# Small-scale seed drying methods

Technical Information Sheet 08

Drying is essential for the effective banking of orthodox seeds. Seeds should be dried to approximately 15% equilibrium relative humidity (eRH) before long-term storage. This allows the seeds to tolerate freezing, increases longevity in storage, prevents attack by pests and pathogens, and postpones germination.

The choice of drying method depends on the projected yearly seed intake. A purpose-built dry room may be the most suitable option for drying large quantities of seeds (see Technical Information Sheet 11). This information sheet describes various lower-cost drying options that may be more appropriate for small-scale seed banks.

## Incubator-drying

Cooled incubators are usually used for germination testing, but can also provide an ideal alternative for small-scale seed drying (Fig. 1). A cooled incubator set at 18ºC can achieve an average internal relative humidity (RH) of 15% RH. Experiments at the Millennium Seed Bank (MSB) showed that a cooled incubator can dry 10kg of freshly harvested seed, with an initial eRH of 99%, to around 15% eRH after approximately 4 weeks. The incubator operates satisfactorily in external environmental conditions of 16ºC to 45ºC and 5% to 75% RH.

## How do cooled incubators work?

The temperature of a cooled incubator is controlled by a standard vapour compression refrigeration system, which constantly cools the internal chamber, together with a heater, which cuts in and out to maintain the desired temperature. Moisture condenses on the cooling coils due to their low temperature. Every six hours, the system begins a 30-minute defrost. Moisture drains from the cooling coils and out of the chamber, evaporating from a tray on top of the hot compressor. The internal RH is usually 7% to 10%, rising to 65% during the defrost cycle. This gives an average seed eRH of 15%, which is ideal for long-term storage. Varying the temperature settings of the incubator will produce different RH conditions.


Figure 1: Cooled incubator with seed collections in cloth bags.

## Using a cooled incubator to dry seeds

Put seed collections into cotton bags and spread these out on the shelves (Fig. 2). Seeds held in trays will take longer to dry because air movement is restricted. You can add seed collections on a daily basis, without affecting the overall performance of the dryer.

Drying times will vary between species, depending on seed size, structure and permeability of the seed coat. Monitor seed eRH weekly during drying using a hygrometer (see Technical Information Sheet 05). When an eRH of 15% has been achieved, remove the collection, seal in an air-tight container (see Technical Information Sheet 06) and store in a freezer or cold room.

The incubator can be used for germination testing once the seeds have been dried and stored, simply by adjusting to an appropriate temperature and photoperiod (by changing the lighting).

## Drying with desiccants

Any hygroscopic substance that can be dried can act as a desiccant and absorb moisture from the surrounding air. If moist seeds are sealed in a container with a dried desiccant, the desiccant will dry the air, which will in turn dry the seeds. Silica gel is commonly used to dry seeds. Other desiccants that work effectively include charcoal and seeds such as rice or maize.


Figure 2: Using an incubator to dry seeds in Burkina Faso.

Choose a non-porous container of appropriate size, with a tightly fitting lid which will seal effectively. Use plastic boxes, buckets with air-tight lids, or a sealed, heavy-duty plastic sack.

## Using silica gel to dry seeds

Silica gel is available as clear beads or as indicating beads which change colour according to moisture status. Methyl violet indicator is dark green when wet and orange when dry (Fig. 3). The colour change from wet to dry occurs either side of a 20-25% RH boundary. The silica gel can be dried and re-used as a desiccant until it no longer absorbs moisture.

Regular monitoring of the moisture status of seeds and silica are important for achieving high quality seeds collections.

Figure 3: Methyl violet indicating silica gel beads mixed with clear silica gel, showing dry (orange) and wet (green) status

- Dry the seeds to ambient conditions before you start.
- Fill the container approximately 20% by volume with oven-dried silica gel beads. A mix of 10% indicating to non-indicating beads is recommended.
- Put seed collections, held in cloth or paper bags, into the container, ensuring adequate air circulation (Fig's. 4 & 5).
- Maintain a minimum weight ratio of 1:1 silica gel to seed material.
- Place the drying container out of direct sunlight, in a cool place.
- On a weekly basis, mix the silica gel in the bottom of the container and measure its eRH using a hygrometer (see Technical Information Sheet 05). Ideally, maintain the silica gel at less than 15% RH.
- If a hygrometer is not available, make weekly checks of the silica gel in the bottom of the container, by looking at the colour of the indicator. As the silica gel absorbs moisture from the air in the container, the indicator will change from orange to green.
- At the same time, mix the seeds within each collection and measure the eRH of these too.
- Seed moisture status can also be assessed by including a 1g indicating silica gel sachet in each collection and comparing it with a colour chart (see Technical Information Sheet 07).

The seeds may take at least one month to dry, but this depends on the initial moisture status of the seeds, the volume of the collection, the type of seeds and the moisture status of the silica gel. Small seeds will dry more quickly so will need to be monitored more regularly to avoid overdrying.

When the seeds are dry, seal the collection in an air-tight container and store in a freezer or cold room. Add a dry indicating silica gel sachet to the collection to monitor moisture status during storage.

## Regenerating the silica gel

Re-dry the silica gel when the RH rises above 15%, or the indicator beads are coloured green. Remove the silica gel from the container, place in a shallow metal tray and dry gently in an oven at no more than 100°C, for 1-2 hours (or until green beads turn orange). If the beads are over-heated, this may damage the colour-change properties of the indicator. Cover the tray and allow the silica gel to cool for 15 minutes, then return to the drying container.

## Using charcoal to dry seeds

Natural or lump-wood charcoal is widely available and can be used as a low-cost alternative to silica gel. Dried charcoal absorbs moisture from the air if sealed in a container with seeds (Fig's. 6 & 7). The use of charcoal as a desiccant is a more flexible and less precise approach than using silica gel. The charcoal can be re-used until it fails to absorb moisture.

- Dry the charcoal before use. Spread out on a metal tray and leave to dry in the sun, or dry at a low heat in an oven, then cover the tray (preventing moisture uptake) and allow to cool.

Figure 4: Sealable plastic drum containing dried silica gel, with central support from which to hang seed collections for drying.

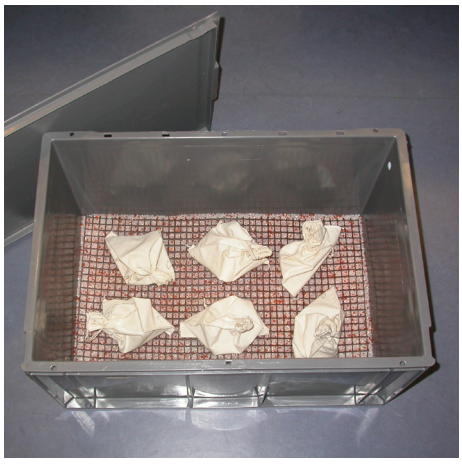

Figure 5: "Box-dryer" - plastic box with seed collections in cloth bags, placed on a plastic mesh above dried silica gel.

Figure 6: "Box-dryer" - plastic box with seed collections, placed above dried charcoal, on a plastic mesh.

- Place the dried, cooled charcoal into a sealable container.
- Spread seeds above the charcoal in the drying container, on a sheet of newspaper or in porous collecting bags.
- The wetter the seeds, the more charcoal is required. Use a minimum weight ratio of 3:1, charcoal to seed material. If possible, dry the seeds to ambient conditions first. This will remove some moisture and mean that less charcoal will be needed.
- Seal the drying container and keep in a cool place (avoid direct sunlight).
- Make weekly measurements of the moisture status of the charcoal, by sealing a small quantity into a separate air-tight container, such as a glass jar, with a moisture indicator. The charcoal will equilibrate with the air inside the container and the moisture indicator will reflect the moisture status of the air.
- Monitor the moisture status of the seeds by adding a low-cost moisture indicator to each seed collection bag (see Technical Information Sheet 07).

The seeds may take at least one month to dry, depending on the initial moisture status of the seeds, the volume of the collection, the size and structure of seeds and the moisture status of the charcoal. Small seeds will dry more quickly so will need frequent monitoring.

Once the seeds are dry, place each collection in an air-tight container to prevent moisture from being re-absorbed, and store in a cool place.

## RBG Kew's Mini Seed Bank

The Mini Seed Bank was designed for gardeners or allotment-holders wishing to save their seeds (Fig. 8), but could also be employed by small-scale conservation projects. The simple instructions followed similar principles to those adopted by large-scale seed banks.

The main components of the kit are a high quality polythene box and a reusable silica gel desiccant with coloured indicating beads (Fig. 9). The box acts both as a drying chamber and as the 'seed bank' at the end of the collecting season. Indicating silica gel sachets are used so that the seed drying process can be monitored, ensuring that the seeds are only stored once they have been sufficiently dried.

Figure 7: "Bag-dryer" - plastic sack containing a tray of dried charcoal, on which seed collections are placed on a plastic mesh.


Figure 9: RBG Kew's "Mini Seed Bank".

In 2009 versions of the mini seed bank were provided to UK schools as part of the Great Plant Hunt project to educate young people about plant conservation. While the kit itself is no longer available for purchase, its design demonstrates the scalability of the technology and can be easily replicated.

## Drying cabinets

MSB partners at Victoria Royal Botanic Gardens, Australia, have limited work space and a moderate throughput of seed collections. The seed bank processes about 100 species per year with a minimum of 4,000 seeds per species. They have opted for a purpose-built drying cabinet instead of a dry room (Fig. 10).

Figure 8: RBG Kew's "Mini Seed Bank" showing seed collections in plastic pots, drying over silica gel.

Figure 10: Bespoke drying cabinet with a dehumidification unit, at Victoria Royal Botanic Gardens, Australia.


Figure 11: Dehumidification unit attached to a drying cabinet for small-scale drying.

The two-door drying cabinet was constructed by a local refrigeration manufacturer. It has a built-in cooling unit and is attached to a dehumidification unit (MCS300, supplied by Munters (Fig. 11)). Moist air is removed by connecting the outlet to the seed bank's duct system.

Seed collections of most species achieve a moisture status below 20% eRH within a few weeks in this drying cabinet, when set at 15% RH and 15°C. The drying time will depend on seed size and collection volume. The largest seeds in the Victorian flora are under 10mm diameter, although some fruits, such as those of *Banksia*, are as large as 150 × 80mm.

The advantage of this drying cabinet system is that it is relatively cheap to buy, run and maintain, and can easily be moved around within the seed bank. A constant temperature and humidity is generated throughout the cabinet. The cabinet is easy to clean, and insects and other pests can be kept under control. However, as all cleaning, counting and testing of seeds has to be conducted outside the drying cabinet, the seeds may become partially rehydrated during processing. During peak collecting times, the drying cabinet can become crowded and collections may be difficult to find.

The machine has run reliably for over three years and has proved suitable for the project at RBG Victoria.

## Acknowledgements

V. Sutcliffe & J. Adams,
Royal Botanic Gardens, Kew

## Further reading

Linington, S.H. (2003). The design of seed banks, pp. 591-636. In: R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard and R.J. Probert (eds), Seed Conservation: turning science into practice. Royal Botanic Gardens, Kew, UK.

Probert, R.J. (2003). Seed viability under ambient conditions, and the importance of drying, pp. 337-365. In: R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard and R.J. Probert (eds), Seed Conservation: turning science into practice. Royal Botanic Gardens, Kew, UK.

## Equipment specifications*

| Description | Model/Product | Supplier |
|---|---|---|
| Cooled incubator with auto-defrost cycle | LMS 280A freestanding incubator (with drying option) | LMS Ltd. www.lms.ltd.uk |
| Desiccant dehumidifier unit | Tinytag View 2 (TV-4505). Range: -25 to +85°C; 0 to 100% RH. | Munters https://www.munters.com |
| Air-tight containers | • Polypropylene drum, box, bucket etc.<br>• Heavy-duty plastic sack<br>• Sealable food storage containers | Locally available |
| Indicating silica gel | • 1g sachets containing orange/green silica gel impregnated with methyl violet indicator<br>• Loose beads of orange/green silica gel impregnated with methyl violet indicator | Baltimore Chemicals Ltd. www.baltimoreinnovations.co.uk |
| Lab-based hygrometer | HC2-AW sensor with USB interface, connected to laptop/PC running HW4-E software. Range: 0 to 100% RH, -40 to 85 °C. | Rotronic Instruments (UK) Ltd. www.rotronic.com |

*Please note that the above equipment is used by the Millennium Seed Bank and has been chosen carefully using our many years' experience. The list of suppliers is for guidance only and does not represent an endorsement by the Royal Botanic Gardens, Kew. The manufacturer's instructions must be followed when using any of the equipment referred to in this Information Sheet.