saxena K., Lifting the level of awareness on pigeonpea-a global perspective, International Crops Research Institute for the Semi-Arid Tropics, **(2010)**

**10.** Parthasarathy Rao P., Birthal P., Bhagavatula S. and Bantilan C., Chickpea and pigeonpea economies in Asia: facts, trends and outlook 76, International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, Andra Pradesh, India, **(2010)**

**11.** Lateef S. and Reed W., Review of crop losses caused by insect pests in pigeonpea internationally and in India, *Indian Journal of Entomology.,* **2**, 284-293 **(1983)**

**12.** Tegegne F., Singh S.P., Duseja D., Ekanem E. and Bullock R., Pigeonpea as a Niche Crop for Small Farmers, *Journal of Food Distribution Research.,* **43**, 90-95 **(2012)**

**13.** Nwokolo E., Nutritional evaluation of pigeon pea meal, *Plant Foods for Human Nutrition.,* **37**, 283-290 **(1987)**

**14.** Minja E., in Status and potential of pigeonpea in Eastern and Southern Africa: proceedings of a regional workshop, 12-15 Sep 2000, Nairobi, Kenya. B-5030 Gembloux, Belgium: Gembloux Agricultural University; and Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 232 pp. 48 (ISBN 92-9066-432-0. Order code CPE 130).

**15.** Dwivedi A., Singh S., Mishra A., Singh R. and Singh M., Adoption of Improved Production Technology of Pigeonpea, *Journal of Community Mobilization and Sustainable Development.,* **6**, 150-154 **(2011)**

**16.** Srilaxmi K. and Paul R., Diversity of Insect Pest Of Pigeon Pea (Cajanus Cajan L. Mill Sp.) And Their Succession In Relation To Crop Phenology In Gulbarga, Karnataka, *The Ecascan.,* **4**, 273-276 **(2010)**

**17.** Rani A., *Maharashtra Hybrid Seeds Company Limited,* **(2011)**

**18.** Saxena K. and Nadarajan N., Prospects of pigeonpea hybrids in Indian agriculture, *Electronic Journal of Plant Breeding.,* **1**, 1107-1117 **(2010)**

**19.** Ranga Rao G. and Shanower T., Identification and management of pigeonpea and chickpea insect pests in Asia, International Crops Research Institute for the Semi-Arid Tropics **(1999)**

**20.** Choudhary A.K., Raje R.S., Datta S., Sultana R. and Ontagodi T., Conventional and Molecular Approaches towards Genetic Improvement in Pigeonpea for Insects Resistance, *American Journal of Plant Sciences.,* **4**, 372-385 **(2013)**

**21.** Chauhan Y. and Ghaffar M., Solar heating of seeds—a low cost method to control bruchid (*Callosobruchus* spp.) attack during storage of pigeonpea, *Journal of Stored Products Research.,* **38**, 87-91 **(2002)**

**22.** Dasbak M., Echezona B. and Asiegbu J., Pigeon pea grain physical characteristics and resistance to attack by the bruchid storage pest, *Int. Agrophysics.,* **23**, 19-26 **(2009)**

**23.** Debashri M. and Tamal M., A review on efficacy of *Azadirachta indica* A. Juss based biopesticides: An Indian perspective, *Res. J. Recent Sci.,* **1(3)**, 94-99 **(2012)**

**24.** Noudogbessi J.P., Alitonou G.A., Avlessi F., Figueredo G., Chalard P., Chalchat J.C. and Sohounhloué D.C.K., Physical characteristics and Chemical compositions of Leaves extracts of *Sorindeia grandifolia* Engl. (Anacardiaceae) harvested at Kato, Benin, *Res. J. Recent Sci.,* **2(3)**, 31-35 **(2013)**

**25.** Sanya E.A., Ahouansou R.H., Bagan G., Vianou A. and Hounhouigan D.J., Effects of some pretreatments of African Locust Bean seeds (*Parkia biglobosa*) on

Delivered Efficacy of a Devised Dehuller, *Res. J. Recent Sci.,* **2**(**3**), 31-35 **(2013)**

**26.** Manal Ismail A., Musa H.A., Yousif K.H. and Sabahelkhier M.K., Investigation Antibacterial Activity Extraction from two Medicinal Plants Available in Sudan, *Res. J. Recent Sci.,* **2**(**10**), 6-9 **(2013)**