Gibberellins and Temperature Influence Long-day Floral Initiation in Poinsettia

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Additional index words. *Euphorbia pulcherrima*, splitting, chlormequat, paclobutrazol

Abstract. Exogenous foliar spray applications of gibberellic acid (GA₃) applied at 7- or 14-day intervals providing 50 or 125 µg per plant inhibited long-day (LD) floral initiation in poinsettia [*Euphorbia pulcherrima* (Willd. ex. Klotzsch)]. Periodic application of GA₃ resulted in an additional number of nodes being produced by the plant before floral initiation equivalent to the number of nodes over which GA₃ was applied. Further, GA₃ application eliminated the nodal position dependence of the long-day node number (LDNN) of axillary meristems observed in control plants. It was concluded that GA₃ application inhibited the inclusion of nodes into the LDNN count and thus inhibited ontogenetic aging of the meristem. Exogenous application of GA₃ also inhibited LD floral initiation, while application of GA₄ had no effect. Application of GA₇ delayed LD floral initiation, but plants did initiate cyathia by the termination of the experiment. All gibberellins increased the average internode lengths similarly. The gibberellin-biosynthesis inhibitors chlormequat and paclobutrazol had no effect on LD floral initiation when applied as single or multiple foliar sprays or as soil drenches, although heights and internode lengths were reduced by application of the inhibitors. The LDNN of plants grown at 31C was significantly higher than of plants grown at 16, 21, or 26C. All plants eventually initiated cyathia regardless of temperature. When plants were grown under a range of day/night temperatures, an increase in the LDNN occurred only when plants were grown at 31C during the day. Chemical names used: 2-chloroethyl-trimethyl-ammonium chloride (chlormequat); (+/-)-(R*,R*)-β-(4-chlorophenyl)methyl-α-(1,1-dimethylethyl)-1-H-1,2,4-triazole-1-ethanol (paclobutrazol).

The poinsettia is a short-day plant (SDP) that flowers when the skotoperiod exceeds ≈ 12.5 h (Grueber, 1985; Kristoffersen, 1969), depending on cultivar and temperature. Under short days, (SD) the poinsettia will rapidly initiate floral structures. The floral structures of poinsettia are termed cyathia and consist of a single pistillate flower with numerous staminate flowers enclosed in an involucre cup (Shanks, 1980).

The poinsettia will also initiate cyathia under LD (commonly referred to as splitting) after the apical meristem forms a cultivar-dependent number of nodes (Hackett and Kofranek, 1971). However, under LD the cyathia that are initiated do not develop to anthesis and are subtended by leaves rather than bracts. Evans (1990) concluded that LD floral initiation occurs after the meristem attains a critical ontogenetic age as measured by node count. When the meristem reaches the cultivar-dependent ontogenetic age, represented by the attainment of the critical node number, it initiates a cyathium. The critical node count required for LD floral initiation to occur is referred to as the LDNN.

The LDNN can be visualized as a clock that measures meristem ontogenetic age (Evans, 1990). As nodes are formed, they are added, or included, in the LDNN count (the clock moves forward). When the count reaches the critical number, the meristem forms a cyathium. For discussion purposes in this paper, inclusion refers to a node being counted by the meristem toward the critical LDNN. The term deletion refers to a node formed

by the meristem, but not counted toward the attainment of the LDNN.

Gibberellins have been reported to inhibit flowering in numerous species including *Malus domestica* Borkh. (Guttridge, 1962; Tromp, 1982), *Fuchsia × hybrida* Hort. ex. Vilm. (Sachs et al., 1967), *Mangifera indica* L. (Tomer, 1984), and *Humulus lupulus* L. (Thomas and Schwabe, 1969). Reversion of mature (able to flower) to the juvenile (unable to flower) form in *Hedera helix* L. by exogenous GA₃ application has also demonstrated (Miller and Goodin, 1976; Robbins, 1957; Rogler and Hackett, 1975).

Guttridge (1963) first demonstrated that exogenous GA₃ application delayed floral initiation in poinsettia under SD. Plants eventually produced cyathia that developed to anthesis, but the number of cyathia was reduced as compared to controls. Hackett and Kofranek (1971) demonstrated that GA₃ also delayed LD floral initiation in poinsettia, and that application of chlormequat as a soil drench resulted in a higher percentage of plants having initiated cyathia after 42 days of growth than control plants. Application of GA₃ negated the promotive effect of chlormequat on LD floral initiation. Chlormequat has also been reported to promote floral initiation and development under LD in the SDP *Humulus lupulus* (Thomas and Schwabe, 1969) and under SD in the SDP *Euphorbia fulgens* Karw. ex. Klotzsch (Runger and Albert, 1975).

Although GA₃ has been shown to inhibit LD floral initiation in poinsettia, the developmental basis of the GA₃ effect on the LDNN, and thus on the ontogenetic age, is not known. Exogenous GA₃ application might only inhibit the process of floral initiation and development and not affect the LDNN. Exogenous GA₃ application might result in a complete deletion of the LDNN count (reset the clock) so that the physiological state of the plant is the same as when the meristem was first differentiated in the embryo or the application of GA₃ may inhibit the inclusion of

Received for publication 12 Nov. 1991. Accepted for publication 15 June 1992. Scientific Journal Series Paper 19584, Minnesota Agricultural Experiment Station, Univ. of Minnesota, St. Paul, MN 55108. We wish to thank the Paul Ecke Ranch, Encinitas, Calif., for support of this research project. 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.

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Abbreviations: LD, long day(s); LDNN, long-day node number; SD, short day; SDP, short day plant.

nodes (stop the clock) into the LDNN count without resulting in a complete deletion of the node count.

Different gibberellins have different effects on flowering, even when applied to the same species at the same stage of development. Although GA₁ application inhibited floral initiation in *Clerodendrum thomsoniae* Balf., GA₇ promoted flowering and increased vigor (Koranski et al., 1979). Michniewicz and Lang (1962) studied the effects of GA₁₋₉ on floral induction of five species and found that certain species could be induced to flower under noninductive conditions by certain gibberellins whereas others were ineffective. Some gibberellins that did not promote flowering did cause shoot elongation. In *Amaranthus caudatus* L. and *A. tricolor* L., GA₃ and GA₄₊₇ enhanced extension growth while GA₁ promoted flowering (Kohli and Sawhney, 1979), and Tromp (1982) reported that GA₃, GA₇ and GA₄₊₇ were effective in inhibiting flowering in apple but GA₄ was ineffective. No information is available on the specificity of gibberellins in relation to flowering in poinsettia.

Temperature has also been shown to affect LD floral initiation in poinsettia. Hackett and Kofranek (1971) demonstrated that plants grown at 21°C initiated cyathia after forming fewer nodes than plants grown at 26.6°C. Further, pretreatment of plants for 7 to 10 days at 15.5°C before growing them at 21 or 26.6°C resulted in plants initiating cyathia at a lower LDNN than plants grown at a constant 21 or 26.6°C. Low temperatures only reduced the LDNN when applied to the shoot (Hackett and Kofranek, 1971). If the roots were subjected to low temperatures and the shoot subjected to a high temperature, the LDNN was similar to that which would be expected if the entire plant was subjected to high temperature. Therefore, the site of perception for the low temperature reduction of the LDNN was the shoot. Gislerod and Litlere (1976) demonstrated that plants originating as cuttings from stock plants grown at low temperatures (15, 18, or 21°C) initiated cyathia sooner than plants derived from stock plants grown at higher temperatures (24 or 27°C), even though all cuttings were rooted and grown at 21°C.

The objectives of this study were to determine the effect of gibberellins and temperature on LD floral initiation in poinsettia and to investigate the developmental basis for these effects.

Materials and Methods

Unless otherwise indicated, materials and methods for all experiments were as follows. Vegetatively propagated plants were received from Encinitas, Calif., and potted into 51 × 31 × 8 cm containers with a synthetic medium of 2 peat : 1 perlite : 1 soil (by volume). After 1 week, plants were decapitated to five nodes. The axillary shoot developing from the fifth node was removed with all nodes intact and rooted under intermittent mist. After rooting, these plants were potted into 1.5-liter pots containing the same growing medium as described above. After 1 week, these plants were decapitated to five nodes. The axillary shoot originating from the fifth node was used as the experimental unit. All shoots below the fifth node were removed. At all times, plants were maintained in a greenhouse at a minimum of 21°C and under LD using incandescent lighting from 1700 to 2200 HR (minimum of 10 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). Plants were fertilized at each watering with a Ca (NO₃)₂ and KNO₃ or 20N-4.3P-16.6K solution at 250 mg/N per liter.

The poinsettia cultivars used in these experiments have about seven unexpanded leaf primordia enclosing the apical and axillary meristems. These leaves and nodes were accounted for in all treatments that were conducted at a given node number and

when counting nodes at the beginning and termination of experiments.

Unless otherwise indicated, the number of plants initiating cyathia and the LDNN of the meristems of interest were recorded. Ten plants were used per treatment. Gibberellin applications were made to the youngest expanding and first expanded leaf.

An analysis of variance was conducted on the data. Where significant differences occurred, means were separated by the LSD method ($\alpha = 0.05$).

GA₃ concentration (Expt. 1). 'Annette Hegg Brilliant Diamond' ('Brilliant') and 'Gutbier V-14' ('V-14') were subjected to applications of 0, 25, 50, or 125 μg GA₃ applied as 0, 5, 10, or 25 mg-liter⁻¹ foliar sprays, respectively, at 7- or 14-day intervals beginning at node seven.

GA₃ application and developmental periods (Expt. 2). 'Brilliant' plants were treated with 125 μg GA₃ as a 25 mg-liter⁻¹ foliar spray over several developmental periods. Plants received a GA₃ application at 7-day intervals beginning at node 7 and continuing until either node 15 or node 30. Other plants received an application at 15-node intervals beginning at node seven and continuing until the termination of the experiment. An untreated control group was included (Table 1).

Single or multiple applications of GA₃ (Expt. 3). 'Brilliant' plants were treated with 50 μg GA₃ applied as a 10 mg-liter⁻¹ foliar spray. Plants received either a single application after the meristem formed 10, 15, 20, or 25 nodes or weekly applications beginning at the same node numbers and continuing at five-node intervals until plants reached 15, 20, or 25 nodes, or until the termination of the experiment. Treatment combinations encompassed all possible combinations of the beginning and terminating node numbers. An untreated control group was included (Table 2).

GA₃ application and decapitation of plants (Expt. 4). 'Brilliant' plants were treated with 50 μg GA₃ applied as a 10 mg-liter⁻¹ foliar spray at 7-day intervals beginning when the first leaf of the axillary shoot of interest unfolded. After plants produced 27 nodes, including unexpanded leaves, treatment was stopped and plants were decapitated at either node 4, 8, 12, 16, or 20, counting from the base of the plant. A control group that had not been treated with GA₃ was decapitated at the same nodal positions. The LDNN of the shoot originating from the node of interest and the total number of nodes between the roots and the cyathium were recorded.

Specificity of gibberellins (Expt. 5). The gibberellins GA₁, GA₃, GA₄, and GA₇ were used to determine if there was specificity for gibberellin inhibition of LD floral initiation. 'Brilliant' plants received a foliar spray application of 50, 125, or 250 μg of a gibberellin from 10, 25, or 50 mg-liter⁻¹ foliar spray, respectively, at 7-day intervals beginning at node seven when the first leaf was unfolding (Table 4). Eight plants were used per treatment.

Application of chlormequat or paclobutrazol (Expt. 6). 'Brilliant' plants were subjected to foliar spray and soil drench applications of chlormequat or paclobutrazol. Chlormequat soil drenches were made as single applications of 500 or 1000 mg a.i./pot or as three drenches of 170 or 330 mg a.i./pot at 7-day intervals. Paclobutrazol soil drenches were applied as either single drenches of 0.25 or 0.50 mg a.i./pot or as three applications of 0.08 or 0.17 mg a.i./pot at 7-day intervals. Spray treatments of chlormequat were made as either single applications of 261 and 522 mg a.i. or as 87 and 174 mg a.i. foliar sprays applied 3 times at 7-day intervals. Spray treatments of paclobutrazol

were made as single applications of 0.36 and 0.72 mg a.i. or three applications of 0.08 and 0.17 mg a.i. applied at 7-day intervals. Treatments began at node seven when the first leaf was about half expanded.

Constant temperatures (Expt. 7). 'Brilliant' and 'V-14' plants were grown in controlled environment chambers at 16, 21, 26 or 31C (constant day/night). A LD of 16 h (0600 to 2200 HR) was maintained in each chamber using a combination of incandescent and fluorescent lamps ($500 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). Plants were allowed to grow until they produced a cyathium. Five plants were used per treatment. The experiment was replicated in time. However, because results of the experiments were the same, the results of only the second experiment are presented.

Day/night temperatures (Expt. 8). 'Brilliant' and 'V-14' plants were grown in controlled environment chambers at 21 or 31C constant day and night temperatures. Additional plants were grown at 21/31C (day/night) or 31/21C (day/night). All other environmental conditions were the same as for experiment seven. Plants were allowed to grow until they produced a cyathium. Five plants were used per treatment. The experiment was replicated in time. However, because results of the experiments were the same, the results of only the second experiment are presented.

Results and Discussion

In experiment one, control plants of 'Brilliant' and 'V-14' formed 29 and 42 nodes, respectively, before initiating cyathia. 'Brilliant' and 'V-14' plants treated with 25 μg GA₃ at 7- and 14-day intervals initiated cyathia after forming 23 and 40 nodes, respectively. Applications of 50 or 125 μg GA₃ at 7- and 14-day intervals completely inhibited LD floral initiation in both 'Brilliant' and 'V-14'. By the termination of the experiment, plants treated with either 50 or 125 μg GA₃ at either 7- or 14-day intervals formed 61 to 71 nodes for 'Brilliant' and 56 to 58 nodes for 'V-14' without initiating cyathia (LSD = 5.6, α = 0.05).

In experiment two, application of 125 μg GA₃ until node 30 resulted in a delay of LD floral initiation, although plants eventually initiated cyathia after producing 50 nodes (Table 1). If application of GA₃ only inhibited floral initiation and development, but had no effect on the LDNN count (and thus ontogenetic aging), initiation should have occurred soon after the termination of the GA₃ treatment. However, the meristem produced an additional 26 nodes after the termination of the treatment before initiating a cyathium. Therefore, GA₃ application had an effect on the LDNN count (and thus on ontogenetic

aging). Whether GA₃ inhibited the inclusion of nodes into the LDNN count or caused complete deletion of the LDNN count (reset the clock to zero) could not be determined from the results of this treatment. If application of GA₃ resulted in complete deletion, an additional 24 nodes should have been produced (LDNN of control), whereas if GA₃ application inhibited inclusion of nodes, an additional 23 nodes should have been produced before floral initiation (number of nodes during which GA₃ was applied; 30 - 7). Either of these two possibilities could explain the 26 additional nodes produced in this treatment after the termination of GA₃ application.

When 125- μg GA₃ was applied until node 15, initiation was delayed by nine nodes (Table 1). As with application to node 30, application of GA₃ to node 15 increased the LDNN. In this treatment, the LDNN is about the same as would be expected if GA₃ application inhibited inclusion of nodes into the LDNN count (stopped the clock), since GA₃ was applied over an eight node period. If GA₃ application resulted in a complete deletion of the LDNN count, an additional 24 nodes should have been produced before initiation of a cyathium for a total LDNN of 39 (LDNN of control + 15 erased by GA₃ application). Thus, GA₃ inhibited the inclusion of nodes into the LDNN count in this treatment but did not cause a complete deletion of the LDNN count.

When 125- μg GA₃ was applied at 15-node intervals, LD floral initiation was delayed but not completely inhibited (Table 1). If GA₃ application had resulted in a complete deletion of the LDNN count (reset the clock), application at 15-node intervals should have completely inhibited LD floral initiation. This is because the LDNN count would be reset before reaching the critical ontogenetic age. Therefore, as in the previous treatments, GA₃ application inhibited the inclusion of nodes into the LDNN count but did not result in a complete deletion of the LDNN count.

In experiment three, a single application of 50- μg GA₃ at nodes 10, 15, or 20 resulted in an additional three to five nodes being produced before plants initiated cyathia (Table 2). When GA₃ was applied continuously, plants did not initiate cyathia. Treatment with GA₃ for varying node counts resulted in production of an additional number of nodes before initiation of a cyathium similar to the number of nodes over which GA₃ was applied plus an additional two to four nodes that can be accounted for by residual GA₃ effects (effect of a single application was three to five nodes). Therefore, as in the previous experiments, GA₃ application inhibited the inclusion of nodes into the LDNN count.

In experiment four, the LDNN of axillary meristems depended on the position of the meristem on the main stem of the plant (Table 3). The most basipetal axillary meristem had the largest LDNN, and the LDNN decreased as the nodal position of the axillary meristem became more acropetal. When GA₃ was applied during the growth of the main shoot, before decapitation, the resulting axillary meristems did not display position dependent LDNN (Table 3).

Application of GA₁ or GA₃ completely inhibited LD floral initiation when applied at a rate of at least 50 μg at 14-day intervals (Table 4). Application of GA₇ delayed but did not completely inhibit LD floral initiation, while GA₄ application had no effect on LD floral initiation. Although specificity was observed with respect to floral initiation, all gibberellins tested increased internode lengths. The higher the concentration applied, the greater the increase in internode lengths, with GA₄ and GA₇ being the most active.

Table 1. Effect of GA₃ application on the LDNN of *Euphorbia pulcherrima* 'Brilliant Diamond' when applied at 7-day intervals until node 15 or 30 and when applied at 15-node intervals.

GA ₃ application ^z	LDNN	Additional nodes over control ^y	Reproductive (%)
None	24	---	100
Continuous	---	---	0
Until node 15	33	9 $\pm$ 2	100
Until node 30	50	26 $\pm$ 6	100
At 15-node intervals	42	18 $\pm$ 7	100

^zPlants received a foliar spray application of 25 mg-liter⁻¹ delivering 125 μg GA₃ at 7-day intervals. Applications began when the shoot first began to elongate and $\approx$ 7 nodes were present. Plants receiving continuous GA₃ applications, which were treated at 7-day intervals until the termination of the experiment, did not initiate cyathia.

^yMean $\pm$ SE.

Table 2. Effect of periodic GA₃ application on LD floral initiation in *Euphorbia pulcherrima* 'Brilliant Diamond'.

Beginning node count ^z	Termination node count ^z	LDNN	Additional nodes ^w	Reproductive plants (%)
Control	---	25	---	100
10	10	29	4	100
	15	33	8	100
	20	36	11	100
	25	42	17	100
	∞	---	---	0
15	15	28	3	100
	20	32	7	100
	25	38	13	100
	∞	---	---	0
20	20	30	5	100
	25	31	6	100
	∞	---	---	0
25	25	26	1	100
	∞	26	1	100
LSD (0.05)		4	4	

^zGA₃ was applied as a 10 mg-liter⁻¹ foliar spray providing 50 µg per application. Applications were made at 7-day intervals beginning after the plant formed the indicated number of nodes. Treatments were terminated after the plant formed the indicated number of nodes. For termination node number indicated as "∞," plants were treated until the experiment was terminated.

^xLDNN indicates the number of nodes formed before the initiation of a cyathium or the number of nodes present at the termination of the experiment for plants not initiating a cyathium.

^wAdditional nodes indicate the difference between the number of nodes formed by the treatment plants as compared to control plants. Ten plants were used per treatment.

Table 5. Effect of GA₃ application on the position dependence of the LDNN of axillary shoots of *Euphorbia pulcherrima* 'Brilliant Diamond'.

Axillary shoot nodal position ^z	LDNN without GA ₃	LDNN with GA ₃
Control	25	---
4	23	25
12	17	26
16	14	27
20	10	24
LSD (0.05)	4	NS

^zControl plants were not decapitated. Nodal position indicates the nodal position of the axillary shoot of interest. Nodes are ordered numerically beginning from the roots and moving acropetally.

^xLDNN is the number of nodes produced by the axillary shoot meristem before initiating cyathia under LD.

^w50 µg GA₃ was applied as a 10 mg-liter⁻¹ foliar spray at 7-day intervals until 20 expanded leaves were produced at which time the plants decapitated.

^{NS}Ten plants were used per treatment at *P* = 0.05.

Neither chlormequat nor paclobitrazol foliar sprays or soil drenches significantly affected the LDNN of either cultivar. Untreated 'Brilliant' plants formed 22 nodes while treated plants formed 20 to 24 nodes, depending on the specific treatment. Untreated 'V-14' plants formed 33 nodes while treated plants formed 32 to 39 nodes, depending on the specific treatment. However, as expected, both inhibitors reduced internode lengths of both cultivars as compared to controls when applied as foliar sprays or soil drenches. As the concentration of the inhibitor

Table 4. Effect of various gibberellins on internode length and LD floral initiation in *Euphorbia pulcherrima* 'Brilliant Diamond'.

Growth regulator	Amount per plant (%)	Internode length (cm)	LDNN ^y	Reproductive plants (%)
Control	0	1.6	24	100
GA ₁	50	1.6	51	0
GA ₁	125	1.7	52	0
GA ₁	250	1.9	56	0
GA ₃	50	1.7	51	0
GA ₃	125	1.9	54	0
GA ₃	250	1.9	58	0
GA ₄	50	1.8	24	100
GA ₄	125	2.3	22	100
GA ₄	250	2.5	25	100
GA ₇	50	1.8	39	100
GA ₇	125	2.0	41	100
GA ₇	250	2.2	37	100
LSD (0.05)		0.5	6	

^zPlants received either 50, 125, or 250 µg of the respective gibberellin as a 10, 25, or 50 mg-liter⁻¹ foliar spray at 14-day intervals. Control plants were untreated.

^yLDNN indicates the number of nodes formed before the initiation of a cyathium, or the number of nodes present at the termination of the experiment for plants not becoming reproductive. Six plants were used per treatment.

was increased, internode length was reduced. Untreated 'Brilliant' plants had an average internode length of 1.8 cm, while treated plants had average internode lengths of 0.8 to 1.4 cm (LSD = 0.4, α = 0.05), depending on the specific treatment. Untreated 'V-14' plants had an average internode length of 2.0 cm, while treated plants had average internode lengths of 0.8 to 1.4 (LSD = 0.5, (α = 0.05), depending on the specific treatment.

The LDNN values for plants grown at 31C were significantly higher than those for plants grown at 16, 21, or 28C (Fig. 1). The LDNN of plants grown at 16, 21, or 28C were similar for a given cultivar. For both cultivars, plants grown at a constant 31C or at 31/21C (day/night) had a higher LDNN than plants grown at a constant 21C or 21/31C (day/night) (Fig. 2). The LDNN was similar for the constant 31 and the 31/21C (day/night) regimes; it also was similar for plants grown at a constant 21C and plants grown at 21/31C (day/night). Therefore, floral initiation was delayed and the LDNN increased only when the plants were grown at 31C during the day.

When the night temperature was higher than the day temperature, internode lengths were reduced as compared to constant temperature regimes (Fig. 3). Internode lengths for the constant 21 and 31C treatments were similar. Just as increasing the day temperature increased the LDNN, increasing the day temperature increased the internode length.

Foliar application of GA₃ inhibited LD floral initiation by inhibiting inclusion of nodes into the LDNN count. Since the LDNN has been shown to represent a critical ontogenetic age required for LD floral initiation to occur (Evans, 1990), GA₃ inhibited LD floral initiation by inhibiting ontogenetic aging of the meristem. This conclusion is based on the fact that the delay in LD floral initiation is always similar to the number of nodes over which the GA₃ treatment was applied. Further, the position dependence of the LDNN of axillary meristems, which was shown to be a function of the ontogenetic age of the apical meristem when the axillary meristem was formed (Evans, 1990),

Fig. 1. Effect of constant day and night temperatures on LD floral initiation in *Euphorbia pulcherrima* 'Brilliant Diamond' (dotted bars) and 'Gutbier V-14' (solid bars). Plants were grown in growth chambers under a long photoperiod (0600 to 2200 HR) using a combination of incandescent and fluorescent lamps providing $500 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Five plants were used per treatment.

was eliminated by GA_3 treatment. Application of GA_3 to the main shoot as it grew and formed axillary meristems inhibited ontogenetic aging of the apical meristem and, thus, the axillary meristems were formed by an apical meristem of the same ontogenetic age and position dependence was absent.

Not all gibberellins inhibited LD floral initiation. Those gibberellins able to completely inhibit LD floral initiation were 13-hydroxylated. Gibberellins that are 13-hydroxylated have been shown to possess high biological activity (Jones and MacMillan, 1984). In *Lolium temulentum* L., Pharis et al. (1987) found that the greater the degree of hydroxylation of a gibberellin, the greater its florigenic properties. All gibberellins increased internode length. Therefore, the inhibitory effect of the 13-hydroxylated gibberellins was not due to their enhancement of vegetative growth. Thus, the ability of a gibberellin to inhibit LD floral initiation may be directly related to its degree of hydroxylation.

Although LD floral initiation was inhibited by application of

Fig. 2. Effect of different day and night temperatures on LD floral initiation in *Euphorbia pulcherrima* 'Brilliant Diamond' (dotted bars) and 'Gutbier V-14' (solid bars). Plants were grown in growth chambers under a long photoperiod (0600 to 2200 HR) using a combination of incandescent and fluorescent lamps providing $500 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Five plants were used per treatment.

GA_3 , application of the gibberellin biosynthesis inhibitors paclobutrazol and chlormequat did not affect LD floral initiation. A biological response was obtained by the application of chlormequat and paclobutrazol as evidenced by a reduction in internode lengths. Inhibition of LD floral initiation by GA_3 and GA_1 , and the lack of promotion by gibberellin biosynthesis inhibitors, may indicate that reduced gibberellin levels are only one of several factors required for LD floral initiation to occur in poinsettia. Therefore, reducing gibberellin levels through the application of gibberellin biosynthesis inhibitors would not be sufficient to bring about LD floral initiation by itself. In addition, the level of specific gibberellins or ratio of gibberellins may be more important than the overall level of gibberellins in the plant.

There are at least two explanations for the high LDNN of plants grown at 31C during the day: 1) The duration of the day temperature treatment was the critical factor, since the day was 16 h, while the night was 8 h. 2) The day temperature is in fact the critical temperature governing LD floral initiation in poin-

Fig. 3. Effect of different day and night temperatures on average internode length in *Euphorbia pulcherrima* 'Brilliant Diamond' (dotted bars) and 'Gutbier V-14' (solid bars). Plants were grown in growth chambers under a long photoperiod (0600 to 2200 HR) using a combination of incandescent and fluorescent lamps providing $500 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Five plants were used per treatment.

settia. The latter explanation seems more plausible, since LDNN was similar for the constant 31C and the 31/21C (day/night) cycle even though the former received the high temperature for 8 h longer than the latter. In addition, no significant difference occurred between the 21/31C (day/night) and the constant 21C treatment even though the former was 8 h at 31C. Thus, duration of the 31C treatment did not affect the LDNN.

Internode lengths were increased when the day temperature was at 31C. Erwin (1989) found that when day temperatures were higher than night temperatures, plant height was increased in numerous species. It may be that the increased internode

lengths under the high day temperature reflect an increase in gibberellin levels. Therefore, high day temperatures may affect LD floral initiation through increasing gibberellin levels that affect the rate of ontogenetic aging and thus the LDNN.

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