Table 3. Effects of AVG (5×10^{-4}M) and 2,4,5-TP on fruit drop and fruit removal force (FRF).

Time of AVG application (days before harvest)	Fenoprop (ppm)	Fruit drop (%) Normal harvest	Fruit drop (%) 2 weeks after harvest	FRF at normal harvest (kg/fruit)
		King of the Pippin		
Control	0	15.8c[z]/	26.0c	1.5a
27, 18, 7 and 1	0	5.9a	10.2a	1.8a
7 and 1	0	9.7b	17.9b	1.8a
–	20	8.5b	22.1bc	1.8a
		Golden Delicious		
Control	0	--	–	1.9a
39, 27, 18, 7 and 1	0	–	–	2.2b
18, 7 and 1	0	–	–	2.2b
18 and 7	0	–	–	2.3b
–	20	-	–	2.4b

[z]Mean separation within columns and cultivars by Duncan's multiple range test, 5% level.

Dr. R. Maag Ltd.). Therefore there is no danger of damage through spray drift, at least on these particular crops.

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The Structure of Processed Pine Bark[1]

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Additional index words. Pinus taeda, Pinus elliottii

Abstract. **The external surfaces and internal structures of particles of milled pine bark (*Pinus taeda* L. and *P. elliottii* Engelm.) were examined with scanning electron microscopy. Numerous external openings, cracked cell walls and internal cellular connections, that might allow water penetration were observed. Periderm surfaces were without pores, and contained rough surfaces and apparently waxy substances that might resist water penetration or absorption.**

Satisfactory growth can be obtained with a wide range of woody ornamental plants (8) and with selected herbaceous pot plants (9) when grown in a milled pine bark medium or one containing milled pine bark as an organic amendment. One problem encountered has been early growth delay which may be serious when growing short-term container crops such as bedding plants (4). However, similar plant growth delay has been encountered with a perlite-vermiculite potting mixture containing a high percentage of perlite. Marshall et al. (6) postulated the growth response resulted from a water deficiency in the perlite-vermiculite substrate.

It has been observed that when plants are established in a medium containing milled pine bark, they require less frequent irrigation when compared to plants grown in a medium containing peat moss. Apparently the utilization of either perlite or milled pine bark in a growing medium results in greater H_2O availability, not to be confused with retention, to the plant (10). A recent study of K distribution and retention in pine bark and sand media suggests that capillary pores exist within

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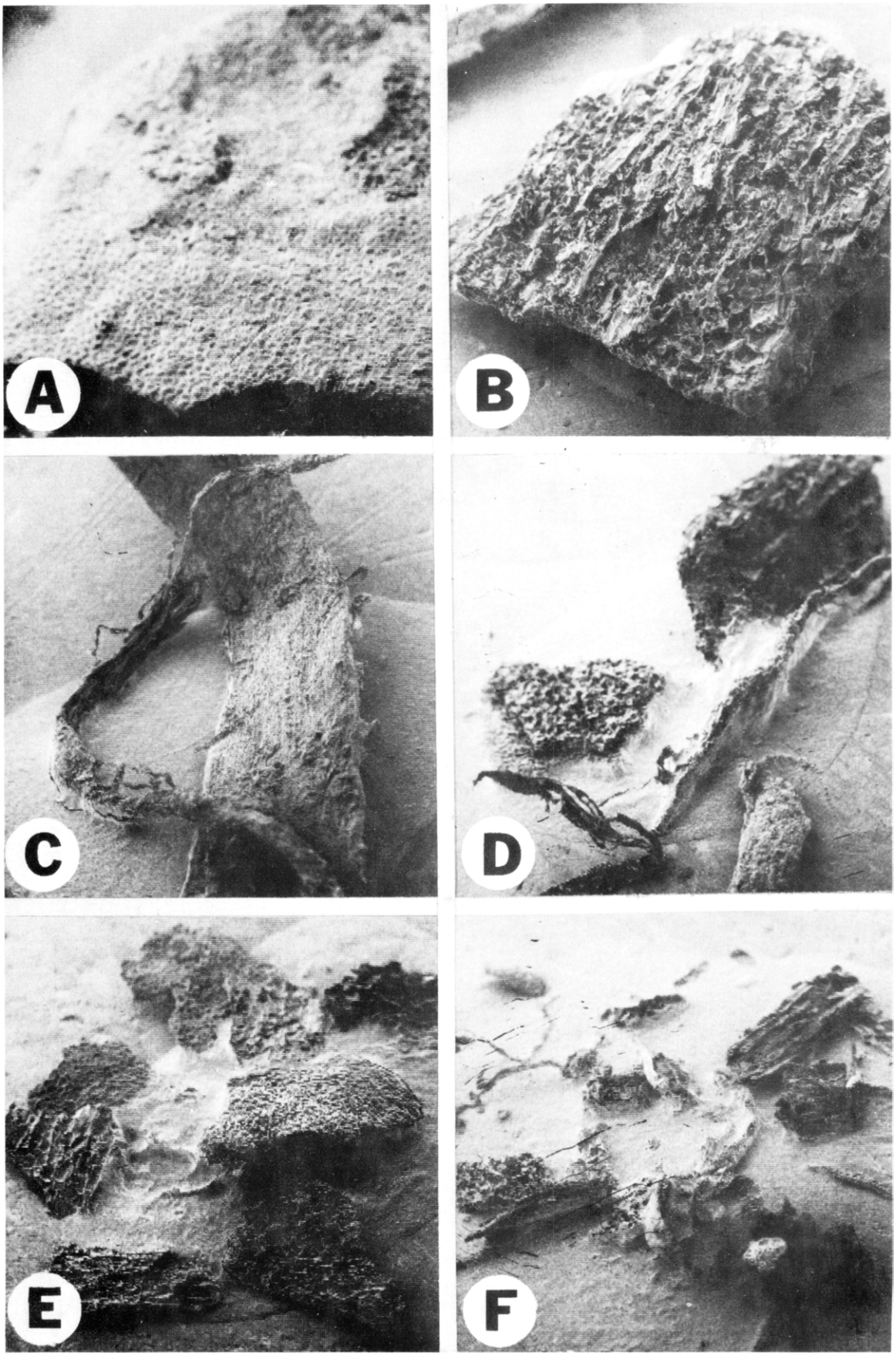

Fig. 1. Types of particles retained on National Bureau of Standards Sieves. A) #8 screen (2.38 mm opening). B) #10 screen (2.0 mm). C) #20 screen (0.84 mm). D) #30 screen (0.62 mm). E) #40 screen (0.42). F) Receiver pan (<0.42 mm). 20×.

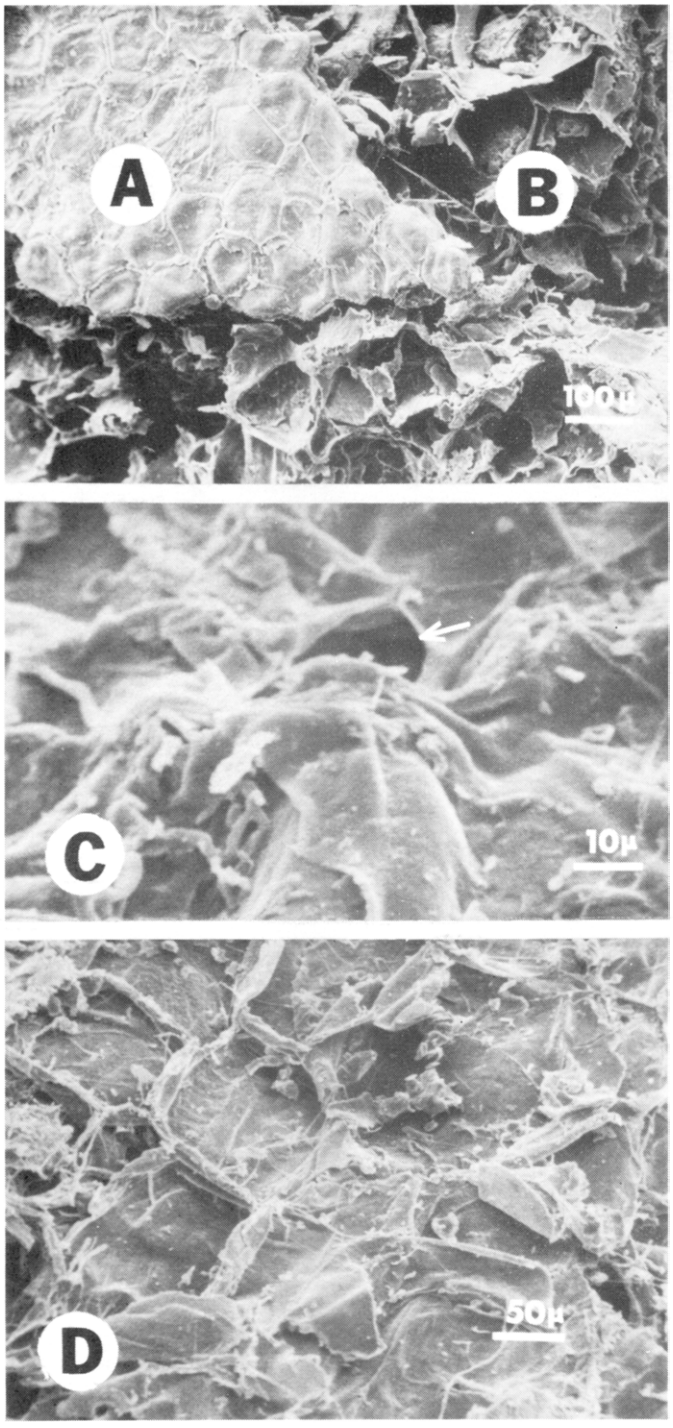

Fig. 2. (A) Tangential section of phellogen cells lacking intercellular spaces; (B) oblique section of porous obliterated phloem; (C) rare minute opening in phellogen surface; and (D) remains of thin radial and transverse phellogen cell walls lacking pores.

the internal structure of the bark itself and the internal H_2O and nutrients are not easily removed by irrigation H_2O rapidly percolating through the medium (1). This internal moisture may be available for plant use.

This study investigated the cellular matrix of milled pine bark particles in relation to the potential for water absorption through the external surfaces into the internal spaces of the pine bark particles.

Materials and Methods

Scanning electron microscopy (SEM) was used to identify the surface characteristics of processed pine bark (2, 11). Milled pine bark (*Pinus taeda* and *P. elliottii*), stored for about 8 months, was air dried for 2 weeks and separated into component particle sizes using a ro-tap Shaker and sieves with openings of 2.38, 2.0, 0.84, 0.62, 0.42 mm diam (NBS Sieves #8, 10, 20, 30, 40) and receiver pan. Samples were prepared for SEM for mounting on Al specimen stubs with silver mounting paint, and sputter coated (Hummer Sputter Coater) with gold-palladium (~150 Å). Prepared specimens were stored in a desiccator until examination. A Stereoscan Mark IIA SEM at 10 KeV accelerating voltage, 160-170 μA beam current, and 10-12 mm working distance was used to examine the particles.

Results and Discussion

There is considerable variation in size, structure, and surfaces of component particles of milled pine bark (Fig 1). Most of the large particles (2.38 mm diam) consist of a layer of phellogen (Fig. 2A) on each side of a layer of phloem (Fig. 2B). The phellogen cell surfaces generally lack intercellular spaces, although minute openings do exist on some surfaces (Fig. 2C). The hammer milling process randomly fractures the phellogen cell walls to expose the internal cells (Fig. 2D).

Obliterated phloem exhibits numerous openings on the surface (Fig. 3A). The internal phloem appears similar (Fig. 3B) with interconnecting channels and sieve areas (Fig. 3C) between the cells.

Numerous cracks in cell walls and fungal hyphae penetration were observed (Fig. 3C and 3D). The cracks may have developed during hot-air drying during the mechanical stresses of hammer milling, or by the natural splitting of tissues as the trunk expanded on the tree. The fractured hyphae coincident with cell wall cracks indicate that cracking occurred after hyphal penetration. Surfaces appearing to be waxy platelets were also common (Fig. 4).

The rhytidome of pine trees consists of alternating layers of periderm and obliterated phloem, with the periderm appearing as thin lines in the phloem when viewed with the naked eye (7). During natural sloughing, the bark peels away along the thin-walled cork cambium cells (phellogen) or thin walled phellem cells (5). During hammer milling, pine bark fractures most easily in the tangential plane of the phellogen or thin-walled phellem. The resulting particles vary in size and shape. The larger particles (> 1.0 mm diam) are constructed like wafers with obliterated phloem sandwiched between phellem cells on one side and phelloderm cells on the other. Usually the phellogen layer is exposed on the surface of these particles. The smaller particles (< 1.0 mm diam) include wafer-types and other tissue components that are randomly fractured, e.g., obliterated phloem, platelets of phellem and phellogen, resin pockets, resins, and crystals. Of significant interest is the potential for the cellulose and lignin, common in the cell walls, to provide exchange site for nutrients (12, 13).

The apparent function of the rhytidome in nature is to prevent water loss or external damage. Consistent with this function the suberized and waxy surfaces repel water molecules and are therefore difficult to wet. Although these surfaces are not frequently observed, they might add to the hydrophobic character of dry pine bark. Contact angles of water droplet/solid surface interfaces have been reported (14) for phellogen and old phloem surfaces. It was found that diethyl ether and methanol extractable substances were responsible for the hydrophobic behavior of the surfaces, but no structural changes were observed in the extracted particles with SEM. Part of the difficulty in wetting might also be due to the size of the openings, as suggested by the K study of Brown and Pokorny (1).

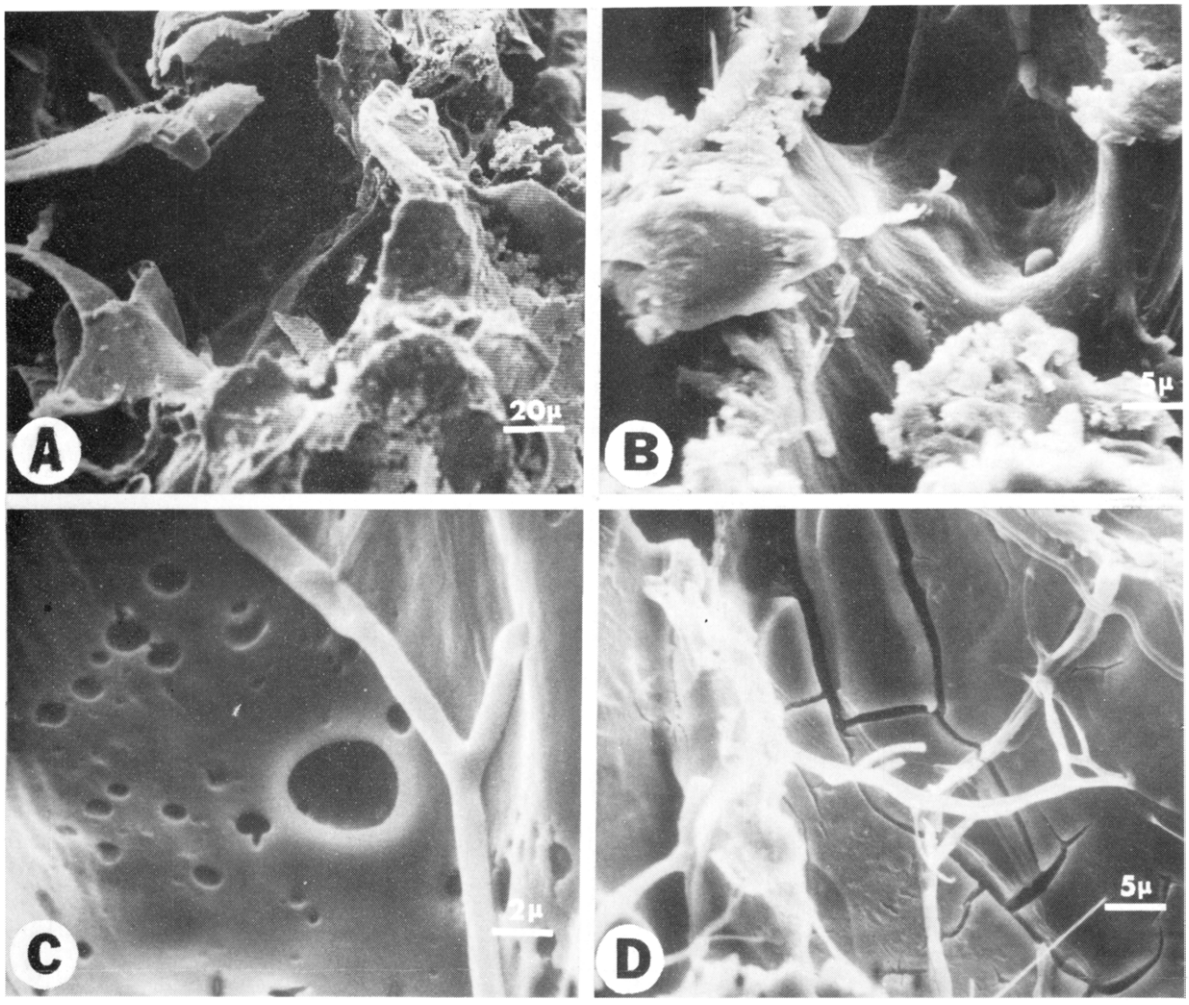

Fig. 3. (A) Surface variation of obliterated phloem on transverse and radial edges of pine bark particle; (B) cell lumen of an expanded parenchyma cell showing internal pores of pine bark particle; (C) sieve areas on tangential and radial walls of an obliterated sieve cell; and (D) thick cell walls with large cracks and hyphae in lumen (note cracks in hyphae).

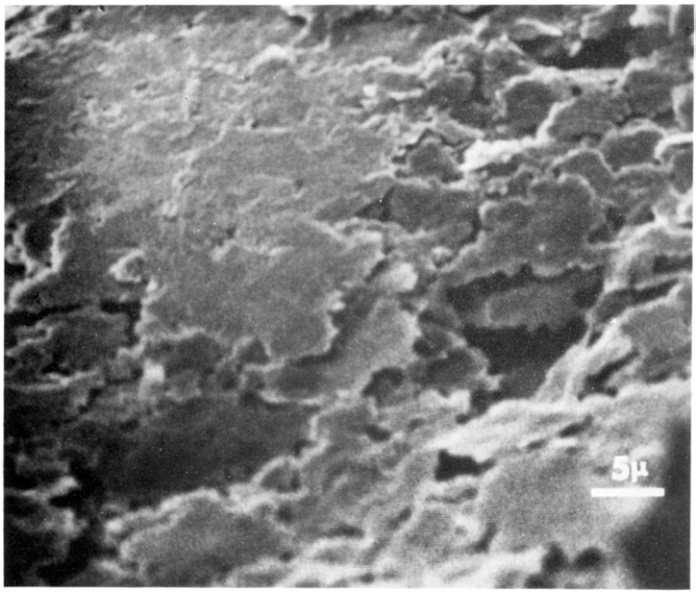

Fig. 4. Surface of what appears to be waxy platelets, bark particle size less than 0.42 mm.

Whether the actual cause of hydrophobic behavior of pine bark substrate is chemical and/or structural has not been determined. This study showed that large openings (5-60 μm) on the obliterated phloem surfaces and interconnecting channels exist and might therefore provide for water penetration and nutrient storage in internal spaces. Openings on phellogen surfaces were less common and minute (5-10 μm), but water may still be able to enter through them. Fungal penetration and cracking may also create openings that would allow water to enter or move into the particle.

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Rootstock and Seasonal Influences on Carbohydrate Levels and Cold Hardiness of 'Redhaven' Peach[1]

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Additional index words. Prunus persica

Abstract. **Flower buds and apical shoots of 'Redhaven' peach (*Prunus persica* (L.) Batsch) were shown to be slightly more cold hardy in the autumn and winter when propagated on seedlings of Siberian C than on those of Harrow Blood. Apical shoots consistently had higher levels of total carbohydrates, reducing sugars, and other carbohydrate fractions on Siberian C than on Harrow Blood seedlings from winter to spring. The cold hardiness of flower buds was closely correlated with the hardiness of apical shoots. In addition, both flower bud and shoot hardiness were closely correlated with total sugars, sucrose, and reducing sugars in the shoots from autumn to spring. However, hardiness of flower buds and apical shoots was not correlated with total carbohydrates or starch. The TI_{50}, a new method of expressing the hardiness of apical shoots was an objective index of cold hardiness and somewhat analogous to the T_{50} method for expressing hardiness of flower buds.**

Cold injury is a major limitation to peach culture in Canada (8) and the Northern U.S. (7). Therefore, any enhancement of cold hardiness of peach scion cultivars by whatever means is potentially very important.

Recently, peach seedling rootstocks obtained from different seed parents have been found to differ significantly in some of the effects they exert on peach scion cultivars, including such important characters as nutrient uptake (8), growth (10), time of leaf fall (11), cold hardiness in fall and winter (11), disease response (9) and winter survival (8, 13).

Certain carbohydrate fractions in peach flower buds and shoots, particularly sugars, have been found to be correlated with cold hardiness (1, 3, 4, 5, 6). According to Levitt (12), sugars may increase the freezing tolerance of plant cells in 2 ways – by the osmotic effect and by the metabolic effect. In the former case, sugars may increase cell avoidance of freeze-induced dehydration while in the latter they may be metabolized to produce unknown protective changes. A decrease in starch and a corresponding increase in sugars has long been associated with cold acclimation in woody plants (3, 12). Cold acclimation is an active process which requires an energy and carbon source. Carbohydrates play an important and ubiquitous role in this process. Their effects are both direct and indirect and are consequently important (12).

It is not known whether or not peach seedling rootstocks influence the carbohydrate metabolism of peach cultivars. If this occurred, it may provide an additional explanation, apart from the recently recognized rootstock effect on early defoliation and dormancy (11), for the promotion of increased scion hardiness by certain peach seedling rootstocks. The study reported here was undertaken to test this possibility, and also to observe the seasonal pattern of carbohydrate metabolism in peach in Southwestern Ontario.

Materials and Methods

This study was conducted beginning at leaf fall in Oct. 1973 and ending just before bloom in late April 1974. Samples were collected from a 5-year old replicated experimental orchard of 'Redhaven' propagated on each of 4 peach seedling rootstocks (10). The study was conducted on only 2 of the 4 seedling stocks – Siberian C and Harrow Blood, which induced early and late defoliation, respectively (11). Each scion-rootstock combination was in 3-tree plots that were replicated 5 times in a randomized complete block design.

The first samples were collected on Oct. 24 after the second fall frost had occurred. At this time trees on Siberian C seedlings were 90% defoliated while those on Harrow Blood seedlings were only 10% defoliated. Samples were also collected during the dormant period in Dec., Jan., and Feb., and the last samples were collected on April 29 when the flower buds were in the prepink to early pink stage of development.

Terminal shoots were collected about 1.5 to 2.0 m above the ground from the periphery of 3 trees per plot. On each sample date 9 shoots per plot were used for cold hardiness tests and 6 for chemical analysis. The shoots were trimmed to a uniform length of 30 cm measured from the apex.

The controlled freezing tests were conducted in a manner previously described using a liquid nitrogen freezing chamber (11). Flower bud hardiness was expressed as the estimated stress temperatures (T_{50}) required to kill 50% of the flower buds (11). Tissue hardiness was assessed based on continuity and intensity of tissue browning in the pholem, cambium and xylem regions of the apical 15 cm portions of each shoot. Ratings were made on a scale from 1 to 4 where 1 represented none to very little injury and 4 represented severe injury likely to cause death (11). A mean tissue injury rating of 2.5 was one

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[2]Research Scientists in Pomology and Chemistry, respectively. Dr. G. M. Ward is now retired. The technical assistance of H. O. Jackson and G. F. Zajacz is gratefully acknowledged.