Performance of Yellow-flowering Magnolias in Zone 6b

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SUMMARY. Yellow-flowering magnolias (Magnolia sp.) were evaluated for flower color, bloom duration, and growth rate in U.S. Department Agriculture (USDA), Hardiness Zone 6b, McMinnville, TN. Of the 30 cultivars evaluated, all were reported to have yellow blooms, however, tepal color ranged from light pink with some yellow coloration, creamy yellow to dark yellow. ‘Daphne’, ‘Judy Zuk’, and ‘Yellow Bird’ had the highest yellow color readings on the outside of the tepal and would often be among the latest cultivars to bloom. Magnolia cultivars Gold Star, Golden Gala, Stellar Acclaim, Sun Spire, and Sundance had the lightest yellow tepal color on the outside of the tepal. ‘Goldfinch’, ‘Butterflies’, and ‘Elizabeth’ were the earliest to bloom; ‘Elizabeth’ had one of the longest flowering periods. ‘Carlos’ and ‘Gold Star’ were two of the tallest cultivars in the test compared with Butterflies, Gold Cup, Golden Gift, Golden Pond, Golden Rain, Green Bee, Honey Liz, Koban Dori, Skyland’s Best, and Sun Spire, which had the least height growth. Trunk diameters ranged from 7.4 to 18.4 cm after 9 years in the evaluation. Cultivars Golden Gala and Gold Star had trunk diameters greater than twice the size of Golden Pond, Golden Rain, Green Bee, Honey Liz, and Koban Dori. Powdery mildew (Phyllactinia corylea and Microsphaera alni) was observed on all cultivars; however, Golden Sun, Green Bee, Solar Flair, Stellar Acclaim, Sunburst, and Yellow Bird had greater than 47% of the leaf area affected with powdery mildew. Over 60% of the canopy was affected with powdery mildew on ‘Green Bee’, ‘Stellar Acclaim’, ‘Sunburst’, and ‘Yellow Bird’. Powdery mildew was less than 20% on both the foliage and plant canopy of ‘Banana Split’, ‘Butterflies’, ‘Carlos’, ‘Elizabeth’, and ‘Sun Spire’.

ADDITIONAL INDEX WORDS. Magnolia denudata, Magnolia acuminata, deciduous magnolia

Deciduous magnolias are well adapted to many landscape situations and are highly desirable due to their flouriferous nature. About 800,000 flowering magnolias are sold each year in the United States and about 10% of the nurseries that grow magnolias are located in Tennessee (USDA, 2014). There has been interest in breeding for deciduous yellow-flowering magnolias since the 1950s. Most of the yellow-flowering magnolias have been bred from a U.S. native magnolia, cucumber magnolia (Magnolia acuminata), or a smaller statured botanical variety of the species, yellow cucumber magnolia (M. acuminata var. subcordata). This species provides cold hardiness and can be grown in a wide array of soil types. Hybridization with Chinese magnolias (yulan magnolia (Magnolia denudata) or lily magnolia (Magnolia liliiflora)) can offer yellow flower color and a range of tree sizes and shapes. Most American magnolias bloom with the foliage, which means a late spring-summer bloom; whereas, the Chinese magnolias bloom before the leaves emerge in the spring. Many cultivars of the yellow magnolias bloom in late March to early April, but often spring frosts and freezes affect flowering as well as leaf-out (Fare, 2011). Cultivars such as Elizabeth, Yellow Bird, and Butterflies were a few of the first commercially available. A second generation of yellow-flowering magnolias with cultivars such as Golden Sun, Golden Gift, Gold Star, and Yellow Lantern were developed by breeders D. Leach and P. Savage; A. Kehr released ‘Gold Cup’, ‘Solar Flair’, ‘Stellar Acclaim’, ‘Sundance’, and ‘Sun Ray’ and in later years, released ‘Sunburst’, ‘Sunsation’, and ‘Sun Spire’. One notable cultivar, Lois, was developed by L. Koerting (Knox, 2001). Yellow-flowering deciduous magnolias are becoming popular landscape plants because they offer an unusual color palette and there are very few yellow-flowering small trees in the landscape plant inventory (Knox, 2002).

This evaluation was conducted at the Tennessee State University Nursery Research Center located in McMinnville, TN (lat. 35.7°N, long. 85.8°W) on the border of USDA Hardiness Zones 6 and 7. The area is known as a climatic and geographic transition zone. Plants produced in this area can be used in landscapes as far north as Zone 5 and as far south as Zone 8. Plant evaluations made in transition zones are ideal because results can be used over a wide geographic and climatic area. The primary objective of this research project was to compare yellow-flowering magnolias for flower color intensity, flower duration, as well as growth rate and canopy form.

Materials and methods

PLANT EVALUATION. Many cultivars of yellow-flowering magnolias were only available in low numbers and small sizes so plants for this evaluation were purchased, grown in a no. 3 or no. 5 container for 1 year, then planted in the evaluation plot the following spring. The first plantings were in March 2006 in a field plot with well-drained silt loam soil (Waynesboro) with a 15-ft in-row spacing and 12-ft between-row spacing. Each magnolia cultivar was planted in a randomized block design with three single plant replications. Plants were maintained with traditional management including fertilization, mulching, and weed control. Pruning was limited to removing branches from the trunk about 24 inches above the soil line. In March 2007, a few weeks of unseasonably warm temperatures occurred followed by a hard freeze that lasted several days. Many plants had

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| Units | To convert U.S. to SI, multiply by | To convert SI to U.S., multiply by |
|-------|-------------------------------------|----------------------------------------|
|       | U.S. unit | SI unit | 6.048 ft | 2.54 inch(cm) | 6.4516 inch²(cm²) |
| 3.2808 | m | cm² | 3.2808 | 0.3048 | 0.1550 |

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For conversion purposes, 1 inch (1 in) = 2.54 cm and 1 foot (1 ft) = 0.3048 m.
broken dormancy, and as a result of the freeze, were killed or suffered severe dieback. Plantings were reestablished and up to 37 cultivars of yellow-flowering magnolias were under evaluation; however, cultivars Brenda, Illini Gold, Illini Moonlight, Miss Honeybee, Evamarie, Coral Lake, and Blue Opal, died from subsequent spring freezes with damage to the trunks and or canopy (Magnolia Society, 2010). Flowering period was determined from the time that flowers first opened until the last flowers senesced. These dates were recorded by days of the year and averaged from 2008 to 2016. To determine flower color, three flowers per tree were removed on the day the flowers opened and color was measured on the inside and outside of the tepal using the Royal Horticultural Society Color Chart (RHS, 2007) and a portable spectrophotometer (CM-2600d; Konica Minolta Sensing Americas, Ramsey, NJ). Leaf-out was recorded from the time the foliage was at least 50% unfurled until full leaf. During June 2014, five fully matured leaves located with 18 inches from the tip of the branch were randomly selected from branches located in the upper top of canopy to determine leaf area with a portable leaf area meter (CI-203; CID, Camas, WA). Powdery mildew was rated during August, September, and October each year for the percentage coverage of powdery mildew on individual leaves and the percentage of the total foliage area affected. In Dec. 2015 after leaf drop, height, canopy width (an average of two canopy widths made perpendicular from dripline to dripline), and trunk diameter (measured 15 cm above the soil surface) were recorded. All data were statistically analyzed using the linear model in SAS (version 9.1; SAS Institute, Cary, NC). Means separation among cultivars was conducted with Duncan’s multiple range test ($P \leq 0.05$).

**Results and discussion**

**PLANT EVALUATION.** Figure 1 shows the average period of time that flowering and leaf-out occurred from

![Diagram](image-url)

**Fig. 1.** Flowering and leaf-out periods of selected yellow-flowering magnolia cultivars were recorded each year by days of the year (Spring 2008 to Spring 2016) then averaged over the time period. Solid lines represent the flowering period from the time that flowers first opened until the flowers senesced. Dashed lines represent the leaf-out period from the time the foliage was at least 50% unfurled until full leaf. This evaluation was conducted at the Tennessee State University Nursery Research Center located in McMinnville, TN, on the border of USDA Hardiness Zones 6 and 7.

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Table 1. Height, canopy width, trunk diameter, and leaf area of yellow-flowering magnolia cultivars after 9 years of evaluation at McMinnville, TN (USDA Hardiness Zone 6b).

| Cultivar       | Ht (cm) | Canopy width (cm) | Trunk diam (cm) | Avg leaf area (cm²) |
|----------------|---------|-------------------|-----------------|---------------------|
| Anilou         | 557     | a–h               | 175             | 11.6 a–f            |
| Banana Split   | 555     | a–i               | 193             | 12.1 a–f            |
| Butterflies    | 444     | d–i               | 180             | 9.6 ef              |
| Carlos         | 708     | a                  | 278             | 18.2 ab             |
| Daphne         | 491     | b–i               | 209             | 10.5 c–f            |
| Elizabeth      | 560     | a–h               | 243             | 15.8 a–c            |
| Gold Cup       | 482     | c–i               | 135             | 10.0 def            |
| Gold Star      | 699     | ab                | 401             | 18.3 a              |
| Golden Gala    | 675     | abc               | 346             | 18.4 a              |
| Golden Gift    | 466     | c–i               | 248             | 11.3 a–f            |
| Golden Pond    | 447     | d–i               | 174             | 9.0 ef              |
| Golden Rain    | 345     | ab                | 172             | 8.0 f               |
| Golden Sun     | 491     | b–i               | 240             | 11.1 b–f            |
| Goldfinch      | 560     | a–h               | 193             | 11.5 a–f            |
| Green Bee      | 355     | hi                | 139             | 7.4 f               |
| Honey Liz      | 422     | e–i               | 150             | 8.3 f               |
| Judy Zük       | 596     | a–g               | 193             | 13.5 a–f            |
| Koban Dori     | 419     | f–i               | 169             | 7.5 f               |
| Lois           | 579     | a–g               | 372             | 18.0 ab             |
| Petal Chicon   | 515     | a–i               | 167             | 9.7 ef              |
| Skyland’s Best | 401     | ghi               | 199             | 9.6 ef              |
| Solar Flair    | 542     | a–i               | 284             | 13.8 a–f            |
| Stellar Acclaim| 561    | a–h               | 317             | 13.6 a–f            |
| Sun Ray        | 635     | a–e               | 354             | 17.0 abc            |
| Sun Spire      | 541     | a–i               | 150             | 12.4 a–f            |
| Sunburst       | 558     | a–h               | 287             | 16.0 a–e            |
| Sundance       | 620     | a–f               | 377             | 17.5 ab             |
| Sunsaition     | 481     | c–i               | 187             | 16.7 a–d            |
| Yellow Bird    | 644     | a–d               | 258             | 14.1 a–f            |
| Yellow Lantern | 667     | abc               | 327             | 17.6 ab             |

*Height, canopy width, and trunk diameter were measured in Dec. 2015. Canopy width was an average from two perpendicular measurements made from dripline to dripline. Trunk diameter was measured 15 cm above the soil surface; 1 cm = 0.3937 inch.

*Average leaf area was determined from five randomly selected mature leaves located with 18 inches (45.7 cm) from the tip of the branch located in the upper top of canopy in June 2014; 1 cm² = 0.1550 inch².

*Means within columns followed by the same letter are not significantly different as determined by Duncan’s multiple range test at P ≤ 0.05.

2008 until 2015. In some years, unseasonably warm periods caused the flowers to mature quickly, thus the flowering period was shorter; whereas, in other years, late spring frosts resulted in poor flowering and delayed leaf-out. ‘Goldfinch’ was the earliest cultivar to bloom in mid-to-late March, followed by Butterflies and Golden Pond. ‘Golden Pond’, ‘Sunsaition’, and ‘Elizabeth’ had flowering periods that frequently lasted up to 3 weeks; however, the best floral display was often during the middle of the flowering period when the most flowers were open. ‘Yellow Lantern’ and ‘Gold Star’ had the shortest flowering period that lasted about 1 week, then had a distinct period of time before leaf-out occurred. The flowers on ‘Honey Liz’ were the last to open; however, the flowering period overlapped with ‘Sunsaition’, ‘Yellow Bird’, and ‘Judy Zük’. In most years, ‘Sunsaition’ flowered about 1 week before ‘Judy Zük’ and ‘Yellow Bird’. Though flower numbers were not quantified, warmer spring temperatures resulted in less yellow color intensity than in cooler spring seasons. In this test, the RHC Color Chart was used to determine the color on the outside of the tepal and the author found differences compared with colors reported in the Magnolia Cultivar Checklist (Magnolia Society, 2010) and other notable sources (Fare, 2011). This is to be expected due to the maturity of the flower, location of the plant, and expected differences from year to year (Knox, 2002). The portable spectrophotometer used in this test to measure color intensity, also showed differences in color from tepal to tepal, plant to plant, and year to year; even though a more precise color was measured than what was dependent on the human eye with the RHS color chart. These readings were based on a three-dimensional space with three axes, x, y, and z. The x axis measured a positive value for red and a negative value for green. The z axis measured a positive value for yellow and a negative value for blue. The higher the yellow value the more intense the yellow color. For instance, ‘Gold Star’, ‘Golden Gala’, ‘Stellar Acclaim’, ‘Sun Spire’, and ‘Sundance’ had the lowest yellow color values in the low 20’s on the outside of the tepal; whereas, ‘Daphne’, ‘Judy Zük’, and ‘Yellow Bird’ had the highest yellow color readings in the upper 30’s on the outside of the tepal.
Since the initial planting, there were some distinct differences in height growth, which ranged from 345 to 708 cm among cultivars (Table 1). Carlos and Gold Star were two of the tallest cultivars in the test (708 and 699 cm, respectively), compared with Butterflies, Gold Cup, Golden Gift, Golden Pond, Golden Rain, Green Bee, Honey Liz, Koban Dori, Skyland’s Best, and Sunsation, which ranged from 345 to 481 cm.

Canopy width was calculated from an average of two perpendicular measurements made from dripline to dripline (Table 1). Canopy width ranged from 135 to 401 cm among cultivars with distinct canopy shapes prominent with several cultivars. ‘Gold Star’ had the widest canopy at 401 cm, but was similar to ‘Carlos’, ‘Golden Gala’, ‘Lois’, ‘Solar Flair’, ‘Stellar Acclaim’, ‘Sunburst’, ‘Sundance’, and ‘Yellow Lantern’. Some cultivars (Anilou, Banana Split, Butterflies, Gold Cup, Golden Pond, Golden Rain, Goldfinch, Green Bee, Honey Liz, Judy Zuk, Koban Dori, Petit Chicon, Skyland’s Best, Sun Spire, and Sunsation), had less than half the canopy width of Gold Star, but in relation to their height growth may eventually be oval or broadly upright. ‘Gold Cup’, ‘Judy Zuk’, and ‘Sun Spire’ had a distinct upright growth habit in relation to their height that will probably become more distinct with age.

To ensure all trunk diameters were measured above the bud union, trunks were measured 15 cm above the soil line. Trunk diameters ranged from 7.4 to 18.4 cm (Table 1). ‘Carlos’, ‘Gold Star’, ‘Golden Gala’, ‘Lois’, ‘SunSpire’, and ‘Yellow Lantern’ are among the cultivars with the largest leaves. The foliage presents a very coarse textured canopy and may result in concerns with fall leaf litter. In contrast, ‘Butterflies’, ‘Daphne’, ‘Gold Star’, ‘Golden Gift’, ‘Green Bee’, ‘Koban Dori’, ‘Skyland’s Best’, ‘Stellar Acclaim’, and ‘Sunburst’ had some of the smallest leaves among the cultivars in the evaluation.

Powdery mildew developed into a serious problem in the evaluation [Table 2 (only data shown are from Oct. 2015)]. This foliar disease appeared naturally and pressure was consistently high in most years. No attempts were made to apply preventive fungicides in the evaluation. There were significant differences among cultivars with powdery mildew. In Oct. 2015, all cultivars had some incidence of powdery mildew on the foliage; however, the percent coverage of powdery mildew varied plant cultivar. ‘Golden Sun’, ‘Green Bee’, ‘Solar Flair’, ‘Stellar Acclaim’, ‘Sunburst’, and ‘Yellow Bird’ had greater than 40% of the leaf area affected with powdery mildew. Of those cultivars, Green Bee, Stellar

### Table 2. Percent coverage of powdery mildew on individual leaves and on plant canopy of yellow flowering magnolia cultivars in Oct. 2015 at McMinnville, TN (USDA Hardiness Zone 6b).

| Cultivar          | Powdery mildew on individual leaves (%) | Powdery mildew on plant canopy (%) |
|-------------------|----------------------------------------|-----------------------------------|
| Anilou            | 24.8 cde                              | 50.0 b–h                          |
| Banana Split      | 20.0 cdef                             | 20.0 hij                          |
| Butterflies       | 10.0 ef                               | 17.0 ij                           |
| Carlos            | 13.0 def                              | 20.0 hij                          |
| Daphne            | 30.0 cd                               | 35.0 e–j                          |
| Elizabeth         | 10.0 ef                               | 16.7 ij                           |
| Gold Cup          | 30.0 cd                               | 46.7 c–i                          |
| Gold Star         | 15.0 def                              | 66.7 a–d                          |
| Golden Gala       | 43.0 bcd                              | 27.5 g–j                          |
| Golden Gift       | 20.0 cdef                             | 40.0 d–j                          |
| Golden Pond       | 43.0 bcd                              | 30.0 f–j                          |
| Golden Rain       | 20.0 cdef                             | 58.3 a–f                          |
| Golden Sun        | 60.0 ab                               | 35.0 e–j                          |
| Goldfinch         | 30.0 cd                               | 25.0 g–j                          |
| Green Bee         | 47.0 abc                              | 83.3 a                            |
| Honey Liz         | 43.0 bcd                              | 80.0 ab                           |
| Judy Zuk          | 17.0 def                              | 23.3 g–j                          |
| Koban Dori        | 41.0 bcd                              | 70.0 abc                          |
| Lois              | 20.0 cdef                             | 28.3 f–j                          |
| Petit Chicon      | 30.0 cd                               | 21.7 g–j                          |
| Skyland’s Best    | 42.0 bcd                              | 77.5 ab                           |
| Solar Flair       | 60.0 ab                               | 35.0 e–j                          |
| Stellar Acclaim   | 47.0 abc                              | 85.0 a                            |
| Sun Ray           | 13.0 def                              | 21.7 g–j                          |
| Sun Spire         | 3.0 f                                 | 13.3 ij                           |
| Sunburst          | 50.0 abc                              | 61.7 a–e                          |
| Sundance          | 10.0 ef                               | 35.0 g–j                          |
| Sunsation         | 43.0 bcd                              | 51.7 b–f                          |
| Yellow Bird       | 63.0 a                                | 71.7 abc                          |
| Yellow Lantern    | 30.0 cd                               | 26.7 g–j                          |

*Values are the means of three replicate plots. Means within columns followed by the same letter are not significantly different as determined by Duncan’s multiple range test at P ≤ 0.05.*
Acclaim, Sunburst, and Yellow Bird had over 60% of the canopy affected. Another cultivar, Gold Star, had 15% of individual leaf surface affected with powdery mildew, but over 66% of the canopy was affected. Powdery mildew covered less than 20% on both the foliage and plant canopy ‘Banana Split’, ‘Butterflies’, ‘Carlos’, ‘Elizabeth’, and ‘Sun Spire’.

Conclusions
A comprehensive replicated evaluation of new and familiar yellow-flowering magnolias in one location will benefit magnolia connoisseurs, the nursery industry and prospective plant breeders. As yellow-flowering magnolias become more widely known, many cultivars in this evaluation may be less popular and will serve only as breeding lines for developing improved cultivars. Time of flowering is critical for plants in USDA Hardiness zones 6 and 7 due to early spring frosts (and freezes) and will be the deciding factor for the success of many yellow-flowered cultivars (Tubesing, 1998). The palette of yellow color is well represented with the magnolia cultivars from borderline creamy yellow to distinctly yellow in color (Cover, 2009). In this evaluation, cultivars that flowered after the threat of spring frosts also leafed-out during the flowering period which decreased the visibility of flowering and had less floral impact than cultivars that bloomed earlier in the spring.

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