

COMING UP IN THIS SERIES

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THE NEW SCIENCE OF FORCING PERENNIALS TO FLOWER

Perennials

FORCING PERENNIALS

— CROP BY CROP —

SPECIES: COREOPSIS VERTICILLATA

COMMON NAME: THREADLEAF COREOPSIS

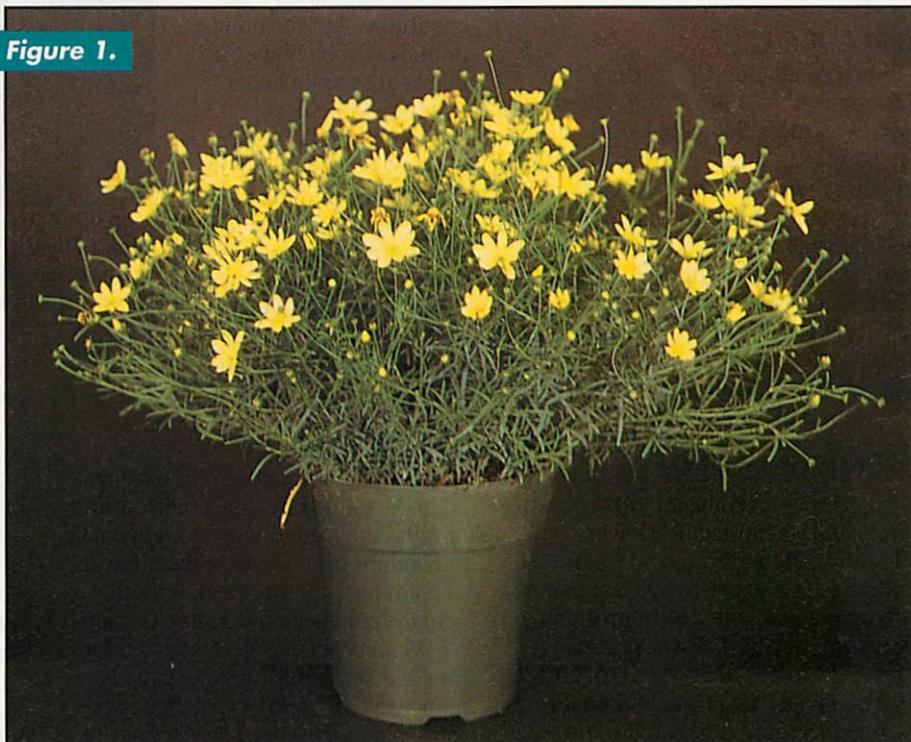
Editor's note: In this exclusive series, Michigan State University researchers tell growers how to give the public what they want: perennials in flower. Part Five provides precise prescriptions for *Coreopsis verticillata* 'Moonbeam.' These 10 articles will be bound into a handy booklet at the end of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

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VOTED Perennial Plant of the Year in 1992 by the Perennial Plant Association, *Coreopsis verticillata* 'Moonbeam' is a showy flowering herbaceous perennial that continues to be popular among consumers. *C. verticillata*, or threadleaf coreopsis, is one of the most drought tolerant of the cultivated *Coreopsis* spp. It has a variety of cultivars that add interesting texture and an extended blooming season to gardens in USDA hardiness zones 3-9.

C. verticillata is a member of a large genus of summer-blooming perennials with yellow daisylike flowers. The *Coreopsis* spp. belong to Asteraceae, the daisy family, and are known for their profuse single and

Figure 1.



A field-grown division of *Coreopsis* 'Moonbeam' will yield an impressive flowering plant, shown here in a 6-inch standard pot.

double composite flowers. Threadleaf coreopsis is indigenous from Maine to Florida and as far west as Arkansas. *C. verticillata* spreads through growth of rhizomes, or underground stems, which results in expansion of the original crown. Once the initial flush of

blooms is finished, plants will re-flower continually from new sprouts rising from the crown.

Cultivars

Threadleaf coreopsis sports dozens of single flowers on soft needle-like

leaves that vary in color based on cultivar. 'Golden Showers' is a 2-foot-tall selection with 2½-inch blooms that are a rich, golden-yellow. 'Zagreb' is a compact version of 'Golden Showers,' reaching only 8-18 inches in height with similar flower color. *C. verticillata* 'Moonbeam' is unique to this species, with pale, lemon-yellow 1-inch blooms atop 1- to 2-foot-tall plants (Figure 1). Selected by Alan Bloom at Bressingham Gardens in England, the blooming season for *Coreopsis* 'Moonbeam' – from June until frost – is unusually long compared to most perennials.

Flower Induction Requirements

All suggested production information is based on observed responses of *C. verticillata* 'Moonbeam.' Because flowering requirements within *Coreopsis* vary, other cultivars within this species may not respond the same way.

1. PLANT SIZE

When producing *Coreopsis* 'Moonbeam' as a flowering potted plant, you must first consider the intended market and the desired final product. Starting material greatly influences the size of the final plant as well as container selection (Figure 2). Starting material, either plugs or divisions, should be able to fill the container with an impressive display of flowers. A comparison between Figures 1 and 2 shows this is more of a concern with plug material.

2. COLD TREATMENT

Coreopsis 'Moonbeam' does not require a cold treatment to flower (Figure 3). However, a cold treatment or storage in a cool greenhouse can offer two advantages during forcing. Flowering occurs 1-2 weeks faster after a 10- to 15-week, 41°F (5°C) cold treatment, and final bud count may be increased compared to uncooled plants.

3. PHOTOPERIOD

Because *Coreopsis* 'Moonbeam' is an obligate long-day (LD) plant, flowering occurs fastest when plants are exposed to a photoperiod in excess of 14 hours or a 4-hour night interruption from 10 p.m. to 2 a.m. (Figure 4). *Coreopsis* 'Moonbeam' also responds to cyclic lighting as a

Figure 2.



Coreopsis 'Moonbeam' is very versatile and can be grown to fit almost any container. It's shown here flowering from a small plug in a 5-inch square pot.

long-day treatment (Figure 5). Plants should be forced for at least 3 weeks under LD conditions. Flower development will continue even if the plants are then placed under short-day (SD) or natural-day (ND) conditions, but the number of buds will be higher if plants are grown under continual long days.

Cool-white fluorescent, high-pressure sodium, incandescent, and metal halide lamps all have been successful in promoting flowering of *Coreopsis* 'Moonbeam.' The minimum light intensity for all lamp types should be 10 footcandles.

4. PROPAGATION

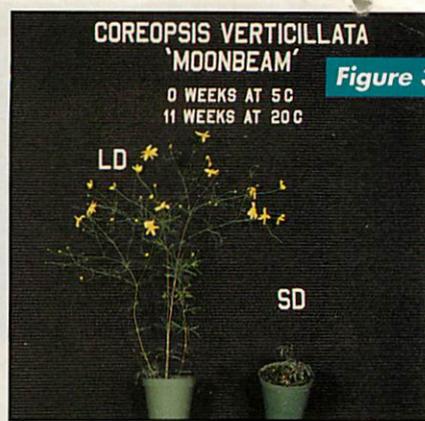
Coreopsis 'Moonbeam' is propagated in the garden by division in spring or fall. Plants are divided to rejuvenate old clumps or to increase the number of plantings, control them, or both.

In the commercial industry, *Coreopsis* 'Moonbeam' has been selected for flower color. It must be vegetatively propagated by stem or root cuttings because plants from seed production are not true to color. In addition, seed production leads to sparse seed set and prevents uniform germination.

Production of quality cuttings for plugs can be difficult. Stock plants of *C. verticillata* 'Moonbeam' grown under photoperiods longer than 13 hours produce abundant cuttings. However, cuttings usually already have been induced to flower under the longer stock-plant photoperiods and

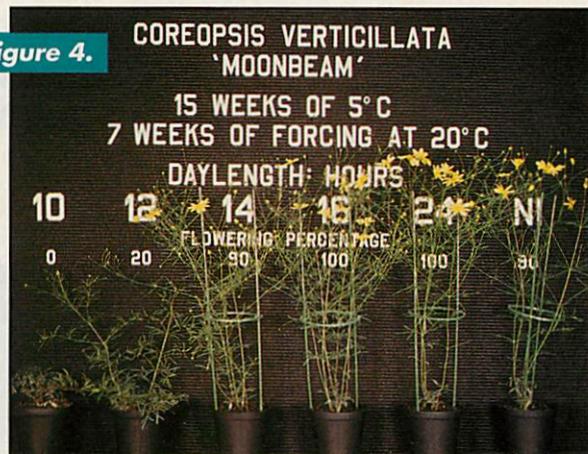
COREOPSIS VERTICILLATA 'MOONBEAM'
0 WEEKS AT 5°C
11 WEEKS AT 20°C

Figure 3.



Coreopsis verticillata 'Moonbeam' will flower without a cold treatment. Both plants did not receive cold, but the plant on the left was forced under long days (LD).

Figure 4.



Coreopsis 'Moonbeam' requires a photoperiod longer than 14 hours for fastest flowering. Following a cold treatment, plants will flower under a 12-hour photoperiod, but flowering will be delayed. Photo courtesy of Erik Runkle.

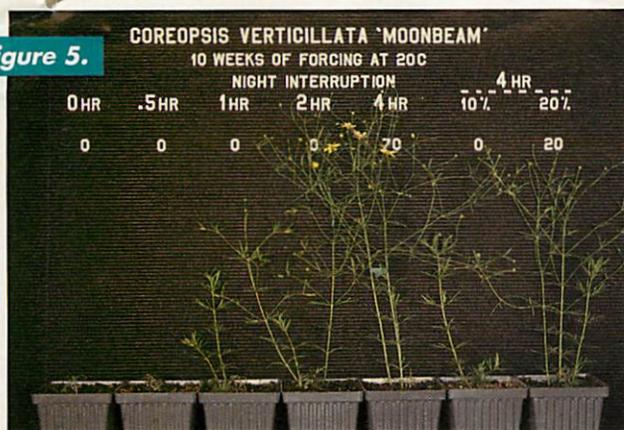
the developing flower buds may compete with the rooting process.

Following a cold treatment, it is possible to obtain cuttings from stock plants grown under noninductive conditions. Cuttings taken from stock plants grown under photoperiods shorter than 14 hours root quickly and profusely but fewer cuttings are produced per plant than on stock plants grown under longer photoperiods (Figure 6).

In our experience, cutting production increased two-fold in successive flushes on stock plants grown under photoperiods longer than 13 hours compared to stock plants grown under shorter photoperiods. However, rooting percentage was less than 50 after 3 weeks.

5. MEDIA AND FERTILIZATION

C. verticillata does not have specific media requirements. Plants will perform well in the greenhouse in any well-drained, evenly moist medium with a pH of 5.8-6.3.

Figure 5.

Coreopsis 'Moonbeam' flowered when plants were grown under night-interruption regimes of at least 4 hours of light. Plants also flowered under either a 2-hour night-interruption treatment or a cyclic lighting treatment (6 minutes on, 24 minutes off for 4 hours) with only a slight delay in flowering. However, plants that were forced under the latter long-day regimes did not flower as uniformly as plants grown under a full 4-hour night interruption. Photo courtesy of Erik Runkle.

In the garden, plant in average soil with a similar pH. *Coreopsis* 'Moonbeam' does not require a high fertilizer concentration either in the greenhouse or garden. We suggest a constant fertilization at 100 ppm N from a balanced fertilizer. Under high-nitrogen fertilization, plants become floppy with weak stems.

6. IRRIGATION

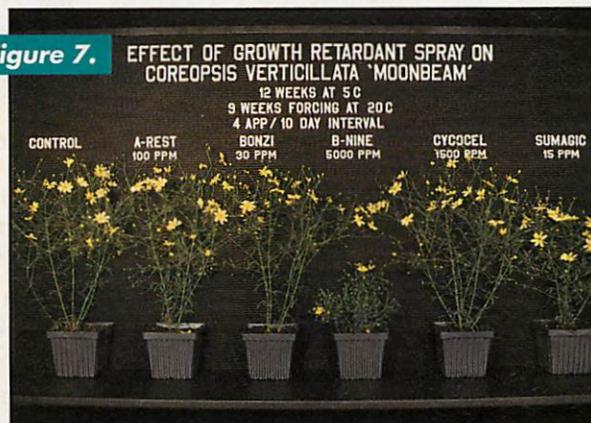
While *Coreopsis* 'Moonbeam' will tolerate dry conditions, best growth occurs when plants are kept evenly moist.

7. LIGHTING AND SPACING

Coreopsis 'Moonbeam' is considered a high-light plant and thrives in full sun. Overall plant quality is best when appropriate lighting and spacing are used. Supplemental lighting from high-intensity discharge lights at 400-500 foot-candles is beneficial in greenhouse conditions, especially during dark winter months. To encourage proper growth habit and stem strength, pots should be spaced so light can reach the lower part of the plant.

8. PLANT HEIGHT CONTROL

In order for *Coreopsis* 'Moonbeam' to be successful as a flowering potted plant, its final height must be reduced. *Coreopsis* 'Moonbeam' responds to at least two methods of height control, growth retardants, and limited induction photoperiod (LIP).

Figure 7.

Response of *Coreopsis* 'Moonbeam' to growth retardants applied at high rates at 10-day intervals during forcing. Both B-Nine and Sumagic were very effective but B-Nine delayed flowering. Rates used are not necessarily those suggested for height control by commercial growers.

Our research has shown that growth retardants are the easiest and most effective way to control final height of *Coreopsis* 'Moonbeam.' Both B-Nine and Sumagic effectively reduced stem elongation under LD conditions when used as foliar sprays (Figure 7). However, we observed a 10-day delay in flowering for plants treated with three applications of 5000 ppm B-Nine. LIP is used to control height through manipulation of photoperiods. Plants are first forced under LD conditions for 3 weeks to induce flower bud formation and then shifted to photoperiods shorter than 14 hours for the remainder of flower development.

An average plant height for *Coreopsis* 'Moonbeam' is about 18

Figure 6.

Cuttings of *Coreopsis verticillata* 'Moonbeam' were taken from stock plants that received a cold treatment of 15 weeks at 5°C. Rooting percentage and number of roots were higher on cuttings from stock plants grown under photoperiods of 10-13 hours. Cutting production increased from three to 10 cuttings per stock plant when stock plants were grown under a 13-hour photoperiod rather than a 12-hour photoperiod. Photo courtesy of Paul Koreman.

inches (45 cm). LIP reduces the final height of *Coreopsis* 'Moonbeam' by 3 inches (8 cm) compared to plants grown under continuous 4-hour night interruption. However, when used as the sole treatment, LIP probably will not provide adequate height control.

9. TEMPERATURES AND CROP SCHEDULING

Forcing a species such as *C. verticillata* 'Moonbeam' requires matching the size of the starting material to the final pot size. Because it is vegetatively propagated, *Coreopsis* 'Moonbeam' does not have a juvenile stage, and even unrooted cuttings will flower if placed under inductive conditions.

Coreopsis 'Moonbeam' must not be induced to flower before the appropriate vegetative size is obtained. This phenomenon can be influenced by stock plant environment (see propagation section), pinching plugs before forcing, or increasing the vegetative size of the plants in photoperiods short enough to prevent induction but long enough for vegetative development to occur, a process we call bulking.

Generally, field-grown divisions do not require pinching or bulking. However, plug material often benefits from a pinch or a pretreatment designed to increase vegetative size. At planting, decide how you will increase plant size. We suggest that plants be

TABLE 1. Coreopsis verticillata 'Moonbeam' Production Schedule

Growing Time	Cultural Practice	Temperature	Photoperiod
3-4 weeks	Take cuttings ↓ Root	Media temperature 72°-76°F (22°-24°C)	<14 hours of light
4-5 weeks (72-cell plug) Longer for larger plugs	Bulk or pinch to increase vegetative growth of plugs	Air temperature 68°-72°F (20°-22°C) 58°-62°F (14°-17°C) for 1-2 weeks before cold	13-14 hours of light initially 10-12 hours of light for final weeks before cold
- OR - Plant plugs or bare root plants			
10-15 weeks (Can be held longer if needed)	Cold treatment ↓	35°-45°F (2°-7°C)	< 12 hours of light
Begin Forcing			≥14 hours of light or a 4-hour night interruption
↓	↓	75°F (24°C)	
↓	70°F (21°C)	7-8 weeks	
65°F (18°C)	8-9 weeks	flower	
9-10 weeks flower	flower		
			Visible Bud to Flower 65°F (18°C) – 24 days 70°F (21°C) – 20 days 75°F (24°C) – 19 days

bulked if planted in the fall and pinched if planted in the spring. Bulking works best on plants that will be overwintered in a low-temperature greenhouse.

Plants are potted in October, then allowed to develop lateral shoots just under the soil line during the fall as daylength decreases. These shoots will develop into flowering shoots when plants are forced under LD in the spring.

The size of flowering plants growing from spring-planted small plugs can be increased by pinching developing shoots. One to three flowering stalks or shoots often develop from smaller plugs when they are planted and placed under LD for forcing.

If these stalks or shoots are pinched when about 2 inches tall and then kept under LD, lateral branches will develop, increasing the number of flowering shoots. While it increases plant size, pinching may make lateral shoots grow horizontally instead of upright.

Time to flower depends on the forcing temperature from the start of long days. As forcing temperatures increase, forcing time decreases.

Coreopsis 'Moonbeam' performs best when forced between 65°-75°F (18°-24°C). Allow about 9-10 weeks at average daily temperatures of 65°F (18°C), 8-9 weeks at 70°F (21°C), or 7-8 weeks at 75°F (24°C) (Table 1).

Plants forced at 80°F (27°C) flowered in 6-7 weeks with no adverse effects at the higher temperature.

Forcing temperatures below 65°F (18°C) resulted in greatly increased forcing time and a marked reduction in final bud number.

FORMULA FOR SUCCESS: 'MOONBEAM'

1. Choose the size of your starting material to match the finish pot size.
2. Provide plants with a 10- to 15-week cold treatment at 41°F (5°C) before LD treatment.
3. Force between 65°F and 75°F (18°-24°C).
4. Provide plants a minimum of 3 weeks' long days 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 a minimum light intensity of 10 footcandles.
5. Apply growth retardants to keep plants compact about 2-3 weeks after forcing begins.

Uncooled or cooled plugs and bare-root plants can be purchased and directly forced into bloom. For small containers – 4- or 5-inch pots – one plug is usually sufficient for final size. In order to fill a 6-inch or 1-gallon container, larger plants are required.

To fill large containers, use field-grown plants or plant an uncooled plug in late September or early

October to allow for bulking during the late fall. If small plugs are used as starting material, you may want to plant several in each large container to produce a high quality final product.

10. DISEASE AND INSECT PESTS

Coreopsis 'Moonbeam' is generally considered a trouble-free species, but we have noted powdery mildew on a few occasions.

11. POSTHARVEST CONCERNS

Coreopsis 'Moonbeam' should be shipped just after the first flower opens. 'Moonbeam' is most salable in full flower, which occurs about 7 days after first flower. Plants also tend to become floppy the longer they are held after first flower.

Coreopsis 'Moonbeam' can be cut back after the initial flush of flowers for a repeat of full bloom. Plants will continue to flower if provided bright light, continual long days, and sufficient water. They can be enjoyed in the garden for many years. **GG**

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