

## COMING UP IN THIS SERIES

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Cold Temperatures  
Lavender (*Lavandula angustifolia*)  
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Coreopsis 'Moonbeam'  
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Balloon flower (*Platycodon grandiflorus*)  
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THE  
NEW SCIENCE  
OF FORCING  
PERENNIALS TO  
FLOWER

Perennials

# FORCING PERENNIALS

— CROP BY CROP —

**SPECIES: COREOPSIS GRANDIFLORA**  
**COMMON NAME: TICKSEED**

*Editor's note: In this exclusive series, Michigan State University researchers tell growers how to give the public what they want: perennials in flower. Part Four provides precise prescriptions for coreopsis grandiflora. These 10 articles will be bound into a handy booklet at the end of the year.*

Figure 1.



A well-proportioned *Coreopsis grandiflora* in flower makes a very attractive plant.

by MEI YUAN, DR. ROYAL D. HEINS,  
DR. ARTHUR CAMERON, and  
DR. WILLIAM H. CARLSON

**C**OREOPSIS GRANDIFLORA belongs to the Asteraceae plant family. The genus includes many annuals and perennials grown for their daisy-like, bright-yellow flowers. *Coreopsis grandiflora* is indigenous from Missouri and Kansas to Florida and New Mexico and is fully hardy from zones 4 to 9. The plant flowers from early summer to late fall and prefers full sun and fertile, well-drained soil. It grows as a rosette plant and bolts before flowering, often reaching a height of 2 feet. It makes a brilliant display in borders and gardens and is excellent as a cut flower. *Coreopsis* responds strongly to photoperiod, which allows growers to control and schedule flowering quite easily. It has great potential as a flowering potted plant and can be enjoyed in the home as well as in gardens. (Figure 1).

### Cultivars

The most common cultivar is 'Sunray,' which has double gold-yellow flowers about 1-2 inches across. 'Goldfink' is a short-lived, dwarf plant that has 2-inch single yellow flowers with an orange center. 'Sunburst' has semidouble golden yellow flowers. 'Early Sunrise' is purported to be a cross between *C. grandiflora* and *C. lanceolata*. It is a short-lived cultivar and is unique in that it does not have a requirement for cold before flowering. Many other cultivars also exist.

### Flower Induction Requirements

Flowering requirements vary among *Coreopsis* species and even cultivars. Unless stated otherwise, the

following suggested production information is based on 'Sunray.' It may not be appropriate for other cultivars and will not be appropriate for other *Coreopsis* species such as *C. verticillata* 'Moonbeam' or *C. rosea*. In order to flower, *C. grandiflora* 'Sunray' plants must be mature, must have received a cold treatment, and must be exposed to long days.

### 1. PLANT SIZE

After germination, seedlings are juvenile and will not flower in response to vernalization or photoperiod. 'Sunray' reaches maturity when plants develop about eight nodes (16 visible leaves). Until then, they should be grown under a photoperiod shorter than 13 hours to promote lateral branching. If only part of a population is mature, only part of the plants will flower (Figure 2). Mature plants will develop about eight new nodes (16 leaves) under the flowers from forcing to bloom.

### 2. COLD TREATMENT

A 10-week cold period at about 41°F (5°C) or cooler is recommended for flower induction in 'Sunray' (Figure 3). Extending the cold treatment from 10 to 15 weeks will enhance flowering percentage on marginally mature plants, although the time to flower for flowering plants remains unchanged.

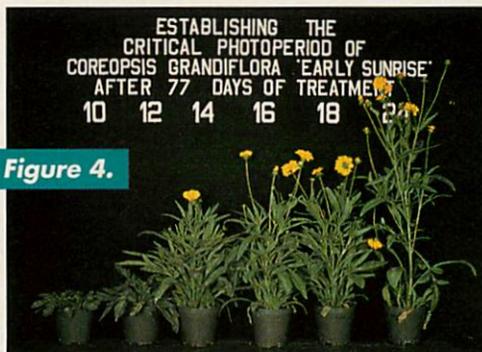
'Early Sunrise' does not have an obligate cold requirement to flower. It does require long days (LD) to flower. We have conflicting experiences about this cultivar's requirement for a period of short days (SD) before exposure to LD. Because we are uncertain at this point, we recommend that 'Early Sunrise' plants be exposed to SD (days shorter than 12 hours) for at least 6 weeks before exposure to LD if precise timing to flower is required.

### 3. PHOTOPERIOD

Horticulturally, all *C. grandiflora* cultivars, including 'Early Sunrise'



**Figure 2.** Only part of a *C. grandiflora* 'Sunray' population may flower if all plants are not mature. Plants from "SM PLUG" were grown in a 128-cell plug sheet; only 50% of the plants flowered. Note the flowering and nonflowering plants after cold and long days on SM PLUG plants. Plants from "LG PLUGS" were grown in a 50-cell plug sheet; all plants flowered under long days (LD) following 10 weeks' cold treatment at 41°F (5°C). Photo courtesy of Beth Engle.



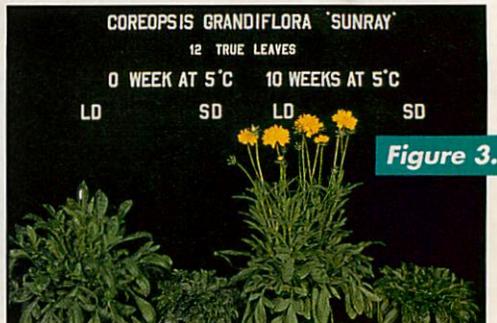
**Figure 4.** *Coreopsis* flowers only when the photoperiod is 14 hours or longer.

and 'Sunray,' are obligate LD plants. Fastest flowering occurs when plants are exposed to LD of 14 hours or more (Figure 4) or are provided night-interruption lighting for 4 hours from 10 p.m. to 2 a.m. (Figure 5). Plants should be exposed to at least 3 weeks of LD. After flowers initiate, their development will continue even if the plants subsequently are placed under SD.

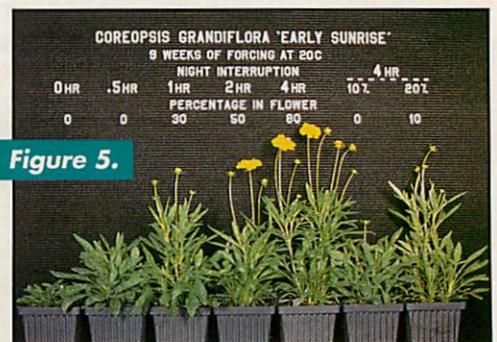
Incandescent, high-pressure sodium, cool-white fluorescent, and metal halide lamps all are effective for night interruption. However, incandescent light may cause more stem elongation than other light sources (Figure 6). The minimum intensity should be 10 footcandles.

### 4. PROPAGATION

*Coreopsis* can be propagated by seed or division. Division is used most commonly by the gardener for rejuvenation or control of plant size and is preferably done in the spring. Seed propagation is prevalent for commercial production because it is less expensive. Cold treatment of seed



**Figure 3.** *C. grandiflora* 'Sunray' plants flower only after receiving a cold treatment and then being forced under long days (LD). Plants on the left did not receive a cold treatment and did not flower, while the two plants on the right received 10 weeks at 41°F (5°C); the plants subsequently forced under LD flowered.



**Figure 5.** Fastest and most uniform flowering of *C. grandiflora* under night-interruption lighting occurs when plants are exposed to at least 4 hours of light during the middle of the night. While plants will flower with as little as half an hour of light during the middle of the night or with cyclic lighting (6 minutes on, 54 minutes off for 4 hours), time to flower will be increased with fewer than 4 hours of continuous light. Photo courtesy of Erik Runkle.

is beneficial but not required for germination. However, darkness is required, which necessitates that seeds be covered with medium or germinated in a dark chamber. Keep the medium at 68°-72°F (20°-22°C) and the humidity high (90%-95%). Seedlings will emerge in about a week.

### 5. MEDIA AND FERTILIZATION

*Coreopsis* does not have specific media requirements; plants will grow well in any well-drained evenly moist medium. The pH should be maintained from 5.8-6.4.

*Coreopsis* prefers low to moderate fertility; constant fertilization at 100-150 ppm N from a balanced fertilizer is adequate. Plants become very lush under high fertility.

### 6. LIGHTING AND SPACING

*Coreopsis* thrives in bright light. Supplemental lighting from high-pressure sodium lamps at 400-500 foot-

candles hastens development and improves quality during winter.

## 7. IRRIGATION

Plants grow rapidly, develop a large leaf area, and require frequent irrigation. Plants readily wilt as the medium dries under high light conditions, which is especially a problem in small pots. Recovery, however, is rapid after watering without detrimental effects, as long as the water stress is not severe.

## 8. PLANT HEIGHT CONTROL

Coreopsis tends to be too tall when grown in 4- or 6-inch pots. Two methods can be used to control plant height: limited induction photoperiod (LIP) and growth retardants. With LIP, plants are given 3 weeks of LD, then

### FORMULA FOR SUCCESS: 'SUNRAY'

1. Force only plants with 16 or more leaves (8 or more nodes).
2. Provide plants a minimum of 10 weeks' cold at 41°F (5°C) before LD treatment.
3. Force at 60° to 70°F (15°-21°C).
4. Provide plants a minimum of 3 weeks LD after cold treatment. Long days can be provided by natural or extended photoperiods of at least 14 hours or by night interruption from 10 p.m. to 2 a.m. with 10 footcandles of light.
5. To keep plants compact, apply growth retardants when the main stem axis starts to elongate. Expect some flowering delay from growth retardant application.

grown to flower under a photoperiod shorter than 14 hours.

Returning plants to SD will delay flowering by up to several days and will reduce flower-bud number compared to continual LD, but plants are shorter. However, once visible, buds develop at the same rate under LD or SD.

Growth regulators also can be used effectively to control plant height. Our research shows that B-Nine and Sumagic are the most effective (Figure 7). Both growth regulators reduce stem elongation under LD conditions but delay flowering in the process. We have observed almost 2 days' delay for every inch in height reduction compared to untreated control plants.

## 9. TEMPERATURES AND CROP SCHEDULING

Coreopsis grows and develops fast in warm temperatures. After germination, plants should be grown at 70°-75°F (21°-24°C) to shorten the juvenile phase. During forcing to flower, temperatures higher than 70°F (21°C) reduce flower-bud number, so 65°-68°F (18°-20°C) is optimum for fast flowering with high quality.

Once LD begins, time to flower depends on the forcing temperature. Allow about 10-11 weeks at average daily temperatures of 59°F (15°C), 8-9 weeks at 64°F (18°C), or 7-8 weeks at 68°F (20°C) (Table 1 next page).

Plants can be purchased in different

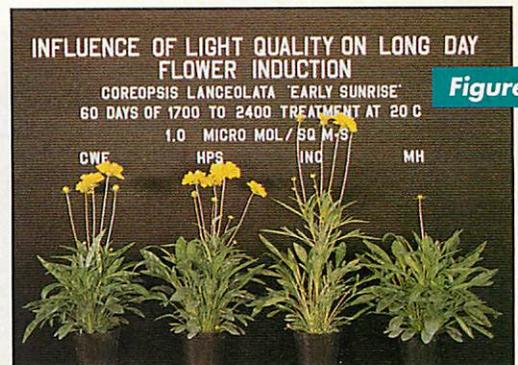


Figure 6.

Cool-white fluorescent, high-pressure sodium, incandescent, and metal halide lamps all induce flowering of *C. grandiflora*; however, incandescent lamps promote more stem elongation than the other lamps. Note: one micromol/sq. m.s is approximately 5 footcandles. Photo courtesy of Catherine Whitman.

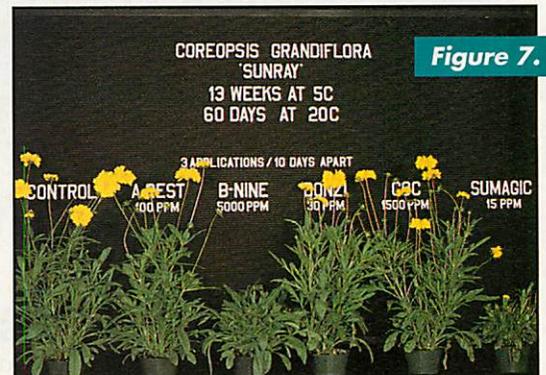


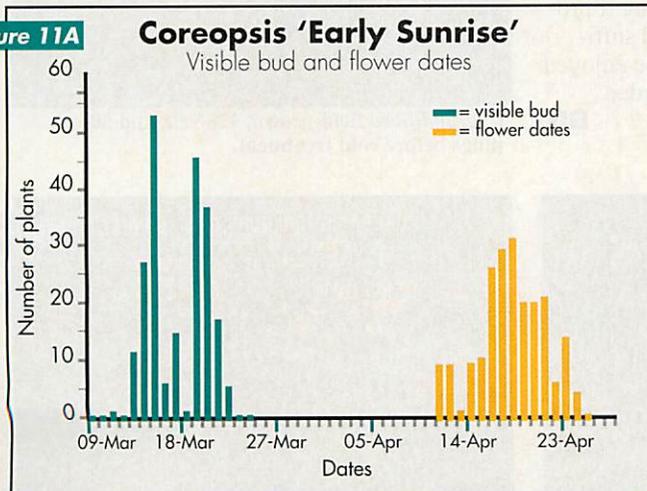
Figure 7.

Response of *C. grandiflora* to common growth retardants applied frequently and at high rates. B-Nine and Sumagic were both very effective but delayed flowering. Rates are not necessarily those suggested for height control.

size plugs or as field-grown plants (Figures 8, 9, and 10 on next page). Final plant size will depend on the size of the plant at the start of LD.

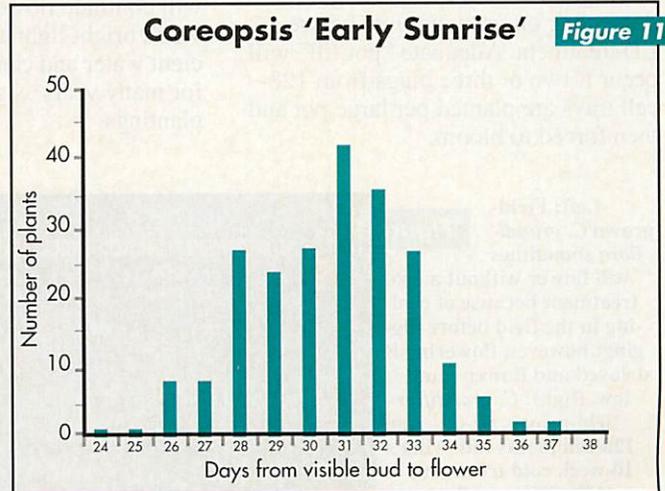
Like many other seed-propagated crops, coreopsis exhibits some variability in time to flower between plants in a population (Figures 11a

Figure 11A



Left: Distribution of plants reaching visible bud (VB) and flower of a 200-plant population we forced to bloom at 65°F (18°C). Right: Distribution in time from VB to flower for 200 *C. grandiflora* 'Early Sunrise' plants growing at 65°F (18°C).

Figure 11B



**TABLE 1.** *Coreopsis grandiflora* 'Sunray' Production Schedule

Growing Time	Cultural Practice	Temperature	Photoperiod
1-2 weeks	Sow seeds ↓ Germination OR purchase plugs	65°-72°F (18°-22°C)	<14 hours of light
8-12 weeks	Grow until at least 16 leaves have formed	72°-76°F (22°-24°C)	<14 hours of light
10-15 weeks (Can be held longer if needed)	Cold treatment ↓	35°-45°F (1°-7°C)	<14 hours of light
<b>Begin Forcing</b>			> 14 hours of light or a 4-hour night interruption.
60°F (15°C) 10-11 weeks flower	65°F (18°C) 8-9 weeks flower	70°F (21°C) 6-7 weeks flower	<b>Visible Bud to Flower</b> 60°F (15°C) – 35 days 65°F (18°C) – 27 days 70°F (21°C) – 21 days

and 11b). You should consider this type of variability if all plants must be in flower to be marketed.

Cooled plugs or bare-root plants can be purchased, planted, and directly forced to bloom. For 1-gallon or larger containers, larger plants are required to fill the pot properly. The best options for large containers are 1) using field-grown plants or 2) planting an uncooled plug (size 128 or 50) in late September and early October to allow for bulking.

When plugs are used, plants fill out during the fall and are cooled during the winter in their finish pot. After plants have received adequate cold, they can be forced to bloom under LD. A plant from a 128-cell plug tray is marginal for a 6-inch or larger pot, depending on growing time before LD treatment. Adequate "pot fill" will occur if two or three plugs from 128-cell trays are planted per large pot and then forced to bloom.

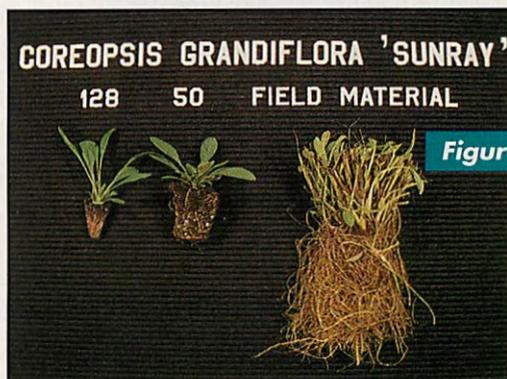
### 10. DISEASE AND INSECT PESTS

*Coreopsis* does not have many pests but is susceptible to powdery mildew and aphids. Plants are susceptible to tospoviruses such as impatiens necrotic spot virus (INSV), which is spread by thrips and causes black spotting on leaves and petioles.

### 11. POSTHARVEST CONCERNS

For longer shelf life, plants should be shipped when the first flower opens. Spent flower heads should be removed to keep plants vigorous and prolong blooming. Plants will continue flowering if provided bright light and sufficient water and can be enjoyed for many years as garden plantings.

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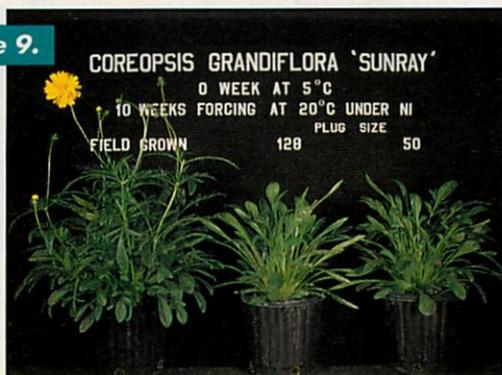


**Figure 8.**

*C. grandiflora* field-grown, 128-cell, and 50-cell plugs before cold treatment.

Left: Field-grown *C. grandiflora* sometimes will flower without a cold treatment because of cooling in the field before digging; however, flowering is delayed and flower count is low. Right: *C. grandiflora* field-grown, 50-cell, and 128-cell plants following a 10-week cold treatment at 41°F (5°C) and 7 weeks' forcing at 68°F (20°C).

**Figure 9.**



**Figure 10.**

