

# EFFECT OF ETHYLENE AND JUVENILITY ON ADVENTITIOUS ROOT INITIATION

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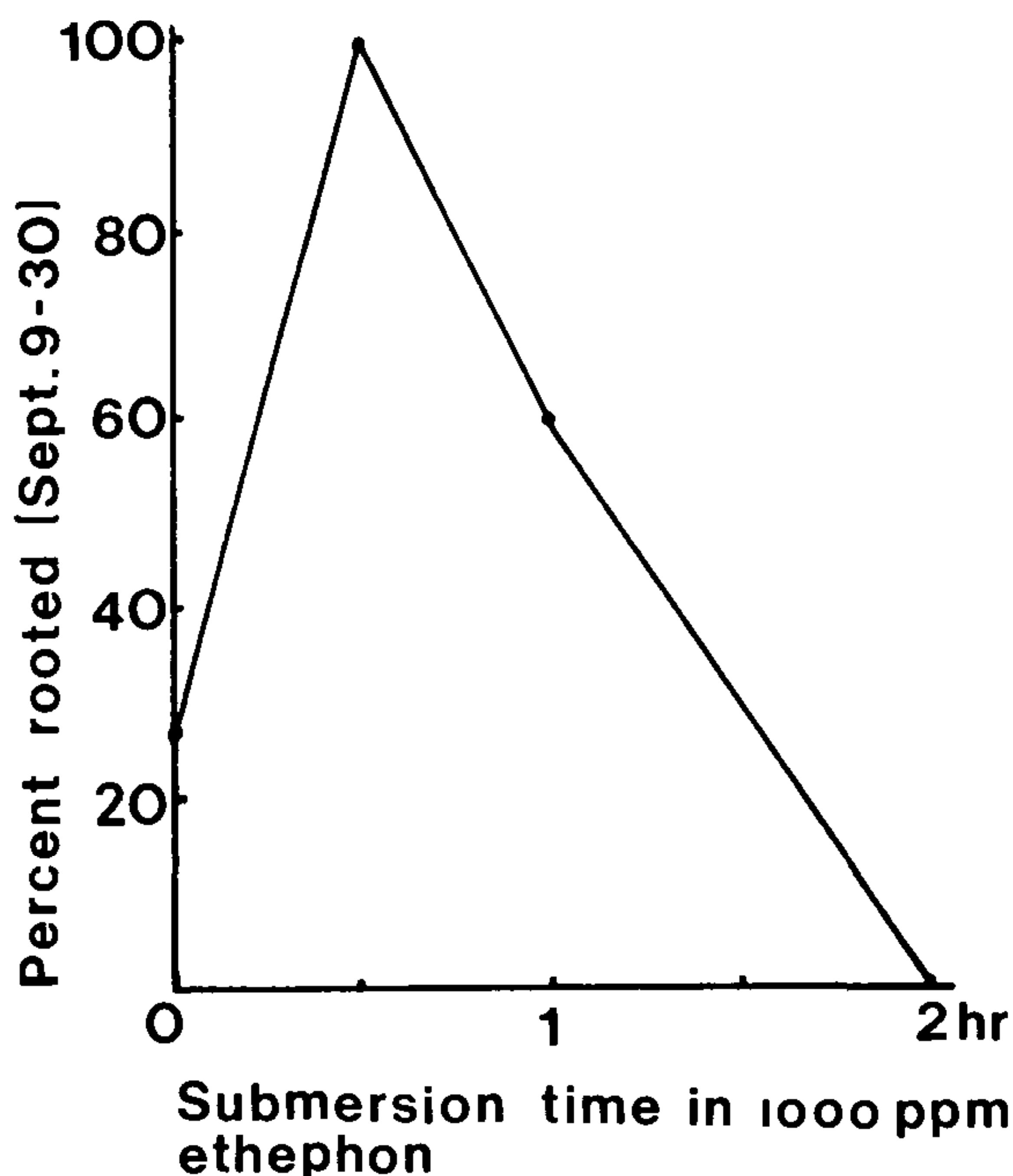
Ethylene was shown to induce root initiation by 1933 (13), yet its use remains controversial and has not been accepted commercially (9). Juvenile cuttings root easily but the reason is not well understood. The purpose of this report is to propose a relationship between ethylene and juvenility to explain easy rooting of juvenile cuttings.

**Juvenile physiological development.** Juvenile growth of plants is physiologically controlled by two principal growth regulator systems. Gibberellins and cytokinins promote cell division and cell elongation while auxins and cytokinins further control growth through apical dominance (8). Other growth-regulating systems exist, but these two should be given prime consideration when explaining root initiation.

Ethylene is known to be an ever-present growth regulator with multiple functions (8). It has an important role in healing, where it is known as wound ethylene (1). In my research, ethylene was released from poinsettia, *Euphorbia pulcherrima* Willd., cuttings and improved root initiation was obtained from applying ethylene as ethephon (Figure 1). Mudge (9) reported that ethylene stimulated rooting in 68% of 52 plant species. Variability of research reports leaves some uncertainty concerning its application to all plants. However, for poinsettia, improper research procedures (2, 11) were the cause of negative results.

Poinsettia cuttings treated heavily with ethephon develop yellow leaves that abscise, indicating movement of metabolites from the leaf. Recent research supports the idea that such mobilization is caused by ethylene (12). Kinetin prevents mobilization (8) and senescence of leaves, but kinetin-treated poinsettia cuttings remained green and failed to root.

Endogenous cytokinins are produced in all meristems of plants, but movement from root meristems is considerable (8). The cutting is deprived of this source of cytokinin since it has no roots. This deprivation combined with the mobilizing effect of ethylene would be expected to mobilize metabolites for rooting. The interaction of ethylene and cytokinins was tested by applying ethephon at rates sufficiently high that abscission should occur and following the



**Figure 1.** Percent rooting of poinsettia cuttings after submersion in 1000 ppm ethephon (Ethrel) for 4 durations. Average deviation from the mean = 9%

ethephon with kinetin treatments. Vigorous rooting was accomplished without leaf abscission, but application rates were very difficult to manage. These results indicated that an ethylene-cytokinin balance is important for the rooting of cuttings and is in accord with the results of Fabijan, *et al* (4).

Ethylene is also released in response to auxin (1,5,8,9). Auxins move from the top of the cutting downward and accumulate at the base of the cutting. Auxin-mediated release of ethylene is consistent with stress-induced release of ethylene if the reaction to concentrated auxin is considered traumatic. While



auxin-induced ethylene accounts for some of the rooting response, it does not account for all of it since low concentrations of auxin are required for root growth. The need for an ethylene-cytokinin balance and an ethylene-auxin activity indicates that cuttings from juvenile mother plants root easily if trauma-induced ethylene is balanced with existing growth regulator systems.

**Mature physiological development.** Mature woody plants are characterized by the onset of flowering. The large number of shoots (twigs) on mature plants reduces the amount of water and nutrients available per shoot. The long shoots typical of juvenile plants become the short and often spur-like twigs of mature woody plants. Short shoot growth indicates that growth of mature plants is suppressed more than on juvenile plants. The dominant growth-suppressing hormone is abscisic acid though many others are known (8).

Cuttings from mature mother plants may contain larger quantities or different types of growth suppressors (3,10). They appear to interfere with root initiation by preventing new shoot growth. New shoot growth promotes the initiation of vascular tissue from which new roots can develop. Growth-inhibitor suppressed mature cuttings are generally released from dormancy and resume new shoot growth before rooting. Deciduous cuttings of crape myrtle, *Lagerstroemia indica*, and kiwifruit, *Actinidia deliciosa*, regularly grow shoots with mature leaves before roots emerge. Cuttings of some species are too weak to root after growing leaves and die (7).

Root initiation of cuttings often follows callus formation. Callus and vascular growth result from relatively differentiated cells, generally parenchyma cells. Cell division from this type of cell apparently is initiated by ethylene since ethylene initiates adventitious roots (13). Ethylene-induced cell division must not be suppressed by abscisic acid or other growth regulators since callus formation occurs on almost any cutting whether dormant or not. Callus tissue results from a proliferation of cell divisions to form a mass of undifferentiated cells. Differentiation of roots can occur from callus (6). Conditions in the cutting must be favorable for root initiation since shoots have also been observed to be initiated from callus. The more common occurrence is a change in color from white to brown or red. Root initiation is generally very slow on cuttings with colored callus.

Results of my research indicate that ethylene has an active role in root initiation. The interaction of ethylene with other growth regulators is proposed to be part of the healing process that began when the cutting was removed from the mother plant.

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