Plant and Environmental Factors Limiting Vegetative Propagation

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INTRODUCTION

Successful vegetative propagation of plants may occur by chance but it is more likely to occur consistently where there has been a systematic consideration of the factors that could be limiting root formation.

PLANT FACTORS

These are concerned with competence and preparation for root initiation.

Genotype. The genetic make up of a plant can have a marked influence on its capacity to form roots under ideal circumstances. This means it is worth propagators keeping records of propagation preplant procedures, propagation environment, and the rate of success. Big differences may occur between different species and cultivars within a species.

Stockplant Management. Plant material should be of the highest quality that can be obtained; where quality refers to the total quality of the plant, including freedom from known pests and diseases. Viruses and physiological disorders may reduce rooting potential. Plant thriftiness will also be influenced by nutritional status with the effect of deficiencies in some essential elements (N, Zn, B, Mn) being well documented. A high level of carbohydrate and nitrogen, as occurs in vigorous shoots producing firm cuttings, normally works well under intermittent mist whereas a lower nitrogen content would favour rooting of hardwood cuttings. Preharvest stem girdling and stem etiolation in low light both improve rooting of some more difficult-to-root species by altering the anatomy of the stem and increasing the sensitivity of the stem to applied auxin (Maynard, 1992).

In many plants there is a decline in rooting capacity as shoot material hardens-up. During a growing season, the plant material changes from softwood through half-ripe or semihardwood to fully lignified wood. These seasonal changes are often confused with the changes that occur during plant maturation as people often use similar names for quite distinct aspects of plant growth.

Juvenility may be an important factor influencing root formation in woody plants. The ability to form regular flowers in the adult stage is associated with decreased rooting potential in many species. Maturity and hence rooting may also be related to the position on the stockplant where the cuttings are collected. Lower shady branches generally provide better cutting material than material collected higher up the stockplant. The closer to the ground the stockplants can be maintained the more reliable they will normally be as a cutting source (Howard, 1991).

Timeliness of Setting Cuttings. For many easily rooted plants or those with preformed root initials the time of the year when they are propagated is really a matter of convenience. This allows the development of a market-driven propagation system as described by Vallis (1991) For many woody plants there are marked seasonal fluctuations in the speed of root formation and in the number of cuttings rooted which does not permit the same flexibility, unless the environment can be controlled artificially to extend the growing season. Davies et al (1984) showed that shoot RNA content was related to bud activity and correlated with seasonal rooting activity Anticipating future bud activity may be a good indicator of the time when cuttings should be set as roots may be initiated shortly afterwards

ENVIRONMENTAL FACTORS

These are concerned with stress minimisation to allow root formation

Water. Cuttings should be fully charged with water at the time when they are collected or if they are stressed they will need additional water to make up for the water they have lost The driving force determining water loss from cuttings is related directly to the difference in the water vapour pressure in the leaves and the surrounding air As root initiation is particularly sensitive to water stress, leaf water deficits in leafy cuttings should be minimised through use of humidification by overhead intermittent misting or a fogging system The type of system may be rather less important than its efficiency at keeping the leaves fully turgid. In misting systems the cooling effect of water evaporating from leaves is often cited as a desirable virtue but this is of rather less importance in humidification or fogging systems where the leaf temperature may be higher than the air temperature

Water in the growing medium should be readily available for plant use as water uptake by cuttings is directly proportional to the volumetric water content of the growing medium Evaporation from the medium surface also will contribute to the humidification of the air surrounding the cuttings.

Light. The most suitable irradiance level (which may vary between 10% to full sun according to the species) needs to be established by propagators in their own facilities This requires a light meter to make objective measurements as our eyes (being self compensating) cannot make a reliable estimate of the irradiance at the height of the set cuttings Greenhouse coverings will change the spectral balance and light intensity, especially if dirty It is difficult to separate out the effects of light and temperature More light can be admitted if the system for water control is effectively controlling the leaf water deficit This is especially evident where nonmisted propagation is attempted without adequate shading.

Outdoor propagation areas don't usually require any shading provided the supply of water can balance the water losses from cuttings Whereas in an unshaded greenhouse environment the balance between light and related heating effects on water requirements can be more critical The relatively small volume of air can heat up quickly creating a rapid increase in the vapour pressure deficit Cuttings are less likely to experience a lethal level of water stress if they can be shaded. The photoperiod and light quality can all be manipulated if the greenhouse is equipped with supplemental lighting to extend the propagation season. Growing rooms may have a use in some climates The New Zealand environment is usually not sufficiently limiting that it warrants supplying all the light and heating when we can get a considerable amount directly from the sun

Temperature. The optimum temperature for crop growth should be considered (Preece, 1993). While it may be difficult to schedule, there is some support for a higher temperature for root initiation and a lower temperature for root growth (Kester, 1970; Dykeman, 1976). The shoot temperature can be usefully maintained at slightly less than the root zone to conserve stored and current carbohydrate supplies.

Gas Exchange. The physical properties of the growing medium have a major influence on its water holding and gas exchange properties. Root formation on cuttings is promoted by rapid permeation of propagation medium by oxygen and release of carbon dioxide. All propagators should be able to measure the simple physical properties of their propagation medium. This will give an estimate of the air- and water-filled pores which is more critical to the success of any propagation medium than the presence of a few pathogens in the medium. Propagation media should contain more air (to cope with the metabolic processes occurring at the base of the cutting during root formation) than water. Water is normally going to be applied regularly, therefore shallow propagation containers (only a few cm deep) are going to favour saturation of a higher proportion of the growing medium than taller containers. This will reduce gas exchange in the medium, encouraging an accumulation of carbon dioxide and reduction in oxygen which will reduce potential root formation.

Microflora. The main pathogenic fungi of concern are the watermoulds; *Pythium* species and *Phytophthora* species. These are most problematic under cool moist conditions. When it is rather warmer *Rhizoctonia* species can be more of a problem. Beneficial organisms include mycorrhiza and *Trichoderma*. These are really only in their infancy in terms of our understanding and application to assist plant propagators produce better plants.

CONCLUSION

The more we understand the factors limiting plant growth and development, the more readily we can develop techniques to investigate and solve issues we now regard as insoluble problems.

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