Assimilative Lighting with High-pressure Sodium Lamps Reduces *Freesia* Quality

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Additional index words. photoperiod, production, corm

Abstract. Four freesia cultivars were exposed to 24 hour-day⁻¹ high-pressure sodium (HPS) lighting during various stages of their development. Upon emergence, freesia plants were exposed to the following four lighting treatments: 1) ambient; 2) ambient until shoot length was 5 to 8 cm followed by HPS lighting until flowering; 3) HPS lighting until shoot length was 5 to 8 cm followed by ambient lighting; and 4) continuous HPS lighting. Supplemental HPS lighting was provided at 37 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ at plant level in a glasshouse. Continuous lighting or lighting during flower development hastened flowering but reduced the number of flowering stems per corm, as well as stem length and weight. Lighting during the vegetative and flower initiation periods produced minor effects. The main benefit of supplemental lighting was found in total corm weight.

There have been mixed results of the effects of short days (SD) on flower initiation and the number of flowers in freesia production (Heide, 1965; Mansour, 1968). De Lint (1969), Kawata (1973), and Gilbertson-Ferriss and Wilkins (1978) showed that long days stimulated and accelerated flower development in comparison with SD. Supplemental assimilative lighting using high-pressure sodium (HPS) lamps (16-h photoperiod) applied during flower development increased the production and quality of cut freesias during the winter in The Netherlands (Doorduyn and Zwinkels, 1990).

The objective of this study was to evaluate the effects of continuous supplemental as-

similative lighting applied during different forcing stages on production and flowering of cut freesias under North American conditions.

On 18 Oct. 1990, 21 corms, 6 to 7 cm in circumference, of four *Freesia* $\times$ *hybrida* Bailey cultivars (Athene, Aurora, Ballerina, and Butterfly) were planted at a 2- to 3-cm depth in 45 $\times$ 45 $\times$ 18 cm (length $\times$ width $\times$ height) plastic perforated crates and placed in a 110-m² glasshouse. Pretreated corms (14 weeks at 30C) were air-freighted from Flamingo Holland (Honselersdijk, The Netherlands). There were eight crates of each cultivar. The growing medium consisted of 50% peatmoss, 35% vermiculite (medium grade), and 15% turface (by volume), amended with (kg·m⁻³) 3.5 calcitic limestone, 1.5 superphosphate, and 0.5 magnesium sulphate, and with 325 g of "Soilwet" (microelements and wetting agent on micro-fine vermiculite) per cubic meter of mix. The initial pH was 6.2 and the electrical conduc-

tivity was 0.9 mS·cm⁻¹ using saturated paste extraction. The air at plant level was set at 16C during the first 5 weeks (seven to eight leaves visible), 14C during the next 5 weeks (flower stems 5 to 8 cm long), and 12C after 31 Dec. Plants were irrigated once a week with water only between 18 Oct. and 23 Nov., and thereafter every 7 to 14 days along with 100 ppm N using 20N-2.2P-25K. Secondary shoots on the original corms (splitters) were removed upon emergence.

Upon emergence of shoots (6 Nov. 1990), the crates were divided into two separate blocks and placed under 1) ambient (no artificial light) or 2) lighted (HPS lights with 37 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ at plant level for 24 h·day⁻¹ conditions for 18 weeks. After 8 weeks under the two lighting regimes (period 1, the plants had completed leaf and flower initiation, and main shoot had elongated to 5 to 8 cm long as determined under a dissecting microscope.). Subsequently, half the crates from each ambient area were placed under a reciprocal lighting regime. The remaining crates stayed at the original location. Plants were grown under these lighting regimes for an additional 10 weeks (period 2) until the end of flowering, 12 Mar. 1991. This procedure resulted in four lighting treatments: AA, continuous ambient; AH, ambient followed by HPS lighting; HA, HPS lighting followed by ambient; and HH, continuous HPS lighting. A permanent vertical black cloth together with a movable horizontal black-out system, drawn daily between 1800 and 0600 HR, prevented light contamination of the ambient areas. Circulation fans positioned in the vertical curtains minimized differences in air temperature between lighted areas.

Repeated (daily) measurements for each crate (experimental unit) were recorded as follows: production, number of flowering stems; harvesting period, first day of harvest after planting (FDH) and the day 70% of total stems were harvested (70H); and quality, fresh weight and stem length of flowering stem and number of colored flowers per spike. In addition, total corm (main corm

Received for publication 13 Jan. 1992. Accepted for publication 17 June 1992. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

Table 1. Performance of four freesia cultivars grown under two lighting regimes [high-pressure sodium (HPS) lights for 24 h·day⁻¹ and ambient] applied during two periods.

Lighting period ^a		Production, no. stems/ corm	Days ^b		Stem length (cm)	Stem wt (g)	Flowers ^c (no.)	Corm ^w fresh wt (g)
1	2		FDH	70H				
A	A	3.1	126	147	33.5	6.2	8.4	20.5
A	H	2.7	117	131	28.3	5.8	7.6	26.3
H	A	3.0	122	150	33.7	6.9	9.0	24.4
H	H	2.9	113	133	28.7	5.7	8.2	28.6
Significance								
Cultivar (C)		***	***	***	***	***	***	***
Orthogonal contrasts								
AA vs. HH		*	***	***	*	*	NS	***
AA + AH vs. HA + HH		NS	*	*	NS	*	*	**
AA + HA vs. AH + HH		**	***	***	***	***	*	***
(AA vs. HH) × C		NS	NS	NS	NS	*	NS	NS
(AA + AH vs. HA + HH) × C		NS	NS	NS	*	**	NS	NS
(AA + HA vs. AH + HH) × C		NS	NS	NS	NS	NS	NS	*

^aPeriod 1 is weeks 2–10 and period 2 is weeks 10–18 after planting; A = ambient; H = HPS lighting.

^bFDH is first day of harvest after planting; 70H is date at which 70% of total harvest is achieved after planting. Corms planted on 18 Oct.

^cNumber of flowers showing color per spike.

^wTotal fresh weight of corms was determined 12 weeks after 70H.

NS,*,***Nonsignificant or significant at 0.01 < P < 0.05; 0.005 < P < 0.01; or P < 0.0005, respectively.

+ cormlets) weights were determined 3 months after 70H.

The experiment was analyzed as a split-block design with blocks (two) and lighting (four) as whole plots and cultivars (four) as subplots. Preliminary analysis of the data on quality aspects showed that sampling error was not significantly different from subplot error. This indicated that correlations among observations were small. Therefore, the quality responses were averaged for each crate before analysis. Orthogonal contrasts were determined for the effect of continuous (HH vs. AA) lighting, and the average effect of period 1 (AA + AH vs. HA + HH) and period 2 (AA + HA vs. AH + HH) lighting were compared to ambient.

Production. Continuous and period 2 lighting reduced the number of flowering stems by ≈0.2 stems per corm. Period 1 lighting did not affect production compared with ambient (Table 1).

Harvesting period. Continuous 24-h lighting hastened FDH and 70H by 2 weeks and had no effect on harvest duration (70H-FDH) when compared with ambient lighting (Table 1). Period 1 lighting hastened FDH but delayed 70H, which resulted in a 1-week extension of the harvest period. Thus, period 1 lighting hastened flowering of the main stem but delayed the development of side breaks. This finding is contrary to that of

Mansour (1968) that flower initiation was stimulated by SD. Also, period 2 lighting hastened harvest but shortened harvest duration by 1 week when compared with ambient lighting, possibly due to a higher plant temperature from assimilative lighting.

Quality. Continuous and period 2 lighting reduced stem length and weight compared with ambient lighting. Period 1 lighting resulted only in increased stem length for 'Ballerina' and increased stem weight for 'Athene' and 'Butterfly'. While continuous lighting had no net effect on the number of flowers per spike, their number was increased by period 1 (+0.8), but decreased by period 2 (-0.7) lighting.

Corm production. The relatively large increase (40%) in total corm weight from continuous lighting was similar in magnitude to the 45% daily lightsum (total integrated irradiation) increase (average for December, January, and February) at plant level. However, there was a larger increase in corm weight during period 2 (23%) than during period 1 (13%). The number of cormlets was not affected by lighting (data not shown).

These results were similar to crops of the previous year (unpublished) but contrary to results (production and quality) with lighting with 'Blue Heaven' conducted at 56°N (Doorduyn and Zwinkels, 1990). The latter experiment was also conducted during the

winter, but with 16-h daylength and at one-half of the global radiation received at our latitude (43°N). Our experiment showed that assimilative 24-h lighting for commercial purposes at latitudes below 45°N or 45°S cannot be recommended at this time. Future lighting studies with cut freesias should include different daylengths, temperatures, and cultivars with higher light requirements, and different initial corm sizes at time of planting.

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