SOME URBAN TREES OF CALIFORNIA: MAINTENANCE PROBLEMS AND GENETIC IMPROVEMENT POSSIBILITIES

by Philip A. Barker, research horticulturist,
USDA Forest Service, Pacific Southwest
Forest and Range Experiment Station, Berkeley, CA 94701.

ABSTRACT.--Tree crew supervisors in 48 California cities were asked what problems they encounter with the five most common trees along their streets. The top five trees of the 20 most often named were sweetgum, Modesto ash, southern magnolia, planetree, and Chinese or lacebark elm. Major problems reported included root damage to sidewalks and curbs, growth of suckers from the root crown, exceptionally fast growth which necessitates frequent pruning, and litter of leaves and fruit. Genetic improvement possibilities to minimize these and other identified problems are discussed.

A LOGICAL STARTING POINT in the genetic improvement of tree species for urban areas is to identify traits that create problems and possible remedies. City tree workers who routinely work on trees are quite perceptive about the problems of various trees and can help pinpoint the direction for needed genetic improvement efforts.

Therefore I did a study to determine maintenance problems and other traits of different urban trees based on the experiences and suggestions of tree crew supervisors. To obtain this information, I visited at least one tree crew supervisor in 48 California cities during 1981 and 1982. Most of these supervisors led a tree crew and routinely worked with the crew on the city's trees. Some supervisors previously had been tree crew leaders and now supervised several crews. All supervisors had been in their present position for at least one year and generally had had several years' previous experience as tree crew members. Most of them had taken college courses in horticulture and other biological sciences.

The meeting with each supervisor lasted for about two hours. Time did not permit covering all species of trees which a city maintains and consequently, our discussion was limited to the five most common species found on the city's streets. For each species, we discussed (1) pruning requirements, (2) problems encountered or unexpected maintenance, (3) unique assets, (4) biological improvements needed, and (5) whether the species was still being planted, and, if not, whether the city was keeping or removing existing trees of that species.

This paper summarizes problems and genetic improvement possibilities of the 20 most prevalent tree species, including clones, along streets of the 48 cities (Table 1).

Table 1. Twenty kinds of trees most frequently named as being among the five most prevalent along streets in 48 California cities.

Common name	Scientific name	No. of Cities
Sweetgum or liquidambar	Liquidambar styraciflua L.	32
Modesto ash	Fraxinus velutina var. glabra 'Modesto'.	22
Southern magnolia	Magnolia grandiflora L.	15
Planetree	Platanus acerifolia (Ait.) WilId..	15
Chinese or lacebark elm	Ulmus parvifolia Jacq.	13
Camphortree	Cinnamomum camphora (L.) J. Presl.	12
Carrotwood or cupania	Cupaniopsis anacardioides (A. Rich.) Radlk.	9
Carob	Ceratonia siliqua L.	8
Crapemyrtle	Lagerstroemia indica L.	8
White mulberry, fruitless clones	Morus alba L.	7
Chinese pistache	Pistacia chinensis Bunge.	7
Holly oak	Quercus ilex L..	7
Glossy privet	Ligustrum lucidum Ait. f.	6
Jacaranda	Jacaranda acutifolia Humb. & Bonpl.	5
Brazilian peppertree	Schinus terebinthifolius Raddi.	5
Siberian elm	Ulmus pumila L..	5
Indian laurel fig	Ficus microcarpa L. nee F. nitida.	4
Shame1 ash	Fraxinus udhei (Wenz.) Lingelsh.	4
Honeylocust, thornless and fruitless clones	Gleditsia triacanthos L..	4
Flowering plum, cherry plum, or myrobalan plum, purpleleaf clones	Prunus cerasifera J. F. Ehrh.	4

The major problems of these 20 species, which were either inherent traits of the trees themselves or the result of attack by other organisms, were classified by roots, suckers, branches, leaves, and fruits.

ROOTS

Roots of some of the species cause serious problems, primarily because they displace sidewalks. (Blockage of sewers was not considered in this study). Displaced sidewalks can cause pedestrians to fall and injure themselves, leading to litigation against the city. For this reason, cities attempt to keep sidewalks in good repair, often spending

substantial amounts of money. This expenditure often is from a Street department's budget, and so does not appear in the city's records as a tree maintenance expense. Surface roots also become obstacles to lawn mowers. Finally, inadequate anchorage by a tree's roots may lead to toppling under strong winds.

Roots damage sidewalks and curbs for one reason because of the narrowness of the spaces in the street rights-of-way in which the trees have been planted. These spaces or treelawns often are no wider than 3 or 4 feet. Damage to sidewalks and curbs in such narrow treelawns occurs when the trees are of younger age, regardless of the species, than when the treelawns are wider.

Regardless of treelawn width, damage to concrete improvements of streets is worse from some of the species than others. Among 10 commonly planted tree species in the San Francisco Bay Area, Wagar and Barker (1983) found sweetgum to be the most damaging to sidewalks, whatever its size. Yet, in the 48 cities I visited, this tree and clones of it were the most commonly grown of any species; being one of the five most common in 7 out of 10 cities.

Many reasons account for the popularity of sweetgum in California. It is readily available as container-grown stock, transplants successfully, has attractive dark green, shiny leaves, and is one of the few trees in California with fall coloration. It also has a definite central leader so the crown is very upright and therefore the tree requires little training pruning when young. Because its damage to concrete improvements was not well documented until quite recently, cities planted sweetgum for many years without knowledge of this shortcoming. And many still plant it.

Other species reported to be particularly damaging to sidewalks and curbs were camphortree, Indian laurel fig, Modesto ash, Shame1 ash, fruitless clones of honeylocust, Southern magnolia, and fruitless clones of white mulberry. Most of these become relatively large. It is understandable, therefore, that they ultimately may damage sidewalks and curbs, particularly when grown in 3- or 4-foot treelawns.

The age when trees begin to damage concrete improvements varies; possibly linked to the rate of growth of each tree. Sweetgum trees are relatively fast growing and they damage sidewalks and curbs several years before the slower growing camphortree and Southern magnolia. In general, for trees of comparable ultimate height, the faster they grow, the earlier and more often their roots will damage sidewalks and curbs.

Selection of rootstocks that do less damage to streets than the species in general may be a possibility for genetic improvement. Recent study of 35 years of maintenance performed on over 100 sweetgum trees growing along a street in Oakland showed that sidewalks or curbs never had been repaired or replaced alongside three of the trees. Although the roots of these three trees have not been examined, there was no evidence

aboveground that the soil environment surpassed that for many of the other trees on the street. Lack of visible sidewalk and curb damage from the three trees may be due to unusually deep roots that descend into the soil at an exceptionally sharp angle. We are attempting to propagate tissue-cultured progeny from these trees for field testing. If the roots of these progeny descend sharply into the soil we may have found promising candidates for use as rootstocks for selected scions. The result could be a sweetgum tree for planting along streets that would do considerably less damage to sidewalks and curbs than the species in general.

Camphor-tree is another example where selection for a less damaging root system would be desirable. Except for doing serious damage to sidewalks and curbs, this medium-sized, broadleaf evergreen approaches perfection. It was extensively planted along streets in California cities in the early 1900's. Many of these trees have been removed because their roots were so devastating to sidewalks and curbs.

Characteristically, camphortree has a globular buttressed trunk at groundline from which radiate roots of unusually immense diameter. An occasional tree of this species has a straight trunk with little or no enlargement at the base. Selecting such a tree for use as a rootstock or as an entire tree may be desirable. Therefore, we plan to propagate clones vegetatively, if feasible, from trees with straight trunks for further evaluation.

Use of a rootstock species that differs from the scion species is another possible way to minimize the damage that trees do to sidewalks and curbs. Modesto ash, for example, may be less damaging if, instead of being budded onto the shallow-rooted green ash (Fraxinus pennsylvanica var. lanceolata (Borkh) Sarg.), as is customary, it were budded onto Arizona ash, (Fraxinus velutina Torr.). The latter may be inherently deeper-rooted because it tolerates arid environments in its native range of southwestern United States.

SUCKERS

At least 4 of the species require frequent removal of suckers from the rootcrown or the trunk to assure traffic clearance. Bootcrown suckers are especially common in clones of crapemyrtle that have been grown from rooted cuttings. Such suckers are also prevalent on trees of flowering plum that have been customarily propagated by budding a scion onto a rootstock. Prolific groundline suckering requires an unacceptable amount of removal. Trunk suckers are particularly prevalent on carob and often on the buttressed trunk of camphortree.

Clearly, selection of non-suckering individuals would be worthwhile.

BRANCHES

Trees planted along streets must regularly be pruned, but some need so much pruning as to constitute a major problem. For example, Chinese

elm must be pruned once or twice each year because of rapid growth of long, pendulous branches that interfere with both vehicular and pedestrian traffic. Few other trees need to be pruned as often. Invariably, tree crew leaders expressed dismay that so many trees of this partially evergreen species, and supposedly more-upright clones of it, have been planted in the past 25 years. Their general consensus was that Chinese elm requires too much pruning ever to justify its use along streets.

Carob, carrotwood and Brazilian peppertree are broadleaf evergreens that must be pruned frequently to thin their crowns. Otherwise, strong winds may break off their trunks, or, in wet soil, uproot them.

Crown size reduction is necessary on species which become exceptionally large, such as Shame1 ash and Indian laurel fig, or which have limbs too weak to withstand unusual load stresses, as, for example, jacaranda. Most trees of Indian laurel fig have been planted since the 1960's and so have not yet attained a size that requires crown size reduction.

Depending on the tree in question, genetic improvement seems most feasible by selecting for slower rate of growth, more upright habit of growth, and smaller ultimate size. While many of the supervisors recognized the possibility of such efforts, they felt that some of the fast growing species, such as the above-mentioned Siberian elm, have so many problems that improvement efforts are not warranted.

LEAVES

Susceptibility of leaves to diseases and insects is a continuing problem. Common pests are anthracnose diseases on Modesto ash and planetree, defoliating insects on elm species, pod gall on honeylocust, and aphids on sweetgum, Modesto ash, carrotwood, Brazilian peppertree, Shame1 ash, and flowering plum. The primary impact of these pests on tree programs and budgets is the time city personnel must spend answering telephone inquiries from residents and conducting followup inspections.

Anthracnose disease of Modesto ash is possibly the most serious pest. In Central Valley cities virtually all of these trees are victims. Infection of new leaves followed by total defoliation may occur 3 or 4 times each spring before rains cease. Chemical control has been ineffective, mainly because of the need for repeated applications, which cities do not consider cost-effective. This clone no longer is planted. Existing trees either are removed, or, generally, the disease is tolerated.

Attitudes about tree pests have changed sharply in the past decade. Chemical pesticides are used less, reflecting residents' acceptance of blemishes and concern about the effect of pesticides on the environment. Pest control is done on a tree by tree basis instead of on all trees.

The need for trees resistant to common pests is obvious. The legacy of such research on trees used for production of food and fiber suggests direction for similar research on urban trees.

Just as leaves are susceptible to attack by diseases and insects they also are the target of criticism by residents, centering on when they fall and how they are disposed of. Broadleaf evergreen trees are often preferred because of the belief that they shed fewer leaves than deciduous trees. Leaves of evergreen trees fall too, of course, but the event is less conspicuous because these trees do not become bare and raking their leaves for disposal is not as critical.

Leaf size also concerns residents. Small leaves, such as those on Chinese elm, are difficult to rake. And they blow into air vents of automobiles, where they may cause malfunction of the heating/cooling system. Exceptionally large leaves, like those of white mulberry and planetree, likewise are difficult to rake up, especially when wet, and they plague street maintenance crews during rainstorms by lodging on grates of street drains and impeding water drainage from the streets.

The problem of collecting and disposing of fallen leaves may have a sociological dimension. Residents may dislike deciduous trees primarily because disposal of their leaves is an unacceptable financial obligation.

Trees vary both in time and duration of defoliating and leafing out. We are studying these traits in existing street plantings of sweetgum in search of individuals that defoliate early and quickly and that leaf out late. With such trees, raking and disposing of the leaves could be done in early fall when weather conditions are still comfortable. And, they would be without leaves at times when solar energy would be most beneficial for home heating.

Scheduling when and where to deploy city equipment for cleanup and disposal of leaves would be simplified with trees that have a consistent pattern of defoliation. Indeed, planned timing of leaf defoliation is one of the prime justifications for a city to have diverse species among its streets but a single species or species selection on each street.

FRUIT

Fruit on street trees usually affects city tree budgets indirectly by increasing the number of phone calls about the nuisance of fallen fruit. A resident's concern may be justified, but a practical remedy with existing trees generally is unavailable, short of tree removal. Nevertheless, it is important to note this potential nuisance aspect of trees as background in considering how the problem may be avoided.

Almost without exception tree crew leaders mentioned the nuisance of sweetgum fruit, a spiny woody ball, slightly smaller than a golf ball. Reel lawn mowers stop abruptly when one of these fruits catches between blade and bar. Raking them up before mowing a lawn is essential.

Other species having fruits that are a particular nuisance are carob, carrotwood, glossy privet, holly oak, planetree, and flowering plum. Carob fruit is a large, brittle pod borne profusely on the female

trees. It falls to the ground and attracts flies. Fruit of carrotwood is so heavy that it often breaks the limbs unless removed. The pea-size fruit of glossy privet and the familiar fruit of flowering plum--both purple and fleshy--easily stain carpets when tracked indoors. The abundant acorns of holly oak may roll when stepped on and pose a hazard to pedestrians. Dust from fruit of planetree fed with prunings into a chipper is especially irritating to tree workers.

Seiecting trees that are non-fruiting is highly feasible, as evidenced by the fruitless clones of honeylocust and white mulberry already introduced. But there still are many untapped possibilities. The selection process will depend on the reproductive system of the species in question. Selecting male, non-fruiting trees of dioecious species should be easiest. Carob is an example. However, with it any real gain is questionable because the flowers of male trees have a particularly offensive odor. Chinese pistache, which is dioecious like white mulberry, is an excellent candidate for selection of males.

It should likewise be feasible to select non-fruiting individuals of polygamous and monoecious species, based on numerous reports of the existence of exclusively male plants in many such species (Barker et al. 1982). Species considered herein, for which exclusively male individuals are likely to exist, are the polygamous carrotwood and the monoecious sweetgum.

Production of fruit is a particularly annoying trait of the numerous clones of flowering plum. Because this species has perfect flowers, the best way of achieving fruitlessness may be selection of individuals with sterile flowers.

DISCUSSION

None of these 20 species of trees was without faults but one of them received particularly generous praise from various tree crew supervisors. This is the deciduous Chinese pistache, notwithstanding the less than ideal fruit on the female trees. Young trees of this species need occasional pruning to shape the crown and establish main limbs well above traffic. Thereafter they need little maintenance and have few problems.

By being among the most common in the 48 cities surveyed, the adaptability of each of the 20 species to urban areas in various parts of California is fairly well known. Problems with any of them undoubtedly can be avoided or reduced by scrutinizing intraspecific differences and by selecting individuals with desired traits for vegetative propagation.

Cities often have little choice but to use high maintenance trees, usually the fast growing kinds. One supervisor noted that fast growing tree species and clones are the antithesis of the kinds cities should plant because they inevitably need a large amount of maintenance. Yet, these are the most readily available because they are the easiest and

the most profitable for nurseries to produce. Slower growing trees, which may require less long-term maintenance and which cities, therefore, often prefer to plant, generally are least profitable for nurseries to grow because of the comparatively little demand for them. Similarly, any improved trees may have little overall demand if they are not fast-growing

It is essential, therefore, that along with development of better trees for city use, ways must be developed for prospective users to get them. To achieve this we expect to follow an integrated approach, involving not only tree improvement by evaluation and selection, but also development of procedures for propagation, production, and delivery. Toward this end, growers will need to be assured of sufficient profit to justify the risk of producing both improved and existing species that may require little maintenance but are in little public demand. To offset lack of demand, such trees may have to be priced quite high, but in reality their cost to a city could be a bargain through future savings in long-term maintenance costs.

To provide a better perspective of the seriousness of problems of the various kinds of trees, it would have been helpful in this study to have had a common denominator for making comparisons. Knowing a city's annual expenditure per tree per species, for instance, would have been useful. Such information was unavailable but it should be more readily available as soon as cities begin computerizing daily tree maintenance accomplishments and expenditures.

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