Extending the Life of your Seeds

Edward Berkelaar

Farmers everywhere plant seeds with the expectation that they will germinate, grow and produce a crop that can be harvested. In some cases, the seeds that are planted germinate as hoped. In other cases, seed germination percentage is quite poor. This article will address some aspects about seeds and how to store them so that they remain alive as long as possible.

First of all, what is a seed? A seed is the result of sexual reproduction of a plant; it is the offspring of the previous generation of plants. Seeds are made up of three parts: a tiny little plant called an embryo; stored food and nutrients; and a protective shell called a seed coat. The embryo within the seed may be alive, or it may be dead. If it is alive, the seed is considered viable, and may germinate and grow when planted. Once the embryo dies, the seed is no longer viable and will never germinate. The largest part of the seed is made up of stored food and nutrients. These are the raw materials the young plant depends on from the time when it germinates and begins to grow until the time when its roots are large enough to accumulate nutrients from the soil and its leaves can supply energy from the sun. The embryo, food and nutrients are neatly packaged in a protective seed coat. A healthy mature seed contains a small living plant that will begin to grow once conditions are right for it to do so. To grow, the seed needs sufficient water, a suitable temperature (not too high or too low), and oxygen.

Sometimes seeds will not germinate even though conditions are favorable for them to do so. This can be explained by one or both of two possibilities.

One possibility is that the seed is alive but dormant. Seeds are dormant if they will not germinate even though they are alive and the external conditions are favorable for germination (e.g. seeds have oxygen and water and are neither too cold nor too hot). Something about the seed prevents germination from occurring; perhaps the seed coat is not permitting air or water to pass through, or perhaps the embryo itself is inhibiting germination. Dormant seeds require a pretreatment before planting. Several examples of pretreatments include soaking in water (sometimes hot water), scarification (scratching a hard seed coat with a knife or sand paper), or stratification (prolonged storage under cool conditions). Seeds of many tree species require treatments like these. If seeds require one of these pretreatments before they will germinate, the information is typically included on the seed package or on a paper accompanying the seeds. Seeds of most vegetables and field crops do not require any pretreatment.

The second reason why seeds may not germinate and grow once they are planted is that they may be dead. Like any other living thing, seeds will die after a time; especially if storage conditions are not good. Some seeds will not live long no matter what you do. For example, many tropical tree seeds will only remain alive for up to a few months or a year. These types of seeds are called recalcitrant. Recalcitrant seeds should typically be planted very soon after harvest; they will most likely fail to germinate if dried much or if stored from one growing season to another. Examples include seeds of mango, jackfruit and avocado. Seeds of most common field and vegetable crops are called orthodox seeds. Orthodox seeds can be dried and can typically be stored for several years under the right conditions. For example, onion and sweet corn may last one to two years, while beans can last for three years and eggplant and squash can last for five years. Some orthodox seeds can remain alive for a very long time. There is a report of *Mimosa glomerata* seeds germinating after being stored for over 200 years. Indian lotus (*Nelumbo nucifera*) seeds that were estimated to be over 1000 years old germinated after being removed from a peat bog. Eventually, though, any type of seed will die if it is not planted; the length of time a seed will live in storage depends on species storage conditions.

A few years ago, we obtained a copy of a booklet published by the seed company Asgrow, titled "*The Preservation of Viability and Vigor in Vegetable Seed*" (Asgrow Monograph No. 2, Associated Seed Growers, Inc., New Haven Conn., 1954). This publication summarizes the results of research that was done to determine which factors affect the quality of orthodox seeds in storage. Seed quality was assessed by looking at both the viability (whether seeds were alive or dead) and vigor (the health of living seeds). Viability of seeds was determined by calculating the percentage of seeds that germinated on wet paper. Vigor was described with a qualitative rating (excellent, good, fair, poor or dead) of how quickly the seeds grew after germinating. Seed vigor typically declines before viability is lost.

The data collected during the study showed that three environmental factors played an important role in determining the quality of stored seeds. These factors were the length of time seeds were stored, the temperature at which the seeds were stored, and the moisture content of the seeds when they were placed in storage.

Length of Time in Storage:

Simply put, the longer the seeds were stored, the greater the decline in seed quality. Some seeds in storage will decline in quality faster than others, but the quality of all seeds will eventually decline. It is best to store seeds only as long as necessary and, if possible, to avoid using seeds collected before the previous year's growing season.

Storage Temperature:

Seed quality remained higher for a longer period of time when seeds were stored at lower temperatures (16 or 21°C; 60 or 70°F) than at a higher temperature (32°C; 90°F). A rough rule of thumb is that the lifespan of stored seeds doubles for every ~5.5°C (10°F) drop in storage temperature.

Moisture Content of Seeds:

The quality of stored seeds remained higher for a longer period of time if their moisture content was low at the time they went into storage (6.5%) than if their moisture content was high (9.3%). As seeds mature on the plant, their moisture content declines. After harvest, seeds are typically dried some more, reducing the moisture content of seeds even further. Another rough rule of thumb is that, for every 1% drop in seed moisture, the lifespan of stored seeds will double. Seeds will begin to germinate when their moisture content is above 30%. A seed moisture content of 10-15% will suppress seed activity and the activity of fungi that may spoil seeds. If the moisture content of seeds is below 10%, few insects will survive. Ideal seed moisture content is probably between 5-7%, but if you want to store seeds from one growing season to the next, a moisture content of 8-10% is probably sufficient. As shown in Figure 1, the effects of storage temperature and seed moisture content on viability interact over time; higher seed moisture content is more detrimental when storage temperatures are high.

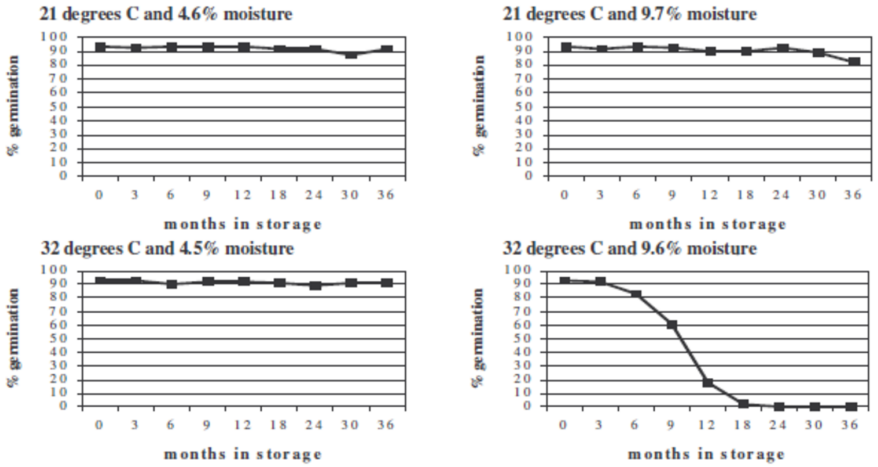

Figure 1: Effects of storage temperature and seed moisture content on percentage germination of tomato seeds stored for up to three years. (Data taken from page 32 of "The Preservation of Viability and Vigor in Vegetable Seed," Asgrow Monograph No. 2, Associated Seed Growers, Inc., New Haven Conn., 1954).

What determines the moisture content of seeds? Moisture within seeds is in equilibrium with water in the air, so seed moisture content depends on the relative humidity of the air that seeds are in. If the relative humidity of the air decreases, then seed moisture will also decrease. There are two ways to reduce the moisture content of seeds. One way is to keep them, for a time, in air with a low relative humidity. This could be low-humidity air in the dry season, or air sealed in a container with a desiccant. Desiccants (any substance used to absorb moisture from the air) cause seeds in the same space to become drier. Appropriate desiccants include silica gel, powdered milk, rice or grain seed. Desiccants can be dried in an oven or over a fire and then wrapped in paper or cloth and sealed in a container with the seeds. A second way to reduce moisture content of seeds is to expose them to warm air (but not greater that 45°C (110°F). Seeds will be damaged if the temperature is too high for too long, so hot-air drying must be done with care.

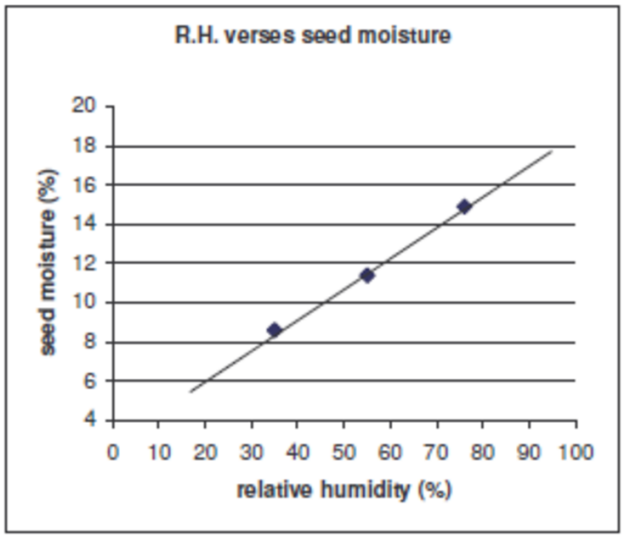

Figure 2: % seed moisture for varying % relative humidities. These data are for onion seed at 68°F. The relationship probably differs for different seed types, but this may be a helpful guide.

Summer temperatures in Florida average in the high 20s°C (low 80s°F) but typically reach 33-34°C (91-92°F) during the day. Average relative humidity ranges from 70 to 90%. Seeds stored in such conditions would be subject to high relative humidity (and would therefore have a high moisture content) and would be subject to high temperatures that fluctuate daily. In such an environment, how can seeds be stored to maintain quality with minimal resources? In the summer of 2002, Krista Pendergrass, a research intern at ECHO, did a simple trial to see how to easily reduce temperature and relative humidity in a container that could be used to store seeds. A PVC pipe six inches in diameter and about 70 cm (2'4") long was sealed on one end and buried vertically in the ground (in the shade) so that the top was even with the soil surface. Rice was dried in an oven, and then placed in a plastic jar with a remote temperature and relative humidity (RH) sensor. The jar was then closed and dropped in the tube and the top of the tube was sealed. The oven-dried rice seeds in the jar absorbed moisture, reducing the relative humidity to 30-40%. [Tim Motis, ECHO staff member in Haiti, likewise obtained 30% relative humidity with rice in 2004 by oven-drying the rice for one hour at about 300 °F to remove nearly 10% of the initial rice grain moisture content.] Because the tube was buried in the soil, the temperature remained stable at ~27°C (80°F), approximately 6-7°C (11-12°F) cooler than daytime highs (Figure 3).

In conclusion, seeds are living, but they have a limited lifespan. The quality of stored seeds will be best if they are stored for as brief a time as possible in an environment that is dry and cool.

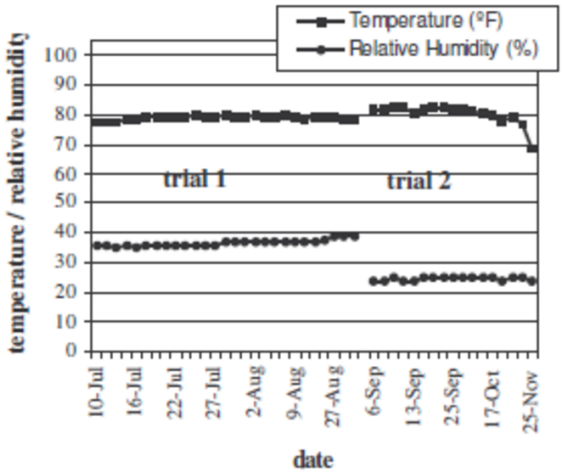

Figure 3: Temperature (in oF) and relative humidity (%) over time in a sealed jar containing dried rice and buried in soil. The relative humidity was much lower than that of outside air. The temperature remained stable throughout the day and was considerably lower than the daytime high temperature. A rule of thumb is that if the temperature in oF and the relative humidity in % add up to 100, conditions are good for the storage of seeds. Using this rule of thumb, imagine a scenario where seeds were stored at 90°F and at 80% RH. Storing seeds at 80°F instead (but still at 80%RH) would double their shelf life. Storing seeds at 90°F and 72%RH would also double their shelf life. Storing seeds at 80°F and 72%RH would