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The Art and Science of Plant Propagation

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Summary

The goal of this paper is to motivate propagators to understand that plant propagation integrates both science and art in producing high quality liners. The underlining goal is maximizing efficiency and yields in propagation for commercial production success.

INTRODUCTION

Science can be defined as a rigorous, systematic endeavor that builds and organizes knowledge in the form of testable explanations and predictions about the world. Modern science is divided into three major branches: physical science, earth science and life science. Horticulture and plant propagation are part of the life sciences – which includes the study of living organisms and life processes as part of the natural sciences. Biology, chemistry, physics, mathematics (statistics) play important roles in understanding the *"why"/science/ principles* of plant propagation, while application of *technology/practices/art* is part of the *"how"* in commercial propagation.

All these sciences play an important role in propagation: how do (adventitious) roots grow, manipulating plant growth and development, understanding plant structures, water, oxygen/aeration, nutrient exchange, understanding ratios among elements such as nitrogen, phosphorus, potassium, calcium, magnesium, micro-elements – and determining fertilizer and pesticide rates. Utilizing science opens a whole new world of knowledge in propagation. It is important to understand plant biology and the different forms of plant reproduction - but it is also important to master their requirements with a high level of precision (art/application/technology) to maximize commercial propagation success.

In essence, plant propagation is the art and science of manipulating plant growth and development – utilizing select propagules and propagation techniques in commercially reproducing plants. Propagation is the process of creating new plants using different propagules: seeds, cuttings, tissue culture plantlets, grafts, layering, etc.

Challenges For the Plant Propagator

In developing a propagation systems approach, the propagator needs to determine sources and types of propagules: buying in unrooted cuttings (URC), seed, tissue culture produced microcuttings or plantlets, etc. (**Figs. 1 and 2**).

Other questions include: propagation tray requirement, propagation media type, plant propagation/production requirements [electrical conductivity (EC), pH]; if propagating unrooted cuttings – what rooting hormones (auxin), application method and concentrations work best? (**Fig. 3**)

Figure 1. *Yucca filamentosa* 'Color Guard' tissue-cultured micro-propagules upon arrival from a tissue culture lab (left), and later, during nursery propagation in trays (right).

Figure 2. *Yucca filamentosa* 'Color Guard' after initially lining-out established propagules in containers (left), and in final container production (right).

Figure 3. Propagating *Abelia* × *grandiflora* 'Kaleidoscope' cuttings treated with auxin to enhance rooting under intermittent mist in cutting tray flats.

Propagating plants, regardless of the method of choice, is not a problem free system. It is up to the propagator to recognize potential problems, such as diseases, pests, rooting rate and acceptable top-growth (shoot) development. The propagator should be able to determine preventative and/or curative measures in order to produce a clean crop and avoid losses.

Selecting The Right Propagation Media

Regardless of plant species, the process starts with a cutting being stuck in suitable propagation media of choice - under the appropriate environmental conditions: temperature, light, mist, etc. The cutting should start rooting and a new plant will be produced with the same uniform characteristics of its parents.

Selecting good, affordable media for propagation can be challenging. Different aspects have to be considered, based on the plant requirements. There are many different choices of media, such as but not limited to: loose fill in open flats and plugs, autoplugs, green plugs, Elle pots/Elle plugs https://www.ellepot.com/, Preforma plugs https://jiffygroup.com/products/jiffy-preforma/,etc. Media can be peat based, fine bark or coir fibers. Media can be amended according to the needs of the plant. Some plugs can have paper holding the material together with loose or compressed media.

ROOTING HORMONES

Understanding rooting hormones such as indolebutyric acid (IBA), more water-soluble indolebutyric acid with potassium salt (K-IBA) and naphthalene acetic acid (NAA) are key factors for propagation. Determining the rate is highly important and is dependent on the plant species and variety (**Figs. 4, 5, and 6**).

Figure 4. Rooting hormones: (top, left) Dip N' Grow (liquid combination of 1% IBA and 0.5 % NAA diluted in water to the desired concentration); (top, center) Advocate – 20% liquid IBA that is diluted to desired concentration and can be applied as a foliar application or basal dip; (bottom, left) Clonex – 0.31% (3100 ppm) IBA waterbased rooting gel; (bottom, center) Hormodin 3 – 0.8% IBA talc powder; (far-right) Hormodin 2 – 0.3% IBA talc powder.

Figure 5. Conducting a rooting study on *Hypericum kalmianum* 'Blue Velvet' using various auxin rates.

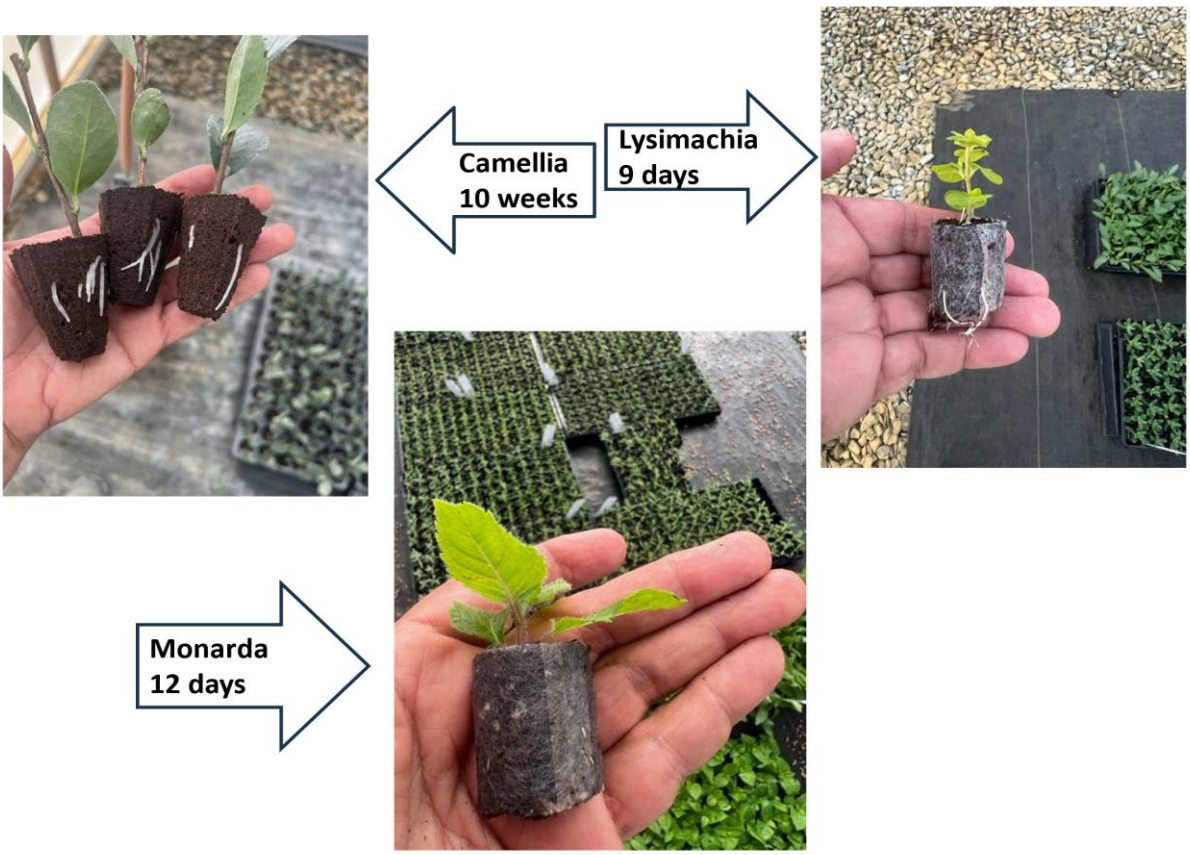

Figure 6. Rooting plug study of Camelia (10 weeks), Lysimachia (9 days) and Monarda (12 days) – showing species differences in rate of adventitious root formation and emergence.

Tank mixes can be used to help with stress, while dealing with unrooted cuttings. Always do a jar test when uncertain if materials are compatible. Tank mixing Advocate with Pageant and adjuvant can be beneficial. Advocate is an IBA compound (auxin) that promotes rooting, while

Pageant is a broad-spectrum fungicide, helps with stress and inhibits ethylene production in the cutting (**Fig. 7**). Not every variety reacts positively to use of liquid IBA or K-IBA. Some plants show toxicity and do not perform as expected. Other rooting hormone choices are gels and powders. Constant monitoring and attention to detail – and maintaining records are critical.

The production process has to be approached in different ways. Efficiency can be improved in multiple ways – and constant fine-tuning is required.

Understanding the physiology of an unrooted cutting, a miniature tissue culture plant or any other part of the plant used to propagate is critical - and so are all the interacting environmental factors: propagation mist (frequency and duration), light levels (percent shade), temperature (soil and air) and heat (source).

When all the possible variables have been put together, results will start showing. The most important and exciting moment for a propagator is to observe that first root (**Fig. 6**)!

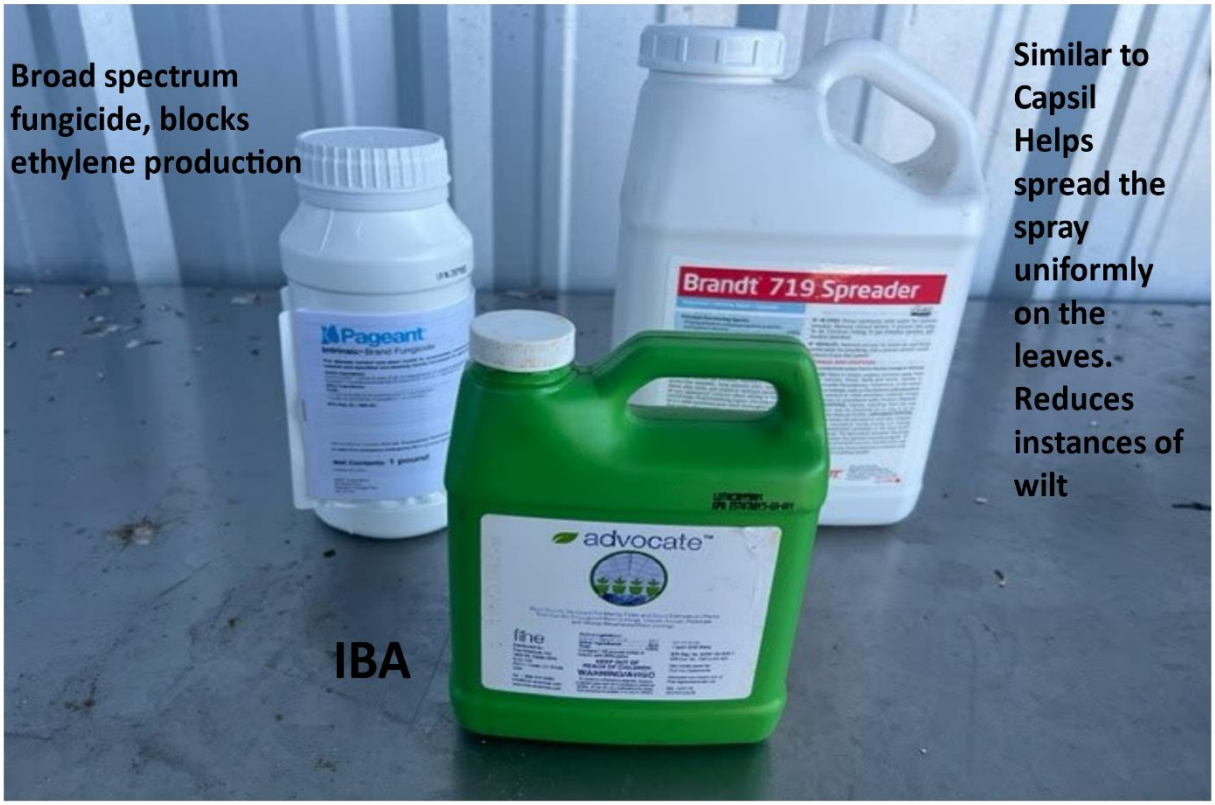

Figure 7. Fungicides and a wetting agent used in propagation with (bottom) Advocate (20% IBA) – to be diluted to desired concentration. (top, left) Pageant is a broadspectrum fungicide, that helps reduce stress and ethylene production in cuttings; (top, right) Brandt 719 is non-ionic surfactant, very similar to Capsil – that is mixed with auxins/chemicals – and helps reduce surface tension so the spray spreads more evenly with better penetration.

Merging Art and Science

Art is defined as something beautiful produced by a highly skilled person, who can put together all the pieces needed. Consistency and quality start from the moment the plant material is selected to be propagated. Top quality crops are not a coincidence or good luck.

Quality plant production is the result of dedication, attention to detail, research and understanding the plant's needs. Inconsistent crops to propagate are hard to work with - not only at the time of transplant but also while growing the finished crop. The main goal should be to increase efficiency and reduce percentage of waste at the production level - regardless if the liners are for in house production or outside customer sales (**Fig. 8**). Producing a finished crop with low quality liners, will produce a higher percent of waste than desired. Efficiency while planting will also be reduced since other tasks such as pruning, discarding and selecting will have to be added. There is a high demand for top quality in all the steps.

Figure 8. The merging of science/biology and application/technology/"the art" of producing quality rooted cuttings during cutting propagation (top, left); loading uniform rooted cutting liners for container production in the field (top, right), and (bottom) finishing off the rooted liners in containers ready for spring or fall sales.

Trialing – Experiments to Determine Optimal Media And Rooting Hormones

When trials are set up, every treatment must be labeled properly. Always include a control to verify the difference between treatments. *Simplify*: minimize the number of variables (treatments) in your propagation experiment to get more definitive results. Trials require constant monitoring, data analysis and if it shows positive results - it can go in two directions: either set up a bigger trial, or implement a new procedure.

The process for setting up a rooting trial is outlined in **Figure 9**.

Trial Process

- Take cuttings
- Disinfect with Zerotol at 0.5 oz per gallon and immerse plant material for 45 seconds
- Process cuttings
- Apply rooting hormone solution
- Cover
- Store in cooler overnight at 45 degrees
- Stick the next day

Figure 9. The trial process for setting up a rooting study, testing auxins of different sources and concentrations.

See examples of propagation media experiments (**Fig. 10**), and rooting trials of selected species using different auxin sources and concentrations (**Figs. 11 and 12**).

Figure 10. Propagation media experiments with *Abelia* × *grandiflora* 'Kaleidoscope'. (far-left)

Blend 10 is Preforma Blend 10 from Jiffy Products, coir fiber media, glued with a unique binding agent; (second, left) Blend 30 is Preforma Blend 30 from Jiffy Product, peat based media, glued with a unique binding agent; (second right) Elleplugs (pots), using a Sungro Propagation mix surrounded by biodegradable paper, consisting of 85% peat and 15% fine perlite with light starter charge; (far-right) Elleplugs (pots) with a greater plug depth.

Figure 11. (left) Shades of Pink™ Viburnum (*Viburnum tinus* 'Lisarose') initial rooting - double stuck in a 36 cell, Preforma Blend 10, treated with Advocate at 1,000 ppm IBA; (right).

Figure 12. (left) Rooting of *Buxus sempervirens* NewGen® Freedom *'SB300'* - 4 weeks after sticking, treated with Advocate at 1,500 ppm IBA; (right) – rooting of *Hypericum kalmianum* 'Blue Velvet' - 2 weeks after sticking, treated with Advocate at 1,500 ppm IBA.

Goals of a Propagator

Some important goals as a propagator are outlined in **Fig.13**. Useful textbooks on propagation and disease control are referenced in the literature cited. In summary, successful commercial plant propagation is maximized when the propagator understands both the science of propagation biology and applies it in the application and art of efficiently propagating plants.

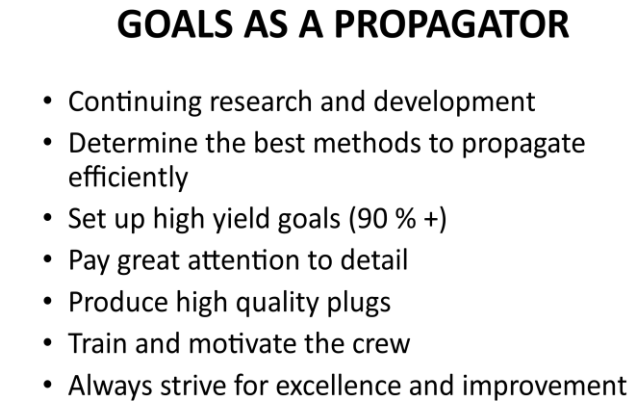

Figure 13. Some important goals of a plant propagator.

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