National elm trial: Initial report from Northern California

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In early May, 2005 14 cultivars of elm trees were planted at the Bowley Plant Science Teaching Center, UC Davis. The planting was part of the National Elm Trial, with trees provided by J.F. Schmidt & Son and Princeton nurseries to 18 locations across the nation. The purpose of the study is to determine the growth and horticultural performance of commercially available Dutch elm disease resistant cultivars in various climate regimes. This initial report summarizes data collected on tree growth, habit, pruning requirements, and pest and disease resistance. A second report will update these results in 2011.

METHODS

The 0.75-1.5 inch (1.9-3.8 cm) caliper bare root stock from J.F. Schmidt & Son were planted May 5, 2005 (Table 1). Five trees from each of the 14 cultivars were planted, or 70 total. Trees were spaced every 20-ft. (6m) in a four-row random block design. The trees were planted into a relatively flat, sandy loam soil. Vertebrate chewing on bark was minimized by trunk guards. During the first year trees were irrigated from a single drip emitter. They received approximately 13 gallons per tree twice a week during the summer, and reduced amounts during spring and fall. The trees received no irrigation from November through March, although weather dictated exact stop and start times. When the second emitter was added trees received about 50 gallons each per watering during summer. In 2007 this amount increased to about 100 gallons per watering. Trees were pruned each spring and measured each fall. In fall 2010 the best performing cultivars will be transplanted to various sites on campus and monitored for another five years.

Ten new trees from Princeton nursery were planted in May 2006, five *Ulmus* 'New Harmony' and five *U.* 'Princeton' (Table 1). Because these cultivars have two growing seasons and the others have three seasons, it is difficult to compare growth across all cultivars. To reduce the bias of initial slow growth after planting, average annual growth data are presented excluding the first year of establishment. Only 2007 growth data are shown for the 2006 transplants, while 2006 to 2007 data are averaged for the 2005 transplants.

Tree measurements included diameter at breast height (dbh) (to nearest 0.1 cm by tape), tree height (to nearest 0.1 m by range pole), and crown diameter in two directions (to nearest 0.1 m by tape). Observations of the presence of pests and diseases were made each spring and fall.

In August 2008, all trees were subjectively evaluated for pruning requirements. Pruning requirement ratings were based on visual assessments of growth rate and structural characteristics. Structural characteristics evaluated included central leader development, branch size relative to the trunk, and branch attachment characteristics. Cultivars viewed as needing a considerable amount of pruning to develop strong structure were assigned a high score (5), while those needing less pruning were given a lower score (1). All evaluations were conducted without prior knowledge of cultivar identification (blind ratings). Trees had completed only two pruning cycles prior to these evaluations, except for New Harmony which had been pruned once.

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Figure 1. An Emerald Sunshine tree, one of the slower growing cultivars, seen in the UC Davis plot June, 2008.

Table 1. Names, parentage and rootstock of sixteen cultivars tested at the UC Davis plot.		
Variety and trade name	Parentage	Rootstock
Ulmus propinqua 'JFS-Bieberich' Emerald Sunshine® Elm	*U. propinqua*	*U. pumila* rootstock, budded
Ulmus parvifolia 'Emer II' Allee® Elm	*U. parvifolia*	Own root, tissue culture
Ulmus 'Frontier' Frontier Elm	*U. carpinifolia* X *U. parvifolia*	Own root, softwood cutting
Ulmus 'Homestead' Homestead Elm	*U. glabra* X *U. carpinifolia* X *U. pumila*	Own root, softwood cutting
Ulmus 'Morton Glossy' Triumph™ Elm	*U. pumila* X *U. japonica* X *U. ???*	*U. pumila* rootstock, budded
Ulmus 'Morton Plainsman' Vanguard™ Elm	*U. pumila* X *U. japonica*	*U. pumila* rootstock, budded
Ulmus 'Morton Red Tip' Danada Charm™ Elm	*U. japonica* X *U. wilsoniana*	*U. pumila* rootstock, budded
Ulmus 'Morton Stalwart' Commendation™ Elm	*U. carpinifolia* X *U. pumila* X *U. ???*	*U. pumila* rootstock, budded
Ulmus 'Morton' Accolade® Elm	*U. japonica* X *U. wilsoniana*	*U. pumila* rootstock, budded
Ulmus 'New Horizon' PP8684 New Horizon Elm	*U. pumila* X *U. japonica*	*U. pumila* rootstock, budded
Ulmus 'Patriot' Patriot Elm	(*U. glabra* X *U. carpinifolia* X *U. pumila*) X *U. wilsoniana*	Own root, softwood cutting
Ulmus 'Pioneer' Pioneer Elm	*U. glabra* X *U. carpinifolia*	Own root, softwood cutting
Ulmus wilsoniana 'Prospector' Prospector Elm	*U. wilsoniana*	Own root, softwood cutting
Ulmus americana 'Valley Forge' Valley Forge Elm	*U. Americana*	Own root, softwood cutting
Ulmus 'Princeton' Princeton Elm	*U. Americana*	Own root, softwood cutting
Ulmus 'New Harmony' New Harmony Elm	*U. Americana*	Own root, softwood cutting

RESULTS

Mortality and new plantings

During the first growing season one *Ulmus* 'Frontier' and all five of the *Ulmus parvifolia* 'Emer II' (Allee elm) died. No other trees died during 2006 and 2007.

Growth

Elms are widely regarded as robust growers. This is certainly the case for the trees in our plot (**Figure 1**). During the first growing season there was little change in tree size. However, most cultivars exhibited rapid growth after the first growing season (**Figure 2**).

The mean size of all trees at planting in spring 2005 was 0.9-in caliper (2.4 cm), 9.4-ft tall (2.9 m), and 2.7-ft average crown diameter (0.8m). In fall 2007 their mean size increased to 3.0-in caliper (7.5 cm), 16.4-ft tall (5.0 m), and 9.8-ft average crown diameter (3.0 m). The increase in size for the three year period averaged 2.0-in caliper (5.1 cm), 7.0-ft tree height (2.1 m), and 7.1-ft crown diameter (2.2 m). This growth is surprisingly rapid, primarily because most trees were well established after only one growing season.

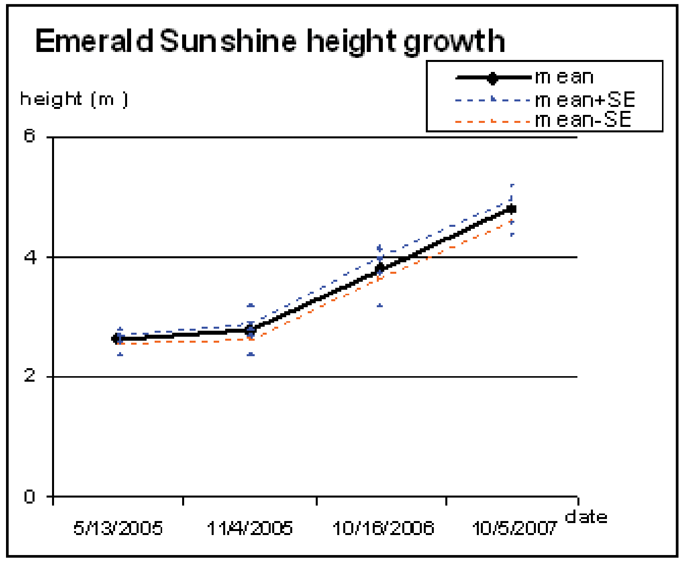

Figure 2. Tree height data points plotted for the five Emerald Sunshine elms, along with mean height plus and minus the standard error.

Table 2. Average annual growth (2005-2007) for fifteen cultivars, excluding growth during the first year of establishment.

Cultivar	DBH (in)	sd	Height (ft)	sd	Diameter (ft)	sd
Emerald Sunshine	0.63	0.25	3.35	0.44	2.10	0.61
Frontier	0.66	0.16	2.42	0.97	2.10	0.61
Homestead	1.23	0.11	6.27	0.86	3.29	1.63
Accolade	0.71	0.16	2.85	1.05	3.64	1.77
Triumph	1.13	0.17	4.04	0.49	4.00	0.87
Vanguard	1.25	0.11	2.62	0.53	5.62	1.29
Danada charm	0.89	0.18	3.77	1.23	3.15	0.86
Commendation	1.15	0.08	4.72	0.84	3.86	1.08
New Harmony	0.78	0.23	5.57	3.00	2.88	0.91
New Horizon	1.31	0.27	2.95	0.49	2.82	0.36
Patriot	1.00	0.05	4.40	1.27	3.53	0.95
Pioneer	1.10	0.39	3.61	0.84	3.17	0.48
Princeton	1.14	0.33	5.35	2.26	3.04	1.21
Prospector	0.83	0.11	2.85	0.72	2.54	1.26
Valley Forge	1.04	0.10	2.76	0.85	3.36	0.85

Cultivars exhibiting the greatest average annual DBH growth were New Horizon, Vanguard, and Homestead (**Table 2**). Interestingly, New Horizon's tree height and crown diameter growth were relatively slow. Slowest growing cultivars in DBH were Emerald Sunshine, Frontier and Accolade.

Usually relatively rapid and slow growth was expressed in several variables, such as DBH and height. All three growth variables were among the fastest for Homestead and Commendation, and the slowest for Frontier, Emerald Sunshine and Prospector. Exceptions were relatively rapid annual tree height growth for New Harmony and slow growth for Valley Forge and Vanguard.

Annual growth for the fastest cultivars was on the order of two to three times greater than for the slowest ones. For example, average annual tree height growth ranged from 2.4 ft. (0.7 m) for Frontier to 6.3 ft. (1.9 m) for Homstead. Average annual DBH and crown diameter growth ranged from 0.6 inches (Emerald Sunshine, 1.6 cm) to 1.3 inches (New Horizon, 3.3 cm) and 2.1 ft. (Frontier, 0.6 m) to 5.6 ft. (Vanguard, 1.7 m), respectively.

Rapid growth may confer some advantages, such as improved visibility in the landscape, increased benefits associated with leaf surface area, and reduced damage from vandalism, rodents, and other threats. However, rampant growth can be problematic when associated with sprawling habit. Such trees are more susceptible to wind throw and require more frequent inspection and pruning. The next section describes impacts of growth rate and habit on the pruning requirements of these cultivars.

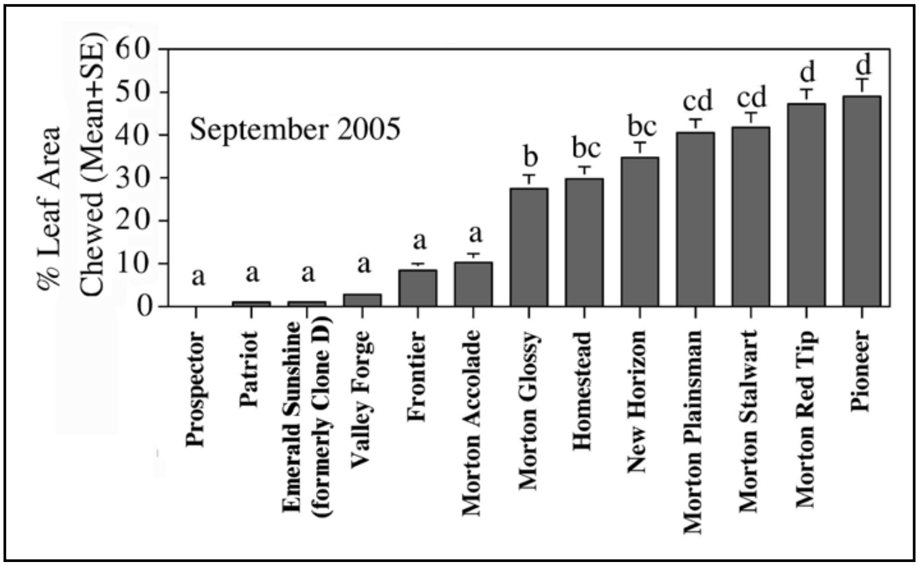

Figure 3. Elm leaf beetle chewing damage to 15 elm cultivars at the UC Davis site of the National Elm Trial, September 2005. Damage does not differ significantly (P = 0.05) between cultivars with bars topped by a same letter according to ANOVA and Tukey's tests for all paired comparisons.

Pruning requirements

From a management perspective, pruning requirement is an important consideration when selecting elms. Cultivars that require extensive pruning to develop strong structure will be more costly to maintain than those that require little pruning. In this study, all cultivars were subjectively evaluated for pruning requirement based on assessments of structural characteristics and growth rate. Frontier, Emerald Sunshine and Accolade were evaluated as having a relatively low pruning requirement, while Valley Forge, Vanguard, Pioneer and Princeton were considered to have a relatively high requirement (**Table 3??**). The remaining cultivars exhibited intermediate traits. Generally, cultivars assessed as having a high pruning requirement also exhibited poor structural characteristics (codominant stems, branches with included bark, and branches with a large diameter relative to the trunk) and were found to have a relatively high growth rate (**Table 2**). Keep in mind that as the cultivars continue to develop, growth rates and structural characteristics likely will change, and pruning requirement may increase or decline accordingly.

Pests, disease & abiotic disorders

The commonly managed pests of elms in California are elm leaf beetle (*Xanthogaleruca luteola*) and honeydew-producing aphids and scale insects. Dutch elm disease (*Ophiostoma* spp.) and the bark beetles (*Scolytus* spp.) that vector these fungi are problems in the San Francisco Bay Area and Sacramento Valley. Several thousand elms have been killed or removed there because of Dutch elm disease since it was found in California in the 1970s.

We observed no Dutch elm disease or bark beetle boring damage on any cultivars at the Davis site from 2005 though spring 2007. Elm leaf beetle (ELB) has been the only significant invertebrate problem. About one-half of the study cultivars experienced 30% or greater leaf-chewing damage by September 2005 (**Figure 3**). ELB damage was lower during 2006 and 2007, with the least damage during those years occurring on the same cultivars as in 2005.

Leaf curling aphids (*Eriosoma* sp.) have infested only the American elm selections Princeton and Valley Forge. They have not occurred on New Harmony (also on *U. americana*) and other cultivars. Because they produce abundant sticky honeydew, these aphids are sometimes treated in California landscapes. A pouch gall aphid (probably *Tetraneura nigriabdominalis*) occurs during spring on leaves of elms with Asian and European parentage. The green, pink, or brown eruptions it causes on elm leaves are a curiosity, not a pest problem. Also called the Oriental grassroot aphid, this species alternates between elms and its many hosts in the grass family (Poaceae). The aphid is from Asia where it is a pest on rice. It has become widely established in the eastern U.S., but we found no published reports of this aphid's occurrence in California.

European elm scale (*Gossyparia spuria*) and European fruit lecanium scale *(Parthenolecanium corni)* are present at low densities on at least some cultivars. Because these scales have only one generation per year and their natural dispersal is limited, several more years of sampling or artificial inoculation studies are needed to assess any cultivar differences in susceptibility to scales.

Abiotic disorders do not appear to have threatened tree health or survival. These include leaf chlorosis and necrosis believed due to drought stress and poor water quality (e.g., alkalinity and salinity), sunburn, and tattering of leaves and breakage of young limbs by wind.

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