CRABAPPLE CULTIVARS TESTED AS STREET TREES: SECOND REPORT

Henry D. Gerhold

Abstract. Seventeen crabapple (*Malus*) cultivars planted under utility wires in 27 communities were evaluated as street trees. In most communities, 2 cultivars were alternated within each of several plots. Cooperators in the Municipal Tree Restoration Program used standardized methods to measure them annually at the end of the growing period for 3 years and periodically afterwards until the ninth year in some cases. Many differences were found in growth rate, height, crown width, and trunk diameter. Most cultivars had healthy foliage, though some injuries were caused by apple scab and several insects. Basal sprouts were common, and low branching of broader cultivars also required periodic pruning especially in confined spaces. Centurion®, Harvest Gold®, Red Jewel®, 'Spring Snow', and Sugar Tyme® are recommended as street trees based on the most extensive data. 'Adams', 'Donald Wyman', 'Prairifire', 'Red Barron', and zumi 'Calocarpa' also appear promising.

Key Words. Crabapple; *Malus*; 'Adams'; American Masterpiece®; American Spirit™; American Triumph™; Brandywine®; Centurion®; 'Donald Wyman'; Harvest Gold®; Madonna®; 'Prairifire'; 'Red Barron'; Red Jewel®; 'Sentinel'; 'Snowdrift'; Sugar Tyme®; Velvet Pillar™; zumi 'Calocarpa'; street trees; performance testing.

Crabapple (*Malus*) cultivars are being evaluated as part of the Municipal Tree Restoration Program. MTRP encourages municipalities to improve their tree programs and provides information to help decision makers select appropriate cultivars for planting under utility wires. Free trees served as an incentive for communities to participate; these were paid for with utility funds. Initial results of crabapple performance tests were reported previously (Gerhold et al. 1994).

Earlier research comparing landscape trees (Reisch et al. 1971; Ticknor 1971; Mower 1973; Kozel 1974) led to the proposal of a cooperative performance testing system for street tree cultivars (Gerhold and Bartoe 1976; Gerhold 1985). The statistical design was based on measurements of 23 cultivars supplied by municipal arborists in Iowa, Michigan, Ohio, Pennsylvania, Vermont, and Washington (Bartoe 1977).

METHODS

Twenty-six communities in Pennsylvania and 1 in Maryland planted the trees represented in this report. Three of the communities had 2 tests planted in different years. Community representatives chose the planting sites with assistance by utility foresters, service foresters, and Extension urban foresters; 2 of these usually assisted each community.

Each test planting consisted of 2 cultivars, except in Dundalk, Maryland, where there were 3, and the second test in Mansfield where there was 1. A typical test consisted of 2 cultivars planted alternately within 4 to 10 plots that could contain 4 to 16 trees each—a total of 50 trees. All test trees were planted along streets and under electric conductors; the utility company arranged for removal of large trees that interfered with utility lines. Both cultivars for a community were ordered B&B from the same nursery, with a caliper of 4.4 or 5.1 cm (1.75 or 2 in.); heights ranged from 2.4 to 3.7 m (8 to 12 ft).

The cultivar tests were planted between 1987 and 1996. A trained cooperator inspected and measured the trees annually during the first 3 years, and then at 3-year intervals. During September or October, a service forester or Extension urban forester used standardized methods to measure tree height, trunk diameter at breast height (dbh), and crown width, and to classify foliage health, branch health, trunk health, maintenance needs, and an overall quality rating (Table 1*). Causes of damage such as disease, insects, drought, and mechanical injuries also were recorded.

An analysis of variance (MINITAB General Linear Model) was conducted on each type of quantitative data from the 2 (or 3) cultivars in a test planting to calculate means and determine significance of differences. Each test location in every year was treated as a

*Tables and figure for this article begin on page 51.

separate experiment with plots providing replication. These results, along with written comments of cooperators, were used to characterize performance of the cultivars.

RESULTS

Many of the cultivars paired at each location differed at ages 3, 6, or 9 in height, crown width, and trunk diameter (dbh) (Table 1). Some of these differences already existed when trees were first planted, even though trees of the same caliper were ordered from the same nursery in most cases. Therefore, it is more revealing to compare growth rates than absolute heights (Figure 1, Table 2). Apical growth was slow for the first 2 years, after which the growth rate was essentially linear until at least the ninth year. Brandywine®, Harvest Gold®, and 'Spring Snow' grew faster than Centurion®, Madonna®, Red Jewel®, and Sugar Tyme®. More limited data on other cultivars indicate that 'Red Barron' grew rapidly, whereas 'Donald Wyman', zumi 'Calocarpa', and 'Snowdrift' grew more slowly in height (Table 2). Data from only the first 3 years proved to be insufficient for classifying growth rates of cultivars, some of which later changed in rank.

By the ninth year, the crown widths of Brandywine and Centurion were broader than heights of the same trees. Sugar Tyme was slightly wider than its height, whereas Harvest Gold, Madonna, Red Jewel, and 'Spring Snow" had narrower crowns (Table 1). The largest trees after 9 years were Brandywine crabs at West Reading, having an average height of 6 m (19.6 ft), a width of 6.9 m (22.6 ft), and dbh of 15.8 m (6.2 in.). The smallest, Sugar Tyme at Ulysses, had an average height of 3.5 m (11.5 ft), a width of 3.6 m (11.8 ft), and dbh of 6.8 cm (2.7 in.).

The foliage of nearly all of the cultivars at all locations was very healthy near the end of the growing season. American Masterpiece®, American Triumph™, and Velvet Pillar™ were the only cultivars that consistently had foliage health ratings below 3.5, indicating more than 25% of their leaf surface area was affected; they had been evaluated at only 1 location. The foliage health ratings of 'Snowdrift' averaged 3.8 at 3 locations, equivalent to about 18% of the leaf area injured. Other cultivars that had occasional foliage ratings below 4.0 were American Spirit™, Brandywine, Harvest Gold, Madonna, and 'Red Barron'. The main causes of foliage injuries were apple scab, fall webworm, Japanese beetle, and gypsy moths.

The overall quality ratings are somewhat more subjective than the other ratings. Opinions could vary among observers, and 1 observer did change his mind as trees matured (see footnote in Table 1). Most ratings consistently were in the range of 7.0 to 9.0, indicating those cultivars were regarded as very good to excellent in health, appearance, and adaptation to site conditions. The ratings of Brandywine and Madonna were inferior to the other cultivars to which they have been compared. Brandywine has large fruit that can be messy when it drops. Madonna fruit was less attractive due to scab and discoloration, and the cultivar had more basal sprouts than others.

Two kinds of complaints applied to most or all of the crabapple cultivars. Basal sprouting was unsightly and occurred repeatedly. The low branching habit could interfere with pedestrians and vehicles, especially branches of the broader cultivars when planted in confined spaces. Proper pruning could overcome these problems, although many municipalities rely on property owners for maintenance practices.

CONCLUSIONS

Cultivars recommended for street trees, based on the evaluations so far, include Centurion, Harvest Gold, Red Jewel, 'Spring Snow', and Sugar Tyme. Others that appear promising according to more limited test data include 'Adams', 'Donald Wyman', 'Prairifire', 'Red Barron', and zumi 'Calocarpa'. Differences in size and growth rate should be considered in relation to space limitations when cultivars are selected for planting.

LITERATURE CITED

Bartoe, D.W., II. 1977. Statistical designs for evaluating and comparing street tree cultivars. M.S. thesis, Penn State Univ., University Park, PA. 98 pp.

Gerhold, H.D. 1985. Performance testing of street tree cultivars: A model project. J. Arboric. 11(9):263–271.

Gerhold, H.D., and W.D. Bartoe, II. 1976. Performance testing tree cultivars in metropolitan environments. J. Arboric. 2(12):221–227.

Gerhold, H.D., H.L. McElroy, and H.L.H. Rhodes. 1994. Street tree performance tests of crabapple cultivars: Initial results. J. Arboric. 20(2):87–93.

Kozel, P.C. 1974. Shade trees for suburban and city arboriculture. HortScience 9(6):515–518.

Mower, R.G. 1973. Some observations on street tree plantings. Proc. Intl. Shade Tree Conf. 49:49–55.

Reisch, K.W., G. Hull, and H.M. Hill. 1971. Case histories of several street tree species and cultivars at selected sites in five Ohio cities. Ohio Agric. Res. Dev. Ctr., Hort. Dept. Series 376. 65 pp.

Ticknor, R.L. 1971. Landscape tree performance. Oregon State Univ. Agric. Exp. Sta., Circular of Information 633. 11 pp.

Acknowledgments. Financial support for the Municipal Tree Restoration Program was provided by utility companies through the Pennsylvania Electric Energy Research Council and by donations of arboricultural firms: ACRT, Allegheny Power Systems, Asplundh Tree Expert Co., Baltimore Gas & Electric Co., Bartlett Tree Expert Co., Davey Tree Expert Co., Duquesne Light, Environmental Consultants Inc., GPU Energy, Hazlett Tree Service, Penn Power, Pennsylvania Power & Light, and UGI Corporation. Service Foresters of the Pennsylvania Bureau of Forestry and the Maryland Department of Natural Resources, and Extension Urban Foresters of Penn State University assisted with community liaison and tree measurements.

Professor of Forest Genetics
School of Forest Resources
Penn State University
109 Ferguson Building
University Park, PA 16802

Zusammenfassung. Es wurden 17 Holzapfelsorten (*Malus*), die in 27 Gemeinden unter Hochspannungsleitungen gepflanzt wurden, als potentielle Strassenbäume bewertet. In den meisten Gemeinden wurden im wesentlichen zwei Sorten an verschiedenen Standorten verwendet. Die Mitarbeiter der kommunalen Baumerhaltungsmaßnahmen benutzten standartsierte Methoden, um die Bäume jährlich am Ende der Wachstumsperiode in einem 3-Jahreszeitraum zu messen. In periodischen Abständen wurde in einigen Fällen auch nach dem neunten Jahr gemessen. Es wurden viele Unterschiede in der Wachstumsrate, Höhe, Kronenweite und Stammdurchmesser gefunden. Die meisten Sorten hatten gesundes Laub, obwohl Apfelrost und verschiedene Insekten Verletzungen verursachten. Das Auftreten von Stockaustrieben am Stammfuß war gewöhnlich, und der tiefe Astansatz bei den breiteren Sorten führte zu regelmäßigen Rückschnitten, besonders an beengten Standorten. Centurion®, Harvest Gold®, Red Jewel®, 'Spring Snow' und Sugar Tyme® werden als Strassenbäume empfohlen, da hier umfangreiches Daten-material vorlag. Adams, Donald Wyman, Prairifire, Red Baron und Calocarpa erscheinen vielversprechend.

Resumen. Diecisiete cultivares de manzano (*Malus*) plantados bajo líneas eléctricas fueron evaluados como árboles urbanos en 27 comunidades. En la mayoría de las comunidades dos cultivares fueron alternados en varias parcelas. Los cooperadores del Programa Municipal de Restauración de Arboles usaron métodos estandarizados para medirlos anualmente y al final del período de crecimiento, durante tres años y periódicamente después hasta el noveno año en algunos casos. Se encontraron muchas diferencias en la tasa de crecimiento, altura, amplitud de la copa y diámetro del tronco. La mayoría de los cultivares tuvieron follaje saludable, aunque la roña del manzano y varios insectos causaron algunos daños. Fueron comunes los rebrotes basales; las ramas bajas de los cultivares amplios también requirieron poda periódica, especialmente en espacios confinados. Centurion®, Harvest Gold®, Red Jewel®, 'Spring now' y Sugar Tyme® son recomendados como árboles para la calle en la mayor parte de la información disponible. 'Adams', 'Donald Wyman', 'Prairifire', 'Red Barron', y 'Calocarpa' también son promisorios.

Table 1. Size, health, and overall ratings of crabapple cultivars, based on data in years 1, 2, 3, 6, and 9 after planting. Average trunk diameter at breast height, tree height, and crown width are given in the most advanced year; foliage health, branch health, and overall ratings are averaged over all years.

Cultivar	Location	Year	Dbh (cm)	Height (m)	Width (m)	Foliage[z] 1 to 5	Branches[z] 1 to 5	Overall[y] 1 to 9
'Adams'	Franklin	3	6.5[x]	3.4[x]	2.6[x]	4.2[x]	4.4[x]	8.2
	Emlenton	3	5.7	3.2[x]	2.5[x]	4.2[x]	4.7	7.5
	Warren	3	2.9	2.7[x]	2.0	4.5	4.9	8.1
American Masterpiece®	Lancaster	3	5.4[x]	3.5[x]	2.7[x]	2.3[x]	3.9	5.0[w]
American Spirit™	Lemoyne-2	3	3.7	3.1[x]	2.3[x]	4.8	5.0	9.0
	Waterford	3	4.2	3.0	1.9	3.9[x]	4.5	7.3
American Triumph™	Mansfield-2	3	2.7	3.3	1.5	2.8	4.5	6.1
Brandywine®	Port Allegany	9	10.2[x]	4.8[x]	5.8[x]	4.0	4.7	5.0[v]
	Galeton	9	10.4	5.4	5.4[x]	3.5[x]	4.6	7.0[v]
	West Reading	9	15.8[x]	6.0[x]	6.9[x]	3.8	4.4[x]	5.5[w]
Centurion®	Ulysses	9	7.1	4.1[x]	4.7[x]	4.0	4.8	7.7
	Dundalk, MD	9	14.1[x]	5.0[x]	5.9[x]	4.7	4.9	—
	Huntingdon	6	9.0	4.1	3.2	4.1	4.6	7.7
	Towanda-2	6	9.0[x]	4.4[x]	3.8	4.3	4.8	6.4
	Roseto	6	6.2	3.4	3.0[x]	4.3	4.2	7.0
	Leechburg	3	5.5[x]	3.7	1.8	4.5	4.7	8.5
	Harrisburg	3	4.6[x]	3.5[x]	2.2[x]	4.4	5.0	9.0
	Hollidaysburg	3	3.6	3.3[x]	2.0[x]	4.4[x]	4.9	6.7
'Donald Wyman'	Southmont	6	7.4	3.7[x]	3.4[x]	4.6	5.0	7.8
	Lemoyne-2	3	3.7	2.8[x]	2.1[x]	4.9	5.0	9.0
	Waterford	3	4.6	3.0	2.0	4.5[x]	4.7	7.9
Harvest Gold®	Towanda-1	9	11.8	5.5	5.3[x]	4.3	4.7	7.4[w]
	Huntingdon	6	8.7	4.4	3.0	4.4	4.7	8.3
	New Milford	3	3.4[x]	3.4	—	3.1[x]	3.9	—
	Lawrenceville	6	8.2	4.7[x]	3.4[x]	4.4[x]	4.9	7.7
	Mansfield-1	6	7.5[x]	4.7[x]	3.6	4.7	4.9	8.2
	Leechburg	3	6.1[x]	3.7	1.9	4.5	4.6	8.5
	Bellefonte	3	4.6[x]	3.7[x]	2.2[x]	3.5[x]	4.0	7.0[w]
Madonna®	Towanda-1	9	11.0	5.4	4.6[x]	3.9	4.8	6.0[w]
	West Reading	9	9.7[x]	5.1[x]	4.0[x]	3.9	3.7[x]	6.5[w]
	Dundalk, MD	9	6.8[x]	3.9[x]	3.8[x]	4.5	4.9	—
'Prairifire'	Lemoyne-1	3	4.7	3.4	2.4	5.0	5.0	9.0
'Red Barron'	Dushore	6	6.8[x]	5.1[x]	2.8[x]	3.7[x]	4.9	7.7[w]
	Mansfield-1	6	6.3[x]	5.1[x]	3.4	4.7	4.9	8.4
	Warren	3	2.6	3.6[x]	2.0	4.5	4.9	7.7
	Harrisburg	3	4.1[x]	3.8[x]	2.0[x]	4.6	4.9	8.9
	Hollidaysburg	3	3.7	3.8[x]	1.8[x]	4.1[x]	5.0	6.0
	Lancaster	3	4.5[x]	4.3[x]	2.1[x]	2.8[x]	3.6	6.0[w]

continued

Table 1 (continued). Size, health, and overall ratings of crabapple cultivars, based on data in years 1, 2, 3, 6, and 9 after planting. Average trunk diameter at breast height, tree height, and crown width are given in the most advanced year; foliage health, branch health, and overall ratings are averaged over all years.

Cultivar	Location	Year	Dbh (cm)	Height (m)	Width (m)	Foliage[z] 1 to 5	Branches[z] 1 to 5	Overall[y] 1 to 9
'Red Jewel®'	Tidioute	9	5.6[x]	4.1	3.2	4.7	4.8	7.5
	Dushore	6	5.4[x]	3.9[x]	2.5[x]	4.5[x]	4.9	8.9[w]
	Robesonia	3	4.6	3.2[x]	1.7[x]	4.2	4.3	7.0[w]
	Bellefonte	3	3.7[x]	3.2[x]	1.7[x]	4.1[x]	4.2	8.0[w]
	Franklin	3	5.8[x]	3.7[x]	2.1[x]	4.8[x]	5.0[x]	8.4
	Lemoyne-1	3	4.8	3.4	2.4	4.9	5.0	9.0
'Sentinel'	Robesonia	3	4.8	3.8[x]	2.0[x]	4.0	4.3	6.0[w]
'Snowdrift'	New Milford	3	4.3[x]	3.4	—	3.6[x]	3.8	—
	Roseto	6	6.6	3.6	3.4[x]	3.9	4.3	6.4
	Montrose	6	6.8	3.9	3.8[x]	3.9[x]	4.7	—
'Spring Snow'	Galeton	9	9.0	5.5	4.0[x]	4.0[x]	4.6	5.4[v]
	Southmont	6	7.7	4.0[x]	2.9[x]	4.4	5.0	8.4
	Towanda-2	6	12.5[x]	5.4[x]	3.9	4.5	4.8	7.1
Sugar Tyme®	Port Allegany	9	7.5[x]	3.9[x]	3.9[x]	4.0	4.7	9.0[v]
	Ulysses	9	6.8	3.5[x]	3.6[x]	4.0	4.7	7.9
	Dundalk, MD	9	13.5[x]	4.8[x]	5.4[x]	4.8	4.9	—
	Tidioute	9	6.9[x]	3.8	3.3	4.6	4.9	7.2
	Lawrenceville	6	8.8	4.3[x]	3.7[x]	4.7[x]	4.6	7.6
	Youngwood	3	4.2[x]	2.7[x]	1.9	4.8[x]	4.9	8.0[w]
Velvet Pillar™	Youngwood	3	4.7[x]	2.8[x]	1.7	3.4[x]	4.9	7.0[w]
zumi 'Calocarpa'	Montrose	6	7.7	4.0	4.1[x]	4.6[x]	4.8	—
	Emlenton	3	5.3	3.1[x]	2.2[x]	4.7[x]	4.6	7.9

[z]Foliage and branch injury ratings: 1 = 65 to 100%, 2 = 45 to 60%, 3 = 25 to 40%, 4 = 5 to 20%, 5 = less than 5% of leaf surface area or of branches injured.

[y]Overall quality ratings: 0 = unsuitable, 5 or 6 = reasonably good appearance and performance, 9 = ideal for the site conditions in adaptation, appearance, and health.

[x]Significantly different at the 95% level from the other cultivar(s) at the same location.

[w]Overall quality ratings at the same location differ by at least 1.0.

[v]Average overall ratings, all by one observer, are not representative of year 9, when Brandywine was rated 0.0 at Port Allegany and 2.0 at Galeton, compared to 9.0 for Sugar Tyme and 8.0 for 'Spring Snow'.

Table 2. Height growth and ranks of crabapple cultivars within 3-year periods from transplanting date until 3, 6, and 9 years later, averaged over varying locations.

	Number of locations			Height growth (cm)				Rank (1 = most)		
Cultivar	3-yr	6-yr	9-yr	Yrs 1–3	Yrs 4–6	Yrs 7–9	Yrs 1–9	Yr 3	Yr 6	Yr 9
'Adams'	3			35				12		
American Masterpiece®	1			62				2		
American Spirit™	2			82				1		
Brandywine®	3	3	3	57	114	45	216	3	1	3
Centurion®	8	5	2	31	68	67	166	13	10	6
'Donald Wyman'	3	1		51	72			7	5	
Harvest Gold®	7	4	1	29	127	90	246	16	3	2
Madonna®	3	2	3	46	69	56	177	10	7	4
'Prairifire'	1			33				15		
'Red Barron'	6	2		52	107			6	2	
Red Jewel®	6	2	1	44	74	49	167	11	6	5
'Sentinel'	1			54				5		
'Snowdrift'	3	2		22	47			17	11	
'Spring Snow'	3	3	1	57	91	114	262	3	4	1
Sugar Tyme®	6	5	4	47	68	30	145	9	7	7
Velvet Pillar™	1			51				7		
zumi 'Calocarpa'	2	1		25	87			14	9	

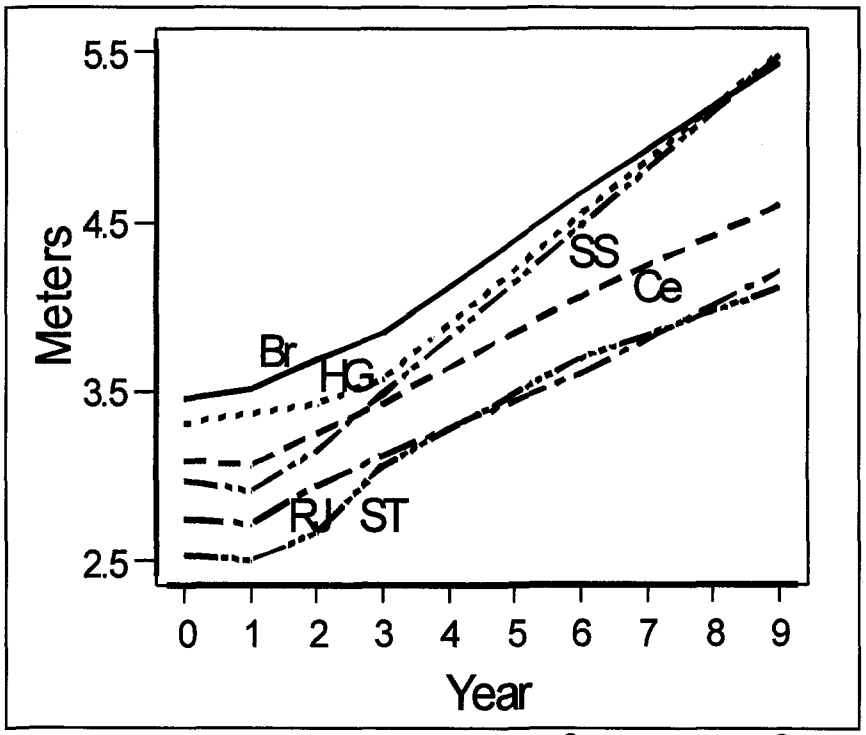

Figure 1. Average height growth of Brandywine® (Br), Centurion® (Ce), Harvest Gold® (HG), Red Jewel® (RJ), 'Spring Snow' (SS), and Sugar Tyme® (ST) crabapples.