'Frontier' Elm

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Because of their adaptability and tolerance to environmental stresses, elms are well-suited for use in urban environments. Unfortunately, Dutch elm disease, caused by the fungus *Ceratocystis ulmi* (Buisson) C. Moreau, can kill many elms, particularly American elm (*Ulmus americana* L.). The 'Frontier' hybrid elm is a product of a U.S. Dept. of Agriculture program to develop new insect- and disease-resistant elm clones.

Origin

'Frontier' elm (NA 55393, PI 536049) resulted from a controlled pollination made in 1971 between a selection of *Ulmus carpinifolia* Gleditsch (female) and a selection of *Ulmus parvifolia* Jacq. (male) (Townsend, 1975). This hybrid showed a high level of disease tolerance when inoculated with a mixed spore suspension of aggressive and nonaggressive strains of *Ceratocystis ulmi* in May 1974 (Townsend, 1979).

For additional disease testing, 'Frontier' was propagated by shoot cuttings and in 1987 these ramets, along with ramets from two other clones, were established in nursery beds in a randomized block, split-plot design with three blocks. Ramets of all three clones were inoculated in 1989 to determine relative resistance. Whole plots in the split-plot design consisted of 14 trees of each clone in each block; the two subplots within each whole plot represented two inoculation dates, either 22 May or 21 June 1989. Thus, seven trees of each clone in each block were inoculated in May and seven other trees of each clone in each block were inoculated in June. Inoculations on each date were made in the two largest branches in the upper one-half of the crown with a mixed spore suspension containing 10^6 spores of *C. ulmi*/ml. 'Frontier' was about as resistant as 'Homestead' elm (Townsend and Masters, 1984), and more resistant than Standard Resistant Clone No. 1 (Table 1). This clone has proved to be resistant to both aggressive and nonaggressive strains of the fungus in previous studies. 'Frontier' has shown moderate resistance to the elm leaf beetle [*Xanthogaleruca luteola* (Müller)] in laboratory and field tests (Hall et al., 1987).

Elm yellows is a systemic, often lethal elm disease apparently caused by mycoplasma-like organisms. Natural infections are known only in five North American species; elm species of European or Asiatic origin and hybrids between these and native species are tolerant or immune (Sinclair et al., 1987). When grown for 7 years among hundreds of infected American elms at Delaware, Ohio, ramets of 'Frontier' have expressed no symptoms of elm yellows. Based on this field

response and on its parentage, 'Frontier' is likely to be highly tolerant to natural infections of elm yellows.

Description

'Frontier' has a pyramidal crown (Fig. 1) and at 19 years from seed in Delaware, Ohio, the original selection was 8.2 m tall and the average crown spread was 4.9 m. Leaves are lanceolate and doubly serrate and average 54 mm long and 32 mm wide. Young leaves show red (47A Royal Horticultural Society, 1966) that gradually changes to mature yellow green (147A) as the leaf matures. Autumn color is red-purple (59A).

Branchlets are numerous and range from yellow-green (153A) to green-brown (199B). Branch angles range from 35° to 80°, and average 50°. At 18 years, bark on 'Frontier' more closely resembles that of the female

Table 1. Relative susceptibility of several elm clones to *Ceratocystis ulmi*.

Clone	Avg. percent of crown affected by symptoms 4 weeks after inoculation		Avg. percent dieback of crown 5 or 6 months after inoculation	
	Inoculation dates (1989)			
	22 May	21 June	22 May	21 June
Standard Resistant				
Clone No. 1 ²	17 ± 4	0	11 ± 2	0
'Frontier'	4 ± 1	0	2 ± 1	0
'Homestead'	0	0	0	0

²*U. glabra* × (*U. wallichiana* × *U. carpinifolia*).

Fig. 1. The 'Frontier' elm.

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parent (*U. carpinifolia*) but has the large orange lenticels of the male parent (*U. parvifolia*). The bark is greyed-green (197B). Flowers have not been produced on the parent tree in Ohio or elsewhere, even though other hybrids between spring- and fall-flowering elms have flowered from late October to mid-November when grown in Washington, D.C. (Santamour, 1989).

Compared to the male parent, *U. parvifolia*, 'Frontier' grows faster and has more upright branching. This clone has performed well in such diverse locations as California, Illinois, Ohio, Oklahoma, Oregon, Tennessee, and Virginia. It has survived three winters in St. Paul, Minn., but sustained major cold injury in that location. It can generally be considered reliable to USDA hardiness zone 5 (U.S. Dept. Agr., 1990).

Because of its small size, disease and insect resistance, and beautiful red-purple au-

tumn leaf color, 'Frontier' elm should make a desirable street, park, landscape, or highway tree. It is easily propagated from softwood cuttings taken May through July and dipped in 0.8% indolebutyric acid, then placed in a mixture of 1 peat : 1 perlite (v/v) in a mist propagation system. Overwintering outside has been successful in Ohio when 10 cm of sawdust is used as a mulch over the pots.

Availability

The U.S. Dept. of Agriculture released the 'Frontier' elm to cooperating nurseries in 1990. Several wholesale nurseries are propagating and growing liners. No materials are available from the U.S. National Arboretum at this time.

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