Drying cabinets

MSBP 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.

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). Moist air is removed by connecting the outlet to the seed bank's duct system.

Below: Dehumidification unit attached to a drying cabinet for small-scale drying

Left: Bespoke drying cabinet with a dehumidification unit, at Victoria Royal Botanic Gardens, Australia

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.

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 250A freestanding incubator	LMS Ltd. www.lms.ltd.uk
Desiccant dehumidifier unit	MCS300 with desiccant rotor technology - can be fitted to a refrigeration unit to create a bespoke drying cabinet	Munters www.muntersglobal.com
Air-tight containers	• Polypropylene drum, box, bucket etc. • Heavy-duty plastic sack • Sealable food storage containers	Locally available
Indicating silica gel	• 1g sachets containing orange/green silica gel impregnated with methyl violet indicator • Loose beads of orange/green silica gel impregnated with methyl violet indicator	Baltimore Chemicals Ltd. www.baltimoreinnovations.co.uk
Seed drying and storage kit	Mini Seed Bank	RBG Kew's Millennium Seed Bank
Hygrometer to measure seed moisture status	AW-DIO sensor with HygroPalm 3 display unit *or* HygroClip SC04 sensor with HygroLog-D unit.	Rotronic Instruments (UK) Ltd. www.rotronic.com

Please note that the above equipment is used by the Millennium Seed Bank Project 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.

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MILLENNIUM SEED BANK PROJECT Kew

Small-scale seed drying methods

Technical Information Sheet_08 Vanessa Bertenshaw and John Adams, Seed Conservation Department

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. A cooled incubator set at 18°C can achieve an average internal relative humidity (RH) of 15% RH. Experiments at the Millennium Seed Bank Project (MSBP) 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 16°C to 45°C 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 relative humidity (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.

Left: Cooled incubator with seed collections in cloth bags

Using a cooled incubator to dry seeds

Spread seed collections loosely inside a cotton bag and place on one of the shelves. 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 seed coat. Monitor seed eRH weekly during drying, using a hygrometer. 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.

One important advantage of this method is that the incubator can be used for germination testing once the seeds have been dried and stored, simply by adjusting to appropriate temperature and photoperiod (lights).

Right: Using an incubator to dry seeds in Burkina Faso

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.

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. The colour change from wet to dry occurs either side of a 20-25% RH boundary.

- 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.
- 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.

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

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

- 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 1 gram 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.

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.

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

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 when sealed in a container with seeds.

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

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

- 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.
- 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).
- To measure the moisture status of the charcoal, seal a small quanitity 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 more 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 is designed for gardeners or allotment-holders wishing to save their seeds, but can also be employed by small-scale conservation projects. The simple instructions follow similar principles to those adopted by large-scale seed banks.

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

This kit has been developed for the collection, processing, drying and storage of seeds, through the MSBP's continuing studies into improved seed conservation technology.

The main components of the kit are a high quality polythene box and a reusable silica gel desiccant with coloured indicating beads. 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 also included so that the seed drying process can be monitored, ensuring that the seeds are only stored once they have been sufficiently dried.

Below: RBG Kew's "Mini Seed Bank"