SHADE TREE IMPROVEMENT RESEARCH: GOALS AND LIMITATIONS

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The forest and the city street are "in two different worlds." Both above and below ground, the urban environment presents a multitude of conditions to challenge the survival and growth of trees. A city tree seldom dies of old age! But the urban areas are the places where we most need trees--trees that can prevent our cities from becoming desolate deserts of concrete and asphalt.

While research on forest tree improvement has grown dramatically since the 1920's, research on improved shade or amenity trees has remained static. Only recently have we awakened to the need for new and better trees for amenity planting. The mistakes of the past surround us. Seedling populations of plane trees have shown varying degrees of resistance to anthracnose disease, and drastic corrective pruning has severely limited their aesthetic value. The Dutch elm disease has decimated the ranks of the popular American elm. Even the ginkgo, resistant to disease and insects, has, in certain localities, developed such irregular crown forms that the trees can be considered eyesores.

Until recently, there was no single research project attempting to breed and select shade and ornamental trees in a wide range of genera for urban planting. As a forerunner of expanding efforts in this area, the establishment of a project on Cytogenetics, Breeding, and Evaluation of Shade Trees, begun at the U. S. National Arboretum in July, 1967, will fill this void. The basic and applied research program of this Shade-Tree Project, in cooperation with other special-purpose projects in Federal, State, and University agencies, should lead to significant improvement in trees for urban tree planting during the coming decades.

In earlier papers (Santamour, 1969 a, b) I have rather extensively compared the forestry and horticultural approach to tree improvement, and discussed the stress factors of the urban environment that must be considered in selection and breeding programs. Rather than repeat much of the material in those papers, I shall attempt to focus attention on a few major problems in the development of improved shade trees.

GOALS

What are the goals of shade-tree improvement? Can we establish a model of perfection toward which we can strive? The ideal shade tree is one which reproduces readily from cuttings; grows rapidly to a specific desired height, and then stops; resists insects and diseases above and below the ground; tolerates air pollution, salt in the soil, and soil compaction; has roots that do not raise sidewalks or clog sewer lines; produces attractive flowers over a long period, but no messy fruit or seed; has leaves that turn yellow, orange, or red in the autumn, and which, when they finally fall, disintegrate before they reach the ground. There are also other traits, such as the ability to withstand repeated bumps by Mustangs, Mavericks, and Wildcats (quadruped resistance?) that would be desirable.

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I hope the tone of the preceding paragraph is clear enough to imply that there is no ideal shade tree, nor do we really seek an ideal with all of these characteristics. It does not mean, however, that most of these characteristics are not important or that these are the only important characters. City foresters, landscape architects, and utility maintenance men could certainly add to the list of desirable features.

The goals of shade tree improvement research should be to develop trees with a variety of growth rates and growth forms that will be adaptable to the multiplicity of planting sites and settings of the urban environment. Pest resistance is of paramount importance in the city, where adverse growing conditions render the trees more susceptible to insects and pathogenic fungi. Resistance or tolerance of air pollution, intense heat, drought, soil compaction, salt, and other stress factors contributing to pest susceptibility should be sought. Resistance to storm damage, whether by virtue of branching angle or superior wood quality, is also a most desirable characteristic.

Often an improvement in only one character, such as resistance to a single major disease, would be sufficient to justify the widespread use of a new tree. But I would consider such single-character improvements merely as "progress reports" on the road to a truly superior tree. The elm breeding program for Dutch elm disease resistance in the Netherlands has provided a good example of such periodic releases (Heybroek, 1966). The elm 'Christine Buisman' was released in 1936 but proved susceptible to Nectria canker and has an undesirable shape. The next selection, 'Bea Schwarz,' grew too slowly. The clone 'Commelin,' released in 1961, seems to have no major drawbacks and is being widely planted as replacement for the old 'Belgica' clone that was once so popular in the Netherlands. In addition, a fourth clone ('Groeneveld'), with a narrow dense crown and slower growth, was released in 1963 because of interest shown by city foresters in a tree of this type. Heybroek (1966) stated: "It is not practical to postpone release until the ideal clone is found." This is absolutely true, but neither should we hasten to issue new trees if it is likely that an even better tree will be forthcoming in a few years' time.

The goals of genetic improvement of shade trees are realized on the street and not in the laboratory or nursery row. Therefore, our "progress reports" should be the very best trees we can produce in any given time period.

Furthermore, we do not need any more "freaks" in most genera. The dwarf, prostrate, variegated, crawling, or weeping types should not be considered as goals. Even if they do turn up as by-products of our research, they should not be released unless they are improved in some characters in addition to their "ornamental" value.

LIMITATIONS

From a biological viewpoint, there are really no limitations that can prevent geneticists from developing superior shade trees. There are, however, certain conditions relative to the current methods of tree production and testing that must be considered as drawbacks to an effective improvement program.

Broadly speaking, forest-tree improvement is based on developing superior <u>populations.</u> Tree improvement in horticulture is based on superior <u>individuals.</u> The ultimate goal of shade-tree improvement in any genus or species is a clone possessing the greatest possible number of desirable attributes. We are all

aware that, in addition to clonal uniformity for superior traits, a clone is also uniform in its inherent weaknesses.

In those few forest trees that can be easily propagated from cuttings, notably poplars, Schreiner (1966 a), has proposed the use of synthetic multiclonal hybrid varieties. The incorporation of many clones having different genetic sources of pest resistance and adaptability but similar cultural requirements gives this multiclonal population a plasticity that enables it to withstand environmental disruptions or new pest outbreaks with a minimum of economic loss. Furthermore, as experience accumulates with this variety over time and geographic range, some clones may be deleted from the mixture and replaced by new clones from the continuing testing program.

Schreiner (1966 b) also recommended synthetic multiclonal hybrid varieties "to be used in random mixtures for amenity planting." However worthwhile this approach may be in forest planting for cellulose production, it is probably not practical for the development of superior street trees at present. My doubts on this subject are based not on biological considerations, but on the economics and customs of the shade-tree business.

First, let us consider the factors relating to the present practice of introducing a new shade-tree cultivar. Any person can introduce a new shade tree. The tree must, however, bear a fancy (non-Latin) name. In order to have nomenclatural validity, this name must be published in a printed, dated periodical available to the public. Such publication media are nursery catalogs and trade or scientific journals. Newspapers are practically the only printed matter specifically unacceptable. The valid publication must also include a description of the new cultivar. Such descriptive phrases as "pyramidal," "thick, green leaves," or "dark red fall color" are sufficient (but hardly significant).

The introducer may also wish to register his new cultivar. This involves the completion of certain ibrms and filing them with the recognized registration authority. The registration authority for most shade tree genera is the Arnold Arboretum of Harvard University. Other genera, such as Magnolia and Ilex, are assigned to different authorities. The descriptive information required is only that necessary to distinguish it from other cultivars in the genus.

A third method of establishing priority is to patent the new tree. It should be pointed out that it is the tree which is patented--not the name. Names may be registered as trademarks. However, even though this system is practiced by some commercial nurseries, it cannot be recommended for research programs.

What degree of improvement must a new cultivar possess as compared to other cultivars? What period of testing is required before release? The answer is, "None." A new cultivar need only be different.

To be sure, some responsible nurserymen have, over the years, applied their practical experience to the selection of the best trees they can obtain. We have benefited much from their activities. The fact remains, however, that the vast majority of shade-tree cultivars presently in the trade do not constitute any improvement in pest resistance or tolerance of urban stress factors.

The shade-tree geneticist should, therefore, name and register an improved tree if it is to be propagated and distributed in the nursery trade and eventually be planted on the city streets. And, these improved trees must compete, on the open market, with trees of sometimes dubious value.

The basic question thus becomes: "How many clones can a nursery handle at a profit?" In the next 10 years we shall probably see the release of a half-dozen American elms resistant to Dutch elm disease. These trees will have been produced by some of the older research programs in various parts of the country. The trees will vary in ultimate size, shape, site adaptability, and resistance to pests other than Dutch elm disease. But these other factors, especially in regard to performance directly on city streets, and in various climatic zones, will be largely "unknown quantities." The first resistant elm (call it 'Alpha') to receive wide publicity and propagation will be hailed as a "dramatic breakthrough" in the popular press. Cities will specify that any elms planted in their jurisdiction must be of that cultivar. Landscape architects will likewise specify the use of the cultivar in their designs. Our commercial nurseries will endeavor to meet this demand by propagating and growing thousands of trees of this single clone. All of this will be done in the absence of a testing program to determine the true potential of the clone. Actually, the testing will come about as a result of the widespread planting of the clone by public and private agencies throughout the country. Some plantings will be successful, some will fail, and some will be adequate. The further utilization of the clone in any area will depend on early experiences.

But what about cultivar 'Beta', and 'Gamma', and 'Delta'? Their acceptance by the nursery trade will depend on the timing of release and the area in which they were originated. It is likely, however, that fewer nurseries will grow 'Beta.' As the list of new clones increases, the propagation and distribution of the newer clones will decrease. 'Delta' may prove to be the best clone, but its widespread use can come only after it has won the competition on the street.

The difficulties to the nursery trade posed by the periodic release of new clones over several years would certainly be multiplied many-fold by the sudden appearance of even a 10-clone synthetic multiclone hybrid variety. It is rather unlikely that such a concept would be accepted by our commercial nurseries or our city foresters. Perhaps, in the years to come, we can strike a compromise somewhere between monoclonal culture and the multiclonal variety.

Geneticists and developers of improved trees want to see the products of their research used to the greatest extent possible. Therefore, since clonal propagation is the norm in tree horticulture, and since the nursery business is not geared to handling many clones in any given species or type, we must practice the most rigid selection in our programs. Testing in various climatic zones should be a basic requirement. Inoculation with important pathogens and deliberate exposure to harmful insect pests should be a standard practice. Any stresses that the tree is likely to encounter in the city should be simulated as far as possible. When the 1,500 trees in your hybrid population have been reduced to one, that is the cultivar we need.

I give you a final word on testing. No cultivated field in Pennsylvania or suburban house lot in Maryland provides quite the same environment as that 4-foot square of ground between the curb and the street at 14th and K Streets in Washington, D. C. Just as forest geneticists would like to make their test plantings on sites similar to those where genetically-improved plantations will be grown, those of us working with shade trees would like to make our test plantings along city streets. Such a test is difficult, but not impossible to achieve.

There may be times when, because of inner desires or outward pressures, we may release a clone that is not the ultimate best, or which has not been tested as strenuously as we would have wished. We shall all do this at one time or another. However, if a clone is superior in some traits and is the best we can hope to offer in the next 10 years, I think such release is justified.

Trees usually outlive their breeders. By careful attention to the goals of improvement, and thorough testing in spite of many difficulties, the trees we leave behind us should be a source of aesthetic pleasure and scientific interest for generations to come.

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DISCUSSION

GABRIEL - Are you aware that there has been a proper description of the Acer nigrum X A. saccharum hybrid published recently by an eastern nurseryman, and that he has a patent on this hybrid?

SANTAMOUR - There is a little admonition at the bottom of all patent applications that government employees should not discuss it -- so I won't.

GABRIEL - What I am trying to say is that we made the cross earlier and had the hybrids growing when five years later somebody comes along and patents it. This kind of thing seems to rub me the wrong way. It's like McKees Poplar. There is nothing you can do about it, is there?

SANTAMOUR - The efficiency of our plant patent system for crosses other than roses, where the clonal turnover is fantastic from year to year, sometimes escapes me. A man may achieve some monetary gain by patenting a tree and being its sole propagator for a certain length of time--then by getting certain royalties on its propagation when it becomes popular. But I think it's creating problems because the public assumes that such plants are really superior--and most are not. It is very difficult to turn down a patent application, because all that is required is that the plant be different. I would prefer to not talk about patents. I wish they would go away.

HUNT - Frank, would you comment on using large lysimeters or punching holes in blacktop pavement around a shopping center as a test area for your new clones. We could place these just about anywhere in the urban area.

SANTAMOUR - You mean you have a nice, well-paved area that they would let you dig holes in?

- I bet with all the emphasis on environmental beauty we could locate areas!

SANTAMOUR - Well, that would be marvelous. I think that would be a fine 'test area for certain materials.

HUNT - In distant corners of shopping centers and behind movie theaters where few people normally park, the lysimeters would be similar to the large container-: trees in Philadelphia and Hartford.

SANTAMOUR - This is an entirely different problem of course, but we will probably have to get into this in the near future. Is there adaptability to continuous container growing? They can get around this by moving the trees back and forth from the nursery on a one- or two-year cycle. This has been done in 'Detroit where they take tree A and put it in a container. After two years, they take tree B in from the nursery and shuttle these trees back and forth from container to nursery until they get so big they don't fit.