Resistance to naturally and artificially induced fire blight in the Harrow pear collection

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Ratings of the severity of fire blight [*Erwinia amylovora*] are reported on 51 cultivars in the Harrow pear collection during an epidemic period 1972 to 1975. This collection included cultivars of *Pyrus* communis grown commercially in Ontario and others used in the Harrow breeding program. In 1975, Succulent shoots of 22 of the cultivars were inoculated with the disease organism using a hypodermic needle, microsyringe, and dispensing attachment. A significant correlation (r -0.737) was found between the percentage length of infected shoot after artificial inoculation and average ratings of natural infection on the whole tree (USDA rating system 1 to 10 with increasing numbers indicating greater resistance). The inoculation technique appeared to be reliable for distinguishing cultivars in which fire blight develops mainly in succulent shoots from those in which fire blight penetrates deeply into the woody parts of the tree. The procedure allowed the removal of infected shoots and prevented loss of susceptible cultivars after the measurements were made.

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Lauteur presente les cotes de gravite de la brûlure bactérienne (*Erwinia amylovora*) sur 51 cultivars de poirier faisant partie de l'assortiment conserve a Harrow au cours d'une epiphytie (1972 a 1975). Cet assortiment comprenait des cultivars de *Pyrus communis* cultives commercialement en Ontario et d'autres servant au programme d'amélioration de Harrow. En 1975, on a inoculé des pousses herbacees de 22 de ces cultivars avec l'agent pathogene au moyen d'une aiguille hypodermique, d'une microseringue et des accessoires de distribution. On a constaté une cortelation positive (r -0.737) entre la longueur relative de pousse infectée apres inoculation artificielle et les cotes moyennes d'infection naturelle de l'arbre en entier (système de notation du ministère de l'Agriculture des Etats-Unis de 1 a 10, l'ordre croissant indiquant une resistance accrue). La technique d'inoculation semble convenir pour distinguer les cultivars ou l'infection touche les pousses herbacees de ceux ou elle penetre les parties ligneuses profondes de l'arbre. La technique a permis l'enlevement des pousses infectées et a prevenu la perte de cultivars sensibles, une fois les mesures effectuées.

Fifty-one pear cultivars were grown at the Research Station, Harrow, to determine their commercial value and use in the breeding program. This planting was comprised mostly of ***Pyrus communis*** L. cultivars but some hybrids of P. ***communis*** with P. ***pyrifolia*** (Burm.) Nak. were also included. When the trees reached bearing age, a severe fire blight outbreak caused by ***Erwinia amylovora*** (Burr.) Winslow et al. occurred which allowed evaluation of cultivar resistance. The reaction of many of these cultivars has been reported previously following fire blight outbreaks in other pear collections (2, 3). One purpose of this study was to evaluate fire blight resistance of these and several new cultivars in southwestern Ontario. Another purpose of the study was to determine the correlation between natural infection and that produced by artificial inoculation.

Materials and methods

One to nine trees of each pear cultivar, sport, or numbered selection, were propagated on seedling rootstocks or grafted on Old Home interstocks. They were planted at a spacing of 4.6 by 5.5 m in one location of the orchard. They were pruned, fertilized, and sprayed according to commercial practice in Ontario. No sprays were applied to control fire blight.

The fire blight epidemic began in 1972 when the trees were 6 to 8 years old. Each fall, during the period from 1972 to 1975, the trees were rated individually using the rating system of van der Zwet et al. (7). In this system trees are rated from 1 (100% infection) to 10 (no infection) on the basis of the number of twigs infected, age of the wood penetrated, and the percentage of the tree infected.

During June 1975, healthy current-season shoots of 22 cultivars representing a range of fire blight resistance, based on previous ratings, were inoculated with the fire blight organism when they were in a succulent stage of growth. Six isolates of ***E. amylovora*** from pear orchards near Harrow were grown individually on slants of nutrient-yeast dextrose agar. Each of twenty succulent shoots (20 to 30 cm long) was inoculated with 10 to 20 ul of the aqueous suspension of a composite (1×10^7 cell/ml) of these strains. The inoculum was injected into the plant through a 26 gauge hypodermic needle with a microsyringe and dispensing attachment (Hamilton Co., Reno, Nevada). The inoculation was made at the first or second node below the shoot apex.

Fire blight resistance was determined by measuring the length of the infected shoot and expressing it as a

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Table 1. Fire blight reaction of cultivars in the Harrow pear collection as determined by rating the trees in the orchard during an epidemic 1972 to 1975 and by measuring percentage length of current season shoots infected after artificial inoculation

Cultivar	No. trees	Mean USDA score'	Mean percentage †§ length of infected shoot after artificial inoculation
A. Classes 7.9 to 10 (blight mainly in current season shoots; required no or little surgical pruning)			
Maxine	4	10.0	18.9 (1.3)
Old Home	4	9.9	15.5 (0.7)
Surecrop	3	9.6	14.9 (2.0)
Star	2	9.5	
Moonglow	6	9.4	
Mac	2	9.3	37.4 (5.9)
Seckel	3	9.3	13.4 (0.7)
Mericourt	3	9.0	
Miney	3	9.0	
Moe	3	9.0	20.5 (2.4)
Pierre Cornielle	3	9.0	
Clara Fris	3	8.6	
Barseck	3	8.5	38.9 (4.0)
Louise Bonne de Jersey	2	8.5	
Anjou (tetraploid)	2	8.4	
Ewart	2	8.4	28.7 (4.5)
Kieffer	3	8.3	24.6 (3.1)
Starking Delicious	5	8.3	16.5 (0.5)
NY8760	6	8.2	39.2 (7.7)
B. Classes 6.0 to 7.9 (fire blight penetrated little beyond 3–year–old wood; required major cuts to save the tree)			
Anjou	5	7.7	70.9 (4.3)
Parburton (tetraploid Bartlett)	2	7.7	52.0 (5.2)
Yakima (tetraploid Bartlett)	2	7.3	38.0 (5.5)
Enie	3	7.0	
Fondante d'Autumne	1	7.0	
Clairgeau	3	6.9	
Giffard	4	6.7	20.5 (3.6)
Russett Bartlett (Bartlett sport)	1	6.5	
Stewart's Bartlett (Bartlett sport)	8	6.2	
Wilder	2	5.8	
Laxton's Progress	2	5.7	38.8 (6.5)
Maxred (Bartlettsport)	4	5.5	
Menie	3	5.4	
Buerré Superfin	3	5.0	

percentage of the total current season growth. Infected shoots were removed to spare the tree further infection after the infection ceased to advance or after the infection penetrated into 1-year-old wood.

Results and discussion

In most cultivars infection usually began in succulent shoots and spread into older wood. A few infections spread from blossom infections. The cultivar Magness was an exception. Fire blight developed directly in the mainstem and not in the shoots and blossoms. This observation agreed with that of van der Zwet et al. (5), who reported that Magness was trunk-susceptible but shoot-resistant.

The average fire blight scores are presented in Table 1. An average score was used instead of the lowest score (2,3) because infected branches were removed from the trees during the course of annual pruning. Some trees became progressively infected from one year to another while others appeared to recover.

Table 1. (Cont.)

Cultivar	No. trees	Mean USDA score*	Mean percentage† § length of infected shoot after artificial inoculation
C. Classes 1.0 to 4.9 (fire blight penetrated trunk and scaffold limbs; productivity severely affected)			
Bosc	5	4.9	56.6 (4.4)
Aurora	4	4.5	57.3 (5.7)
Buerré Henri Courcelle	2	4.5	
V25021	2	4.5	55.6 (3.1)
Magness	9	4.5	
Merton Pride	3	4.4	
Souvenir du Congress	3	4.3	
Fertility	3	3.8	
Flemish Beauty	3	3.8	55.6 (5.4)
Highland	4	3.7	51.0 (3.1)
Precose de Trevoux	2	3.5	
Santa Maria	3	3.4	
Devoe	3	3.2	
President Devoilaine	2	3.0	
Sheldon	3	2.8	
President Barabe	2	2.5	
Bartlett	6	2.2	53.9 (4.6)
Doyenned'Ete	3	2.2	
Dr. Jules Guyot	3	1.6	
Starkcrimson (Clapp's Favoritesport)	5	1.5	
Clapp's Favorite	2	1.5	
Gorham	2	1.4	
Buerré Hardy	2	1.3	
Dessertina	2	1.3	
Phileson	2	1.0	
Mean of:			
11 inoculated cultivars, mean scores 10.0–8.0 (A)		9.0	24.4
5 inoculated cultivars, mean scores 7.9–6.0 (B)		7.0	44.0
6 inoculated cultivars, mean scores 5.9–1.0 (C)		3.9	55.1

* USDA Fire Blight Scoring System: 10 = no blight; 9 = 1–3%, current season wood only; 8 = 4–6%. 1– to 2–year–old wood; 7 = 7–12%, 1– to 3–year–old wood in upper 1/8 of tree; 6 = 13–25%. 2– to 3–year–old or older wood and in upper 1/4 of tree; 5 = 26–50%. 3–year–old or older wood and in upper 1/2 of tree; 4 = 51–75%, older wood in lower 1/2 of tree; 3 = 76–88%, old wood in lower 1/4 of tree; 2 = 89–99%, base of trunk and 1 = 100%. tree dead.

† The measurements of percentage length of infected shoot is significantly correlated with the field ratings (r = 0.737).

§ The standard error of the mean is presented in the brackets.

Maxine was the only cultivar that remained free of fire blight. Maxine is not immune because infection in it has been reported previously (2, 3). Cultivars with a score of 8.0 or greater were considered resistant. In this class fire blight infection was limited mainly to current season shoots, although some infection penetrated as far as 2-year-old wood. Minimal surgical pruning was required to remove fire blight and maintain fruit production. Seckel, Kieffer, and Moonglow were the only cultivars grown commercially in Ontario that fell into this class. Old Home is a resistant cultivar that is used as a parent for seedling rootstock production, but the fruit is of no Commercial worth. Cultivars in Table 1 with a rating of 7.9 or greater are being used as sources of fire blight resistance in the Harrow breeding program.

Fire blight penetrated 3-year-old wood of cultivars scoring 6.0 to 7.9. Major surgical pruning was required to remove diseased branches. Production was maintained at commercial levels in the pruned trees. Anjou, Giffard, Stewart's Bartlett, and Russett Bartlett were cultivars of commercial importance in Ontario that fell in this class.

Fire blight penetrated 4-year-old and older wood of cultivars scoring 5.9 or less. Commercial production could not be maintained by surgical pruning and whole trees were frequently killed.

Reaction ratings of cultivars in the Harrow collection were similar to those in other collections (2, 3) with few exceptions. Reaction of several new cultivars, including Aurora, Barseck, Doyenne d'Ete, Highland, V-25021, N.Y. ***8760,*** Mac, Mericourt, and Merton Pride, are reported which did not appear in these previous reports.

All inoculated shoots showed fire blight symptoms. The percentage infection in current season shoots was significantly correlated with ratings of natural fire blight (r -0.737) (Table 1).

Analysis of variance on the mean percentage infected shoots was not carried out because of wide differences in variance among cultivars (significantly different at the 1% level by Bartlet's test of homogeneity). The standard errors of the mean are presented in Table 1.

On the average, cultivars in which natural fire blight penetrated little beyond current season shoots (USDA score ***8.0*** to 10.0) were more resistant to artificial inoculation than cultivars in which natural fire blight penetrated into 3-year-old wood (USDA score 6.0 to 7.9). and these latter cultivars in turn were more resistant to artificial inoculation than cultivars in which natural fire blight penetrated beyond 3-year-old wood (USDA score 1.0 to 5.9). All cultivars that which were rated ***8.0*** or higher ranked greater in resistance to artificial inoculation than cultivars that ranked 5.9 or less. The artificial inocualtion technique appeared to be reliable for distinguishing cultivars in which fire blight developed no further than succulent shoots from those in which it deeply penetrated the woody parts of the tree. Magness, which is trunk-susceptible and shoot resistant, is an exception, but this type of cultivar is rare and can be identified by a trunk inoculation technique (6).

Inoculation techniques have been used previously for measuring fire blight resistance of pear cultivars (1, 4, ***6).*** but with this method the infection was removed when it reached 1-year-old wood and further spread of the disease was prevented. This allowed susceptible cultivars to be spared for fruit evaluation and for breeding purposes.

Acknowledgments

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