SOME FACTORS AFFECTING ROOTING OF CUTTINGS

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Within the past 60 years, there has been tremendous advances made in the field of plant propagation. During this time, we have seen the isolation and utilization of auxin (IAA and others), the development, with all of its modifications, of the intermittent mist system, the use of polyethylene plastic, growing plants in containers, and many physiological/biochemical research findings in plant growth and development. Because of this, today we root many of our species, cultivars, and clones by cuttings, which years ago were unrootable.

Plants are rooted from cuttings to preserve the genetic (clonal) characteristics, is a fast method of increase, is relatively cheap, and is relatively simple (6). Many plants today are grown from cuttings. Factors affecting the rooting of cuttings fall into three very broad categories; one is the anatomical relationships of where the new (adventitious) roots emerge; another is the physiological or biochemical aspects of the internal workings of the cuttings, which causes it to root or not to root; the third is the environmental aspects, which are the cultural and environmental manipulations performed on the plant before, during, and after the cutting is stuck. Root initiation and development is the interaction of many factors.

Juvenility. Woody perennial plants go through a juvenile phase before maturing and going into flower. This juvenile phase may last 40 or 50 years. Juvenile wood usually roots much easier than wood from mature plant parts. On a plant that has reached maturity, the more mature branches will be nearer the top of the plant. Lower branches tend to be more juvenile and have a tendency to root with greater ease.

The following methods have been shown to retain juvenility in a plant and therefore could increase the rootability of cuttings.

1. Very hard pruning or heading cuts: The resulting branches may be rejuvenated. The cuttings of these generally form adventitious roots much easier.
2. Adventitious buds will produce shoots that are more juvenile in character. This can be buds sprouting from around large pruning cuts or buds sprouting from roots or root cuttings.
3. Grafting a mature scion onto a juvenile rootstock may cause the scion to revert to more juvenile characteristics. This can be done in serial fashion.

4. Tissue cultures, especially when a number of subcultures are made, will eventually provide very juvenile (very easy-to-root) shoots. (For a more complete discourse on juvenility, see Hackett (4, 5).)

Etiolation and Banding. Etiolation is growing plants in either total darkness or very heavy shade. Banding is the use of 2 to 3 in. wide tape around the base of the cutting to etiolate or blanch the stem. It has long been known that etiolation and/or blanching can increase the rooting of some difficult-to-root plants (3, 7, 8).

Stock Blocks. Stock beds for the sole purpose of supplying cuttings and scionwood for propagation materials are used in Europe more than in the United States or Canada. While stock blocks may take space away from production, they can increase efficiency in the production of plants and uniformity of the plants themselves. Advantages of stock blocks include:

1. Ease of management, particularly when timing of cutting taking is critical.
2. Plants may be managed so cuttings are uniform and, therefore, subsequent crops may be more uniform.
3. Ease of monitoring the plants' health.
4. History of plant and management procedures of the stock plant is known.
5. Stock block plants may be maintained to produce the type of cutting wood needed and when it is needed. These procedures may not be the same as those used on production plants.
6. More juvenile, easier-to-root, cuttings may be produced.

Cutting Water Status and Rooting of Cuttings. Cuttings when taken are detached from and devoid of any root system, thus they develop water deficits. The greater the deficit, the less likely the cutting is to root. Control of water deficits within the cutting should be one of the prime objectives in any propagation scheme. The relatively recent development and use of polyethylene film and intermittent mist system has lessened some of the internal water deficit problems in cuttings and has greatly expanded the scope of the plants which can now be propagated by cuttings.

Some of the factors affecting water loss from cuttings are:

1. *Temperature:* Temperature increases around the cuttings can decrease the relative humidity. Higher temperatures may also increase respiration rates, which may deplete carbohydrate reserves and retard the rooting processes.
2. *Humidity:* At high relative humidities the humidity gradient between the leaf and the surrounding air can be small. Propagation systems, i.e., polyethylene tents, mist, humidifiers, etc., attempt to keep the humidity around the cutting leaf/stem as close to 100% as possible.

3. *Foliage wetting:* The wetting of cutting foliage has certain advantages and certain disadvantages. Evaporation from the leaf surface cools the cutting, reducing respiration. Water may be absorbed through the leaves, reducing water loss from the leaf surface, and may reduce evaporative demand from the leaves, thus conserving internal water. Excessive watering can leach needed nutrients from cutting leaves. Excessive water can also lead to increased disease incidence from a wet, poorly aerated rooting medium.

Root Promoting Substances. The naturally occurring root promoting substance, auxin (indole-3-acetic acid or IAA) was first reported in 1934 (9). Later, indole-3-butyric acid (IBA) and 1-naphthaleneacetic acid (NAA), two synthetic compounds, were shown to have root inducing activities on cuttings. Since IAA is naturally occurring, the plant has the ability to endogenously synthesize this hormone and also has the ability by enzymes to destroy this material. Because IBA and NAA, other derivatives of these two, and a few other compounds with root-inducing properties are synthetic or foreign to the plant's biosystem, the plant cannot destroy these as readily as IAA. Therefore, the effect of the synthetic root-inducing substances in generally considered to be longer lasting. Except for physiological research and tissue culture, IAA is now used very little as a root-inducing substance.

IAA, IBA, and NAA, plus their derivatives, are essentially insoluble in water and are usually dissolved in an organic solvent such as alcohol (methyl, ethyl, or isopropyl) or an alcohol water solvent. The potassium (K) salts of IAA, IBA, and NAA are water soluble and are as effective as the organic acids (1).

Relatively new compounds with root-inducing properties include some aryl and thioaryl esters of IBA. These have the advantage of being synthetic, are just as effective as IBA, and are considerably less toxic than IBA. (1, 2).

There are three methods of application of root-inducing substanccs to cuttings to enhance adventitious root formation. These are:

1. Root-inducing substances thoroughly mixed and suspended in an inert material, such as talc. While this method is effective, it can be messy. The amount of root-inducing substance actually applied is also variable, as this depends on the degree of wetness of the cutting and physical characteristics of the cutting (smoothness, hairiness, roughness, etc.).
2. Concentrated Dip: The cutting is dipped into a solution of the root-inducing material. The solvent is usually organic or at least partially organic. The advantages of this method is uniform application with some penetration into the stem tissue. The

range of application concentration is about 500 to over 10,000 ppm.

3. Dilute Soak: The cutting is put into a very dilute solution of the root-inducing substance for a period of six to 24 hours. Concentrations range from two to about 200 ppm. The dilute soak method is seldom used but may be beneficial for rooting of small batches of cuttings or extremely difficulty-to-root plants.

The rooting of cuttings has taken giant leaps forward in the last fifty or so years. We are now rooting plants that used to be impossible to root. Knowing some of the basics, observing plant growth and behavior, and gathering as much information as possible beforehand, can lead to rooting of many plants which are now considered difficult.

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