

# 'Rose Lantern': A New Cultivar of *Koelreuteria paniculata*, the Golden-Rain Tree

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**Modern techniques of molecular biology can be a valuable tool in unravelling the confusion that occasionally surrounds important horticultural plants.**

The discovery of a new cultivar sometimes involves a degree of serendipity, particularly when one has known the plant in question for many years and has assumed that it was correctly identified when it was received. These circumstances certainly apply to the situation recounted here, and we hope that this article will help to resolve any confusion that may have arisen surrounding two very prominent trees growing in the collections of the Arnold Arboretum.

On October 7, 1994, the senior author (FSS, Jr.) was visiting the Arnold Arboretum, and the junior author (SAS) was pleased to be able to accompany his colleague from the United States National Arboretum through the Arboretum's collections and to help locate plants of particular interest. Two accessions of *Koelreuteria paniculata* Laxmann were pointed out, along with plants of the same species of a somewhat smaller stature that had been grown from seed collected in Korea in 1977 by Spongberg and Richard E. Weaver, Jr. (Spongberg, 1978). While the plants of Korean provenance were of interest because of their habit, the senior author was truly astonished by the two older accessions (AA 577-66 and 771-68), which were labeled as the cultivar 'September'. Knowing this cultivar only from the Arboretum accessions, the junior author was likewise surprised to hear that the Arboretum plants differed from the true 'September' by virtue of their rosy-red capsules. He wondered how this could possibly be, particularly since the older accession had been received from the National Arboretum, the institution that had helped to make 'September' widely available in the mid-1960s. The explanation requires that we start at the beginning and trace

the history of *Koelreuteria paniculata* 'September' as well as the "discovery" of 'Rose Lantern', the cultivar name we have chosen for the two Arnold Arboretum trees.

Between August 25th and 27th of 1958, the late Joseph C. McDaniel of the University of Illinois' Department of Horticulture, attended a meeting of the American Institute of Biological Sciences on the campus of Indiana University in Bloomington. While there, he was surprised to see two mature trees of *Koelreuteria* in full flower so late in the growing season: most golden-rain trees flower in late June and early July, and the capsules on their large infructescences have already developed by mid-August. McDaniel continued to observe these trees for several years and found that they consistently flowered from late August into early September.

Seeds from these trees were subsequently distributed to several attendees at the 1960 meeting of the International Plant Propagators Society, Eastern Region. In addition, on December 5, 1960, seeds of the more floriferous of the two trees were supplied to Sylvester G. March at the National Arboretum, where the seed lot was given the accession number NA 16548. Several seedlings of this accession were planted in a nursery at the National Arboretum in 1961. The first of these plants flowered and fruited in 1965, and all of the them flowered in 1966; in both years none flowered earlier than August 20. In 1966, according to National Arboretum records, six seed-grown plants of this accession were growing in the nursery, ranging between nine and eleven feet in height. The records show that the plants varied in the size of their capsules, but no other attributes were recorded, and none



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The large inflorescences of the golden-rain tree produce hundreds of bright yellow flowers and enliven any landscape in which the tree is planted. Normally, the trees flower in late June and July, but the cultivars 'September' and 'Rose Lantern' postpone their floral display until late August and early September when few other trees are in flower.

has ever been given a cultivar name.

In a letter to March dated January 28, 1966, Professor McDaniel suggested that these trees, as well as the parent trees at the University of Indiana, might conform to *Koelreuteria apiculata* Rehder & Wilson. In his response that September, March noted that Frederick G. Meyer of the National Arboretum staff believed that the trees were merely late-flowering variants of *K. paniculata*. Indeed, in his subsequent monograph of the genus, Meyer (1976) placed both the specific and varietal designations of *apiculata* in the synonymy of *K. paniculata*.

The late Donald Wyman, then Horticulturist at the Arnold Arboretum, had received a carbon copy of McDaniel's 1966 letter to March, and in February of that year he wrote to March requesting seeds or seedlings from the National Arboretum trees for the Arnold Arboretum col-

lections. Since neither seeds nor seedlings were available, March offered root cuttings for propagation. In his typical fashion, Wyman penned his response to this offer on the original letter and returned it to March, commenting, "We can certainly try root cuttings, if you can spare them, but don't hurt the tree." Sixteen root pieces from one or more of the six seed-grown plants at the National Arboretum (NA 16548) were subsequently sent to Wyman on March 21. At the Arnold Arboretum these materials were accessioned as "*K. paniculata*—Special," and given accession number AA 577-66.

In 1967 McDaniel and March described and proposed the cultivar name 'September' for the most floriferous of the two late-flowering trees growing at the University of Indiana, which by that time was being propagated by softwood cuttings. This cultivar name was duly registered

with the Arnold Arboretum (which at that time served as International Registration Authority for cultivar names of otherwise unassigned woody genera), and a fruiting specimen collected from the Indiana tree on September 28, 1966, was deposited in the Arboretum's Jamaica Plain herbarium to document the plant to which this cultivar name was applied. It was not until November, 1968, that the National Arboretum received a plant of 'September' vegetatively propagated from the University of Indiana original. The four-inch-tall rooted cutting that Professor McDaniel sent was accessioned as NA 31132. Four additional individuals of 'September' were subsequently incorporated into the National Arboretum's collections, but accession records for these plants are missing.

Meanwhile, only a single plant resulted at the Arnold Arboretum from the sixteen root pieces that had been received from the National Arboretum and accessioned under number AA 577-66. And once McDaniel and March had published the cultivar name 'September', the assumption was made that the Arnold Arboretum's solitary plant represented this clone. Consequently, its name in the Arboretum's records was changed from "Special" to 'September' in 1969, and the sole representative was planted adjacent to other golden-rain trees in a prominent position along Meadow Road, across from the *Cotinus* and *Acer* collections. One additional plant, propagated in 1968 as a rooted softwood cutting from AA 577-66 and given accession number AA 771-68, was incorporated into the Arboretum's collections in another prominent location, on the edge of Bussey Hill Road where the birch and cherry collections merge. Both of these trees begin flowering during the last weeks of August and continue to please visitors to the Arboretum with their bright yellow floral display into the month of September, followed by their equally handsome display of reddish pink capsules into October and November. (The capsules can be seen on the inside front cover.)

The next sequence of events began in 1984, when the senior author, along with his colleague at the National Arboretum, Alice J. McArdle, attempted to hybridize *Koelreuteria paniculata* and *K. bipinnata* Franchet. The lat-

ter species is native to areas south of the 30th parallel in China and is not as cold hardy as *K. paniculata*. In 1984 the National Arboretum collections included two thirty-foot trees of *K. bipinnata* (NA 34048) as well as four smaller specimens (NA 44305). Both of these accessions had been received from the Los Angeles State and County Arboretum in Arcadia, California, in 1972 and 1980, respectively, and the trees of the older accession were vigorous plants with upright crowns. Meyer (1976) had described the color of the capsules of *K. bipinnata* as "rose-purple while young," and in some years the fruiting display on the National Arboretum trees was truly spectacular.

The goal of the interspecific hybridization program was to combine the upright growth habit and reddish capsule color of *Koelreuteria bipinnata* with the cold hardiness of *K. paniculata*. Because *K. bipinnata* normally flowers in late August and early September, *K. paniculata* 'September'—in flower during the same period—was the obvious choice for the *paniculata* parent in the hybridization experiments. Hybrids between the two species were indeed obtained, and McArdle and Santamour (1987) were able to verify the hybrid status of the seedlings using a process known as gel electrophoresis on isoperoxidase enzymes extracted from tissue at the base of leaf petioles. This process is similar to the DNA analysis of human tissue that is increasingly used in today's forensic laboratories. The researchers analyzed hundreds of hybrid plants and found only three major anodal peroxidase bands—"A," "B," and "C." The enzyme profile of 'September' proved to be "AC," while that of all six plants of *K. bipinnata* used in the hybridization program was "B."

Twelve of the progeny from crossing 'September' as the seed parent with *K. bipinnata* as the pollen parent were identified as "true" hybrids inasmuch as they exhibited enzyme patterns of either "AB" or "BC," with the "B" band inherited from *K. bipinnata* and either the "A" or "C" band coming from *K. paniculata*. Further confirmation came from later studies of isoperoxidases in cambial tissue (Santamour, unpublished), which yielded enzyme banding patterns identical with those obtained earlier from petiolar tissue. The interspecific hybrids,



The oldest plant of *Koelreuteria paniculata* 'Rose Lantern' in the Arnold Arboretum grows along Meadow Road across from the *Cotinus* and *Acer* collections. As can be seen in this photograph, it has a rounded habit. It measured 34 feet in height with a crown spread of 40 feet in July of 1996. Note that the *K. paniculata* on the left is in fruit while 'Rose Lantern' is in flower.

planted at the United States Department of Agriculture Station at Glenn Dale, Maryland, in 1986, have exhibited hybrid vigor in their growth rate (they were twice as tall as equal-age seedlings of the parent species in 1994), yet unfortunately, the hoped-for capsule color had not been captured.

It was because of the senior author's failed attempts to produce a hardy, red-fruited plant of the golden-rain tree through hybridization of the normally red-fruited *Koelreuteria bipinnata* with *K. paniculata* that he was literally dumbfounded when he visited the Arnold Arboretum in the fall of 1994. For there, growing along Meadow and Bussey Hill Roads, were two golden-rain trees with rosy-red capsules glowing like Japanese or Chinese lanterns in the October sunshine—the very plants he had hoped to syn-

thesize through hybridization, except that the Arnold Arboretum trees exhibit a rounded rather than an upright growth habit. And both of these trees, as explained above, were labeled as representing the cultivar 'September'. Not convinced of their identity, the senior author collected material from the younger tree (AA 771-68) for enzyme analysis. There was the outside possibility that these Arnold Arboretum trees did indeed represent 'September', and that geographic location and climatic differences between Boston and Washington, DC, were responsible for the development of their rosy-red capsules, which are most highly colored on the surfaces exposed to the sun. (This phenomenon is a typical response to sunlight of anthocyanin pigments, which are frequently responsible for imparting a red coloration in plant tissues and structures.)

Since electrophoretic analyses of cambial tissue confirmed that the oldest National Arboretum specimen of 'September' (NA 31132) carried the enzyme phenotype "AC," as did the other four trees known as 'September' at the National Arboretum, the question became: Did the Arnold Arboretum tree have the same enzyme profile? No! It produced only one enzyme band in electrophoretic analysis, the "A" band. The six unnamed seed-grown plants at the National Arboretum accessioned as NA 16548—the plants from which the root pieces sent to the Arnold Arboretum originated—showed three enzymatic profiles: two plants with "A," two plants with "C," and two plants with "AC." Further analysis of stem cambium of Arnold Arboretum accession AA 577-66 and root cambium of both AA 577-66 and AA 771-68 confirmed the "A" enzyme phenotype for both Arnold Arboretum trees. It seems reasonable to assume that the root pieces of NA 16548 sent to the Arnold Arboretum in 1966 were taken from tree number 6, at the end of the National Arboretum's nursery row, since it has the same enzyme profile ("A") as the Arnold Arboretum

trees and would have been the easiest tree from which to collect root pieces. However, tree number 6, like all the others, produces green immature capsules.

The one likely explanation for the rosy-red capsules on the Arnold Arboretum trees is that a rare somatic mutation—a genetic change, in this instance affecting capsule color—occurred during the process of bud initiation on the root piece that developed into the original Arnold Arboretum tree. This seems quite possible in view of the fact that shoot meristems produced by roots normally have a different structure from those produced by stems (Peterson, 1975).

The distinctive coloration of the Arnold Arboretum's trees is the attribute on which we base the naming of this genotype as a distinct cultivar. The name 'Rose Lantern'—given because the papery rosy-red capsules look like miniature Japanese lanterns—has been submitted to the Brooklyn Botanic Garden, which now serves as the International Registration Authority for otherwise unassigned woody genera, and specimens from both trees have been deposited in the Arboretum's Jamaica Plain

### Size and Shape

The cultivar 'September' is not a well-formed or robust plant, its only special virtue being its late flowering period. In October of 1994, measurements were made of all the specimens at the National Arboretum that had been derived from the University of Indiana original. By then, the tree labelled 'September', received in 1968 as a propagated plant (NA 31132), was 26 years old. It measured 16.7 feet in height, with a crown spread of approximately 20 feet, and its trunk was 7 inches in diameter at one foot above ground level. According to the Royal Horticultural Society's color chart, its immature fruit capsules are a yellow-green, ranging from RHS 145-B to 150-C. At the same time, the six trees grown from seeds of the original Indiana tree—received at the National Arboretum in 1960 (NA 16548)—ranged in height from 34 to 39 feet, with trunk diameters measuring from .5 to 14.6 inches. Since these trees are growing in a short nursery row, crown spread was difficult to measure, but the trees at either end averaged a 39-foot spread. The color of the immature capsules was similar to that of 'September'.

The two Arnold Arboretum trees, now christened 'Rose Lantern', are also of rounded habit. The older of the two trees (AA 577-66) has a single trunk with a diameter of 1 foot 7 inches at one foot above ground level, but at 2 feet 6 inches the trunk diverges into three main limbs. Its crown spread measures 40 feet, and the tree is 34 feet in height at thirty years of age. The younger tree (AA 771-68) is 28 feet in height with a crown spread of 35 feet. It has three trunks growing from the base, with diameters at one foot above ground level of 5.5, 10, and 11 inches. Both of these individuals, like *Koelreuteria paniculata* 'September', flower at the end of August and into the first weeks of September, but their immature capsules are a decided rosy-red (RHS 180-A).

herbarium. On a cautionary note, however, it should be kept in mind that the plant we are now calling 'Rose Lantern' has been growing on the grounds of the Arnold Arboretum under the name 'September' since 1969, and that propagation material has been shared with growers under that name. Depending on the source of propagation material, then, some of the plants being sold as 'September' could, in fact, be the newly named cultivar 'Rose Lantern'. The pink immature fruit capsules would be the telltale trait.

The next question that arises concerns the most efficient and effective way to propagate the two Arnold Arboretum trees to ensure that their flowering and fruiting attributes are maintained in subsequent progeny. More than likely, a high percentage of the seedlings arising from self-pollination of the two trees would produce rosy-red capsules. We can assume for simplicity's sake that there is one gene (with two alleles) for fruit color. Any mutation would likely occur in only one allele, and even though that mutation might be dominant—as the red pigmentation appears to be—the plant would be heterozygous at that locus (that is, with both the dominant and recessive alleles present). Self-pollination would then result in a seedling population that is 25 percent homozygous red (two dominant alleles), 50 percent heterozygous red, and 25 percent homozygous green (two recessive alleles). Seedling populations from the Arnold Arboretum's trees should obviously be grown to sexual maturity to test this hypothesis. Such a trial would also provide the opportunity for further selection of outstanding plants from within these populations and their naming and introduction into the horticultural trade. However, because of the possibilities outlined above, seed propagation of 'Rose Lantern' would not necessarily guarantee late-flowering and rosy-red fruited trees.

Ideally, *Koelreuteria paniculata* 'Rose Lantern' would be vegetatively propagated by rooting stem cuttings. However, this has proved to be a difficult procedure, typically successful

only in low percentages. To date, commercial production of the cultivar 'September', or 'Rose Lantern', is done mainly by midsummer budding on seedlings of *K. paniculata*.

Currently, propagation trials of *Koelreuteria paniculata* 'Rose Lantern' are underway at the Arnold Arboretum's Dana Greenhouses using both root and softwood cuttings. In the meantime, budwood and scions of 'Rose Lantern' are scheduled for distribution to commercial nurserymen and sister institutions via "PIPD," the Arboretum's Plant Introduction, Promotion, and Distribution Program (Tripp, 1995). We hope that this late-flowering, rosy-red fruited variant of the golden-rain tree will gain the popularity in the horticultural marketplace we feel it deserves, and that those now growing 'Rose Lantern' under the misapprehension that it is 'September' will note the distinction between the two late-flowering cultivars.

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