Seed Storage: Best Practices

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Introduction

Botanically, seed is a fertile and ripened ovule which contains an embryonic plant usually supplied with food storage tissue, and surrounded by a protective coat (Ellis *et al,* 1985). However, physiologically, seed is the organ for propagating plant species. Seed being a living organism, respires by absorbing oxygen and giving off carbon dioxide and water vapour and producing heat at the same time. These phenomena play a major role in the preservation of seeds, (Jean, 1987).The seed is a very important element in the quality of seedlings produced in the nursery since the quality of the seedling is determined by the genotype of the seed from which it originates. Hence, to produce high quality crop one has to sow high quality seeds and have to maintain the quality of that seed from harvest till it is germinate. Seed storage is to preserve planting stocks from one season to the next. In some cases (e.g. seed companies) the objective of seed storage is to maintain seed quality for the longest duration possible. In addition, seed storage enables the maintenance of germplasm over time for improved plant breeding program. The seed should be harvested when it reaches harvest maturity, dried to safe moisture content, cleaned and stored under favourable conditions, and protected from damage and pests until planted. The most important factors affecting storability are the type of seed crop, moisture content, storage conditions (temperature, relative humidity) and storage pests (Babiker, 2015). During storage, seed quality can remain at the initial level or decline to a level that may make the seed unacceptable for planting purpose. Several environmental factors have been reported to affect seed viability during storage (Rindels, 1995). Some of the factors that affect the longevity of seeds in storage could be the genotype of seed, initial seed quality, storage conditions, and moisture content among others. Within the same plant species, different varieties may exhibit different storing abilities either from genetic variations or other external factors (Simic *et al*., 2007). However, irrespective of the initial seed quality, unfavorable storage conditions, particularly air temperature and relative humidity contribute to accelerating seed deterioration (Heatherly & Elmore, 2004). High relative humidity and temperature cause high moisture content in seeds and result in low germination at the end of storage (McCormack, 2004). People may think that seed storage is equivalent to placing seeds in storage, but what is more important is how the seed and its internal biological-physiological-biochemical process function and interact with its surrounding environment. In reality, if we pay attention to the way the seeds function, seed storage actually starts in the field. It starts when the seeds have reached physiological maturity, because after that moment, the seed does not receive the full protection of the mother plant any more.

Seed Storage

Preservation of seed with initial quality until it is needed for planting

Purpose of seed storage: Purpose of seed storage is to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted

Stages of seed storage

1) **Storage on plants**: Seeds are considered to be physiologically and morphologically mature when they reach maximum dry weight. At this stage dry down or dehydration of the seed is well underway. Dry down continues after physiological maturity until moisture content of the seed and fruit decreases to a level which permits effective and efficient harvest and threshing. This stage can be termed as harvest maturity. Any delay in harvesting the seed after they reach harvest maturity prolongs the first segment of the storage period.
2) **Storage from harvesting until processing:** The period of harvesting and cleaning is frequently one of high temperatures. During this period seed still have a high moisture content. Transport from field to threshing floors, threshing floors to processing plants and at the processing plants, involve periods of storage during which deterioration can be rapid and serious.

3) **Storage in warehouse**: It is customary for seeds man, and others interested in storage of seeds, to give primary attention to rooms and buildings labelled as seed storages.

Principles of storage

1. Seed storage conditions should be dry and cool
2. Effective storage pest control
3. Proper sanitation in seed stores
4. Before placing seeds into storage, they should be dried to safe moisture limits

Thumb rules of effect of seed moisture and temperature on storage

1) **1% decrease** in seed moisture content nearly **doubles storage life of seeds** and this rule is applicable between seed moisture content of **5-14%.**

2) **5^{O}C decrease** in temperature nearly **doubles the storage life of seeds** and rule is applicable between **32-87^{O}F (0-30^{O}C).**

3) Good seed storage is achieved when **relative humidity in storage environment (%) + storage temperature (^{O}F) < or = 100** but contribution of temperature should not be more than 50 %.

Classification of seed storage

Based on seed storage behaviour

a) **Orthodox seed:** Orthodox seeds are the seeds which can be dried to 6-10% moisture depending upon the species. There is no decline in germination when dried. They are tolerant to desiccation (5-7%) moisture content and low temperature (0-5^{0}C). They can be store for several years. E.g. Cereals, pulses, oilseeds etc.

b) **Recalcitrant seed:** Recalcitrant seeds are the seeds which cannot be dried below 30% moisture content and should maintained at this moisture. There will be decline in germination if dried below this moisture. They are intolerant to desiccation (30-35%) moisture content and low temperature (12-15^{0}C). They can be stored for few days to few months. E.g. Rubber, coffee, Coconut, Mango, Citrus etc.

Based on period of storage

a) **Storage of commercial seeds:** The largest storage needs (75-80%) is fit storage of seed from harvest until planting time, the next year. The storage period ranges from a few days to 8-9 months. For most of the species the requirement for seed storage are relatively simple. For such seed storage facilities can vary greatly. Successful storage structures and methods of storage for meeting the required needs should have following features:

Seeds placed in storage must be cleaned to free them of trash which may harbour insects or fungi and prevent free circulation of air.

Seeds must be dried to moisture content less than 14% for starchy seeds, and less than 11% for oily seeds.

Storage structure should be constructed so that rain cannot enter, and that no serious gain in moisture will occur during this short storage period.

b) **Storage of carry over seeds**: The remaining 20-25% of stored seeds may have to be carried over through one growing season to the second planting time. The storage period is usually between one year to one and half years. In dry regions and cool areas, seeds of most cultivated species can maintain a high germination capacity for as long as 18 months with only the bare shell of storage. The storage requirement consists of:

Some insulation of storage houses is necessary to keep the storage as cool as possible. This could be achieved by providing a false ceiling with ventilation between ceiling and roof by constructing thick stone or bricks walls.

c) **Storage of foundation seed stock:** It is desirable to store foundation seed stocks for several years, since genetic drift is minimised by reproducing foundation or stock seeds as seldom as is practical. This calls for much better seed storage facilities than are needed for commercial or carry over seeds. Requirement for storage of foundation seed stock are:

Combination of relative humidity and temperature that will maintain germination without loss for three to five years. This is usually accomplished with relative humidity of about 25% at 30^{O}C or less or a relative humidity of about 45% at 20^{O}C.

d) **Storage of germplasm seeds:** Germplasm seeds are required to be kept for many years, perhaps very long periods. Basic requirements for such very long-term storage are the coldest temperatures economically possible and seed moisture in equilibrium with 20-25% relative humidity. Germplasm storage built so far have rooms which can be maintained at 5^{o}C and -10^{O}C and 30% relative humidity. The requirement for storage of germplasm seeds is:

Based on environment

a. Open storage: It is only short-term storage and is amenable for fluctuations in temperature and relative humidity (RH). This is nothing but storing of seeds under ambient conditions of temperature and RH.

b. Controlled storage: For the preservation of seed viability for a long period, the temperature and RH of the storage environments is kept under controlled conditions and is in other terms known as controlled storage. It is practiced mainly for long term storage.

Traditional Seed Storage Structures

1) **Gourd casing:** Traditional method of seed storage is use of outer casing of gourd vegetables. They are used to store the seeds of vegetable crops. In some cases, gourd shaped vessels made of clay or gourd shaped baskets are also used for storage. If it is a basket, then it should be tightly plastered with mud.

2) **Kuthir:** Farmers store the cereals in tall mud pots or bins, which is known as kuthir in Tamil. These are made up of clay soil and plant fibres. Sometimes husks of cereal crops and also mixed with clay to make the storage structure stronger. The mud pot of about 1-3m height has a narrow opening at the top and covered with a tight lid. Seeds and grains can be stored in it can be taken out only through the top opening.

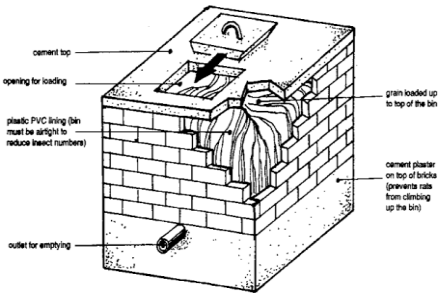
3) **Puri:** It is constructed with the help of paddy straw over a hard surface of the ground after a layer of loose straw provided at the bottom. This is done in order to prevent the absorbance of moisture from the ground. After loading the seeds, the structure has to be covered with straw in such a way to form a conical roof. It is easily prone to damage by rodents; hence side walls can be built with the help of bricks/ cement concrete. Capacity of such storage container is 3-20 metric tonnes.

4) **Underground pits:** Underground pits can be used to store vegetables in dry areas for few months. Underground storage keeps vegetables cool during the hot season. Roots and tubers such as cassava and potatoes store well underground. Pits can vary in size, depending upon the quantity of seeds to be stored. Usually they are 1-2 m deep. Pit may be round or square. Pit is lined with straw, entrance closed by heaping earth or sand or seal by mud. Storage duration could be between 1-5 years without opening and once opened all content must be emptied. Seeds of sorghum, millets and cowpea are stored.

Improved Rural Level Storage Structure

Coal tar drum: It is made of metal bin. The diameter and the height of the bin vary according to the seed shape and the quantity of the seeds to be stored. Generally, the bin of diameter must be 520mm and

900mm height. The seeds of wheat, Bengal gram can be stored easily.



Pusa Bin: It is the modification of the ordinary mud storage structure commonly used in villages. To provide the moisture proof and air tight conditions, polyethylene film of 700-gauge thickness has been embedded at the top, bottom and all the side of the bin. The embedding process provides mechanical support and safety to the polyethylene film. The construction of the outer walls burnt bricks up to 45 cm height makes the structure rat proof as well. The grains and the seeds both remain safe in the bin for more than one year with the proper precautions.

Seed Stored For Long Term Storage

Cryopreservation: Cryopreservation refers to the preservation in the frozen state. The term cryopreservation means storage at very low temperature such as in deep freezers (-80^{O}C) in vapour phase nitrogen (-150^{O}C) or in liquid nitrogen (-196^{O}C). Also called as cryogenic storage. Storage technique of germplasm conservation (storage of cells, tissues, embryo and seeds).

Conclusion

Seed is living matter and can deteriorate if not handled and stored properly. The purpose of seed storage is to preserve planting stocks from one season to the next. In some cases (e.g. seed companies) the objective of seed storage is to maintain seed quality for the longest duration possible. In other way, seed storage enables the maintenance of germplasm over time for improved plant breeding program. The most important factors affecting storability are the type of seed crop, moisture content, storage conditions (temperature, relative humidity) and storage pests. Cereals store better than legumes, and legumes store better than oilseed crops. Keeping the store clean, cool and dry is the best management practice because this reduces physiological processes, fungal and insect activities. The storage facilities should be cleaned and sprayed with suitable pesticides to protect the seed from insect pests. A number of factors influence the viability and maintenance of seed quality in the storage. Generally, care needs to be given to seed storage conditions and the resulting effect on shelf life and performance. Proper seed storage conditions and facilities can be developed based on the desired length of storage, the type of crop, the packaging materials, and environmental conditions.

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