minded. The upper bracket manager must always bear in mind the need to make reasonable profits, for without them no business can long survive in our economy. Profit mindedness is an absolute necessity for success and the good executive is constantly aware of the need to keep costs down and production and sales up. He thinks, decides, and acts to the end that the company will earn a fair profit — a fair return on the capital that has been invested in it so that the company can continue to operate, grow and expand.

How do YOU size up?

RALPH SHUGERT: George, I thank you for a very excellent presentation. I think your 19-year-old son is an outstanding young man and I am sure you are proud of him.

PLANT PROPAGATION AND ECOLOGY

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The term "ecology" has become a household word with many connotations. Ecology in the strict sense is the science that deals with the interrelationships of living organisms and their environment. Frequently this is construed to mean how the environment, particularly the polluted environment, affects plants and animals. However, if one considers the strict definition, the effect of the plant and animal on the environment should also be considered.

What is the relationship of plant propagation and ecology? In a very limited sense this has already been considered in the session dealing with environmental factors. Yet, in the broad sense of the term, ecology goes much beyond this. Every time a new plant is propagated from seed, cutting, or graft the propagator has participated in the modification of the environment, even though the effect of a single plant may be small. If we consider man and his immediate landscaped environment it is interesting to note the many ways in which plants modify the local environment and reduce certain human stresses that exist in cities and suburbs.

The role of plants in modifying the microclimate is recognized by many. The use of trees for windbreaks and in providing shade has been practiced for centuries. This principle is applied regularly in residential and other small scale landscapes. An important question

is to what extent can vegetation in the larger landscape be effective in modifying microclimate as well as alleviating other human stresses such as air pollution, noise pollution, glare and others?

One type of pollution that is characteristic in cities is thermal pollution, producing what is known as the "heat island" effect. This is increased air temperature due to the high absorption of solar energy by concrete and asphalt that covers so much of our cities, as well as the heat from auto exhausts, air conditioning units, etc. Temperature differences of 10° F or more are quite common between the city and surrounding countryside, particularly during the night.

This can be modified in localized areas by the type of ground cover that is used. For example, air temperature over artificial turf has been measured to be 8 to 12° F higher than over natural turf. Landscape plantings are also effective in reducing temperature. Whereas building and pavement absorb 90 to 95% of the incoming solar energy, foliage only absorbs 50 to 60%. In addition, evaporative cooling from vegetation further reduces the air temperature.

In a recent St. Louis study, the air temperature was 92°F in a city park and 102° F in the downtown business district. This 10 degree difference points out the effectiveness of grass and trees in reflecting the sun's radiation contrasted to the heat absorption and storage of asphalt and concrete. Also noted in the study were differences of 2 to 4 degrees between open and tree-lined streets.

Another influence that has been investigated is the effect of plantings on noise reduction. Generally, vegetation is most effective in reducing irritating high frequencies as much as 10 to 20 decibels, which is more than half, while the lower frequencies were less effectively reduced. Large pine and spruce plantings, 50 to 100 feet wide, are also capable of reducing some of the lower frequency noise, characteristic of traffic, as much as 10 decibels.

The lowest frequencies, which are the most difficult to eliminate but fortunately the least annoying, are not affected by plantings. Plantings of a single species usually exhibit a non-reducing zone about midway between the low and high frequencies.

Effective evergreens for year around noise reduction are arborvitae, Douglas-fir, spruce and pine, all of which have foliage to the ground. Other evergreens, such as hemlock, holly, and juniper, are not as effective. Some good deciduous plants are thickets of sassafras and pawpaw, as well as mixed species. Size and density of the plantings is critical in noise control, with hedges and other narrow plantings being relatively ineffective. Proper selection and spacing of plants, along with proper land grading, could contribute significantly to the alleviation of noise along highways and other problem areas.

We all learned in elementary school that human beings and animals inhale oxygen and exhale carbon dioxide. Plants in contrast absorb the caxon dioxide in the process of photosyntheus and give off oxygen to the atmosphere. Thus man and plants must depend on each other for life-giving materials. While absorbing carbon dioxide, plants also absorb other gases in the air, including pollutants.

The effects of vegetation on reducing air pollution was also considered in a recent study. It has been suggested that trees and green belts remove various types of air pollutants, both gases and solid particles. Based on sulfur dioxide (SO_2) uptake studies of Douglas-fir, it was calculated that a 15" DBH tree has the potential of removing 43.5 lbs. of SO_2 per year if the concentration of SO_2 was 0.25 ppm. If the SO_2 level gets much higher the plants would be injured but they can tolerate this lower level indefinitely. Putting this into perspective, greater St. Louis pumps 455,000 tons of SO_2 into the air annually. Theoretically, 50 million trees or 5 percent of the land space could absorb this much, assuming the SO_2 content remained constant at 0.25 ppm. Although these exact conditions do not exist the significance of vegetation as a potential secondary filter or control is apparent. However, without primary pollutant controls the pollution may reach levels that injure the plants making them useless for any purpose.

The most effective way to control air pollution is at the source, such as reducing the amount of pollutants from autos. However, to further combat this air pollution, green belts of trees and shrubs should be placed along highways to remove various pollutants, both gaseous and solid particles. Although trees, shrubs, vines and turf remove a vast array of harmful impurities from the air we must breathe, plants, like people, can only tolerate so much. It is imperative that we find ways of combatting pollution at the source before it is too late.

Plants may also clean air by just allowing pollutant particles to precipitate out on their leaves, stems and branches. Many plants also have very fine hairs or pubescence on their parts which tend to trap dust and other particles. Also moisture on the leaves may trap dust particles. These particles are usually washed away by rains or heavy sprinklings.

This same trapping effect can be useful in removing ragweed pollen and other allergy irritants from the air. Studies have revealed that 110 yards inside a dense coniferous forest more than 80% of the pollen is removed from the air.

In addition to the effect of plants on these physical discomforts landscape plantings can also be used to alleviate other forms of pollution, such as visual pollution. A well planned planting screen can conceal an ugly junkyard or even a parking lot. Also how often have you been disturbed by the glare of bright lights, either from oncoming

traffic or streetlights. Plantings can be very effective in reducing glare.

As we consider the many ways in which landscape plantings enhance the environment, the task of the plant propagator takes on added significance. Yet, the task of the propagator is not just to propagate more of the same plants. As one considers the many environmental stresses imposed on man, it is quite apparent that plants are exposed to these same stresses. In fact, unlike man who is mobile and able to temporarily escape the contaminated environment, plants are stationary and must endure the hostile conditions continuously. Consequently, plants are needed that will endure the hostile conditions of the city and surrounding areas. Air pollution, high temperatures, moisture stress and salt toxicity are just a few of the problems that threaten the survival of existing plants as well as future plantings. The propagator must be just as aware of these environmental factors as he is about the adaptability of plants to a particular natural climate. The following discussion will attempt to describe the nature of the various problems that are characteristic of the urban landscape in the 20th century.

Air pollution is not new, but it has changed and become more critical. In the earlier part of this century industrial smoke and sulfur dioxide (SO_2) were serious problems in many of our cities. Many plantings were unable to survive these conditions, particularly the evergreens. Fortunately, this problem was greatly reduced with stricter controls on the quality of coal that could be used by industry. Now, in addition to industrial emissions, some of the more serious air pollutants to plants are due to the proliferating traffic situation and the photochemical pollutants generally called smog. This type of air pollution is not restricted to Los Angeles, but exists wherever there is a heavy concentration of traffic, typical of cities on the east coast as well as in our midwestern cities. Some of the specific pollutants that occur in areas of heavy traffic that are known to be toxic to plants at rather low concentrations are ozone and peroxyacetylnitrate (PAN).

This changing pattern of air pollution requires a re-evaluation of plants that are to be recommended for city plantings. For example, lilac has frequently been recommended, but we now know that lilac is one of the most sensitive woody plants to ozone and becomes badly disfigured upon exposure to 0.2 to 0.3 ppm of ozone. Others that are relatively sensitive to ozone include black locust, sycamore, white ash, white and Scotch pine. The ginkgo, one of our most durable and generally recommended city trees is showing noticeable injury in a number of cities, particularly when located close to highways. The cause of this particular problem has not been defined but is suspected of being related to one of the photochemical pollutants.

Air pollution is just one of the problems we face in growing plants in cities. Yet, I believe it is the most serious problem because of the

difficulty of control and the inevitable increase in air pollution with increasing population, industrialization and the mushrooming transportation problem. If something isn't done to alleviate this situation, and all indications are dismal, we should anticipate severe damage in the future to many forms of vegetation in the city and surrounding areas. Rural areas will not completely escape this problem. We must begin selecting and propagating pollution-resistant plants.

The situation in the city becomes even more foreboding when we look at some of the other environmental stresses imposed on plants. Less and less space is allocated to plantings, forcing them into restricted root environments of raised planters or sidewalk tree wells. Moisture frequently becomes limited in restricted soil areas. Although water can be added, provisions for this type of landscape maintenance are usually lacking. Another problem is the abnormally high or low temperatures that the roots of trees are exposed to in raised planters. Unfortunately, plants have generally not evolved root systems that can tolerate these extremes. Plants that can tolerate these conditions must be propagated and made available for the future.

Even if the root environment is adequately cared for we still have the problem of excessive heat in the ambient air. The causes of the abnormally higher temperatures in urban areas include high absorption of radiant energy by asphalt and concrete, heat output of air conditioning and industrial activities, and the reduced air movement that frequently occurs. The effects of these high temperatures on urban trees can only be surmised at this point as we do not have adequate information on this or most of the other problem areas I have mentioned.

In addition to the problems encountered in urban situations, there is a demand to use plants in other locations and situations that are unsuitable for plant growth or survival. Trees and shrubs are planted along our new highways which are void of topsoil and frequently will not support this type of vegetation. Even if the soil is improved for planting, so much salt is placed on some highways that plantings 20 to 30 feet away soon become victims of this serious stress. We need to consider propagating plants that are adaptable, not only to the salt, but to the sterile soil conditions that exist. We can learn much about this by observing those plants in nature which will grow in gravel soils or along railroad tracks, such as sumac. The usual selection of plants for landscaping are not satisfactory for these hostile conditions.

The challenge to the plant propagator is great. The problems are many but the possibilities are even greater. The possibilities can only become a reality if the technology and mechanism for implementation are available. Our primary job is to define these problems more critically and then explore ways of overcoming them.

This will require selection and breeding for resistance to such stresses as air pollution. Greater emphasis is needed in solving some of these pressing problems. We cannot ignore our role in enhancing man's environment.

CLOSING REMARKS

RALPH SHUGERT

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Ladies and Gentlemen and Guests: For the past several days we have been exposed to a multitude of words of wisdom, have enjoyed a delightful tour of the St. Paul area and, in addition, have enjoyed the camaraderie of fellow propagators and dear friends. In 1953 I had the pleasure of attending my first meeting as a guest of Hugh Steavenson. I recall Hugh's explanation of the International Plant Propagators' Society as being an extremely unique organization, wherein exchange of ideas were freely expressed. This general theme and philosophy is still with us today. We heard on the first day of the meeting the expression of the International Plant Propagators' philosophy as expressed by Jim Wells, and I think it goes without saying that all of us in this room have a bit of this inner feeling, if you will, to plant propagation and its role in the nursery community. Without a doubt, the plant propagator today is a man respected and certainly appreciated by his fellow nurserymen.

Just one week ago tonight, I spent a pleasant hour in rereading the Proceedings of our first meeting and it was fascinating to reread the words of the gentleman who founded this Society. I would place it in my library bookshelves with Hemingway, perhaps, on one side and Robert Frost on the other. We have all witnessed the excitement of change in the 20 years of this Society and I think probably today the challenges are certainly as great, or perhaps even greater, than they were a score of years ago. Today's present market and plant challenges are quite different than they were during the first years of this Society. This morning you heard George Oki give an outstanding talk in summing up and putting together the words and the ideas that were expressed during this meeting. He told us what it means for the nurseryman and the nursery community to take from this meeting the ideas engendered and return to implement them. The language was certainly well expressed and it would behoove all of us to utilize the knowledge that we have been exposed to this week, and fit it into our own specific organization. So today, the present, we are witnessing new thoughts and a new standard, if you will, for 1970. In the next score of years it would be fascinating to gaze into a crystal ball