Knorpelkirsche' and 'Gros Blanc' gave genetic ratios characteristic of those from crosses with the homozygous recessive genotype. Therefore it is assumed that both 'Donnissen's Gelbe Knorpelkirsche' and 'Gros Blanc' are *aa bb* for fruit color. The data for the pairs of crosses are combined in Table 1 and in the discussion that follows.

Some differences in intensity of blush and dark coloration were noted among the seedlings in 1975, but in 1976 such differences could not be distinguished when evaluation was delayed until the fruit was thoroughly ripe. Consequently, the data were not separated into different classes of color intensity.

All 46 seedlings of 'Emperor Francis' and 34 seedlings of 'Napoleon' produced blushed yellow fruit (Table 1). No differences in amount of blush were observed among the seedlings. Therefore, these 2 cultivars are homozygous dominant for the blush locus; their genotype is *aa BB* and that of the test cross seedlings *aa Bb*. None of the seedlings showed the blotchy blush of 'Emperor Francis'.

The progenies from the crosses involving the dark-fruited parents 'Badacsoner Riesenkirsche', 'Bing', 'Lambert', and 'Ulster' all segregated for dark- and light-colored fruits in ratios not differing significantly from 1:1. No variations in intensity of flesh color were observed among the dark-fruited segregants. All of the 45 segregants with light-colored fruit bore blushed fruit. Again, no differences in amount of blush were observed among the seedlings. Therefore, the genotype of the 4 parent cultivars is *Aa BB*, and the genotypes of the dark- and light-fruited test cross seedlings are *Aa Bb* and *aa Bb*, respectively.

It is possible that the failure to obtain segregants exhibiting variations in fruit color within each color class is due to presence in both 'Donnissen's Gelbe Knorpelkirsche' and 'Gros Blanc' of factors that suppress expression of these effects in their seedlings. It is also possible that the expression of these effects in the parent cultivars is due to maternal cytoplasmic factors.

Fogle (2) reported that the genotype of 'Napoleon' was *aa Bb* and that of 'Bing' *Aa Bb*, because he observed seedlings bearing nonblushed light-colored fruit in his progenies. These were probably seedlings bearing blushed yellow fruit that were evaluated prematurely. The data presented here show conclusively that both cultivars are homozygous dominant at the blush locus.

The 30 seedlings from the crosses involving 'Sam' all bore dark-colored fruit, indicating that 'Sam' is homozygous for the character. The status of the blush gene could not be determined, because its effect was masked by the gene for dark-colored fruit.

No evidence was found for the existence of modifier genes affecting the intensity or shade of skin and flesh color in sweet cherry fruit. The variations observed in the field are probably due primarily to differences in maturity.

Table 1. Inheritance of fruit color in crosses between sweet cherry cultivars bearing colored fruit and homozygous recessive (*aa bb*) tester cultivars bearing light yellow fruit.

Pollen parent	Proposed genotype	Test cross progeny: Dark	Yellow blushed	Yellow no blush
Blushed yellow				
Emperor Francis	*aa BB*	0	46	0
Napoleon	*aa BB*	0	34	0
Dark				
Badacsoner Reisenkirsche	*Aa BB*	12	13	0
Bing	*Aa BB*	12	9	0
Lambert	*Aa BB*	8	12	0
Ulster	*Aa BB*	9	11	0
Sam	*AA*	30	0	0

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Effect of Soil Fumigation and Pruning Date on the Resumption of Growth of the Vascular Cambium of Peach Trees in a Short Life Site[1]

George E. Carter, Jr.[2]

Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29631

Additional index words. vessel elements, cold injury, dormancy, fumigation, fall-pruning, *Prunus persica*

Abstract. **Fall-pruned peach trees (*Prunus persica* (L.) Batsch) growing in either a fumigated or nonfumigated soil initiated vascular cambium growth earlier in the spring than winter-pruned trees growing in fumigated soil. Early resumption of growth is initiated by certain cultural practices which predispose trees to the cold injury death seen in peach tree short life.**

Peach tree short life (PTSL) is a term used to describe a disease or disease complex that results in premature death, often in the first 4 years after the trees are set. Prince (9) studied the possible relationship between winter temp patterns and tissue injury in the cambial zone of peach trees in an attempt to explain tree loss. He suggested that under weather conditions conducive to physiological development, once the chilling requirement of a cultivar is substantially satisfied, activity proceeds during each warm period and thereby makes the tree progressively more susceptible to freeze injury. This injury was serious in young trees planted at the site where peaches had previously grown. Fall-pruned trees and trees in nonfumigated soil showed an elevated indoleacetic acid (IAA) level with respect to control trees grown in preplant fumigated soil and pruned in Feb. (1). Such trees were predisposed to cold injury by alteration of the growth hormone balance which could release the tree from dormancy. This study was initiated to examine some of the effects of fall-pruning and fumigation on the vascular cambium viability and time of resumed growth in peach trees.

The trees used for the study were the same ones used for a previously reported experiment (1). The orchard was originally established in Dec. 1972 by E. I. Zehr (personal communication) at the Clemson University Sandhill Experiment Station near Columbia, SC, in Lakeland fine sand that was infested

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with *Criconemoides xenoplax* Raski as determined by the sugar flotation centrifugation method (5). Peaches had been grown on the site twice previously. PTSL had occurred, and trees were last removed from the site in 1964. In the intervening 8 years natural vegetation was allowed to grow on the site. Preplant treatment consisted of deep plowing of 4390 kg/ha dolomite lime in early Oct. 1972. In early Nov. half of the test rows were fumigated with 1,2-dibromo-3-chloropropane (Fumazone 86, 47 liters/ha treated) in 2.4 m strips on centers across the rows. 'Blake' peach trees on Lovell, Halford, or Elberta rootstock were planted in a randomized block design to give a rootstock/fumigation comparison in the orchard. On four occasions between May 30, 1973, and March 31, 1975, randomly selected tree sites were sampled, and soil nematode populations were established by the sugar flotation centrifugation method (5). As before only trees on Lovell rootstock were investigated. When the experiment was initiated, 20 trees were surviving in nonfumigated soil and 24 in fumigated soil. Trees were randomly numbered and divided into 3 groups as follows: (a) all trees in nonfumigated soil were fall-pruned (Nov. 1974) (NF-FP); (b) randomly selected trees in fumigated soil were fall-pruned (F-FP); (c) the remaining 12 trees in fumigated soil were winter-pruned (Feb. 1975) (F-WP). Duplicate samples consisting of two 2-cm long woody twigs from the 1974 growth from 5 trees in each treatment were collected monthly from Nov. 1974 through May 1975.

Vascular cambium viability was tested for all samples by a modification of the 2,3,5-triphenyltetrazolium chloride seed viability test (8). Freshly cut twigs 2–10 cm long were prepared by cutting longitudinal slits through the bark. These sections were placed in a phosphate buffer (4) at pH 7.2. After 10 min the twigs were removed and incubated in 1% 2,3,5-triphenyltetrazolium chloride in 0.1 M phosphate buffer (pH 7.1) for 30 min at 37°C. The sections were washed in phosphate buffer (pH 7.2), fixed in 10% neutral formalin for 1 to 2 hr, washed in water, and observed for the development of a deep red ring at the vascular cambium.

A 2-cm peach twig was retained from each sample for anatomical examination. This segment was placed in a formalin:acetic acid:50% ethanol (70:30:900) fixative (FAA) for woody tissue. After 5 days the samples were removed from the fixative and placed in 70% ethanol for 30 min. The samples were then placed in 50% ethanol for 30 min and then in distilled water for at least 3 hr. Sectioning to a thickness of 15 μm was done on a sliding blade microtome with a CO_2 freezing attachment. The thin sections were stained with safranin and light green according to the procedure outlined by Purvis, Collier, and Walls (11). Sections were mounted in Canada balsam and observed under the light microscope. The area of the vascular cambium was closely examined for the production of new cells indicative of the onset of spring growth. Initiation of and rate of growth were monitored from November 1975 for five trees per treatment.

Nematode population in the orchard site prior to planting was determined to be 166 *Criconemoides xenoplax*/100 cm^3 soil. Some other nematodes, notably spiral forms, were present in much lesser concn. By the March 31, 1975 sampling period the nonfumigated sites contained an average of 204 ring nematodes (*Criconemoides* sp.) per 100 cm^3 of soil and, in some sites, a very few *Helicotylenchus* sp. and *Tylenchorrhynchus* sp. The fumigated sites contained an average of 20 individuals per 100 cm^3 of soil (only one fumigated site contained any nematodes). Previous samples had shown similar counts (E. I. Zehr, personal communication). Of the 20 fall-pruned trees in nonfumigated soil, 8 died during the course of the experiment. Of the original 12 fall-pruned trees in fumigated soil, 1 died during the course of the experiment. No winter-pruned trees in fumigated soil died. Symptomatology associated with tree death was identical to that generally attributed to cold injury (2). Cold injury was not observed on trees that did not die, but this is not ruled out because scattered cambium cold injury is difficult to detect.

Routinely the tetrazolium chloride viability test gave negative response on trees that later declined. This often occurred well in advance of distinctive macroscopic symptoms, and, when used in conjunction with histological observations, provided a good qualitative test for cold damage. However, as pointed out by Purcell and Young (10), the same limitations apply to the tetrazolium test that apply to any test used to analyze a small portion rather than the whole organism. The more representative the sample the more reliable the test.

Resumption of tree growth after dormancy was monitored by observing the cells of the vascular cambium at each sampling period. Two distinct events accompanied the resumption of growth. First, the cells of the vascular cambium appeared to darken and become more dense. Second, new tracheids or fibers, or both, appeared in the xylem immediately outside the ring of fall and winter wood. This was followed closely by the production of large spring wood vessel elements. These indicators of renewed growth were seen in samples collected Feb. 7, 1975 in fall-pruned trees planted in nonfumigated soil and in samples collected March 7, 1975 in the other two treatments.

Counts of new vessel elements produced by the time of the March sampling revealed that fall-pruned trees in nonfumigated soil and the fall-pruned trees in fumigated soil had grown more than the other treatment. (Probability >f = 5%, NF-FP=F-FP>F-WP). This trend continued through the April sampling period, but by May the winter-pruned trees in fumigated soil had grown most, and the other two treatments had begun to show the characteristic poor vigor associated with nematode infestation (12) and fall-pruning (6) (Probability > f = 5%, F-WP > F-FP = NF-FP) (Fig. 1).

The biochemical potential of the peach trees to resume growth was monitored by quantitative analysis of IAA. In Nov., trees in the nonfumigated treatment had significantly higher (5% level) IAA concn than those in the fumigated treatments. After fall-pruning, IAA levels in the NF-FP and F-FP were higher than those in the F-WP trees (1). Based on these data, it was predicted that the winter-pruned trees growing in fumigated soil would be the last to resume growth. Monthly observations of each treatment and counts of the number of spring wood vessel elements confirmed this prediction. These findings imply that the same cultural practices that affect the IAA level of peach trees also affect the time growth resumes.

The high correlation between tree death and treatment suggests that those trees which resume growth the earliest in the spring are the most susceptible to PTSL-type cold injury.

Our observations indicate that the sudden spring-wilt syndrome of PTSL is

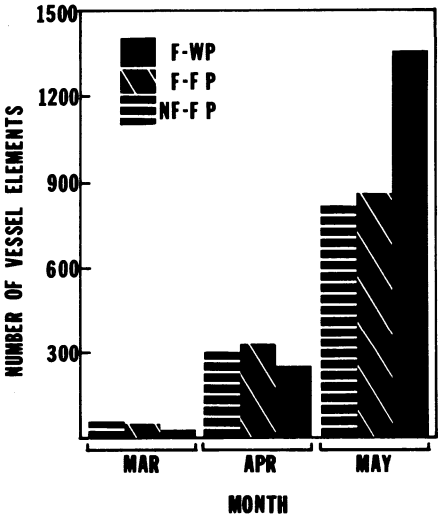

Fig. 1. Number of vessel elements produced at 3 sampling periods by peach twigs beginning their second growing season under various cultural practices. (Each value represents the mean of 25 observations.

related to vascular cambial death. The older wood of the xylem becomes disfunctional through time, and this disfunctionality is marked by the intrusion of gum into the vessel elements (3). Peach trees seem to be dependent upon the yearly production of new water-carrying vessel elements (Carter, unpublished). If this production is prevented by cold injury to the vascular cambium, the sudden severe water stress of bloom or leaf, or both, may place the tree in a water deficit condition from which it cannot recover. Nesmith and Dowler (7) found that some injured trees in PTSL site did not collapse immediately, but were weakened and declined slowly during the summer. It is suggested that in cases like these, injury to the vascular cambium results in loss of vessel element production insufficient to cause death, but sufficient to diminish the water-carrying capacity of the tree. This condition may then result in a weakened tree that undergoes a summer-long slow decline similar to that previously reported (7).

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Response of Phony-infected Peach Trees to Gibberellic Acid[1]

W. J. French and D. L. Stassi
Agricultural Research Center, IFAS, Monticello, FL 32344

Additional index words. Prunus persica, rickettsia-like bacteria

Abstract. **Peach trees (*Prunus persica* (L.) Batsch) dwarfed by phony disease responded to 2 summer applications of 264 ppm gibberellic acid (GA) by breaking the disease-induced rest period and resuming nearly normal twig growth. No twig growth was produced on untreated trees and no significant growth occurred on phony trees treated with combinations of cytokinins, sodium isoascorbate, calcium nitrate, urea, or citric acid.**

Peach trees infected with phony peach bacterium, a rickettsia-like organism (3), appear dwarfed in comparison to healthy trees of the same age. Infected trees flower and leaf out earlier than normal and retain their leaves later in the fall (4). Twigs grow slowly (2 to 15 cm/yr) and become quiescent by mid-summer while normal twigs continue to grow more or less continuously (30 to 90 cm/yr) until fall. Although some occlusions do occur in xylem elements of phony trees (1), there is an absence of foliar wilting, chlorosis, and necrosis which are often associated with restricted vascular transport. Phony symptoms indicate that the disease is caused by alterations in the endogenous levels of plant growth regulators. Application of growth substances may overcome dwarfing without directly affecting the pathogen. Stunting symptoms associated with corn stunt, aster yellows, and wound tumor have been partially overcome by spraying the plants with GA (7). Citrus trees affected with young tree decline were rejuvenated with applications of cytokinins (8) and sodium isoascorbic acid (6). This paper reports the use of GA in breaking the summer rest period of peach trees which had phony peach disease (PPD) symptoms.

Seven-year-old peach trees of the 'June Gold' cultivar were selected for their well developed PPD symptoms. Pretreatment measurements of 10 twigs per tree were recorded on June 16. Current season's growth (March to June) was measured on upright branches on the periphery of the upper crown. None of the phony trees in the test were actively producing new shoot growth at that time; all spring growth had become woody and terminal buds had formed, or were beginning to form. Healthy trees were actively growing and were measured as a comparison.

Treatments are listed in Table 1. Each treatment was applied to 1-tree plots replicated 3 times. Sprays were applied on June 22 and July 26 with a handgun at a pressure of 14.1 kg/sq cm. Sprays were applied to runoff (about 9 liters/tree). One and 2 months after the second treatment, trees were examined for new growth and 10 terminals per tree were measured.

GA stimulated new growth on almost all terminal buds on the phony trees (Table 1). New twigs appeared nearly normal in color, as did leaf shape and size. Internodes were slightly longer in GA treatments and leaf margins slightly more wavy. The twigs were thinner than normal; however, the previous season's growth was also thinner than comparable healthy trees. No shoot growth occurred on untreated trees or those treated with urea and calcium nitrate. On the GA treatments, new twig growth on the outer periphery of the crown was upright rather than horizontal or decumbent, as is typical of phony trees. Symptomless trees maintained continuous twig growth throughout the summer but at a reduced rate during mid-June and July, when dry weather prevailed. When daily rain occurred during mid-August, twig growth resumed at about the same rate in GA treated trees as in healthy trees.

While these data are preliminary in nature, they clearly indicate that partial remission of phony peach symptoms can be achieved through the use of GA. Although the rate of new twig growth on GA-treated trees appeared equal to that of healthy trees, the total new growth was actually less. While normal trees produced some twig growth all summer, the treated trees did not respond to GA for over 2 months. Further tests will be required to determine the most effective rate and timing of GA applications to sustain normal twig growth throughout the growing season. Combination of GA with other growth regulators may be needed.

Another consequence of phony disease is the reduction of fruit size and number. The effects of GA and other growth regulators on the fruiting char-

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