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Wow! The Hormones Have Kicked In©

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In propagating plants from cuttings, rooting hormones can improve adventitious root formation, nutrients can influence plant health and growth rate, and various biological and chemical means can be pursued to combat pests.

ROOTING HORMONES

Plants naturally produce many growth regulators including auxins, cytokinins, gibberellins, abscisic acid, and other ancillary compounds. Some promote root formation, some inhibit it, and others seem to have little effect. Of these compounds, auxins have the most influence on adventitious root formation of cuttings. Indole-3-acetic acid (IAA) is an auxin produced in the buds and translocated down to the base of the cutting where rooting occurs. In some species, the presence of buds is necessary for root formation. For most species, rooting will not occur unless there is enough endogenous auxin present or supplementary auxins are applied to provide sufficient amounts.

The formation of adventitious roots occurs in two stages: (1) root initiation and (2) root growth and development. During root initiation, stem tissue dedifferentiates from stem tissue into root primordia. The addition of auxin during this phase can have a major impact on adventitious root formation. Once root initials are present, they will grow outward emerging through the epidermis while developing connections to the plant's vascular system. At this point, the addition of auxin has little effect on growth as there is generally enough endogenous auxin present to promote cell division and these roots are now capable of taking up water and nutrients.

Commercially, auxin is applied to cuttings to (1) increase the percentage of cuttings that root, (2) hasten root initiation, (3) increase the number and quality of roots that are formed, and (4) increase the uniformity among cuttings. The most widely used rooting hormones are the synthetic compounds indole-3-butyric acid (IBA) and naphthalene acetic acid (NAA). Although natural IAA may seem to be ideal, it must be extracted from plant tissue, an expensive process, and has a very short shelf life. In contrast, IBA and NAA are relatively stable and can be stored for longer periods of time when refrigerated in darkness. It is important to realize that both IBA and NAA can exist as either an acid or potassium salt formulation. The acid form must be dissolved in base, whereas the potassium salt form will dissolve in water. There are numerous formulations of these auxins available on the market as powders, liquids, or gels.

Auxins may be applied to cuttings in various ways. The most common methods include the use of powder or a quick dip (for a few seconds) in a concentrated solution. When cuttings are dipped into powder, the active ingredient, which is mixed in talc, adheres to the base of the cutting. In the quick dip method, cuttings are dipped for a few seconds into a solution. Powder applications are easy to perform, but the quick dip method usually provides better results because it is easier to evenly apply the active ingredient to the cuttings. Varying amounts of powder may adhere to individual cuttings, which lessons uniformity. In addition, auxin present in powder must first dissolve before it can be taken up by the cutting, thus causing a delay in absorption. Other application methods include prolonged soaking (up to 24 h) in a dilute solution, foliar sprays, and incorporation into the media (Blythe and Sibley, 2003). Regardless of application method, woody plants are generally treated with higher auxin concentrations than herbaceous material.

FERTILIZATION

Fertilizer may be incorporated into the media, top-dressed during rooting, or applied in liquid form through the mist system or during irrigation. It is important to keep in mind that nutrients present before rooting occurs are often wasted because there are no roots to efficiently absorb the nutrients. Much is leached through the container. Nutrients do not promote root initiation, but promote root and shoot growth once roots are formed. Excess nutrients can cause a proliferation of algae due to the wet environment. When direct sticking, it often advantageous to mix a controlled-release fertilizer into the growing media prior to propagation.

PEST PROBLEMS

Any biological organism that can interfere with producing quality plants could be considered a pest. This includes bacteria, fungi, viruses, viroids, phytoplasma, insects, mites, weeds, parasitic higher plants, birds, and mammals. Common insect pests such as mealy bugs, aphids, white flies, and thrips are a nuisance because of their ability to fly, walk, or crawl to uninfected plants. *Pythium*, *Phytophthora*, *Fusarium*, and *Rhizoctonia* are examples of soil-borne pathogenic fungi, whereas *Botrytis* is an aerial fungus that affects foliage.

A goal of all propagators should be to keep stock plants, propagation houses, mist beds, media, and surrounding areas free of pests and pathogens through preventative measures instead of remedying the situation with the constant use of pesticides. Keeping the production pest free is a challenge because the warm, humid conditions found in a propagation house are ideal for the proliferation of bacteria and fungi. When problems do occur, the least toxic strategies should be used under the principles of integrated pest management to achieve the desired results. This practice may begin with the selection of cultivars that are resistant or less susceptible to specific diseases and pests. In addition, the resistant qualities of these plants will be passed on to the consumer.

Selecting healthy, clean plant material and sanitation of the physical propagation facilities is critical. Cuttings taken from branches near the ground are more likely to be contaminated with soil-borne pathogens than those removed from the upper portions of stock plants. Even so, it may be advantageous to dip cuttings in a disinfectant of fungicide solution before sticking. Traffic and visitors should be minimized through propagation areas and debris should be removed daily. All tools, working surfaces, flats, etc., should be disinfected with solutions such as sodium hypochlorite (Clorox) or benzylkonium chloride (Physan 20, Green-Shield). Mist benches and growing areas should be kept free of weeds or any dead or diseased plant material. Water used in the mist system also should be free of pathogens. *Pythium*, *Phytophthora*, and *Rhizoctonia* are easily spread through surface water or intermittent mist systems (Hartmann et al., 2002). Treating water with Zerotol or hydrogen peroxide are two options to help alleviate this problem (Albert, 2003).

Propagation media must also be kept pathogen free. Perlite, vermiculite, pumice, and rockwool are usually sterile when received, but components such as bark, sand, and peat may harbor pathogens. All media should be pasteurized if reused. In the industry, the terms sterilization and pasteurization are often used interchangeably. In reality, sterilization involves heating the media to a minimum temperature of 100 °C (212 °F), a process that will kill all organisms. A preferable treatment is pasteurization with aerated steam at 82 °C (180 °F) for 30 minutes, a process that kills most harmful bacteria, fungi, insects, nematodes, and weed seed. Pasteurization at 60 °C (140 °F) is considered even more beneficial by some, because it kills pathogens, but many beneficial organisms remain alive to compete with pathogens when they are reintroduced. Chemical sterilization is another option, but products such as methyl bromide are scheduled to be phased out in the near future.

After cuttings have been stuck, some propagators use biological controls such as predator insects and beneficial nematodes, fungi, and bacteria to help control disease and insect infestations. In some cases, biological control can be less expensive and more effective than chemicals. For example, two-spotted spider mites can be controlled by Chilean predatory mites (Hartmann et al., 2002). When using biological controls, the propagator must be knowledgeable of the life cycles of the target organisms, keep track of growing degree days, and establish a monitoring program (Rosettta, 2003). Timing is very important, as many organisms are only controllable at certain stages of their life cycles. Even under the best-managed IPM program, the use of pesticides may be warranted if populations get out of control. Most commercial propagators follow a preventative schedule for fungicides and apply pesticides when insect populations pose real or potential danger to their crop. These may be applied in granular form, as sprays, or as drenches. Although chemicals are very effective, they pose potential environmental problems, and pathogenic organisms can develop resistance to these chemicals. When using any pesticide, it is advisable to test it on a small plot before using it on an entire crop. Also, in order to be legal, chemicals must be labeled for specific crops and particular functions. For example, few herbicides are labeled for use inside of a greenhouse (Altland et al., 2003).

SAFETY

In addition to common safety procedures such as “no running with scissors,” rooting hormones and pesticides are chemicals that can cause potential harm to workers and the environment. It is very important to follow the precautions listed on the label for each chemical. Personal protection equipment may include rubber gloves, boots, a spray suit, respirator, goggles, and a helmet, depending on the toxicity of the substance used. Signage specifying the chemical used and re-entry periods may need to be posted at the entrance.

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