Our results suggest that the control of greenhouse whitefly on feeding and subsequent oviposition aldicarb is potentially beneficial for the control of greenhouse whitefly on poinsettia. 

<table>
<thead>
<tr>
<th>Chloromequat (mg/13 cm pot)</th>
<th>Aldicarb</th>
<th>Annette Hegg Maxi</th>
<th>Eckespoint F-4</th>
<th>Eckespoint C-1</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>4.7a</td>
<td>5.3a</td>
<td>4.9b</td>
<td>4.9a</td>
</tr>
<tr>
<td>160</td>
<td>1.4d</td>
<td>1.4c</td>
<td>1.7d</td>
<td>1.5d</td>
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</tr>
<tr>
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<td>1.1e</td>
<td>1.1d</td>
<td>1.1e</td>
<td>1.1e</td>
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</tr>
<tr>
<td>750</td>
<td>3.9b</td>
<td>4.5b</td>
<td>5.3a</td>
<td>4.6b</td>
<td></td>
</tr>
<tr>
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<td>0</td>
<td>3.3e</td>
<td>4.3c</td>
<td>4.0c</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>1.0e</td>
<td>1.1d</td>
<td>1.1e</td>
<td>1.1e</td>
<td></td>
</tr>
<tr>
<td>320</td>
<td>1.1e</td>
<td>1.0d</td>
<td>1.0e</td>
<td>1.0e</td>
<td></td>
</tr>
</tbody>
</table>

Means for cultivars: 2.0 2.3 2.4

Means for aldicarb: 0 2.4a 2.6a 2.6a 2.5a 2.5a

Means for chloromequat: 0 750 2.0b 2.2b 2.2b 2.0c

\( ^1 \) (least infestation) to 6 (severe damage). Mean separation within groups within columns by Duncan's multiple range test, 5% level.

for feeding and subsequent oviposition (1). Our results suggest that the combination of chloromequat and aldicarb is potentially beneficial for the control of greenhouse whitefly on poinsettia.

### Anthocyanin Pigments and Breeding Potential in Crapemyrtle (Lagerstroemia indica L.) and Rose of Sharon (Hibiscus syriacus L.)

Donald R. Egolf and Frank S. Santamour, Jr.

U.S. Department of Agriculture, Washington, D.C.

Abstract. The anthocyanins in the flowers of crapemyrtle (Lagerstroemia) species and cultivars are the 3-glucosides of delphinidin, petunidin, and malvidin. These three pigments are also present in most of the cultivars of rose of sharon (Hibiscus syriacus), but one cultivar contained cyanidin 3-glucoside as the major petal pigment. Thus, the development of plants with "true-red" petals is remotely possible in rose of sharon but unlikely in crapemyrtle.

Rehder's (6) description of flower color variation in Hibiscus syriacus was "white to red or purple or violet" and for Lagerstroemia indica was "pale pink to cherry red and violet, and one with white." In fact, true-red petal colors such as Vermilion (41A), Scarlet (43B), Blood Red (45D), and Crimson (52A) are unknown in both species. One exception to this statement does occur in H. syriacus, where the basal color blotch on the inner surface of the petals, especially in white-petaled forms, may be classified in the red group. However, the major flower colors in both species range from the red-purple group through purple to purple-violet and in some H. syriacus to violet-blue.

Of the 6 common anthocyanidin glucosides found in flowers, pelargonidin glucosides normally produce orange-red to scarlet petals, cyanidin and peonidin glucosides give crimson to magenta shades, and delphinidin, petunidin, and malvidin glucosides usually give hues of mauve, violet, or blue. These pigment types may occur singly in different concentrations or in mixtures of varying proportions to produce an array of floral colors. Furthermore, the color expression may be modified by co-pigmentation, by pH, or occasionally by metal complexing. Recent studies (1, 2, 7) involving direct observations on living cells compared to analyses of extracted pigments have provided convincing evidence of the importance of these factors. However, most of the modifications tend to increase the maximum absorption wavelength and thus the "blueness" of the visible color. The possibility of extending the existing color range in these two summer-flowering ornamental shrubs by breeding led us to study the anthocyanin pigments in a wide range of flower-color phenotypes in both major species and some related species.

The plants for this study are located at the U.S. National Arboretum, Washington, D.C. Many were older cultivars that were being tested or that had been used as parental stock, some were selections of intra- or interspecific hybrid progenies, and some were new cultivars developed at the National Arboretum.

The analytical methods of Harborne (4) were employed with anthocyanins extracted from petals in cold methanol containing 1% HCl. These extracts were banded on Whatman No. 3MM paper and the pigments were separated and purified by ascending development in one or more of these solvent systems: BAW (n-butanol-acetic acid-water, 4:1:5, upper phase); aqueous 1% HCl (97:3); HOAc-HCl (acetic acid-HCl-water, 15:3:82); and BuHCl (n-butanol-2N HCl, 1:1, upper phase). The number and sequence of solvents used for purification were based on chromatograms run in HOAc-HCl. The purified pigments were eluted in methanolic 1% HCl and the maximum absorption peaks in the visible and

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1 Received for publication September 14, 1974.
2 Research Horticulturist and Research Geneticist, respectively, U.S. National Arboretum, Agricultural Research Service.
3 Specific and group color-names refer to the Royal Horticultural Society Colour Chart, 1942, and color code numbers to the R.H.S. Colour Chart, 1966.

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Table 1. Effect of chloromequat and aldicarb on whitefly infestation of 3 poinsettia cultivars.

<table>
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Means for cultivars: 2.0 2.3 2.4

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Means for chloromequat: 0 750 2.0b 2.2b 2.2b 2.0c

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21 (least infestation) to 6 (severe damage). Mean separation within groups within columns by Duncan's multiple range test, 5% level.

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**Literature Cited**

ultraviolet range determined spectrophotometrically. The purified pigments were hydrolyzed by boiling in 4N HCl for 20 min. The products of hydrolysis were also analyzed by standard chromatographic techniques: anthocyanidins in Forestal solvent (acetic acid-HCl-water, 30:3:10) and simple sugars in iso-propanol-water (4:1) with glucose control. Absorption spectra of the anthocyanins were also determined.

*Crape Myrtle.* A series of cultivars of *L. indica* from the red-purple and purple groups were analyzed: 'Pink Lace', 'Pink Ruffles', 'Low Flame', 'Seminole', 'Carolina Beauty', 'Conestoga' and ' Catawba'. All contained the 3-glucosides of delphinidin, petunidin, and malvidin as the only anthocyanins. Even 'Dwarf Blue' (81C, Amethyst Violet) of the purple-violet group contained all three pigments. Delphinidin 3-glucoside was predominant in 'Dwarf Blue' but it also was the major pigment in many of the redder cultivars.

The only anthocyanin in the lightly pigmented *L. amabilis* Mak. (purple group, 75D) was delphinidin 3-glucoside. When this species was crossed with *L. fauriei* Koehne (white petals), all 3 pigments appeared in the hybrid seedlings having colored petals.

Because of the absence of pelargonidin and cyanidin pigments in the same gene pool of *L. indica* and related species, it is unlikely that any cultivars with "true red" petals can be developed. Methylation of hydroxyl groups may have a small reddening effect on color (3), but the effect of methylation is generally obscured by other factors, such as co-pigmentation. Certainly the presence of petunidin and malvidin, both methylated derivatives of delphinidin, does not have a recognizable effect in *L. indica*.

It is possible that cultivars with bluer flowers could be created by intercrossing of the bluest types. However, in *L. indica*, in which blueness appears to depend on factors other than anthocyanin content (such as pH or co-pigmentation), more sophisticated analyses are needed to determine the choice of parental material.

*Rose of Sharon.* The cultivars 'Bluebird' and 'Celestial Blue' are the bluest in *H. syriacus* with a color rating of 92B-Wistaria Blue. Both had malvidin 3-glucoside as the predominant pigment, and a trace of delphinidin 3-glucoside. The reddish petal blotch of these cultivars was largely cyanidin 3-glucoside.

We also analyzed the anthocyanins in the petal blotches of a number of pigmented and white-petaled cultivars of *H. syriacus*. In all of them, the pigment composition was exclusively or predominantly cyanidin 3-glucoside. Petal blotches in *H. moscheutos* L. and *H. rosa-sinensis* L. had cyanidin 3-glucoside as the major pigment. This is especially interesting in view of the report (5) that cyanidin 3-sophoroside (a diglucoside) was the red pigment in petals of *H. rosa-sinensis*. We have confirmed this determination of the major petal pigment, but the petal blotch in this species was, as in *H. syriacus*, mainly cyanidin 3-glucoside.

The senior author has attempted to introduce the red petal pigments of *H. rosa-sinensis* into *H. syriacus* by hybridization, but repeated crossing attempts have failed. Another approach to developing a true red *H. syriacus*, undertaken before the present pigment analyses, was to try to "spread" the petal blotch in white-flowered cultivars. Intraspecific crosses have yielded seedlings with larger red blotches, but in no instance did the blotches occupy more than 30% of the petal area. In addition, the blotches became streaky and unattractive. Neither of the above schemes to develop a red-flowered *H. syriacus* was successful.

The flowers of the cultivar *H. syriacus* 'Puniceus Plenus' (purple group, 77D) were typical of plants in this color group in containing approximately equal proportions of the 3-glucosides of delphinidin, petunidin, and malvidin. Flower petals of 'Bonjoia' (red-purple group, 70B) contained the same three pigments plus a trace of cyanidin 3-glucoside. The reddest of the red-purple group was 'Suminokura-ya' (58D, China Rose). The predominant pigment in this cultivar was cyanidin 3-glucoside, although the other three pigments were also present.

In most plants, delphinidin (and its derivatives) is dominant to cyanidin (5). Pigment inheritance is further complicated by the polyploid nature of *H. syriacus* and the fact that so-called triploids are the most desirable ornamentals. Still, by judicious selection of parental stock and raising large populations, the development of red-flowered rose of sharon pigmented by cyanidin 3-glucoside is a remote possibility.

Literature Cited

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Experimental Hydroponic Germination and Growth of Turfgrass Seedlings

L. Art Spomer

University of Illinois, Urbana-Champaign

Received for publication September 3, 1974. Contribution from the Department of Horticulture and Illinois Agriculture Experiment Station. Project No. 65-353; partially supported by the U.S. Golf Association Green Section Research and Education Fund, Inc. The author greatly appreciates assistance and support from A. M. Radko and F. Lee Record U.S.G.A. Green Section.

1Assistant Professor, Plant Physiology in Horticulture.
2The author appreciates the kind donation of the polyethylene pellets by H. H. Petrie Sporting Goods, Madison, Wisconsin, and Ride Manufacturing Company, 5929 South Archer Avenue, Chicago, and Polypropylene pellets by Eastman Chemical Products, Inc., Kingsport, Tennessee. Details on chemical properties can be obtained from the supplier of each plastic.

Abstract. A method utilizing small, bouyant particles in a floating mat for the hydroponic germination and growth of small plants is described. The bouyant mat supports the seeds and small plants on the culture solution surface and allows easy, non-destructive removal of the plants analysis and re-insertion. This method was used successfully to germinate and grow seedlings of bluegrass (Poa pratensis L.)

Experimental hydroponic germination and growth of small plants such as individual turfgrass seedlings is very difficult because of the difficulty in supporting them in such a way so as to maintain uniform, continuous,