

Supplemental Lighting for Cut Godetia Production for Christmas and Valentine's Day Crops

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Godetia or satin flower, *Clarkia amoena*, has spectacular flowers of pink, red, lavender and white appropriate for Christmas and Valentine's Day. Work in 1991-1992 at the University of Kentucky demonstrated a reliable schedule for high quality cut godetia stems. The plants were grown at 7-10° night/10-12° day temperatures with 8 weeks of seedling growth (250-400 plants m⁻²) during natural days followed by 12 weeks of supplemental HID lighting (6 hours per day at approximately 800 foot candles of light) with plants at 40-60 plants m⁻². The cost of 800 ft candles of supplemental lighting may be prohibitive to a potential godetia grower that does not have HID lighting.

Although incandescent lighting caused poor plant growth at warmer temperatures in our studies, it may not be a significant problem at cold temperatures; one Southern California grower has used incandescent light successfully in winter. Additionally, our work showed that plants grown under incandescent lighting flowered only 10-14 days later than those grown under HID lighting did and incandescent lighting would be much less expensive to install and use.

The objective of this study was to compare godetia production under different types of supplemental lighting to determine how to schedule godetia as a cut flower in a Kentucky greenhouse.

METHODS

Godetia plants were grown under different types of supplemental lighting in double poly greenhouses in 1992-1993 at the University of Kentucky Horticulture Research Farm. Cold grown plugs were obtained from Sakata Seed America, Salinas CA for transplant to the greenhouse Sep 24 (sown Aug 25, AUG crop), Oct 15 (sown Sep 17, SEP crop) and Nov 5 (sown Oct 6, OCT crop). One to four days after transplanting, plants were placed in the following supplemental day extension (1800-2400 HR) lighting treatments:

1. Approximately 120 : M m⁻² sec⁻¹ HPS (high pressure sodium) (or approx. 600 ft candles);

'Grace Rose Pink' godetia at harvest.



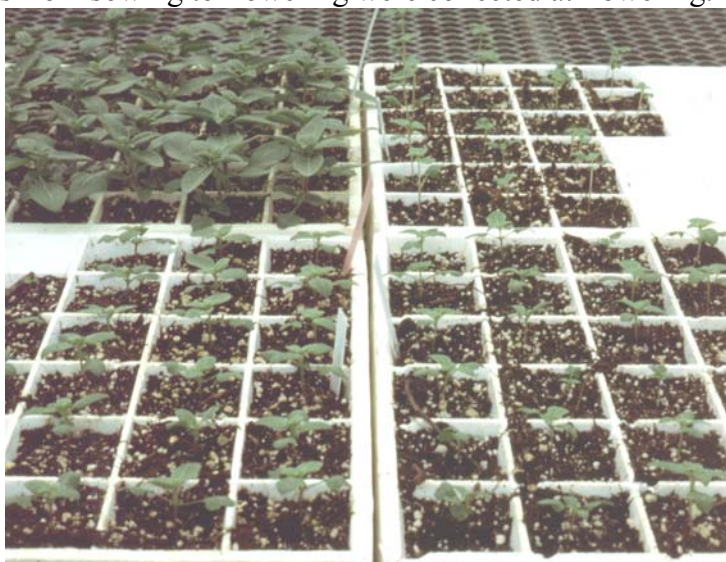
2. Approximately 40 : M m⁻² sec⁻¹ HPS (or approx. 100 ft candles);
3. Approximately 10 : M m⁻² sec⁻¹ (or 20 ft candles) of light from incandescent lamps;
4. No supplemental light (ambient light only).

Plants were grown at 46-52°F (8-12°C) night and 59-62°F (14-16°C) day temperatures. Godetia plugs were transplanted into ProGrow bark-based growing medium in 4-inch (10 cm) square pots and placed pot to pot (approximately 9 plants ft² or 91 plants m⁻²) in a plastic flat with fifteen plants per flat. The flats were placed on benches with one layer of support mesh. Three replicates (a flat or 15 plants per replicate) of ‘Grace Rose Pink’, ‘Grace Salmon’, ‘Grace Red’ and ‘Satin White’ godetia were placed in each lighting treatment in a randomized block design. Measurements of plant height were collected 8 weeks after sowing (approximately visible bud stage in lighting treatments) and the stem length (from the soil to the top of the flowers), the number of nodes, and the number of days from sowing to flowering were collected at flowering.

RESULTS AND DISCUSSION

1. Plant height at 8 to 9 weeks.

The effects of the lighting treatments were clear when the plants were 8 weeks old (AUG and SEP crops) or 9 weeks old (OCT) crop. Plants grown under the lighting treatments for 4 to 5 weeks were significantly taller than plants grown under ambient light conditions (Table 1). Additionally, the SEP and OCT crops were taller than the AUG crop. These data for ‘Grace Rose Pink’ are similar to the data from the other cultivars.



Godetia seedlings grown with long days HID (top left), long days incandescent (top right), short days HID (bottom left), and ambient light (bottom right).

Table 1. The effect of supplemental lighting treatments on the height of 9-week-old ‘Grace Rose Pink’ godetia plants after 4 weeks of treatment (AUG and SEP crops) or 5 weeks of treatment (OCT crop).

	Plant Height (cm)			
	Supplemental Lighting Treatment			
Sow Date	120 : M HPS	40 : M HPS	10 : M INC	AMBIENT
AUG 25	21.5 ± 2.2	25.6 ± 3.4	20.5 ± 1.5	9.5 ± 0.8
SEP 17	32.3 ± 4.4	30.5 ± 3.6	33.2 ± 3.3	19.8 ± 10.9
OCT 6	30.2 ± 2.6	32.9 ± 4.9	34.0 ± 2.6	14.1 ± 2.0

The appearance of flower buds was greatly affected by the supplemental lighting treatments. All ‘Satin White’ flower buds were visible in the AUG, SEP and OCT crops after 4 to 5 weeks of lighting while fewer flower buds were visible in ambient light (Table 2). The

appearance of flower buds in ‘Grace Rose Pink’ and ‘Grace Salmon’ was closely related to the amount of supplemental light they received. The percentage of visible flower buds generally decreased from the high light treatment to the moderate, low and no light treatments. The flower buds of ‘Grace Red’ were the slowest to form, with only a few buds visible in the high light treatment of the SEP and OCT crops.

Table 2. The effect of supplemental lighting treatments on the percentage of flower buds visible on 9-week-old godetia plants after 4 weeks of treatment (AUG and SEP crops) or 5 weeks of treatment (OCT crop).

Light Treatment	‘Satin White’			‘Rose Pink’			‘Salmon’			‘Red’		
	Aug	Sep	Oct	Aug	Sep	Oct	Aug	Sep	Oct	Aug	Sep	Oct
120 : M HPS	100	100	100	75	95	100	20	95	60	0	25	15
40 : M HPS	100	100	95	95	85	25	8	60	35	0	0	0
10 : M INC	100	100	90	80	60	20	20	35	15	8	0	0
Ambient	100	0	45	0	0	0	2	0	0	0	0	0

2. Number of Days to Flower Harvest

The number of days required to harvest commercial quality cut flowers of godetia is of critical importance to cut flower growers. Past experiments have shown that supplemental lighting can effect the flowering date of godetia plants, but we did not have specific details that could be used for crop scheduling for growers. These experiments do give specific details that cut flower growers can use for scheduling cut godetia production for Christmas and Valentine's Day sales.

The average harvest date for ‘Grace Salmon’ and ‘Grace Rose Pink’ was quite similar in each lighting treatment. Plants that received any supplemental lighting treatment flowered much sooner than those grown without supplemental lighting (Tables 3 & 4). Plants grown with ambient light conditions required 8 to 10 weeks longer to flower. Thus California plug growers should sow seed of ‘Grace Salmon’ and ‘Grace Rose Pink’ August 25 to September 1 for godetia production in Midwest greenhouses with supplemental incandescent lighting (mum lighting) for Christmas sales. Seed of these same cultivars should be sown September 15 to 20 for godetia production with supplemental lighting for sales at Valentine's Day.

The number of days to harvest ‘Grace Salmon’ and ‘Grace Rose Pink’ also varied with the crop and with the amount of light received in the supplemental lighting treatments. The crop time increased 2 to 4 weeks between the AUG crop and the SEP crop and 2 to 3 weeks from the SEP crop to the OCT crop (Tables 3 & 4). The decreasing natural light intensities and the cooler temperatures during the winter probably caused this. Additionally, the plants flowered somewhat faster in the high light treatment than the moderate light treatment and faster in the moderate light than the low light treatment (Tables 3 & 4). Although the plants flower fastest in the high light intensities of the high-pressure sodium lamps, the extra cost is not justified. Supplemental incandescent lighting, such as mum lighting, was just fine for godetia cut flower production.

The average harvest date for ‘Grace Red’ was quite similar in each lighting treatment. Plants that received any supplemental lighting treatment flowered much sooner than plants grown without supplemental lighting (Table 3 & 4). Plants grown with ambient light conditions required 8 to 10 weeks longer to flower. Additionally, ‘Grace Red’ plants required 1 to 2 weeks longer to

flower than ‘Grace Salmon’ and ‘Grace Rose Pink’. Thus, California plug growers should sow seed of ‘Grace Red’ August 10 to August 20 for godetia production in Midwest greenhouses with supplemental incandescent lighting (mum lighting) for Christmas sales. Seed of ‘Grace Red’ should be sown September 1 to September 10 for godetia production with supplemental lighting for sales at Valentine's Day.

The number of days to harvest ‘Grace Red’ varied with the crop and with the amount of light received in the supplemental lighting treatments similar to the other ‘Grace’ cultivars. The crop time increased 1 to 3 weeks between the AUG crop and the SEP crop and 1 to 2 weeks from the SEP crop to the OCT crop (Figure 4 and Table 4). This was probably caused by the decreasing natural light intensities and the cooler temperatures during the winter. Additionally, the plants flowered somewhat faster in the high light treatment than the moderate light treatment and faster in the moderate light than the low light treatment (Figure 4 and Table 4). Although the plants flower fastest in the high light intensities of the high-pressure sodium lamps, the extra cost is not justified. Supplemental incandescent mum lighting was fine for ‘Satin Red’ cut flower production.

The average harvest date for ‘Satin White’ was similar in each lighting treatment. Additionally, ‘Satin White’ plants that received supplemental lighting flowered only 10 to 13 days earlier than plants grown without supplemental lighting (Tables 3 & 4). The number of days to harvest of ‘Satin White’ varied with the crop but did not vary with the amount of light received in the supplemental lighting treatments. The crop time increased 2 to 4 weeks between the AUG crop and the SEP crop and 1 to 2 weeks from the SEP crop to the OCT crop (Figure 5 and Table 5). It is possible that this was caused by the decreasing natural light intensities and the cooler temperatures during the winter. Thus, growers can sow seed of the ‘Satin’ series 90 to 120 days before flowering is scheduled, based on the time of year. A shorter time to flowering will occur under periods of higher temperatures and light and longer periods under periods of lower temperatures and low light. It appears supplemental lighting may not be required for production of ‘Satin’ godetia.



‘Grace Salmon’



‘Satin White’



‘Grace Red’

Table 3. The mean harvest date and mean number of weeks from seed germination to flower harvest for godetia cultivars grown under different supplemental day-extension lighting treatments.

		Supplemental Light Treatments			
Sow Date (Transplant Date)	Cultivar	120 : M HPS	40 : M HPS	10 : M INC	Ambient
AUG 25 (SEP 24)	‘Satin White’	Nov 20 12 weeks	Nov 15 12 weeks	Nov 20 12 weeks	Nov 28 14 weeks
	‘Salmon’	Dec 10 15 weeks	Dec 10 15 weeks	Dec 10 15 weeks	Feb 15 ^Z 24 weeks
	‘Rose Pink’	Dec 12 16 weeks	Dec 8 15 weeks	Dec 12 16 weeks	Feb 15 ^Z 24 weeks
	‘Red’	Dec 20 17 weeks	Dec 20 17 weeks	Dec 25 17 weeks	Mar 5 ^Z 26 weeks
SEP 17 (OCT 15)	‘Satin White’	Dec 25 14 weeks	Jan 2 15 weeks	Dec 25 14 weeks	Jan 15 18 weeks
	‘Salmon’	Jan 15 18 weeks	Feb 1 19 weeks	Feb 4 19 weeks	Apr 2 ^Z 29 weeks
	‘Rose Pink’	Jan 15 18 weeks	Feb 1 19 weeks	Feb 1 19 weeks	Apr 2 ^Z 29 weeks
	‘Red’	Jan 26 18 weeks	Feb 10 20 weeks	Feb 8 20 weeks	Apr 22 ^Z 32 weeks
OCT 6 (NOV 5)	‘Satin White’	Jan 20 15 weeks	Jan 25 16 weeks	Jan 25 16 weeks	Feb 5 ^Z 18 weeks
	‘Salmon’	Feb 15 19 weeks	Feb 20 20 weeks	Mar 1 21 weeks	Apr 27 29 weeks
	‘Rose Pink’	Feb 20 19 weeks	Mar 5 21 weeks	Mar 5 21 weeks	Apr 27 29 weeks
	‘Red’	Mar 1 21 weeks	Mar 8 22 weeks	Mar 15 23 weeks	May 7 30 weeks

z - The mean harvest date and mean number of weeks from seed germination to flowering are approximate because the greenhouse had a power outage and temperatures dropped to -8° C for 1 night in early February which damaged some plants.

Table 4. The mean number of days from seed germination to flower harvest for godetia cultivars grown with different supplemental day-extension lighting treatments.

		Supplemental Light Treatments			
		120 : M HPS	40 : M HPS	10 : M INC	Ambient
Sow Date (Transplant Date)	Cultivar	Mean Days to Flower Harvest (\pm standard error)			
AUG 25 (SEP 24)	‘Satin White’	85.8 \pm 3.7	83.0 \pm 2.6	85.4 \pm 4.1	97.0 \pm 5.3
	‘Salmon’	108.7 \pm 3.6	108.0 \pm 10.4	107.6 \pm 4.2	165.0 \pm 8.9
	‘Rose Pink’	109.7 \pm 4.5	104.4 \pm 10.2	107.7 \pm 3.7	163.6 \pm 6.5
	‘Red’	117.3 \pm 5.1	124.1 \pm 14.9	122.5 \pm 6.1	180.4 \pm 11.3
SEP 17 (OCT 15)	‘Satin White’	99.5 \pm 6.3	104.1 \pm 11.6	100.4 \pm 7.9	123.5 \pm 10.6
	‘Salmon’	123.6 \pm 8.2	132.9 \pm 9.1	135.7 \pm 8.4	200.0 \pm 8.9
	‘Rose Pink’	126.4 \pm 8.4	136.3 \pm 6.4	136.4 \pm 5.1	204.3 \pm 11.8
	‘Red’	133.6 \pm 6.4	144.2 \pm 3.0	143.4 \pm 5.0	226.8 \pm 14.3
OCT 6 (NOV 5)	‘Satin White’	109.3 \pm 3.8	115.2 \pm 12.1	112.0 \pm 9.1	122.8 \pm 8.0
	‘Salmon’	134.6 \pm 13.5	139.3 \pm 12.8	144.7 \pm 7.1	201.3 \pm 5.4
	‘Rose Pink’	133.4 \pm 11.7	146.5 \pm 9.5	147.4 \pm 4.2	203.1 \pm 6.6
	‘Red’	144.0 \pm 7.7	152.8 \pm 5.2	160.1 \pm 5.2	213.7 \pm 5.0

3. Number of Nodes at Flower Harvest

The number of nodes at harvest is of little importance to cut flower growers. However, the node number at flowering is an excellent indicator of when flowering was initiated. Once flowers are initiated on the stem, no new leaves are initiated. Therefore, the number of nodes at flowering offers evidence for the influence of the lighting treatments on floral initiation. Past experiments have shown that supplemental lighting affects the node number at flowering. Those results were confirmed in the 1992-1993 experiments.

The average node number at flowering for ‘Grace Salmon’, ‘Grace Rose Pink’ and ‘Grace Red’ was quite similar in each lighting treatment. Plants that received supplemental lighting had significantly fewer nodes at flowering than those grown without supplemental lighting (Table 5). Plants grown under ambient light conditions had nearly twice as many nodes at flowering when

compared to those in the supplementary lighting treatments. Thus flowering was initiated much earlier with supplementary lighting. This result along with the significant difference in the number of days to flower between lighting and no lighting treatments confirms that the 'Grace' series godetia are long day plants. Thus, supplemental lighting treatments should be used for fall, winter and spring godetia production.

The number of nodes at flowering of 'Grace Salmon' and 'Grace Rose Pink' did not vary with the crop or with the amount of light received in the supplemental lighting treatments. However, there was a significant difference in node number between the crops when the plants were grown at ambient light levels (Table 5). This probably relates to the changing day lengths that were present when the seedlings were grown in California or while they were grown in Kentucky. 'Grace Red' showed significant differences in node number between the crops and between the lighting treatments (Table 5). The node number increased from the AUG crop, to the SEP crop and to the OCT crop. Likewise, the node number increased from the high light crop, to the moderate light crop and to the low light crop. This is another indication of the fact that 'Grace Red' is somewhat different from the other 'Grace' cultivars.

The average node number at flowering for 'Satin White' was similar in all treatments. The one exception is the plants in the OCT crop that received no supplemental light (Figure 11). The data from these plants is questionable because of the low temperature problem that occurred in that greenhouse in early February. It appears supplemental lighting may not be required for production of 'Satin' godetia.

'Satin' cultivars are different from the 'Grace' cultivars. As seen in the data (days to harvest and node number at harvest), the 'Satin' series reacts much differently to supplemental light. While the 'Satin' series is sold as a "dwarf" godetia, it may be shorter only because it flowers sooner. The 'Grace' series is clearly a long day plant whereas the 'Satin' series appears to be day neutral. The development and utilization of the day neutral feature of the 'Satin' series should be extremely important for the continued development of all godetia cultivars.

Table 5. The mean node number of godetia stems at flower harvest for cultivars grown with different supplemental day-extension lighting treatments.

		Supplemental Light Treatments			
		120 : M HPS	40 : M HPS	10 : M INC	Ambient
Sow Date (Transplant Date)	Cultivar	Mean Days to Flower Harvest (\pm standard error)			
AUG 25 (SEP 24)	‘Satin White’	16.2 \pm 1.7	16.2 \pm 1.7	16.0 \pm 1.8	16.1 \pm 2.0
	‘Salmon’	26.5 \pm 1.6	26.5 \pm 1.9	26.1 \pm 1.8	41.6 \pm 3.5
	‘Rose Pink’	28.1 \pm 1.9	29.0 \pm 2.2	28.4 \pm 1.7	45.0 \pm 3.6
	‘Red’	27.6 \pm 1.5	28.2 \pm 1.5	27.8 \pm 1.6	68.8 \pm 7.3
SEP 17 (OCT 15)	‘Satin White’	20.0 \pm 2.7	20.7 \pm 3.2	20.5 \pm 3.1	21.9 \pm 4.8
	‘Salmon’	26.2 \pm 2.0	28.6 \pm 2.5	29.4 \pm 3.0	48.8 \pm 4.0
	‘Rose Pink’	28.4 \pm 2.2	30.0 \pm 3.0	32.3 \pm 3.0	55.1 \pm 3.3
	‘Red’	29.9 \pm 2.0	32.6 \pm 2.7	34.6 \pm 2.1	82.9 \pm 5.1
OCT 6 (NOV 5)	‘Satin White’	17.3 \pm 2.9	17.0 \pm 3.3	17.5 \pm 2.9	26.5 \pm 13.7
	‘Salmon’	24.8 \pm 3.8	26.6 \pm 3.4	31.0 \pm 4.4	60.4 \pm 4.1
	‘Rose Pink’	30.0 \pm 2.3	31.3 \pm 3.6	34.7 \pm 3.2	61.6 \pm 2.6
	‘Red’	35.0 \pm 3.8	39.4 \pm 3.5	42.9 \pm 3.0	79.1 \pm 6.3

3. Height at Harvest -- Cut Flower Stem Length

The length of cut flower stems is one of the primary criteria for cut flower quality. The long stems ‘Grace’ godetia easily meet the stem length criteria for cut flower use. Stem length varied from 65 cm to 125 cm (28 - 48 inches) long in ‘Grace Salmon’, ‘Grace Rose Pink’ and ‘Grace Red’ (Table 6). Stem length varied by crop and by lighting treatments. Although some of the differences are statistically significant, the differences would have little significance to cut flower growers and markets. The stems were strong and straight. Excellent quality cut flower stems were produced in all treatments.

Table 6. The mean stem length of godetia stems at flower harvest for cultivars grown with different supplemental day-extension lighting treatments.

		Supplemental Light Treatments			
		120 : M HPS	40 : M HPS	10 : M INC	Ambient
Sow Date (Transplant Date)	Cultivar	Mean Stem Length at Harvest (\pm standard error)			
AUG 25 (SEP 24)	‘Satin White’	21.9 \pm 2.7	25.8 \pm 2.4	31.3 \pm 5.8	24.0 \pm 3.9
	‘Salmon’	65.0 \pm 7.3	69.5 \pm 6.3	75.4 \pm 8.6	95.0 \pm 8.6
	‘Rose Pink’	61.7 \pm 7.7	65.8 \pm 6.1	74.5 \pm 6.7	87.8 \pm 7.2
	‘Red’	71.2 \pm 8.4	76.4 \pm 11.7	85.8 \pm 6.9	89.0 \pm 6.9
SEP 17 (OCT 15)	‘Satin White’	45.2 \pm 6.2	52.3 \pm 9.5	58.1 \pm 6.5	47.9 \pm 5.4
	‘Salmon’	89.4 \pm 8.6	95.6 \pm 16.7	105.5 \pm 7.0	102.5 \pm 6.7
	‘Rose Pink’	88.3 \pm 6.7	89.4 \pm 7.3	115.7 \pm 8.5	98.7 \pm 8.1
	‘Red’	88.8 \pm 6.9	106.6 \pm 9.8	121.1 \pm 5.6	111.6 \pm 9.8
OCT 6 (NOV 5)	‘Satin White’	53.0 \pm 7.2	60.4 \pm 8.0	65.1 \pm 7.6	41.5 \pm 5.9
	‘Salmon’	98.2 \pm 10.5	111.2 \pm 10.8	126.6 \pm 8.7	98.7 \pm 8.3
	‘Rose Pink’	96.0 \pm 7.2	112.3 \pm 7.3	123.4 \pm 7.5	83.5 \pm 7.9
	‘Red’	110.0 \pm 5.2	114.3 \pm 6.0	125.8 \pm 9.9	104.4 \pm 8.3

The stem length of ‘Satin White’ godetia plants was much shorter than the ‘Grace’ godetia plants. Overall, the plant height was just less than 50% of the cut flower ‘Grace’ series (Figure 15). Yet, the ‘Satin White’ plants were still relatively tall when grown at the same high plant density as the ‘Grace’ cultivars. Thus, this trial is not indicative of the typical production height of ‘Satin’ godetia, but indicative of the production conditions. It is interesting to note, however, that the ‘Satin’ godetia could be grown as a shorter cut flower (45-60 cm, 18-24 inches long). When the possible day-neutral nature of the ‘Satin’ godetia and the broad color selection is considered, it may be best that future cut flower breeding revolve around the ‘Satin’ series.



AUG, SEP and OCT crops of godetia (from left to right) grown under ambient light conditions on Dec. 1, 1993.



AUG, SEP and OCT crops of godetia (from left to right) grown under high light conditions on Dec. 1, 1993.

Acknowledgement

The author wishes to thank Sakata Seed America, Inc. and the Kentucky Agricultural Experiment Station for financial support of this project.

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