Peach Tree Response to Fluctuating Temperatures

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Abstract

All peach cultivars exhibited serious shoot, scaffold branch and trunk injury when exposed to low and fluctuating temperatures during the test winter of 1981-82. The potential 1982 crop was destroyed, and the fruit size and quality of the 1983 crop were adversely affected.

Fluctuating high and low temperatures occurred throughout the peach growing regions of Southern Illinois during November-December of 1981 and January-February of 1982. The fluctuations were so severe that tree injury and fruit losses of that winter will determine the locations and profitability of present and future peach producing areas.

All fruit buds in the State of Illinois were killed in this test winter of 1981-82. Ontario, Canada, reported an average bud mortality of peaches and nectarines ranging from 64.9 to 82.2% (and that the average injury to the shoot xylem was moderate to high) (5). Virginia also reported less than 100% bud kill (6).

This report records the effects of low and fluctuating temperature injury upon peaches growing in Southern Illinois during the "test winter" of 1981-82.

Temperature variations

Temperature extremes were from 72°F (22.2°C) on November 28, 1981, and 66°F (18.9°C) on December 7 to 1°F (−17.2°C), 0°F (−17.8°C) and 2°F (−16.7°C) on three consecutive days, December 18, 19, and 20. Fluctuations began, with 60°F (15.6°C) being the highest on January 6, 1982. Four days after the warm 60°F, the temperature again dropped [to −13°F (−25°C)]. This cold period extended over a period of seven days during which it dropped to −21°F (−29.4°C) in one area.

Materials and Methods

Current season shoots originating from the vegetative buds of the larger scaffold and lateral branches were collected to study the injury and regenerative development of the vascular system.

They were placed in distilled water, frozen in a freeze-dry condition, and sectioned on a freezing microtome at 20μ (at a temperature of −10°C). The stains utilized were safranin and fast green according to Johansen (4) and adapted for use on fresh material (7, 8, 9). The injured tissues readily stained with safranin and the meristematic tissues by fast green.

Permanent slides were made of the longitudinal and cross sections and photographed with a Zeiss photomicroscope.

Field observations

Bark and wood damage occurred to the scaffold branches and trunks when temperatures reached the lower levels. In areas of Southern Illinois where the temperature was not lower than −13° F (−25°C) no tree loss was observed, but shoot damage was prevalent. In many one- and two-year old orchards, severe browning of the sapwood occurred, but new growth in 1982 was normal and vigorous. Older trees, and those with low vigor, made poor growth and produced small amounts of new wood. Winter injury and low fertility levels contributed to this reduction in growth. Weak, mature trees also showed browning of the sapwood and did not regain vigor throughout the summer. In contrast, mature trees with excellent vigor

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showed potential for continued growth and production.

A record of the peach injury by cultivar in producing areas of Illinois is recorded in Table 1.

Table 1. Serious injury observed on peaches, Illinois.

County	Cultivars	Age (yr.)
Adams	Reliance, Harmony	6
Adams	Redhaven, Loring	3, 10
Bond	Sunbright	8
Bond	Redhaven, Redskin, Harmony	3, 9
Calhoun	Redkist, Cresthaven	10
Calhoun	J. H. Hale	6
Jersey	Velvet, Redhaven, Earliglo	3, 6
St. Clair	Loring, Harmony	1, 2
	Redskin, Cresthaven	8
Monroe	Redhaven	4

Peach trees generally survived the freeze except for isolated instances of juvenility, vigor and site location. For example, a 4-year old cultivated vigorous Redhaven orchard was trunk killed in contrast to the survival of weaker trees of the same age growing in sod.

Trunk splitting occurred in 2% of 1200 trees (1-year-old Loring) as contrasted to 8% of 1000 Harmony trees of the same age. The remaining trees grew well in 1982 and produced a vigorous layer of new wood over the injured heartwood.

Microscopic observations of shoot damage

Figures 1, 2, and 3 show a cross section at the base of a Redskin shoot (May 28, 1982) in the initial stages of growth from the basal portion of the previous year's shoot. The apical end of the shoot was dead or dying.

The 1981 xylem growth (X^2) is compared with that of the 1982 (X'), showing its failure to develop after injury (Fig. 1, 2). The heartwood (X^2) was damaged after exposure to −29.4°C on February 10, 1982 (1). Esau (2) describes the functional phloem as the plant part in which the sieve elements are actively conducting food near the cambium. The functional phloem (FP, Fig. 1, 2) has been destroyed in these young shoots.

The increased vigorous growth of the bud initial was apparent (BI, Fig. 3) originating from the pith and protruding through the first year's xylem. These shoots developed with intense vigor during the growing season of 1982. This was the bearing wood for the 1983 crop, dependent upon the inherent vigor of the tree. The meristematic tissue (including the cambium) responded with extreme rapidity in growth.

An example of complete disintegration of the active, functioning phloem of the Redskin shoot tip is illustrated in Fig. 4-6. This includes breakage, distortion and killing of the phloem-ray cells (PRC, Fig. 4, 5) in which all the active, functioning phloem extended through the cambium and into the wood. The injury was so extreme that shoot dieback occurred to the scaffold branches, forcing lateral growth from the bud initials at the shoot base. However, heartwood damage still persisted and could prove to be a breakage problem when the tree bore fruit. Cambial tissues had been completely killed (C, Fig. 6). The adjacent phloem (PRC) and xylem (X) tissues of the 1981 growth were completely killed throughout parts of each tree.

Fig. 7-9 are cross-sections of a basal portion of an injured Redskin shoot (exposed to −13°F (−25°C). They show how terminal shoots of a vigorously growing tree (that had been injured) responded when growth resumed. The functional phloem had been killed, but the regenerative growth at the basal portion (that had been partially injured) was developing at a fast rate, indicating that the tree had suffi-

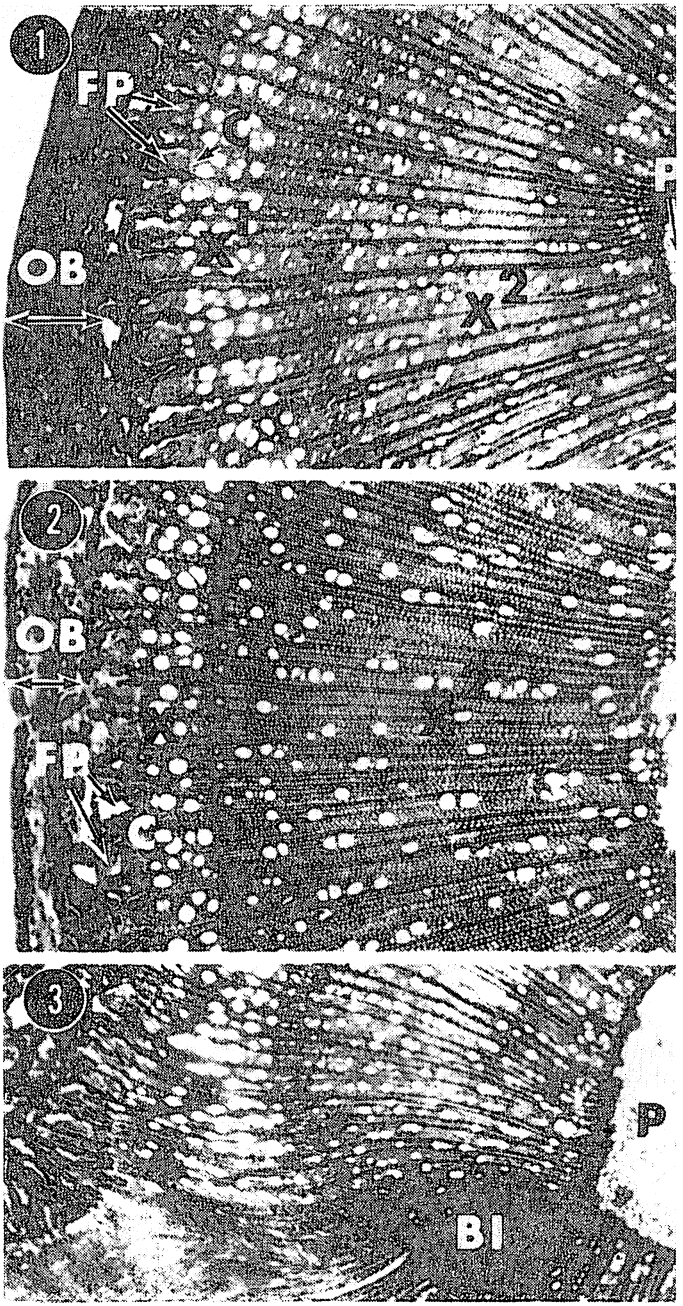

Fig. 1-3. Cross-section of the basal portion of a dying Redskin shoot, showing initiation of a lateral shoot (Fig. 3) on 5-28-82. Outer bark or non-functioning phloem (OB); Functioning phloem (FP); Vascular cambium (C); New xylem (X^1); older xylem (X^2); Pith (P). Fig. 1, X 25; Fig. 2, X 40; Fig. 3, X 65.

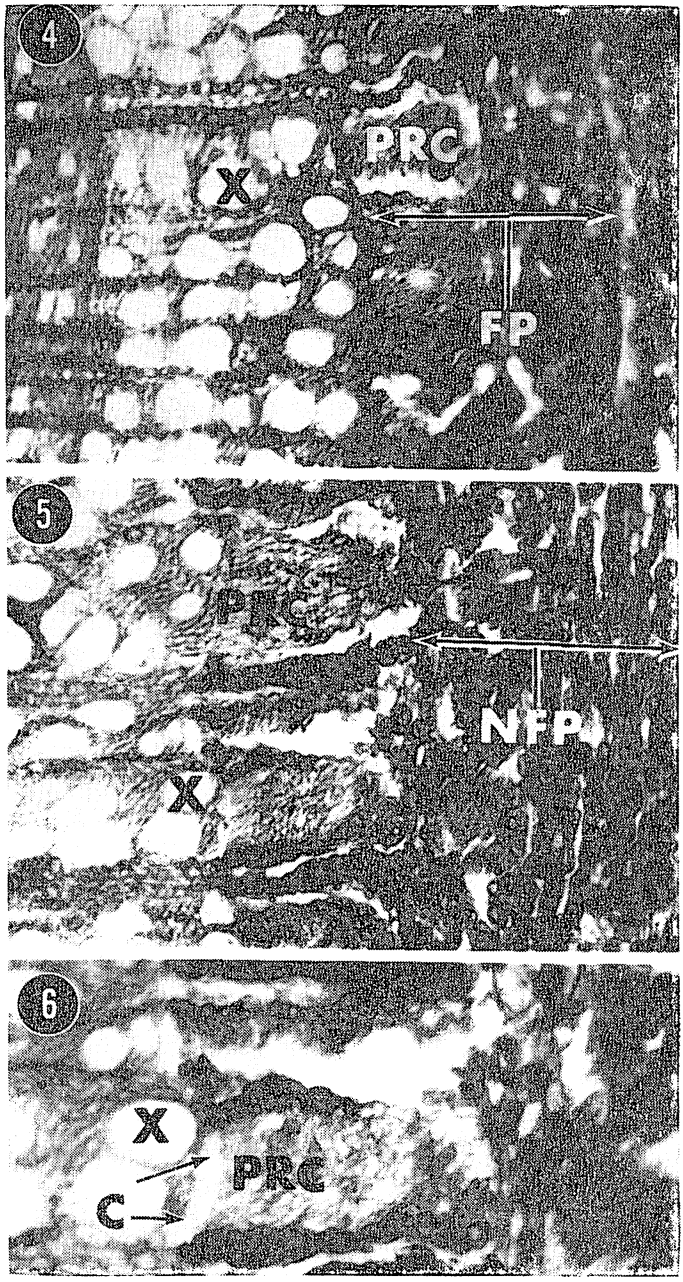

Fig. 4-6. Cross section of a severely injured Redskin shoot tip, showing complete disintegration of the functioning (FP) and nonfunctioning phloem (NFP), with accompanying breaks throughout the cambial tissues, extending into the secondary xylem (X). Fig. 5 shows dying phloem ray cells (PRC) and resulting disruption into the phloem fibers (PF). Fig. 4, X 160; Fig. 5, 6, X 40.

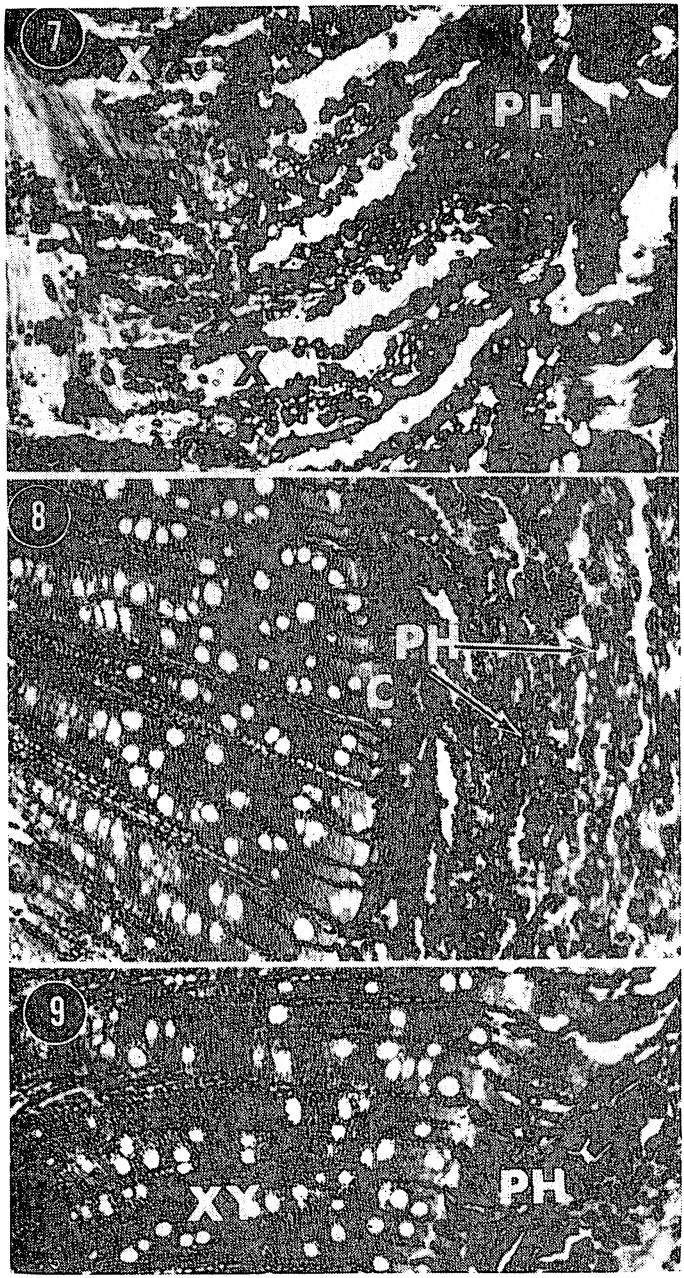

Fig. 7-9. Transverse section of a basal portion of a Redskin shoot showing phloem, cambium and xylem injury. Fig. 7. Phloem disrupted into the outer bark. Fig. 8. Phloem, cambium and xylem rays killed; Fig. 9. Xylem and phloem rays are necrotic. Phloem (PH); Cambium (C); Xylem (XY). Figs. 7, 9, X 160; Fig. 8, X 320.

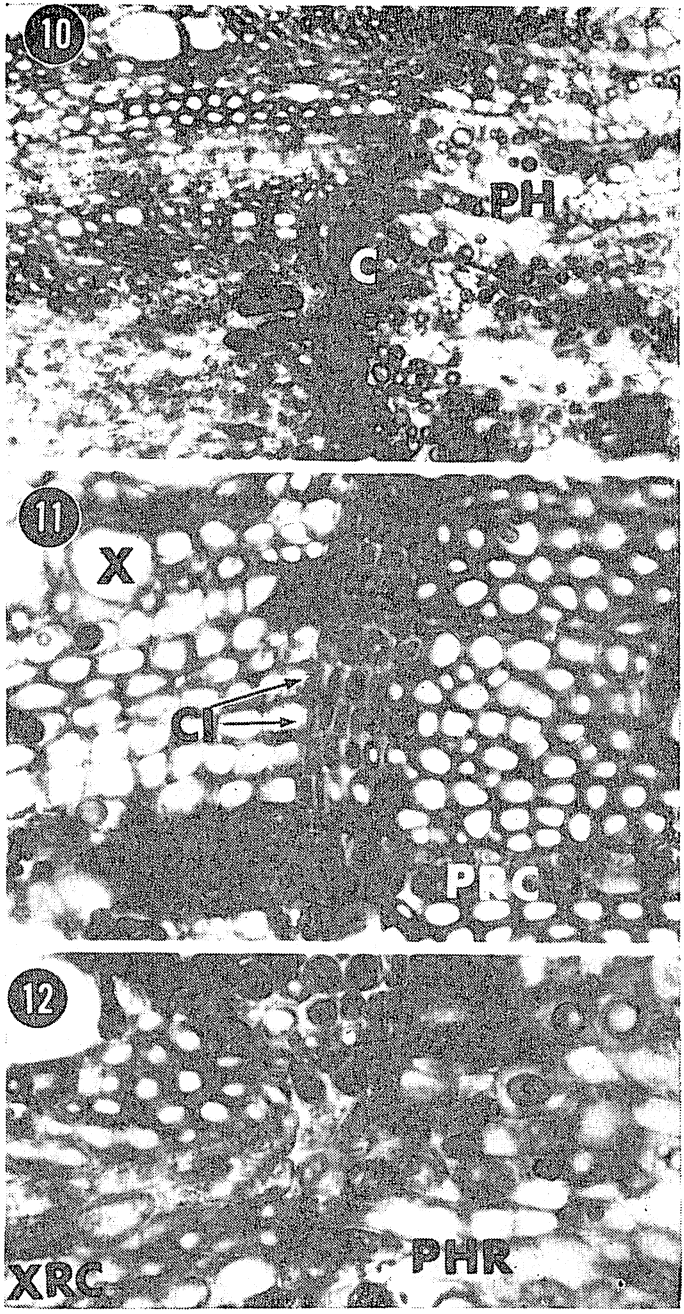

Fig. 10-12. Cross section of vasular cambium at the base of a Redskin shoot on May 28, 1982. The cambial line (C) shows many cells which had been killed (dark staining intensity). Vascular cambium line (C); cambial initials (CI); Phloem (PH). Fig. 10, X 160; Figs. 11, 12, X 400.

cient food reserves to overcome this damage. The terminal 6-8″ had been killed, as contrasted to Fig. 1-3 where the entire shoot had been killed. These trees made excellent growth during 1982 and a full crop was produced in 1983.

Fig. 10-12 show a cross section of cambial injury at the base of a Redskin shoot on May 28, 1982. The dark, cambial cells indicated absorption of safranin within the injured cells. The dark line (C) in Fig. 10 is the demarcation line between the xylem (X) and phloem (PH), both of which are injured in this shoot base. An increased magnification of the cambium (C, Fig. 11) shows specific injury to the cambial cells along with the xylem-ray cells (XRC) and the phloem-ray cells (PRC).

Renewal, from the basal portion of a Redskin terminal shoot, is shown in Fig. 13 as indicated by the bud initial (BI). These were in medium vigor, but the initiation of the lateral shoot was forced into vigorous growth due to the entire tree top being subjected to severe winter injury. The bud initial had become meristematic and would develop with intense vigor.

All of the 1982 fruit were lost, but mature vigorous trees were able to regenerate and produce a limited crop in 1983.

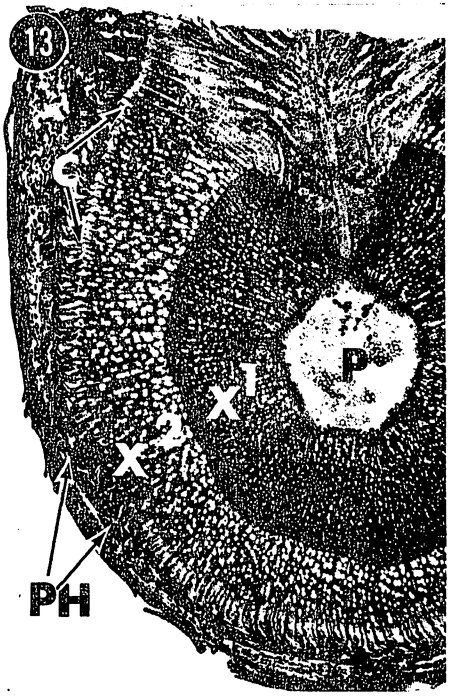

Fig. 13. Cross section of a basal part of a Redskin shoot on May 28, 1982 showing initiation of a shoot trace originating from the pith. The pith (P) has not been injured, but the xylem (wood X^1) has had considerable injury. The xylem (X^2) has remained intact, with the injury adjacent to the cambium. The phloem (PH) and outer bark have all been killed or disrupted by the freeze. X 40.

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