

Leaf abscission kinetics of peach cultivars and clones in relation to peach canker disease

A. R. BIGGS

West Virginia University, University Experiment Farm, P.O. Box 609, Kearneysville, WV 25430, U.S.A.

Received February 13, 1991

BIGGS, A. R. 1991. Leaf abscission kinetics of peach cultivars and clones in relation to peach canker disease. *Can. J. Bot.* **69**: 2020–2025.

Leaf abscission kinetics of several peach cultivars and clones were studied for 2 or 3 years at two locations. Cultivars varied significantly in leaf abscission rates, dates of 50 and 75% leaf abscission, and area under the abscission progress curve. 'Veeglo', 'Madison', and 'Vivid' exhibited the most rapid rates of leaf abscission, clone V68101 and 'Redhaven' showed moderate rates of leaf abscission, and 'Babygold 5', 'Vanity', 'Candor', 'Earlired', and clone V68051 were relatively slow to abscise leaves. No significant relationship could be demonstrated for any of the leaf abscission parameters with field performance ranks of cultivar susceptibility to the peach canker pathogens. Mean annual harvest date for the various cultivars or clones was not associated with susceptibility to the peach canker pathogens or any of the leaf abscission parameters. The role of autumn wound response in relation to screening for pathogen resistant peach genotypes is discussed.

Key words: *Prunus persica*, *Leucostoma* spp., defoliation, resistance.

BIGGS, A. R. 1991. Leaf abscission kinetics of peach cultivars and clones in relation to peach canker disease. *Can. J. Bot.* **69** : 2020–2025.

L'auteur a étudié la cinétique de l'abscission chez plusieurs clones et cultivars de pêche au cours d'une période de 3 ans et sur deux sites. Il y a une variation considérable dans les taux d'abscission foliaire, dans les dates où 50 et 75% des abscissions sont complétées et dans la surface sous la courbe du progrès de l'abscission. Les cultivars Veeglo, Madison et Vivid ont les taux d'abscission les plus rapides et le clone V68101 ainsi que le 'Redhaven' montrent des taux modérés d'abscission, alors que les 'Babygold 5', 'Vanity', 'Earlired' ainsi que le clone V68051 sont relativement lents à réaliser leur abscission. Aucune relation significative n'a pu être démontrée pour aucun des paramètres d'abscission avec l'ordre de performance au champ concernant la susceptibilité aux agents pathogènes responsables des chancres. La date annuelle moyenne de la récolte pour les différents cultivars et clones n'est pas reliée avec la susceptibilité aux pathogènes responsables des chancres, ni avec aucun des paramètres d'abscission foliaire. L'auteur discute la réaction automnale aux blessures comme outil de sélection pour les génotypes de pêche résistants aux agents pathogènes.

Mots clés : *Prunus persica*, *Leucostoma* spp., défoliation, résistance.

[Traduit par la rédaction]

Introduction

Peach canker, a fungal disease caused by *Leucostoma cincta* (Pers. ex Fr.) Höhn. (anamorph = *Leucocytophora cincta* (Sacc.) Höhn.) and *L. persoonii* (Nits.) Höhn. (anamorph = *L. leucostoma* (Pers.) Höhn.), continues to be a major limiting factor in peach production in the northern areas of North America. The pathogens initiate disease in wounds created by pruning, leaf abscission, winter injury, and insect damage (Willison 1936). The disease appears as perennial cankers on trunks, scaffold limbs, and branches, and causes crop losses mainly through reduction in bearing surface and premature tree death. Leaf scars have been identified as the major site of entry for *L. cincta*, and this fungus is considered to be the primary canker pathogen of 1-year-old twigs in the Niagara Peninsula of Ontario (Willison 1937; Tekauz and Patrick 1974). *Leucostoma persoonii*, the pathogen associated with the destructive phase of the disease, is isolated only rarely from such twigs and usually is present in perennial cankers on older branches, scaffold limbs, and trunks (McCubbin 1918; Wensley 1964; Willison 1933). All the currently grown peach cultivars are susceptible to these pathogens (Scorza 1982), and there is no known treatment that will prevent infection over the long term (Biggs 1989b).

Many factors have impeded progress in breeding peach trees for increased resistance to the canker pathogens, including

regional variation in cultivar performance (Scorza 1982), cultivar by year variation in susceptibility to pathogens (Dhanvantari and Dirks 1983), lack of standardized inoculation procedures (Scorza and Pusey 1984), lack of knowledge regarding pathogen variation, lack of breeding material in *Prunus* with immunity to the pathogens, and the land- and labor-intensive nature of conventional fruit tree breeding. A rapid, reliable and economically efficient method to detect pathogen resistance would expedite development of new, *Leucostoma*-resistant peach cultivars.

Willison (1937) noted that the cultivar Rochester was highly susceptible to leaf scar infections relative to Elberta, a moderately resistant cultivar. Rate of leaf fall and the temperature during the leaf abscission period were considered to be critical factors affecting outbreaks of the disease. Weaver (1963) observed marked differences among cultivars in rate of leaf fall and that rapid leaf abscission was correlated with moderate levels of pathogen resistance. He concluded that natural infection would be greatly reduced by the selection of breeding lines that exhibited rapid defoliation (Weaver 1963). Given the potential importance of this observation to peach breeding programs, the objective of the present study was to document the kinetics of leaf abscission in several different peach cultivars and clonal selections and to examine the correlation among several leaf abscission parameters and susceptibility to the peach canker pathogens.

TABLE 1. Progress of leaf abscission in six peach cultivars at the Jordan site in autumn 1986 and the Spearman's rank correlation coefficients for the relationship between each cultivar's susceptibility to peach canker disease, based on its field performance history and the leaf abscission parameters

Cultivar	Abscission rate*	Date of abscission† (day of year)		Abscission severity‡
		50%	75%	
Sunhaven	0.0756a	306.9c	318.3b	163.9c
Redhaven	0.0657a	299.4de	312.5c	201.0b
Garnet Beauty	0.0774a	296.3e	307.4c	225.4a
Loring	0.0412a	316.0a	336.9a	115.2d
Vanity	0.0475a	312.7b	330.8a	127.9d
Candor	0.0552a	302.3d	317.9b	180.5bc
Spearman's r_s	0.60	0.26	0.26	0.26
Significance	ns	ns	ns	ns

NOTE: Each value is the mean of five single-tree replications from 10 terminals per tree. Letters indicate mean separation within columns by Waller-Duncan Bayesian k -ratio t -test ($P \leq 0.05$). Cultivars are listed from least susceptible ('Sunhaven') to most susceptible ('Candor').

*Estimated from the linear regression of Gompertz-transformed percent abscission against day of year (Julian day).

†Estimated from the linear regression of Gompertz-transformed percent abscission.

‡Area under the leaf abscission progress curve.

Materials and methods

Orchard sites

Peach (*Prunus persica* (L.) Batsch.) orchards were established at the Agriculture Canada experimental farm in Jordan Station, Ont., (Jordan) and at the experimental farm of the Horticultural Research Institute of Ontario in Vineland Station, Ont., (Victoria) in May of 1984 and 1985, respectively. The Jordan farm is about 3 km east of the Victoria farm. Soils on both farms are imperfectly drained Vineland fine sandy loam and are typical of peach orchard soils in the Niagara Peninsula. The Jordan orchard was established with 1-year-old, virus-tested, canker-free nursery stock on cultivar Bailey rootstock. Cultivar Boone County rootstocks were used at the Victoria site, except for the combination of cultivar Madison on Halford. Trees on the Victoria farm were canker-free although not virus-tested. Tree spacing was 1.5×4.0 m and 3.0×5.0 m at the Jordan and Victoria farms, respectively. Orchards were managed with clean cultivation in the spring followed by a rye grass cover crop planted in July. Fungicides and insecticides were applied as needed to control peach leaf curl, brown rot, and oriental fruit moth (ferbam, captan, and phosmet, respectively). The cultivars listed in Tables 1 and 3 were planted in randomized complete blocks at each orchard site. Cultivars were selected to represent a range of susceptibility to *Leucostoma* spp. based on historical field performance ratings with visual assessment and a 1 to 10 numerical rating system (Biggs and Miles 1988, R.E.C. Layne, personal communication). The field performance ratings for the Jordan cultivars were determined at the Agriculture Canada Harrow Research Station in Harrow, Ontario. For those cultivars established at the Victoria site, field performance ratings were determined in an adjacent planting at the same site. None of the cultivars selected for these experiments were immune to the pathogens because known sources of immunity are not available. Therefore, the cultivars selected ranged from highly susceptible to moderately resistant.

Sampling methods and statistical analysis

Leaf abscission was evaluated on 10 terminal shoots, selected to be of similar length and from around the periphery of the tree, from one single-tree replicate at each of three (Victoria) or five (Jordan) blocks at the two sites. The Jordan site was utilized in 1986 and 1987, and the Victoria site in 1987, 1988, and 1989. Shoots were marked with coloured flagging, and the total number of nodes per shoot was determined in September of each year. Beginning at approximately 10–25% defoliation (estimated visually), weekly counts of the number of defoliated nodes were made and data collection continued until all cultivars exhibited > 95% defoliation. The percent defoliation was then determined for each cultivar on a weekly basis.

Abscission ratings were determined from simple linear regression, Gompertz, or logistic equations that were fitted to the sigmoidal percent defoliation curves (REG procedure, SAS Institute, Inc., Cary, NC). Examination of the residuals and correlation coefficients for individual trees indicated a better fit with the Gompertz transformation ($-\ln(-\ln(Y))$), where Y is the proportion of abscised leaves. Linear regression of Gompertz-transformed values against time was used to estimate rates of defoliation for each tree (Berger 1981). The days of the year (Julian day) corresponding to 50 and 75% defoliation were estimated from the regression equations. In addition, the areas under the curves for percent defoliation (AUAPC) where

$$[1] \quad \text{AUAPC} = \sum_{i=1}^N \left(\frac{R_i + R_{i+1}}{2} \right) (t_{i+1} - t_i)$$

where t_i day of year at evaluation i , R_i is percent defoliation at evaluation i , and i is 1 to N evaluations where N is the total number of cultivars examined, i.e., $N = 6$ at Jordan, $N = 10$ at Victoria.

Ranked defoliation ratings (from 1, quickest to N , slowest) were examined for correlation (Spearman's r_s) (Steel and Torrie 1980) with the ranks of disease susceptibility (from 1, least susceptible to N , most susceptible) established from the historical field performance data. Correlation of disease susceptibility with ranks of mean annual harvest date (from 1, earliest to N , latest) for the cultivars and clones used in the study was also examined, although none of the trees were bearing significant amounts of fruit during the course of the study. Mean annual harvest date was determined from older trees established in another planting at Victoria.

Results and discussion

Progression of leaf abscission in the six cultivars examined at the Jordan site varied significantly among cultivars for date of 50 and 75% abscission and AUAPC in 1986, although only AUAPC varied significantly in 1987 (Tables 1 and 2). In 1986, 'Garnet Beauty' and 'Redhaven' lost a greater proportion of their leaves earlier than the other cultivars. However, leaf abscission rate, as estimated from the slope of the Gompertz-transformed linear regression curves, did not vary significantly among cultivars at this site in 1986 or 1987 (Table 2). In addition, correlation analyses of abscission parameters between 1986 and 1987 revealed no significant relationships. Furthermore, no significant relationships as estimated by Spearman's

TABLE 2. Progress of leaf abscission in six peach cultivars at the Jordan site in autumn 1987 and the Spearman's rank correlation coefficients for the relationship between each cultivar's susceptibility to peach canker disease, based on its field performance history and the leaf abscission parameters

Cultivar	Abscission rate*	Date of abscission† (day of year)		Abscission severity‡
		50%	75%	
Sunhaven	0.0970a	293.8a	302.6a	626.2d
Redhaven	0.1390a	292.0a	298.5a	782.0a
Garnet Beauty	0.0873a	293.3a	302.4a	708.4bc
Loring	0.0915a	293.7a	303.1a	671.4cd
Vanity	0.0998a	293.4a	302.1a	697.7bc
Candor	0.1222a	292.4a	299.4a	759.7ab
Spearman's r_s	-0.086	-0.26	-0.20	-0.26
Significance	ns	ns	ns	ns

NOTE: Each value is the mean of five single-tree replications from 10 terminals per tree. Letters indicate mean separation within columns by Walker-Duncan Bayesian k -ratio t -test ($P \leq 0.05$). Cultivars are listed from least susceptible ('Sunhaven') to most susceptible ('Candor').

*Estimated from the linear regression of Gompertz-transformed percent abscission against day of year (Julian day).

†Estimated from the linear regression of Gompertz-transformed percent abscission.

‡Area under the leaf abscission progress curve.

TABLE 3. Progress of leaf abscission in six peach cultivars at the Victoria site in autumn 1987 and the Spearman's rank correlation coefficients for the relationship between each cultivar's susceptibility to peach canker disease, based on its field performance history and the leaf abscission parameters

Clone or cultivar	Abscission rate*	Date of abscission† (day of year)		Abscission severity‡
		50%	75%	
V68101	0.1715ab	296.9cd	301.9de	891.7bcde
V68051	0.1213abc	298.9bc	306.2bc	756.5cde
Veeglo	0.1862a	295.4de	300.4de	1057.2ab
Babygold 5	0.0817c	303.6a	314.2ab	641.9e
Redhaven	0.1238abc	296.4cd	303.3cd	969.4abcd
Vanity	0.0649c	303.3a	316.6a	687.6de
Candor	0.0986bc	295.7de	304.5cd	1020.9abc
Madison	0.1375abc	296.5cd	302.8cd	950.1abcd
Vivid	0.1713ab	292.3e	298.3e	1218.1a
Earlired	0.0859c	300.0b	310.0b	796.6bcde
Spearman's r_s	0.28	-0.15	0.05	-0.25
Significance	ns	ns	ns	ns

NOTE: Each value is the mean of three single-tree replications from 10 terminals per tree. Letters indicate mean separation within columns by Waller-Duncan Bayesian k -ratio t -test ($P \leq 0.05$). Clones and cultivars are listed from least susceptible (V68101) to most susceptible ('Earlired').

*Estimated from the linear regression of Gompertz-transformed percent abscission against day of year (Julian day).

†Estimated from the linear regression of Gompertz-transformed percent abscission.

‡Area under the leaf abscission progress curve.

r_s were observed between susceptibility to the peach canker pathogens and leaf abscission parameters in either year at the Jordan site (Tables 1 and 2). The inability to establish a consistent pattern of leaf abscission for the six cultivars during the 2 years of study at this site could be related to the relatively high planting density when compared with standard orchard practices. Genetic differences in leaf abscission may have been overshadowed by the physiological effects of competition for light, water, and nutrients.

Progression of leaf abscission at the Victoria site varied significantly among cultivars or clones for all the parameters examined during all 3 years (Tables 3–5). In 1987, 'Veeglo', V68101, and 'Vivid' exhibited the highest abscission rates whereas 'Vanity', 'Earlired', and 'Babygold 5' exhibited the slowest abscission rates (Table 3). 'Vivid', which ranked as

the second most susceptible cultivar in our historical field performance ratings, also exhibited the earliest dates of 50 and 75% abscission and the highest AUAPC (Table 3). 'Babygold 5', a cultivar with relatively moderate resistance, exhibited the latest 50 and 75% abscission dates and the lowest AUAPC in 1987. No significant correlations (Spearman's r_s , Table 3) were observed between leaf abscission parameters and susceptibility to the peach canker pathogens.

Results similar to those from 1987 were obtained in 1988 (Table 4). Again, 'Vivid', 'Veeglo', and V68101 exhibited the most rapid leaf abscission rates, and 'Vanity' and 'Babygold 5' were slowest. 'Vanity' and 'Babygold 5' showed the latest dates for 50 and 75% leaf abscission and 'Vanity' had the lowest AUAPC (Table 4). 'Vivid' showed the earliest dates for 50 and 75% leaf abscission and the highest AUAPC. No sig-

TABLE 4. Progress of leaf abscission in six peach cultivars at the Victoria site in autumn 1988 and the Spearman's rank correlation coefficients for the relationship between each cultivar's susceptibility to peach canker disease, based on its field performance history and the leaf abscission parameters

Clone or cultivar	Abscission rate*	Date of abscission† (day of year)		Abscission severity‡
		50%	75%	
V68101	0.1141 <i>b</i>	280.9 <i>cd</i>	288.6 <i>cd</i>	2268.6 <i>bcd</i>
V68051	0.0662 <i>d</i>	284.2 <i>ab</i>	297.3 <i>a</i>	2116.3 <i>cde</i>
Veeglo	0.1270 <i>ab</i>	278.7 <i>d</i>	285.8 <i>de</i>	2454.4 <i>b</i>
Babygold 5	0.0693 <i>d</i>	285.4 <i>a</i>	298.0 <i>a</i>	1967.8 <i>de</i>
Redhaven	0.0806 <i>cd</i>	280.9 <i>cd</i>	291.9 <i>bc</i>	2500.1 <i>b</i>
Vanity	0.0710 <i>d</i>	286.3 <i>a</i>	298.5 <i>a</i>	1851.3 <i>e</i>
Candor	0.0758 <i>cd</i>	281.9 <i>bc</i>	293.2 <i>b</i>	2416.0 <i>bc</i>
Madison	0.0914 <i>c</i>	279.3 <i>d</i>	288.7 <i>cd</i>	2559.0 <i>b</i>
Vivid	0.1325 <i>a</i>	276.0 <i>e</i>	282.6 <i>e</i>	2856.3 <i>a</i>
Earlired	0.0826 <i>cd</i>	282.3 <i>bc</i>	292.7 <i>b</i>	2280.0 <i>bcd</i>
Spearman's r_s	-0.18	-0.13	-0.08	-0.44
Significance	ns	ns	ns	ns

NOTE: Each value is the mean of three single-tree replications from 10 terminals per tree. Letters indicate mean separation within columns by Waller-Duncan Bayesian k -ratio t -test ($P \leq 0.05$). Clones and cultivars are listed from least susceptible (V68101) to most susceptible ('Earlired').

*Estimated from the linear regression of Gompertz-transformed percent abscission against day of year (Julian day).

†Estimated from the linear regression of Gompertz-transformed percent abscission.

‡Area under the leaf abscission progress curve.

TABLE 5. Progress of leaf abscission in six peach cultivars at the Victoria site in autumn 1989, and the Spearman's rank correlation coefficients for the relationship between each cultivar's susceptibility to peach canker disease, based on its field performance history and the leaf abscission parameters

Clone or cultivar	Abscission rate*	Date of abscission† (day of year)		Abscission severity‡
		50%	75%	
V68101	0.0948 <i>b</i>	289.6 <i>bc</i>	302.6 <i>cd</i>	1551.4 <i>bc</i>
V68051	0.0744 <i>c</i>	291.0 <i>b</i>	307.7 <i>b</i>	1494.6 <i>cde</i>
Veeglo	0.1090 <i>b</i>	288.5 <i>cd</i>	299.8 <i>de</i>	1531.9 <i>bcd</i>
Babygold 5	0.0746 <i>c</i>	290.7 <i>b</i>	307.3 <i>bc</i>	1534.9 <i>bcd</i>
Redhaven	0.0969 <i>b</i>	287.2 <i>d</i>	300.0 <i>de</i>	1828.3 <i>a</i>
Vanity	0.0682 <i>c</i>	294.0 <i>a</i>	312.5 <i>a</i>	1340.3 <i>e</i>
Candor	0.0737 <i>c</i>	288.2 <i>cd</i>	305.1 <i>bc</i>	1828.4 <i>a</i>
Madison	0.1350 <i>a</i>	287.2 <i>d</i>	296.4 <i>e</i>	1587.3 <i>bc</i>
Vivid	0.1050 <i>b</i>	287.7 <i>cd</i>	299.5 <i>de</i>	1700.8 <i>ab</i>
Earlired	0.0609 <i>c</i>	294.7 <i>a</i>	314.9 <i>a</i>	1356.7 <i>de</i>
Spearman's r_s	0.14	-0.09	-0.03	0.13
Significance	ns	ns	ns	ns

NOTE: Each value is the mean of three single-tree replications from 10 terminals per tree. Letters indicate mean separation within columns by Waller-Duncan Bayesian k -ratio t -test ($P \leq 0.05$). Clones and cultivars are listed from least susceptible (V68101) to most susceptible ('Earlired').

*Estimated from the linear regression of Gompertz-transformed percent abscission against day of year (Julian day).

†Estimated from the linear regression of Gompertz-transformed percent abscission.

‡Area under the leaf abscission progress curve.

nificant correlations were observed between leaf abscission parameters in 1988 and susceptibility to the peach canker pathogens.

In 1989, 'Madison' exhibited the most rapid leaf abscission rate, followed by 'Veeglo', 'Vivid', 'Redhaven', and V68101 (Table 5). 'Earlired' and 'Vanity' had the slowest abscission rates, although these cultivars were not significantly different from 'Babygold 5', 'Candor', and V68051. Dates of 50 and 75% leaf abscission were earliest for 'Madison', 'Veeglo', and 'Vivid' and latest for 'Earlired' and 'Vanity'. 'Redhaven', 'Candor', and 'Vivid' exhibited the highest AUAPC, whereas 'Vanity', 'Earlired', and V68051 had the lowest AUAPC in

1989. No significant correlations were observed between leaf abscission parameters in 1989 and susceptibility to the peach canker pathogens. Average harvest date was not correlated with pathogen susceptibility ranks or with any of the leaf abscission parameters from either site over the course of the study (data not shown).

The leaf abscission kinetics of the various cultivars or clones appeared consistent during the 3 years of study at the Victoria site. Significant correlations were obtained for leaf abscission rate, dates of 50 and 75% abscission, and AUAPC ranks over the 3-year period (Table 6). It can be concluded from these data that genetic variation exists in peach germ plasm for the

TABLE 6. Correlation matrix (Spearman's r_s) for leaf abscission rate (LAR), date of 50% abscission, date of 75% abscission, and area under the abscission progress curve (AUAPC) for peach cultivars and clones at the Victoria site 1987–1989

Parameter	LAR		Date of 50% abscission		Date of 75% abscission		AUAPC	
	1988	1989	1988	1989	1988	1989	1988	1989
LAR								
1987	0.82**	0.75**	—	—	—	—	—	—
1988	—	0.67*	—	—	—	—	—	—
Date of 50% abscission								
1987	—	—	0.87**	0.72*	—	—	—	—
1988	—	—	—	0.68*	—	—	—	—
Date of 75% abscission								
1987	—	—	—	—	0.96**	0.76**	—	—
1988	—	—	—	—	—	0.68*	—	—
AUAPC								
1987	—	—	—	—	—	—	0.87**	0.64*
1988	—	—	—	—	—	—	—	0.66*

*Significant Spearman's rank correlation values at $P \leq 0.05$.

**Significant Spearman's rank correlation values at $P \leq 0.01$.

various leaf abscission parameters investigated in this study and that cultivar \times year interactions are probably not significant in peach leaf abscission rate studies.

The results of the present study did not substantiate earlier observations on the association of leaf abscission rate with susceptibility to the canker pathogens (Weaver 1963). This is unfortunate because measuring rate of leaf abscission is easy when compared with other techniques for evaluating resistance to *Leucostoma* spp. (Scorza and Pusey 1984; Biggs and Miles 1988; Biggs 1989a). Weaver collected leaf abscission data during only one season, and his data and method of rating disease susceptibility (number of cankers per year of tree age) may not have reflected the long-term impact of the disease on tree morbidity and mortality as revealed by the rating scheme used in the present study. Tekauz and Patrick (1974), also unable to support Weaver's observations, demonstrated that all nodes on a twig are equally susceptible to inoculation with *L. cincta* and concluded that early defoliation by itself does not confer resistance to infection.

The interaction of temperature with rate of leaf abscission, as observed by Willison (1936), requires further study. Temperature has been shown to influence the rate of boundary zone and periderm formation in peach bark (Biggs 1986) and leaf scars (Biggs and Northover 1985). In the latter study, wound healing in peach leaf scars was delayed for up to 16 days at 7.5°C relative to 17.5°C. It is possible, as Willison (1936) indicated, that fungal infection proceeds at low temperatures even though resistance mechanisms in leaf scars have been impeded by low temperatures.

The present study is the second investigation in these orchards to examine the association between wound-related events in autumn and susceptibility to the peach canker pathogens. Biggs and Miles (1988) reported that the rate of suberin accumulation in mechanically wounded peach twigs was correlated significantly with susceptibility to the peach canker pathogens but only when wounds were inflicted and suberin determined during the months of May and June. Wounds created and examined for suberin in September and October showed no correlation of suberin with susceptibility. These authors suggested that the wound system employed in the earlier study inadequately represented events associated with abscission. From the results of both studies, it can be concluded

that wound-related events in autumn are not associated with cultivar variation in susceptibility to the peach canker pathogens.

In summary, the present investigation confirmed the presence of genetic variation in leaf abscission kinetics in peach cultivars and clones. However, variation in leaf abscission rate, as demonstrated in the present study, is useful as an expression of partial resistance to *Leucostoma* spp. only if it can be established that a significant association exists between rate of leaf fall and relative cultivar susceptibility to the pathogens. Unfortunately, this relationship could not be demonstrated over the course of the current investigations. Given the results of the present study and earlier reports (Biggs and Miles 1988; Biggs 1989a), the importance of leaf scar infection by *L. cincta* and the role of this fungus in tree decline and death should be evaluated further.

Acknowledgements

This work was conducted while the author was a Research Scientist with Agriculture Canada. Appreciation is extended to R.E.C. Layne for suggesting the cultivars established at the Jordan farm, to N.W. Miles for establishing the experimental orchard at the Victoria farm and providing historical field performance data, to R.F. Cerkauskas for writing the algorithm to calculate AUAPC, and to A.M. Curwin, K. Slingerland, and K. Schneider for technical assistance.

- BERGER, R. D. 1981. Comparison of the Gompertz and logistic equations to describe plant disease progress. *Phytopathology*, **71**: 716–719.
- BIGGS, A. R. 1986. Prediction of lignin and suberin deposition in boundary zone tissue of wounded tree bark using accumulated degree days. *J. Am. Soc. Hortic. Sci.* **111**: 757–760.
- 1989a. Temporal changes in the infection court after wounding of peach bark and their association with cultivar variation in infection by *Leucostoma persoonii*. *Phytopathology*, **89**: 627–630.
- 1989b. Integrated approach to control *Leucostoma* canker of peach in Ontario. *Plant Dis.* **73**: 869–874.
- BIGGS, A. R., and MILES, N. W. 1988. Association of suberin formation in uninoculated wounds with susceptibility to *Leucostoma cincta* and *L. persoonii* in various peach cultivars. *Phytopathology*, **78**: 1070–1074.

- BIGGS, A. R., and NORTHOVER, J. 1985. Formation of the primary protective layer and phellogen following leaf abscission in peach. *Can. J. Bot.* **63**: 1547-1550.
- DHANVANTARI, B. N., and DIRKS, V. A. 1983. An evaluation of peach cultivars and selections for resistance to *Leucostoma cincta*. *Can. J. Plant Sci.* **63**: 307-310.
- MCCUBBIN, W. A. 1918. Peach canker. *Can. Dep. Agric. Bull. Ser. 2*, No. 37.
- SCORZA, R. 1982. Resistance to *Cytospora* in stone fruit trees. In *Proceedings of the Stone Fruit Decline Workshop*, Michigan State University, East Lansing, MI, Oct. 18-20, 1982. pp. 34-43.
- SCORZA, R., and PUSEY, P. L. 1984. A wound-freezing inoculation technique for evaluating resistance to *Cytospora leucostoma* in young peach trees. *Phytopathology*, **74**: 596-572.
- STEEL, R. G. D., and TORRIE, J. H. 1980. Principles and procedures of statistics. 2nd ed. McGraw-Hill, New York.
- TEKAUZ, A., and PATRICK, Z. A. 1974. The role of twig infections on the incidence of perennial canker of peach. *Phytopathology*, **64**: 683-688.
- WEAVER, G. M. 1963. A relationship between the rate of leaf abscission and perennial canker in peach varieties. *Can. J. Plant Sci.* **43**: 365-369.
- WENSLEY, R. N. 1964. Occurrence and pathogenicity of *Valsa* (*Cytospora*) species and other fungi associated with each canker in southern Ontario. *Can. J. Bot.* **42**: 841-857.
- WILLISON, R. S. 1933. Peach canker investigations. I. Some notes on incidence, contributing factors, and control measures. *Sci. Agric.* **14**: 32-47.
- 1936. Peach canker investigations. II. Infection studies. *Can. J. Res. Sect. C*, **14**: 27-44.
- 1937. Peach canker investigations. III. Further notes on incidence, contributing factors, and related phenomena. *Can. J. Res. Sect. C*, **15**: 324-339.