Republic of the Philippines
Department of Environment and Natural Resources
FOREST MANAGEMENT BUREAU
Visayas Avenue, Diliman, 1100 Quezon City
Tel. No. (632) 927-47*-88/ Fax No. (632) 9289313
E-mail Address: fmb@mozcom.com/website: http://forestry.denr.gov.ph

MEMORANDUM

FOR : The Regional Directors
Regions 2, 3, 4A, 5, 6, 9, 12, 13, NCR and NIR

FROM : The Director

SUBJECT : **FMB TECHNICAL BULLETIN NO. 23, GUIDANCE IN THE WATERING OF CONTAINER TREE SEEDLINGS UNDER THE MODERNIZED AND MECHANIZED FOREST NURSERY**

DATE : MAY 31, 2016

I. This Technical Bulletin

This Technical Bulletin will provide some information on the principles and practices of watering for the container tree seedlings particularly on the amount and timing of watering as well as planning and monitoring.

II. Users of the Technical Bulletin

The users of the Technical Bulletin are the Nursery Managers, Growers, Assistant Growers and readers who plan to start and operate a nursery for native plants as well as exotic plants in the tropics.

III. Introduction

Growers have a saying: "Spare the roots, they can make or break your crop".

In nursery operations, water is considered to be one of the principal growth-limiting as well as growth-promoting factors in seedling production. Plant physiological processes are directly and indirectly affected by water. For example, photosynthesis will decrease when moisture stress increases that would reduce the production of carbohydrates which in turn reduces plant energy.

Crop quality is closely tied to watering because both the amount and the timing of watering are important and should be carefully planned and monitored. Water influences plant growth in four important ways:

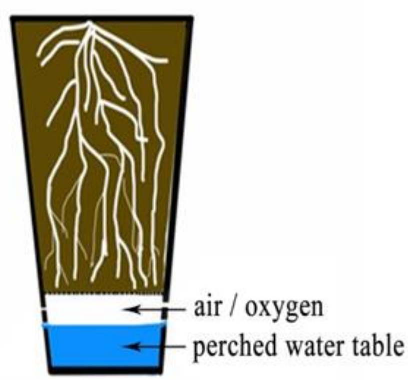
a. Water is essential to the plant which composes 80 to 90% of its weight.
b. Water provides nutrient transport within the plant.
c. Water helps the plant's biological processes such as photosynthesis.
d. Water is critical to maintain plant turgidity, cell expansion and plant growth.

IV. The Science and Art of Watering

In the Philippines where summers are usually warm and dry, plants need to be watered frequently. Knowing when and how much water is a combination of art and science.

The “science of watering” begins by understanding the container-root-media-water relationship especially the cell capacity (volume) and perched water table. Perched water table is defined as the “free water” at the bottom of the container after watering. Perched water table is one of the reasons large particles are added to the growing media to improve aeration, increase the number of pore spaces that will hold water and increase water movement.

Plants usually make roots only above the perched water table where there is adequate aeration (oxygen). As the medium dries up and the perched water table goes down, the plants will chase the water or search for water, hence, the plants make roots.



Crops need different levels of water depending on their stages of growth, the type of growing media, the weather conditions and the species. Some growers can be referred as dry growers or wet growers to describe their watering tendencies. Dry growers would run the risk of damaging plants if the plants get too dry, and wet growers would run the risk of root diseases if the media get too wet. The best approach would be *moderate watering*.

It takes a lot of experience, a little of “gut feeling” or “instinct” and learning from own mistakes and experiences to learn the art of watering. The “art of watering” is determining when to water the plants and then applying the right amount of water.

To determine when to water the plants, walk through the crop and pick up a few trays at random. If the trays are heavy, even though the surface looks dry, do not water. If the trays are light, even though the surface of the media is wet, consider watering. Turn the tray over and examine the media at the bottom of the tray if wet or dry. Pull out some plants from the tray and inspect the moisture level of the entire media. This will give a better assessment whether to water or not.

While checking the moisture of the growing media check also the roots. Healthy roots are white and unhealthy roots are dark in color and hard to distinguish from the media and the media will smell rotten.

Once watering the crop is determined, the next question is: “How much water should be applied"? This is where science collides with the art of watering. Instead of developing a watering schedule based on calculations and charts, monitor the nursery daily to determine watering needs throughout the growing season. There is no set amount of water that can be prescribed, so the grower needs to use the resources available to make the watering decision by considering the following parameters before watering: *cell volume; crop stage; weather forecast;* and *present crop moisture*.

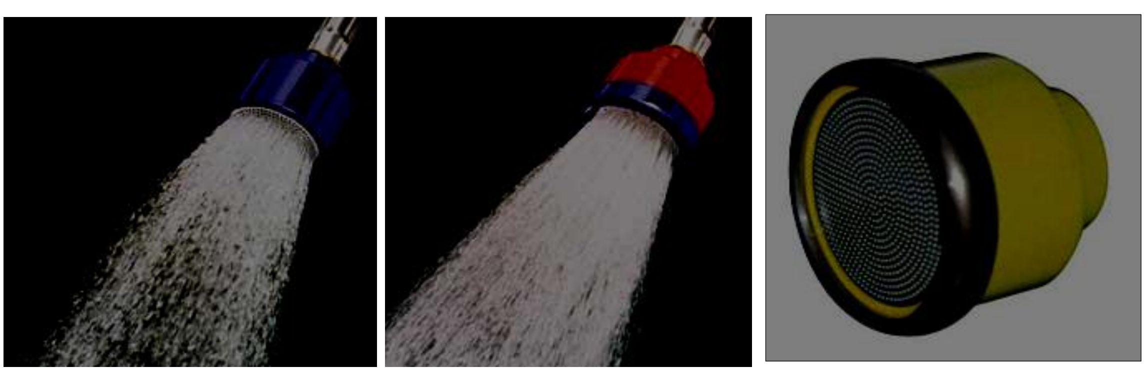
V. Methods of Watering

There are several methods and ways to water plants: hand watering, sprinklers, and irrigation booms.

1. Hand Watering

   Hand watering is considered uneconomical because it is labor inefficient, and automated systems are relatively inexpensive in the long run. For better efficiency, have a quarter-turn valve just behind the breaker (below left photo) to adjust the water pressure quickly without having to go to the faucet, then adjust the pressure until the water flows out in a uniform manner in a cone-shaped pattern (below right photo).

   Next time a new employee is tasked to do hand watering, take some time to explain the concepts of hand watering so he will understand the science of watering, and he will begin to master the art.



Different types of water breakers (nozzles). From left to right: 400 PL, 750 PL and 1000PL. The higher the number the finer the nozzle holes

2. Overhead and basal sprinklers

The basic design consideration of any irrigation system used in container tree seedling nurseries is that water must be applied uniformly at a rapid rate.

Overhead sprinklers are fixed watering system consisting of a series of parallel irrigation lines. They are usually constructed out of plastic PVC pipe or flexible polypipe, with the sprinklers spaced at 2 meters intervals to form a regular grid pattern and the nozzles are installed downward with the nozzle height about 1.0-2.4 meters above the crop.

The basal sprinklers are fixed watering systems similar to the overhead sprinklers but the nozzles are installed upright and placed 1.0-1.2 meters above the crop.

Table 1. Recommended flow rates and spacing of fixed irrigation systems

			Height above crop	Height above crop	
	Flow rate	Spacing	Upright	Inverted	Coverage
Propagation mist	1.2 liters/min	100 cm	100 cm	100 – 120 cm	210 cm max
Overhead irrigation	2.2 liters/min	200 cm	100 cm	120 – 240 cm	420 cm max
Basal irrigation	3.6 liters/min	200 cm	100 cm	n/a	540 max

3. Mobile irrigation booms

Irrigation boom systems distribute water very evenly because they supply a moving curtain of water. A variety of nozzle types can be used on irrigation booms but the most commonly used is the flat fan nozzle. A number of passes has to be done to completely saturate the containers and this can be programmed electronically.

VI. Water Quality

A successful container nursery must have an ample supply of quality irrigation water available throughout the growing season. The chemical balance in the water is crucial to the survival of the plant in the nursery.

1. *pH and Alkalinity*

Alkalinity and pH are two important factors in determining the quality of water for irrigating plants. pH is a measure of the concentration of hydrogen ions (H+) in water or other liquids. Water for irrigation should have a pH between 5.0 and 7.0. Water with pH below 7.0 is termed "acidic", water with pH above 7.0 is termed "basic" (alkaline) and pH 7.0 is "neutral". The pH can be measured using a pH meter.

Alkalinity is a measure of the water's ability to neutralize acidity by testing or measuring the level of bicarbonates, carbonates, and hydroxides in water. Test results are generally expressed as "part per million (ppm) of calcium carbonate ($CaCO_3$)". The levels between 30 and 60 ppm of calcium carbonate are considered optimum or desirable for most plants. Excessive alkalinity level can result in unacceptable rise of the growing media pH which can lead to nutrient deficiencies.

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2. Filters

Suspended solids need to be removed from water to prevent clogging of water lines, pipes, valves, and nozzles in the irrigation system. Suspended solids such as sand, soil, leaves, organic matter, and algae can be removed through filtration.

A 200 mesh filter is usually recommended. The flow rate through the filter should be large enough to handle the peak demand. Maintenance of a filter is important. Filters should be cleaned periodically to maintain consistent water pressure and water volume.

pH meter

3/4" screen filter, 200 mesh

VII. Overwatering and Underwatering

Watering decision considerably affects crop health and quality. Overwatering can drown plants by filling up the media pores with water leaving little or no oxygen for plant roots. Overwatering happens when plants are watered too frequently and not by applying too much water in a single watering. Water thoroughly the crop each time and allow the growing media to dry between watering. Inactive root systems due to saturated conditions in the growing media can lead to insufficient uptake of nutrients and eventually plant nutrient deficiencies. Also excessive watering leaches away nutrients.

Even mild underwatering can cause photosynthesis to shut down. When plants lack adequate water for absorption, plant development slows down and can result to stunted leaves and stem growth. Severe underwatering can result in a burned appearance on the foliage. Furthermore, frequent shallow watering keeps roots from growing deep and makes plants susceptible to drought.

If trying to grow on the dry side (reduced irrigation frequency) especially during the hardening phase, reduce also the fertilizer dosage to prevent accumulation of salts or the roots will be fried. Keep salts and watering in balance to produce good and healthy roots.

VIII. Growing Media Moisture Level

The importance of proper moisture management during germination and propagation should not be overlooked. When the root zone is kept consistently wet, poor root development will follow due to the lack of air or oxygen in the growing media.

A moisture scale has been developed to help growers determine the moisture status of their plants and to help them determine when watering is required.

Table 2. Growing Media Moisture Level Table

	Level 1 Dry	**Level 2 Medium Dry**	**Level 3 Medium**	**Level 4 Medium Wet**	**Level 5 Saturated**
Growing media color	Very light brown or gray	Light brown	Brown to dark brown	Dark brown	Brown-Black glistening with water
Growing media feel when squeezed in hand	No moisture is detected in media	Media squeaks when squeezed	A small drop of water can be squeezed from the media	Water can be easily squeezed from the media	Water runs freely out of the media
Growing media structure	Media is dusty and freely scatters when blown	Media will barely stick together under pressure	Media will clump together but cracks apart under its own weight	Media easily clumps together and stay as one	Media has a semi-liquid consistency

If the planting stock is wilting, it is could be due to too much or too little water. If the growing media is dry above and below the surface, water immediately regardless of the time of day. If the wilting is due to too much water, check to see if the growing media is waterlogged. Avoid watering again until the growing media is dry.

IX. Watering Tips

1. Use a well-drained and well-aerated growing media so proper watering can be achieved.

2. Schedule watering by monitoring the media moisture to determine when to water. Watering should not be based on a fixed schedule but based on the plant water needs. Water just before moisture stress occurs. The result is a properly aerated growing media as well as healthy root development.

3. Assess weather forecasts or conditions before watering. For example, do not water the plants when it is raining or cloudy because the plants are not transpiring. It will result in water logging which can lead to root rot.

4. Adjust amount of water application based on varying crop demands at different growth stages. Gradually increase the amount of water as the plants grow bigger to prevent excess amount of water in the growing media.

5. The best time to water the crop is in the morning. This will ensure that the water is fully absorbed by the growing media and roots. Watering at the middle of the day

can shock the hot plants and burn their leaves or the water will just evaporate rather than be absorbed by the plants which would result to more watering. Watering at night would leave the plants wet, a situation that would encourage diseases such as powdery mildew and damping-off.

6. Make sure plants are watered thoroughly to the point where the media can no longer hold any more water against the pull of gravity. When trays or cells are brought to container capacity at the same watering, they will dry down at the same time. Shallow watering keeps the roots from growing deep and will develop shallow root system that would make the plant susceptible to drought. A thorough watering will penetrate the media's surface and ensure the plant is well nourished. When doing crop planning, consider grouping the species with the same watering regime in the same area to make watering easier.

After watering a section of plants, allow the trays to drain then pick up a few plants. Pull out a few plugs and inspect the media to see if the entire cell is completely wet. Don't be afraid to dismantle a few root balls from time to time to be sure. If the cells are not completely saturated, water again and adjust the volume of water to fully saturate the cells.

FOR THE REFERENCE AND GUIDANCE OF ALL CONCERNED.

RICARDO L. CALDERON, CESO III