

Nursery experiments for improving plant quality

Why try nursery experiments?

Often the common production techniques are used without experimenting with other procedures. Even if growth has been adequate in the past, and especially if it has not been, it is worth trying other techniques to see if growth can be enhanced.

Speeding up production time is important to get trees out of the nursery within one season. Species that produce seed during the middle of the rainy season are often not ready for planting out during the same season. Thus, the trees often remain in the nursery into the next year, often eight months or more. By this time, plants are often overgrown and exhibit root coiling.

Improving plant growth not only improves plant quality, but also means more efficient use of time, labour and resources for the nursery.

An experiment with a big result

In Costa Rica, a common tree used to shade coffee, *Cordia alliodora*, is normally grown as *pseudo-estacas*. These are bare-root plants that are grown for 18 months, then drastically cut back to 15 cm root and 3-5 cm shoot. When grown in bags of soil, seedling growth is very slow, thus *pseudo-estacas* are preferred. However, *pseudo-estacas* grow slowly in the field and have a low survival rate. When *Cordia* seedlings were tested in bags filled with compost or soil plus fertilizer, growth improved dramatically. Average plant height was 50 cm with the improved substrates, versus only 15 cm in unfertilized soil substrate. The plants were ready within three months for planting out, a great saving for the nursery.

Everyone is a researcher

Experimentation is always a good idea. Planning an experiment, applying different treatments and analysing the results means that you are curious and interested in solving problems or trying out new ideas in the nursery. You don't have to be a fancy engineer or technician to do experiments. Everyone is a researcher!

Research is about making observations and about paying close attention to the exact causes and effects of something. Research is about solving a big puzzle, by collecting little pieces of information and seeing how they fit together. You will not always know the outcome of the puzzle and you will make some mistakes. Don't be discouraged; use your imagination and initiative to try again. The only danger lies in thinking you already know everything and not being open to new possibilities!

How to conduct experiments

You may have observed that the soil from one area produces better plants than the soil from another area. This is an important casual observation. When we do experiments, we want to verify or prove without a doubt that one soil is better than another. In order to prove something is better we need to design a test with several plants and with several repetitions. We apply the treatments to groups or blocks of plants, called a repetition. Repeating the treatments three to six times ensures that the result we obtain was not just by coincidence.

The treatments are the different materials or methods we are comparing, for example, two levels of fertilizer, or two different seed pre-treatments. Always include the control, which is the current nursery practice, for example the soil you regularly use. Do not test more than five treatments at one time. With many treatments, it becomes too difficult to manage and interpret the results. Always plant the seedlings on the same day, or apply the treatments to seedling of the same age.

The key to any testing is to know for sure that only one factor (or group of factors) is the cause for the results you see. You do not want to confound the results. For example, if some plants were grown in a substrate with rice hulls and fertilizer added, and others only in soil, you do not know if the rice hulls or the fertilizer caused the changes. Similarly, make sure that not all of the trees in one of the experimental treatments are at the shadier end of the nursery or at the end of the beds without a good shelter belt. If possible have blocks of each treatment in different parts of the nursery.

All the plants in an experiment must be treated equally. For example, if some trees receive more water because they are closer to the irrigation sprinkler, and they are all the trees that were treated with fertilizer, you will not know whether the plants responded to the fertilizer or the water.

Correct data collection

Generally, the size of the plants at the time of (ideal) planting out is of most interest. Intermediate data, for example, taken at months one, two and three after germination, are useful only if growth rates are being followed.

- Measure height to the tip of the growing point, not to the tip of the last leaf.
- It is easier to measure diameter at the soil line, than at a specified height above the soil line.
- Fresh weights of leaves, stems and roots are not useful — they depend on the water content of the plant at the time of harvesting.
- Dry weights (dried for three days at 65°C) are used after you carefully remove any soil from roots.

Substrate experiments

Probably the most important factor influencing seedling growth is the correct substrate. Both the physical and chemical properties of the substrates play a role. Therefore, substrate tests should include a range of levels, for example, in nutrient content and porosity. Again, these tests should not be limited to new tree species.

Treatments should be carefully chosen to exhaust the most important comparisons. Tests could include for example:

- soil only
- soil with 25% and 50% compost, and 100% compost (no soil)
- soil with low, medium and high levels of fertilizer.

If you tested all these conditions, you would then have seven treatments. If you wanted to reduce the number of treatments because it is difficult to manage seven, use those which you suspect will give the best results. In this case, you could use only the medium level of fertilizer or 50% mixture of compost.

Test any treatments separately for their effects on the physical and chemical properties of the substrate. For example, to test the effects of porosity on the substrate, add sand,

rice hulls or some other light material such as perlite. To test the effect of increased nutrient levels, add fertilizer. Then, test the effect of the addition of both. The following will allow the comparison of each element as well as their combination:

- soil only
- soil with sand (or rice hulls)
- soil with fertilizer
- soil with sand (or rice hulls) and fertilizer.

Plant density experiments

Plant density studies are easy to establish for both bare-root beds and containers. The objective is to find the optimum density that allows the plants to develop with minimal competition for light, water, and nutrients. As plant density increases, plant growth usually decreases. Plants should be evenly spaced in the nursery to allow for best development.

To find the best spacing, first check the current plant density per square metre. Try to choose areas that are typical — not very high or very low densities. Count several areas and take an average. Optimal plant density will vary with the species and/or the bag size used. A general guideline for choosing treatments would be three densities. For example, for bare-root beds:

- high density — 600 seedlings per square metre
- medium density — 400 seedlings per square metre
- low density — 200 seedlings per square metre.

Choose three one-metre square areas with similar shade conditions, water and soil types. If the beds are wider than one metre, for example 1 m 40 cm, then you will have to multiply all suggested planting densities by 1.4. If the beds are less than 1 m wide, say 80 cm, then you must multiply the planting densities by 0.8.

If you are going to use the current plants in production, start the experiment when the plants are still small, about 10 cm or less. The larger the plants, the harder it will be to see any plant density effects. If the current density used is 550 seeds per square metre, then this should be considered the high density treatment. For the medium density treatment, remove every third seedling to reach a final density of 369. For the low density treatment, leave only every third seedlings to reach a final density of 187. Try to maintain even spacing between plants.

You will have more flexibility in determining plant density if you plan the experiment in advance and plant the different seedling densities to start with. Remember to plant extra seedlings because some may not germinate.

For plants grown in bags, the size of the bags will greatly determine the final plant density. For example, for 7 cm diameter bags, there are 13 rows of 13 plants or 169 bags per square metre. For larger bags, there are fewer plants per square metre. Pick an area of bagged plants, and try the following arrangements to understand the effects of different plant densities:

- for high density, leave the bags side by side
- for medium density, remove every third row
- for low density, remove every other row.

Interpreting the results

Measure the height and diameter of the plants when they are to be taken to the field. For some of the plants, examine the root systems and make a visual estimate of the root volume or mass. Check to see that there are many white root tips which indicate that the plant is vigorously growing.

You will probably find that the low density plants are shorter than the high density plants, and that they have larger diameter stems and more root mass. Diameter and root mass are often positively correlated. That means, generally, the larger the diameter of the stem, the more roots it produces. This is because plants in the high densities are competing for light, so they grow tall. Because the plants are investing in shoot growth, they do not invest in root growth. In the case of bare-root beds, plants compete for limited water and nutrients, and this competition also reduces root growth. Remember that the root system is more important for early growth and survival in the field than the shoots and leaves.

Planting the experiments in the field should be an important part of any nursery research. A demonstration area can be established near the nursery to show the importance of nursery work. Chose a site that has homogenous soil conditions throughout the site. The growth during the first year is most important because this is when plants need to compete most strongly with weeds and when mortality is highest.