Leaf Abscission of Cuttings

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INTRODUCTION

Leaves supply cuttings with necessary carbohydrates for the life processes. Leaves are also important for supplying the cuttings with hormones needed for root formation. Leaf abscission or leaf drop will, therefore, make it difficult for cuttings to undergo changes necessary for the development of a new root system. It is, therefore, of great interest to obtain increased knowledge of factors which may initiate unwanted leaf drop.

Leaf drop which occurs in the fall is initiated by a decreased flow of auxin out of the leaf. The decreased auxin level initiates synthesis of ethylene in the nodal region, and this ethylene activates enzymes that degrades the cell wall at the base of the petiole and subsequent leaf drop. The increased ethylene level also initiates senescence of the leaf which enables the plant to mobilize all the nutrients present in the leaf before the leaf falls off. The validity of this has been shown, not only by measurements of auxin and ethylene during leaf abscission, but also by the use of transgenic plants that are unable to synthesize ethylene. When ethylene synthesis is prevented, senescence and leaf drop occurs at a much slower rate than normally observed (Isaac et al., 1995). It can, therefore, be concluded that ethylene is the hormone that is most important for initiation of leaf drop.

Cuttings are taken from plants in good growth. We would, therefore, not expect either auxin production to decrease nor ethylene synthesis to be initiated. However, several environmental factors additionally influence ethylene synthesis. Because ethylene is not only a ripening and senescence hormone, but also a stress hormone, any treatment that will cause stress may also initiate ethylene synthesis. We know (Veierskov et al., 1982) that carbohydrates accumulate in cuttings to very high levels and high levels of carbohydrates in leaves have been suggested to accumulate as starch whereafter the chloroplasts begin to malfunction and photooxidative stress occurs. This process can be counteracted by high levels of soluble carbohydrates which can down regulate the rate of photosynthesis and make production and demand meet (Foyer, 1998).

MATERIALS AND METHODS

We designed an experiment with two cultivars of *Hibiscus rosa-sinensis* — an easy-to-root cultivar, Holiday, with no tendency for leaf drop, and a difficult-to-root cultivar, Cardinal, that has problems with leaf drop during root formation. The aim of the work was to see if the known carbohydrate accumulation in the cuttings was caused by an inability to down regulate photosynthesis, and if unwanted leaf drop occurred because of this. The cuttings were rooted under greenhouse conditions at midsummer. During the 30-day rooting period samples were taken for carbohydrate determinations and measurements of photosynthesis.

RESULTS

The photosynthesis rates of the cuttings responded immediately to the rooting condition. In both cultivars photosynthesis decreased to about 20% of the level observed in similar leaves on intact plants (Fig 1) However, the level of soluble carbohydrates increased 250% to 500% during the first 10 days of rooting (Fig. 2). The initial level was three times higher in the easy-to-root cultivar compared to the difficult-to-root cultivar (Fig 2). The level of carbohydrates tended to decrease when roots began to emerge (Day 15 to Day 20 in 'Holiday', Day 20 to Day 25 in 'Cardinal').

DISCUSSION

When cuttings are rooted in a high light environment during midsummer a dramatic down regulation of photosynthesis is observed. Several explanations exist for this down regulation The cutting has lost its root system which supplies the tissue with water and hormones important for normal stomata function However, in this experiment there was no indication of the cuttings being water stressed Another explanation is that there is no longer a sink for the produced carbohydrates because cutting growth ceases. The photosynthetic apparatus responds to this by the observed down regulation (Fig. 1) It is notable that this down regulation occurs during the first 3 days in both cultivars even though carbohydrate accumulation during this period only occurs in the easy-to-root cultivar (Fig 2) We, therefore, conclude that the observed down regulation of photosynthesis is not regulated by carbohydrate accumulation

Although it was not possible to cause leaf abscission in the difficult-to-root cultivar, it is notable that this cultivar had a much lower level of soluble carbohydrates in the leaves of intact plants, and a five-times accumulation occurred during the rooting period It is our belief that this high level of carbohydrate accumulation can stress the photosynthetic apparatus, induce ethylene formation, and be the cause of leaf abscission

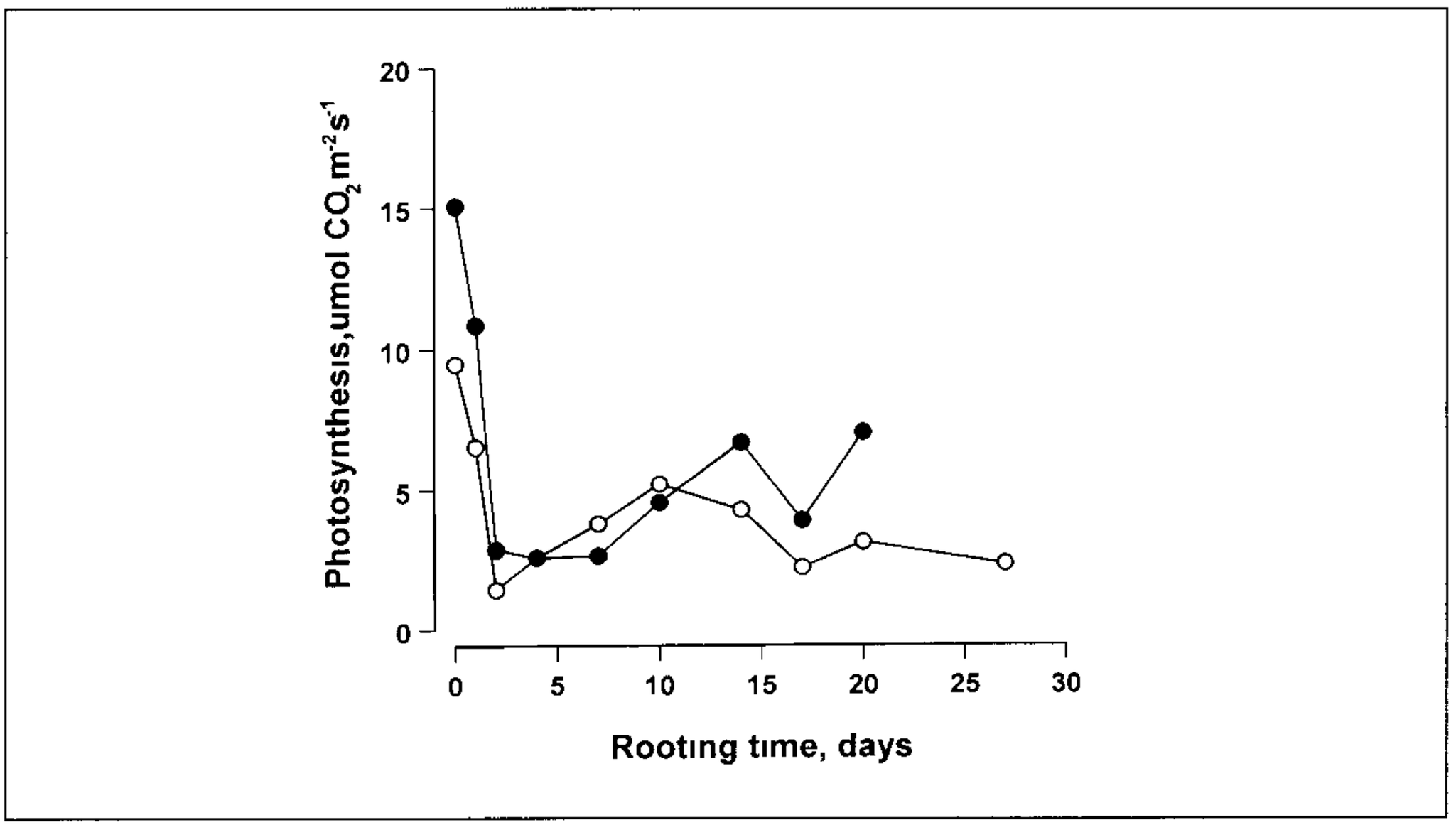

Figure 1. Photosynthetic CO_2 uptake in cuttings of *Hibiscus rosa-sinensis* during the rooting period Closed circles represent 'Holiday', an easy-to-root cultivar, open circles represent 'Cardinal', a difficult-to-root cultivar.

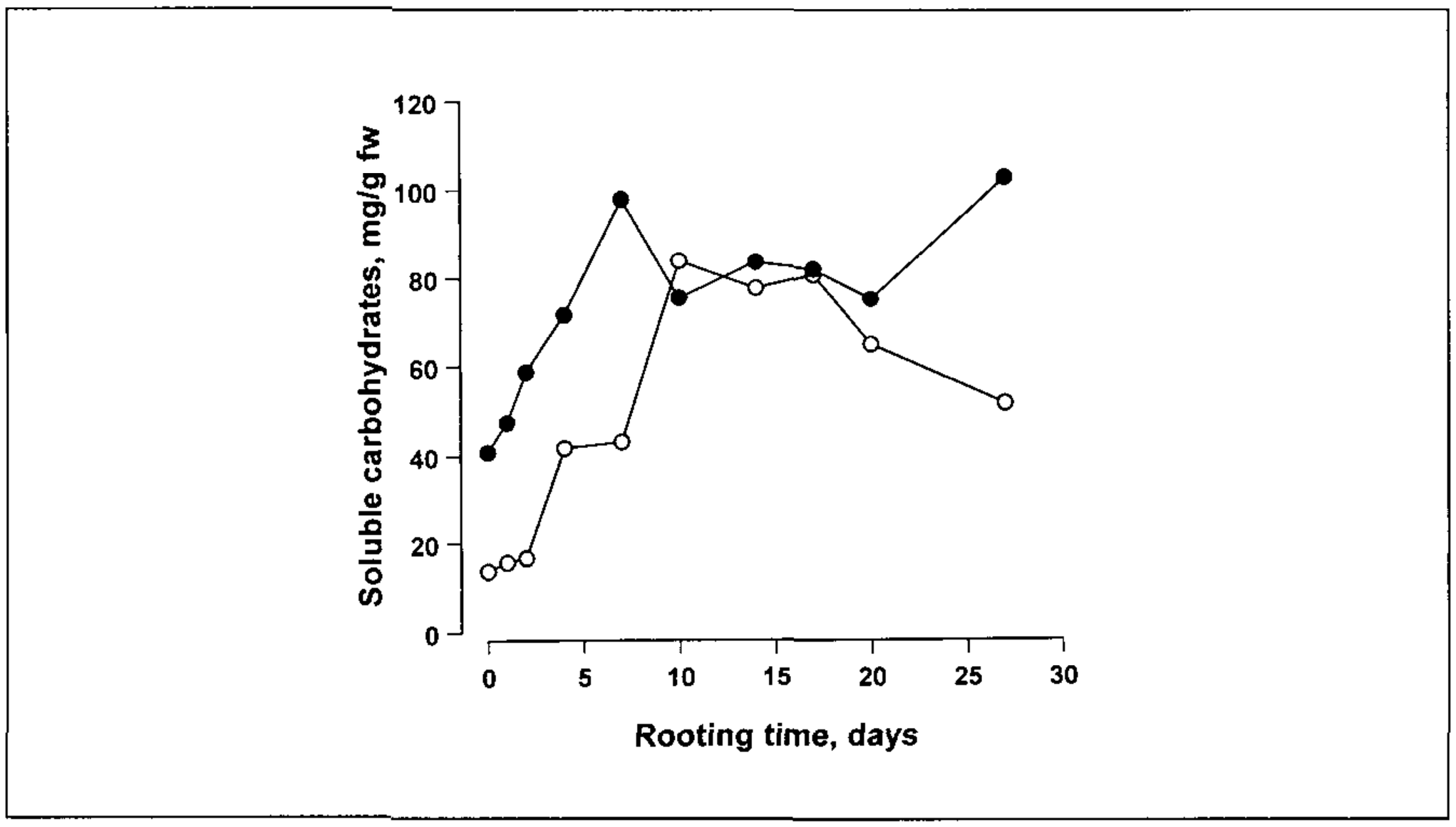

Figure 2. The level of soluble carbohydrates in cuttings of *Hibiscus rosa-sinensis* during the rooting period. Closed circles represent 'Holiday', an easy-to-root cultivar, open circles represent 'Cardinal', a difficult-to-root cultivar.

LITERATURE

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