Gaillardia:

Unique Forcing Requirements Of Old And New Cultivars

Figure 1. It is not uncommon to observe gaillardia planted alongside annuals because of their profuse and continuous flowering, as seen here in the Michigan State University trial gardens.

This article highlights the flowering requirements of the vibrantly hued gaillardia cultivars, which have recently reclaimed the limelight. Growers interested in successfully producing flowering potted gaillardias should keep reading.

By Sonali Padhye, Catherine Whitman, Arthur Cameron and Erik Runkle

Gaillardia adorns its native North and South American habitats and cultivated gardens with daisy-like flowers of red and yellow, which resemble vibrant-colored blankets created by American Indians. Hence, gaillardia has been given the common name of blanket flower. Gaillardia consists of more than a dozen annual and perennial species of which *Gaillardia x grandiflora*, a naturally occurring hybrid between *Gaillardia aristata* and *Gaillardia pulchella,* has been particularly popular in the past several years. This is at least in part due to its perennial life cycle; cold hardiness to USDA Zone 4; heat, humidity and draught tolerance; vigor; and attractive flower color and form. Most commercially available perennial cultivars of gaillardia, including some discussed here, have *Gaillardia x grandiflora* in their genetic background. Although a short-lived perennial in the landscape, gaillardia continues to be popular and is widely used in flower beds and mixed containers.

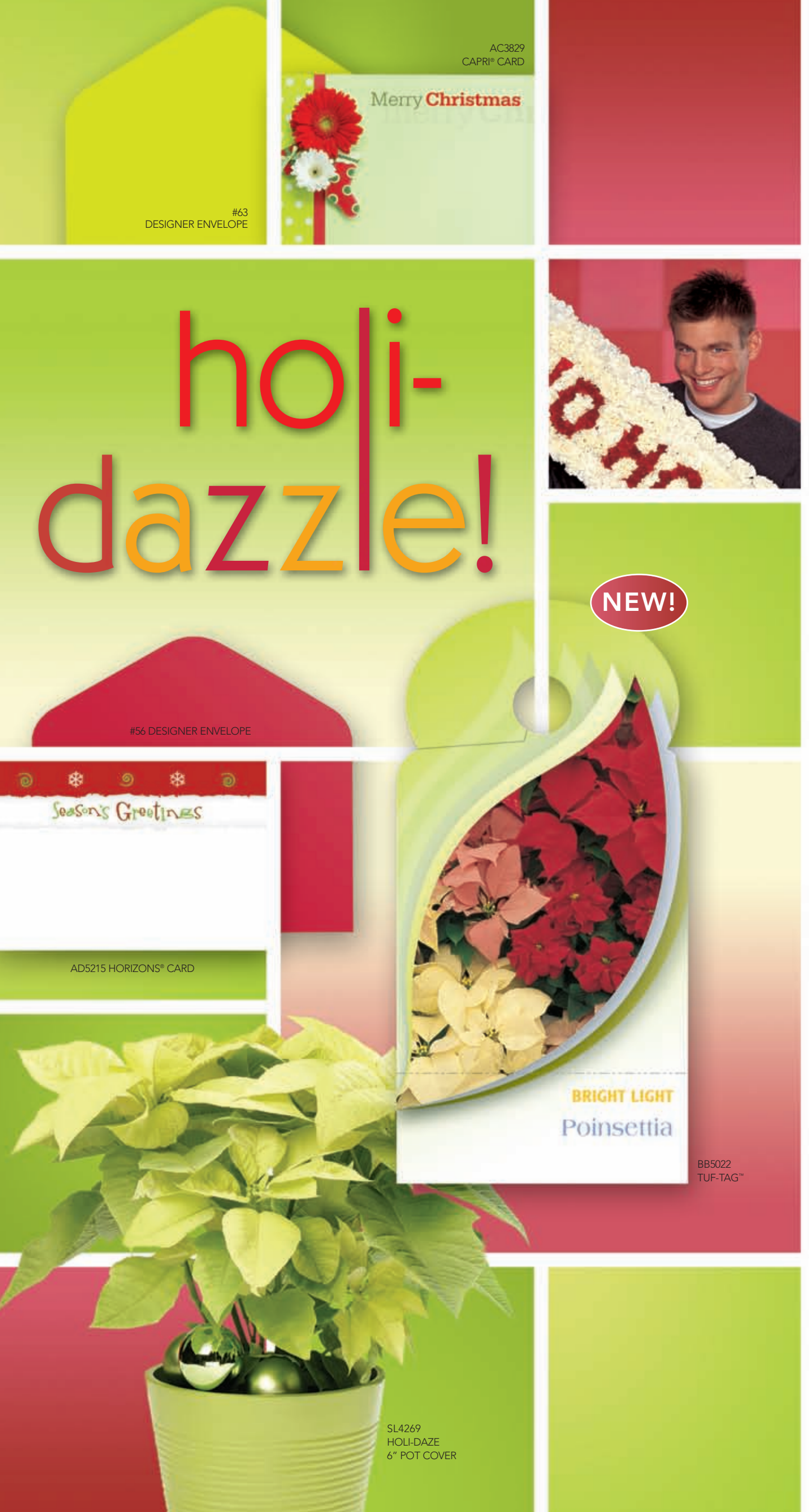
In recent years, the introduction of exceptional new cultivars has brought gaillardia back into the limelight. In 2003, gaillardia 'Sundance Bicolor' was awarded the All American Award. Gaillardia 'Arizona Sun' is even more impressive and can be used alongside annuals to provide an instant splash of color in the garden with its non-stop flowering (Figure 1). It won both the All American and Fleuroselect awards in 2005. More recently, 'Fanfare', with its cool tubular petals, and 'Oranges and Lemons', with its continuous yellow orange flowers, have brought even more attention to this genus (Figure 2, below).

Figure 2. Unique yellow-orange flower color of gaillardia 'Orange and Lemons' (left) and exceptional tubular petals of gaillardia 'Fanfare' (right).

Cultivars

Hybridization between annual and perennial species of gaillardia has yielded an array of cultivars with attractive colors and forms, adaptability to diverse growing conditions, and an extended bloom season. The introduction of genes from annual species has decreased the lifespan of several cultivars, making many selections short-lived perennials in the garden. However, genes from annual species also have contributed to the non-stop flowering of many cultivars, attracting consumer interest.

We have evaluated traditional gaillardia cultivars with red- and yellow-colored flowers including 'Goblin', 'Dazzler', 'Baby Cole' and 'Burgundy'. 'Goblin' has been rather popular over the years and requires vernalization treatment and long days for synchronized and complete flowering. 'Baby Cole' is shorter, while 'Dazzler' is taller than 'Goblin'. We've also experimented with newer red and yellow flower introductions, including 'Arizona Sun', 'Galileo' and 'Gailarus'. As its name suggests, 'Burgundy' has maroon inflorescences. The color pallet of gaillardia has been broadened by the introduction of peach and apricot flowers of 'Oranges and Lemons' and 'Summer's Kiss'. 'Fanfare' has tubular ray flowers and is a favorite among consumers.



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Cultivar	Starting Material	Vernalization Response	Photoperiod for Flowering	Time Flower at 68° F		USDA Cold Hardiness Zone	Comments
				Weeks to VB	Weeks to Flower		
'Arizona Sun'	128-cell seedlings	Facultative response. 15 weeks at 41° F hastened flowering by 2-3 weeks.	Facultative long day (LD) plant. Under LD, flowering was hastened and buds and height were increased compared to short days (SD).	3 after 15 weeks of cold & under LD	5-6 after 15 weeks cold & under LD	3-8	Nice flower color and non-stop flowering in the garden. Variability associated with seedlings was observed.
'Dazzler'	128-cell seedlings	Unknown. All plants were cooled for 15 weeks.	Facultative LD plant. Faster to flower, more flowers, taller under LD.			3-10	Fewer flowers under SD. Plants look similar to 'Goblin' but taller.
'Gailarus'	Vegetative cuttings	Facultative response. Cooling for 3-15 weeks hastened flowering under SD. Cooled plants had more flower buds under SD and LD.	Facultative LD plant. Plants under SD were shorter, had fewer buds and flowered later than LD plants.	5-7 after ≥3 weeks at 41° F & LD forcing	6-7 after ≥6 weeks at 41° F & LD forcing		During cooling, several leaves died in the cooler and at forcing plants quality was poor for 2-3 weeks. However, plants subsequently recovered. Flowers fairly similar to that of 'Arizona Sun'.
'Galileo'	Vegetative cuttings	Facultative response under LD and obligate under SD. 3-15 weeks at 41° F hastened flowering under SD. ≥3 weeks at 41° F recommended for LD force.	Obligate LD without vernalization treatment and facultative LD following vernalization treatment. After 15 weeks at 41 °F, flowering under SD was incomplete and delayed.	4-5.5 after ≥3 weeks of cold & under LD	7-9.5 after ≥3 week cold & under LD		Flowers have red centers like 'Gailarus' but more yellow on the petal tips. 'Galileo' rooted more easily and responded more strongly to photoperiod and vernalization treatments than 'Gailarus'.

Table 1. Research-based production information and flowering characteristics for select gaillardia cultivars.

Our floriculture research group at Michigan State University (MSU) has performed research to identify the flowering requirements of several new and old gaillardia cultivars. This article highlights our findings and provides information for successful production of flowering potted gaillardia.

Like many temperate herbaceous perennials, the flowering of many gaillardia cultivars requires exposure to low temperature, also known as vernalization treatment, as well as exposure to a long photoperiod. During our experiments, we have recorded significant differences in vernalization and photoperiodic requirements of gaillardia cultivars (Table 1). Hence, to successfully force a gaillardia cultivar for a scheduled market date, it is essential to consider its specific forcing requirements. Additionally, starting material often has a significant impact on vigor and flowering time and therefore should also be considered prior to forcing.

Propagation

Depending on the cultivar, gaillardia can be

Cultivar	Starting Material	Vernalization Response	Photoperiod for Flowering	Time Flower at 68 °F		USDA Cold Hardiness Zone	Comments
				Weeks to VB	Weeks to Flower		
'Goblin'	Seed. Juvenility ends with ~16 nodes (leaves)	Facultative response. Vernalization treatment increased flowering percentage and uniformity and hastened flowering. 9-12 weeks at 41° F is recommended. Some plants flowered without a cooling treatment.	Facultative LD plant. Plants flowered without cold but were slower to flower, had fewer flowers and were shorter.	3	6.5	4-8	Traditional cultivar that has large and showy red flowers with yellow rings. Can be highly variable in form and flowering. Deadheading is beneficial in the garden for continuous bloom.
'Fanfare'	Tissue culture	No response.	Facultative LD. Flowering time was similar under SD and LD but more buds under LD.	1-2	5-6	4-9	Very showy plants bloom non-stop in pots and gardens. Seed-heads are quite attractive and dead-heading not required for re-blooming.
'Oranges and Lemons'	Vegetative cuttings	No response.	Facultative LD. Flowering slightly delayed under SD and plants shorter with fewer buds under SD.	3-4	4.5-6	6-10	Very unique yellow-orange flower color. Plants flower non-stop in the garden and in containers. Seed heads are attractive and dead-heading not required for re-blooming.

Table 1. (continued)

propagated by seed, shoot-tip cuttings, division or tissue culture. Similar to many other herbaceous perennials, seed-propagated cultivars such as 'Goblin' and 'Arizona Sun' were more variable in their flowers and flowering compared to vegetatively propagated cultivars such as 'Fanfare' and 'Gailarus'. In some cultivars, providing inductive treatments such as long days may reduce (but not eliminate) the variability in flowering time associated with seedlings. For example 'Arizona Sun' was highly variable in flowering time when plants were forced under a 9-hour photoperiod, while a 16-hour photoperiod induced more uniform flowering.

Although vegetatively propagated gaillardia cultivars are more uniform than seedlings, a potential challenge with them can be maintaining vegetative stock plants and liners until forcing begins. This is particularly an issue with continuously flowering cultivars such as 'Oranges and Lemons' that generally do not require vernalization for flowering. Under long days, stock plants flower and thus cuttings are reproductive. Under short days, few cuttings are produced because plants remain as a rosette. Also, liners that are rooted and bulked under long photoperiods can flower sporadically in the plug tray.

Juvenility and Bulking

During the juvenile phase, seedlings remain vegetative and do not respond to inductive treatments such as vernalization or long ➧

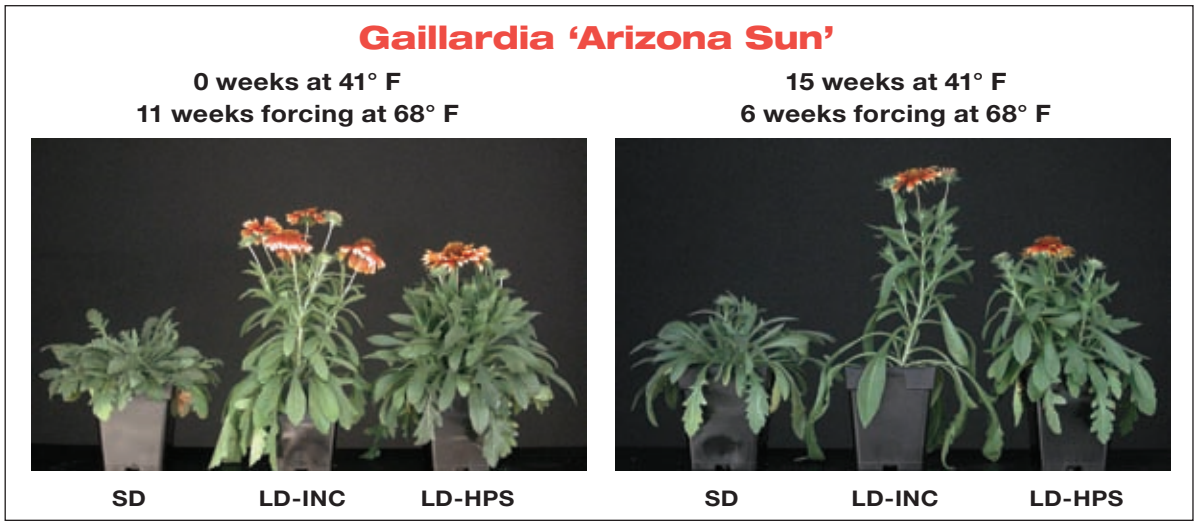

Figure 3. Gaillardia 'Arizona Sun' had a facultative vernalization response when cooled at 41° F for 15 weeks. Flowering was hastened by 6-7 weeks when vernalized plants were forced under a short day (SD, 9 hours), while when forced under long days (16 hours) provided by incandescent lamps (LD-INC) or high-pressure sodium lamps (LD-HPS), vernalized plants flowered 2-3 weeks earlier than non-vernalized plants.

Figure 4. The critical photoperiod of gaillardia 'Goblin' is between 12 and 13 hours. Note that the flowering percentage reported in the figure was recorded when the photograph was taken. More plants eventually flowered. Plant height at flowering generally increased with photoperiod.

photoperiods. Typically, plants become mature and capable of flowering once they have grown a certain number of leaves. This leaf number varies among species and cultivars. For example, research at MSU found that the juvenile phase of 'Goblin' ends after the plant has unfolded about 16 leaves. Hence, 'Goblin' seedlings need to be bulked under short photoperiods until at least 16 leaves are present prior to providing vernalization or photoperiod treatments. In our evaluations, 'Arizona Sun' seedlings had more than 10 leaves upon receipt. Therefore, it did not exhibit juvenility and flowered uniformly when provided with a vernalization treatment followed by long days.

To maintain the aesthetic appeal of gaillardia produced for large-sized final containers, it is important to allow plants to bulk up to size prior to forcing. Also, if some of the plugs have flower buds upon receipt, their removal prior to bulking is beneficial to ensure synchronized flowering.

Vernalization

Vernalization is defined as the promotion of flowering following a cold treatment. The cooling treatment itself is sometimes called a vernalization treatment. Some cultivars require vernalization for flowering and thus have an obligate vernalization response. Other cultivars have a facultative vernalization response, where vernalization can accelerate flowering, improve flowering characteristics such as higher flowering percentage, synchronize flowering and increase flower number.

The vernalization response of gaillardia is highly cultivar-dependent and ranges from no response to an obligate response, depending on the photoperiod (Table 1, pages 22 and 23). For example, a 15-week vernalization treatment at 41° F did not influence the flowering time or flowering characteristics of 'Fanfare' and 'Oranges and Lemons'. In contrast, 'Arizona Sun', 'Gailarus', and 'Goblin' exhibited a facultative response, and their flowering was accelerated by a vernalization treatment. 'Galileo' required vernalization to flower when forced under a 9-hour photoperiod and had a facultative vernalization response when forced under a 16-hour photoperiod.

In many cultivars, the magnitude of acceleration of flowering by a vernalization treatment depended on the forcing photoperiod. For instance, a vernalization treatment at 41° F for 15 weeks hastened flowering of 'Arizona Sun' by 2-3 weeks when forced under a 16-hour ➧

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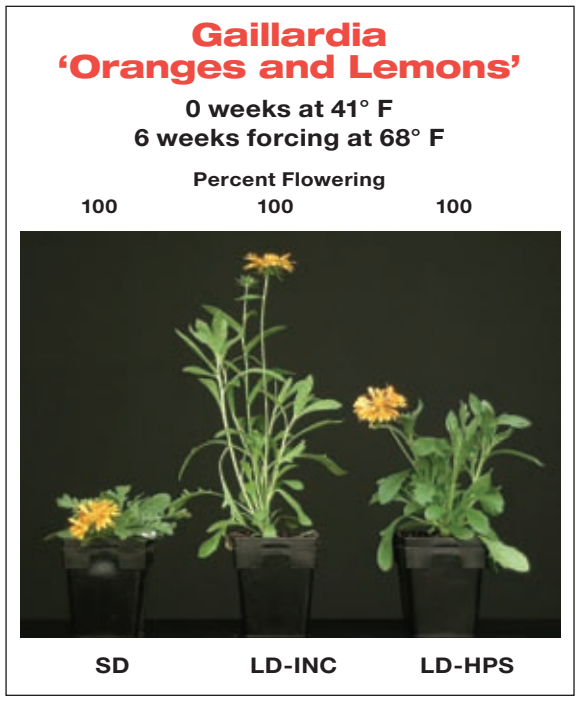

Figure 5. Although gaillardia 'Oranges and Lemons' flowered completely under short days (SD) or long days (LD), plants under SD formed rosettes and had fewer flowers and branches. Hence, horticulturally 'Oranges and Lemons' can be considered a LD plant. Note that plants grown under high-pressure sodium lamps (LD-HPS) were more compact and had more branches and buds than those under incandescent lamps (LD-INC).

photoperiod at 68° F, but when plants were forced under a 9-hour photoperiod, vernalization hastened flowering by 6-7 weeks (Figure 3, page 24).

Photoperiod

Similar to many photoperiodic herbaceous perennials from temperate origins, most gaillardia cultivars are long-day plants and flower when the photoperiod exceeds a critical value, typically 12-13 hours (Figure 4, page 24). Gaillardia typically respond facultatively to long days and flower faster and/or have improved flowering characteristics when forced under long days, including more uniform flowering, increased flowering percentage, and more flowers and flowering laterals.

Although many cultivars do eventually flower when grown under short days, the plants are excessively compact and form rosettes with few flowers (Figure 5, left). Therefore, we consider most gaillardia to be obligate long-day plants and recommend a photoperiod greater than 13 hours during forcing. To achieve this, long-day lighting is required in North America from mid-September through early April. Long-day lighting can be provided as a 4-hour night interruption or day extension. When providing long day lighting for forcing gaillardia, plants tend to stretch under incandescent lamps and hence, may require more liberal use of plant growth regulators to control stem extension.

Light Quantity

Gaillardia is a sun-loving perennial and becomes rather floppy when grown under shade in the garden. Similarly, gaillardia thrives under high light in the greenhouse and produces weaker stems when grown under lower light. When provided with supplemental light, gaillardia cultivars were more compact and produced more branches and flowers in our trials (Figure 5). To produce high-quality gaillardia, the average daily light integral in the greenhouse should exceed 10 $mol \cdot m^{-2} \cdot d^{-1}$.

Regulating Plant Growth

Many gaillardia cultivars are unruly and floppy when grown under low light levels, and plants elongate excessively when long day lighting is provided by incandescent lamps. Among various factors to consider for plant growth regulation of gaillardia, cultivar selection is of particular importance. In our trials, 'Gailarus' and 'Galileo' were appropriate for 5½-inch containers when forced without plant growth regulator applications (Figure 6, oppo-

'Gailarus' 'Galileo'

Figure 6. Gaillardia 'Gailarus' and 'Galileo' were compact and suitable for 5½ inch containers when forced without plant growth regulator applications.

site). In contrast, 'Oranges and Lemons' was too tall for 5½-inch containers when grown under a 16-hour photoperiod provided by incandescent lamps (Figure 5).

We have tested the effects of 100 ppm of A-Rest (ancymidol), 5,000 ppm of B-Nine (daminozide), 90 ppm of Bonzi (paclobutrazol), 1,500 ppm of Cycocel (chlormequat chloride) and 15 ppm of Sumagic (uniconazole) as foliar sprays on height control of 'Burgundy'. A-Rest was slightly effective, and B-Nine and Sumagic were highly effective at inhibiting stem extension. Sumagic also was effective in controlling the height of 'Fanfare'. We recommend growers conduct their own trials to determine effective plant growth regulator rates for their growing conditions and use graphical tracking to determine application time.

Summary

Gaillardia cultivars comprise a group of great garden plants and can be used in combination with annuals and perennials for non-stop color through the summer. Similar to their flower colors and forms, the regulation of flowering varies among Gaillardia cultivars. 'Goblin' and 'Arizona Sun' facultatively respond to a vernalization treatment, whereas 'Oranges and Lemons' and 'Fanfare' do not require vernalization. Most gaillardia cultivars are horticulturally long-day plants, and thus a photoperiod longer than 13 hours is recommended for rapid and uniform flowering. We've been impressed with the new introductions of gaillardia and anticipate more exciting introductions from breeders in the near future. GPN

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