**Potting and Seedling Growth in Nurseries**

**What kinds of containers are recommended?**

Containers must be large enough to allow development of a good root system, and support adequate shoot growth. They must have sufficient holes to permit good drainage, be lightweight, inexpensive, durable and readily available. Plastic bags are probably the most commonly used containers. The optimum size is 9 inches tall by 2½ inches wide (230 x 65 mm), since it allows tap roots to grow fairly long, before they would reach the bottom of the bag and start spiraling.

**What makes a good potting medium?**

A potting medium consists of coarse and fine soil particles with pores between them for aeration and drainage. The medium must provide growing trees with 1) support, 2) moisture, 3) oxygen, 4) nutrients and 5) symbiotic micro-organisms. Soil *alone* is unsuitable, because it is easily compacted and the container prevents free drainage. This causes water-logging, which suffocates roots. However, it is important to include some forest soil in the medium, since it carries the spores of soil micro-organisms (e.g. *Rhizobium* bacteria and mycorrhizal fungi), which help trees to grow. To prevent compaction, mix forest soil with bulky organic matter. Mixing forest soil with these ingredients “opens out” the medium and improves drainage and aeration. Whichever materials you choose, they should be locally available throughout the year and cheap. A standard, general purpose medium consists of 50% forest top soil mixed with 25% fine organic matter and 25% coarse organic matter. To prevent the spread of diseases, never re-cycle the potting medium.

**Potting (picking out)**

Fill containers with moist medium. Bang each container on the ground a few times to allow the medium to settle. Then, top up containers with more medium until they are full again. With plastic bags, check for correct consistency by firmly grasping the bag. The impression of your hand should remain after you let go and the bags should stand up straight, unsupported. Seedlings are ready for pricking out, when after the first 1-3 pairs of true leaves have fully expanded. Make a hole in the medium, big enough to take the seedling’s roots without bending them. Gently grasp a leaf (not stem) of a seedling and slowly, prise it out of its germination tray with a spoon. Place the seedling’s root into the hole in the potting medium and fill the hole with more medium. Bang the container on the ground to settle the medium. Top up with more medium, until the medium surface is 1-2 cm below the container’s rim and the seedling’s root collar (junction between root and shoot) is at the medium surface. Then, press the medium to make sure the plant is upright and centrally placed. Suspend larger plants in a partly filled container and add medium around the roots.



**Steps of pricking out and potting**

**Seedling growth and survival**

**Problems with Potting (left to right from the top):**

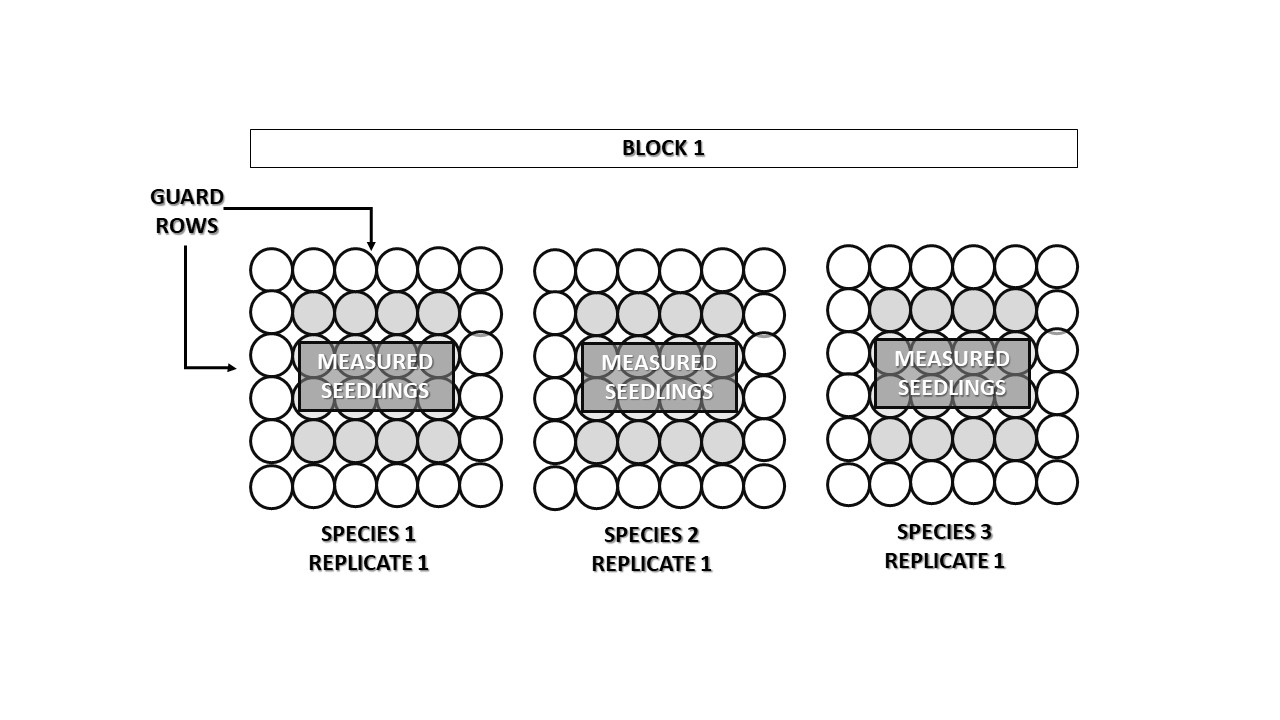
1. Medium has settled; rim of plastic bag collapses, blocking watering.
2. Curled roots will make the adult tree susceptible to wind throw.
3. Seedling not placed centrally.
4. Medium too soft.
5. Medium compacted.
6. Excellent medium consistency.
7. The perfectly potted seedling!

Monitoring the performance of tree species in nurseries enables calculation of the time needed to grow trees, of each selected species, to a plantable size by the planting-out date.

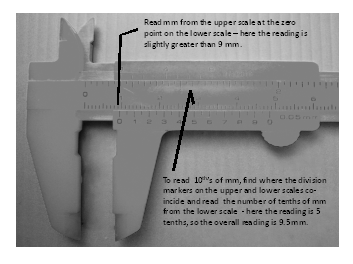
Tree species that grow well in nurseries usually perform well in the field. So, one of the simplest nursery experiments is to compare survival and growth among species. Adopt a standard production method for all species and use a RCB experimental design to compare performance among species. In this case, there are no “control” and “treatment” replicates. A “block” consists of one replicate (no less than 16 containers) of each species.

Subsequent experiments can test different techniques to manipulate growth rates in order to grow saplings to a suitable size. Treatments to test include:

* **Container type** - compare plastic bags with other container types such as rigid plastic cells or tubes, which exert more control over root form, with or without air-pruning
* **Media and fertilizer regime** – vary the potting media composition, such using different forms of organic matter (coconut husk, rice husk, peanut husk etc.) or adding nutrient rich materials such as cattle dung. For slow-growing species, try accelerating growth by experimenting with different fertilizer treatments.
* **Pruning** - If trees start to out-grow their containers before planting-out time, experiment with shoot pruning treatments. Compare different shoot pruning intensities, timing and frequencies.

To test treatments, use a randomized complete block design. Decide on the treatments that can be applied. Then, for each block, select a minimum of 16 plants (more is better) to constitute one “replicate” for each treatment and the same for the control. Make sure that all treatments (and a control) are represented by the same number of plants in all blocks. Place each block, consisting of one replicate of each treatment + control, in a different bed in the standing down area of the nursery. Within each block, position treatment and control replicates randomly. Select uniform plants for experiments. Plants at the edge of a block experience no competition from neighbours on one side and they may be affected by people brushing up against them. Reduce these “edge effects” by surrounding each replicate with a “guard row” of plants that are not included in the experiment.

**Data Collection and Analysis**

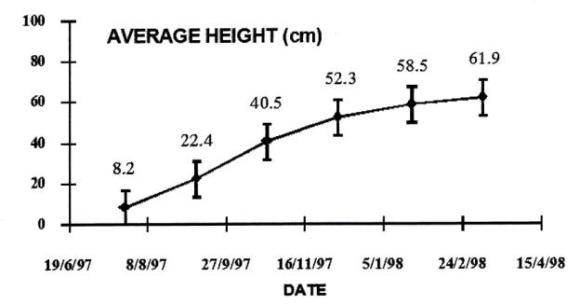
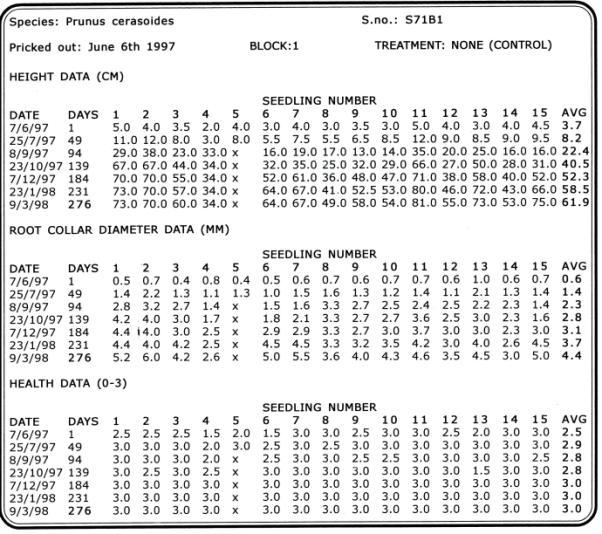
Collect data immediately after the experiment is set up and at intervals of approximately 45 days, thereafter. Measure the height of each sapling (from root collar to apical meristem) with a ruler. Measure RCD (root collar diameter), at the widest point, with Vernier scale calipers Use a simple scoring system to record plant survival and health (0=dead, 1=severe damage or disease; 2=some damage/disease but otherwise healthy; 3= good health). Also, record descriptions of any pests and diseases observed, as well as any signs of nutrient deficiency.

For each replicate, count the number of saplings that survive until planting-out time. Then calculate the mean value for each treatment and standard deviation; repeat for the control. Apply ANOVA to determine if there are significant differences among treatments or species in mean survival. If so, then use paired comparisons between each treatment mean and the control mean, to identify which treatments significantly increase survival. Use the Data Analysis tool in MS Excel.

Represent sapling growth graphically by constructing a growth curve. Plot time elapsed since pricking out (horizontal axis) vs. mean sapling height (or mean RCD), averaged across blocks, for each treatment (vertical axis). By extrapolation, such curves can be used to roughly estimate how long saplings must be kept in the nursery to grow to the optimum planting size. Also calculate relative growth rates (RGR), which removes the effects of differences in the original sizes of seedlings/saplings, immediately after potting, on subsequent growth, i.e. it can be used to compare plants that were larger at the beginning of the experiment with those that were smaller. It is defined as the ratio of growth of a plant to its mean size over the period of measurement, according to the equation below…

(ln FS - ln IS) x 36,500 No. days between measurements

...where ln FS = natural logarithm of final sapling size (either sapling height or RCD) and ln IS = natural logarithm of initial sapling size. The units are per cent per year.

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**Seedling growth data for a pioneer tree species. Trees reach a size suitable for planting out by January, six months ahead of the optimal planting time. Therefore, seed storage to delay germination is recommended to prevent waste of nursery space and avoid the need to prune the saplings.**