Scion/Rootstock Tissue Development of the Apple as a Result of Asexual Propagation and Mechanical Injuries

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Tissue response, as a result of wounding in the graft union, affects the vigor of young trees. A poor graft union usually results from one or more of the following factors: (1) scion/rootstock incompatability; (2) climatic conditions in the nursery (such as drought or temperature stress) detrimental to the susceptible, developing parenchyma cells in the graft union; (3) poor propagating technique in the nursery; (4) improper handling of the young trees before planting; and adverse climatic regimes or exposure to poor nutrition immediately after planting.

Graft Union Conditions

When the tissue is wounded during the grafting process, immediate destruction of the exposed injured cells takes place. The greater the injury, the greater is the amount of necrotic or dead tissue that will develop in the wounded area.

In a poor graft union, the large areas of necrotic tissue that develop create an incompatible situation between the scion and the rootstock, even though they may be compatible under normal conditions.

Procedures of Graft Union Study

Examples of wound injury from a six-week old chip bud of a 'Delicious'/EMVII combination are shown in Figures 1 to 7. This material was collected and placed in distilled water and then quick-frozen for sectioning to 20 mu in thickness. The freezing microtome, 'Cryostat', was used throughout the study.

A longitudinal section in Fig. 1 illustrates the extensive area of the wound. The union of the vascular elements has a continuous cambium with little necrosis appearing. Mosse and Labern (1) list three main phases that can be distinguished in the subsequent establishment of the bud: (1) the establishment of callus, which surrounds the bud shield and holds it firmly in position; (2) the establishment of a continuous cambium between the bud and the rootstock, followed by the resumption of cambial activity in the bud; and (3) lignification of the callus and shortening of the cambial connections. These three phenomena are seen in the chip bud union of the young bud just initiating growth, as shown in Fig. 1. The arrows to A and B identify the apical and basal portions of this bud. As indicated by Mosse (1), the callus tissue (C) has developed almost entirely from the rootstock tissue, mainly from the exposed surface of the xylem cylinder, and to a lesser extent from the bark flap.

Very little callus development was noted on the sides of the bud. The bud shown in Fig. 1 was grown under greenhouse conditions, and growth resumed at a fairly fast rate, with the vascular elements being quickly connected. However, this same development could be delayed by adverse growing conditions in the field.

Meristematic activity (M) in the bud is shown in Fig. 1 at the basal part, and new layers of cambium will develop through the callus tissue in

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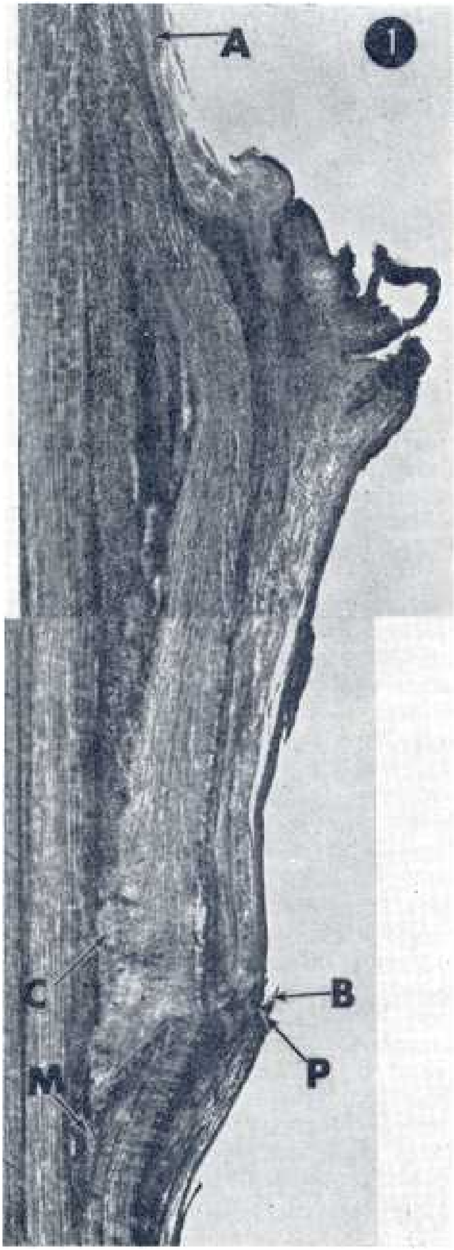


Fig. 1. A longitudinal section showing the development of a 'Red Delicious'/EM IX bud-union combination. 'A' and 'B' designate the apical and basal portion of the bud, respectively. C = callus tissue. M = meristematic activity. P = phellogen. (X 12.8).

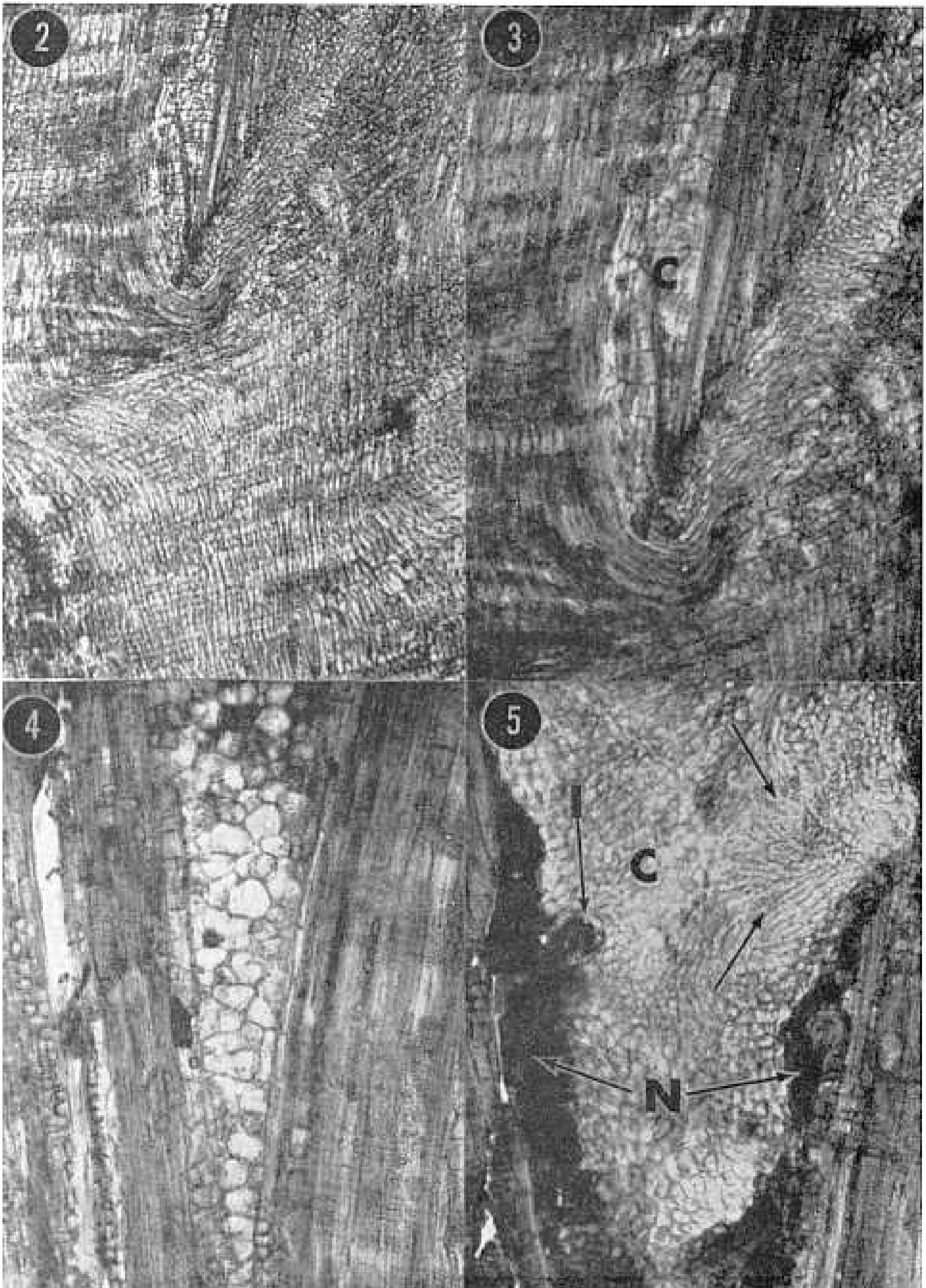
order to make the union complete. The areas of bud injury have been sealed off by phellogen tissues as indicated by (P). These isolated areas that have developed internal or external periderm will provide some protection against disease and against a rapid loss of moisture from the adjacent cells in the wounded area.

Graft Union Development

The extent of tissue development at the basal portion of the bud is unique in the combination of Delicious on EM IX. Figures 2 and 3 show the development of callus (C) at the basal portion of the bud, and the influence of wounding upon the adjacent tissues by the change of normal orientation to compensate for the growth around the basal portion of the wound. This stage of development indicates cambial activity that is intact between the scion and the rootstock. Also, callus tissue has developed extensively on the rootstock side of the union, with very little necrotic or dead tissue in evidence. Other sections through this same region reveal large quantities of callus tissue (C) at the basal part of the wound. This is shown in Figures 4 and 5.

No necrosis was present in the area shown in Figure 4, but some had developed adjacent to the callus tissue, as shown in Fig. 5 (N). This development would not be considered extreme compared to the difficulties which might arise under adverse conditions in an orchard. The particular union illustrated, should respond favorably to good growing conditions.

Fig. 5 also indicates the origin of considerable swirling of the tissue (marked with arrows). Mosse (1) describes these amphivasal nodules in which the xylem surrounds the phloem in a concentric vascular bundle. These nodules occurred in tissues derived from the xylem, and was found particularly in the rootstock of

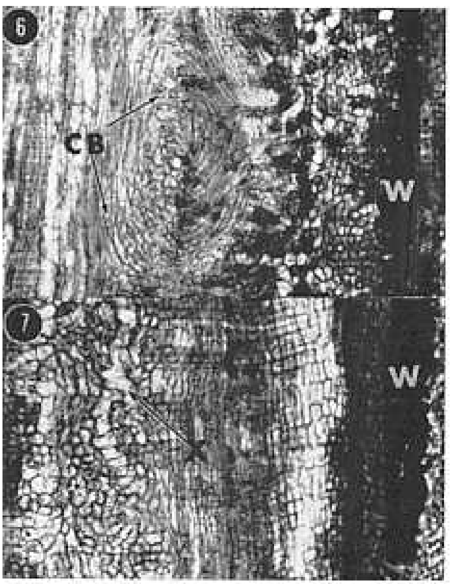


Figs. 2-5. Longitudinal sections of wound response within the bud union showing extreme development of adjacent tissues and the formation of callus which is essential to the union of the stock and scion. C = callus tissues; N = necrotic tissues. Fig. 2, X 63; 3, 4, 5, X 100.

EM VII. In an adversely affected union, necrotic inclusions (I) may form throughout the callus tissue as shown in Fig. 5.

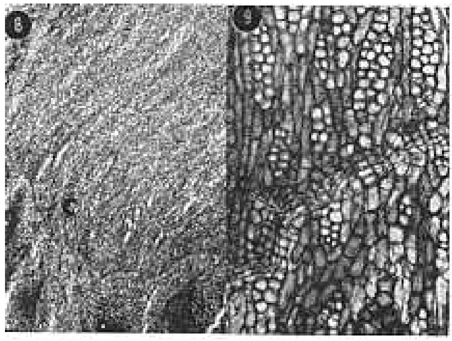
The development of concentric bundles is shown in Figures 6 and 7. These bundles (CB) originated adjacent to the wound mecrosis of this area. Under commercial production, a similar condition, but more extreme, could develop to a point where complete girdling of the tree would take place (2).

The arrows in Fig. 7 indicate changes of callus tissue into the first formed xylem elements (X). These will eventually orient around the wound (W), which is necrotic, and form vascular continuity with the plant.



Figs. 6-7. Longitudinal sections showing bud union tissue development adjacent to the wound. Necrotic tissue is present in the immediate wound area. New xylem tissues originates from the concentric bundles (CB).

Fig. 7 indicates the first tissues of xylem development (X). W = necrotic wound tissues. Both X 100.



Figs. 8-9. Tangential longitudinal sections of phloem from the graft-union area of a 3-year-old 'Golden Delicious'/EM IX tree showing meristematic activity of the scion tissue adjacent to the dying rootstock tissue. Area above the cambial line is scion tissue and that below the rootstock tissue which is dark in color. C = cambial development. Fig. 8, X 32; Fig. 9, X 128.

Graft Union Wounding Response

Another wound response of the phloem tissues is shown in Figures 8 and 9. This is tissue from a degenerating three-year-old Golden Delicious/ EM IX rootstock. Death of the rootstock has produced a new line of cambial development (C), cutting transversely across the live, functioning phloem of the 'Golden Delicious' scion, to form a wound periderm. This was a response to the dying of the rootstock tissues. It occurred in October, at the time of cessation of growth for that season. Several new layers of cambial activity in these phloem tissues will take place before eventual death of the tree. This would be a deterring factor in translocation. A more detailed discussion has been presented elsewhere concerning the development of phloem-wound tissues in this area (2).

In conclusion, the above discussion illustrates the vulnerability of the tissues involved in a developing graft union. Extreme care should be exercised in all phases of fruit tree propagation and orchard management, in order to insure normal, healthy cultivar/rootstock combinations. In many cases, these combinations have been blamed for failure, when the real cause was an oversight or poor technique in propagation or orchard management.

Literature Cited

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Peaches for Warm Climates

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Peaches that can fruit with very little winter cold have been available to the plant breeder for many years. Their fruit has been of very limited commercial value because of small size, soft flesh or other undesirable qualities. A breeding program to develop new low chilling peach varieties adapted to central Florida was initiated in 1952, after tests disclosed that varieties from other areas were not adapted. Numerous crosses were made, and some 20,000 seedlings were grown from 1952 to 1961. Only one variety was released from these selections. Another 20,000 seedlings have been tested for desirable fruit qualities and quite a large number of rootstock types since 1961.

No commercially satisfactory selections were obtained in the first two or three generations of breeding, because of poor fruit characteristics of the low-chilling-requiring parent plants. In subsequent generations, selections used in breeding have been closer to commercial quality, and a useful new variety can be expected from perhaps each 4000 seedlings.

Through 1969, nine peach and nectarine varieties adapted to Florida conditions have been released. Of these, six peach and one nectarine variety were released for central Florida trials, and one peach and one nectarine for north Florida. Emphasis on nectarine breeding has increased since 1965, and several promising selections are now under trial.

An ideal peach for fresh market should be firm, two inches or larger in diameter, with yellow flesh, capable of a week long shelf life, and with 70 percent or more attractive surface blush. It should also be freestone and, for Florida, needs to be adapted to local conditions, and early enough ripening to market before other peach areas. Present varieties represent some compromise of these desirable traits. Varieties considered most suitable for commercial use are discussed briefly below, and others, useful for home planting, are listed in Table 1.

'Flordared': This peach is adapted to south central Florida with a 100-hour chilling requirement. Is first ripe April 18 to May 1. It has a medium-firm, white flesh sprinkled with heavy red skin blush, and is freestone. Fruit size is mostly two inches and up. The bloom period is long, normally peaking by February 1. "Flordared" was released in 1970 by the Florida Agricultural Experiment Station (R. H. Sharpe).

'Early Amber': This variety is adapted to central Florida, requiring