

MR. GERMANY: Yes, we do use a water filter. Our main problem is corrosion of the electrodes. I think they will get this fault worked out in the near future.

MR. JAMES WELLS: I missed your information as to the time you took your cuttings. When do you start and how long do you continue?

MR. GERMANY: In our particular area we can start sometime around the first of July and continue right on until frost around the first of December, although I don't believe timing makes a lot of difference.

MODERATOR FLEMER: That is all the time we will have allotted for discussion. Thanks again, Mr. Germany, for a most interesting talk.

The Agricultural Research Service of the United States Department of Agriculture is currently engaged in a most interesting project in hybridizing and breeding hardier and better forms of evergreen *Berberis* and *Mahonia*. We are fortunate in having with us, Toru Arisumi, from the Station at Worthington, Ohio, who will talk about some of the objectives and problems of the program.

Mr. Arisumi then presented his address on "Some Breeding Objectives for the Improvement of *Berberis* and *Mahonia*" (Applause)

SOME BREEDING OBJECTIVES FOR THE IMPROVEMENT OF MAHONIA AND BERBERIS

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The two closely related genera of *Berberidaceae*, *Mahonia* and *Berberis*, comprise a large group of useful ornamental shrubs. According to Rehder (4) there are about 50 species of *Mahonia* found in North and Central America and in East and South Asia, and about 175 species of *Berberis* found mostly in East and Central Asia and South America, with a few in North America, North Africa, and Europe. Many species in these genera are susceptible to some of the rust fungi (*Puccinia graminis*) of cereals, acting as alternate hosts in the life cycles of these fungi. For this reason the cultivation and distribution of rust-susceptible barberries and mahonias are prohibited in 19 states within or near the cereal growing regions of this country. Fortunately, there are about 30 species of barberries and 9 species of mahonias that are rust resistant and safe for cultivation in these states (5). This group of rust-resistant species includes many diverse and attractive types suitable for use in a breeding program.

A survey of the literature indicates the existence of many interspecific and a few intergeneric hybrids in these genera. Rehder (4) lists about 18 interspecific hybrids of *Berberis* and 2, *Mahonia* hybrids. Some of these hybrids represent crosses of quite divergent species from widely separated geographical regions. Interspecific hybrids of *Berberis* normally found in the nursery trade, such as *B. stenophylla* and *B. men-*

toensis, show some degree of fertility. Dermen (2) reported 5 successful and 6 unsuccessful interspecific crosses from different cross combinations of 11 *Berberis* species. He also tried some crosses between *Mahonia aquifolium* and 3 species of *Berberis* and obtained seeds from the cross of *Berberis heteropoda* X *Mahonia aquifolium*. He did not have any success with reciprocal crosses of *Mahonia aquifolium* and *Berberis julianae* or *Berberis sargentiana*. Later attempts at intergeneric hybridization by Jensen in Sweden resulted in the hybrids *Mahonia aquifolium* X *Berberis sargentiana* (3) and *Mahonia aquifolium* X *Berberis candidula* (6). At the present time there are at least 4 known *Mahoberberis* hybrids. All of these intergeneric *Mahoberberis* hybrids are supposed to be sterile, non-flowering forms (2) (6).

Cytological studies (2) (3) (6) also show a close relationship between these genera. The chromosomes of *Mahonia* and *Berberis* are similar in number and appearance, although there is some disagreement on the size of these chromosomes. Most of the species studied so far have 28 chromosomes, and only 4 species have been found to be tetraploids with 56 chromosomes (1).

Since interspecific and even intergeneric hybrids can be obtained in these genera, there are good possibilities of combining diverse genotypes to create new and improved forms of mahonias and barberries by breeding. Embryo-culture techniques widely used in plant breeding could be employed for the more difficult crosses. Also, colchicine treatments could be used to induce polyploidy in these species. Breeding could then be carried on at the diploid and polyploid levels. Research along these lines just mentioned is now in progress at our station in Columbus, Ohio.

Some of the more important objectives of our breeding program are listed as follows.

1. Breeding for hardiness.
2. Breeding for improved foliage and fruits of mahonias and barberries.
3. Breeding for improved dwarf forms.

The hardiest species in the group of rust-resistant barberries and mahonias are listed in Rehder's Manual (4) as being hardy in Zone 5. Included in this category are 4 species of *Mahonia*, 6 species of evergreen *Berberis*, and 4 species of deciduous *Berberis*. These species are: *Mahonia aquifolium*, *M. repens*, *M. nervosa*, *M. bealei*, and *Berberis buxifolia*, *B. stenophylla*, *B. verruculosa*, *B. triancathophora*, *B. gagnepainii*, *B. julianae*, *B. thunbergii*, *B. koreana*, *B. gilgiana*, and *B. circumserrata*. By selecting from seedling plants of these species we hope to obtain some hardy forms for breeding. Hardy forms known to be growing in colder climatic zones will also be selected for further tests and breeding. By selecting and breeding for hardier plants we hope to extend the range of these species or their hybrids beyond their present geographical limits.

The foliage of mahonias and evergreen barberries is the most important attribute of these species. There is a wide variation of foliage types, not only between the different species but also within each species. For example, seedlings of *Mahonia aquifolium* exhibit a wide

range of leaf types that vary in size, shape, color, gloss, and ability to withstand winter conditions. The foliage of most mahonias show various degrees of injury due to wind, sun, and frost during the winter months. Some of these plants lose their foliage early in the winter, others retain them for longer periods, and some keep their foliage until spring. The variability of foliage types indicates that much work could be done in selecting and breeding for improvement of foliage in this group of plants.

The fruits of evergreen barberries and mahonias are not persistent, nor are they so showy as those of some of the deciduous barberries. Practically all of these have bluish or black berries which are quickly eaten by birds when they ripen or shrivel up within a short time. However, there are good indications that some plants in the species hold their fruits for longer periods than others. We hope to select these. Barring the occurrence of favorable mutations affecting fruit color of mahonias and evergreen barberries, the development of red-fruited forms of these species would entail a long process of breeding and selection of hybrids showing evergreen, red-fruited, and rust-resistant characters. Except for some rust-susceptible mahonias, the best red-fruited forms of barberries are all deciduous. A remote but interesting possibility is the use of red-fruited *Nandina domestica* for crossing with mahonias and barberries.

The third objective under consideration is that of breeding and selection for attractive dwarf forms. Because of the ever increasing need for small shrubs, breeding for dwarf mahonias and barberries is an important objective of the breeding program. These dwarfs should be compact, slow-growing types that retain most of the good qualities of the species. Some species of mahonias and barberries are actually dwarf species, but many others are fairly large shrubs that would be more useful in smaller forms.

LITERATURE CITED

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4. Rehder, Alfred. 1949. Manual of Cultivated Trees and Shrubs Hardy in North America. The Macmillan Company, New York. Second Edition.
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6. Vaarama, Antero. 1947. Contributions to the Cytology of the Genus *Berberis*. *Hereditas* 33: 422-424.

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MODERATOR FLEMER: Thank you very much, Mr. Arisumi. Are there any questions?

MR. JOHN HILL (Dundee, Illinois): Toru, what can you tell us of the intergeneric crosses between *Berberis* and *Mahonia*, that are

somehow or other finding their way into the trade? What can you tell us specifically regarding hardiness and propagation methods?

MR ARISUMI Nothing, since it was only three weeks ago that we obtained specimens

MODERATOR FLEMER. Would Roger Coggeshall please comment on the rooting qualities of these hybrids?

MR ROGER COGGESHALL (West Newbury, Mass.): They root very well taken from cuttings in the months of September and October. As far as the hormone treatment is concerned, Hormodin No 2, appears to be the best. Hormodin No 3 seems to be too strong since it generally will kill the bases of the cuttings. For the medium we use sand and peat mixed, half and half, by volume.

MODERATOR FLEMER: Were these hybrids fairly hardy in Boston?

MR COGGESHALL: No, they were not. They didn't remain totally evergreen. As I remember the portion of the plant which was above the snow defoliated without killing the stems, and the portion below the snow remained evergreen and retained its leaves.

MODERATOR FLEMER: Thank you very much, Mr. Arisumi

Since we are running behind time I will ask Lee Enright and John Sjuln to defer their talks until this afternoon, when we have an opening in the program.

Unless there are announcements, the meeting is adjourned for lunch.

The meeting recessed at twelve o'clock, noon