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The Influence of Node Number, Light Source, and Time of Irradiation during Darkness on Lateral Branching and Cutting Production in 'Bright Golden Anne' Chrysanthemum[1]

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Abstract. **Plants of *Chrysanthemum morifolium* Ramat. cv. Bright Golden Anne irradiated as a day continuation or night interruption with light from cool white fluorescent tubes wrapped with red cellophane (red) produced more cuttings than plants irradiated with incandescent light. There were no significant differences in cutting production when plants were irradiated just prior to dawn. Increased cutting production from plants irradiated with red light was attributed to increased axillary bud activity, especially at the middle nodal position. When shoots were pruned to 4 or 8 nodes, the apical axillary bud produced the maximum number of cuttings and the basal produced the minimum, irrespective of light quality or time span of irradiation.**

Chrysanthemum flowers under short days (SD). New plants are propagated by terminal shoot cuttings from plants kept vegetative by long days (LD). Red (R) light inhibits flowering when plants are irradiated in the middle of a long night, as is typical of many SD plants (12). A single exposure to 25.9 klx from cool white fluorescent (CWF) tubes for 1 min during a long night will inhibit flowering of chrysanthemum (3). This response has been associated with the high R to far red (FR) light ratio in CWF light. The R light present converts sufficient phytochrome from the P_r to the P_{fr} form to inhibit flowering (3). On the other hand, a single short exposure of incandescent (INC) light of any intensity will not inhibit flowering (3). This lack of inhibition has been attributed to the low R to FR light ratio in the INC lamp spectrum (9) and the absorption of R light by the upper chrysanthemum leaf surface (3, 4). Therefore inadequate R light penetrates the canopy and insufficient P_r is converted to P_{fr} to inhibit flower induction. However, 4-5 hr of INC light during the middle of a long dark span will inhibit flowering (1). Due to the effectiveness and ease of irradiating the plants, lighting with INC light during the middle of the night has become the standard method of maintaining chrysanthemums in a vegetative state under inductive photoperiods.

The light quality to which shoots with intact apices are exposed prior to the dark span has a marked effect on lateral bud activity. The elongation of lateral buds is essentially inhibited in tobacco when plants are exposed to 30 min of INC light prior to the dark span (21). Tomato plants respond similarly to only 5 min of FR light (18). When the light spans ended without the INC or FR irradiation, profuse branching occurred.

Since R light is effective in inhibiting flower induction in chrysanthemum, and since it promotes lateral branching in plants with intact apices, our objectives were to determine the effect of: 1) light source and time of irradiation during the dark span, and 2) nodal number and position on lateral branching and cutting production in chrysanthemum.

Materials and Methods

Three experiments (I, II, III) were conducted. Rooted cuttings of 'Bright Golden Anne' were potted in a 1 perlite: 1 peat:1 soil (by volume) medium in 10 cm pots on August 20, 1976, April 8, 1977, July 11, 1977 for the 3 respective experiments. The potted plants were immediately placed under the light treatments shown in Table 1. Three weeks after potting, uniform plants under each treatment were selected. The terminal growing points were removed leaving a group of plants with 4 nodes per plant in Expt. I, II and III, and in addition, a group of plants with 8 nodes per plant in Expt. II and III. About 0.5 cm of the stem was removed to obtain the 8 node plants, and 5 cm was removed to obtain the 4 node plants. Plants were spaced to prevent leaf overlap and shading. Temperatures were controlled to 20°/15°C day/night by heating or fan and pad cooling but reached 30° on hot summer days. Nutrients were applied when required as determined by weekly soil analysis.

In Expt. I, 5 cm or longer cuttings were taken 28 and 56 days after the terminals were removed; and after 77 days all actively growing lateral buds on the stock plants were counted. When the 5 cm or longer cuttings were taken, 2 leaves were left subtending the internodes from which the cutting was severed. Cuttings were removed weekly for 9 or 7 weeks in Expt. II and III, respectively. The apical node was designated as position 1 and the basal node as position 4 or 8.

Table 1. Lighting treatments applied to chrysanthemum plants during all experiments.

Treatment	Description
Normal day (ND)	Natural light conditions at 45° N latitude.
Day continuation (DC)	Irradiated from 30 min prior to sunset and continued for 4 hr. Time adjusted every 15 days.
Night interruption (NI)	Irradiated from 2200 to 0200.
Pre-dawn (PD)	Irradiated from 3 hr 30 min prior to sunrise to 30 min after sunup (total 4 hr). Time adjusted every 15 days.
Day continuation and Pre-dawn (DC + PD)	Combination of DC and PD (sum of 8 hr).

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Table 2. Average number of chrysanthemum cuttings removed per plant grown under different light treatments from August 20 to November 5, 1976 (Expt. I).

Irradiation time[z]	Light quality[y]	No. of cuttings: Nodal position 1 (Apex)	2	3	4	Total	R vs. INC (% difference)
DC	R	4.3	4.2	3.9	1.7	14.1	
	INC	4.5	4.2	3.6	1.2	13.5[NS]	+ 4.4%
NI	R	4.6	4.4	3.8	2.0	14.7	
	INC	3.9	4.0	3.2	1.2	12.3**	+19.5%
PD	R	4.7	4.4	3.6	1.6	14.3	
	INC	4.4	4.1	3.6	1.6	13.7[NS]	+ 4.4%
DC+PD	R	4.8	4.4	3.8	1.2	14.2	
	INC	4.3	4.4	4.0	1.9	14.6[NS]	– 2.7%
	Mean	4.4	4.3	3.7	1.6		
	SE = 0.18						

[z]4 hr continuous illumination starting: a) DC: 30 min prior to sunset; b) NI: 2200 hr; c) PD: 3 hr 30 min prior to sunrise.

[y]R = 20 W GE cool white lamp wrapped with 2 layers of red cellophane 2.9 $\mu w\ cm^{-2}$ 650-700 nm; 0.6 $\mu w\ cm^{-2}$, 700-750 nm; INC = 100 W incandescent bulb; 303 $\mu w\ cm^{-2}$; 650-700 nm; 395 $\mu w\ cm^{-2}$, 700-750 nm.

*, **, NSR vs INC significant at 5% (*) level, 1% (**) level, or nonsignificant (NS). SE = 0.18.

Table 3. Average number of actively growing chrysanthemum lateral shoots remaining on the plant per nodal position after the final cuttings were removed on November 5, 1976 plants and then allowed to continue growing under the different light treatments 21 days (Expt. I).

Irradiation time[z]	Light quality[y]	No. of lateral shoots: Nodal position 1 (Apex)	2	3	4	Total	R vs. INC (% difference)
DC	R	9.8	9.7	7.0	1.5	28.0	
	INC	10.3	8.7	6.3	0.7	26.0[NS]	+ 7.7%
NI	R	8.8	7.7	5.6	1.5	23.6	
	INC	6.5	6.2	4.6	0.6	17.9**	+31.7*
PD	R	10.5	9.5	6.4	0.9	27.3	
	INC	7.9	8.3	6.2	1.5	23.9*	+14.2%
DC+PD	R	8.8	8.3	6.2	0.4	23.7	
	INC	7.2	7.0	5.3	1.7	21.2[NS]	+11.8%
	Mean	8.7	8.2	6.0	1.1		
	SE = 0.57						

[z]4 hr continuous illumination starting: a) DC: 30 min prior to sunset, b) NI: 2200 hr; c) PD: 3 hr 30 min prior to sunrise.

[y]R = 20 W GE cool white lamp wrapped with 2 layers of red cellophane 2.9 $\mu w\ cm^{-2}$ 650-700 nm; 0.6 $\mu w\ cm^{-2}$, 700-750 nm; INC = 100 W incandescent bulb; 303 $\mu w\ cm^{-2}$, 650-700 nm; 395 $\mu w\ cm^{-2}$, 700-750 nm.

*, **, NSR vs. INC significant at 5% (*) level, 1% (**) level, or nonsignificant (NS).

Plants were irradiated by either a 100 W INC bulb (303 $\mu w\ cm^{-2}$, 650-700 nm; 395 $\mu w\ cm^{-2}$, 700-750 nm) or a General Electric 20 W cool white fluorescent lamp wrapped with 2 layers of red cellophane (2.9 $\mu w\ cm^{-2}$, 650-700 nm; 0.6 $\mu w\ cm^{-2}$, 700-750 nm) which was replaced at the beginning of each experiment. Light measurements were made with a spectroradiometer (ISCO Model SR, Instrumentation Specialties Co., Lincoln, NE 68507). The INC light intensities would be at or above commercial intensities. During the treatments, plants were separated by 6 mil black polyethylene film which was removed during the day.

A randomized complete block design with 2 blocks and 5 plants per experimental unit was used. Analysis of variance was conducted and differences between means were compared by single degree of freedom f tests (17).

Results

Experimental I. Plants exposed to R light produced both more cuttings and more lateral breaks per nodal position on the average when compared to plants exposed to INC light (Table 2 and 3). Irradiating plants with R instead of INC light during the "commercially accepted" night interruption (NI) span resulted in a highly-significant increase (19.5%) in the number of cuttings produced. The apical shoot produced almost 3 times more cuttings and 8 times more lateral shoots compared to the basal shoot 21 days after the final flush of cuttings.

Experiments II and III. Significantly more cuttings were produced on plants with 8 nodes irradiated with R light than those irradiated with INC light for the Day Continuation (DC), NI, or Day Continuation Pre-Dawn (DCPD) lighting periods in Expt. II and III (Tables 4, 5). Irradiation of 4 node plants with R light also produced more cuttings than those irradiated with INC for both DC and NI in Expt. II and DCPD in Expt. III. The overall average number of cuttings produced from all plants irradiated with R light was a highly significant 13% greater than for INC irradiated plants.

The greatest cutting production came from plants receiving a R light treatment either as DC or as NI. Red light given as a Pre-dawn (PD) treatment was no more effective than the most effective INC treatments (Table 6). While DC and NI were the most effective periods for irradiation, DC was the least effective for the INC light. Although plants in the R light PD treatments produced the fewest cuttings of the R treatments, plants receiving INC light during the PD period produced the most cuttings among the INC treatments.

Treatments of R light increased average cutting production at all nodal positions except node 8 when R was compared to INC light. Plants receiving the different light treatments showed greater differences in cutting production at the middle nodal positions with smaller differences at the apical and basal nodes (Fig. 1).

Nodal position has a highly significant effect on the number of cuttings produced. This was illustrated when the apical shoots produced the maximum number of cuttings, the basal the minimum (Tables 4 and 5). The decrease in number of cuttings produced per nodal position was not linear between the apical and basal nodes. The differences steadily increased from the first to fourth nodal positions of 4 node plants and with the 8 node plants, the differences between nodes first increased, then decreased.

Discussion

If cutting production from stock plants is to be optimized, then numerous axillary buds must rapidly develop and elongate. Reducing apical dominance while the terminal bud is intact, or by increasing axillary bud activity and growth when the apex is removed can potentially increase cutting production. One method of accomplishing this in intact plants, notably in tobacco and tomato (8, 18, 19, 20, 21, 22), has been to expose plants to light with a high R to FR ratio just prior to darkness.

When the shoot apex was removed in our experiments, a substantial increase in cutting production occurred if the chrysanthemum plants were irradiated with R light just prior to the dark period (Tables 4 and 5). Conversely, cutting production was reduced when plants were irradiated as a DC or NI with INC rather than with R light. This phenomenon was observed in all 3 experiments which were conducted throughout the year, both in the inductive SD of winter and noninductive LD of summer. However, when plants were irradiated just

Table 4. Average number of cuttings produced per chrysanthemum plant grown under different light treatments from April 8 to July 1, 1977 (Expt. II).

Irradiation time[z]	Light quality[y]	No. of cuttings: Nodal position 1 (Apex)	2	3	4	5	6	7	8	Total	R vs. INC (% difference)
					4-node plant						
DC	R	9.8	9.5	5.2	2.2					26.7	
	INC	7.6	6.9	5.0	1.2					20.7**	+30.0%
NI	R	8.7	8.0	6.5	3.0					26.2	
	INC	8.3	7.2	5.4	1.9					22.8*	+14.9%
PD	R	6.6	8.2	5.8	2.5					23.1	
	INC	8.9	8.1	5.0	2.7					24.7NS	− 6.5%
DC+PD	R	7.8	7.1	5.4	2.8					23.1	
	INC	8.0	6.9	5.0	2.5					22.4NS	+ 3.1%
	Mean	8.2	7.7	5.4	2.4						
Δ between nodes			0.5	2.3	3.0						
SE = 0.59											
					8-node plant						
DC	R	7.6	6.8	6.2	4.8	3.1	0.8	1.5	1.0	31.0	
	INC	5.6	5.0	4.9	3.3	1.8	1.0	1.0	1.5	24.1**	+28.6%
NI	R	6.2	8.6	7.0	4.8	2.4	1.4	1.2	1.0	32.8	
	INC	7.1	5.7	4.7	2.9	2.0	1.0	1.4	1.0	25.8**	+26.4%
PD	R	6.9	6.6	6.1	2.6	2.4	1.4	1.4	0.8	28.2	
	INC	8.5	7.9	5.5	3.2	2.7	1.1	1.0	1.2	31.1*	− 9.3%
DC+PD	R	7.5	6.2	6.1	4.7	3.0	1.8	1.4	1.3	32.0	
	INC	6.7	7.4	5.5	3.1	2.0	2.0	1.0	1.0	28.7**	+11.5%
	Mean	7.0	6.8	5.8	3.7	2.4	1.3	1.2	1.1		
Δ between nodes			0.2	1.0	2.1	1.3	1.1	0.1	0.1		
SE = 0.40											

[z]4 hr continuous illumination starting: a) DC: 30 min prior to sunset; b) NI: 2200 hr; c) PD: 3 hr 30 min prior to sunrise.

[y]R = 20 W GE cool white lamp wrapped with 2 layers of red cellophane 2.9 μw cm^{-2} 650-700 nm; 0.6 μw cm^{-2}, 700-750 nm; INC = 100 W incandescent bulb; 303 μw cm^{-2}, 650-700 nm; 395 μw cm^{-2}, 700-750 nm.

*, **, NS R vs. INC significant at 5% (*) level, 1% (**) level, or non-significant (NS).

prior to sunrise, only small differences in cutting production occurred between plants irradiated from the 2 light sources. These data concur with other reports that a low phytochrome photoequilibrium (P_{fr}/P_{total}) at the end of the light span inhibits lateral branching (8, 18, 19, 20, 21). Irradiating with FR light just prior to sunrise should have little effect on the form of phytochrome because it should have reverted to P_r during the dark span (12). Irradiating with R light just prior to sunrise should also have a minimal effect on lateral branching since the phytochrome would be converted to high phytochrome photoequilibrium by the solar radiation immediately after sunrise.

Morgan and Smith (13) have shown with *Chenopodium album* that linear shoot elongation of the primary axis is 80% dependent upon the phytochrome photoequilibrium established during the day and to a smaller extent on its value established just prior to the dark span. While the effect of phytochrome photoequilibrium during the light span has ben studied on primary stem elongation (7), no such work has been conducted on axillary bud release.

We would expect axillary bud release to respond to the day time phytochrome photoequilibrium somewhat as it does to the phytochrome photoequilibrium which exists going into the dark period. Widely spaced plants growing in light with an approximately equal R to FR ratio (5, 14) would established a higher phytochrome photoequilibrium (higher P_{fr} relative to P_r) which would tend to inhibit elongation (12) and probably stimulate lateral branching. Irradiation early in the dark span by light high in FR would promote a reduced phytochrome photoequilibrium (low P_{fr} relative to P_r) which would stimulate stem elongation and inhibit lateral branching (8).

However, plants growing close together form a leaf canopy which filters much of the R light out of the spectrum while allowing larger amounts of FR to pass through (6, 8, 15). We have also measured this spectral shift under chrysanthemum leaves (unpublished data). The lower leaves, stems and lateral buds of such plants would be exposed to a low R to FR ratio. This light quality should establish a reduced phytochrome photoequilibrium (low P_{fr} relative to P_r) which should inhibit lateral branching and stimulate primary stem elongation. While irradiating widely spaced plants with R light during the dark span increased lateral branching (Tables 2-5), we would not expect the same response from plants growing in high populations. Such plants would be exposed during the day to high FR irradiation. If branching responds predominately to daytime light quality as terminal shoot elongation does (13), then any irradiation with R light during the dark span may only have a minor influence on branching. It has been shown in tomato (20), that FR light, as an end of day treatment, supresses lateral shoot growth for plants that were returned to normal day irradiation. This FR response persisted for up to 4 weeks. Some evidence suggests that this effect may be mediated through an ABA mechanism (20). Therefore, we might expect high cutting production from plants grown in an environment

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Table 5. Average number of cuttings produced per chrysanthemum plant growth under different light treatments from July 11, to September 19, 1977. (Expt. III).

Irradiation time^{z}	Light quality^{y}	No. cuttings, Nodal position^{x}: 1 (Apex)	2	3	4	5	6	7	8	Total	R vs. INC (% difference)
					4-node plant						
DC	R	7.1	6.0	5.1	2.5					20.7	+16.9%
	INC	5.4	5.8	3.9	2.6					17.7^{NS}	
NI	R	6.9	5.9	5.8	2.7					21.3	+ 2.9%
	INC	6.6	6.5	4.9	2.7					20.7^{NS}	
PD	R	5.4	6.6	5.9	2.8					20.7	+ 9.5%
	INC	5.5	5.8	4.7	2.9					18.9^{NS}	
DC+PD	R	7.6	7.5	5.3	3.3					23.7	+33.1%
	INC	5.9	4.8	4.6	2.5					17.8**	
ND		5.3	5.1	5.5	2.8					18.7	
	Mean	6.2	6.0	5.1	2.8						
Δ between nodes		0.2	1.1	2.3							
SE = 0.59											
					8-node plant						
DC	R	10.0	8.3	4.4	2.9	2.4	1.9	1.0	1.1	32.0	+14.7%
	INC	8.3	7.3	4.5	2.7	2.0	1.1	1.2	0.8	27.9**	
NI	R	9.6	9.4	5.8	4.4	2.6	1.6	2.1	1.2	36.7	+24.8%
	INC	8.1	7.8	5.4	2.1	2.0	1.4	1.5	1.1	29.4**	
PD	R	9.1	8.1	4.3	3.2	2.9	1.3	1.9	0.9	31.7	+ 7.1%
	INC	8.8	6.9	4.5	3.0	2.2	1.5	1.6	1.1	29.6^{NS}	
DC+PD	R	9.4	8.2	5.3	3.0	2.1	1.4	1.5	1.1	32.0	+12.3%
	INC	8.4	6.8	4.2	2.3	2.5	1.4	1.7	1.2	28.5*	
ND		6.6	6.6	5.6	3.1	2.5	2.0	2.9	1.0	30.3	
	Mean	8.7	7.7	4.9	3.0	2.4	1.5	1.7	1.1		
Δ between nodes		1.0	2.8	1.9	0.6	0.0	−0.2	0.6			
SE = 0.40											

^{z}4 hr continuous illumination starting: a) DC: 30 min prior to sunset; b) NI: 2200 hr; c) PD: 3 hr 30 min prior to sunrise.
^{y}R = 20 W GE cool white lamp wrapped with 2 layers of red cellophane 2.9 μw cm^{-2}, 650-700 nm; 0.6 μw cm^{-2}, 700-750 nm; INC = 100 W incandescent bulb; 303 μw cm^{-2}, 650-700 nm; 395 μw cm^{-2}, 700-750 nm.
*, **, ^{NS}R vs. INC significant at 5% (*) level, 1% (**) level, or non-significant (NS).

Table 6. Ranking of the means for number of cuttings produced from chrysanthemum plants exposed to R vs. INC light during the dark span.

	4 nodes				8 nodes			
	R		INC		R		INC	
Rank	Irradiation time^{z}	Mean	Irradiation time^{z}	Mean	Irradiation time^{z}	Mean	Irradiation time^{z}	Mean
				Expt. II				
1	DC	26.7	PD	24.7	NI	32.6	PD	31.1
2	NI	26.2	NI	22.8	DC+PD	32.0	DC+PD	28.7
3	PD	23.1	DC+PD	22.4	DC	31.0	NI	25.8
4	DC+PD	23.1	DC	20.7	PD	28.2	DC	24.1
	SE = 0.59				SE = 0.40			
				Expt. III				
1	DC+PD	23.7	NI	20.7	NI	36.7	PD	29.6
2	NI	21.3	PD	18.9	DC	32.0	NI	29.4
3	DC	20.7	DC+PD	17.8	DC+PD	32.0	DC+PD	28.5
4	PD	20.7	DC	17.7	PD	31.7	DC	27.9
5	ND	18.7			ND	30.3		
	SE = 0.59				SE = 0.40			

^{z}4 hr continuous illumination starting: a) DC: 30 min prior to sunset; b) NI: 2200 hr; c) PD: 3 hr 30 min prior to sunrise.
^{y}R = 20 W GE cool white lamp wrapped with 2 layers of red cellophane 2.9 μw cm^{-2}, 650-700 nm; 0.6 μw cm^{-2}, 700-750 nm; INC = 100 W incandescent bulb; 303 μw cm^{-2}, 650-700 nm; 395 μw cm^{-2}, 700-750 nm.

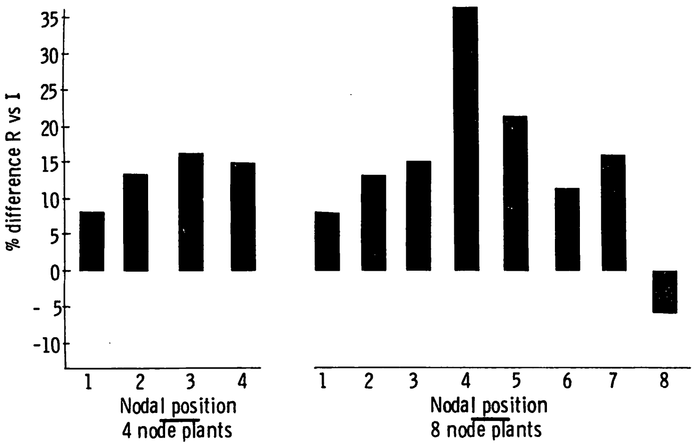

Fig. 1. Average percent difference in number of chrysanthemum cuttings which were produced per nodal position on plants irradiated with R compared to INC light. Data for Expt. II and III combined for all light treatments.

where the plants do not shade each other and which are irradiated with R light prior to the dark span.

The R to FR ratio in solar radiation shifts to a higher FR to R light ratio as the sun sets (5, 14, 16). This would shift the phytochrome photoequilibrium toward a state that would stimulate stem elongation and inhibit lateral branching. Red irradiation at sunset may be needed for several hours during the twilight span in order to maintain a desirable phytochrome photoequilibrium for lateral branching as twilight can last for several hours, especially at high latitudes during the summer months (23). Note that in Expt. III where ND photoperiods were sufficiently long to maintain the chrysanthemum in a vegetative state, a DC irradiation with R light increased cutting production over the ND (Table 5).

Holmes and Smith (7) have suggested that an elongation response to a low R to FR ratio would be advantageous to plants requiring high light intensities growing in an open herbaceous habitat. Conversely, plants in an understory of a forest or woodland may not respond to the R to FR ratio because extra stem elongation would not increase the probability of receiving more light. These responses could have evolved through natural selection. We feel the chrysanthemum, a high light requiring plant, responded similar to plants native to open, herbaceous habitats. It is not advantageous for the chrysanthemum to expend metabolites for the growth of lateral branches at the expense of the terminal shoot when competing for light in a dense population. The high FR light under the canopy would establish a phytochrome photoequilibrium which would inhibit lateral branching and stimulate primary shoot elongation.

In contrast to a plant growing in an open herbaceous habitat, an understory plant may be at an advantage to branch and intercept more light. In experiments with *Peperomia obstifolia*, an understory type of plant, no response to a DC irradiation with either R or INC light was observed (unpublished data). However, NI irradiation from both light sources inhibits branching and cutting production.

Nodal position has been shown to influence morphological growth of axillary buds in *Nicotiana tabacum* (10). Basal axillary shoots formed more nodes before floral differentiation than those growing from apical nodes. This difference occurred whether a bud grew *in situ* or was grafted onto a plant at a different nodal position. In our experiments, nodal position had a significant influence on the number of cuttings produced (Tables 2-5). Since each axillary bud had a subtending leaf for photosynthesis, either the position of the bud relative to other buds predetermined the number of cuttings that may be produced or the apical axillary buds developed a form of apical dominance over the basal buds. The latter may have been the dominant factor as we observed the apical axillary shoots to continue cutting production while the basal often ceased any active growth after 1 or 2 cuttings had been removed.

When apical dominance and lateral branching are considered, one notes that lateral branching is not a spontaneous process like terminal stem elongation. A seedling or apical shoot placed in darkness will continue to elongate without branching until its carbon supply is exhausted (11). Light will inhibit this elongation and can induce or promote lateral shoot growth. Red light is more effective in inducing lateral shoot growth than is FR as shown in Tables 2-5 (8, 18, 21). Interestingly, phytochrome reverts to P_r when shoots are placed in the dark, FR light transforms P_{fr} to P_r and further phytochrome predominates in the P_r form in dark green etiolated seedlings (12). Thus, a similar response to P_r occurs in all three cases, stem elongation is stimulated and lateral branching is inhibited.

Commercial photoperiodic manipulation of chrysanthemum is almost exclusively controlled by the use of INC lamps. This is due, at least in part, to the easy and inexpensive installation of INC fixtures relative to fluorescent. Fluorescent lamps may be cheaper, however, when lower electrical consumption (2) and the increased cutting production by R light are considered. In addition, irradiating stock plants with R light may increase lateral branching of the rooted cutting after removal of the apical growing point by the commercial grower. On the other hand, it may be desirable to use INC lighting during some stage of development for production of shoots with a single terminal flower. The INC light may inhibit the development of reproductive lateral shoots and therefore decrease the need for disbudding.

These data suggest that increasing the number of nodes left on a stock plant results in greater cutting production. However, plants were spaced so that their leaves did not overlap. Whether greater cutting production occurred based on an area basis with plants pinched to 8 nodes or to 4 nodes was not determined.

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