

COMING UP IN THIS SERIES

Basic Science
Cold Temperatures
Lavender (*Lavandula angustifolia*)
Tickseed (*Coreopsis grandiflora*)
Threadleaf (*Coreopsis verticillata*)
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Balloon flower (*Platycodon grandiflorus*)
Speedwell (*Veronica longifolia*)
Obedient plant (*Physostegia virginiana*)
✓ Black-Eyed Susan (*Rudbeckia fulgida*)
Russian sage (*Perovskia atriplicifolia*)

THE NEW SCIENCE OF FORCING PERENNIALS TO FLOWER

Perennials

FORCING PERENNIALS

— CROP BY CROP —

SPECIES: *RUDBECKIA FULGIDA* 'GOLDSTURM'

COMMON NAME: BLACK-EYED SUSAN



Figure 1a.

Rudbeckia fulgida 'Goldsturm' forced in a greenhouse and ready for sale as attractive flowering potted perennials (left). *Rudbeckia* looks fabulous in the landscape, especially next to ornamental grasses (below). Photo courtesy of Marlene Cameron.

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 Nine provides a precise prescription for *Rudbeckia fulgida*.

by **MEI YUAN, ERIK S. RUNKLE, ROYAL D. HEINS, ARTHUR CAMERON, and WILL CARLSON**

RUDBECKIA FULGIDA is a member of Asteraceae or the sunflower family. It is native from Connecticut to West Virginia and west to Michigan and Missouri, flowers through late summer into early fall, and produces abundant daisylike flowers. The yellow flower heads have conical black centers that remain



Figure 1b.

an interesting display even after the petals have fallen. The flowers are long lasting and ideal for cuttings.

The plant is fully hardy from zones 4 to 9 and often reaches a height of 2-3 feet in gardens but is shorter when planted in containers. It grows as a rosette plant in almost any type of soil and bolts before flowering. Plants tolerate partial shade but flower best in full sun.

The flowering of *Rudbeckia* is strictly controlled by photoperiod, which can be manipulated to flower a crop at any time of the year. Plants may be sold in flower, enjoyed indoors for weeks, then planted outdoors for continued enjoyment (Figures 1a and 1b).

Cultivars

The most popular cultivar is 'Goldsturm,' which has beautiful golden flowers about 2-3 inches across. 'Deami' has lighter-yellow flowers. There are many other species of *Rudbeckia*, several of which are annuals, such as *R. hirta*.

Flower Induction Requirements

The following production information is based on *R. fulgida* 'Goldsturm.' 'Goldsturm' must be mature and exposed to long days in order to flower. A cold treatment is not required,

but it does hasten flowering.

1. PLANT SIZE

Juvenile plants will not flower in response to inductive photoperiods (Figure 2). Our research has shown that 'Goldsturm' reaches maturity when plants develop about 10 nodes (leaves). Plants that have fewer leaves take much longer to flower and do so sporadically.

Grow plants under photoperiods no longer than 12 hours to an average of 10 or more leaves. Field-grown plants are generally mature and do

not require further growth before exposure to cold temperatures or long days. After cold treatment and exposure to long days, mature plants develop an additional 12-15 leaves under the first flower.

2. COLD TREATMENT

'Goldsturm' does not require a cold treatment for flowering. However, 10 weeks or more in a cold (41°F or 5°C) greenhouse or cooler is recommended because it reduces time to flower by approximately 3 weeks; extending the cold treatment for more than 10

weeks does not further accelerate flowering. Cold treatment does not seem to influence other flowering characteristics. Plants may be held in coolers for longer periods if needed.

3. PHOTOPERIOD

The effects of photoperiod on flowering of *Rudbeckia* has been investigated since the discovery of photoperiodism by Garner and Allard in the early 1920s. Over the years, many *Rudbeckia* species have been studied, and all have been found to be long-day plants.

Rudbeckia fulgida 'Goldsturm' is an obligate long-day plant. Without a cold treatment, plants remain as rosettes when photoperiods are

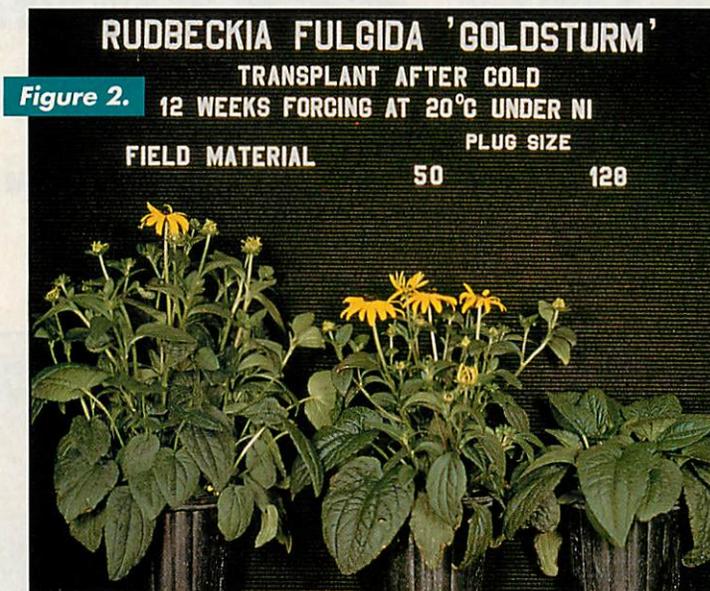
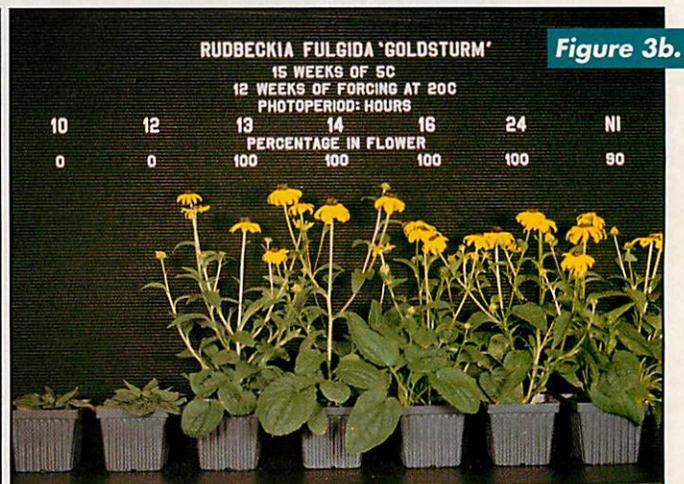
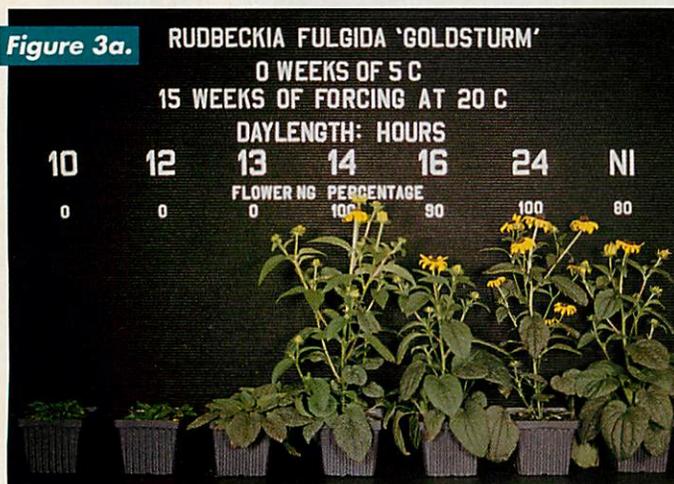


Figure 2. Only some 'Goldsturm' plants flower in a population if plants are not mature. After 22 weeks of long days, only 60% of plants from 128-cell plugs that averaged five nodes flowered, 75% of plants from 50-cell plugs that averaged nine nodes flowered, and 100% of plants from bare-root material flowered.



Rudbeckia that are not provided with a cold treatment (left) only flower when photoperiods are 14 hours or longer or with a 4-hour night interruption (NI) from 10 p.m. to 2 a.m. After a cold treatment of 10-15 weeks at 41°F (5°C) (right), *Rudbeckia* flowers only when photoperiods are 13 hours or longer with a 4-hour night interruption (NI) from 10 p.m. to 2 a.m.

shorter than 13 hours. Flowering occurs only when plants are exposed to long days of 14 hours or more or are provided with 4-hour night interruption (e.g., 10 p.m.-2 a.m.). After a cold treatment, plants flower under photoperiods of at least 13 hours (Figures 3a and 3b). Some plants flower under 12-hour photoperiods, but flowering is greatly delayed, and the flowering percentage is poor. Daylengths longer than 14 hours do not further accelerate flowering.

'Goldsturm' will flower with 1 or 2 hours of night-interruption lighting or 20% cyclic lighting (6 minutes on, 24 minutes off for 4 hours), but flowering is delayed by 3 weeks or more compared to that following a continuous 4-hour night interruption (Figure 4). Lighting for more than 4 hours during the middle of the night is recommended for the most rapid and uniform flowering.

Incandescent, high-pressure sodium, cool-white fluorescent, and metal halide lamps all effectively extend the daylength or night-interruption lighting (Figure 5). However, incandescent lamps may cause more stem elongation than light from other sources. The minimal light intensity for fastest flowering should be 10 footcandles in all corners of the greenhouse.

4. PROPAGATION

'Goldsturm' can be propagated by seed or division, the latter being the most common method used by gardeners. In the landscape, division is recommended every few years for rejuvenation and plant-size control and is best when performed in the spring or after flowering in the late fall.

Seed propagation is prevalent for commercial production because it is less expensive. For optimum seed ger-

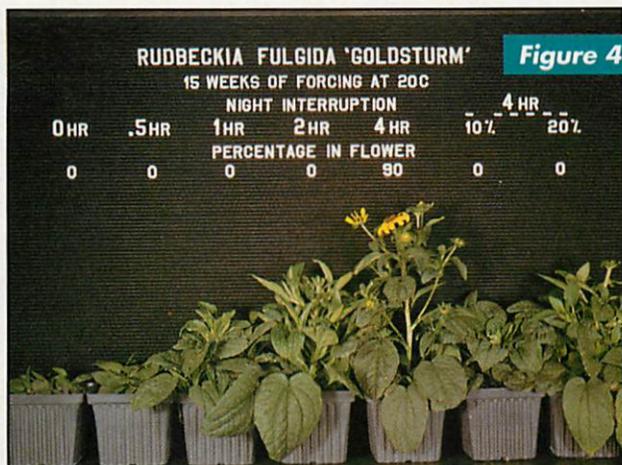


Figure 4. Fastest and most uniform flowering of *R. fulgida* under night-interruption lighting occurs when plants are exposed to at least 4 hours of light during the middle of the night. Plants flower with as little as 1 hour of light during the middle of the night or with cyclic lighting of 6 minutes on, 24 minutes off for 4 hours (20% cyclic), but flowering is delayed by at least 3 weeks.

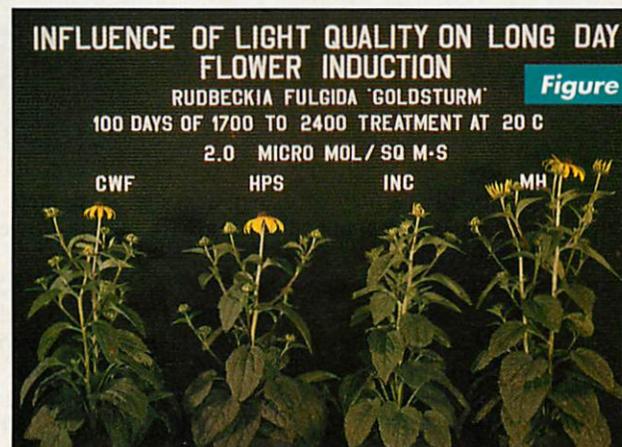


Figure 5. Cool-white fluorescent (CWF), high-pressure sodium (HPS), incandescent (INC), and metal halide (MH) lamps effectively induce flowering of *R. fulgida* 'Goldsturm.' Note: $2 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ is approximately 10 footcandles. Photo courtesy of Catherine Whitman.



Figure 6. 128-cell and 50-cell plugs and field-grown 'Goldsturm.'

mination, cold-treat seeds for 8-12 weeks at 41°F (5°C). Seeds will germinate in either light or dark. Keep the medium at 68°-72°F (20°-22°C) and maintain high humidity (90%-95%). Seedlings emerge in 1-2 weeks.

5. MEDIA AND FERTILIZATION

'Goldsturm' can grow in almost any kind of soil but prefers a moist medium. The pH should be maintained around 5.8-6.4. The cultivar prefers moderate fertility; constant fertilization of 100-200 ppm N, 10-20 ppm P, and 100-150 K₂O is recommended (for example, 20-10-20).

6. LIGHTING AND SPACING

'Goldsturm' thrives in bright light. Supplemental lighting from high-pressure sodium lamps at 400-500 footcandles improves plant quality during the winter and slightly accelerates development. Plants may be spaced pot to pot before and during cold treatment. However, space plants soon after forcing under long days or plants will develop too tall.

7. IRRIGATION

'Goldsturm' grows well in moist medium and therefore requires frequent irrigation when plants are large. Plants readily wilt as the medium dries under intense light and warm temperatures, which may result in leaf damage (such as leaf-tip burn). However, plants usually will recover quickly after watering if the water stress was not severe.

8. PLANT HEIGHT CONTROL

'Goldsturm' tends to be too tall when grown in 4- or 6-inch pots. Our research has shown that 'Goldsturm' responds to limited-induction photoperiod, although the exact number of long days required for flower induction is unknown. After flower induction, transferring plants to short days will not delay flowering but will

TABLE 1.

***Rudbeckia fulgida* 'Goldsturm' Production Schedule**

Growing Time	Cultural Practice	Temperature	Photoperiod
1-2 weeks	Sow seeds ↓ Germination OR purchase plugs	68°-72°F (20°-22°C)	natural day lengths
10-12 weeks	Grow until at least 10 leaves have formed	72°-76°F (22°-24°C)	≤ 12 hours of light
10 weeks (can be held longer if needed)	Cold treatment ↓	35°-45°F (1°-7°C)	≤ 12 hours of light
Begin Forcing			≥14 hours of light or a 4-hour night interruption Visible Bud to Flower 60°F (15°C) – 49 days 65°F (18°C) – 44 days 70°F (21°C) – 38 days
↓	↓	70°F (21°C)	
59°F (15°C) 16-17 weeks flower	64°F (18°C) 14-15 weeks flower	11-12 weeks flower	

reduce flower number. Our research indicates that A-Rest, B-Nine, Bonzi, and Cycocel only slightly reduce plant height, with little or no delay in flowering.

9. TEMPERATURES AND CROP SCHEDULING

Rudbeckia can be purchased in a variety of plug sizes or as field-grown plants (Figure 6). Mature, cooled plugs or bare-root plants can be purchased, planted, and directly forced into bloom. Bare-root plants are ideal for 1-gallon or larger containers. When 128-cell plugs are used for large containers, two or three plugs may be required to fill a pot properly. Final plant size will depend on the size of the plant at the start of long days.

For the most rapid development, juvenile plants should be grown at warm temperatures (70°-75°F or 21°-24°C) until they develop approximately 10 nodes. From forcing to flower, plants grown above 72°F (22°C) have fewer and smaller flowers. Thus, a temperature setting of 65°-68°F (18°-20°C) is recommended for the highest quality and most floriferous

plants. Plants may be grown at cooler temperatures, but flowering will be delayed.

Time to flower depends on the forcing temperature. Allow about 16-17 weeks from the start of long days with a daily average of 59°F (15°C), 14-15 weeks at 64°F (18°C), or 11-12 weeks at 70°F (21°C) (Table 1). Plants not provided with a cold treatment flower approximately 2-4 weeks later. *Rudbeckia* takes longer to force into flower than most other herbaceous perennials we have inves-

tigated, but they are in demand once in flower.

10. DISEASES AND INSECTS

'Goldsturm' has few pests. Occasionally plants may develop cupped or deformed leaves or inflorescences that are branched at the base. The cause(s) remains unknown, but fortunately the problem does not reduce ornamental value unless it is severe.

11. POSTHARVEST CONCERNS

'Goldsturm' has long-lasting flowers, so for the best display, plants should be shipped after the first flower has opened. Plants tend to improve in quality as subsequent flowers open for up to several weeks. Individual flowers will last 3 weeks or more if enough light and especially water are provided. **GG**

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**FORMULA FOR SUCCESS:
'GOLDSTURM'**

1. Grow plants under photoperiods (≤ 12 hours) until plants average at least 10 leaves (nodes).
2. Provide mature plants with at least 10 weeks of cold at 41°F (5°C) before long-day treatment.
3. Grow plants under long days (≥14 hours) after cold treatment. Long days can be easily provided by using 4-hour night-interruption lighting from 10 p.m. to 2 a.m.
4. Force at 60°-70°F (15°-21°C) for the highest quality plants.