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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. 22-B, SEEDLING NUTRITION AND FERTILIZATION FOR CONTAINER TREE SEEDLINGS**

DATE : FEB 07 2015

I. This Technical Bulletin

This Technical Bulletin on seedling nutrition and fertilization will provide some information on the importance of mineral nutrition on both the quality and quantity of growth of container tree seedlings.

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

The importance of mineral nutrition on both the quality and quantity of growth of container tree seedlings should not be overlooked. Like irrigation or watering, fertilization controls both the rate and type of growth in container tree seedling nurseries.

The main process of mineral nutrition is *absorption.* The roots in plants take up nutrients through the absorbent hairs (root hairs) of the young roots which are the main avenue of absorption for water and nutrients into the plant. Root hairs can be infected with mycorrhizal fungi, which act as extensions of the root system and collect nutrients, especially phosphorus for root development. In exchange the plant supplies carbohydrates (sugar) to the fungus, hence, it is a symbiotic relationship.

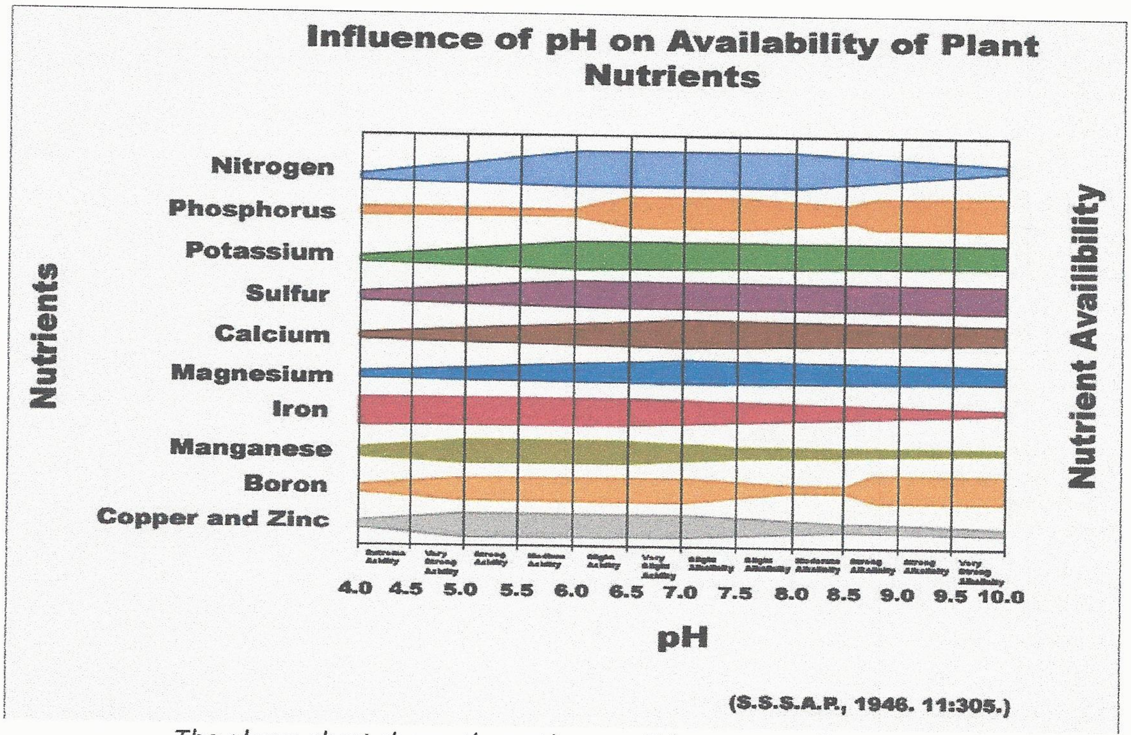
Container plants in a nursery should be grown at optimum fertility levels because of the importance of mineral nutrition on both the quality of growth and subsequent survival of seedlings produced once they are out-planted. Nutritional problems can delay crops and reduce quality. Majority of these nutritional problems can be prevented by monitoring two simple parameters: pH and electrical conductivity (EC).

IV. Managing the Electric Conductivity (EC) and the pH

The most common nutritional problems occur in nursery crops when the pH of the growing media is outside the optimum range. The pH is a measure of the acidity (low pH) or alkalinity (high pH) of the growing media. The optimum range for most crops growing in a soilless media is 5.6-6.4 because at this range micronutrients are soluble to satisfy plant needs without becoming toxic.

The saturated media extract test has the advantage of being an accurate test for EC and pH. However, it requires removing substrate from the pot, so care must be taken not to disturb the roots. Below is the procedure to test the EC and pH using the saturated media extract method:

1. Obtain 200 to 300 milliliters of growing media from the root zone (avoid sampling from the top inch and bottom inch of the pot because of the possibility for a higher salt content).
2. Place the sample in a 500 milliliter container.
3. Add enough distilled water to wet the sample to saturation — there should be no free water on the sample surface.
4. Let the sample stand for 30 minutes to equilibrate.
5. Then test the pH using a pH meter.



The above chart shows the optimum pH for tree seedling growth

V. The Role of Mineral Nutrients

Of the 17 nutrients required for plant growth, 12 are typically supplied through the fertilization program, either pre-plant as part of the growing media using controlled release fertilizer or post-plant as water-soluble fertilizer. These nutrients are classified as "macronutrients" and "micronutrients".

The macronutrients (macros) are Nitrogen (N), Phosphorus (P), Potassium (K) [considered as the big 3], Magnesium (Mg) and Sulphate (S). These macros are constituents of organic compounds, such as proteins.

The micronutrients, based on the relative amounts needed for plant growth, are Calcium (Ca), Iron (Fe), Manganese (Mn), Molybdate (Mo), Boron (Bo), Zinc (Zn) and Copper (Cu). The seven micronutrients are constituents of enzymes that act as catalyst for nutritional elements to be available to the plant.

1. **Nitrogen, N**

After water, nitrogen as a source of protein is the most important plant nutrient in terms of plant growth. More nitrogen means more growth as characterized by soft, sappy stem, deep green foliage called "nitrogen green". A deficiency of nitrogen can be poor or stunted growth and yellowness.

Nitrogen-rich plants are vulnerable to infection by pathogenic fungi, sap suckers and herbivores. This explains the way that intensive use of nitrogen is addicted to pesticides. They are also mechanically softer and open to wind damage etc.

The three main source of nitrogen used are urea, ammonium and nitrate. Urea is converted by ammonium oxidizing bacteria into ammonium. Ammonium is further converted by nitrifying bacteria into nitrate known as nitrification. Nitrification is fuelled by carbohydrates at the expense of plant growth. In waterlogged growing media (soil or clay), the oxidation of ammonium is restricted which will result to acidification of the growing media.

Nitrates are the preferred nitrogen source. They are mobile in the soil so they can be directly absorbed efficiently by the plant. Nitrates promote the uptake of potassium, calcium and magnesium while ammonium and urea compete for the uptake of these elements. Nitrates limit the uptake of harmful elements such as chloride.

Common basic fertilizer materials as source of nitrogen and their nutrient contents				
Material	**Analysis**	**N (%)**	**P_2O_5 (%)**	**K_2O (%)**
Ammonium nitrate	**33-0-0**	**33**	**0**	**0**
Ammonium sulfate	**21-0-0-24S**	**21**	**0**	**0**
Urea	**46-0-0**	**46**	**0**	**0**

2. **Phosphorus, P**

This macronutrient is second in importance after nitrogen. Phosphorus transports energy, encourages the development of roots and root hairs. It is for these reasons that phosphorus should be high during the establishment phase. It is generally applied as phosphate (PO_4^{3-}). Phosphate deficiency leads to stunted growth and poor root growth, hence, limited uptake of nutrients. It promotes cell division, mechanical strength, seed set, and diseases resistance.

Phosphorus is immobile in the growing media because many of its salts are made of highly insoluble such as bones and iron phosphates. Phosphorus once applied can be locked up in the growing media without the plants getting any benefit because acidic conditions of the growing media (low pH) immobilize phosphorus.

Managing phosphate can be achieved by controlling growing media pH, which should be held around pH 6-7 range. Soils rich in iron oxide such as tropical clays will immobilize phosphorus whatever the pH. Coco peat has 5.5 – 5.9 pH, the perfect pH for most plants.

3. Potassium, K

Potassium is a major determinant of plant growth because it determines turgidity, hardiness and resistance to wind. These are the reasons potassium should be high during the hardening phase. Potassium deficiency is characterized by stunted growth and yellowing of the older leaves because this mobile element is translocated to the newest tissue.

Potassium will rapidly leach out of media. It is low on acidic sandy or organic soils and highest in clays. Organisms take up potassium rapidly so that its distribution in ecosystems is defined by biological not chemical processes. Plants take up more potassium than they need if it applied so it is best to fertilize little but often.

4. Calcium, Ca

Calcium is considered as the cell “architecture” and helps in anti-toxic activity.

5. Magnesium, Mg

Magnesium is called the chlorophyll molecule.

VI. Fertilizing Seedlings

The most important factor to manipulate seedling growth is the control of the nitrogen (N) level. Fertility is not a critical factor during germination and root emergence because most seeds have enough stored nutrients to carry out germination. Furthermore, many growing media contain some mineral nutrients as a starter fertilizer to supply nutrients as the root emerges and elongates. The most important factors during germination are the temperature of the growing media and a proper balance between moisture level and aeration. Beginning in the development of the first set of leaves, a small dose of fertilizer is normally started and the rate of nutrient concentration is gradually increased as the seedlings grow.

The recommended nitrogen fertilization levels during the three different growth stages are as follows:

- Establishment phase - moderate N (50 ppm); high phosphorus; low potassium (Ex. 11-41-8)
- Rapid growth phase – higher N levels (100 ppm); low phosphorus; high potassium (Ex. 20-8-20)

- Hardening phase - low N levels (25 ppm); high phosphorus; high potassium (Ex. 8-20-30)

VII. Nutrient deficiency chart

Symptoms	N	P	K	Ca	S	Mg	Fe	Mn	B	Mb	Zn	Cu	Over fert
Yellow upper leaves	No	No	No	No	Yes	No	Yes	No	No	No	No	No	No
Yellow middle leaves	No	No	No	No	No	No	No	No	No	Yes	No	No	No
Yellow lower leaves	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No
Red stems	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No
Necrosis	No	No	Yes	No	No	Yes	No	Yes	Yes	No	No	Yes	No
Spots	No	No	No	No	No	No	No	Yes	No	No	No	No	No
Growing shoots die	No	No	No	No	No	No	No	No	Yes	No	No	No	No
White leaf tips	No	No	No	No	No	Yes	No	No	No	No	Yes	No	No
Stunted growth	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No
Deformed new growth	No	Yes	No	No	No	No	No	No	No	No	No	No	No
Yellow tips	No	No	No	No	No	No	No	No	No	No	No	No	Yes
Twisted growth	No	No	No	No	No	No	No	No	Yes	No	No	No	No

Nutrient Deficiency Chart

VII. Methods of Fertilizing Container Seedlings

The characteristics of fertilizers used on tree seedling are in liquid and dry forms There are three methods of fertilization: 1) incorporating a controlled-release fertilizer into the growing medium; 2) applying a mixed liquid fertilizer solution during watering; and 3) top dressing solid fertilizers to the surface of the growing medium.

1. Controlled-release fertilizer (CRF)

The most reliable and effective way to make the availability of nutrients coincide with plant requirements is by controlling their release into the soil solution, using controlled release fertilizers. Controlled-release fertilizers are products manufactured from fertilizer salts designed to release fertility at a controlled rate over time. This is accomplished by encapsulating fertilizer granules in a polymeric coating.

Controlled-release fertilizer can be either mixed with the potting media or added as a top dressing after planting. Top-dress and media **incorporation** rates are usually printed on the product container. Do not exceed the manufacturer's recommendations. When the controlled-release fertilizers are applied to the growing media, the coating acts as a semi-permeable barrier that allows continuous release of nutrients to the root zone with no hazardous excesses or damaging effects.

WARNING: Do not use sulfur-coated urea CRF. They are rarely used in forest, conservation, and native plant nurseries.

The table below shows the macro nutrient composition (N-P-K) and longevity of CRF (Osmocote):

Longevity at 21 C (70 F)	PCRF (Osmocote) Classic
3 to 4 months	14-14-14; 19-6-12
8 to 10 months	13-13-13; 19-6-12
12 to 14 months	19-6-12
14 to 16 months	19-6-12

Some of the advantages of incorporating fertilizers into the growing media of container nurseries are:

a. No specialized fertilizer equipment is necessary.
b. Low labor costs involved in the frequent mixing and application of liquid fertilizers.
c. Mineral nutrient levels can also be maintained during wet months when nutrient leaching can be a problem.

2. Commercial fertilizer formulations

Commercially available, water-soluble fertilizers are combinations of fertilizer salts called *fertilizer carriers* which are essential nutrients for plant growth. Complete fertilizers contain the three macronutrients, nitrogen, phosphorus, and potassium in various proportions, e.g., 20-10-20. Fertilizer packages are labeled with these three percentages. The first indicates the percent actual nitrogen (N), the second, the oxide form of phosphorus (P_2O_5), and the third, the oxide form of potassium (K_2O). To get true element content of P_2O_5 and K_2O, they must first be converted to their true element content:

P_2O_5 divided by 2.291 = P (elemental phosphorus content)
K_2O divided by 1.205 = K (elemental potassium content)

Coco peat typically contains phosphorus and potassium. In this case, use a low or no phosphorus fertilizer such as 20-10-20 or 15-0-15. If pre-plant phosphorus was added to the growing media such as in the case of coco peat, the 10% phosphorus is not necessary.

VIII. Liquid Fertilizer Calculations

Usually, fertilizer requirements are given in ppm (parts per million), or mg/kg or mg/L. To calculate the amount of fertilizer needed for any given quantity of solution:

$$\frac{(\text{ppm required / elemental content \%}) \times \text{liters required}}{1000} = \text{grams/liter required}$$

- ppm (parts per million required) – this is the feed concentration (when using blended or "complete" fertilizers; normally calculate the amount to dissolve based on the ppm nitrogen required
- elemental content of the fertilizer – the fertilizer label lists the elemental content of each fertilizer constituent as a percentage.
- liters required – the amount of finished (diluted) fertilizer solution.

Example: Using a 19–19–19 fertilizer, a 50–80 ppm solution is recommended for frequent use. Calculate the correct amount:

- In a 19% N fertilizer, 100g fertilizer contains 19 g or 19,000 mg N
- a solution of 50 ppm is wanted (50 mg N in 1 L)

  $$\frac{100\ g \times 50}{19000} = 0.263 \text{ grams per liter or } 263 \text{ mg per liter}$$

- For each litre of fertilizer solution, dissolve 263 mg of 19–19–19 granular fertilizer.

IX. Fertility Monitoring

Developing and monitoring a fertility program is very important to the success of the nursery project. Many nursery growers are confused about what type and rate of fertilizer to use. Many try to develop and simplify a "fertilizer recipe" without understanding the consequences it may have on plant growth under certain growing conditions. Growers should also realize that there are a lot of ways to supply the nutrients of a crop, but the grower must account for the different sources and amounts of nutrients to make sure plants do not receive too much or too little fertilizer.

Diagnosing nutritional problems in greenhouse crops requires a combination of experience, systematic process, and data on the nutrient status of the crops. Nutritional problems can be reduced by keeping accurate records on the day-to-day events in the production process and the details of the fertilization program. Nutritional problems can be corrected before they occur by visual diagnosis, tracking EC and pH, water testing, media testing, and foliar analysis.

FOR THE REFERENCE AND GUIDANCE OF ALL CONCERNED.

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