FLOWERING OF G Y P S O P H I L A P A N I C U L A T A CV. BRISTOL FAIRY IN RELATION TO IRRADIANCE

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Contribution Number 1882

Abstract

Low levels of photosynthetically active radiation (PAR) in winter daylight at northern latitudes (45°N) present an obstacle to year-round greenhouse production of G y p s o p h i l a p a n i c u l a t a cv. 'Bristol Fairy'. Supplemental PPF (93 µmol $s^{-1}m^{-2}$ supplied from high pressure sodium lamps from 2000-0700 h each day) applied for 42 or 63 days to plants, enhanced flowering and vegetative growth in crops grown between September and February (fall) and January and June (spring).

In a second experiment, plants were grown in growth chambers at either 8.8 (HPAR) or 3.2 (LPAR) Mol m^{-2} day (24 hour irradiance). At 14-day intervals plants were transferred from HPAR to LPAR chambers, and v i c e v e r s a. Flower buds were formed first on plants which received between 500 and 550 Mol m^{-2} during the first 76 days in treatments. Thereafter, buds were initiated within 8 to 10 days irrespective of cumulative PAR. Yield of flowers and vegetative plant parts increased with cumulative PAR up to about 745 Mol m^{-2} received over a 115-day period. Higher irradiances during early development were most effective in improving yield.

1. Introduction

G y p s o p h i l a p a n i c u l a t a has been traditionally imported to the Canadian market from the principal North American production areas in Florida and California. In recent year, strong demand for this cut flower has prompted several greenhouse growers to attempt culture in Canada and the northern United States.

Flowering of G y p s o p h i l a is retarded by photoperiods of less than 18 h (Kusey et al., 1981), but little is known of the plants' response to photosynthetic photon flux during the production period. In one study conducted in greenhouses in Israel (Shillo et al., 1982), the percentage of nonflowering (blind) shoots increased with shade. It seems likely that winter production in northern areas may be limited, not only by short, natural photoperiods, but by low levels of incident radiation.

Supplemental lighting improves the flowering performance of several floricultural crops under northern winter conditions, but the technique has not been applied to G y p s o p h i l a. Commercial application, in this case, will only be feasible if plants can be effectively pretreated by lighting prior to transplanting to their final wide spacing in ground beds. This paper presents the results of studies which sought to define the flowering response of G y p s o p h i l a to irradiance, as a first step in scheduling winter production of the crop in northern greenhouses.

2. Materials and Methods

2.1 Experiment 1

Tip cuttings of G y p s o p h i l a p a n i c u l a t a cv. 'Bristol Fairy' were rooted during August (fall crop) and December (spring crop), 1984. On each occasion, 48 plants were potted into 15-cm-diameter pots filled with a sterilized soil, peat, sand medium (1:2:1). They were divided into 4 groups and assigned to one of the treatments listed in table 1. Plants were pinched to a single shoot bearing 4 nodes before placement in a greenhouse.

Lighting (from 2000 h to 0700 h) was provided by high pressure sodium, or incandescent lamps. PAR at initial plant height, from HPS lamps was 93 μmol $s^{-1}m^{-2}$ (400-700 nm), and from incandescent lamps, 8 μmol $s^{-1}m^{-2}$. Greenhouse minimum temperatures were 15°C at night. Daytime minima were 15°C during November, December, January and February; 18°C during October and March and 22°C during the remaining period.

At the end of the treatment period, plants were transplanted into 20-cm-diameter pots containing 5.5 L of medium. Lighting from incandescent lamps (2000 h-0700 h) was continued until harvest which was performed when all florets on an individual plant had opened.

2.2 Experiment 2

Plants were obtained from a commercial propagator, potted and pinched as described above and assigned to one of 4 growth chambers. PAR was either 8.8 Mol $m^{-2}day^{-1}$ (2 chambers:HPAR) or 3.2 Mol $m^{-2}day^{-1}$ (2 chamber:LPAR). The daily LPAR integral corresponded with typical mid-winter values in greenhouses in Kentville, Nova Scotia (latitude 45°N). The height of the lamp bank was adjusted weekly to maintain the original irradiances at the top of the leaf canopy. Lighting was continuous from a mixture of incandescent and cool-white fluorescent lamps. High irradiance was applied for 7 hours per day (HPAR chambers at 300 μmol $s^{-1}m^{-2}$) or 4 hours per day (LPAR chambers at 130 μmol $s^{-1}m^{-2}$). Groups of six plants were transferred, at intervals, from HPAR to LPAR chambers and vice versa (figure 3). Plants were harvested at 115 days after pinch.

3. Results

3.1 Experiment 1.

Plants grown as a fall crop with nighttime photoperiod extension, but without HPS lighting failed to develop flower buds following 140 days of growth (table 2, figure 1). These plants also showed poor development of stem length and diameter. Flowering and vegetative growth were stimulated by HPS lighting. The most rapid flower bud development occurred following either 42 or 63 days of treatment. Other traits increased linearly with duration of lighting.

Similar results were obtained for the spring crop except that limited flowering did occur in plants maintained only under photoperiod extension lighting (table 3, figure 2). The time taken to reach visible bud stage, again decreased with increasing duration of lighting, while the greatest change occurred in response to the shortest treatment duration (21 d). The most vigorous flowering occurred following either 42 or 63 days of HPS lighting.

3.2 Experiment 2.

Incident PAR exerted a strong influence on time to flower bud initiation up to approximately 76 days after pinch and transplant (figure 3). After this period, initiation occurred within 8 to 10 days in all plants, irrespective of lighting prehistory. Earliest flower buds were formed at approximately 58 days following pinch on plants which had, by that time, received between 500 and 550 Mol m^{-2}.

The time from bud initiation to anthesis was constant (approximately 28 days) irrespective of incident PAR. As a consequence, those plants which were maintained under constant HPAR conditions or which were transferred from HPAR to LPAR at 56 or 70 days, flowered between 85 and 89 days. Plants from other treatments all flowered between 104 and 110 days.

Yield of stems, leaves, and inflorescences increased with cumulative PAR, up to approximately 745 Mol m^{-2}, received over a 115-day period (figure 4). Plants transferred from HPAR to LPAR chambers had greater yields of floral and vegetative tissue for an equivalent cumulative total PAR, than those transferred from LPAR to HPAR chambers.

4. Discussion and Conclusions

Several previous studies (Kusey et al., 1981; Shillo et al., 1982) have demonstrated the strong promotive influence of increasing duration of photoperiod on flowering in G y p s o p h i l a. Results of the first experiment in the present work established that maintenance of an 18 h photoperiod did not, by itself, promote flowering in plants which received only 8 μmol $s^{-1}m^{-2}$ PAR. A quantitative relationship appeared to exist between vegetative and

flower development, and total PAR received by the plant. It seemed that flowering could be promoted in winter crops by selective use of supplemental lighting to increase the total PAR during production.

The results of experiment 2 provided quantitative information which may help in scheduling lighting treatments for the crop. The data suggest that a total of 500 to 550 Mol m^{-2} PAR is necessary for flower bud initiation within a 76 day period (for plants pinched to 4 initial nodes). The time to bud initiation, between 58 and 76 days, (and, subsequently, to anthesis) depends directly upon the time taken to achieve this critical PAR integral. Higher irradiances than those applied in this experiment might be used to achieve the critical integral at an earlier time, and further work would be necessary to determine the effective limits of this irradiance/time relationship.

Yield of flowers and vegetative tissue is apparently dependant, not only upon cumulative PAR over the growth period, but upon the time at which higher irradiances are provided to the plant (figure 4). Little improvement in final harvest weights may be expected beyond those achieved with a total integral of 745 Mol m^{-2} (PAR) over 115 days. Yield may, however, be maximized by ensuring that the majority of this radiation reaches the plant during early growth. One explanation for this may be that, since flower induction can be improved in some Long Day Plants by increasing photosynthetic photon flux (Bernier, 1969; Friend, 1964), provision of higher irradiances at an early stage in the growth cycle may substantially increase numbers of flower buds.

Production of flowering G y p s o p h i l a crops requires adequate levels of PAR, as defined in this study, as well as maintenance of long photoperiods. It appears that winter production at northern latitudes may be feasible with the provision of supplemental PAR during early growth. The operation of this program must take into account expected seasonal levels of PAR to determine duration of treatment, but requires only a transplant from pot to greenhouse ground bed as an additional production input.

Acknowledgements

The author expresses his appreciation to Mr. K. G. Cairns for excellent technical assistance in this work.

References

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Table 1 - G y p s o p h i l a lighting treatments, experiment 1

	Length of lighting period (d)
Group 1	0*
Group 2	21
Group 3	42
Group 4	63

* - Photoperiod extension lighting only (8 μmol $s^{-1}m^{-2}$)

Table 2 - Characteristics of plant growth and inflorescence development for the fall crop of G y p s o p h i l a p a n i c u l a t a

Supplemental lighting (d)	Days, pinch to visible bud	Number of flowering branches	Inflorescence length (cm)	Stem length (cm)	Stem diameter (cm)
0	NF*	NF	NF	55.3	0.35
21	48.3	2.3	13.0	79.2	0.57
42	43.7	4.7	15.9	85.5	0.60
63	43.5	6.1	17.8	92.4	0.64
SE	0.3	0.6	0.1	0.2	0.01
Significance**	L,R	L	NS	L	L

*NF, nonflowering
**Significant polynomial effects (5% probability): L = linear, R = residual, NS = not significant

Table 3 - Characteristics of plant growth and inflorescence development for the spring crop of G y p s o p h i l a p a n i c u l a t a

Supplemental lighting (d)	Days, pinch to visible bud	Number of flowering branches	Inflorescence length (cm)	Stem length (cm)	Stem diameter (cm)
0	67.0	1.8	12.6	65.8	0.68
21	51.4	1.8	12.2	64.5	0.65
42	47.7	6.8	18.3	86.7	0.77
63	45.8	7.7	19.8	101.1	0.87
SE	0.3	0.1	0.2	0.5	0.01
Significance*	L,Q,R	L,Q,R	L,Q,R	L;Q,R	L,Q,R

*Significant polynomial effects (5% probability): L = linear, Q - quadratic, R = residual

Fig. 1. 13 December 1984: Fall-grown plants subjected to 0, 3, 6 or 9 wk (21, 42 or 61 d) of supplemental lighting

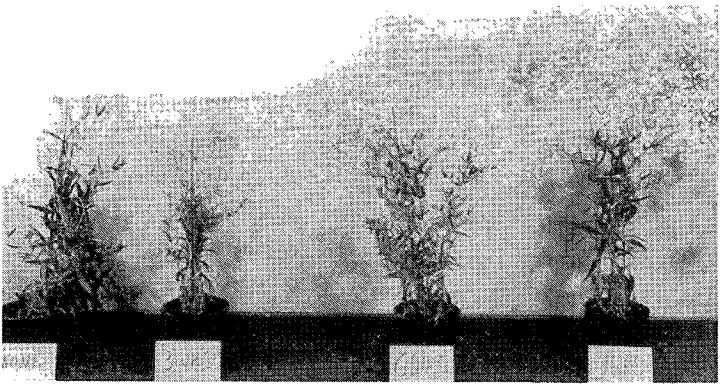

Fig. 2. 17 May 1985: Spring-grown plants subjected to 0, 3, 6 or 9 wk (21; 42 or 63 d) of supplemental lighting.

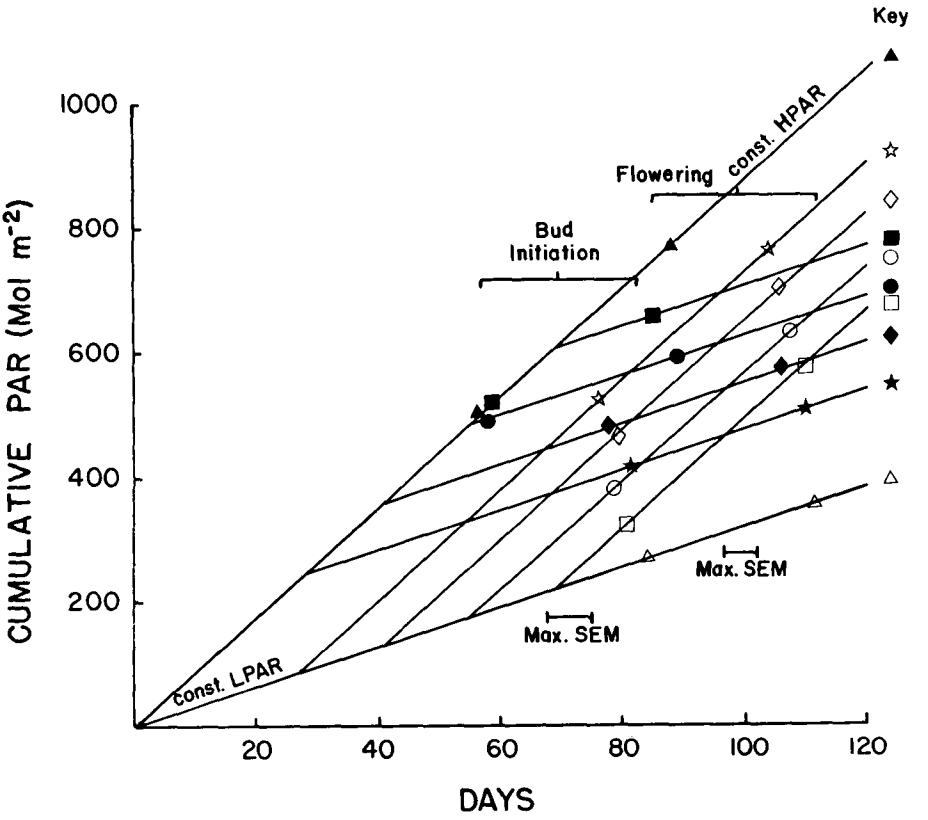

Fig. 3. Time to bud initiation and flowering in relation to cumulative PAR.

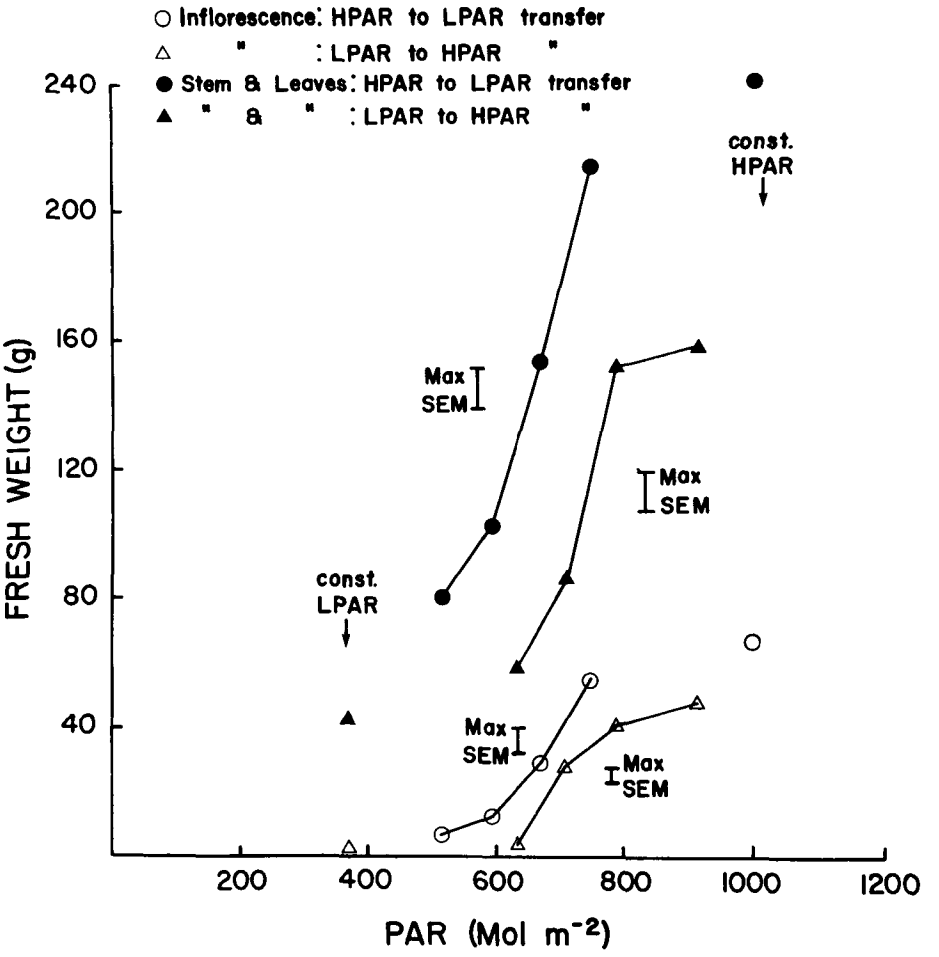

Fig. 4. Fresh weight of inflorescence, stems and leaves in relation to cumulative PAR.