

Cold Hardiness of Crabapple and Pear Cultivars.

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Cultivars of crabapple and Callery pear are widely used in landscaping in much of the United States for their excellent spring floral display. One of the limiting factors for successful use of the Callery pears and some of the crabapple cultivars in northern states is lack of sufficient winter hardiness. Little information is available concerning the timing of initiation and rate of cold acclimation, the maximum cold hardiness potential and the relative rates of deacclimation during warm periods in mid or late winter. To gain some of this information, we've been studying the cold hardiness patterns of many cultivars of crabs and ornamental pears throughout the winter season during the past few years. I'll start with a discussion of the research with pears.

Pear Cold Hardiness

Methods and Materials

Dormant, bare-root, 1-1/4"-caliper, branched trees of ten *Pyrus taxa* were acquired from a commercial nursery in the winter of 1989. In early-May of 1990, six trees of each taxon were potted in 15 gallon containers and grown outdoors at the University of Minnesota Horticultural Research Center, Chanhassen. Four trees of each cultivar were planted in a research nursery approximately 1 mile from the container-grown trees for observation of field performance.

To prevent exposure to lethal temperatures, containerized trees were moved into an overwintering greenhouse during the first week of November after hardening under natural outdoor conditions. Inside the house, containers were covered completely with wood chips to a depth 4 in above the top rim to prevent cold injury to the roots. The greenhouse was covered with an inflated double layer of white polyethylene, and interior air temperature was regulated with thermostatically controlled electric heaters and ventilation fans. Minimum nighttime temperatures were maintained at or above 20° F from November 5 through December 14 and thereafter at or above -4° F. The taxa included in the study were *P. regelii* 'Angel Wing', *P. ussuriensis*, and the *P. calleryana* cultivars 'Aristocrat', 'Autumn Blaze', 'Bradford', 'Capital', 'Chanticleer', 'Fauriei', 'Redspire', and 'Whitehouse'.

Due to a lack of material on the containerized plants, laboratory determinations of hardiness were performed on only a

limited number of sampling dates in 1990-91 and 1991-1992. Evaluations were performed on the same plants at approximately four-week intervals from October 19, 1992 through March 11, 1993. Also evaluated were a single field-grown *P. salicifolia* 'Silver Frost' and mature specimens of *P. ussuriensis* (35 years old) and *P. fauriei* (estimated to be 15-20 years old), growing at the Minnesota Landscape Arboretum. On each sampling date, terminal shoots consisting of the current year's growth were harvested. Stem sections 4 cm in length were prepared after discarding the terminal 5 cm of the shoot. Twelve polyethylene bags were prepared containing six cuttings of each taxon. A copper-constantan thermocouple was inserted into a hole drilled in the pith of one stem section in each bag and the bags were placed in an ultralow-temperature freezer. The temperature in the freezer was dropped at a rate of 5° C per hr. Sample temperatures were monitored on a strip-chart recorder. The range of temperatures used was varied by season to bracket the estimated lethal temperature. Samples were removed from the freezer at 2° C intervals and allowed to thaw under refrigeration at 2° C for 24 hr. The samples were then incubated at ambient room temperature (22 ± 2° C) for 7 days. Stem sections were cut longitudinally and visually evaluated for injury with the aid of a dissecting microscope. Browning of the xylem or cambium/phloem was considered fatal.

Variability in injury between replicates was observed in some taxa as treatment temperatures reached lethal levels. The lowest surviving temperature was determined as the temperature at which no more than one third of the replicates exhibited injury.

Field-grown plants were visually evaluated each spring for cold injury.

Results and Discussion

Of the cultivars included in the study only 'Angel Wing', 'Autumn Blaze', and 'Chanticleer' were still alive in the field following the winter of 1992-93 and none of the cultivars survived the winter of 1993-94.

Results from the freezing tests (Table 1) indicate that there are considerable differences in both the timing of acclimation and in the maximum hardiness potential of the different cultivars of Callery pear. 'Autumn Blaze' possessed the best overall cold tolerance. The rapid acclimation observed between October 19 and November 18, 1992 would limit the susceptibility of this cultivar to injury from early-season freezing events. The maximum mid-winter hardiness level measured for 'Autumn Blaze' was -34° C (-29° F)

'Bradford' was the least hardy cultivar tested, acclimating slowly in the fall and achieving a maximum hardiness level of -28° C (-18° F).

P. salicifolia 'Silver Frost' exhibited greater cold tolerance than the Callery pear cultivars on all sampling dates. This cultivar exhibited good early-season acclimation and tolerated -36° C (-33° F) by mid-December 1992. 'Silver Frost' has been growing in our field trials since 1988, withstanding

-33° C (-28° F) on February 3, 1988 without injury. It exhibited only minor shoot-top die-back after exposure to -36° C (-32° F) in January 1994. A small-statured tree with a pendulous habit and attractive silver-gray foliage, this selection merits further evaluation for use in northern climates.

P. fauriei was more hardy than the Callery pear cultivars on nearly all sampling dates. The specific plant tested has survived at the U of M Horticultural Research Center for more than 15 years without winter injury and recently withstood -36° C (-32° F) in mid-January without injury. This species grows as a large, highly-branched shrub or small tree 3-7 m (10-20 ft) tall (2,4) and is distinctly different from the more upright, medium-size tree, *P. calleryana* 'Fauriei'. With its good cold-hardiness, small fruit, and colorful fall foliage, *P. fauriei* has potential for more widespread use as an ornamental shrub in northern landscapes. It may also have value to breeding programs for development of hardy, small trees.

P. ussuriensis, Ussurian pear, is considered the most cold tolerant member of the *Pyrus* genus. The Arboretum specimen of *P. ussuriensis* was the hardiest of the taxa tested on all sampling dates. This tree withstood -42° C (-44° F) in mid-winter and exhibited excellent early- and late-season hardiness.

Crabapple Cold Hardiness

Materials and Methods

Plants used in this study were established trees growing in field plots at the University of Minnesota Landscape Arboretum. Cold hardiness testing procedures were the same as that used for the pear taxa described previously.

Results and Discussion

Substantial differences in hardiness among crabapple taxa were observed on all sampling dates (Tables 2,3), with no individual cultivar consistently most hardy on all dates. The greatest range of hardiness among taxa (14° C) occurred on the earliest (November 11, 1992) sampling date, indicating that cultivars differed substantially in timing and/or rate of acclimation. The cultivars 'Dolgo', 'Red Jade', 'Red Splendor', and 'Selkirk' possessed the greatest early season hardiness. A comparison of the hardiness profile of 'Red Splendor' with temperature data from Chanhassen, Minn. (Fig. 1), illustrates that these cultivars are capable of withstanding the extreme cold temperatures in this region of the country. In contrast, 'Christmas Holly', 'Donald Wyman', 'Jewelberry', 'Profusion', 'Sentinel', *M. floribunda*, *M. sargentii*, and *M. x zumi calocarpa* were much less hardy in mid-November and would be susceptible to injury from below-average temperatures.

Literature Cited

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- Pellett, Harold and Steve McNamara. 1991. Hardiness of Pyrus taxa. Landscape Plant News 2(nol):4-5.
- Pellett, Harold and Lisa Hunt. 1992. Cold hardiness of Pyrus accessions. Landscape Plant News 3(no. 1):6-7.
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Table 1. Lowest surviving temperatures ($^{\circ}\text{C}$ ($^{\circ}\text{F}$)) of ornamental pear taxa from October 19, 1992 through March 11, 1993

Sampling date (1992-1993)						
Variety	10/19	11/18	12/14	01/13	02/10	03/11
<i>Pyrus calleryana</i>						
'Aristocrat'	-18(0)	-26(-15)	-32(-26)	-32(-26)	-30(-22)	-28(-18)
'Autumn Blaze'	-16(3)	-30(-22)	-32(-26)	-34(-29)	-30(-22)	-26(-15)
'Bradford'	-8(18)	-16(3)	-24(-11)	-24(-11)	-20(-4)	-20(-4)
'Capital'	-14(7)	-20(-4)	-26(-15)	-26(-15)	-26(-15)	-24(-11)
'Chanticleer'	-16(3)	-28(-18)	-30(-22)	-30(-22)	-28(-18)	-26(-15)
'Fauriei'	-14(7)	-26(-15)	-28(-18)	-30(-22)	-28(-18)	-26(-15)
'Redspire'	-16(3)	-28(-18)	-28(-18)	-32(-26)	-28(-18)	-26(-15)
'Whitehouse'	-14(7)	-22(-8)	-26(-15)	-26(-15)	-22(-8)	-20(-4)
<i>P. regelii</i>						
'Angel Wing'	-22(-8)	-28(-18)	-32(-26)	-34(-29)	-32(-26)	-28(-18)
<i>P. salicifolia</i>						
'Silver Frost'	-20(-4)	-32(-26)	-36(-33)	-36(-33)	-32(-26)	-30(-22)
<i>P. fauriei</i>	-20(-4)	-28(-18)	-34(-29)	-36(-33)	-30(-22)	-30(-22)
<i>P. ussuriensis</i>	-26(-15)"	-32(-26)	-34(-29)	-36(-33)	-34(-29)	-32(-26)
<i>P. ussuriensis</i>	-26(-15)"	-40(-40)	-42(-44)	-42(-44)	-42(-44)	-34(-29)

Table 2. Lowest surviving temperature of shoots of ornamental crabapple cultivars in 1991-92.

Taxa	Sampling date		
	11-19	01-13	04-14
Adams	-30 (-22)	-36 (-33)	-18 (0)
Beverly	-34 (-29)	-40 (-40)	-28 (-18)*
Bob White	-30 (-22)	-34 (-29)	-20 (-4)
Candied Apple	-26 (-15)	-32 (-26)	-16 (3)
Centurion	-24 (-11)	-36 (-33)	-16 (3)
Chistmas Holly	-24 (-11)	-30 (-22)	-12 (10)
David	-28 (-18)	-38 (-36)	-14 (7)
Dolgo	-36 (-33)	-40 (-40)	-28 (-18)*
Donald Wyman	-30 (-22)	-34 (-29)	-18 (0)
Harvest Gold	-34 (-29)	-36 (-33)	-24 (-11)
Indian Magic	-24 (-11)	-36 (-33)	-22 (-8)
Indian Summer	-26 (-15)	-36 (-33)	-14 (7)
Jewelberry	-26 (-15)	-26 (-15)	-12 (10)
Liset	-30 (-22)	-36 (-33)	-22 (-8)
Mary Potter	-30 (-22)	-34 (-29)	-24 (-11)
Molten Lava	-36 (-33)	-36 (-33)	-22 (-8)
Ormiston Roy	-34 (-29)	-36 (-33)	-26 (-15)
Prairifire	-32 (-26)	-34 (-29)	-20 (-4)
Prof. Sprenger	-30 (-22)	-38 (-36)	-20 (-4)
Profusion	-28 (-18)	-36 (-33)	-22 (-8)
Ralph Shay	-26 (-15)	-36 (-33)	-24 (-11)
Red Baron	-26 (-15)	-38 (-36)	-20 (-4)
Red Jade	-36 (-33)	-38 (-36)	-20(-4)
Red Splendor	-34 (-29)	-36 (-33)	-16 (3)
Robinson	-24 (-11)	-34 (-29)	-22 (-8)
Ruby Lustre	-26 (-15)	-38 (-36)	-22 (-8)
Selkirk	-36 (-33)	-40 (-40)	-22 (-8)
Sentinel	-28 (-18)	-34 (-29)	-8 (18)
Snowdrift	-32 (-26)	-34 (-29)	-22 (-8)
Sugar Tyme	-30 (-22)	-34 (-29)	-24 (-11)
Velvet Pillar	-32 (-26)	-34 (-29)	-24 (-11)
White Cascade	-30 (-22)	-36 (-33)	-8 (18)
Winter Gold	-32 (-26)	-36 (-33)	-28 (-18)
Zumarang	-26 (-15)	-34 (-29)	-18 (0)
M. baccata 'Jackii'	-34 (-29)	-36 (-33)?	-18 (0)
M. floribunda	-26 (-15)	-34 (-29)	-12 (10)
M. sargentii	-32 (-26)	-38 (-36)	-20 (-4)
M. x zumi calocarpa	-26 (-15)	-32 (-26)	-12 (10)

* Samples were not injured by lowest test temperature.

Table 3. Lowest surviving temperature ($^{\circ}\text{C}$ ($^{\circ}\text{F}$)) of shoots of ornamental crabapple cultivars in 1992-93.

Taxa	Sampling date					
	11-11	12-15	01-19	02-16	03-17	04-26
Adams	-24(-11)	-34(-29)	-38(-36)	-34(-29)	-32(-26)	-23 (-9)
Beverly	-32(-26)	-38(-36)	-38(-36)	-38(-36)	-36(-33)	-21 (-6)
Bob White	-24(-11)	-34(-29)	-38(-36)	-34(-29)	-30(-22)	-17 (1)
Candied Apple	-24(-11)	-36(-33)	-38(-36)	-36(-33)	-32(-26)	-17 (1)
Centurion	-24(-11)	-34(-29)	-38(-36)	-36(-33)	-32(-26)	-19 (-2)
Christmas Holly	-22(-8)	-36(-33)	-38(-36)	-36(-33)	-30(-22)	-21 (-6)
David	-28(-18)	-38(-36)	-38(-36)	-36(-33)	-36(-33)	-15 (5)
Dolgo	-36(-33)	-40(-40)	-40(-40)	-40(-40)	-38(-36)	-26(-15)
Donald Wyman	-22(-8)	-36(-33)	-38(-36)	-36(-33)	-32(-26)	-17 (1)
Harvest Gold	-24(-11)	-36(-33)	-36(-33)	-34(-29)	-34(-29)	-19 (-2)
Indian Magic	-26(-15)	-38(-36)	-38(-36)	-36(-33)	-34(-29)	-23 (-9)
Indian Summer	-24(-11)	-38(-36)	-38(-36)	-36(-33)	-32(-26)	-21 (-6)
Jewelberry	-22(-8)	-32(-26)	-32(-26)	-32(-26)	-26(-15)	-12 (10)
Liset	-24(-11)	-38(-36)	-38(-36)	-38(-36)	-36(-33)	-26(-15)
Mary Potter	-24(-11)	-36(-33)	-36(-33)	-34(-29)	-32(-26)	-15 (5)
Molten Lava	-24(-11)	-38(-36)	-38(-36)	-36(-33)	-34(-29)	-15 (5)
Ormiston Roy	-32(-26)	-36(-33)	-36(-33)	-36(-33)	-32(-26)	-23 (-9)
Prairifire	-26(-15)	-38(-36)	-38(-36)	-38(-36)	-36(-33)	-19 (-2)
Prof. Sprenger	-24(-11)	-38(-36)	-38(-36)	-38(-36)	-34(-29)	-21 (-6)
Profusion	-22(-8)	-34(-29)	-38(-36)	-36(-33)	-34(-29)	-23 (-9)
Ralph Shay	-24(-11)	-36(-33)	-36(-33)	-36(-33)	-32(-26)	-17 (1)
Red Baron	-26(-15)	-38(-36)	-36(-33)	-34(-29)	-32(-26)	-21 (-6)
Red Jade	-36(-33)	-38(-36)	-40(-40)	-36(-33)	-30(-22)	-23 (-9)
Red Splendor	-36(-33)	-40(-40)	-42(-44)	-40(-40)	-36(-33)	-23 (-9)
Robinson	-24(-11)	-32(-26)	-38(-36)	-34(-29)	-32(-26)	-23 (-9)
Ruby Lustre	-26(-15)	-36(-33)	-36(-33)	-36(-33)	-34(-29)	-23 (-9)
Selkirk	-36(-33)	-38(-36)	-42(-44)	-40(-40)	-36(-33)	-21 (-6)
Sentinel	-22(-8)	-36(-33)	-38(-36)	-34(-29)	-28(-18)	-17 (1)
Snowdrift	-26(-15)	-38(-36)	-38(-36)	-36(-33)	-34(-29)	-21 (-6)
Sugar Tyme	-24(-11)	-36(-33)	-38(-36)	-36(-33)	-34(-29)	-19 (-2)
Velvet Pillar	-30(-22)	-36(-33)	-38(-36)	-36(-33)	-34(-29)	-23 (-9)
White Cascade	-22(-8)	-36(-33)	-36(-33)	-32(-26)	-28(-18)	-17 (1)
Winter Gold	-24(-11)	-36(-33)	-38(-36)	-36(-33)	-34(-29)	-21 (-6)
Zumarang	-26(-15)	-38(-36)	-38(-36)	-38(-36)	-32(-26)	-15 (5)
<i>M. baccata</i> 'Jackii'	-32(-26)	-42(-44)	-44(-47)	-38(-36)	-32(-26)	-19 (-2)
<i>M. floribunda</i>	-22(-8)	-34(-29)	-34(-29)	-32(-26)	-28(-18)	-17 (1)
<i>M. sargentii</i>	-22(-8)	-34(-29)	-36(-33)	-36(-33)	-32(-26)	-17 (1)
<i>M. x zumi calocarpa</i>	-22(-8)	-30(-22)	-36(-33)	-36(-33)	-34(-29)	-9 (16)

—●— RS —▲— JB —■— MZC

▨ Average minimum

▨ Record minimum

