Back to the Basics in Propagation

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AUXINS

Powder (talc) formulations of auxins are still used to stimulate rooting of cuttings. A problem with talcs is that they may not be uniformly applied at the base of cuttings and they are easily removed when cuttings are inserted into the propagation medium. Spray or quick-dip applications of 1 to 5 sec are the preferred methods to apply auxins since a more uniform response and potentially better penetration of auxins occurs. Indolebutyric acid (IBA) and naphthalene acetic acid (NAA) are the two most common forms of auxin used singly or in combination in commercial propagation.

LOSS OF PROPAGATION CHEMICALS

Propagation and nursery production will be less reliant on chemicals in the future. Technical-grade auxin can no longer be used in commercial propagation. The EPA considers IBA to be moderately toxic with an LD50 of 100, even though for 50 years this chemical has been safely used. Currently, technical-grade IBA has a conditional registration. Plant propagators can buy registered, formulated products containing IBA, such as Dip 'N Grow which contains 1% IBA and 0.5% NAA. These products can be serially diluted down to lower concentrations. Other alternatives to IBA may include P-ITB (Rootal), which is a phenyl indole-3-thiolobutyrate product, that may clear EPA registration. The Dupont Co. has recently cancelled all ornamental uses for Benlate (Benomyl), which was the most widely used fungicide for propagation and ornamental use. No longer can it be used in dips and drenches for cuttings. Some possible substitutes include: Topsin M (Atochem N.A.), Domain (Sierra-Grace) and Cleary 3336 (W.A. Cleary). Always conduct small tests before trying new products in your propagation system.

The beneficial fungus *Gliocladium virens* may be an alternative to Benlate. It has been cleared by the EPA for biological control of *Rhizoctonia colani* and *Pythium ultimum*, which are two of the principle pathogens causing damping-off diseases.

CULTURAL PRACTICES TO ENHANCE ROOTING

With the reliance on fewer chemicals, there will continue to be a greater need to use sound cultural techniques to enhance rooting. Cultural practices include sanitation, stock plant manipulation, stress reduction, temperature and light manipulation, water management, and fertilization practices.

Sanitation. Good sanitation practices include taking cuttings from nutritionally fit and disease-free stockplants or container plants. Cleaning the propagation work area and propagation beds should be standard routine. For cleaning benches and walkways and sanitizing propagation tools, consider using Agribrom (oxidizing biocide), Physan 20 (benzly chloride), household beach, pine disinfectant, or Green-Shield. Dilute household vinegar is good for control of algae along walkways. Methyl bromide has been an effective gas sterilant for killing pathogens, insects and weeds in propagation media This chemical is currently banned for horticultural use in Holland, since it gets into the aquifer system It may be no longer available in the USA in the future Propagators have used chemical drenches to avoid pasteurizing propagation media. Pasteurization (165°F/74°C) may be used more in the future. Water chlorination is also effective in reducing pathogens and potential algae problems in propagation.

Drench Cuttings. Many nurseries dip cuttings into chemicals then quick-dip with auxin Most use dilute bleach solutions, Agribrom, Physon 20 or various fungicides for broad-spectrum control of damping-off organisms Agri-strep (agricultural streptomycin) helps control bacterial problems, and one biological control, *Agrobacterium* spp. helps prevent crown gall of hardwood rose cuttings. Once a cutting or plant becomes infected with a bacterium, there is no effective control other than rouging and destroying the cuttings. Again, always conduct small tests with a control before wide-scale use of a chemical.

Temperature. Bottom heat can significantly speed up root formation and development. Intermittent mist lowers the temperature of the propagation media through evaporative cooling. Medium temperature can be raised by using hot water PVC pipes, commercially available plastic tubes or electric cables Root initiation is optimum under somewhat higher temperatures than root development (elongation). The exact optima vary with species (Hartmann, et al , 1991)

Timing and Scheduling. Taking cuttings at the optimum time of year is more critical than using auxins. Softwood cuttings from the first growth flush must be taken in early spring. This is often the only time to get successful rooting with more difficult-to-root species Semihardwood cuttings with more lignified tissues are taken in late spring into summer. These cuttings are less stress susceptible Hardwood cuttings are taken when a plant is dormant during late fall or winter. The October 15, 1991, edition of the American Nurseryman has an excellent series of articles describing timing, scheduling and other propagation techniques.

Commercial priorities drive scheduling in a nursery. When cuttings are stuck may be determined by heavy shipping demands in the spring, availability of propagation space and efficient use of personnel, rather than the optimum biological time to take cuttings. However, with some species it is critical that cuttings be taken during a specific period if successful rooting is to occur. For example, *Ulmus parvifolia* cuttings must be taken 6 to 8 weeks after budbreak (Whitcomb, 1982). As a general rule of thumb, more difficult-to-root plants are stuck early in the propagation season. Easier-to-root cuttings can be taken later in the season since they require less time and propagation space.

Records. It is critical that good records be maintained. With such large numbers of different cultivars and species both written records and pictures are important Both show new propagation personnel how to propagate plants, and what optimum results should look like Video tapes can be effective in training personnel; most people want to learn and improve their skills when given the proper environment and encouragement.

Juvenility and Maturity. Auxins will only speed up and enhance the rooting process if cuttings have the genetic potential to root. This is particularly true with difficult-to-root species or cuttings taken from physiologically mature stockplants, which do not respond to auxin application.

Research in biotechnology systems using agrobacterium to incorporate genes into tobacco plants indicates that those genes responsible for making the plant tissue respond to auxin application, and thus root, are more critical than those responsible for the actual production of auxin (Hartmann, et al , 1991). This makes sense if one considers that as a plant becomes physiologically mature, certain genes that affect the rooting process are turned on and off. In the future, there may be opportunities to incorporate genes that increase tissue receptivity to auxin into higher plants. For the present, there are a number of techniques to manipulate stock plants to retard maturity and increase rooting success.

Stock-Plant Manipulation. Rooting can be enhanced by reducing nitrogen fertilization in stock plants to maintain an optimum carbohydrate/nitrogen ratio The C/N ratio affects rooting of rose hardwood cuttings, (Hambrick, et al., 1991) Likewise, rooting can be enhanced by manipulating light intensity, taking basal vs. apical cuttings, more closely spacing stock plants and utilizing pruning, girdling and layering techniques (Davies and Hartmann, 1987). The effect of most of these procedures is species dependent

Stress Reduction. It is important to collect cuttings early in the day when shoots are turgid and stockplants are not under water stress. Cuttings should be maintained under low light, high relative humidity and cool conditions until stuck. Cuttings of some species can be stored in a refrigerator for 6 hours to 2 months prior to sticking.

Direct Sticking vs. Propagating in Community Flats. The majority of nursery cuttings are now direct stuck in small liner pots in liner flats rather than a large community flat of 50-200 cuttings bunched together. Direct sticking avoids the production step of shifting rooted cuttings into liner pots, and is thus more labor efficient. Direct sticking avoids transplant shock from having roots disturbed during shifting up. However, direct sticking takes more propagation space so it is not cost effective for poor-rooting species.

Wounding and Stripping Cuttings. For many species, wounding the cutting base and stripping off needles at the cutting base is an unjustified production cost. With certain species these techniques can increase rooting by: (1) allowing greater uptake of liquid auxin solutions; (2) creating a "sink" area where accumulation of naturally occurring auxin, carbohydrates and other root-promoting metabolites can occur; (3) stimulating cell division essential for root-primordia formation; and (4) improving the contact area between the cutting base and propagation media for better cutting water relations.

Low Tech. If it works and it is cost effective, use it. There is little purpose in purchasing elaborate propagation equipment and facilities if a proportional economic gain does not occur. If you have success rooting cuttings in simple plastic bags, cold frames or inexpensive hoop propagation houses, use them.

Intermittent Mist. Intermittent mist systems have revolutionized the rooting of cuttings. Now propagators can propagate over a much longer time period and are not limited to using dormant hardwood cuttings for only a few months of the year Intermittent mist allows higher light levels which are important for root development and faster turnover of rooted cuttings (Svenson and Davies, 1989).

A disadvantage of mist is that the evaporative cooling, which is important for reducing heat stress to the cutting, may cause too low a temperature in the medium. Likewise, nutrients are rapidly leached from cuttings, which is a considerable problem for more difficult-to-root species, maintained under mist for longer time periods (Davies and Hartmann, 1987).

Alternatives to Mist. Mist tents can reduce the amount of mist needed. Likewise, contact polyethylene systems allow semihardwood and hardwood cuttings to be stuck, watered-in and then covered, thus avoiding the need to mist. These are commercially important where light intensity and temperature can be controlled. The fog system using centripetal foggers, (Agritech System), high pressure fogging (Mee System) or ultrasonic humidifier nozzles (Ultrasonics Ltd.), produce water droplets <20µm that remain suspended in the air as a vapor. Evaporative cooling occurs without the leaching and media saturation problems of larger sized intermittent mist water droplets.

SEXUAL AND ASEXUAL PROPAGATION

Sexual propagation by seed remains an important propagation system for nursery crops. For many shade and flowering trees it is the most common means of propagation. Nursery propagators frequently combine sexual and asexual propagation techniques by growing seedling rootstocks and grafting or budding with selected cultivars.

Seed propagation is generally cheaper than asexual propagation. Most seed (except apomictic seed) are produced through meiosis and fertilization, which enables a diverse genetic base for a seedling population. Therefore, plants are more tolerant of varying growing conditions and pests, as opposed to genetically uniform asexually (clonally) produced plants with the same genes and resistance level. Advisors to the Global Releaf program for planting millions of shade trees in the United States to combat the greenhouse effect, are recommending planting native species produced from seed to give a broad genetic base.

For sexual propagation to be successful in a nursery, it is critical that only the best seed be utilized, that marginal seedlings be rouged and that only the most uniform seedlings be allowed to continue in the nursery production system.

It is critical that the propagator know the seed provenance or the original geographic source of the seed, so that the plant produced is adapted to have sufficient cold and heat tolerance to reach maximum potential growth. *Cercis canadensis* from seed collected in Texas will not have sufficient cold hardiness to survive in Ohio. Ecotypes of this species from seed collected in Ohio and grown in Texas may not be tolerant enough of the higher heat stress conditions, nor will they obtain the same growth potential of plants from locally collected Texas seed. Seed should be collected from regions that are ecotypically similar to where the plant will be grown.

DO NOT PROPAGATE EVERY ITEM YOU SELL

It simply may not be cost effective to propagate 400 plus species and cultivars. It is important that a nursery grow the correct product mix to service its clientele, but few nurseries make a profit on every item they propagate. If a custom propagator or other reliable nursery source can propagate rooted liners, seedlings or tissue-culture liners more cheaply than you can, it is better to buy the liner material and finish off the nursery crop with your system. A nursery needs to make a profit on every item propagated.

GENERAL PROPAGATION MAXIM, RULES AND GOALS

(1) Do not overmist; (2) consider alternative propagation systems other than mist, such as contact polyethylene systems, fog or layering with hard-to-root cuttings; (3) remember a cutting will not efficiently absorb nutrients until roots are formed but relies on the residual nutrition of the stock plant; (4) consider preincorporating or topdressing with slow-release fertilizers or applying liquid fertilizer after roots are initiated; (5) wean cuttings from mist as quickly as possible; and (6) maintain the plants *momentum* by *taking cuttings during the time of the year when rooting* is optimal (Davies, 1988)

SOURCES FOR PRACTICAL PROPAGATION INFORMATION

Some excellent sources on how to propagate specific species and cultivars can be found in:

1) American Nurseryman Magazine
2) Combined Proceedings of the International Plant Propagators' Society
3) Practical Plant Propagation for Nursery Growers (Macdonald)
4) The Reference Manual of Woody Plant Propagation (Dirr and Heuser)
5) Plant Propagation—Principles and Practices (Hartmann, Kester and Davies)

All of these are fully referenced below.

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