Anatomy of root initiation in stem cuttings of the kiwifruit plant (*Actinidia chinensis* PLANCH.)

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ETUDE ANATOMIQUE DE L'INITIATION DES RACINES CHEZ LES BOUTURES DE KIWI (*ACTINIDIA CHINENSIS* PLANCH.).

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RESUME - Des cellules initiales de racines déjà préformées ne sont pas observées sur les boutures de Kiwi. Les sites d'origine des cellules primaires des racines ont été trouvés dans la région cambiale. Sur la base des boutures enracinées un anneau de bois secondaire entourant le bois primaire a été observé. Ce bois secondaire a été formé presque en même temps que les cellules primaires des racines. L'action de la feuille sur l'enracinement des boutures est mise en évidence.

INTRODUCTION

Propagating kiwiplant usually involves working the scion variety onto a seedling rootstock. However the propagation by rooted stem cuttings has already started to be employed in practice because it ensures uniformity and quality in the planting material and shortens the juvenile period of the plant.

The rooting potential of kiwi stem cuttings varies markedly (LIONAKIS, 1981 ; LAWES and SIM, 1980), therefore attempts are being made to improve propagation techniques. The present study is a contribution to the improvement of propagating kiwiplant by rooted stem cuttings.

MATERIALS AND METHODS

Rooted kiwi plants one year old of the female cultivar «Bruno» raised from stem cuttings, were grown in pots under glass in natural daylength at 16°C-29°C. Leafy stem cuttings 15 cms long, each having only one expanded leaf, were collected from the current season's growth of these plants in August. Immediately after collection, transverse sections were made through the stem of 25 cuttings and these were examined microscopically. The remaining cuttings were divided into two groups each group having 25 cuttings ; the bases of one group of cuttings were dipped into a 50% alcoholic solution of 3,000 ppm IBA for four seconds, while the cuttings of the other group were left untreated. Both groups were then placed on a heated mist bench for rooting at 25°C. Fifteen days later both groups of cuttings (untreated and treated with IBA) had started to root. Microscope sections were then made through the root-bearing base and the stem above, from both types of cuttings. For comparison, sections were also made from fresh cuttings collected from the original parent plants.

The sections were made with a hand microtome, stained with 1% aqueous phloroglucinol and mounted in glycerol after a brief colour development in concentrated hydrochloric acid. Selected sections were photographed under a Leitz photomicroscope, using Kodak Pan F film and printed in hard paper.

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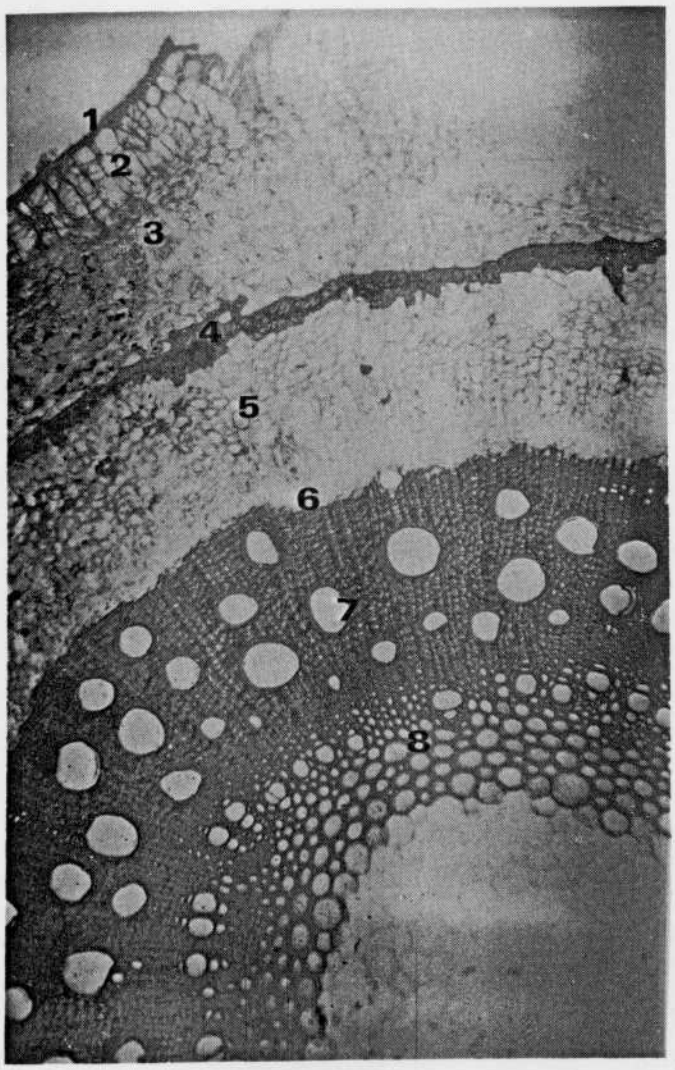

Figure 1 - Transverse section from unrooted stem cutting (Magnified x 35).
1. epidermis ; 2. cork ; 3. cortex ; 4. sclerenchyma ring ; 5. phloem ; 6. cambium ; 7. primary xylem ; 8. pith.

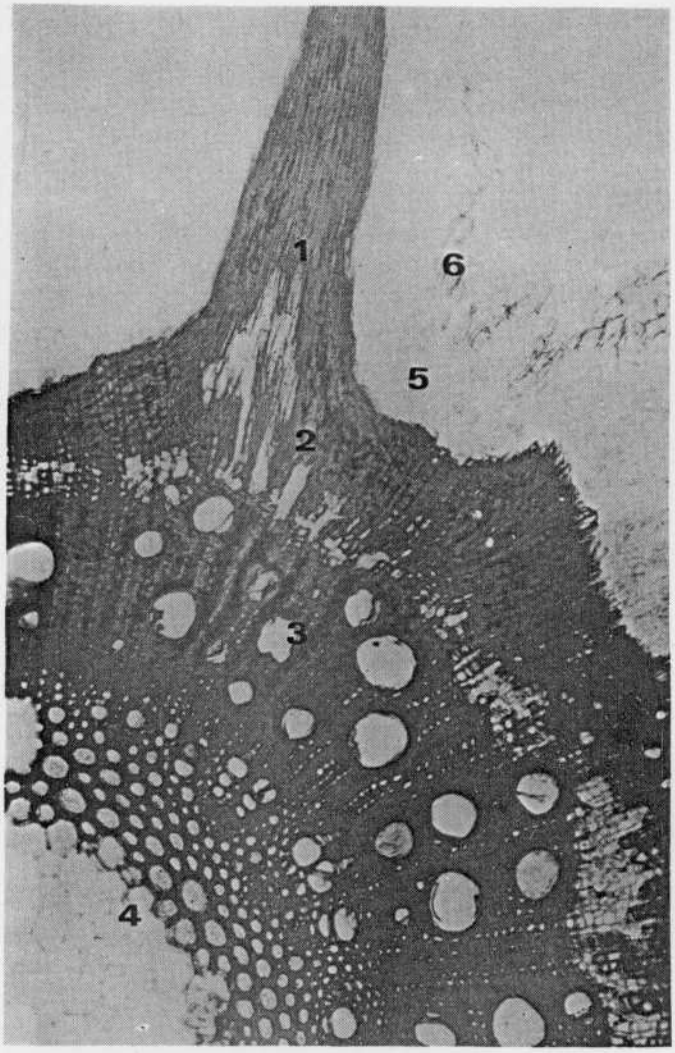

Figure 2 - Transverse section from rooted stem cutting showing the secondary xylem (Magnified x 35).
1. root ; 2. secondary xylem ; 3. primary xylem ; 4. pith ; 5. phloem ; 6. broken sclerenchyma ring.

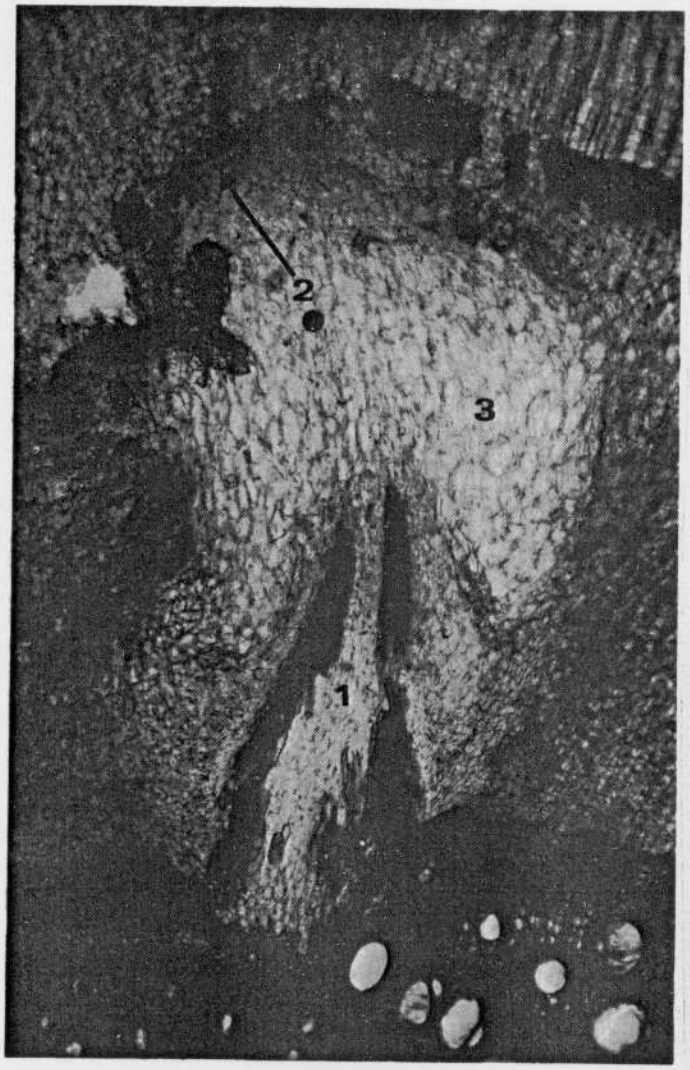

Figure 3 - Transverse section from rooted stem cutting showing root primordium (Magnified x 35)
1. root primordium ; 2. broken sclerenchyma ring ;
3. phloem.

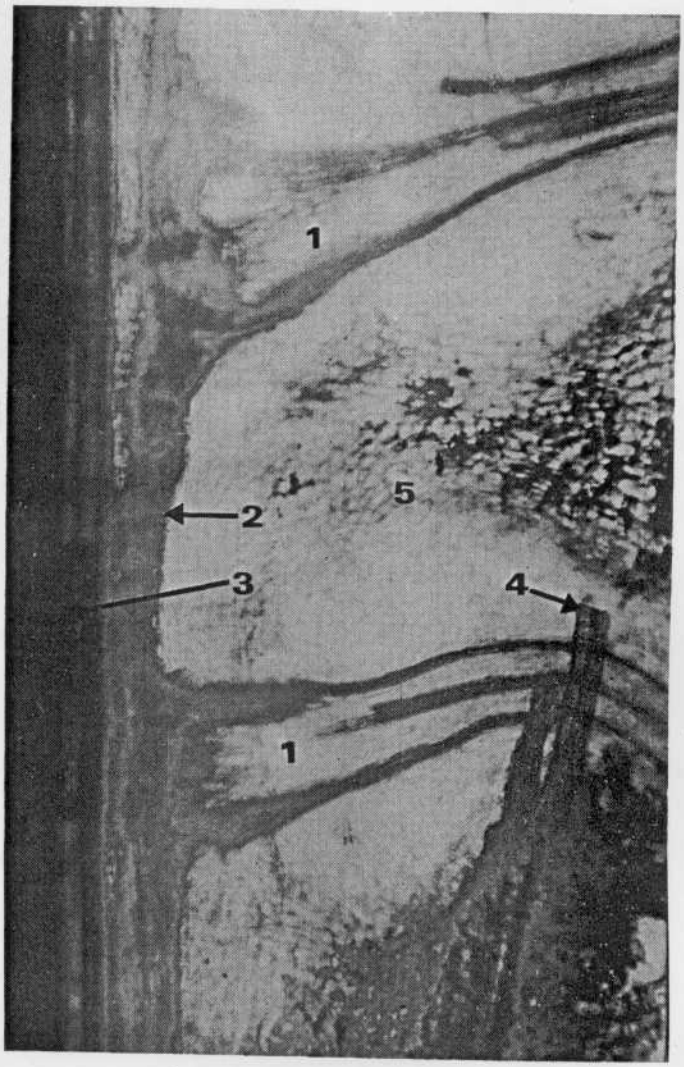

Figure 4 - Longitudinal section from rooted stem cutting (Magnified x 35) :
1. roots ; 2. secondary xylem ; 3. primary xylem ;
4. broken sclerenchyma ring , 5. phloem.

RESULTS AND DISCUSSION

The sections obtained from fresh cuttings either collected initially or fifteen days later were identical ; a typical such section is shown in figure 1 and eight tissues have been identified : - the epidermis consisting of a single layer of cells ; the cork consisting of thin-walled cells ; a multi-layered pericycle containing cortical tissus and a continuous but narrow ring of sclerenchyma ; the phloem which is devoid of sclerenchymatous elements ; the primary xylem with vessels of varying diameter tending to be in radial rows ; and the pith. No preformed root initials were ever observed in any of the numerous sections examined.

The stem sections obtained from rooted cuttings above the actual rooted bases were again identical to those obtained from freshly cut stems (figure 1). On the other hand the sections from the rooted part of stem had the appearance shown in figures 2, 3 and 4. The site of origin of root primordia was located in the cambial region as is seen in the figures. Unexpectedly, a new ring of xylem was seen to have formed outside the primary xylem, the thickness of which was varied, being thicker at the points where the roots originated. The roots commenced to grow by pushing through the phloem tissues, then rupturing the sclerenchyma ring and passing through the cortex. This could be either by a mechanical action or at least partly by biochemical processes. The bases of cuttings were noticeably swollen and the swelling seems at least partly related to the volume increase through formation of the secondary xylem ring.

Adventitious root initiation from the cambial region has been reported for many plants (HARTMAN and KESTER, 1975) but the formation of a distinct secondary xylem ring surrounding the primary xylem almost simultaneously with the root initiation i.e. two to three weeks after placing the cutting on the rooting bench, seems to be a very unusual feature. A new xylem ring is normaly formed in woody species after the resumption of cambial activity in the spring.

Exogenous applications of either IAA and/or GA3 are known to initiate cambial division in winder shoots of various arborescent angiosperms, but only IAA can promote the cambial derivatives to differentiate and produce xylem tissue (WAREING, 1958). It is well accepted that auxin (natural or applied exogenously) is a requirement for the initiation of adventitious roots in stems (HAISSING, 1972). In leafy stem cutting of kiwi, IBA treatment gave only slightly superior rooting compared with the untreated controls. It was shown earlier (LIONAKIS, 1981) that leafless kiwi cuttings could not be induced to root until after bud break and leaf formation and IBA treatment conferred no benefit ; by contrast, the presence of an entire leaf was very important for root formation and subsequently for survival of the cutting.

In single node cuttings of the rose, a leaf is vital for survival and root formation (JENSEN, 1975) ; the same has been reported for numerous other species (SEN and BOSE, 1967), where leaf cuttings contained more carbohydrates and nitrogenous compounds.

The beneficial effects of a leaf for the rooting and survival of the kiwi cuttings is likely to be due primarily to the synthesis of fresh carbohydrate, but secondarily it may also be a source of auxin and perhaps other substances stimulating cambial activity, xylem differentiation and root initiation.

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