Bicycle Pump Vacuum Sealer for Seed Storage

Dr. Abram Bicksler

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Introduction

From related ECHO research (Croft *et al.*, 2012 and 2013)

Storing seeds in the tropics can often be difficult; with high temperatures and humid conditions, seeds lose their ability to germinate quickly. Many techniques for seed storage exist, from the high-tech standards of gene banks to simple methods used by villagers for saving their own seeds. All have their strengths and weaknesses, but when balancing costs and resources, which methods are really the most effective? This article highlights research conducted by ECHO Asia regarding the use of vacuum sealing, using a simple bicycle tire pump, for tropical seed storage under resource-constrained settings.

The three key factors that determine the rate of seed deterioration in storage are: oxygen pressure (amount of oxygen with the seeds in storage), seed moisture content, and temperature (Roberts, 1973). An increase in any of these factors will lower the storage life of the seeds, and as a general rule any increase of 1% moisture content or 10° F (5.6° C) in storage will halve the storage life of the seeds (Bewley and Black, 1985). Each factor contributes to seed decay in specific ways, and minimizing these conditions is critical to effective seed storage. Vacuum sealing is a relatively low-cost method that requires few inputs after an initial investment. Sealing helps conserve seed quality by minimizing oxygen presence and exposure to ambient humidity, thereby keeping seed moisture content low.

Historical perspective (Dr. Tim Motis and Dr. Abram Bicksler)

ECHO's initial exposure to the use of bicycle pumps for vacuum seed storage came from a writeup sent to our Florida seed bank by development worker, Patrick Lahr. Based on that writeup, Dr. Tim Motis modified a bicycle pump to demonstrate the concept of vacuum sealing at the ECHO Florida Seedbank. A similar pump was also constructed at the ECHO Asia Seedbank by Niemeet Chompoothong, with further improvements made by Brock Mashburn to create a more usable machine (Fig. 1) that is able to create a better vacuum in a jar containing the seeds.

Figure 1: Bicycle tire pump modified for vacuum sealing.
Photo by ECHO Asia staff.

Research summary (Dr. Abram Bicksler)

The key(s) to this revised pump are: 1) reversing the bicycle pump piston and valves, 2) utilizing a tire stem with a reversed valve to ensure that evacuated air does not seep back into the jar while pumping, and 3) using a PVC cap with gasket to ensure that a tight, leak-free seal is created on the lid of the jar while evacuating the jar. For an associated powerpoint with details on the creation of the vacuum sealer, visit ECHOcommunity.org (https://c.ymcdn.com/sites/echocommunity.site-ym.com/resource/collection/F6FFA3BF-02EF-4FE3-B180-F391C063E31A/Revised_Bicycle_Pump_Vacuum_Sealer.pdf).

Preliminary results of a 1-year experiment utilizing the bicycle pump vacuum sealer on 500g samples (batches) of Lablab beans (*Lablab purpureus*) at the ECHO Asia Seedbank's Earthbag House (Fig. 2) demonstration structure suggest that the bicycle pump vacuum sealer was able to evacuate a sufficient amount of ambient air from glass jars to maintain lablab seed viability at levels comparable to those obtained with an expensive, commercial vacuum sealer. When the experiment began in May 2013, all lablab seeds used in the experiment had an average seed moisture content of 9.5% (ideal seed moisture should be between 4-8%, but that is difficult to achieve in the moist tropics) and a seed germination rate of 94.5%.

Figure 2: Batches (500g lots) of lablab seeds in earthbag house. *Photos by ECHO Asia staff.*

To preserve seed viability, so that germination rates remain high over time, orthodox seeds should be stored under dry, cool conditions (see EDN 86 (https://www.echocommunity.org/resources/af7cf233-9e26-4fa1-8bca-eadd5bf4b96b) for more information). Orthodox seeds include those of most grain, pulse (dry bean), and vegetable crops; they can survive storage with most of the water removed from the seeds. One rule of thumb used by ECHO to assess seed storage conditions is that the sum of air temperature in degrees Fahrenheit and percent relative humidity should be close to 100 (Harrington, 1972). Keep in mind, however, that as humidity approaches 70%, seed moisture content increases to approximately 13%, at which point higher seed respiration rates and storage fungi become significant problems (McCormack 2004; Justice and Bass, 1978; Nakamura 1958).

In the ECHO Asia Seedbank Earthbag House, air temperature in the jars---under vacuum drawn with a bicycle tire pump--- averaged 23°C (73°F). Ambient air temperature, outside of the earthbag house, averaged close to 30°C (86°F), indicating that the earthbag house had a moderating influence on temperature. Relative humidity inside the bicycle-vacuum jars averaged 63%, not as low as can be achieved with desiccants but significantly lower than the 78% ambient humidity outside the earthbag house and the 77% average humidity in paper bags (located inside the earthbag house).

After one year in the various storage treatments, the lablab seeds stored in traditional vacuum-sealed bags using a commercial vacuum sealer had a seed moisture content of 13.0% and a seed germination rate of 97.5%. By comparison, the lablab seeds stored in glass jars using the bicycle pump vacuum sealer had a seed moisture content of 10.3% and a seed germination rate of 97.5%, and lablab seeds stored in paper bags on the floor of the humid earthbag house deteriorated due to fungal and pathogen presence.

From this work, it is clear that seeds stored by means of some form of vacuum sealing have a much greater viability over the course of time than seeds stored using traditional (in our case, paper bags in a cool, moist structure) storage methods. In particular, we found that seeds stored with the modified bicycle pump vacuum sealer possessed a more desirable seed moisture content (the lower, the better) and an identical seed viability to those seeds stored with an expensive commercial vacuum sealer. We hereby heartily encourage the use of this bicycle pump vacuum sealer in conjunction with a cool storage environment as part of a suite of appropriate seed storage techniques. We also look forward to publishing this research in greater detail in a future ECHO Asia Note.

References and Further Reading

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