



# Disease and Insect Resistant Ornamental Plants

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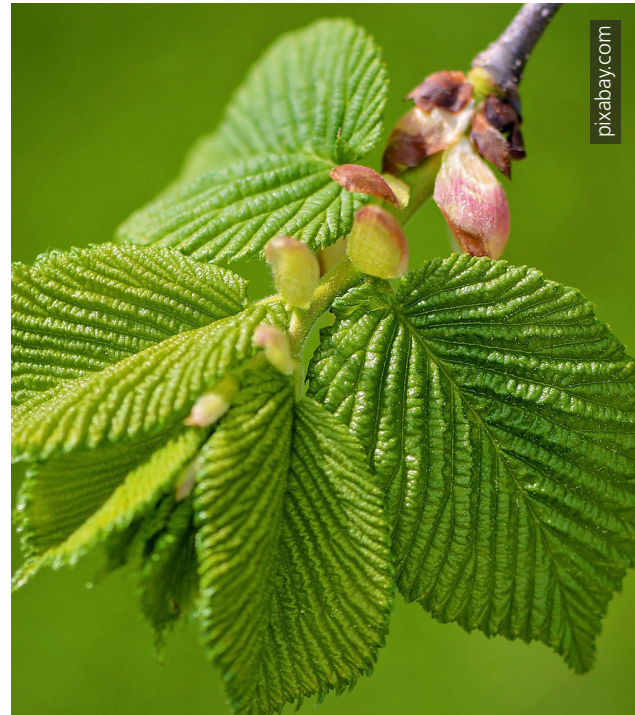
## ULMUS

## Elm

*Ulmus* is a genus of mostly large, deciduous trees found throughout much of the Northern Hemisphere. Until the introduction of the Dutch elm disease pathogen in 1930, the American elm (*U. americana*) was one of the most commonly planted ornamental trees in the United States, known for their graceful, arching form.

The devastating effects of Dutch elm disease on native elms in North America prompted efforts to develop tolerant or resistant cultivars and hybrids\*, including introductions by the National Arboretum of the Agricultural Research Service (USDA) and The Morton Arboretum. The [National Elm Trial](#), coordinated by Colorado State University, was established in 2005 to evaluate commercially available elms at multiple locations across the United States. The trial monitored cultivar survival and growth, as well as disease and insect pressure. A summary of the ten-year study can be found at the [Ten-Year Performance of the United States National Elm Trial](#).

Dutch elm disease is the most serious disease of elms, but there are many potential pests. Other diseases include phloem necrosis (elm yellows), bacterial leaf scorch, cankers, and Verticillium wilt. Insect pests include elm bark and leaf beetles, Japanese beetle, gypsy moth, leafminers, and aphids.



## DISEASES

**Dutch Elm Disease** is a vascular wilt disease caused by the fungi *Ophiostoma novo-ulmi* and *O. ulmi*. Vected by bark beetles and root grafts, symptoms include wilting and yellowing of leaves on one or more branches in the crown of the tree which gradually spread through the entire crown (31). A tree may die within a year or survive in declining condition for several years. For more information on Dutch elm disease, see Cornell's fact sheet: [plantclinic.cornell.edu/factsheets/dutchelmdisease.pdf](https://plantclinic.cornell.edu/factsheets/dutchelmdisease.pdf)

Elm species vary from highly susceptible to highly resistant, and susceptibility varies widely within some species, including *U. glabra*, *U. minor* and *U. pumila* (31). While none are immune, disease-tolerant American elm cultivars are available, and resistant hybrid elms have been bred using European and Asian species (14). Note that some cultivars that are tolerant or resistant to Dutch elm disease may be susceptible to other disease or insect problems.

\*See Appendix for summary of elm cultivar parentage.

Dutch Elm Disease				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus alata</i>				31
<i>Ulmus americana</i>				3, 5, 31
<i>Ulmus americana</i>	American Liberty (=Liberty series)	25, 37, 39	3	
	Augustine			25
	Colonial Spirit®	11		
	Creole Queen	4		
	Delaware	3, 22, 37, 38		
	Independence	22, 36, 37		
	Jefferson	3, 6, 10, 25, 29, 46	31	
	Moline			25
	New Harmony	3, 6, 10, 22, 37, 38, 49	31	
'Lewis & Clark'	Prairie Expedition®	3, 6		
	Princeton	3, 6, 10, 25, 38, 39	31	
	Valley Forge	3, 6, 22, 37, 38, 49	31	
	Washington	3		
<i>Ulmus davidiana</i>	Greenstone™	12		
<i>Ulmus davidiana</i> var. <i>japonica</i> *		4, 31, 37		
	Jacan	3, 23, 25		
	Mitsui Centennial	3, 25		
	Prospector	3, 5, 6, 37, 39, 40, 44, 48		
	Thomson	25		
<i>Ulmus davidiana</i> var. <i>japonica</i> 'Morton'	Accolade®	3, 5, 6, 10, 37		
<i>Ulmus davidiana</i> var. <i>japonica</i> 'JFS-Bieberich'	Emerald Sunshine®	4, 5, 6, 10		
<i>Ulmus glabra</i>				4, 5
<i>Ulmus x hollandica</i>				3, 31
<i>Ulmus laevis</i>				31
<i>Ulmus minor</i>			3	
<i>Ulmus parvifolia</i>		3, 9, 31, 37	5	
<i>Ulmus parvifolia</i>	Allée®	3		
	Athena®	3		
	D.B. Cole®	3		
	Dynasty	24	5	
	Emerald Prairie	9		

Dutch Elm Disease				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus procera</i>				3, 5
<i>Ulmus pumila</i>		3, 31, 37	5	
<i>Ulmus rubra</i>				3, 31
<i>Ulmus serotina</i>				3, 31
<i>Ulmus thomasii</i>				3, 31
<i>Ulmus</i> x	Arno	26		
	Bea Schwarz	3		
	Cathedral	3, 22, 25, 37		
	Charisma	37		
'Morton Stalwart'	Commendation™	3, 5, 6		
	Christine Buisman	3		
	Dampieri		3	
'Morton Red Tip'	Danada Charm™	3, 5, 6, 10, 37		
	Discovery	3		
	Fiorente	26		
	Frontier	5, 6, 10, 22, 37, 39, 40, 43, 45		
	Groeneveld	3		
	Homestead	3, 5, 6, 22, 37, 40, 41		
	New Horizon	3, 5, 6, 10, 22, 33, 37		
	Patriot	3, 5, 6, 10, 22, 25, 37, 47		
	Pioneer	3, 5, 6, 22, 37, 42		
	Plinio	27		
	Regal	3, 6, 22, 35, 37		
	San Zanobi	27		
	Sapporo Autumn Gold	3, 34, 37		
	Sarniensis			3
'Morton Glossy'	Triumph™	3, 5, 6, 10		
	Urban	3, 28, 37		
'Morton Plainsman'	Vanguard™	5, 6, 37		

\*syns. *U. japonica*, *U. wilsoniana*, *U. propinqua* (USDA Germplasm Resource Information System)

**Elm Phloem Necrosis**, also known as **Elm Yellows**, is an often fatal systemic disease of *Ulmus* species usually caused by phytoplasmas. Infection affects fine root hairs first and eventually spreads into phloem tissue, depriving the tree of nutrients. Symptoms include yellowing leaves, premature leaf drop and death of branches. Trees often die within a year or two after foliar symptoms appear (31). In North America, elm yellows can infect several species and hybrids, including *U. alata*, *U. americana* (all cultivars that have been tested are susceptible), *U. crassifolia*, *U. parvifolia*, *U. rubra*, *U. serotina* and *U. rubra x pumila* (31).

ELM YELLOWS				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus americana</i>				3, 31
<i>Ulmus americana</i>	American Liberty (=Liberty series)			30, 37
	Delaware			37
	Independence			37
	New Harmony			37
	Princeton		6	
	Valley Forge			37
<i>Ulmus davidiana</i>	Greenstone™	12		
<i>Ulmus davidiana</i> var. <i>japonica</i> *		37		
<i>Ulmus davidiana</i> var. <i>japonica</i>	Prospector	3, 37, 44		
<i>Ulmus davidiana</i> var. <i>japonica</i> 'Morton'	Accolade®	3, 6, 37		
<i>Ulmus davidiana</i> var. <i>japonica</i> 'JFS-Bieberich'	Emerald Sunshine®	10		
<i>Ulmus parvifolia</i>		37		
<i>Ulmus parvifolia</i>	D.B. Cole®	3		
	Pathfinder	32		
<i>Ulmus pumila</i>		3, 37		
<i>Ulmus</i> x	Cathedral	37		
	Charisma	37		
	Commendation™	3		
'Morton Red Tip'	Danada Charm™	3, 6, 10, 37		
	Discovery	3		
	Frontier	6, 10, 32, 37, 43, 45		
	Homestead	3, 6, 32, 37		
	New Horizon	10, 37		
	Patriot	10, 32, 37, 47	6	
	Pioneer	3, 37		
	Sapporo Autumn Gold	37		

ELM YELLOWS				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
'Morton Glossy'	Triumph™	10		
	Urban	37		
'Morton Plainsman'	Vanguard™	37		

\*syns. *U. japonica*, *U. wilsoniana*, *U. propinqua*

In New York State, the following species of elms can be grown without significant threat from either Dutch elm disease or elm yellows.

DUTCH ELM DISEASE & ELM YELLOWS	
Species	Reference
<i>Ulmus davidiana</i> var. <i>japonica</i> *	7
<i>Ulmus glabra</i>	7
<i>Ulmus laciniate</i>	7
<i>Ulmus laevis</i>	7
<i>Ulmus minor</i>	7
<i>Ulmus parvifolia</i>	7
<i>Ulmus pumila</i>	7

\*syns. *U. japonica*, *U. wilsoniana*, *U. propinqua*

**Verticillium Wilt** is a vascular disease caused by the soil-borne fungi *Verticillium albo-atrum* and *V. dahlia*. Many herbaceous and woody plant species are susceptible, including *Ulmus*. Blockage of conductive tissues may cause yellowing, wilt, scorch, dieback, and decline or death of the plant (31).

Resistance is reported for several hybrids, including *U. x 'Cathedral'* (25), *U. x 'New Horizon'* (6, 33), and *U. x 'Regal'* (35). *U. x 'Sapporo Autumn Gold'* is reported to be tolerant (25, 34) and *U. americana* 'Independence' shows reduced susceptibility (36).

**Elm Anthracnose**, also known as black spot of elm, is caused by the fungal pathogen *Gnomonia ulmea* (syn. *Stegophora ulmea*). Active during prolonged cool, moist weather in spring and early summer, many *Ulmus* species, including all of those native to the US and Canada, are susceptible to varying degrees (31). Symptoms include black spots and premature shedding of diseased leaves, and severe defoliation may occur in highly susceptible trees.

Resistance is reported for *U. parvifolia* cultivars 'Emerald Prairie' (3, 9), 'Prairie Shade' (3), 'Brea' (5) and 'Drake' (5). Limited susceptibility is reported for *U. americana* 'Independence' (36) and hybrids *U. x 'Regal'* (35), *U. x 'New Horizon'* (33), and *U. x 'Sapporo Autumn Gold'* (34).

## INSECTS

**Elm Leaf Beetle**, *Xanthogaleruca* (= *Pyrrhalta*) *luteola*, a European native, was accidentally introduced to the eastern United States in the early 19th century. Today it is found across the country wherever elms are grown. All species are potential hosts, but local preferences for one kind of elm over another may occur where multiple species are found (13).

Both larvae and adults can cause significant foliar damage. Larvae are responsible for skeletonized leaves, while adults chew irregular holes resulting in brown, curled leaves and premature drop. Repeated defoliation can weaken trees and cause branch dieback. Such trees are more susceptible to attack by elm bark beetles which vector for Dutch elm disease.

ELM LEAF BEETLE				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus americana</i>				5
<i>Ulmus americana</i>	American Liberty series (=Liberty series)	34		
	Delaware	37		
	Independence	37		
	New Harmony	37		
	Valley Forge	5, 37	5	
<i>Ulmus canescens</i>				16
<i>Ulmus changii</i>		18		
<i>Ulmus davidiana</i> var. <i>japonica</i> *	Burgundy Glow	50		
	Prospector	3, 5, 6, 37, 44, 48		
<i>Ulmus davidiana</i> var. <i>japonica</i> 'Morton'	Accolade®	3, 6, 10, 37	5	
<i>Ulmus davidiana</i> var. <i>japonica</i> 'JFS-Bieberich'	Emerald Sunshine®	3, 5, 10		
<i>Ulmus glabra</i>				3, 5
<i>Ulmus lanceaefolia</i>		18		
<i>Ulmus parvifolia</i>		3, 5, 9, 37		
<i>Ulmus parvifolia</i>	Allee®	3, 5		
	Athena®	3, 5		
	Drake	5		
	Dynasty	24		5
	Emerald Prairie	9		
	Evergreen	5		
	Prairie Shade	3		
	True Green	5		
<i>Ulmus procera</i>				5
<i>Ulmus pumila</i>				4, 5, 16, 17, 18, 37

ELM LEAF BEETLE				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus prunifolia</i>		18		
<i>Ulmus pseudopropinqua</i>		18		
<i>Ulmus szechuanica</i>		17		
<i>Ulmus taihangshanensis</i>		18		
<i>Ulmus wallichiana</i>				18
<i>Ulmus</i> x	Cathedral			3
'Morton Stalwart'	Commendation™			5, 6, 16
'Morton Red Tip'	Danada Charm™			5, 6
	Discovery	3		
	Frontier	37, 43	3, 5, 6, 45	
	Homestead			5, 6, 37
	New Horizon			5, 33
	Patriot	5, 6, 25, 37, 47		
	Pioneer			5, 6, 37
	Princeton	3	6	
	Sapporo Autumn Gold			37
'Morton Glossy'	Triumph™	6		5
'Morton Plainsman'	Vanguard™	6	3	5
	Urban			25, 37

\*syns. *U. japonica*, *U. wilsoniana*, *U. propinqua*

**Elm Leafminer**, *Fenusa* (= *Kaliopenusa*) *ulmi*, is a European species introduced to North America on imported elms. It is well established in the Northeast and Great Lakes region, including southeastern Canada (13) and has recently been found in the Pacific Northwest (20). Elm leafminer is associated primarily with American elm, English elm and hybrids (2). Larval feeding first appears as whitish spots on leaves which coalesce into blotchlike mines. Severe infestations can cause browning of leaves and defoliation.

ELM LEAFMINER			
Species/Hybrids	Cultivar	Reference	
		Resistant	Susceptible
<i>Ulmus americana</i>			13
<i>Ulmus americana</i>	Jefferson	21	
	New Harmony	21	
	Prairie Expedition	21	
	Princeton	21	
	Valley Forge	21	
<i>Ulmus davidiana</i> var. <i>japonica</i> 'Morton'	Accolade®	3, 25	

ELM LEAFMINER			
Species/Hybrids	Cultivar	Reference	
		Resistant	Susceptible
<i>Ulmus davidiana</i> var. <i>japonica</i> 'JFS-Bieberich'	Emerald Sunshine	21	
<i>Ulmus davidiana</i> var. <i>japonica</i>	Prospector	21	
<i>Ulmus glabra</i>			13
<i>Ulmus glabra</i>	Camperdownii		13
<i>Ulmus parvifolia</i>	Athena Classic Lacebark	21	
<i>Ulmus procera</i>			13
<i>Ulmus procera</i>	Emer II Allee	21	
	Everclear Lacebark	21	
<i>Ulmus</i> x	Cathedral	25	
	Frontier	21	
	New Horizon	6, 33	
'Morton Glossy'	Triumph™	21	

\*syns. *U. japonica*, *U. wilsoniana*, *U. propinqua*

**Japanese Beetle**, *Popillia japonica*, is a foliage feeder of many landscape plants. Leaf pubescence on some *Ulmus* species appears to be a feeding deterrent (15).

JAPANESE BEETLE				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus americana</i>				8, 19
<i>Ulmus americana</i> 'Lewis & Clark'	Prairie Expedition®		1	
<i>Ulmus davidiana</i> var. <i>japonica</i> * 'JFS-Bieberich'	Emerald Sunshine®	1, 10		
<i>Ulmus elongata</i>		15		
<i>Ulmus glaucescens</i>		15		
<i>Ulmus lamellosa</i>		15		
<i>Ulmus lanceaefolia</i>		19		
<i>Ulmus macrocarpa</i>		15		
<i>Ulmus parvifolia</i>		1, 3, 9, 15		
<i>Ulmus parvifolia</i>	Athena Classic Lacebark	1		
	Emer II Allee	1		
	Everclear Lacebark	1		
<i>Ulmus procera</i>				8, 19
<i>Ulmus prunifolia</i>		19		
<i>Ulmus pseudopropinqua</i>		19		



JAPANESE BEETLE				
Species/Hybrids	Cultivar	Reference		
		Resistant	Intermediate	Susceptible
<i>Ulmus rubra</i>			8	
<i>Ulmus taihangshanensis</i>		19		
<i>Ulmus wallichiana</i>			19	
<i>Ulmus</i> x 'Morton Stalwart'	Commendation™			6
	Frontier		1	
	New Horizon		1	

\*syns. *U. japonica*, *U. wilsoniana*, *U. propinqua* (USDA Germplasm Resource Information System)

**Aphids** are small, soft-bodied insects that feed on plant sap and are common on many ornamental plants. Most do not cause serious harm, but extensive feeding can cause leaf curling and wilting. Resistance is reported for *U. x 'Discovery'* (3) and *U. davidiana* var. *japonica* 'Jacan' (23).

## REFERENCES

- Condra, J.M., C.M. Brady, and D.A. Potter. 2010. Resistance of landscape-suitable elms to Japanese beetle, gall aphids, and leaf miners, with notes on life history of *Orchestes alni* and *Agromyza aristata* in Kentucky. *Arboric. & Urban Forestry* 36(3):101-109.
- Cranshaw, W., and D. Shetlar. 2018. *Garden Insects of North America*. Princeton University Press, Princeton, NJ.
- Dirr, Michael A. 2009. *Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses*. 6th ed. Stipes Publishing L.L.C., Champaign, IL.
- Dirr, Michael A. 2011. *Dirr's Encyclopedia of Trees & Shrubs*. 1st Ed. Timber Press, Inc., Portland, OR.
- Dreistadt, S.H., and J.K. Clark. 2016. *Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide*. 3rd Ed. University of California, Agriculture and Natural Resources, Oakland, CA.
- "Elm cultivars." 2017. The Morton Arboretum. [mortonarb.org/trees-plants/tree-plant-descriptions/elm-cultivars](http://mortonarb.org/trees-plants/tree-plant-descriptions/elm-cultivars)
- "Elms: Disease Resistance Beyond Dutch Elm Disease". (2002, May 17). *Branching Out: An Integrated Pest Management Newsletter for Trees and Shrubs*, Vol. 9, No. 4.
- Fleming, W.E. 1972. *Biology of the Japanese beetle*. Technical Bulletin 1449 of the Agricultural Research Service, USDA, Washington, D.C.
- Griffin, J.J., H. Khatamian, J.C. Pair, and M. Shelton. 2004. 'Emerald Prairie' lacebark elm. *Hort-Science* 39(1):181-182.
- J. Frank Schmidt & Son Co. "Elm renaissance is on the horizon." [jfschmidt.com/elmtrial](http://jfschmidt.com/elmtrial)
- J. Frank Schmidt & Son Co. "*Ulmus americana* 'JFS-Prince II' Colonial Spirit® Elm" JFS Introductions. [jfschmidt.com/pdfs/colonialspiritelm.pdf](http://jfschmidt.com/pdfs/colonialspiritelm.pdf)
- J. Frank Schmidt & Son Co. "*Ulmus davidiana* 'JFS KW2UD' Greenstone™ Elm" JFS Introductions. [jfschmidt.com/pdfs/greenstoneelm.pdf](http://jfschmidt.com/pdfs/greenstoneelm.pdf)
- Johnson, W.T., and H.H. Lyon. 1991. *Insects that Feed on Trees and Shrubs*. 2nd Ed. Cornell Univ. Press, Ithaca, NY.
- Marcotrigiano, M. 2017. Elms revisited. *Arboric. & Urban Forestry* 43(6):217-241.

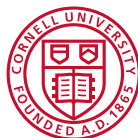
15. Miller, F., S. Jerdan, and G. Ware. 1999. Feeding preference of adult Japanese beetles (Coleoptera: Scarabaeidae) for Asian elm species and their hybrids. *J. Econ. Entomol.* 92(2):421-426.  
doi: [10.1093/jee/92.2.421](https://doi.org/10.1093/jee/92.2.421)
16. Miller, F., K. Malmquist, and G. Ware. 2003. Resistance of Ulmaceae to feeding by the adult elm leaf beetle (Coleoptera:Chrysomelidae). *J. Arboric.* 29(2):98-103.
17. Miller, F., and G. Ware. 1994. Preference for and suitability of selected elms, *Ulmus* spp. and their hybrids for the elm leaf beetle, (*Pyrrhalta luteola* Coleoptera:Chrysomelidae). *J. Environ. Hort.* 12(4):231-235.
18. Miller, F., and G. Ware. 2001. Resistance of temperate Chinese elms (*Ulmus* spp.) to feeding by the adult elm leaf beetle (Coleoptera:Chrysomelidae). *J. Econ. Entomol.* 94(1):162-166.  
doi: [10.1603/0022-0493-94.1.162](https://doi.org/10.1603/0022-0493-94.1.162)
19. Miller, F., G. Ware, and J. Jackson. 2001. Preference of temperate Chinese elms (*Ulmus* spp.) for the adult Japanese beetle (Coleoptera: Scarabaeidae). *J. Econ. Entomol.* 94(2):445-448.  
doi: [10.1603/0022-0493-94.2.445](https://doi.org/10.1603/0022-0493-94.2.445)
20. "Pacific Northwest Nursery IPM, Insects." 2017. Oregon State University. [oregonstate.edu/dept/nurspest/elm\\_leafminer.htm](http://oregonstate.edu/dept/nurspest/elm_leafminer.htm)
21. Potter, D.A., and C.T. Redmond. 2013. Relative resistance or susceptibility of landscape-suitable elms (*Ulmus* spp.) to multiple insect pests. *Arboric. & Urban Forestry* 39(5):236-243.
22. Pscheidt, J.W., and C.M. Ocamb (Senior Eds.). 2017. Pacific Northwest Disease Management Handbook. Oregon State University.
23. Ronald, W.G. 1979. Jacan Japanese elm. *Can. J. Plant Sci.* 59(1):267-268. doi: [10.4141/cjps79-042](https://doi.org/10.4141/cjps79-042)
24. Santamour, F.S., Jr. 1984. 'Dynasty' Chinese elm. *HortScience* 19(6):898-899.
25. Santamour, F.S., Jr., and S.E. Bentz. 1995. Updated checklist of elm (*Ulmus*) cultivars for use in North America. *J. Arboric.* 21(3):122-131.
26. Santini, A., A. Fagnani, F. Ferrini, L. Ghelardini, and L. Mittempergher. 2007. 'Fiorente' and 'Arno' elm trees. *HortScience* 42(3):712-714.
27. Santini, A., A. Fagnani, F. Ferrini, and L. Mittempergher. 2002. 'San Zanobi' and 'Plinio' elm trees. *HortScience* 37(7):1139-1141.
28. Schreiber, L.R., and H.V. Main. 1976. 'Urban' elm. *HortScience* 11(5):517-518.
29. Sherald, J.L., F.S. Santamour, Jr., R.K. Hajela, N. Hajela, and M.B. Sticklen. 1994. A Dutch elm resistant triploid elm. *Can. J. For. Res.* 24(4):647-653. doi: [10.1139/x94-087](https://doi.org/10.1139/x94-087)
30. Sinclair, W.A., H.M. Griffiths, and I. Lee. 1994. Mycoplasma-like organisms as causes of slow growth and decline of trees and shrubs. *J. Arboric.* 20(3):176-189.
31. Sinclair, W., and H.H. Lyon. 2005. *Diseases of Trees and Shrubs*. 2nd Ed. Cornell Univ. Press, Ithaca, NY.
32. Sinclair, W.A., A.M. Townsend, H.M. Griffiths, and T.H. Whitlow. 2000. Responses of six Eurasian *Ulmus* cultivars to a North American elm yellows phytoplasma. *Plant Disease* 84(12):1266-1270.  
doi: [10.1094/PDIS.2000.84.12.1266](https://doi.org/10.1094/PDIS.2000.84.12.1266)
33. Smalley, E.B., and R.P. Guries. Elm tree named New Horizon. US Plant Patent 8,684, filed June 18, 1992 and issued April 12, 1994.
34. Smalley, E.B., and D.T. Lester. 1973. 'Sapporo Autumn Gold' elm. *HortScience* 8(6):514-515.
35. Smalley, E.B., and D.T. Lester. 1983. 'Regal' elm. *HortScience* 18(6):960-961.
36. Smalley, E.B., and D.T. Lester. Elm tree named Independence. US Plant Patent 6,227, filed October 15, 1985 and issued July 19, 1988.
37. Tisserat, N., J. Sherald, G. Moorman, and P. Colbaugh. 2001. Elm diseases, pp. 136-139. In: R.K. Jones and D.M. Benson, editors. *Diseases of Woody Ornamentals and Trees in Nurseries*. APS Press, St. Paul, MN.

38. Townsend, A.M., S.E. Bentz, and L.W. Douglass. 2005. Evaluation of 19 American elm clones for tolerance to Dutch elm disease. *J. Environ. Hort.* 23(1):21-24.
39. Townsend, A.M., S.E. Bentz, and G.R. Johnson. 1995. Variation in response of selected American elm clones to *Ophiostoma ulmi*. *J. Environ. Hort.* 13(3):126-128.
40. Townsend, A.M., and L.W. Douglass. 2004. Evaluation of elm clones for tolerance to Dutch elm disease. *J. Arboric.* 30(3):179-184.
41. Townsend, A.M., and W.O. Masters. 1984. 'Homestead' elm. *HortScience* 19(6):897-898.
42. Townsend, A.M., and W.O. Masters. 1984. 'Pioneer' elm. *HortScience* 19(6):900.
43. Townsend, A.M., L.R. Schreiber, W.O. Masters, and S.E. Bentz. 1991. 'Frontier' elm. *HortScience* 26(1):80-81.
44. Townsend, A.M., L.R. Schreiber, W.O. Masters, and S.E. Bentz. 1991. 'Prospector' elm. *HortScience* 26(1):81-82.
45. U.S. National Arboretum Plant Introduction. 1990. *Ulmus* 'Frontier'.
46. U.S. National Arboretum Plant Introduction 2005. *Ulmus americana* 'Jefferson'.
47. U.S. National Arboretum Plant Introduction. 1993. *Ulmus* 'Patriot'.
48. U.S. National Arboretum Plant Introduction. 1990. *Ulmus davidiana* var. *japonica* 'Prospector'.
49. U.S. National Arboretum Plant Introduction. 1996. *Ulmus americana* 'Valley Forge' and 'New Harmony'.
50. West, T.P., G. Morgenson, L. Chaput, and D.E. Herman. 2017. *Ulmus davidiana* var. *japonica* 'Burgundy Glow' (Northern Empress® Japanese elm): A new fall color tree. *HortScience* 52(1):198-199. doi: [10.21273/HORTSCI11140-16](https://doi.org/10.21273/HORTSCI11140-16)

## OTHER RESOURCES

"Missouri Botanical Garden." [missouribotanicalgarden.org](http://missouribotanicalgarden.org)

"Woody Plants Database." Urban Horticulture Institute, Cornell University, [woodyplants.cals.cornell.edu/plant/search](http://woodyplants.cals.cornell.edu/plant/search)



**Cornell Cooperative Extension**

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# Appendix

## Parentage Elm Cultivars of Importance to the American Nursery Trade

