PERFORMANCE OF URBAN STREET TREES EVALUATED

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Abstract. Street tree plantings in Philadelphia, Pa. were evaluated 14 years after planting. Measurements of dbh, height, and crown diameter as well as foliage condition were used as an indication of adaptability to urban growing conditions. Of the 15 species rated, Kwanzan oriental cherry, black locust, Chinese elm, Japanese pagoda tree, ginkgo, and English oak were the most successful, both in terms of growth rates and overall freedom from insects and disease.

Well documented, long-term evaluations of the adaptability of various tree species to urban growing conditions are scarce because of the commitment of time and space necessary to accumulate such data. Collaboration between George Patton, Inc., a landscape architectural firm, and the Morris Arboretum of the University of Pennsylvania has provided an unusual opportunity to obtain comparative data on trees planted on city streets.

In 1965 the Patton firm designed a 22 square block street tree planting for the Washington Square East Redevelopment Area of Philadelphia. This plan, which was unusual in the diversity of tree species included, called for 15 different kinds of trees to be planted according to rigid planting specifications (Fig. 1). All planting sites were curbside pits 1m by 1.5m excavated to a depth 15cm greater than the height of the root ball. Fifteen cm of thoroughly compacted topsoil was placed under the ball. A 15cm by 15cm ring of 1.3cm diameter gravel was placed around the base of the pit peripheral to the root ball. Two vertical sections of 5 cm transite pipe extended from the gravel up to the grade level; these allowed for watering the trees and liquid fertilization with 15-30-15 Hellergrow each spring for the first three years. More importantly, until they became clogged with silt, the pipes undoubtedly provided access for air to the root zone.

The tree pits were backfilled with a mixture of 70% topsoil, 20% peatmoss and 10% dehydrated cow manure. Coarse sand to a depth of 2.5cm and bricks laid level with the existing pavement finished the installation. All trees were wrapped, staked and protected with a 15cm diameter ring of hardware cloth. The specifications called for balled and burlapped trees of 6.4-7.6cm caliper, littleleaf linden (*Tilia cordata*) was 7.6-8.9cm.

Methods

During August and September 1979, 414 trees of 23 different species were individually evaluated. Measurements were made of dbh and crown diameter. Tree height was measured using a Haga altimeter (Forestry Suppliers, Inc., 205 W. Rankin St., Box 8397, Jackson, MS). Tree height was measured in October 1980. Condition of the foliage was rated on a 1 to 4 scale (1-excellent, 2-good, 3-fair, 4-poor). In addition, specific insect, disease or abiotic stress factors were noted and laboratory diagnoses were made when necessary.

An attempt was made to determine the survivability of each tree species, however, due to deviations from the original planting plan, this was not always possible.

Results and Discussion

Data for 15 tree species are presented in Table 1. As we compared the existing street trees with the 1964 plan, it soon became apparent that numerous substitutions had been made at planting time, presumably due to the unavailability of certain species. However, some cases of mistaken identity also occurred. For example, two water oaks (*Quercus nigra*) and several shingle oaks (*Q. imbricaria*) were found in an area where willow oak (*Q. phellos*) predominated. Interestingly, the water oaks were thriving, although this tree is generally not hardy so far north. Similarly, several

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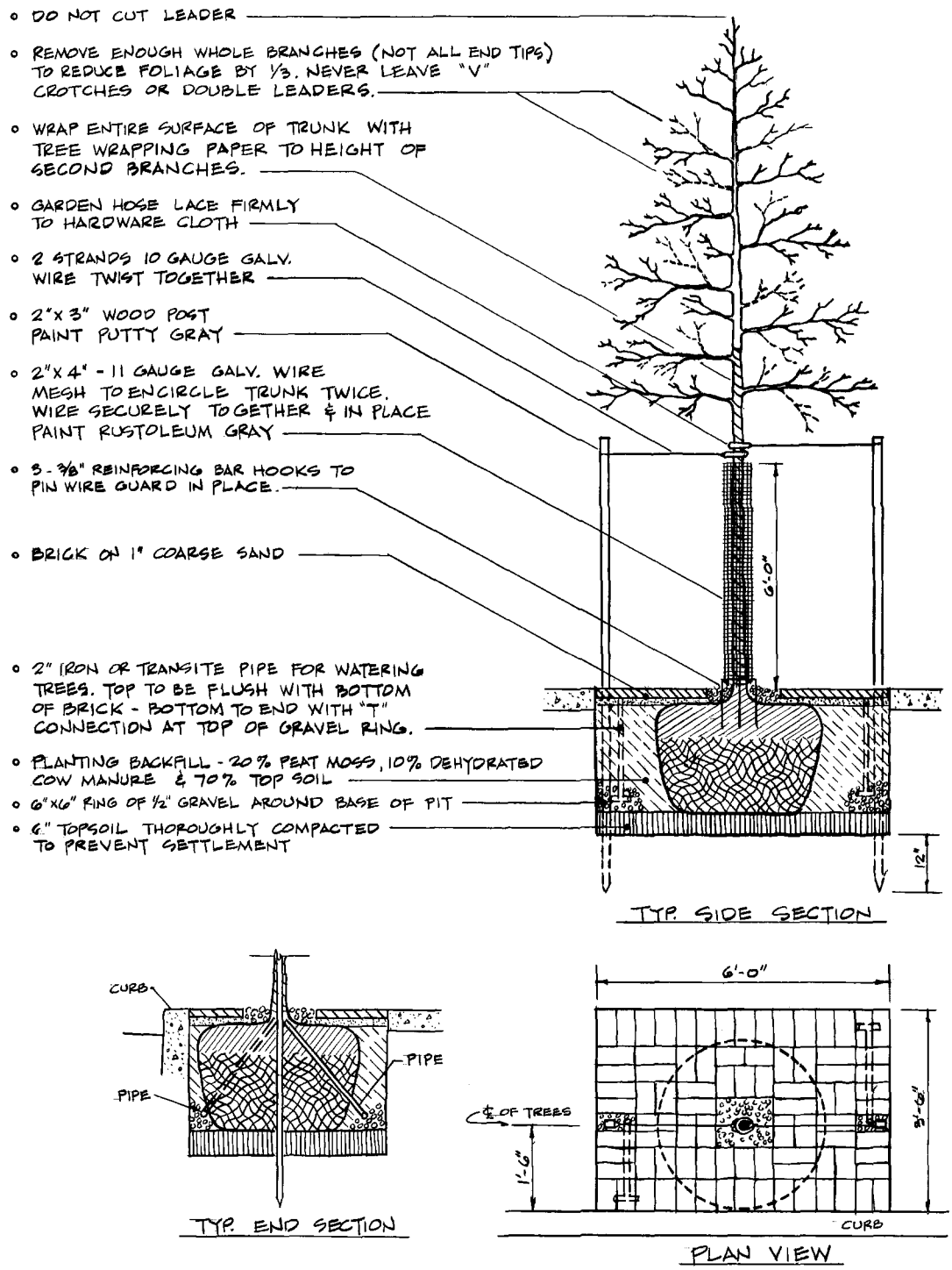

Fig. 1. Planting specifications for street trees, Washington Square Redevelopment Area, fall 1965, George E. Patton, Inc.

Table 1. Evaluation Data for Urban Street Trees (Ranked According to Foliage Condition)

Name	No. of trees evaluated	Ave. height (m)	Ave. dbh (cm)	Ave. crown diameter (m)	Foliage* condition	Major problems
Prunus serrulata cv. Kwanzan	8	7.3	19.2	6.8	1.00	none
Robinia pseudoacacia	10	14.4	22.3	7.0	1.00	none
Ulmus parvifolia	6	12.4	26.0	9.8	1.00	none
Sophora japonica	36	12.1	23.8	9.7	1.08	none
Ginkgo biloba	14	12.5	23.3	5.2	1.15	none
Quercus robur	17	10.7	21.8	7.0	1.29	none
Liquidambar styraciflua	18	9.5	15.7	5.0	1.44	branch dieback
Gleditsia triacanthos	44	14.2	22.1	10.0	1.54	mimosa webworm frost cracks
Quercus rubra	53	12.0	18.7	5.7	1.72	obscure scale kermes scale**
Crataegus phaenopyrum	9	6.2	12.3	5.1	2.10	lacebug***
Ulmus americana cv. Augustine ascending	47	16.3	28.2	7.9	2.15	elm-leaf beetle
Quercus phellos	48	13.1	24.3	8.4	2.42	obscure scale, chlorosis
Tilia cordata	40	8.7	18.5	6.4	2.50	marginal leaf scorch
Quercus palustris	6	13.4	23.6	10.2	2.60	obscure scale chlorosis
Acer platanoides	26	10.1	20.3	7.5	2.77	leaf scorch, frost crack

*foliage condition rated on a 1-4 scale — 1=excellent, 2=good, 3=fair, 4=poor
**kermes oak scale (*Kermes* sp.)
***Hawthorn lacebug (*Corythuca cydoniae*)

scarlet oaks (*Q. coccinea*) occur in a pin oak (*Q. palustris*) block.

Six species which stand out due to their good growth rate and general freedom from pests and diseases are ginkgo (*Ginkgo biloba*), Kwanzan oriental cherry (*Prunus serrulata* cv. Kwanzan), black locust (*Robinia pseudoacacia*), English oak (*Quercus robur*), Japanese pagoda tree (*Sophora japonica*), and Chinese elm (*Ulmus parvifolia*).

Ginkgo is presently widely planted in Philadelphia with good results. It tolerates diverse soil conditions, air pollution, and reflected heat and therefore is suitable for most urban sites. Its irregular form and the rancid smelling seeds in the fall can be a problem on many sites. Thus, seedless male clones with a more regular form are usually recommended, and were evidently used in this case.

Kwanzan oriental cherry (Fig. 2) performed remarkably well in this planting and should help fill the need for small, flowering street trees. It is not usually a long-lived tree and often succumbs to borers and canker after 20 to 25 years. White peach scale (*Pseudoasulacaspis pentagonia*) has been a problem on this species elsewhere in the city, but was not observed in this study. To date, the trees evaluated appear to be in excellent condition.

It is not surprising that black locust is thriving in the streetside environment. This species is extensively used on strip mines and road cuts because of its tolerance of poor soils. As a member of the legume family, it can support bacteria on its roots which convert atmospheric nitrogen to a form which can be utilized by plants. Locust borer (*Megacyllene robiniae*) and carpenterworm (*Prionoxystus robiniae*) are common problems on this species and justifiably limit its landscape use. However, these insects are not yet a problem on the trees evaluated. Even if they eventually succumb, they will have already outlived many street tree species.

Few trees can match the majesty of a spreading English oak growing in its native habitat. Like many oaks, it also thrives in the urban environment. Its growth rate exceeded that of Norway maple in both height and dbh (Table 1), thus exposing the myth that all oaks are slow growing. In this test, the 17 specimens observed were free of insect or disease problems.

The Japanese pagoda tree (Fig. 3) is just beginning to be widely used as a steet tree, though it

Fig. 2. Kwanzan Oriental Cherry

was first introduced into western cultivation in 1747. Its creamy white flowers in early August add interest to the summer street scene. The 36 trees reviewed had grown well and were free of insect and disease problems indicating this species deserves wider use as a street tree.

Chinese elm (Fig. 4) is another species which should be more widely planted. Its use has been limited by confusion with Siberian elm (*Ulmus pumila*), a weak-wooded species subject to elm-leaf beetle (*Pyrrhalta luteola*). Chinese elm is a smaller tree with a clean habit. It is resistant to the Dutch elm disease and fairly pest-free. Its exfoliating bark is attractive throughout the year. One possible drawback of this species is a reported tendency to heave sidewalks (1) although we did not observe this occurring.

In addition to these six most highly rated trees, several other species merit discussion. Thornless honeylocust (*Gleditsia triacanthos* f. inermis) grew very well under the conditions of this planting, however, mimosa webworm (*Homadavla anisocentra*) and frequent frost cracks were a problem.

Willow oak grew well in many sites, though some trees exhibited severe iron deficiency chlorosis. Stressed trees also carried heavy infestations of obscure scale, (*Melanaspis obscura*). Where the soil is uniformly acidic, willow oak can be a reliable street tree. For winter hardiness in colder areas, only trees grown from northern seed sources should be used.

Augustine ascending elm (*Ulmus americana* cv. Augustine ascending) was very impressive, with average dbh in excess of 27.9cm and an average height of over 16m, it had the greatest growth of all trees studied. However, by late summer, many leaves had been skeletonized by the elm-leaf beetle. There was no evidence that Dutch elm disease had affected this planting, but because of its susceptibility to this problem, Augustine ascending elm should be used with caution.

Two of the most widely planted street trees in

Fig. 3. Japanese Pagodatree

Fig. 4. Chinese Elm

the northeast, Norway maple (*Acer platanoides*) and littleleaf linden were among the lowest rated of the 15 species tested. Marginal leaf scorch, a symptom of sensitivity to de-icing salt, was commonly observed. Neither of these species should be used where salt spray or runoff are likely.

Another factor examined was the relative growth rate of each species (Table 1). Although all trees were approximately the same diameter at the time of planting, growth rates varied. Augustine ascending elm, Chinese elm, Japanese scholar tree, and willow oak, achieved the greatest increase in diameter. In terms of height, Augustine ascending elm, black locust, honeylocust, pin oak and willow oak grew most rapidly. However, rapid growth rates are not the only factor to be considered in evaluating adaptability to urban conditions. Kwanzan oriental cherry, for example, performed well, but is naturally a smaller tree. In selecting trees for urban sites, species should be chosen which are appropriate for the space available, as well as tolerant of the growing conditions.

For all species where data were available (Augustine elm, Japanese pagoda tree, and willow oak), the survival rate was approximately 85%, indicating no obvious species differences.

Although trees are plentiful in our northeastern cities, species diversity is very low. Norway maple, silver maple (*Acer saccharinum*), and London planetree (*Platanus X. acerifolia*) predominate (1, 2, 3). Other species which are now in danger of being overused include red oak (*Quercus rubra*), Bradford callery pear (*Pyrus calleryana* cv. Bradford) and littleleaf linden.

Dependence on one or a few species carries risks; the devastating loss of American elms in many midwestern and New England towns is evidence for the hazard inherent in monoculture. Increased species diversity in urban plantings not only reduces the danger of widespread losses due to an insect or disease epidemic, but also enhances the aesthetic appearance of the landscape.

The Morris Arboretum is actively encouraging the wider use of species shown here to be well adapted to growth on city streets. Future programs of the institution include testing and introduction of additional candidates for urban use. During a recent Arboretum-sponsored plant collecting trip to mountainous areas of Korea and Taiwan, trees with potential for urban use were specifically sought. Several candidates are now being grown and testing for local adaptability will start soon.

Literature Cited

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