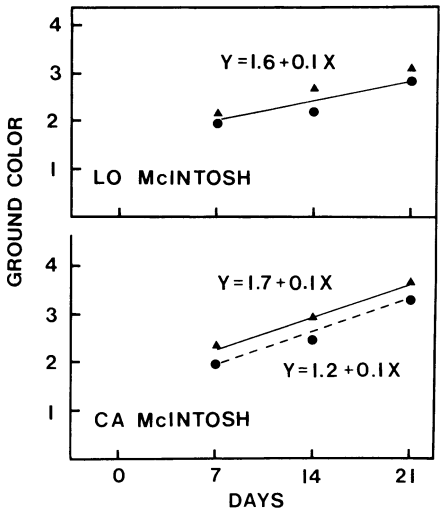

Fig. 2. Changes in ground color ratings of low-oxygen- (LO) and controlled-atmosphere- (CA) stored apples treated with 1% TAL Pro-long poststorage dip (●), as compared to a water-dipped control (▲), and kept at 15°C and 90% to 95% RH for 21 days. Separate regression lines on the same diagram indicate differences (P = 0.01) between coated and uncoated treatments.

Pro-long retarded the softening process of LO 'McIntosh' but did not benefit CA 'McIntosh' apples (Fig. 1). 'McIntosh' apples from LO storage were consistently firmer than 'McIntosh' from CA storage, which is consistent with the results of Lidster et al. (4). Firmness of CA 'McIntosh' apples was 7.2 N less than the firmness of LO 'McIntosh' when measured immediately after storage (i.e., day 0) and did not show a significant decrease during the shelf life study. Blanpied and Dewey (3) indicated that the firmness of 'McIntosh' apples may decrease to a minimum plateau at the end of their CA storage life. The present study indicated that the effectiveness of poststorage Pro-long coating application on 'McIntosh' apples depended on the significance of the residual retention of firmness over the minimum plateau at the time of treatment.

There was a decrease in firmness of CA 'Empire' apples at a rate of 0.5 N/day during the shelf life study (Fig. 1). Application of Pro-long did not influence the maintenance of firmness.

CA 'Delicious' showed a decrease in firmness at a rate of 0.7 N/day during the shelf life evaluation (Fig. 1). Application of Pro-long treatment to CA 'Delicious' reduced the rate of firmness drop significantly to 0.3 N/day.

Ground color of LO 'McIntosh' apples gradually changed from green to yellow during the shelf life studies. Pro-long did not improve the retention of green color of LO-stored 'McIntosh' apples (Fig. 2).

Poststorage Pro-long coating retarded the loss of green ground color of CA 'McIntosh' apples throughout the shelf life period (Fig. 2). However, the rate of the loss of green ground color was not affected by the coating treatment.

Pro-long coating may modify the atmospheric condition inside the fruit (5, 7). The levels of O_2, CO_2, and C_2H_4 inside the fruit depends on the rate of respiration and ripening of the fruit and the gas permeability of the coating material. The physical impediment of gaseous diffusion from a Pro-long-coated banana fruit is caused by stomatal blockage by the coating (2). The effect of Pro-long on the percentage of weight loss of apples (2, 7) indicates the reduction of the transpiration rate is due to the blockage of lenticels by the coating treatment. The oxygen concentration in the internal atmosphere of the coated fruit can reach 1.2% in banana (2) and <5% in 'Cox's Orange Pippin' apples (7) at 20°C for about 48 hr. The rate of softening and ground color loss of the fruit may be depressed in the modified-atmosphere environment. However, only good quality fruit may be treated with Pro-long to extend shelf life.

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Reduction of Bitter Pit of Apples with Phorone

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Abstract. **Phorone reduced bitter pit of apples during 4 seasons. The degree of control varied between cultivars and seasons. The study was carried out in 3 Australian states and New Zealand and involved 'Cox's Orange Pippin', 'Golden Delicious', 'Granny Smith', and 'Twenty Ounce'. The apples were held in sealed or unsealed polyethylene bags, and the chemical was placed in small containers among the fruit or was injected into the core. Phorone was as effective in reducing bitter pit as a postharvest dip in 4% (w/w) calcium chloride, but it sometimes induced an off flavor. Chemical names used: 2,6-dimethyl-2-5-heptadien-4-one (phorone).**

Bitter pit (3) is a physiological disorder of apples that may occur on the tree or develop during cold storage. Susceptible fruit contain low levels of Ca in combination with high levels of K or Mg (1, 2, 5). The incidence and severity of bitter pit may be reduced by spraying the fruit during the growing season with a Ca salt (6) or by postharvest treatment of the fruit with calcium chloride (9, 10).

Phorone, a condensation product of acetone, has been reported to produce an effect similar to that of gibberellins when applied to germinating beans (7). It has reduced several physiological disorders of apples: low temperature breakdown (13), core flush (8),

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Table 1. Effect of phorone on bitter pit of apples after storage at 3°C for 3 months. In seasons 1–3 phorone crystals were placed near fruit. In season 4 the chemical was directly injected (in 0.2 ml ethanol) into the core of each fruit.

Season	Cultivar	Source of fruit	Treatment	Bitter pit[z] (%)
1	Cox's Orange Pippin	New Zealand	No treatment	25 a
			Sealed PE bag	22 a
			Sealed PE bag + 1.0 g phorone	6 b
2	Cox's Orange Pippin	New Zealand	Sealed PE bag	16 a
			Sealed PE bag + 4% $CaCl_2$ dip	2 b
			Sealed PE bag + 1.5 g phorone	1 b
			Sealed PE bag + 4% $CaCl_2$ dip + 1.5 g phorone	0 b
2	Twenty Ounce	New South Wales	No treatment	31 a
			Sealed PE bag	24 b
			Sealed PE bag + 0.5 g phorone	22 bc
			Sealed PE bag + 1.0 g phorone	14 c
2	Cox's Orange Pippin	Tasmania	No treatment	9 a
			Sealed PE bag	10 a
			Sealed PE bag + 0.5 g phorone	5 ab
			Sealed PE bag + 1.0 g phorone	1 b
2	Granny Smith	Western Australia	No treatment	41 a
			Sealed PE bag	40 a
			Sealed PE bag + 0.5 g phorone	42 a
			Sealed PE bag + 1.0 g phorone	32 a
3	Cox's Orange Pippin	New Zealand	No treatment	54 a
			Sealed PE bag	33 b
			Sealed PE bag + 4% $CaCl_2$ dip	3 c
			Sealed PE bag + 2.5 g phorone	1 c
			Sealed PE bag + 4% $CaCl_2$ dip + 2.5 g phorone	0 c
3	Cox's Orange Pippin	Tasmania	Unsealed PE bag	62 a
			Sealed PE bag	54 a
			Sealed PE bag + 2 g phorone	40 a
3	Golden Delicious	Tasmania	Unsealed PE bag	17 b
			Sealed PE bag	14 b
			Sealed PE bag + 2 g phorone	4 a
3	Granny Smith	Western Australia	Unsealed PE bag	47 b
			Sealed PE bag	22 ab
			Sealed PE bag + 2 g phorone	14 a
4	Granny Smith	Western Australia	No treatment	57 a
			Unsealed PE bag each fruit injected with ethanol (control)	68 a
			Unsealed PE bag each fruit injected with 10 μM phorone	17 b
			Unsealed PE bag each fruit injected with 40 μM phorone	11 b

[z]Mean separation within each season–cultivar–source by Duncan's multiple range test, 5% level.

superficial scald (11), and soft or deep scald (12). This paper reports on the effects of phorone on bitter pit.

The studies were carried out in Australia or New Zealand during 4 seasons. The cultivars used were 'Cox's Orange Pippin', 'Golden Delicious', 'Granny Smith', and 'Twenty Ounce'. The apples were harvested from trees known to be susceptible to bitter pit, but the fruit used for the experiments were free of external pit. In New Zealand, the fruit were grown and stored in Nelson whereas in Australia, the fruit from Tasmania and Western Australia were air freighted to North Ryde (Sydney) and treated the following day.

Samples were held in a cold room for several days, then grouped into experimental units of 20–25 fruit. The treatments included: no treatment (no bag), bagged in polyethylene (thickness 0.04 mm) and sealed, or left unsealed. Phorone was applied by either placing 0.5–2.5 g on filter paper in 4 petri dishes or injecting into the core (via calyx) with 0.2 ml ethanol containing 10 or 40 μM of phorone. In 2 experiments, the effect of phorone and a calcium chloride dip (4%, w/w) were compared. Each experiment was treated as a randomized block with 3–5 treatments. All treatments were replicated 4 times. Specific treatments are listed in Table 1. The fruit were stored for 3 months at 3°C. After storage, the fruit were removed from the polyethylene bags and held at 20° for one week. They were then cut, and the percentage of fruit with external or internal bitter pit was determined.

Bitter pit occurred on or near the surface of the fruit 'Granny Smith' but developed in the flesh as well as on the surface in 'Cox's Orange Pippin', 'Golden Delicious', and 'Twenty Ounce'. In all experiments, the highest level of phorone had the lowest percentage of bitter pit, and results were statistically significant in 8 of the 10 experiments (Table 1). The experiments in which phorone did not significantly reduce pit had very high levels of the disorder, and increased amounts of phorone may have been required to prevent pit development. Placement of crystals of phorone near, but not in contact with the fruit, was as effective as dipping the fruit in a solution containing 4% calcium chloride. Injection of 40 μM of phorone into the core also reduced bitter pit.

Phorone must be regarded as a remarkable compound. The 5 disorders of apples that the compound has now been shown to control or ameliorate—low temperature breakdown, core flush, superficial scald, soft or deep scald and bitter pit—are all regarded as having different causes. Low temperature breakdown and soft scald are regarded as low-temperature injuries (4) while core flush (2, 4) results either from senescence or exposure of the fruit to high concentrations of CO_2 in storage. Superficial scald (5) is considered to occur when the fruit contains insufficient natural antioxidants to prevent the oxidation of α-farnesene, while bitter pit (1, 6) is considered to be due to mineral imbalance in the fruit.

There is little known about the mode of action or the toxicology of phorone, and it seems to have few commercial uses. The early report of phorone acting like a gibberellin (7) has not been widely investigated. A potential barrier to its use on fruit is that it can impart an off-flavor to the fruit.

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Variation in Cyathia Abscission of Poinsettia Cultivars in a Greenhouse and a Simulated Postharvest Environment

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Abstract. **Differences in cyathia abscission of poinsettias (*Euphorbia pulcherrima* Willd.) 'Annette Hegg Dark Red' (Dark Red), 'Annette Hegg Lady' (Lady), 'Annette Hegg Brilliant Diamond' (Brilliant), 'Gutbier V-14 Glory' (V-14), and 'Mikkel Triumph' were evaluated chronologically based both on the number of days after the start of short days and on the number of days after anthesis. Seventy days after the start of short days, 'V-14' had the least abscission of the tested cultivars in the greenhouse or postharvest environment, while 'Lady' had the greatest abscission. In contrast, 7 days after anthesis, 'V-14' had the greatest abscission in the postharvest environment while 'Brilliant' and 'Dark Red' had the least abscission. The difference in 'V-14' ranking between evaluation method was due to 'V-14' reaching anthesis 7–10 days later than the other cultivars. Abscission was greater in the postharvest environment than in the greenhouse, probably due to the reduced photosynthetic photon flux (PPF) levels in the postharvest environment (5.1 mol·d^{-1}·m^{-2} PPF in the greenhouse compared to 0.29 mol·d^{-1}·m^{-2} PPF in the postharvest environment).**

Cyathia abscission in poinsettia can be a problem both prior to anthesis and during marketing (2). Abscission seems to be caused by a modification of source/sink relationships in the plant due to environmental stresses such as low irradiance, high temperature, or water stress (2, 3, 4, 5, 7). These environmental stresses appear to reduce carbohydrate availability to cyathia, causing them to abscise (2).

Information on occurrence of cyathia abscission for different cultivars is limited. Scott et al. (4) observed that 'V-14' had less cyathia abscission than 'Dark Red Hegg' or 'Mikkel Improved Rochford' after being held in either a dark or lighted postharvest environment. This was attributed to 'V-14' being more tolerant of stress than other cultivars (3). Because the date of anthesis was not reported for these experiments, it is not possible to determine if plants of all cultivars were at the same stage of physiological development during the experimental treatments. Differences in abscission may have been due to differences in physiological age of the cyathia rather than any specific cultivar differences.

The objective of this research was to determine if there was variation in cyathia abscission among poinsettia cultivars held in a greenhouse or in a simulated postharvest environment when evaluated on both a chronological and physiological basis.

Rooted cuttings of 'Annette Hegg Dark Red' (Dark Red), 'Annette Hegg Lady' (Lady), 'Annette Hegg Brilliant Diamond' (Brilliant), and 'Gutbier V-14 Glory' (V-14) from Paul Ecke Poinsettias, Encinitas, Calif., and 'Mikkel Triumph' from California–Florida Plant Corp., Fremont, Calif., were received 25 Aug. 1983 (Expt. 1) and 22 Sept. 1983 (Expt. 2). One cutting was planted per 10-cm plastic pot (an experimental unit) in VSP medium (Michigan Peat Co., Houston, Texas) composed of 2 peat : 1 perlite : 1 vermiculite (by volume) amended with dolomitic limestone, superphosphate, and trace elements. Plants were placed in a glass greenhouse and grown single stem at a spacing of 33 plants·m^{-2}. Plants for Expt. 1 were initially grown under natural daylight (ND), and plants for Expt. 2 were initially grown under ND plus 4 hr (2200 HR to 0200 HR of 5 μmol·s^{-1}·m^{-2} PPF from 60 W General Electric incandescent lamps (General Electric Co., Cleveland, Ohio) to prevent flower initiation. Short days (SD) were initiated 1 Sept. (Expt. 1) and 1 Oct. (Expt. 2) by pulling black sateen cloth over plants from 1600 HR to 0800 HR daily. The SD were maintained throughout both experiments.

The night temperature (NT) during vegetative growth was 18°C and was set at 16° when SD started. Day temperature (DT) and venting temperature were set 3° and 6° above the NT. When 50% of the plants for each cultivar reached visible bud (about 28 to 35 days after the start of SD), half of the plants were moved to a 21° NT greenhouse. Plants remained at the 2 NT until anthesis. Plants were fertilized with 260 mg·liter^{-1} N, 130 mg·liter^{-1} K, and 0.1 mg·liter^{-1} Mo. Chlormequat chloride (2-chloro-*N*,*N*,*N*-trimethylethanaminiumchloride) was applied as a foliar spray for height control at 1500 mg·liter^{-1} at the start of SD and one week later, and at 750 mg·liter^{-1} after 3 weeks of SD.

When 50% of the plants in each cultivar reached anthesis, half of the plants were moved and evaluated in a simulated post-

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Table 1. Number of days to anthesis for 5 poinsettia cultivars grown at 16°C until visible bud (about 28 days from the start of SD), then at 16° or 21° night temperature to anthesis.

	No of days to anthesis			
	Expt. 1[z]		Expt. 2	
Cultivar	16°C	21°C	16°C	21°C
Annette Hegg Dark Red	54 a[y]	51 a	65 b	56 a
Annette Hegg Lady	56 a	52 a	63 b	57 a
Annette Hegg Brilliant Diamond	54 a	50 a	58 a	55 a
Gutbier V-14 Glory	63 b	60 b	70 c	64 b
Mikkel Triumph	54 a	56 ab	65 b	59 a

[z]Short days started on 1 Sept. and 1 Oct. for Expt. 1 and Expt. 2, respectively.
[y]Mean separation within columns using Duncan's multiple range test (5% level).