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Cytokinin and Light Intensity Regulate Flowering of Easter Lily

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Abstract. Lilium longiflorum **Thunb. 'Nellie White' plants were selected when their first flower buds reached 2 or 5 cm in length, sprayed with 2 mL of PBA at 0 or 500 mg·L^{-1}, and then placed under 1440 or 60 μmol·m^{-2}·s^{-1} photosynthetic photon flux (PPF) during flowering. PBA resulted in delayed anthesis and increased dry matter accumulation in flowers under the high PPF but had no effect under the low PPF. PBA did not decrease the severity of flower bud abortion under the low PPF. Application of PBA induced the formation of numerous bulbils in the leaf axils. Regardless of PPF, PBA-treated plants had less dry weight in the main bulbs than the control plants. Chemical name used: *N*-(phenylmethyl)-9-(tetra-hydro-2*H*-pyran-2-yl)-9*H*-purin-6-amine (PBA).**

Heins et al. (1982) determined that short-term complete darkness at early stages of development had no effect on Easter lily (*Lilium longiflorum* Thunb.) flower count. Miller and Langhans (1989) found that an 85% light exclusion (≈1.4 mol·m^{-2}·d^{-1} photons) from bud initiation promoted Easter lily flower bud abortion. Wang and Gregg (1992) reported that all flower buds aborted as a result of prolonged exposure to complete darkness when the largest buds on plants were ≈7 cm long. However, none examined a possible solution to reduce bud abortion under unfavorable light conditions.

Foliar application of ^{6}*N*-benzylaminopurine at 500 mg·L^{-1} immediately before simulated shipping drastically decreased the degree of Easter lily leaf yellowing after 4 weeks in darkness (Han, 1995). Because overcast skies can result in flower bud abortion (Miller and Langhans, 1989), the application of cytokinin to Easter lily plants while flower buds are small might assist in their development under low light conditions.

Materials and Methods

'Nellie White' bulbs (20 to 23 cm in circumference) were vernalized and planted one per 2.6-L pot on 28 Nov. 1990 using Sunshine Mix No. 1 (Fisons Horticultural Products, Vancouver, B.C.). Pots were placed on a greenhouse bench with 1300 μmol·m^{-2}·s^{-1} maximum photosynthetic photon flux (PPF) measured at solar noon. Plants were fertigated with water containing 20N–8.7P–16.6K soluble fertilizer with trace elements (Grace-Sierra, Fogelsville, Pa.) at 1.5 g·L^{-1} and they occasionally were flushed with water. Shoots started to emerge in late December. The air in the greenhouse was maintained between 28 °C (day maximum) and 12 °C (night minimum) until 15 Mar. 1991, after which it ranged between 35 and 20 °C.

Twenty-four uniform plants were selected on 27 Feb. 1991 and again on 6 Mar. when their largest flower buds were 2 and 5 cm long, respectively. On each date, flower buds on half of these plants were sprayed with 2 mL of water containing PBA at 500 mg·L^{-1} (Abbott Laboratories, North Chicago, Ill.) and 0.05% Tween 20 (Fisher Scientific, Fair Lawn, N.J.). I did not attempt to prevent PBA solution from running down the plant and wetting the bases of leaves because it is difficult to do so in a commercial operation. Control plants were sprayed with 2 mL of water containing 0.05% Tween 20. The Weslaco, Texas, area received 611 mol·m^{-2} of photons between 27 Feb. and 5 Mar. and 2430 mol·m^{-2} between 6 Mar. and 7 Apr. Half of the plants treated on each date were exposed to 1440 μmol·m^{-2}·s^{-1} (high light, 79% of full sun), whereas the other half received 60 μmol·m^{-2}·s^{-1} (low light, 3.2% of full sun) peak PPF, which is known to cause bud abortion (Miller and Langhans, 1989; Wilkins et al., 1986). The low PPF was achieved by covering six large wooden frames with several layers of polypropylene shade fabric.

Date on which the first flower opened and flower length were recorded for each plant. The first three flowers on a plant were collected individually when opened and their dry weights determined. The numbers of total and aborted flowers were recorded. The experiment was a split plot design, with PPF level being the main plot, replicated six times with a single plant representing an experimental unit. Data were subjected to analysis of variance. Duncan's multiple range test was used for mean separation.

Results and Discussion

Exposing plants to low PPF starting at the 2- or 5-cm bud stage resulted in complete or severe flower bud abortion, respectively (Table 1). Under low PPF, PBA was ineffective in preventing flower bud abortion. However, under high PPF, the application of PBA at 500 mg·L^{-1} at either bud stage resulted in more dry mass accumulation in the slightly longer flowers. Dry masses of the first three flowers in a given plant were similar under high PPF. Dry mass of individual flowers on the control plants was similar to that previously reported for field-grown buds (Wang and Breen, 1984) and much heavier than that reported by Miller and Langhans (1989), but flowers that developed and bloomed on plants treated with PBA were substantially heavier (Table 1). These results suggest that, when applied at a proper stage of development, PBA can promote the accumulation of dry matter in flowers being exposed to high PPF. Since PBA delayed anthesis of the treated plants, I do not know whether this

Table 1. Effect of developmental stage and PBA on Easter lily flowering under two light levels.

Flower bud length (cm)[z]	PBA concn (mg·L^{-1})	Flower bud abortion (%)	Flower dry mass (g) Flower no. 1	2	3	Total	Mean flower length (cm)	Days to anthesis
			Low light					
2	0	100 a	0.08 b	0.07 b	0.05 b	0.21 b	---	---
	500	100 a	0.09 b	0.07 b	0.06 b	0.22 b	---	---
5	0	76 a	0.77 a	0.72 a	0.49 b	1.98 a	---	---
	500	67 a	1.00 a	0.94 a	0.97 a	2.92 a	---	---
			High light					
2	0	0 a	1.54 c[y]	1.63 c	1.61 c	4.78 c	18.2 b	119 b
	500	2 a	1.99 b	2.01 ab	2.08 ab	6.05 ab	19.1 a	124 a
5	0	0 a	1.77 b	1.77 bc	1.80 bc	5.31 bc	18.7 ab	115 c
	500	0 a	2.21 a	2.22 a	2.25 a	6.67 a	19.2 a	123 a
F significance								
Light (L)		***	***	***	***	***		
Size (S)		NS	***	***	***	***	NS	***
PBA (P)		NS	*	*	**	**	*	***
L × S		NS	*	**	*	*		
L × P		NS	*	NS	NS	NS		
S × P		NS	NS	NS	NS	NS	*	*
L × S × P		NS	NS	NS	NS	NS		

[z]When treatments were initiated.
[y]Mean separation in each column and within each light level by Duncan's multiple range test when $P \le 0.05$.
NS, *, **, ***Nonsignificant or significant at $P \le 0.05$, 0.01, or 0.001, respectively.

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increased flower weight was due to longer developmental time or the accumulation of nonstructural carbohydrates. Nightingale (1979) reported that date of flowering was not affected by foliar applications of PBA at 500 mg·L^{-1} when plants were 5 or 15 cm tall. In my test, PBA also caused a few deformed flowers that split as they developed.

The results of this experiment suggest that the application of PBA at 500 mg·L^{-1} to developing Easter lily flower buds does not prevent flower bud abortion under stress induced by low light.

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