Literature Cited

1. Bartram, R. D., K. L. Olsen and M. W. Williams. 1971. Influence of summer applications of succinic acid-2,2-dimethylhydrazide on firmness of Delicious apples in storage. *HortScience* 6:240-241.
2. Batjer, L. P., Max W. Williams and George C. Martin. 1966. Effects of N-dimethyl amino succinamic acid (Alar) on watercore and harvest drop of apples. *Proc. Amer. Soc. Hort. Sci.* 88:76-79.
3. Edgerton, L. J. and G. D. Blanpied. 1970. Interaction of succinic acid 2,2-dimethyhydrazide, 2-chloroethyphosphoric acid and auxins on maturity, quality, and abscission of apples. *J. Amer. Soc. Hort. Sci.* 95:664-666.
4. Greene, D. W. and W. J. Lord. 1975. Influence of light and spray coverage on red color development of ethephon-treated McIntosh apples. *HortScience* 10:254-255.
5. Hammett, L. K. 1976. Ethephon influence on storage quality of Starkrimson Delicious and Golden Delicious apples. *HortScience* 11:57-59.
6. Southwick, F. W., I. E. Demoranville and J. F. Andrews. 1953. The influence of some growth regulating substances on preharvest drop, color, and maturity of apples. *Proc. Amer. Soc. Hort. Sci.* 61:155-162.
7. Unrath, C. R. 1972. Effects of preharvest applications of ethephon on maturity and quality of several apple cultivars. *HortScience* 7:77-79.

Abscission Development in the Floral Tube of Peach (*Prunus persica* L.)

Roy K. Simons and Mel C. Chu[1, 2]

Abstract

Abscission of the floral tube progresses in successive stages that encompass large areas from the distal to the proximal portion of the break. Carbohydrates accumulate in the phloem at the basal portion where the fruit is attached to the pedicel. Carbohydrate depletion was found distally to the abscission zone. Xylem tissues were the last to abscise and the point of origin of abscission was the adaxial surface of the floral cup. Understanding these stages of development should assist fruit growers in regulating their cultural practices for economic production of fruit.

Abscission of peach floral parts has been investigated (6, 7) in an effort to characterize stages of development. The morphological stages of abscission have been listed as: 1) differentiation for an abscission zone, 2) abscission zone in Stage I, 3) abscission zone in Stage II, 4) separation, and 5) healing (6). Separation of the cells in abscission is not a senescence process, but some cellular progress toward the senescent state is apparently prerequisite for abscission (2). Abscission of maturing sweet cherry fruit (*Prunus avium* L. cv. Windsor) occurred at 2 different locations, depending on the stage of fruit development (9).

A study on leaf abscission in *Phaseolus* (8) found 4 sequential stages which culminate in separation and that are distinct in the laminar abscission region. These include: 1) pith-cell breakdown, which may not be related to abscission; 2) cell division; 3) cellular differentiation; and, 4) cortical and vascular cell breakdown.

Shedding always occurs in the same general abscission zone in the cotton plant, although the actual pathway of separation may vary within this zone and seldom can be predicted (3).

This research report describes the progress of abscission in the floral-cup of peach. Also, sequential abscission development is characterized in the floral organ.

[1]Department of Horticulture, Unicersity of Illinois, Urbana, Illinois 61801.

[2]The authors acknowledge support of the Illinois Agricultural Experiment Station and the Center for Electron Microscopy of the University of Illinois, Urbana, Illinois.

Materials and Methods

Peach blossoms were collected shortly after anthesis (Stage II) from trees having a uniform bloom. Samples were preserved in 50% ethyl alcohol and subsequently dehydrated to absolute alcohol.

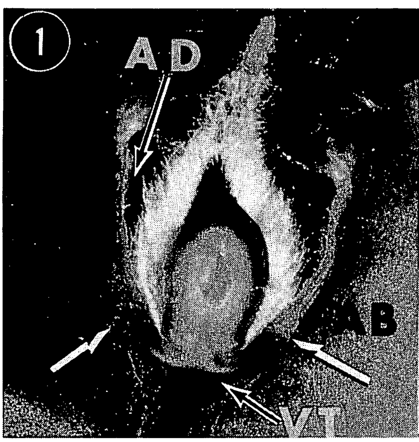
Preparation for scanning electron microscopy (SEM) followed the critical point procedure (1, 4). Observations were made with a Cambridge Stereoscan Mark II microscope.

Longitudinal sections for light microscopy were made utilizing the microtome "Cryostat" and were stained with Periodic-Acid-Schiff's reagent (PAS) for determination of carbohydrate localization within the fruit and associated floral parts (5). Iodine-potassium-iodine (IKI) was used for starch determinations (5).

Results and Discussion

Floral Tube morphology — abaxial surface in relation to abscission—The abaxial surface is illustrated by scanning micrographs (Fig. 3-9). Characteristic stages of development visible by light microscopy at the beginning of petal-fall (Stage II) have been previously outlined (7). Progressive development of abscission within reproductive structures is rapid, with growth interrelationships occurring between varied floral organs such as the stigma, style and ovary (Fig. 1, 10, 13). Remnants of bud scales that have previously abscised at the basal portion of the fruit bud are shown in Fig. 2.

The floral tube at a more advanced stage of development shows breaks in different areas (Fig. 3). Growth



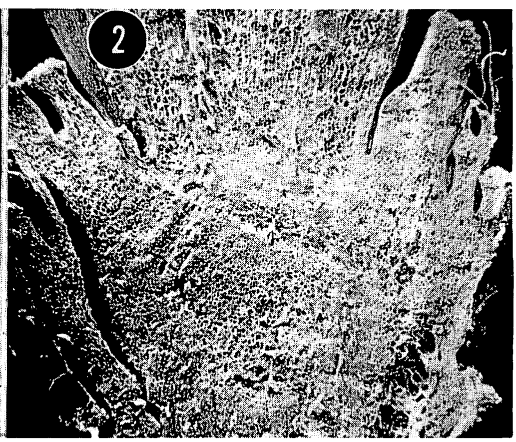
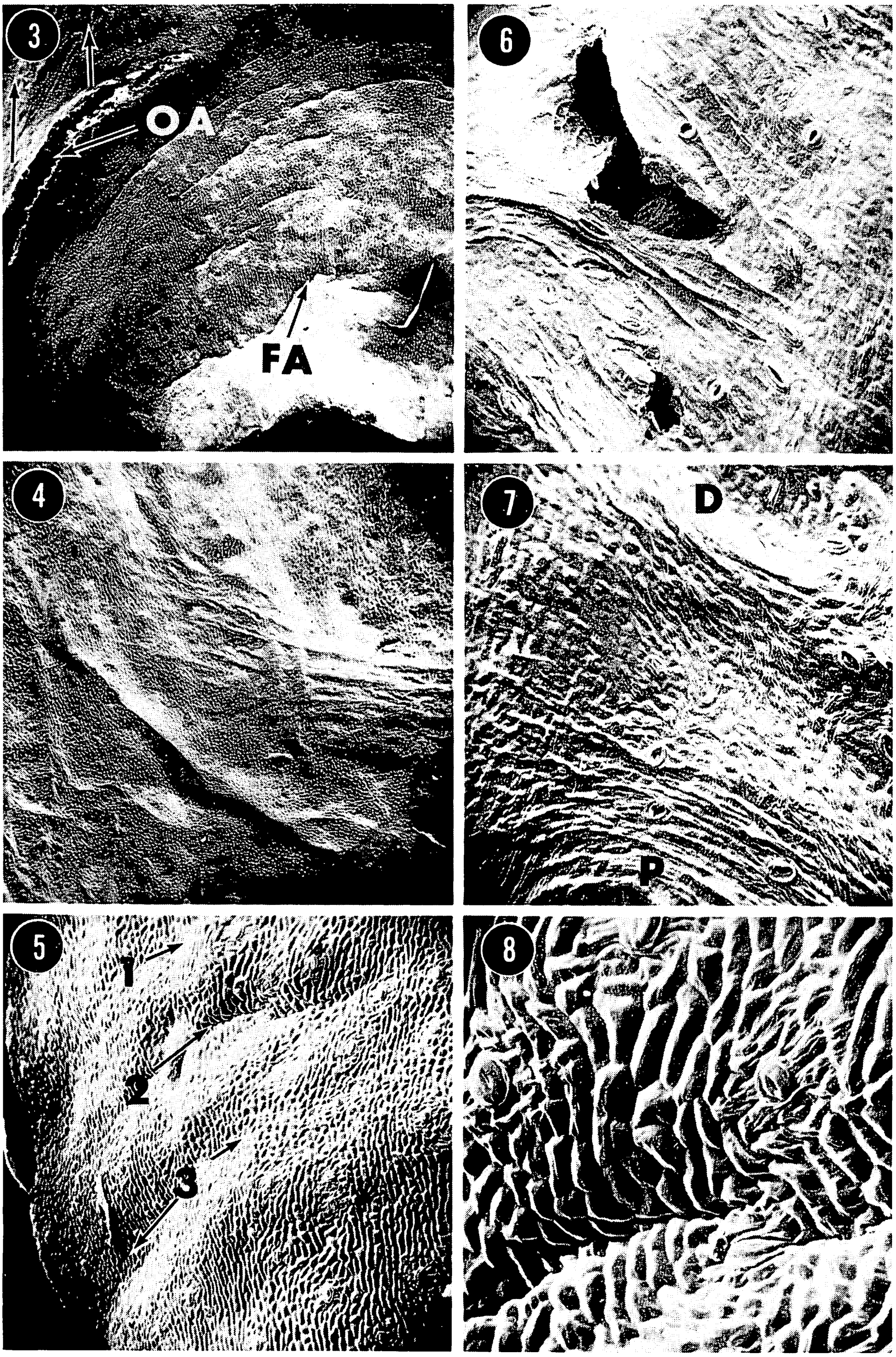


Fig. 1-2. Fig. 1, longitudinal sect of developing peach (Stage II), highly pubescent, with Abscission occurring in floral tube (arrows). Abaxial AB and Adaxial AD surfaces of the floral tube are indicated. Note vascular tissue (VT) leading to the basal portion of the fruit. Fig. 2 indicates remnants of bud scales from the proximal portion of the fruit bud. Fig. 1, X3; Fig. 2, X14.

⟶

Fig. 3-8. Abaxial epidermal surface development in relation to abscission of the floral tube. Fig. 3, original abscission break and the final abscission break showing large surface areas being affected. Fig. 4, surface morphology indicating abscission initiation. Fig. 5, distal and proximal surfaces with areas 1 being (distal), 2 (intermediate) and 3 (proximal) to abscission. Fig. 6, tissue degeneration of the floral tube with distal and proximal areas adjacent to abscission. Fig. 7, distal and proximal development contiguous to abscission. Fig. 8, cellular orientation within the area of abscission activity showing the distal and proximal sides. OA = original abscission; FA = final abscission; D = distal; P = proximal. Fig. 3, X97; 4, X39; 5, X92; 6, 7, X178; 8, X333.


3
OA
FA
6
4
7
D
P
5
1
2
3
8

ceased in the distal portion (arrows) where tissues would have continued to separate between the original site on the floral tube and final abscission on the proximal end of the floral cup. Abscission development resulted in a break in the floral cup on the abaxial surface (Fig. 4). It was contiguous to tissues where crushed epidermal cells appear as a result of cessation of growth in sequence to the concurrent increase in fruit growth. The epidermis had degenerated in the abscission area. Stomates were abnormally small, and the surrounding epidermal tissue was shrivelled, with a swirling formation resulting in disorientation from the distal to the proximal end of the floral tube. Growth ceased in the distal portion and it will abscise in relation to increased fruit growth.

External cellular morphology of the abscission break (Fig. 5, No. 2, arrow) is shown in greater magnification in Fig. 8, with the proximal portion of the floral tube indicated. Tissue comprising this area was similar in different peach cvs. and there were at least 3 abscission zones evident. Arrow 1 in Fig. 5 shows the distal zone with tissue separation continuing proximally (arrows 2, 3). Througout contiguous tissues of the break (Fig. 8), guard cells and subtending tissues have been changed in orientation, with subsequent collapse of adjacent cells. Initial tissue separation produced small cells in the line of abscission and small, shrinking cells appeared on the distal side.

Cellular surface growth disruptions (Fig. 6, 7) are found in the distal portion of the break (top, Fig. 6) and the extreme proximal area (bottom, Fig. 7). The abscission region lies between. Distally, disintegration and rupture of the epidermal tissue was evident in that stomates were distorted in size and shape and eventually the guard cells collapsed. Stretching and growth compensation of these tissues in the area proximal to the abscission zone had swirled to a 45° angle from the normal pattern of growth. Stomates on the distal portion were closed, distorted and collapsed (Fig. 7).

The abaxial surface of the floral tube showing the line of abscission (arrow) is shown in Fig. 9. Initiation of abscission is evidenced by a yellowish-green region around the circumference of the floral-cup base. Small cracks, a slight growth depression of the abscission zone and lack of pubescence are characteristic of the abaxial surface.

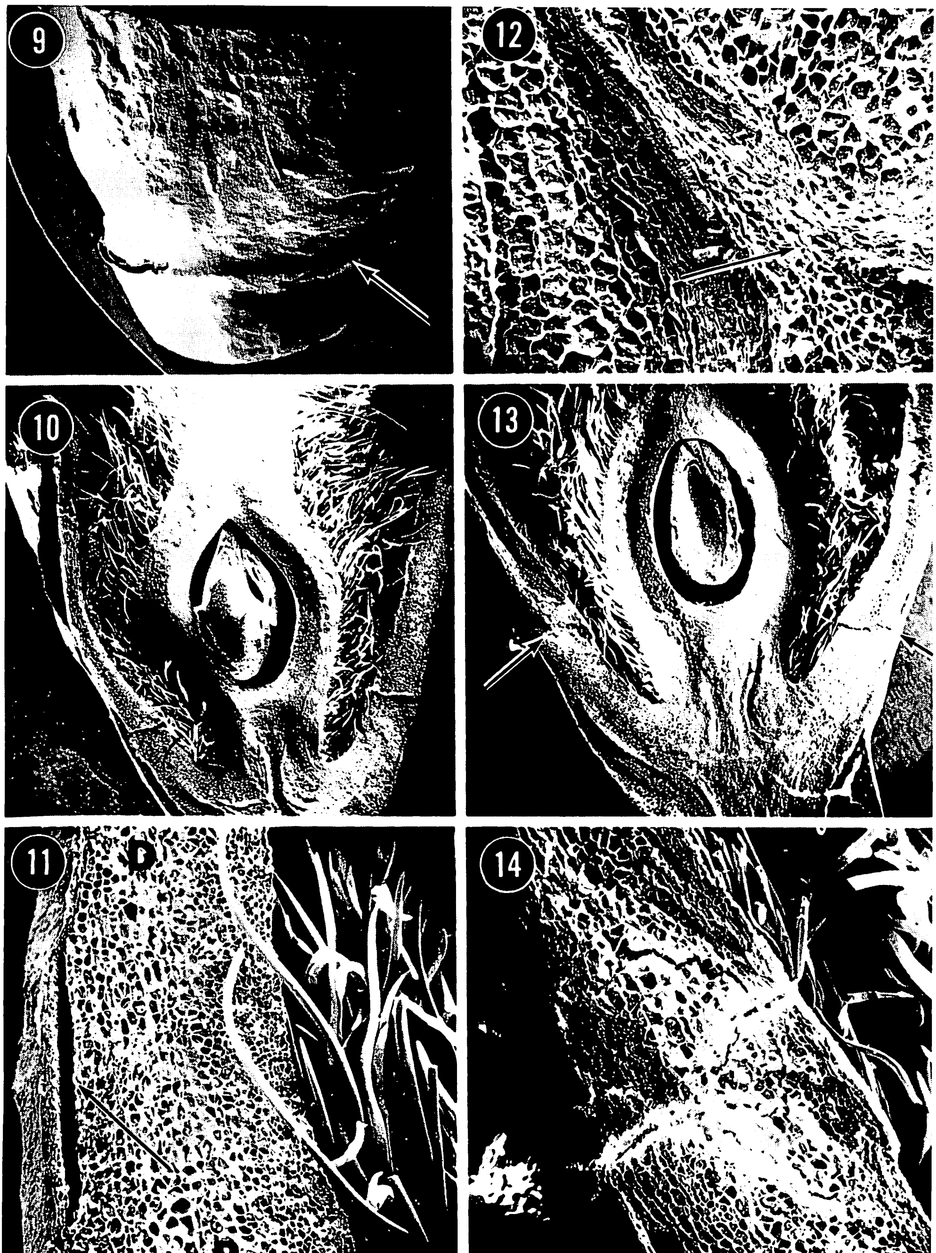
The PAS reagent stained intensely, indicating localization of carbohydrates in the phloem at the basal portion of the fruit where it is attached to the stem apex (Fig. 18). Slight reaction occurs distal to the break. Cells containing carbohydrates and starch were contiguous to the cells with yellowish-orange pigmentation (Fig. 10, 13). Carbohydrates were localized proximal to the break.

A longitudinal break on the distal side of abscission (abaxial surface) is illustrated (arrow, Fig. 11). Tissue at this point was normal and cell divisions occurred at the proximal end of tissue separation.

Supportive tissue at the base of the floral cup had vascular branching at the apex of the fruit pedicel (Fig. 12).

→

Fig. 9-14. Abscission in floral tube and cup development. Fig. 9, abscission development on the abaxial surface (arrow). Fig. 10, longi.-sect. through the fruit and floral cup base showing abscission development. Fig. 11, longi-sect. through the floral cup base showing distal development (D) and the proximal (P) area where abscission will develop. Fig. 12, vascular branching at the basal portion of the floral cup (arrow). Fig. 13, longi-sect, through the fruit showing abscission in the floral cup (arrows) and at the juncture between the stem apex and the fruit. Fig. 14, extensive development of abscission showing distal and proximal portions of the break. Fig. 9, X77; 10, X17; 11, 12, X87; 13, X16; 14, X93.


9
12
10
13
11
14

The tissue was proximal to the point where abscission of the floral tube normally occurs. Carbohydrates were localized in these vascular tissues.

Abscission of the floral tube (Fig. 13) progresses from the upper left portion to the more proximal portion of the floral tube (Fig. 14). The concurrent cessation of growth on the distal portion, away from the abscission zone, indicates that a large area of tissues has been affected by the initiation of abscission. It is a continuing process that covers a definite area before the cessation of cell division in the proximal portion of the break. The upper right of Fig. 13 shows the distal, disorganized portion of the floral tube in relation to the eventual abscission break. It was initiated on the adaxial side, occurring at right angles to the original abscission, with the abaxial surface remaining intact.

Abscission progressing from the adaxial surface (Fig. 15) had perpendicular splitting proximal to the break, with vascular tissues being last to separate. Another example of separation in which abscission is almost completed, with tissue development on the distal side and the extent of wound regenerative tissue on the proximal side, is indicated by arrow, Fig. 16. Continuing proximally to the floral tube base (Fig. 17), abscission has developed into the vascular strands at the base of the fruit, thus indicating ultimate abscission of the fruit at the stem apex of the fruit pedicel.

Vascular bundle branching at the stem apex is shown where it is connected with the basal portion of the young fruit (Fig. 18). Abscission, occurring across the outer periderm and cutting into the vascular tissues, terminates the abscission process of the young fruitlet. The tissues in the vascular-bundle region are indicated by arrow (Fig. 18, enlarged in Fig. 19, 20). Cellular degradation and breakage have progressed across the vascular bundle (xylem) in periclinal and anticlinal planes. Contiguous cell divisions were indicated by small, compact cells in the abscission zone (Fig. 19). Abscising tissue on the stem apex shows that xylem became necrotic on the distal side of the break, and is the last tissue to separate in the abscission process. Phloem in this area was located at right of the xylem strand.

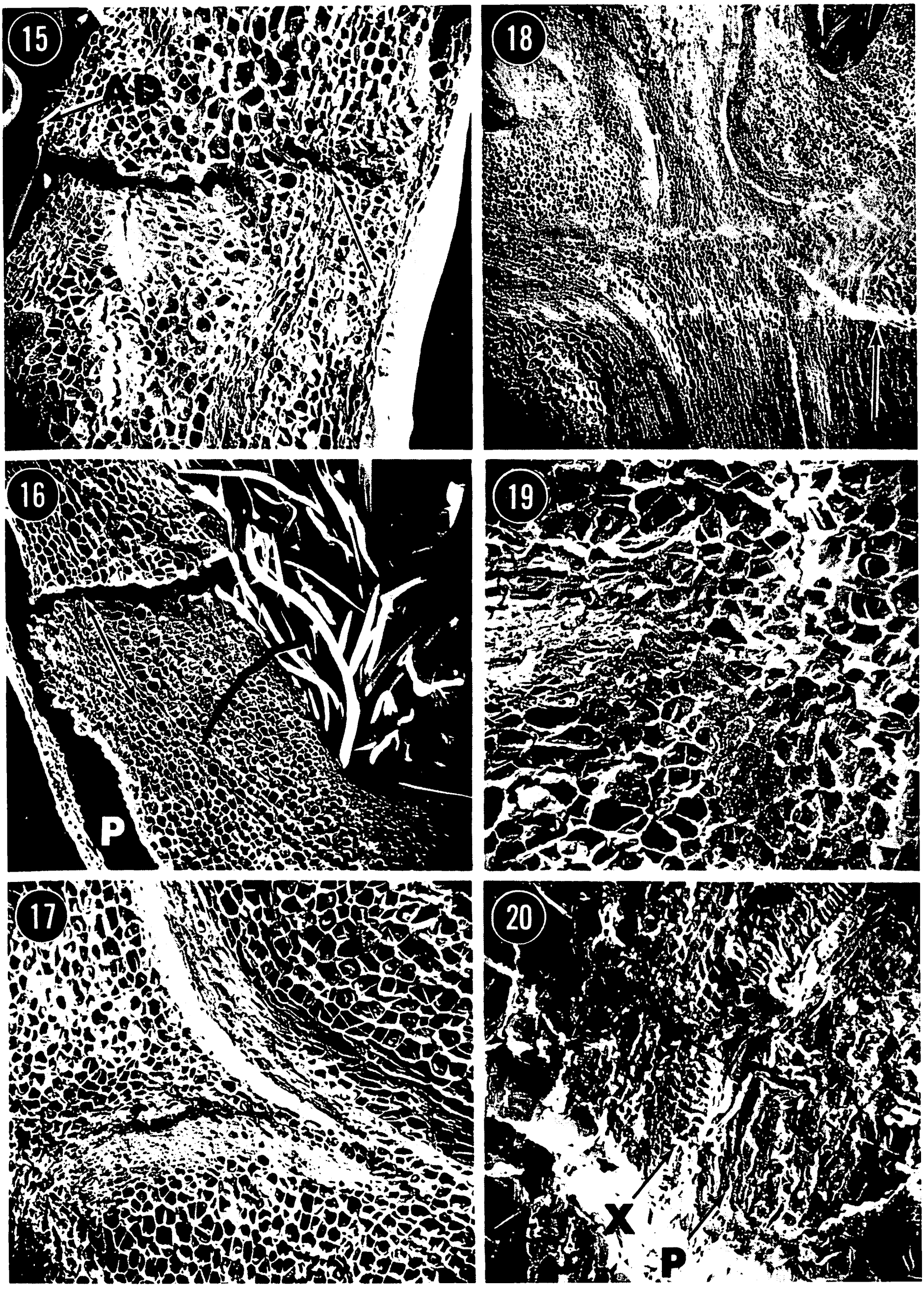
Xylem tissues were the last to break in abscission, with separation almost complete at the upper left of the floral tube. The point of origin of abscission was on the adaxial surface and agrees with previous findings (7). The abscising floral cup had only remnants of pubescence in various degrees of senescence covering an epi-cuticular mass.

Abscission of the distal and proximal portion of the xylem tissue in the floral tube indicates that many areas are integrated in abscission. Carbohydrates accumulate in the immediate proximal area of the break, are depleted in the distal portion and localized in the stem apex where the fruit was attached.

The progression of abscission development encompasses large areas of

→

Fig. 15-20. Floral cup and fruit abscission. Fig. 15, abscission zone area showing advanced development on the adaxial (AD) side of the floral cup with concurrent longitudinal splitting on the proximal side of the break. Vascular tissues (arrow) were the last to abscise. Fig. 16, longi-sect. through floral cup base (advanced Stage II in development). The proximal portion (P) of Fig. 16 is illustrated in Fig. 17, with abscission developing across the vascular bundle. Fig. 18, longi-sect. through basal portion of the fruit showing abscission partially developed (arrow). The enlargement of this area is shown in Fig. 19 and Fig. 20 (X, xylem; P, Phloem). Fig. 15, X122; 16, X87; 17, X110; 18, X46; 19, X275; 20, X475.


15
AB
16
P
17
18
19
20
X
P

tissues. The successive stages of abscission illustrated by SEM provide more precise knowledge of fruit growth, more specific timing of development from blossom at anthesis and subsequent growth of the young fruitlet.

Literature Cited

1. Anderson, T. F. 1951. Techniques for the preservation of three dimensional structures in preparing specimens for the electron microscope. *Trans. N. Y. Acad. Sci.* 13:130-133.
2. dela Fuente, R. K. and A. C. Leopold. 1968. Senescence processes in leaf abscission. *Symposium on leaf abscission, Dept. of Army, Fort Detrick, MD.*
3. Hall, W. C. 1958. Physiology and biochemistry of abscission in the cotton plant. *Texas Agr. Exp. Sta. Bul.* 3:23. 285 p.
4. Horridge, G. A. and S. L. Tamm. 1969. Critical point drying for scanning electron microscopic study of ciliary motion. *Science* 163:817-818.
5. Jensen, W. A. 1962. Botanical histochemistry. W. H. Freeman and Co., San Francisco and London.
6. Leopold, A. C. 1971. Physiological processes involved in abscission. *HortScience* 6:376-378.
7. Lott, R. V. and R. K. Simons. 1964. Floral tube and style abscission in the peach and their use as physiological reference points. *Proc. Amer. Soc. Hort. Sci.* 85:141-153.
8. Webster, B. D. 1970. A morphological study of leaf abscission in *Phacolus.* Amer. J. Bot. 57:443-451.
9. Wittenbach, V. A. and M. J. Bukovac. 1972. An anatomical and histochemical study of abscission in maturing sweet cherry fruit. *J. Amer. Soc. Hort. Sci.* 97:214-219.

American Hybrid Grape Cultivars in Australia

A. J. ANTCLIFF[1]

About ten years ago a planting of American hybrid grape cultivars was started at the Merbein field station of the CSIRO Division of Horticultural Research. Merbein is a semi-arid irrigation area of the Murray Valley in north-west Victoria, Australia. Mean maximum temperature during the hottest months is about 32°C and the relative humidity is low. Soils are highly alkaline and the soil type supporting the planting, Coomealla sandy loam (2), has a brown sandy loam above a light brown sandy clay subsoil containing moderate amounts of lime and rubble. Soils of this kind are widespread in the area.

Such conditions might not be expected to favor American hybrid grapes. The growth of the cultivars planted is shown in Table 1. Only three vines of each cultivar were planted and yield in American hybrids is, of course, very much influenced by cultural practices (5). Under the somewhat restrictive practices used at Merbein, Canada Muscat, Himrod and Romulus yielded at the rate of about 10-12 kg m^{-2}.

The cultivars in each group in Table 1 are listed in approximate order of vigor. Those listed as very weak barely survived and in six years did not develop far enough to produce any fruit. The poorer cultivars in the weak group produced very little fruit, and even on the better cultivars in this group the fruit suffered from excessive exposure to direct sunlight because of the sparse cover of foliage. Lime-induced chlorosis commonly occurred.

The use of a vigorous rootstock appeared to be a possible way of overcoming these problems. Dogridge (V. champini), which is noted for the

[1]CSIRO Division of Horticultural Research, Merbein, Victoria, 3505, Australia.