Table 2. Effects of arbutin on spore germination and growth of *B. cinerea*, *M. piriformis*, and *P. expansum*.

Arbutin (mg·liter^{-1})	Growth (mm)[z]			Germination (%)[y]		
	B. cinerea	*M. piriformis*	*P. expansum*	*B. cinerea*	*M. piriformis*	*P. expansum*
0	46.5	41.0	50.6	31.0	47.7	29.0
100	45.4	40.3	50.3	27.0	30.6	22.5
200	45.8	37.7	50.8	32.0	30.3	24.3
300	43.2	38.1	51.0	26.5	32.5	22.5
400	41.7	37.4	50.7	28.0	32.4	20.0
500	41.3	35.5	51.0	28.5	33.2	21.0
Significant effects						
Linear regression	**	**	NS	NS	NS	*
Intercept	46.82	40.89	---	---	---	26.73
Slope	−0.011	−0.010	---	---	---	−0.014

[z]Each value represents colony diameter on 4 replicate plates at 20°C after 6, 2, and 6 days for *B. cinerea, M. piriformis,* and *P. expansum*, respectively.
[y]Each value represents germination of 100 spores per plate on 4 replicate plates at 20°C after 6, 8, and 16 hr for *B. cinerea, M. piriformis*, and *P. expansum*, respectively.
**,*,NSLinear regression of growth or germination on arbutin concentration significant at 1%, 5%, and nonsignificant, respectively.

bulbs stimulated germination of conidia of *B. cinerea*, while a breakdown product, anthocyanidin, was slightly toxic. In this study, we found that chlorogenic acid simulated both germination and growth of *B. cinera*. Dubernet and Ribereau-Gayon (4) concluded that *B. cinerea* possesses a polyphenol oxidase (laccase) that degrades several phenolic substances such as chlorogenic acid, anthocyanins, tannins, and vanillic acid.

From a previous study (1), the amounts of chlorogenic acid and arbutin in pear fruit were low, about 12–60 mg·liter^{-1} in flesh tissues and 240–480 mg·liter^{-1} in peel tissues. Although the phenolic amounts in flesh may be too low to have inhibitory effects on decay pathogens, the phenolics in peel are in the approximate concentration range found to be inhibitory to certain fungi in this study. Spotts (8) reported that *B. cinerea, M. piriformis*, and *P. expansum* caused decay of detached, wounded 'd'Anjou' and 'Bartlett' pear fruit but not of nonwounded fruits. Thus, the role of specific phenolics in resistance of pear fruit to certain decay fungi merits further study, particularly where mechanical injuries do not penetrate very deeply beneath the skin surface.

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Influence of Simulated Shipping on the Interior Performance of Poinsettias

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Additional index words. abscission, chilling, temperature, postproduction, *Euphoribia pulcherrima*

Abstract. **'Gutbier V-10 Amy' ('Amy') poinsettia lost more leaves and cyathia after simulated shipping at different temperatures (4°, 16°, or 24°C) and 30 days under interior conditions than 'Annette Hegg Dark Red' ('AHDR') plants. 'Amy' and 'AHDR' plants lost a large number of leaves when shipped for more than 4 days at 24°. 'Amy' quality was reduced when shipped at 4° due to chilling injury (white lesions on bracts). Bracts less than 2.5 cm long were most sensitive to this injury.**

Poinsettia production has been increasing in the southeastern United States (8), and plants are transported and sold throughout the eastern United States. Plants are typically sleeved, boxed, and then shipped for 2–7 days before being sold in retail outlets. In recent years, growers have encountered problems with leaf yellowing and abscission during shipping of 'Amy' poinsettia.

Previous research has shown that shipping temperatures and duration affect postproduction quality of 'Gutbier V-14 Glory' ('Glory') (5, 6), 'AHDR', and 'Annette Hegg Supreme' (5, 6, 7) poinsettias. Best quality 'Glory' poinsettia plants were obtained at storage temperatures of 13°C, while reduced epinasty and highest quality plants were observed in the other 2 cultivars at 10°. Plant quality decreased with increased shipping duration, but only 28% of leaves abscised on 'Glory' after 6 days at 18°. Leaf yellowing and abscission have not been reported for other poinsettia cultivars following shipping. Sleeving of poinsettias prior to boxing caused leaf epinasty in some cultivars such as 'AHDR', but not 'Amy' (3). The study reported here was conducted to evaluate effects of simulated shipping temperature and duration on the interior performance of 'AHDR' and 'Amy' poinsettias.

Rooted cuttings of 'Amy' and 'AHDR' poinsettias were obtained from a commercial source on 8 Sept., planted one per 15-cm container in Metro-Mix 500 (W.R. Grace, Cambridge, Mass.), and placed in a poly-

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Table 1. Response of 2 poinsettia cultivars to simulated-shipping duration and temperature after removal, and 30 days under interior conditions.

Simulated shipping temp (°C)	Simulated shipping time (days)	No. leaves abscised/plant[z]		No. cyathia abscised/plant[z]		Visual grade[z,y]		No. leaves abscised/plant[x]		No. cyathia abscised/plant[x]	
		Annette Hegg Dark Red	Gutbier V-10 Amy	Annette Hegg Dark Red	Gutbier V-10 Amy	Annette Hegg Dark Red	Gutbier V-10 Amy	Annette Hegg Dark Red	Gutbier V-10 Amy	Annette Hegg Dark Red	Gutbier V-10 Amy
4	1	0	0	0	1	5	4	4	4	49	84
	4	0	3	0	9	4	2	4	38	54	59
	7	0	3	0	10	4	1	3	32	52	68
16	1	0	0	0	1	4	4	3	18	47	77
	4	0	4	2	17	3	2	5	21	43	70
	7	2	25	13	43	4	2	3	45	50	76
24	1	0	0	0	0	5	3	3	13	43	77
	4	11	12	2	35	3	2	11	22	68	72
	7	12	36	21	51	3	1	12	39	66	67
Cultivar		**		**		**		**		**	
Time		**		**		**		**		NS	
Temperature		NS		**		NS		NS		NS	
Cultivar × time		**		**		**		**		**	
Cultivar × temp		NS		**		NS		*		NS	
Time × temp		**		**		NS		**		NS	
Cultivar × time × temp		NS		NS		NS		NS		NS	

[z]Observations made when each treatment was removed from simulated shipping.
[y]Visual grade evaluated on a scale of 1 to 5: 5 = excellent (red bracts, no leaf yellowing); 3 = good (moderate bract fading and 25% of leaves yellowing); and 1 = poor (faded bracts, yellow or abscissed leaves).
[x]Observations made following 30 days under interior conditions.
[NS,**]Nonsignificant (NS) or significant at 5% (*) or 1% (**) level.

ethylene covered greenhouse in Gainesville, Fla. Plants were pinched to 5 nodes 3 weeks after planting. Minimum night temperatures were 18°C from planting to the beginning of bract color (5 Nov.) and 16° until anthesis (5 Dec.). Plants were provided noninductive photoperiod conditions until 10 Oct., when long nights were initiated by covering plants with an opaque polypropylene cover from 1700–0800 HR daily until anthesis. Plants were watered as needed with a 300 mg·liter^{-2} N solution from a 20N–4.4P–16.6K soluble fertilizer. Plants were drenched with 180 ml of a 2950 mg·liter^{-2} solution of 2-chloro-*N,N,N*-trimethylethanaminion chloride (chlormequat chloride) on 5 Oct. to maintain plant height.

At anthesis, plants were sleeved, boxed, and placed into temperature-controlled chambers at 4°, 16°, or 24°C for 1, 4, or 7 days. Plants were removed from the boxes and placed in an evaluation room (21° ± 1°, 50% ± 10% RH, with lighting from cool-white fluorescent lamps at 20 μmol·s^{-1}·m^{-2} for 12 hr daily) at each removal time. Plant quality was evaluated [5 = excellent (red bracts, no leaf yellowing); 3 = good (moderate bract fading and 25% of leaves yellowing); and 1 = poor (faded bracts, yellow, or abscised leaves)] and abscised leaves and cyathia were counted after removal from simulated-shipping chambers and 30 days later at termination of the interior holding period. A randomized block design with 3 blocks was used and 4 plants constituted each experimental unit.

More leaves and cyathium abscised from plants of 'Amy' than from 'AHDR' following 7 days of shipping at 4°, 16°, or 24°C and cyathia abscission for 'Amy' was higher than for 'AHDR' at all temperatures when plants were held for 4 days or longer (Table 1). There was no leaf abscission on 'Amy' following one day of shipping, regardless of temperature. The greatest abscission of leaves and cyathia from 'Amy' plants occurred when plants were held for 7 days at 16° or 24°. 'AHDR' lost the most leaves when shipped for 4 or 7 days at 24°. Cyathia drop for 'AHDR' was observed only when the plants were shipped for 4 or 7 days at 16° or 24°. Plant quality was reduced substantially on 'Amy' plants shipped at 4° due to white lesions on the bracts. Some plants had 75% of the bracts exhibiting white lesions following 7 days of storage; bracts less than 2.5 cm in length were nearly white. Stems of chilled 'Amy' bracts had extensive latex eruption. Some white lesions were present on 'AHDR' bracts, but damage was slight and was restricted to the small bracts.

After 30 days indoors, bract color of both cultivars had faded from red to light pink, rendering the plants poor to unacceptable (data not shown). 'Amy' bracts faded after 7 days. Substantial leaf abscission occurred in interior conditions and was affected strongly by previous simulated shipping time and cultivar. 'Amy' lost more leaves overall than 'AHDR'. The fewest leaves abscised from plants that had been held previously at 4° C for one day. All other shipping temperatures and durations resulted in a large number of abscised leaves. The number of abscised leaves increased with 4 and 7 days of shipping for 'AHDR' at the highest temperature, but no adverse effects were observed at 4° and 16°. Shipping duration and temperature did not affect cyathia loss.

The cause of severe leaf and cyathia abscission in 'Amy' after simulated shipping is not known but may relate to its sensitivity to ethylene or to its light compensation point (LCP). Epinasty in some poinsettia cultivars has been related to ethylene generation following mechanical bending during plant sleeving (3). Although 'Amy' has been classified as tolerant to epinasty, it is possible that leaf abscission under interior conditions results from generation of low levels of wound ethylene.

'Amy' bracts shade most of the leaf canopy, greatly reducing light intercepted by the leaves in the evaluation rooms. This shading might also account for leaf abscission from 'Amy' plants, as has been observed in non-acclimatized foliage plants (1, 2). Light intercepted by the leaves may be below the LCP of 'Amy'. Modification of cultural procedures may be valuable in production of 'Amy', since plant maturity, production temperature (4), and increased fertilizer rates (6) have affected postproduction leaf and cyathia abscission in other poinsettia cultivars.

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Interaction between an Indigenous Endomycorrhizal Fungus and Mineral Nutrition of *Rosa multiflora* Understock

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Abstract. **Disbudded 'Brooks 56' *Rosa multiflora* Thunb. plants were grown in 0.01 or 0.1 Steiner solutions and inoculated with indigenous vesicular–arbuscular mycorrhizal fungal (VAMF) species, *Glomus fasciculatum* (Thax. sensu Gerd.) Gerd. and Trappe. Inoculation resulted in a significant increase in both fresh and dry weight of the *R. multiflora* plants. Increasing the Steiner solution from 0.01 to 0.1 resulted not only in a significant decrease in the rate of VAMF infection, but also in a significant increase in the fresh and dry weight of the multiflora understock.**

The amount of plant tissue (roots) in the world infected by vesicular–arbuscular endomycorrhizal fungi (VAMF) exceeds that infected by any other group of fungi (8, 9). The fungi are found primarily in the cortex of the living plant root (8) but can also colonize organic fragments (25), weed seeds (24), and other ecological niches that may provide appropriate environments, such as portions of dead insects. The mycorrhizal–root association is recognized as a symbiotic interaction (4, 8). Recent research suggests that this relationship can be manipulated to improve economical use of superphosphate fertilizers and increase exploitation of less-soluble rock phosphate (1, 4, 9). Mycorrhizal fungi increase both water and nutrient uptake by increasing the volume of soil explored (11). The fine mycorrhizal roots with increased surface area and length per unit weight are able to draw both water and inorganic phosphorus (P_i) from a greater volume of soil and increase plant uptake (6, 7, 12, 16).

In general, VAMF are more prevalent in plants grown in low-fertility soils (3, 9, 11) than in those grown in fertile conditions. A balanced high-mineral nutrition may reduce the degree of infection, whereas a low or unbalanced nutrient supply may increase it (3, 11, 13). Graham et al. reported that foliar application of P_i inhibited VAMF infection of onion, demonstrating that P_i concentration in the host plays an important role (10). Nitrogen, complete fertilizer, and bacterial fertilizer can also reduce mycorrhizal infection in the field (11).

The droughty, infertile soils of East Texas support one of the 2 major centers of field rose bush production in the United States—worth an estimated $15 million (23). Although much is known about specific elemental leaf tissue levels needed for optimum growth (26), few data have been published concerning specific fertilizer requirements for field roses in Texas or the United States; however, Seeley and Davidson (21) found that roses require more P than is needed by peach and apple trees and other horticultural crops.

Little information is available on the occurrence of mycorrhizal fungi in *Rosa* spp., and no information is available on responses of roses to VAMF. Malloch and Malloch (15) reported roots of 3 Rosaceous plants to be endomycorrhizal, but other Rosaceae, including *Rosa acicularis* Lindl., completely lacked mycorrhiza. They concluded that the mycorrhizal status of the Rosaceae may be correlated with subfamily, i.e., the 4 species of Rosoideae they examined were weakly or nonmycorrhizal and 2 species of the Maloideae showed well-developed endomycorrhizae.

Paterson et al. (18) were the first to show that commercial rootstock plants of *R. multiflora* (subfamily Rosoideae) grown in East Texas were heavily infected with *G. fasciculatum*. Furthermore, it was found that the use of methyl bromide in field soil fumigation experiments significantly reduced VAMF infection in both root and soil samples of *R. multiflora* ('Brooks 56') understock (18). This reduction of VAMF may affect mineral uptake and growth of *R. multiflora*. The following study was designed to investigate the effects of 2 levels of a nutrient solution and an indigenous VAMF on the nutritional uptake and growth of *R. multiflora* understock grown under hydroponics.

Four uniform, disbudded 20-cm *R. multiflora* understock hardwood cuttings were planted in each of sixty-four 15-cm cans placed in eight 27 × 61-cm metal containers filled with extra-coarse silica sand. Four 5-mm holes were punched in the bottom of each can. Four of the large metal containers were subirrigated for 15 min with a 0.01 aerated Steiner solution and 4 with a 0.1 aerated Steiner solution (22) to a height of 5 cm and then drained 5 times a day with a soxhlet

Table 1. Influence of VAMF and nutrient solution concentration on fresh and dry weight and % VAMF infection (percentage) of *R. multiflora* understock.

Steiner solution Concn	Fresh wt/4 plants (g)			Dry wt/4 plants (g)			Infection (%)		
	VAMF			VAMF			VAMF		
	Dead	Live	Avg	Dead	Live	Avg	Dead	Live	Avg
0.01	25	33	29 B[z]	7.2	9.2	8.2 B	7	85	46 A
0.1	54	64	59 A	13.4	17.3	15.3 A	0	16	8 B
Avg	39 b	48 a		10.3 B	13.3 B		4 B	26 A	

[z]Mean separation between VAMF treatments or between concentrations by F test at 5% (lower case letter) or 1% (upper case letter).

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