# THE FUTURE IN ORNAMENTAL PLANT BREEDING[1]

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The breeding of new ornamental plants is beginning to gain momentum in the United States and overseas. This includes efforts on annuals, perennials, woody shrubs and shade trees. A growing number of horticulturists and foresters at academic institutions, the U. S. Department of Agriculture, and commercial companies have a primary concern in ornamental plant breeding. Recently, Egolf (1) and Goldsmith (2) reviewed the present status of breeding efforts on woody ornamentals and hybrid annual flowers, respectively. The former report relates the plant species, including *Camellia, Chaenomeles, Hibiscus, Ilex, Lagerstroemia, Magnolia, Malus, Pyracantha, Rhododendron, Rosa, Syringa* and *Viburnum,* being studied by some 41 researchers. The latter report presents the current picture in $F_1$ hybrid annuals with special reference to petunia, snapdragon, marigold, zinnia, and geranium.

The purpose of this paper is to review three selected research areas of ornamental plant breeding which are undergoing change relative to the future task of developing improved types of ornamental plants.

**1. Plant Improvement by Mutation Selection vs Employment of the Sexual Mode of Reproduction.** To date the majority of ornamentals, particularly asexually propagated woody ornamentals and greenhouse crops such as poinsettias, chrysanthemums, geraniums and carnations have been introduced as a result of sport, chance seedling, selected ecotypic variants or planned crosses between parents which probably were derived from open-pollinated heterozygous wild relatives. This type of plant improvement, where asexual propagation of superior forms resulting from sports or chance seedlings, is of limited value in the development of superior type plants. The limiting condition is mainly that these singular changes in a plant characteristic, when compared to the standard form, result from mutations. The latter occur at a very low rate, approximately $10^{-6}$ and, furthermore, most mutations are of a deleterious nature. Mutant forms do have the advantage of giving a single change in what is genetically a heterozygous condition. Another advantage is that those ornamental plant species which are asexually propagated are uniform by virtue of clonal propagation from the original parent.

An example of an ornamental plant improvement program which has evolved from sport selection to hybridization is the greenhouse-

[1] Michigan Agricultural Experiment Station Journal Article No. 5267

grown poinsettia for Christmas sale. This plant, *Euphorbia pulcherrima* Willd. ex. Klotzsch, was introduced into the U. S. from Mexico about 1835. Until 1963, all cultivars which were introduced as being superior to older types were derived as sports or somatic variants on pre-existing clones. Advances were made by introducing redder forms, tetraploids, and types with increased bract size, but no improvement in keeping quality was found in red types similar to that observed in the best white keeping type, 'White Ecke'. The red-bracted cultivars, which make up about 85 to 90 percent of all plants sold at Christmas, had very poor leaf and bract retention when placed in the home environment following culture in the greenhouse. This created numerous problems for the grower; namely, his crop had to reach optimum bloom for a short, precise marketing period prior to Christmas, so that the customer would realize maximum enjoyment from a plant destined to last until New Year's at most. Jim Mikkelsen, at Ashtabula, Ohio, had the idea to hybridize red and white cultivars to incorporate the keeping quality of the latter into the former, and it resulted in the variety 'Paul Mikkelsen' in 1963.

An example where selection in self-pollinated lines derived from heterozygous varieties, which had previously been asexually propagated, has resulted in superior plant types is the seed-grown geranium for bedding plant purposes.

Prior to the introduction of the 'Nittany Lion Red' geranium, the plants grown for spring bedding plant sale were produced by stem and leaf-bud cuttings from stock plants during the spring. The seed-produced crop gives the grower a uniform, disease-free, shorter growing time product which can be readily programmed for specific marketing periods. The plant breeder can provide a better geranium by selecting lines for such traits as flower size, flower type, plant height, flower color and recombine these in a vigorous growing hybrid product. There is still a tremendous challenge in breeding geraniums for the future for earlier flowering and final plant height and, already there are improved varieties, the Morton and Carefree hybrids, when compared to the original seed types.

In woody ornamental breeding it would appear that the selection of sports, seedling and ecotypic variants as a means of plant improvement has been used almost to the point where further yield of unique plants will be negligible in relation to the efforts expended. Woody ornamental breeding is a complex task due to the long time interval between generations, seed dormancy factors, land area requirements and maintenance. However, it is encouraging to note that there are already a number of established genetics and breeding projects which hopefully will be carried forward and funded in succeeding generations of researchers which will be necessary to provide continuity for such programs.

2. **Plant Hardiness as a Factor in Breeding Programs.** Our current knowledge of the factor(s) responsible for winter survival of

plants and flower buds in perennial, ornamental shrubs and small trees is limited. Very few geneticists and breeders have identified the phenotypic characteristic(s) associated with hardiness and established their inheritance patterns. An example of this type of research is that presented by Kneckt and Orton (3). These researchers found that stomate density was related to plant hardiness in *Ilex*. A low stomate number was observed on hardier clones and it was proposed to employ this phenotypic character as a selection index to develop hardy breeding lines.

The hardiness of evergreen flower buds and stems has been studied by Glen Lumis, a graduate student in our Department. His observations during the past three winters showed that most of the flower buds of *Rhododendron yedoense* var. *poukhanense* (unnamed cultivar) were injured by low temperatures during December and January (See Fig. 1 for temperature data). Splitting of upper stems just below the flower bud was often observed outdoors and after artificial freezing tests. However, most of the buds of *R*. 'Maryann' were not injured. Bud survival data are shown in Table 1. During the months of December and January a significant difference in upper stem moisture content was observed between the 2 cultivars (See Fig. 1).

By sectioning the upper stems while they were frozen it was found that large ice masses had formed in the vascular tissue. These damaging splits occurred only in *R. yedoense* var. *poukhanense,* the less hardy cultivar with the higher water content. Artificial lowering of the water content of *R. yedoense* var. *poukhanense* twigs eliminated the splits and increased the hardiness to nearly that of *R*. 'Maryann'. Efforts to determine differences between the two cultivars, in addition to water content, were to no avail.

Browning is an obvious sign of low temperature injury in the flower bud. Although browning of floral tissues is symptomatic of low temperature, it provides neither any evidence of the location of initial injury, nor any differentiation between direct injury (caused by low temperatures) and indirect injury (caused by dead cells adversely affecting their living neighbors). In order to determine living from dead cells, whether of twigs from outdoors or from artificial freezing tests, the vital stain—neutral red—was used. This stain proved to be very useful. Initial injury to azalea twigs occurred in the upper stem. Exposure to slightly lower temperatures injured the upper stem pith and also the flower bud. There was no intermediate in flower bud injury; the flower was either dead or alive. In some cases only the ovary was injured directly by the low temperature. The rest of the flower soon became brown due to the deterioration of the ovary.

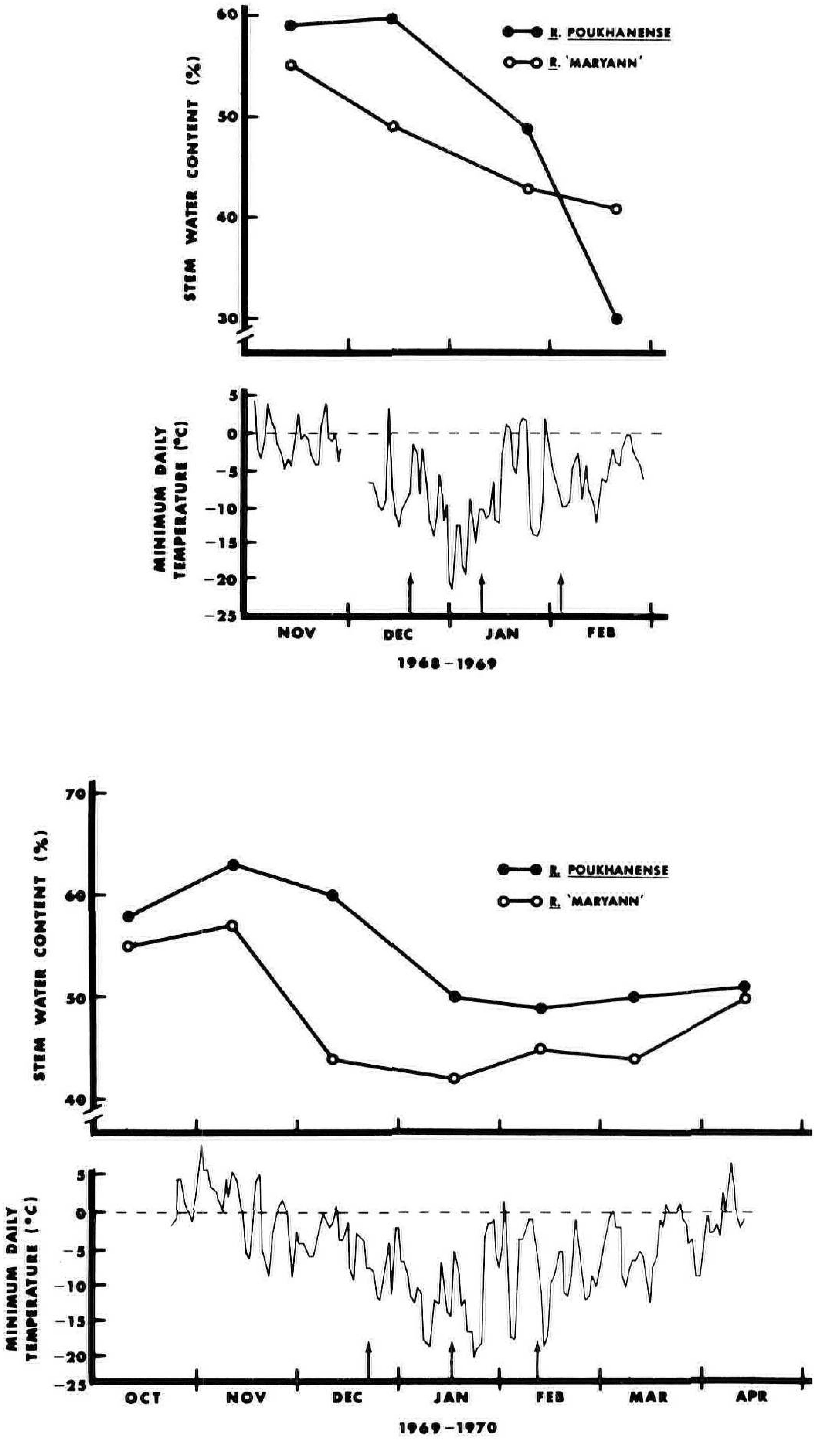


Fig. 1.

**Temperatures and stem water contents of Rhododendron obtained from outdoor surveys in 1968-1969 and 1969-1970. Vertical arrows indicate flower bud injury sampling dates.**

**Table 1. Number of flower buds appearing normal or injured at various sampling dates prior to and after low temperature periods for three azalea cultivars.**

| Date | *R.* 'Maryann' | | *R.* 'Mikado | | *R. yedoense* var. *poukhanense* | |
|---|---|---|---|---|---|---|
| | injured* | uninjured* | injured | uninjured | injured | uninjured |
| 12 / 18 / 68 | 2 | 58 | 2 | 58 | 3 | 57 |
| 1 / 10 / 69 | 9 | 51 | 33 | 27 | 48 | 12 |
| 2 / 3 69 | 12 | 48 | 39 | 21 | 54 | 6 |
| 12 / 21 / 69 | 2 | 46 | 2 | 46 | 3 | 45 |
| 1 / 16 / 70 | 9 | 39 | 6 | 42 | 39 | 9 |
| 2 / 11 / 70 | 8 | 40 | 9 | 39 | 44 | 4 |

*' Total for three replications

Further studies of the freezing process in azalea twigs revealed that freezing occurred in a nonequilibrium pattern where ice formation was not a function of decreasing temperature. Ice formed very rapidly. This is in sharp contrast to *Prunus* and *Malus* twigs under similar conditions in which ice formed much more slowly, as a function of decreasing temperature. Fig. 2 depicts the difference in freezing pattern between azalea, apple and cherry. When ice formation is rapid, the ice is directly involved in stress. Water content is a very important consideration during nonequilibrium freezing. A high water content, combined with the rapid ice formation, caused the large, splitting ice masses mentioned earlier. Even when the water content is moderate the strain of rapid ice formation can be damaging as tissues are contorted by their water loss and the formation of extracellular ice.

A screening technique based on stem and bud water content is planned for the future. We are also studying the possibility of using differences in the freezing process as screening procedure.

3. **Future Trends in Breeding Ornamental Plants.** There will be a continued effort to place on trial, evaluate and introduce worthy plant species which are discovered through ornamental plant explorations.

Cooperation between forest tree geneticists, breeders of ornamental plants, and ornamental horticulturists will increase in the evaluation of trees for landscape use, particularly pines, spruces, cedars and other evergreen types.

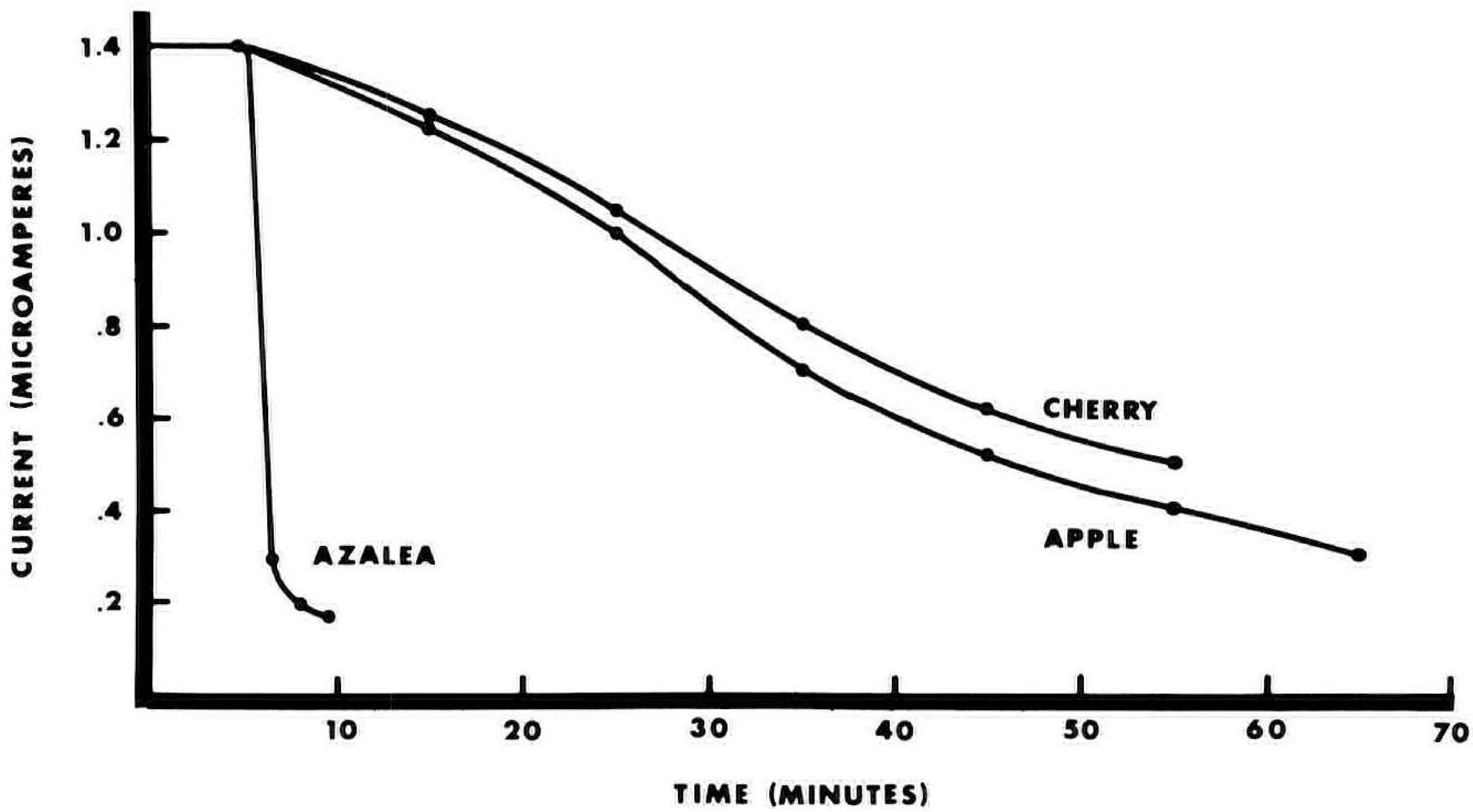


Fig. 2. Freezing pattern comparison among azalea, apple and cherry twigs.

New plant materials released should be a significant contribution to the diversity of types available and possess the ability to withstand such environmental stresses as air, water and soil pollution, cold and drought, and be adapted to the cultural practices used for growing plants to marketable size.

In annual flower crops there will be $F_1$ hybrids available in more species and refinements in the techniques used to produce seed crops will be made by the breeder.

Asexually propagated greenhouse crops will be tried as seed crops and breeders will continue to select and develop inbred lines, identify heritable characters and their genetics, and combine desirable traits in hybrid varieties.

## LITERATURE CITED

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MODERATOR LEISER. I will now turn the microphone over to Al Fordham from the Arnold Arboretum, whom you all know. He will start the session on "New Plants". Al.