# Evaluating Fire blight Resistance among Flowering Crabapples (*Malus* spp.)

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**Nature of Work:** Fire blight, caused by the bacterium *Erwinia amylovora*, is one of the most significant diseases of rosaceous plants, particularly members in the subfamily Maloideae. Susceptible plants can be severely damaged and killed by fire blight in nursery and landscape plantings. The disease can be especially problematic in the SE United States where environmental conditions are favorable for the pathogen. Flowering crabapples vary considerably in resistance to this disease providing opportunities for the selection and development of superior plants (2, 7).

Research on fire blight resistance of flowering crabapples has been limited and has primarily been based on observations of natural infection (2, 4, 5, 6, 7). Because incidence of fire blight can be sporadic and vary from region-to-region and year-to-year, observations and results from field surveys can be inconsistent and variable. Plants that initially appear to be resistant may later be found to be susceptible when conditions are favorable for disease development. Controlled inoculations of actively growing shoots with *E. amylovora* can provide an effective and consistent means for evaluating fire blight resistance (1, 3).

Forty-nine *Malus* taxa, in a field plot arranged as a randomized complete block experimental design with three replications, were screened for fire blight resistance at the Mountain Horticultural Crops Research Station, Fletcher, N.C. Trees were planted between March 1990 and March 1991. *Erwinia amylovora* strain Ea 273, a virulent strain obtained from Cornell University, was used as the inoculum at a concentration of ~ 4.7 x $10^8$ cfu/ ml. The two youngest leaves on actively growing shoots were bisected with a small pair of scissors that had been dipped into the inoculum prior to each cut. Each tree was divided into quadrants and one actively growing shoot (subsample) in each quadrant was inoculated on 20 May 1999. Disease assessments were made 40 days after the initial inoculations. Lesion length and total length of the current season's growth were measured. The severity of infection was calculated as the length of the fire blight lesion as a percentage of overall shoot length.

Trees in the same field plot as described previously were also evaluated for natural occurrence of fire blight. Disease severity was rated during the summers of 1994, 1995, and 1999 (see Table 1 for rating scale). All data were subjected to analysis of variance.

**Results and Discussion:** Resistance to fire blight varied widely among the taxa screened. Lesion lengths ranged from 0 to 100 % of overall shoot length (Table 1). 'Sinai Fire', 'Golden Raindrops' and M. tschonoskii were highly susceptibility and differed significantly from other taxa screened. Lesions extended into prior year's growth on some of the replicates of 'Sinai Fire', 'Golden Raindrops', 'Silver Moon', M. tschonoskii. Thirty-six taxa did not differ significantly from 0 % infection while ten others differed significantly from both 0 and 100% and were considered intermediate in susceptibility to fire blight strain Ea 273 under the conditions of this test.

Disease ratings of natural infections varied considerably over the three years (Table 1). Nine, 14, and 22 taxa showed some infection for 1994, 1995, and 1999, respectively. Infection in 1999 was higher on average than in 1994 and 1995. There were many instances where certain cultivars had no disease in some years, but severe infections in others. For example, *Malus tschonoskii* and *Malus* 'Brandywine' received a zero rating for both 1994 and 1995 but had mean disease ratings of >2 for 1999.

In many cases there was considerable agreement between results from natural infection and controlled inoculations. The taxa *M. sieboldii* 'Calocarpa', 'David', and 'Adirondack' showed no symptoms of natural infection in all three years, which was consistent with the 0% lesion length under the controlled inoculations. 'Golden Raindrops', 'Sinai Fire', and *M. tschonoskii* all showed symptoms of natural infection, particularly in 1999 when all three received at least a rating of 2, also consistent with susceptibility found in controlled inoculations. However, there were also cases where plants appeared to be resistant based on natural infection, but were susceptible based on controlled inoculations. For example, 'Baskatong' and 'White Angel' showed no sign of natural infection for all three years, yet had mean lesion lengths of 32 and 41%, respectively, under controlled inoculations. In previous studies (6), 'White Angel' was reported as "resistant" and 'Sinai Fire' as "moderately resistant" under natural disease pressure. In this study, 'White Angel' was found to be susceptible under controlled inoculations while 'Sinai Fire' was found to be one of the most susceptible cultivars under both natural and controlled conditions. Those cultivars reported as highly resistant in this study (*i.e.* 0% lesion length and rating = 0) have also been reported as being resistant in previous studies (6).

Differences in inoculum levels and conditions favoring infection during bloom within and between years may account for differences observed in this study and among studies at various locations. Our results indicate that field observations of fire blight susceptibility, under conditions of natural infection, can be misleading and may not be a reliable method to evaluate resistance. The results presented in this paper are being used as a foundation for additional research on the role of secondary plant metabolites in host plant resistance to *E. amylovora,* host by pathogen strain interactions, and the development of new disease resistant cultivars.

**Significance to the Industry:** Flowering crabapples are one of the most economically important flowering trees produced in the United States. Evaluation, selection, and improvement of cultivars with superior disease resistance will contribute to lower production costs, reduced need for pesticides, improved environmental quality, and superior products. This research utilized a rigorous approach of controlled pathogen inoculation to screen cultivars for resistance to fire blight under “worst case” conditions. Information from this study provides a reliable basis for the selection and improvement of more disease resistant crabapples.

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**Table 1.** Fire blight ratings for flowering crabapples.

| *Malus* taxa | Controlled Inoculations 1999[z] | Natural Infection 1994[y] | Natural Infection 1995[y] | Natural Infection 1999[y] |
|---|---|---|---|---|
| *sieboldii* 'Calocarpa' | 0 | 0.0 | 0.0 | 0.0 |
| 'David' | 0 | 0.0 | 0.0 | 0.0 |
| 'Adirondack' | 0 | 0.0 | 0.0 | 0.0 |
| 'Sentinel' | 1 | 0.3 | 0.7 | 0.0 |
| 'Adams' | 1 | 0.0 | 0.0 | 0.0 |
| 'Pink Princess' | 2 | 0.0 | 0.0 | 0.0 |
| 'Sutyzam' (Sugar Tyme™) | 3 | 0.2 | 0.0 | 0.0 |
| 'White Cloud' | 4 | 0.0 | 0.0 | 0.0 |
| 'Centurion' | 4 | 0.0 | 0.0 | 1.0 |
| *baccata* 'Jackii' | 4 | 0.0 | 0.0 | 0.0 |
| 'Radiant' | 6 | 0.0 | 0.0 | 0.7 |
| 'Molten Lava' | 6 | 0.0 | 0.0 | 0.0 |
| 'Pink Satin' | 6 | 0.0 | 0.0 | 0.0 |
| 'Camzam' (Camelot™) | 7 | NA | 0.0 | 0.0 |
| 'Ormiston Roy' | 7 | 0.0 | 0.7 | 1.7 |
| 'Prairifire' | 7 | 0.0 | 0.0 | 0.0 |
| 'Indian Summer' | 8 | 0.0 | 0.0 | 0.0 |
| *floribunda* | 9 | 0.3 | 1.0 | 1.0 |
| 'Robinson' | 9 | 0.0 | 0.0 | 0.0 |
| 'Narragansett' | 10 | 0.0 | 0.0 | 0.0 |
| 'Dolgo' | 10 | 0.0 | 0.0 | 0.3 |
| *sargentii* | 10 | 0.0 | 0.0 | 0.0 |
| 'Liset' | 11 | 0.0 | 0.0 | 0.7 |
| 'Jewelberry' | 11 | 0.0 | 0.0 | 0.0 |
| 'Purple Prince' | 11 | 0.0 | 0.0 | 0.0 |
| 'Strawberry Parfait' | 11 | 0.3 | 0.0 | 0.0 |
| 'Callaway' | 12 | 0.0 | 0.0 | 0.0 |
| 'Candy Mint' | 13 | 0.0 | 0.0 | 0.0 |
| 'Glen Mills' | 14 | 0.0 | 0.0 | 0.3 |
| 'Silver Drift' | 14 | 0.0 | 0.0 | 0.7 |
| 'Snow Drift' | 14 | 0.0 | 0.3 | 0.3 |
| 'Canary' | 17 | 0.0 | 0.0 | 0.0 |
| 'Hargozam' (Harvest Gold™) | 18 | 0.3 | 0.7 | 1.3 |
| 'Louisa' | 19 | 0.0 | 0.0 | 0.2 |
| 'Prairie Maid' | 22 | 0.0 | 0.0 | 0.0 |
| 'Red Splendor' | 23 | 0.0 | 0.0 | 0.0 |
| 'Doubloons' | 28 | 0.3 | 0.7 | 0.7 |
| 'Baskatong' | 32 | 0.0 | 0.0 | 0.0 |

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| 'Professor Sprenger' | 33 | 0.0 | 0.3 | 0.3 |
| 'Branzam' (Brandywine™) | 39 | 0.0 | 0.0 | 2.0 |
| 'Mary Potter' | 40 | 0.0 | 1.0 | 1.3 |
| 'White Angel' | 41 | 0.0 | 0.0 | 0.0 |
| 'Mazam' (Madonna™) | 50 | 0.0 | 1.7 | 0.3 |
| *hupehensis* | 55 | 0.0 | 0.8 | 2.7 |
| 'Donald Wyman' | 61 | 0.0 | 0.3 | 0.5 |
| 'Silver Moon' | 61* | 1.3 | 2.0 | 2.7 |
| 'Schmidtcutleaf' (Golden Raindrops™) | 91* | 1.0 | 2.0 | 2.3 |
| *tschonoskii* | 100* | 0.0 | 0.0 | 2.5 |
| 'Sinai Fire' | 100* | 1.0 | 0.7 | 2.0 |
| $LSD_{0.05}$ | 25.6 | 0.5 | 0.4 | 0.8 |

[z] Controlled Inoculations: % of total shoot length infected.
[y] Natural infection: 0=no evidence of fire blight, 1=few (1-3) branch tips infected, 2=numerous (>3) branch tips showing symptoms and few (1-3) major branches infected, 3=several (2-3) major branches infected and considerable dieback, 4=major (>30%) portion of the tree killed. NA = data not available.
* Lesion extended into prior year's growth on some branches.