Four Cultivars of Iochroma

Alan W. Meerow
USDA–ARS–SHRS, National Germplasm Repository, 13601 Old Cutler Road, Miami, FL 33158

Rick J. Schoellhorn
University of Florida, Department of Environmental Horticulture, 1545 Fifield Hall, Gainesville, FL 32611

Michael Kartuz
Kartuz Greenhouses, 1408 Sunset Drive, Vista, CA 92085-0790

Additional index words. Solanaceae, tropical shrubs, potted plants, ornamentals, landscape, floriculture, AFLP

Iochroma Benth. (Solanaceae) is a South American genus of some 20 species of shrubs and trees (Huxley et al., 1992). Iochroma cyaneum (Lindl.) M.L. Green is a soft-stemmed, shrubby Ecuadorian endemic generally found between 1800 and 2500 m elevation. The species is described typically as having dark blue flowers. It is used occasionally as an ornamental shrub in the United Kingdom, southern Europe, Australia, and California. In this paper, we announce the formal recognition and release of three distinct color forms of this species, and a third unidentified Iochroma, all of which have shown remarkable heat tolerance in south Florida, given their native range in elevation. We believe that these fast-growing cultivars have great potential for use as landscape shrubs in USDA Hardiness Zones 9B–11 (USDA, 1990), root-hardy perennials in Zones 8B–9A, and as annuals and/or flowering pot plants in all zones.

Origin

Iochroma cyaneum ‘Indigo’, ‘Royal Blue’, ‘Sky King’, and ‘Wine Red’ were obtained by the third author before 1993 as unnamed collections of I. cyaneum, and have been grown and sold by his mail-order nursery for several years. All are believed to have originated in Ecuador and were received from various collectors over the years (no further detailed provenance is available). The first author obtained rooted cuttings of each cultivar from Kartuz Greenhouses in 1999 and began 3 years of evaluation. All four have shown a surprising amount of heat tolerance in Miami, given the altitudinal distribution of this species in the Andes. They are propagated readily, very fast-growing, and virtually ever-blooming. We believe that, given their ease of propagation, rapid production rate, and ever-blooming phenology, all four have potential to be mass-marketed for seasonal color in USDA Hardiness Zones beyond their expected low temperature tolerance.

Received for publication 6 Dec. 2002. Accepted for publication 8 Mar. 2003. Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that may be suitable.

Molecular characterization using AFLPs

DNA extraction. DNA was extracted from all four cultivars using the Dellaporra (1983) method from 2.0 mg of fresh leaf samples. After drying, the DNA was resuspended in 30 µL TE, pH 7.4. DNA concentration was evaluated by gel visualization. Duplicate extractions were performed for each accession.

Amplified fragment length polymorphisms of total DNA from the four cultivars were assayed using fluorescent dye-labeling and gel electrophoresis. Duplicate amplifications were performed for each accession.

Iochroma cyaneum ‘Indigo’ (Fig. 1) has petals 1.0 to 1.5 cm long and leaf blades 5.5 to 6.8 cm long, 3.6 to 4.2 cm wide. Pedicels are 12 to 17 mm long. The calyx is 7.5 to 10 mm long. The flowers are 3.8 to 4.4 cm long measured from the base of the calyx, 3.5 to 4.0 cm wide at the base of corolla, widening in the apical 8 to 10 mm to a 12–14-mm-wide, 10-lobed limb. Alternate lobes are keeled on their interior surface. When the flowers first open, they are RHS purple-blue 93A; at anthesis they lighten to 88D.

Iochroma cyaneum ‘Sky King’ (Fig. 3) has petals 1.0 to 2.0 cm long, and leaf blades 4.5 to 6.0 cm long, 3.0 to 3.6 cm wide. Pedicels are 20 to 23 mm long. The calyx is 9 to 10 mm long. The flowers are 4.5 to 4.8 cm long measured from the base of the calyx, 4.0 to 5.0 mm wide at the base of the corolla, widening in the apical 8 to 10 mm to a 10–12-mm-wide, 10-lobed limb. Alternate lobes are keeled on the interior surface. When the flowers first open, they are RHS violet 88C; at anthesis they lighten to 88D.

Iochroma ‘Wine Red’ (Fig. 4) has not yet been identified as to species, and DNA amplified fragment length polymorphism (AFLP) profiles (see below) suggest that it is a taxon other than I. cyaneum. ‘Wine Red’ has hairy young stems than the previous three cultivars, petals 9.0 to 16 mm long, and leaf blades 8.0 to 13.0 cm long, 3.8 to 5.0 cm wide. Pedicels are 11 to 17 mm long. The calyx is 7 to 8 mm long. The flowers are 4.0 to 5.0 cm long measured from the base of the calyx, 4.0 to 4.5 mm wide at the base of the tube, widening in the apical 8 to 10 mm to a 7.5–8.5-mm-wide, 5–(to 7)-lobed limb. The limb is keeled between the lobes on interior surface. When the flowers first open, they are RHS red-purple 61B, fading to 64D.

‘Royal Blue’ has a longer calyx than does any of the other cultivars. ‘Wine Red’ may be distinguished from the three cultivars of I. cyaneum not only by flower color, but also by its larger leaves, pilose young stems, and 5–(to 7)-lobed limb. To date, there is no published treatment of Iochroma that would allow easy identification of an unknown species. The first author has seen I. cyaneum in habitat in Ecuador on multiple occasions, and the first three cultivars described in this paper are readily assignable to that species. Iochroma cyaneum does vary in flower color, and other cultivars have been described over the years, e.g., ‘Alba’, ‘Apricot Belle’, and ‘Woodcote White’ (Ellison, 1995; the latter mislabeled as a cultivar of I. grandiiflora). The I. grandiiflora pictured by Ellison (1995) appears similar to ‘Wine Red’, but is definitely not I. grandiiflora, a high-elevation scrambling shrub with very large blue flowers (Shaw, 1998; personal observation).

Molecular characterization using AFLPs

DNA extraction. DNA was extracted from all four cultivars using the Dellaporra (1983) method from 2.0 mg of fresh leaf samples. After drying, the DNA was resuspended in 30 µL TE, pH 7.4. DNA concentration was evaluated by gel visualization. Duplicate extractions were performed for each accession.

Amplified fragment length polymorphisms of total DNA from the four cultivars were assayed using fluorescent dye-labeling and gel electrophoresis. Duplicate amplifications were performed for each accession.

Received for publication 6 Dec. 2002. Accepted for publication 8 Mar. 2003. Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that may be suitable.

194 cm long measured from the base of the calyx, 4.0 to 4.5 mm wide at the base of the corolla, widening in the apical 8 to 10 mm to a 12–14-mm-wide, 10-lobed limb. Alternate lobes are keeled on their interior surface. When the flowers first open, they are RHS violet-blue 93A; at anthesis they lighten to 88D.

Iochroma cyaneum ‘Sky King’ (Fig. 3) has petals 1.0 to 2.0 cm long, and leaf blades 4.5 to 6.0 cm long, 3.0 to 3.6 cm wide. Pedicels are 20 to 23 mm long. The calyx is 9 to 10 mm long. The flowers are 4.5 to 4.8 cm long measured from the base of the calyx, 4.0 to 5.0 mm wide at the base of the corolla, widening in the apical 8 to 10 mm to a 10–12-mm-wide, 10-lobed limb. Alternate lobes are keeled on the interior surface. When the flowers first open, they are RHS violet 88C; at anthesis they lighten to 88D.

Iochroma ‘Wine Red’ (Fig. 4) has not yet been identified as to species, and DNA amplified fragment length polymorphism (AFLP) profiles (see below) suggest that it is a taxon other than I. cyaneum. ‘Wine Red’ has hairy young stems than the previous three cultivars, petals 9.0 to 16 mm long, and leaf blades 8.0 to 13.0 cm long, 3.8 to 5.0 cm wide. Pedicels are 11 to 17 mm long. The calyx is 7 to 8 mm long. The flowers are 4.0 to 5.0 cm long measured from the base of the calyx, 4.0 to 4.5 mm wide at the base of the tube, widening in the apical 8 to 10 mm to a 7.5–8.5-mm-wide, 5–(to 7)-lobed limb. The limb is keeled between the lobes on interior surface. When the flowers first open, they are RHS red-purple 61B, fading to 64D.

‘Royal Blue’ has a longer calyx than does any of the other cultivars. ‘Wine Red’ may be distinguished from the three cultivars of I. cyaneum not only by flower color, but also by its larger leaves, pilose young stems, and 5–(to 7)-lobed limb. To date, there is no published treatment of Iochroma that would allow easy identification of an unknown species. The first author has seen I. cyaneum in habitat in Ecuador on multiple occasions, and the first three cultivars described in this paper are readily assignable to that species. Iochroma cyaneum does vary in flower color, and other cultivars have been described over the years, e.g., ‘Alba’, ‘Apricot Belle’, and ‘Woodcote White’ (Ellison, 1995; the latter mislabeled as a cultivar of I. grandiiflora). The I. grandiiflora pictured by Ellison (1995) appears similar to ‘Wine Red’, but is definitely not I. grandiiflora, a high-elevation scrambling shrub with very large blue flowers (Shaw, 1998; personal observation).

Molecular characterization using AFLPs

DNA extraction. DNA was extracted from all four cultivars using the Dellaporra (1983) method from 2.0 mg of fresh leaf samples. After drying, the DNA was resuspended in 30 µL TE, pH 7.4. DNA concentration was evaluated by gel visualization. Duplicate extractions were performed for each accession.

Amplified fragment length polymorphisms of total DNA from the four cultivars were assayed using fluorescent dye-labeling and gel electrophoresis. Duplicate amplifications were performed for each accession.

Received for publication 6 Dec. 2002. Accepted for publication 8 Mar. 2003. Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that may be suitable.

194
Fig. 1. *Iochroma cyaneum* ‘Indigo’.

Fig. 2. *Iochroma cyaneum* ‘Royal Blue’.

Fig. 3. *Iochroma cyaneum* ‘Sky King’.

Fig. 4. *Iochroma* ‘Wine Red’.
EcoRI-AAG JOE + MseI-CAA 22
EcoRI-AAG JOE + MseI-CAC 12
EcoRI-AAG JOE + MseI-CAG 15
EcoRI-AAG JOE + MseI-CTA 32
EcoRI-AAG JOE + MseI-CTC 18
EcoRI-AAG JOE + MseI-CTG 17
EcoRI-AAG JOE + MseI-CTT 23
EcoRI-AAC NED + MseI-CTG 14
EcoRI-AAC NED + MseI-CAG 18
EcoRI-AAC NED + MseI-CTA 26
EcoRI-AAC NED + MseI-CAA 21
EcoRI-ACT FAM + MseI-CTG 19
EcoRI-ACT FAM + MseI-CTA 19
EcoRI-ACT FAM + MseI-CAA 15
EcoRI-ACT FAM + MseI-CAA 17
EcoRI-AGC JOE + MseI-CTT 28
EcoRI-AGC JOE + MseI-CTG 28
EcoRI-AGC JOE + MseI-CTC 35
EcoRI-AGC JOE + MseI-CTA 16
EcoRI-AGC JOE + MseI-CAG 21
EcoRI-AGC JOE + MseI-CAC 23
EcoRI-AGC JOE + MseI-CAA 22
EcoRI-ACC NED + MseI-CTT 15
EcoRI-ACC NED + MseI-CTA 16
EcoRI-ACC NED + MseI-CAG 8
EcoRI-ACC NED + MseI-CAC 21
EcoRI-ACC NED + MseI-CAA 12
EcoRI-ACC FAM + MseI-CAG 23
EcoRI-ACC FAM + MseI-CAC 19
EcoRI-ACC FAM + MseI-CAA 14
EcoRI-ACA FAM + MseI-CAC 13
EcoRI-ACA FAM + MseI-CAA 15
EcoRI-ACA FAM + MseI-CTT 11
EcoRI-ACA FAM + MseI-CAA 21
EcoRI-ACA FAM + MseI-CAG 27
EcoRI-ACA FAM + MseI-CAC 31
EcoRI-ACA FAM + MseI-CGT 22
EcoRI-ACA NED + MseI-CTT 15
EcoRI-ACA NED + MseI-CAG 15
EcoRI-ACA NED + MseI-CAC 10
EcoRI-ACA NED + MseI-CAA 14
EcoRI-ACA NED + MseI-CAC 7

Table 1. Primer combinations and number of polymorphic peaks scored in the AFLP analysis of four cultivars of Iochroma cyaneum.

Applied Biosystems) for each primer combination. Peaks less than 100 bp and more than 450 bp in size were filtered out, and those differing by less than a base in size were collapsed into the same category. Any peak present in only one of the two replications of any cultivar was disqualified from consideration. Amplification products were scored for presence (1) or absence (0) of peaks. Peaks common to all accessions were considered non-informative. Ultimately, 47 of the 64 primer combinations yielded usable peaks. The total number of polymorphic peak categories was 868 (Table 1). Using the program FreeTree (Pavlicek et al., 1999), a pairwise similarity matrix (Table 2) between genotypes was estimated according to Nei and Li (1979):  

$$ S = \frac{2a}{(2a + b + c) \times 100} $$

where $S$ is the similarity between two individuals $i$ and $j$, $a$ the number of positive peaks shared by both individuals, $b$ the number of peaks present in $i$ and absent in $j$, and $c$ the number of peaks present in $j$ and absent in $i$. A dendrogram (Fig. 5) was constructed using the unweighted pair group method (UPGMA; Sneath and Sokal, 1973) and confidence limits on the clusters were determined with 5000 replications of bootstrapping (Felsenstein, 1985).

Bootstrap confidence intervals were 100% for all clusters based on the AFLP data (Fig. 5). Highest similarity (0.8856) was between $I$. cyaneum ‘Royal Blue’ and ‘Sky King’ (Fig. 5, Table 2). ‘Wine Red’ had the highest similarity coefficients with the other three cultivars (Table 2), and is a distant outlier in the UPGMA dendrogram (Fig. 5). ‘Wine Red’ had the highest genetic similarity with ‘Indigo’ (0.2966). Based on these data, coupled with the morphological differences between ‘Wine Red’ (see above) and other three cultivars, we believe that ‘Wine Red’ is a form of another species of Iochroma.

Cultural notes

All four Iochroma cultivars are readily propagated in spring and autumn, and probably at any other time of year. Both softwood and semi-ripened wood cuttings from actively growing plants root within 4 to 6 weeks under intermittent mist, treated with a 5-5 basal end dip in 1000–2500 mg·L$^{-1}$ indolebutyric acid, though percentages were slightly lower at the lower concentration. Rooting percentages ranged from 83% to 94%. Rooted cuttings should be pinched at the time of transplanting, and again once lateral shoots are 76–101 cm long, in order to produce well-branched plants (we are currently experimenting with growth regulators on all four cultivars). We have trialed three different production regimes. Rooted cuttings placed directly into 2.7-L containers were finished and flowering 8–10 weeks after transplant. Rooted cuttings were also placed into 0.5-L pots, and then transplanted 4 weeks later into 5.4-L containers. These were finished and flowering 10 to 12 weeks after transplant. We also transplanted five rooted cuttings into 5.4-L hanging baskets. Only rooted softwood cuttings (vs. semi-ripened wood) should be used for this purpose. ‘Wine Red’ and ‘Royal Blue’ seem most amenable to basket culture, but baskets were no longer attractive after 5 months.

We have successfully grown all four cultivars in 5-aged pine bark: 4 coconut coir dust: 1 coarse sand (by volume), amended with 5.0 kg·m$^{-3}$ 17N–2.3P–10K Osmocote (Scotts, Milpitas, Calif.), 4.2 kg·m$^{-3}$ dolomite, and 1.2 kg·m$^{-3}$ Micromax (Scotts). We have also lightened this mix with 25% coarse perlite (by volume) with similar results. A pH of 6.0 to 6.5 is essential. Substrate pH in excess of 7.0 results in chronic iron-deficiency symptoms. If allowed to become potbound, all four cultivars of $I$. cyaneum exhibit “hard,” woody growth, and drop their lower leaves. Such plants can be renovated by cutting the stems back to a few nodes, disrupting and pruning the dense root mass, and transplanting into fresh substrate.

Trial blocks of all four cultivars were established in the ground at the National Germplasm Repository, Miami, from plants established in 5.4-L containers in Apr. 2001 in both amended (10-year-old aged compost from vegetative solid waste) and unamended soil. The plants in amended substrate are 1 to 1.5 m

Fig. 5. UPGMA phenogram of Iochroma cultivars based on Nei and Li (1979) similarity coefficients generated from AFLP analysis. Numbers above branches are bootstrap percentages.

Table 2. Pairwise similarity coefficients (Nei and Li, 1979) between four cultivars of Iochroma cyaneum.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Indigo</th>
<th>Royal Blue</th>
<th>Sky King</th>
<th>Wine Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Blue</td>
<td>0.6100</td>
<td>----</td>
<td>0.8856</td>
<td>---</td>
</tr>
<tr>
<td>Sky King</td>
<td>0.5943</td>
<td>0.8856</td>
<td>----</td>
<td>0.1655</td>
</tr>
<tr>
<td>Wine Red</td>
<td>0.2966</td>
<td>0.1462</td>
<td>0.1655</td>
<td>----</td>
</tr>
</tbody>
</table>
tall and have been in continuous bloom. The plants in unamended substrate (pH = 8.5–9.0) are consistently iron deficient and flower only sporadically.

In the landscape, all four cultivars of *I. cyaneum* should be situated in full sun, on soils amended with organic matter, and fertilized regularly. In sites with lower light levels, stem internodes elongate and flowering decreases. Once each year the plants should be cut back to one-half to two-thirds of their height. The soil should be evenly moist throughout the growing season; irrigation can be reduced during the winter.

Pest and disease problems are few. Tobacco [*Manduca sexta* (Linnaeus)] and tomato [*M. quinquemaculata* (Haworth)] hornworms will feed on *I. cyaneum*, and occasional light infestations of various homopteran insects have been observed. *Iochroma cyaneum* is potentially susceptible to tobacco mosaic virus (TMV), and nursery workers who use tobacco should not propagate the plants, or should at least wash their hands with 95% EtOH before doing so.

The rapid rate of growth, ease of propagation, and long flowering season suggest that these *I. cyaneum* cultivars could be marketed as annual plants beyond their expected hardiness range (USDA Zone 9B–11, Huxley et al., 1992; Shaw, 1998). We are hopeful that our experiments with growth regulators may also support their future use as flowering potted plants for the mass market.

**Availability**

Small quantities of each of the four cultivars are available for research purposes only by request through the USDA-ARS National Plant Germplasm System (http://www.ars-grin.gov/npgs/) as accessions PI 632348 (‘Indigo’), PI 632350 (‘Royal Blue’), PI 632357 (‘Sky King’), and PI 632349 (‘Wine Red’). The third author should be contacted for commercial quantities.

**Literature Cited**


