

Increasing Number of Adventitious Roots Accelerates Axillary Bud Growth in Cuttings

Jürgen Hansen and Niels Bredmose

Department of Ornamentals, Danish Institute of Agricultural Sciences, DK-5792 Aarslev, Denmark

The promotive effect of an increasing number of roots per cutting on onset of axillary bud growth, stem growth, or number of leaves can be explained by phase controlled synthesis and transport of growth regulators. The production of cytokinin in adventitious roots is suggested to be proportional to the number of adventitious roots. This may increase the content of cytokinin in the axillary buds resulting in accelerated onset of bud growth.

INTRODUCTION

Root growth and other functions of roots are intensely investigated and the complexity of root : shoot relationships in intact plants has been reviewed by Troughton (1974) and Wilson (1988). Root : shoot relationships in cuttings have, however, only been dealt with in few cases.

Although root formation in cuttings of many plants is an initial barrier to successful plant propagation, specific treatments of stock plants or cuttings can overcome in part the difficulties in root initiation and growth. The success criterion *per se* is the percentage of cuttings forming roots and ultimately the percentage of plants that survive and begins to grow. The significance of the number of roots per cutting for onset of axillary bud growth and subsequent growth of the cutting is less evident and only few investigations have dealt with this subject.

In rooting experiments with *Origanum*, *Mentha*, and *Melissa* Kuris et al. (1980) found that auxin promoted root formation in cuttings. Their results show that an increase in number of roots increased the fresh weight of shoots. In *Mentha* additionally plant height and branching was promoted by an increase in number of roots. Results by Gad et al. (1987) indicate that a 4-chlororesorcinol mediated increase in number of roots in *Pelargonium peltatum* cuttings slightly increases the number of leaves, total dry weight, and leaf fresh weight.

Experiments with *Schefflera arboricola* (Hansen, 1986a) demonstrated the effect of topophysis and cutting stem length on root formation in leaf-bud cuttings and in *Stephanotis floribunda* (Hansen, 1989) root formation could be controlled by topophysis and temperature during rooting. These results were later analyzed to elucidate the root : shoot relationship and except for the topophysis related results for *Stephanotis* the results showed a positive relationship between number of roots and onset of axillary bud growth and subsequent plant growth (Hansen and Kristensen, 1990).

Separate experiments with *Schefflera arboricola* tip cuttings also showed that with increasing cutting size the number of roots increased and that this was positively related to subsequent plant growth (Hansen, 1986b). Further, plant growth rate was higher in cuttings forming many roots than in cuttings forming few roots (Figure 1).

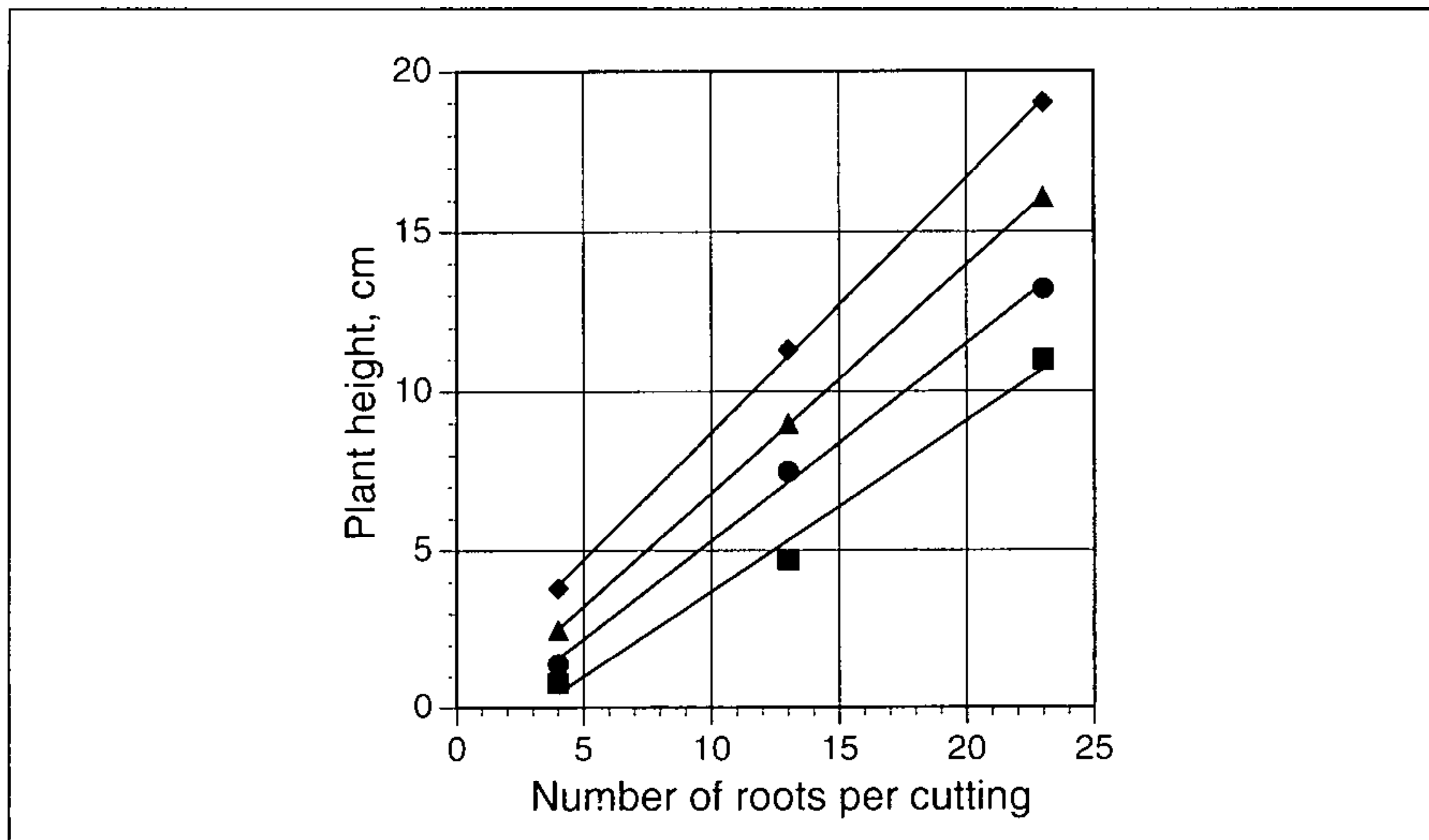


Figure 1. Relationship between plant height and number of roots per cutting in *Schefflera arboricola*. Average rooting results after 28 days for differently sized tip cuttings, large cuttings producing many roots, small cuttings producing few roots. Plant height was measured after 33 (■), 44 (●), 56 (▲), and 71 days (◆) from cutting and planting.

At least two ways of explanation are obvious to explain the relationship between number of adventitious roots and onset of axillary bud growth: (1) Some factors such as water and/or nutrient uptake are mediated by the roots to accelerate axillary bud growth, (2) Roots produce growth regulators to stimulate axillary bud growth.

PHYSIOLOGICAL EXPLANATION

Water and Nutrient Uptake. Water (Tschaplinski and Blake, 1985) and nutrient uptake (Wott and Tukey, 1967) are necessary for axillary bud growth and subsequent plant growth and may under certain conditions promote these processes. Under the controlled experimental conditions for *Schefflera* (Hansen, 1986a, b) and *Stephanotis* (Hansen, 1989) it is, however, not likely that water and/or nutrient uptake influenced the experimental results. It is much more likely that root produced growth regulators exert an effect on axillary bud growth.

Role of Bud Produced Auxin. In intact plants the terminal bud produces auxin which is transported basipetally and inhibits the growth of axillary buds (apical dominance). It is also well-known that auxin stimulates adventitious root formation in cuttings and that the presence of axillary buds in decapitated cuttings influences the formation of adventitious roots (Roberts and Fuchigami, 1973; Eriksen, 1973, 1974). Although the major auxin source, the apical meristem, has been removed in leaf-bud cuttings the axillary bud soon begins to synthesize auxin (Gocal et al., 1991) which is transported basipetally in the cutting and is involved in the initiation of adventitious roots. Within certain limits root formation is generally improved at increasing auxin levels in the cutting.

Root Produced Cytokinin. Cytokinins are the most prominent growth regulators produced by the roots and translocated to the shoot (Featonby-Smith and Van Staden, 1981). With leaf cuttings of *Phaseolus vulgaris* Engelbrecht (1972) and Featonby-Smith and Van Staden (1981) showed that the cytokinin activity in the cuttings began to increase early during root formation, and that the cytokinin level was high at the stage where the roots penetrated the epidermis. Changes in endogenous cytokinins in relation to root formation have been reviewed by Van Staden and Harty (1988).

If the amount of cytokinin synthesized in the root apex (Short and Torrey, 1972) is positively correlated with the number of adventitious roots as suggested by Eriksen (1974) then cuttings with many roots produce more cytokinin than cuttings with few roots and more cytokinin can be transported to the stem and axillary buds of cuttings with many roots.

Cytokinin and Axillary Bud Growth. Cytokinins stimulate axillary bud growth in intact plants (Sachs and Thimann, 1964; King and Van Staden, 1988) and in cuttings (Wickson and Thimann, 1958). Further, Nakano et al. (1980) found that cytokinin activities in buds of intact vines and cuttings of *Vitis* were low prior to bud growth but increased concomitantly with bud growth. Quamaruddin et al. (1990) also observed an increasing cytokinin content in *Pinus sylvestris* buds during dormancy release reaching a peak just before bud growth. Recently Dieleman et al. (1997) reported a high cytokinin content in buds forming the buttom breaks in *Rosa*, and their study support the findings that root produced cytokinin is transported to the axillary buds.

CONCLUSION

We suggest that auxin and cytokinin control root formation and axillary bud growth as outlined above. The acceleration of onset of bud growth in *Schefflera* and *Stephanotis*, therefore, may be a result of an increased cytokinin production in the roots. Practical observations that root formation normally precedes or coincides with axillary bud break support our explanation, and results by Mertens and Wright (1978) that root growth in *Ilex crenata* is preceding shoot growth by 7 to 14 days are in agreement with our hypothesis.

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