

# Seed handling, seedling germination and sowing

## *Seed pre-treatments and seed storage*

If seeds are enclosed in a fleshy fruit, remove as much as possible of the flesh with a knife, wash off the rest under water, and plant the seeds immediately. Fruit flesh attracts insects and fungi which may damage the seed, so it's important to plant the seed as soon as you can. For seeds in a seed pod, such as a bean, let the pods split open naturally by laying them in a semi-shaded place. Similarly, for other fruits with a woody outer coating, drying them in semi-shade or gently cracking should open them and let you collect the seed. Some sun is good, but be careful not to overheat, which might kill the seeds.

A *good nursery practice* is to pre-treat the seeds, if they take more than a week to germinate. You will save time and resources by pre-treating seeds. Faster production time in the nursery lowers nursery costs and may also allow the farmers to plant the seedlings during the best planting times. If you are unsure how long the seed will take to germinate, sow some BEFORE you sow all of the seeds to find out. There are four basic types of seed pre-treatment used in the lowland tropics of Latin America. Sulphuric acid is sometimes recommended as a fifth seed pre-treatment but, because of the danger and cost involved, we do not recommend it. In order to determine the best pre-treatment method, take a few handfuls of seed and try the methods described on the next page in the order given. If most of the seed germinates well with the first method, then that is probably sufficient. If not, try the next method and so on until you obtain the best germination rates.

**Pre-treat the seeds, if they take more than a week to germinate.**

The seeds contain two parts: an outer protective coat, and the inner embryo that develops into the plant. Germination begins when water penetrates the seed coat and the seed swells. When seeds swell, plant immediately. Discard seeds that float; they probably have air pockets caused by insects or dead embryos. Always use 2–5 parts of water for each part of seed (e.g. two to five tablespoons of water for one tablespoon of seed). Change the water every 12 hours to remove chemicals that may also slow down germination.

Do some tests to see the best orientation for sowing the seeds. This is especially important if the shoots or roots are twisted when they emerge from the seed, which is common in mahogany

and mango. In southern Mexico, the common way to sow mahogany seedlings is with the wing pointing up. But in one nursery, the manager noticed that the best way to plant was with the wing pointed down. In Puerto Rico, it is recommended by a forest research station that seed be planted flat. In such cases, you should do trials of all three methods and see what works best under the conditions you have.

### ***Four basic seed pre-treatments***

**1. Cold water treatment:** Soak seeds in cold water for at least 12 and up to 48 hours. You can also try soaking the seeds in water during the day, and leaving them to dry at night.

**2. Hot water treatment:** Boil water in a large pot, remove from heat and cool for 10 minutes. Add seed to water and let soak for up to two days.

**3. Boiling water treatment:** Boil water in a large pot, remove from heat, add seed and leave for two minutes. Pour off the hot water and replace with cold water. Soak the seed for up to two days.

**4. Mechanical:** It is important not to damage the embryo, or the part of the seed where the root will emerge (usually an indented place or a pointed area). Nick the seed with a knife, crack it with a stick, or scratch its surface on a concrete floor, or with sandpaper. For small seed, place in a jar lined with sandpaper facing the inside of the jar, and shake vigorously. It is not necessary to completely remove the tough outer seed coat — just crack it so that water can enter the seed and trigger germination.

**Sow the seed immediately after collecting, or store correctly if necessary.**

*A good nursery practice* is to sow the seed immediately after collecting, or store correctly if necessary. You should plan ahead and have containers filled, so that seed can be sown without delay. If you must store seed before sowing, make sure it is kept well ventilated in a cloth or mesh sack, or in clay pots. These materials ‘breathe’ and reduce the chance of mould. If a refrigerator is available, you can use plastic bags or containers.

Only clean, dry seed should be stored. Hang the sacks from a pole so that air can circulate all around them. Keep the seed in a cool dry place, out of direct sunlight. A fungicide may help reduce fungus attack. Moth balls or other strong-smelling materials like cedar wood may also help reduce insect attack. Check seed regularly for signs of decay, insect or rodent damage.

The length of time seed can be stored for varies greatly between species. Some seed can be stored for many months, while other seeds lose their viability (ability to germinate quickly). If the seed has been stored for more than one month, a *good nursery practice* is to test the germination rate to see if the seed is still good. A *poor, but unfortunately common nursery practice* is to sow old seed in many containers, without knowing if it will germinate — you might be wasting time, labour, and resources. Sow 100 seeds in a shady germination bed and water normally. Count the number of seeds that germinate, and this will tell you how many you need to put into each container to achieve one plant per pot. If, for example, only 25 out of 100 seeds germinate, sow four in each container.

**Test the germination rate to see if the seed is still good.**

### ***Controlling germination***

The most important factor for good germination is constant humidity around the seed. Seeds can be covered with sieved soil, sand, rice hulls or pine needles, to keep them moist. A light material allows the tender roots and shoots to emerge without hindrance. The substrate should be moist, but not soggy; excess water should drain off. It is often recommended that you plant large seeds deeply and small seeds close to the surface. While this is usually sensible, if the substrate dries out quickly, or water is not always available, you will need to plant the seeds deeper. If the water pressure in the hose is very high, it may wash the seeds out, so again, plant the seeds deeper. A *good nursery practice* is to carefully control the light, water and shade conditions during initial seedling growth. Shade helps retain humidity and prevents new leaves from scorching. This can be achieved in a seed bed as well as directly in the container.

**Carefully control the light, water and shade conditions during initial seedling growth.**

The substrate should not receive additional fertilizer because this could increase the risk of diseases such as damping-off. Germinating seedlings generally receive all nutrients

they require from the cotyledons (or in the case of palms, from the first leaf), that are formed inside of the seed. Thus, a substrate like sand, which does not contain fertilizer, is generally a good germinating medium. Damping-off is common with small seedlings and is recognizable as either decayed seed or, more frequently, decay around the stem at the soil line. The leaves of the seedling droop as though they need water, although the substrate is wet, then the stem appears “pinched” and brown near the base. Eventually, the seedling falls over at the soil line.

Damping-off is caused by fungi which can be present on the surface of the seed or in the substrate. Seed can be sterilized by immersing it for 30 minutes in a 10% solution of clorox (1 tablespoon of bleach plus 9 tablespoons water). Hydrogen peroxide, a common antiseptic available at the pharmacy, is also an effective seed sterilant. Its advantages are that it is less toxic than bleach, and it can increase germination because it softens the seed coat allowing water and oxygen to enter more easily. Seed is soaked directly in the antiseptic for up to four hours. With both bleach and hydrogen peroxide, some experimentation may be necessary to find the most effective solution strength and soaking time. A 30 minute soak with hot (just too hot to touch comfortably — definitely not boiling) water also works well on seed. The substrate can be sterilized by wetting the area well with water then covering the area with a black plastic sheet for several days while it stands in abundant sunshine. The heat kills bacteria, fungi, and weed seeds. You can sterilize sand by washing it several times until the wash water appears perfectly clear.

**Carefully recognize the type of damage on the seedling, and control the specific problem with the right method for that particular pest.**

When deciding whether sterilization is necessary, first determine whether seedling growth is being harmed by something living in the soil by carefully examining the type of damage to the plant. Is the damage at the soil line or at the roots? If yes, then sterilization may be necessary. Test the different methods to determine if seedling growth really improves. A *good nursery practice* is to carefully recognize the type of damage on the seedling, and control the specific problem with the right method for that particular pest. Remember that sterilization of the substrate can also kill beneficial fungi, bacteria and insects. Certain bacteria and fungi are necessary to break down organic

matter or help plants better absorb nutrients. Many insects too are useful because they eat other insects that eat plants. Read more about these in chapter 3.

### ***Direct sowing versus seed beds***

Most nurseries use seed beds to germinate seeds. In fact, many nursery manuals recommend using them for all seedlings and give specific instructions on how to build ‘beautiful’ seed beds. We take a different approach. We strongly recommend sowing the seed directly in the container, and using germination beds only in special cases. We do so because we believe that this is best for seedling growth.

Some of the common problems with seed beds are that:

- pricking out almost always results in root deformities
- when plants are left in the seed bed too long (which often happens), they produce long roots that are easily damaged or twisted when pricked out
- many seedlings suffer a ‘shock’ when they are transplanted from seed beds — their growth is slowed for 1–4 weeks before they begin to show visible new growth
- pricking out is often done by staff with little nursery experience, and even people with experience often prick out incorrectly, and
- paying people by the number of plants pricked out in one day gives no incentive to prick out correctly.

### ***When to direct sow seed***

Careful control of water, light and nutrients is required during germination *and* during the first weeks of seedling growth. Directly sowing the seeds in the container saves time, labour and money, because the extra step of preparing a seed bed and transplanting is eliminated. Even if it takes a little longer to plant small seed directly in the containers or if they have to be moved and resown, this is easier and cheaper than pricking out. Direct sowing allows undisturbed seedling growth and thus reduces stress for the seedling. In a well-managed nursery, seedlings can almost always be directly sown!

When you are direct sowing, follow these ***good nursery practices***:

- use only fresh and ripe seed
- pre-treat seed, if necessary, to speed up germination
- prepare containers and shade in advance
- mix small seed with sand or rice hulls, or use a bottle with a screen top (like a salt shaker, but larger), to make dispersing it easier
- test seed for viability before sowing. If less than 70% germinate, plant more than one seed per bag. Throw away any extra seedlings in each pot. This is a small price to pay to avoid root deformities.

### ***When to use seed beds***

Depending on the conditions in your nursery, including the tree species, number of plants produced, and labour availability, a combination of direct sowing and use of seed beds may be your best way of operating. The use of seed beds is NOT recommended simply in order to ensure every container has a seedling. Seed beds can be used:

- to select seedlings of uniform size and development for transplanting. Only plants of the same age should be compared when judging plant quality. When seed germination is highly erratic, seedlings should be transplanted in groups of the same age. Seedlings should be pricked out in groups of even ages so that later they will not be compared with plants of a different age class.
- when seed is old, or when the germination is low or unknown. Use a seed bed to test seed viability (as described above) before filling too many containers and wasting resources.
- if seed does not store well (that is, if it is ‘recalcitrant’).
- if containers are not available, or not filled in time to use. Seed beds can be used until the containers are ready.

### ***Types of seed beds***

There are two types of seed beds, temporary and permanent. Temporary seed beds include any tilled bed of soil. Alternatively, seeds can be germinated between bags of jute or sheets of newspaper that are kept constantly wet, but not soggy. The advantage of using newspaper or a similar material as opposed to planting in a bed of sand or soil is that you can easily check the stage of seed germination and prick the seedling out as the tap root emerges. It is not necessary to wait until the seedling grows 15 cm and produces its first true leaf, and in fact that’s not a good idea, because the older, better-developed seedlings are more susceptible to damage when pricked out.

Plastic flour bags filled with a sand and soil mixture are common in the State of Yucatan, Mexico. The bag can be closed initially to provide shade and a humid micro-environment. Small seed lots can be germinated, and the substrate can be easily loosened to remove the seedlings. Another advantage of these bags is that they can be moved directly to the rows of containers where the seedlings will be planted.

Permanent seed beds are commonly constructed with cement blocks at 1 m or more height and 1.2 m width for working comfort and efficiency. They are filled starting at the bottom with stones, then gravel, then soil or sand. A common practice in Costa Rica is to

prepare wooden boxes with a fine wire mesh bottom and fill them with sand. The boxes are placed on tables in a greenhouse or under a roof. The tables are also covered with fine wire mesh to allow good drainage and aeration. Frequent watering is necessary because the sand does not retain much water. Creating the proper germination conditions in containers, and pricking out correctly, are more important than constructing tidy, permanent germination beds.

### ***How to prick out correctly***

Even when pricking out is done very carefully as described below, it is still very hard to do it correctly, especially when thousands of plants must be transplanted. Only those who are trained in correctly pricking out should attempt it. Unfortunately, many people who have

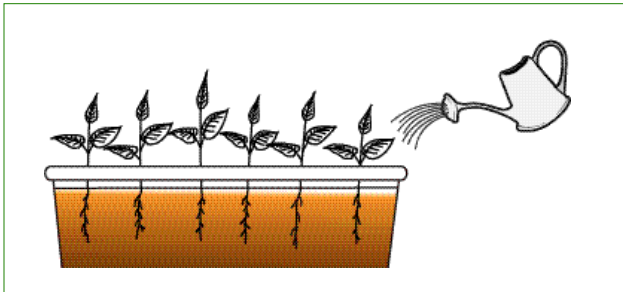
#### ***Good pricking out practices***

- throw away any seedlings that appear sick or deformed
- transplant when the tap root emerges or seedlings are still small (5 cm), before secondary roots are formed
- water the bags well, one night before you prick them out, so that water penetrates to the bottom of the seedbed
- ensure that the area where the transplanted seedlings will be kept is well shaded before you begin pricking out
- water the seedlings 24 hours before, and one hour before, pricking out
- on days with strong sunshine, prick out in the early morning or late afternoon
- use a shovel or stick to gently loosen the soil around the seedlings
- remove seedlings by grasping their cotyledons or lower leaves – do not lift them out by the stem
- put seedlings in water as soon as you take them from the germination bed
- prepare planting holes with a stick and ensure they are sufficiently wide and deep
- clip long or very branched roots to ensure they are pointed downwards
- gently pull the seedling upward after placing it in the hole, to straighten out roots
- pack the soil against the roots, starting at the bottom of the hole
- water the plants immediately after transplanting, and again when they wilt

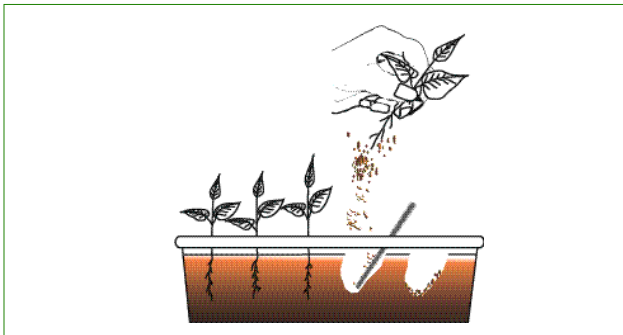
pricked out in the past have done it incorrectly. Close supervision and revision of the plants is necessary in order avoid root deformities. Always open a few containers after a few days to check that it has been done correctly.

### **Poor, but unfortunately common pricking out practices**

- waiting until plants are large and have long roots
- pricking out plants into dry soil and then watering them
- constructing shade after pricking out is done
- pricking out in direct, hot sunlight
- transplanting damaged seedlings
- removing seedlings by grasping the stem, as this may permanently damage the flow of water
- carrying seedlings in your hand or on a plate without water
- preparing the holes with a finger — the hole will usually be too small
- allowing roots to bend upwards when inserting them into the hole
- leaving air pockets around the roots — the plants will die



Water the plants well before transplanting them.

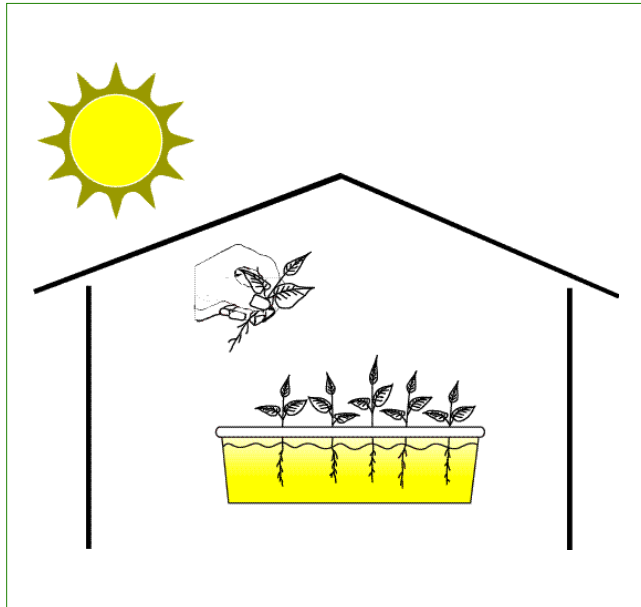


Lift the soil around the seedlings and pull them up carefully. Use a small shovel or stick to gently pull out the seedling. Don't squeeze the stems, because they are fragile.

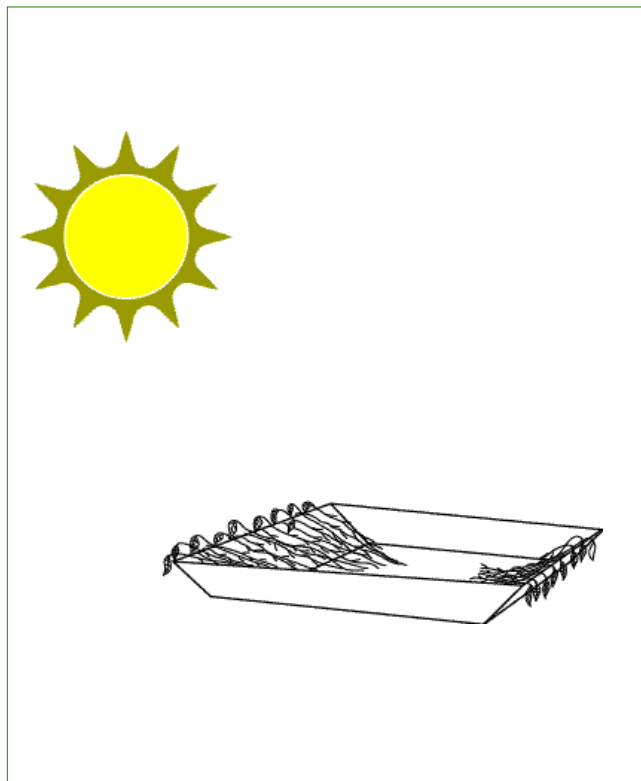


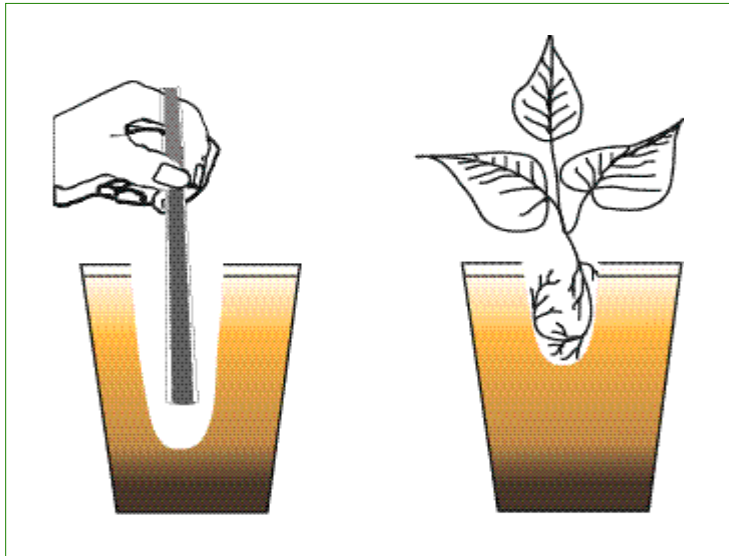
## 2 SEED HANDLING, SEEDLING GERMINATION AND SOWING

Put the plants in a dish with water.  
Keep them in the shade  
and plant them immediately.



Roots dry out within  
minutes! When they dry out,  
they die. Make sure that they  
are covered with water,  
wet paper or a mud slurry.

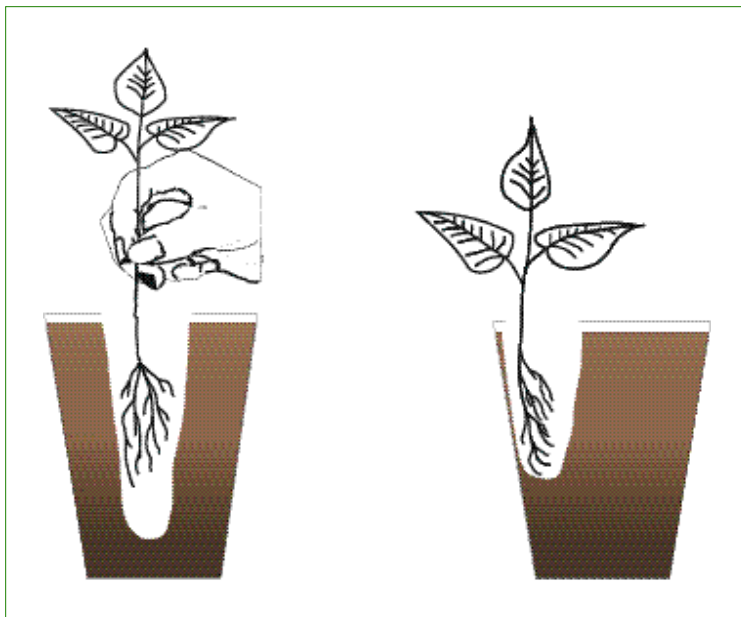




right

wrong

Make the hole sufficiently deep with a long stick. Do not let the roots curl upwards.



right

wrong

Plant the seedling in the middle, not at the edge of the container. Carefully pack the soil around the roots so that no air pockets are left around the roots.

### ***Summary of sowing and seedling germination***

Whenever possible, direct sow seed into containers, to avoid root deformities. Controlling the germinating environment and correctly pricking out are more important than constructing fancy seed beds.

#### ***Good nursery practices***

- sow seed as soon as possible after harvest
- pre-treat seed, if it takes more than a week to germinate
- test old seed before planting to know if it will still germinate
- carefully control the light, water and shade during seedling growth
- sow seed directly in the container

#### ***Poor, but unfortunately common nursery practices***

- expending a lot of effort to build fancy seed beds
- careless pricking out, resulting in damaged plants with root deformations
- leaving seedlings in the germination bed too long