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Comparison of Conditioning, Precooling, Transit Method, and Use of a Floral Preservative on Cut Flower Quality[1,2]

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Abstract. **Excessive temperatures recorded within flower boxes on transcontinental refrigerated trucks were avoided by using an integrated system of preshipment cooling with forced-air, standardized containers and appropriate stacking pattern. The longevity and quality of flowers shipped from California to Florida by refrigerated trucks were comparable to or better than that of air-shipped flowers. Preshipment conditioning treatments did not improve flower longevity of shipped roses, carnations or gladioli. Preconditioning chrysanthemum stems in $AgNo_3$ solution eliminated the need to recut stems after shipment. Carnations and gladioli handled dry lasted as long as conditioned flowers. Floral preservative used on roses and carnations after shipping had a more positive affect on longevity than any other handling treatment.**

Half of the floral production grown in California is distributed by refrigerated truck to distant markets. The remainder is sent by air freight. Air rates to many markets are nearly twice those charged for refrigerated truck delivery. Thus, California shippers have a strong economic motive to utilize refrigerated trucks.

Most previous studies on cut flower transportation involved air shipment (1, 2, 10, 11, 12, 13, 19, 20), while a few other studies evaluated transit times and temperatures on truck shipments (9, 14) or evaluated handling flowers under simulated transport conditions (3, 4, 5, 7, 8, 15, 17, 18, 21, 22, 24, 26). Halevy et. al. (9) evaluated transcontinental truck shipments of cut carnations, chrysanthemums and roses. Best results were obtained when the flowers were pretreated after harvest with a chemical solution for 16 hr, precooled prior to shipment and transported in insulated boxes. However, in a later study, simulated shipments of 'Cara Mia' roses in non-insulated boxes under hot summer stress conditions (8) indicated good quality can be maintained if the blooms are cooled with forced-air after packaging, held at 6°C during transit and placed in a floral preservative at the consumer level. Effective temperature management has not been available for most cut flower shipments made by air or truck (6, 19).

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This study included many preliminary shipments during 1976 and 1977, the results of which support these observations. Thermorecorders were packed with flowers in boxes and shipped to various markets to characterize the temperatures that occurred in commercial refrigerated truckloads of non-cooled flowers. An example of poor temperature management that occurred when flowers were shipped during heat stress periods (July, 1977) with incomplete refrigeration and inadequate precooling is presented. Results from 3 experimental transcontinental truck shipments made after commercial facilities for cooling with forced-air became available in September, 1977, also appear in this paper. The studies were designed to characterize the temperatures provided in commercially precooled truckloads of flowers and to gather more information on the influence of cooling with forced-air and post-harvest conditioning treatments on quality of California-grown cut flowers.

Materials and Methods

Test 1

Monitoring temperatures of uncooled carnations in a refrigerated truck-trailer. Thermorecorders were attached to wooden cleats and packed among carnation flowers at Salinas and Watsonville, California, during the early morning of July 30. Nonvented, fiberboard, full telescope containers (122 × 51 × 30 cm) were used for the test shipment. After packing, the boxes of flowers were held at ambient temperature (17.5°C) until they were placed aboard a nonrefrigerated truck and transferred to a nonrefrigerated freight consolidation dock at Santa Clara, California. The test boxes were loaded mid-point in a refrigerated trailer (Fig. 1) 12 hr after packing for transit to Alsip, Illinois. The refrigeration in the trailers used in this and the other experiments was produced by a thermostatically controlled mechanical unit. Cooled air was introduced through a canvas duct into the top of the load about two-thirds from the front of the trailer. The return air was drawn around and through the load, and back to the refrigeration unit located at the front of the trailer. The load in this experiment consisted of many types, sizes and shapes of fiberboard containers. This prevented an organized stacking pattern which would have allowed refrigerated air to flow efficiently through the load. One thermorecorder was placed in the refrigerated air output duct to measure the temperature of the air cooled by the refrigeration unit during transit. Flower longevity was not evaluated in this shipment.

Test 2

Monitoring temperatures of precooled cut flowers in a refrigerated truck-trailer. Commercial facilities for cooling with

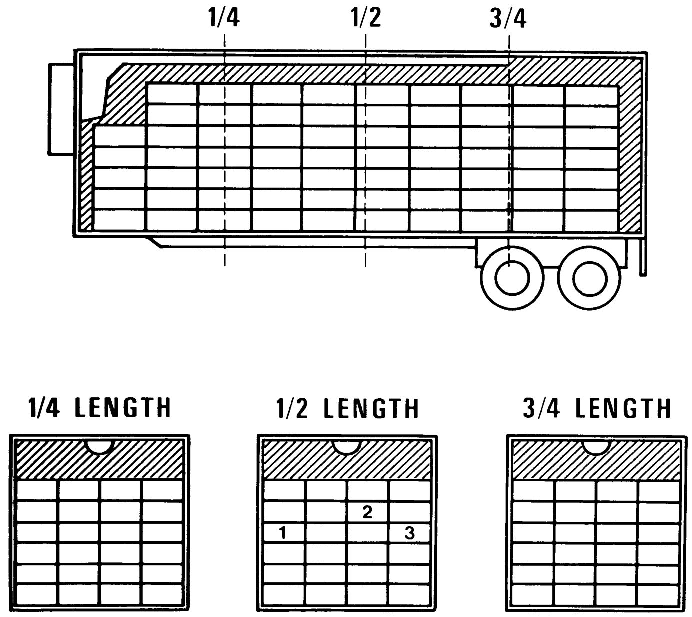

Fig. 1. Location of non-vented, full telescope type fiberboard containers of carnations and thermorecorders on a refrigerated truck-trailer of mixed cut flowers in non-standard containers, California to Illinois, July 1977.

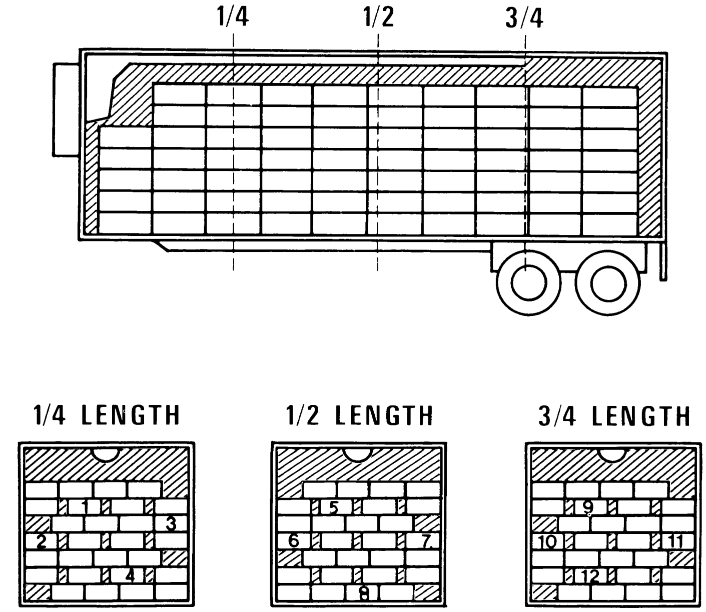

Fig. 2. Location of precooled full telescope type fiberboard containers of mixed flowers and thermorecorders on a precooled refrigerated truck-trailer of standardized mixed cut flower containers. California to Hampton, South Carolina, September 1977.

forced-air (6, 23) became available in September 1977, as did standardized fiberboard full telescope shipping containers designed with vents that can be closed (8). Container dimensions were the same as those in Test 1. Thermorecorders were attached to wooden box cleats and packed among mixed cut flower blooms in 12 containers at ambient temperature (24°C). The entire refrigerated truck-trailer load of floral products (310 containers) was cooled with forced-air for 1 hr at 1°C and 95% relative humidity (RH). The cooled boxes were loaded directly from the cooling facility into a refrigerated truck-trailer with the test boxes placed as diagrammed in Fig. 2. All test boxes were shipped from Sunnyvale, California to Hampton, South Carolina. Boxes located in the rear quarter or center of the trailer were set aside and left on board during the unloading of surrounding boxes at delivery points between Sunnyvale and Hampton. The test boxes at the front of the trailer remained undisturbed until delivered to the wholesaler in Hampton.

Tests 3 and 4

Comparison of transcontinental air and refrigerated truck shipments of four major cut flower crops. Two transcontinental cut flower test shipments were conducted in the fall of 1977 to evaluate 1) the influence of preshipment conditioning treatments, 2) cooling with forced-air and 3) consumer level handling treatments on the longevity of 'Cara Mia' roses, 'White Sim' carnations, 'White Albatross' chrysanthemums and 'Snow Velvet' gladioli.

Roses and carnations (October shipment, Test 3). 'Cara Mia' roses and 'White Sim' carnations were harvested from greenhouses at Watsonville the morning of October 24. Flowers were graded, bunched into groups of 25 and held dry until conditioned or "pulsed" with chemicals. Shipments by air and by refrigerated truck were made the following day from Sunnyvale, CA to Bradenton, Florida. Handling methods and conditioning treatments differed for the 2 flowers.

The roses were placed in conditioning solutions for 1 hr in the grading room (18°C) and then refrigerated at 5° until packed at Sunnyvale the following day. The 3 conditioning solutions consisted of deionized (DI) water containing either 300 ppm citric acid (Cit), Rogard floral preservative, 1:100 dilution, or 300 ppm Cit + 0.5% sucrose (Su).

The carnations were held dry after bunching and transported dry in fiberboard boxes by nonrefrigerated van from Watsonville to Sunnyvale – a distance of 80 km. Conditioning treatments began at 4:00 PM on the day of harvest and were continued until 8:00 AM the following day when the blooms were packed for transit tests. Groups of carnations were conditioned in 1 of 3 ways:

1. Blooms held dry until received at Bradenton. Dry blooms were packed in vented, full telescope type fiberboard boxes, cooled with forced-air at 1°C for one hour and held at that temperature until packed for shipment the following day.
2. Blooms conditioned overnight (16 hr) in DI water at ambient temperatures (12° – 27°C).
3. Blooms conditioned overnight (16 hr) at ambient temperatures in DI water containing 200 ppm Physan-20 + 10% Su. Physan-20 contains 10% n-alkyl (60% C_{14}, 30% C_{16}, 5% C_{12}, 5% C_{18}) dimethyl benzyl ammonium chlorides, and 80% inert ingredients. It is distributed by Consan Pacific, Inc., P. O. Box 208, Whittier, California 90608.

Chrysanthemums and gladioli (November shipment, Test 4). 'Albatross' standard chrysanthemums ("commercial harvest" stage) were harvested from a greenhouse in Watsonville on November 7 and conditioned overnight (18 hr) in the packing room at ambient temperatures (10-24°C). Conditioning solutions were DI water or DI water containing 25 ppm silver nitrate ($AgNO_3$). The initial level of water or solution in each container was 10 cm. New plastic containers were used for conditioning to minimize the initial level of microorganisms. Flowers were removed the following morning and transported dry without refrigeration to Sunnyvale in fiberboard boxes (about 1 hr at 18° ambient). Flowers were packed for shipment at ambient temperature (18°).

Chrysanthemums were conditioned and shipped with one of two stem lengths (60 or 65 cm). The objective was to determine if flowers could be conditioned to rehydrate and regain turgor after shipping. Upon arrival at Bradenton or San Jose, 5 cm were cut from the 65 cm stems, while the 60 cm stems were not trimmed.

'Snow Velvet' ('Snow White') gladioli were harvested from the field at Fremont, CA on November 7. Two stages of maturity were selected: "commercial harvest" stage with color showing on basal florets and "tight bud" stage without color showing on basal florets (about 2 days less mature than the "commercial harvest" stage). The spikes were transferred dry to Sunnyvale under nonrefrigerated conditions (40 min at 24°C) and subjected to the following overnight treatments:

a) "Commercial harvest" stage gladioli held dry. These were placed in vented boxes upon arrival at Sunnyvale and cooled with forced-air for 1 hr at 1°C and 95% RH. They were then held at this temperature and RH for 16 hr until packed for transit the following day.
b) "Commercial harvest" stage gladioli held in DI water at 1°C for 16 hours until packed the following day.
c) "Tight bud" stage gladioli were conditioned overnight at ambient temperature (18°C) in DI water containing 25 ppm $AgNO_3$, 200 ppm 8-hydroxyquinoline citrate (HQC), and 300 ppm aluminum sulfate $(Al_2(SO_4)_3 \cdot 18 H_2O]$, and 20% Su.

The spikes were also cut to 110 cm prior to conditioning overnight at the shipping room.

Handling, packing and shipping treatments. All flowers were transported in full telescope type fiberboard boxes of the same dimensions with a thermorecorder placed in the same manner as described in Test 2. Test bunches of flowers were packed in the boxes after the conditioning treatments and refrigeration-roses with 18.2 kg of crushed ice; carnations, chrysanthemums, and gladioli without ice. Test bunches of roses and carnations were each packed in separate boxes among other blooms of the same respective type (600 flowers per box). The chrysanthemums and gladioli were packed together with pompons to fill the containers. The boxes in Tests 3 and 4 were transported to San Jose (i.e., not shipped) or shipped by air or by refrigerated truck to Bradenton. Flowers that were *cooled after packing* were packed into vented boxes at ambient temperature (24°C) and then cooled with forced-air at 1°C and 95% RH for one hour. Those for evaluation at San Jose (not shipped) were unpacked immediately after cooling and transported to San Jose. The vent covers of boxes for shipment were secured with metal staples. Flowers that were *not cooled after packing* were packed at ambient temperature (24°C) into nonvented boxes. Those for evaluation at San Jose were held for 1 hr at ambient temperature then unpacked and transported as above.

Flowers not shipped were evaluated beginning immediately after transfer (20 min travel time by pickup truck at 24°C) to San Jose. Flowers shipped by air arrived at Bradenton either October 27, 56 hr after packing, or November 10, 48 hr after packing. Flowers shipped by truck arrived either October 29, 108 hr after packing, or November 12, 80 hr after packing. In both instances flowers were left in boxes, refrigerated overnight and unpacked the following morning. In Test 3, the foliage was removed from lower portions of rose and carnation stems and 5 cm of each stem cut off before blooms were placed in the vase. In Test 4, either 5 cm of each chrysanthemum stem was cut off or the stem was placed directly in water. Gladiolus stems were cut to 20 cm lengths and rachis trimmed to 10 florets.

Rose and carnation longevity was evaluated both in DI water and in DI water containing Oasis floral preservative (20 g/liter). Chrysanthemum and gladiolus longevity was determined in DI water. The keeping room at Bradenton was maintained at 23.5°C and 1 klx of cool white fluorescent light was provided for 12 hr per day. A similar light source and intensity was used at 21° at San Jose, but the duration of lighting was 24 hr per day. The relative humidity was 75 to 80% at Bradenton and 60 to 70% at San Jose.

Rose life was considered terminated when stems, leaves, or petals wilted, when petals abscised, or when stems developed the condition termed "bent neck." The last condition may be described as one in which the stem below the flower bud loses its turgidity and wilts. Carnation longevity was considered terminated when petal margins began to wilt or reflexed upward ("sleepiness"). Chrysanthemums were terminated when the blooms lost turgidity, or when the foliage wilted or became chlorotic. Gladioli were discarded when one or more petals of the basal-floret wilted. Vase longevity is reported in days as the average of three vase replications containing four blooms each (three blooms each for the chrysanthemums).

Results

Test 1

Monitoring temperatures of uncooled carnations in a refrigerated truck-trailer. The temperature data (Fig. 3) gathered from this shipment illustrate the lack of temperature control within flower boxes that can occur where an integrated system of precooling and refrigerated transit does not exist. The flowers warmed rapidly after packing when exposed to a non-refrigerated truck transit and consolidation dock environment. Once aboard the refrigerated truck, the cool air did *not* reduce the temperature of the 3 test boxes adequately (Fig. 1). The truck refrigeration unit functioned satisfactorily but the blooms did not cool sufficiently during transit.

Test 2

Monitoring temperatures of precooled cut flowers in a refrigerated truck-trailer. Data summarized from the thermorecorders indicate that flower temperatures measured in test boxes placed throughout the load (Fig. 2) stayed well below 4°C for the entire trip (Fig. 4). The highest temperatures

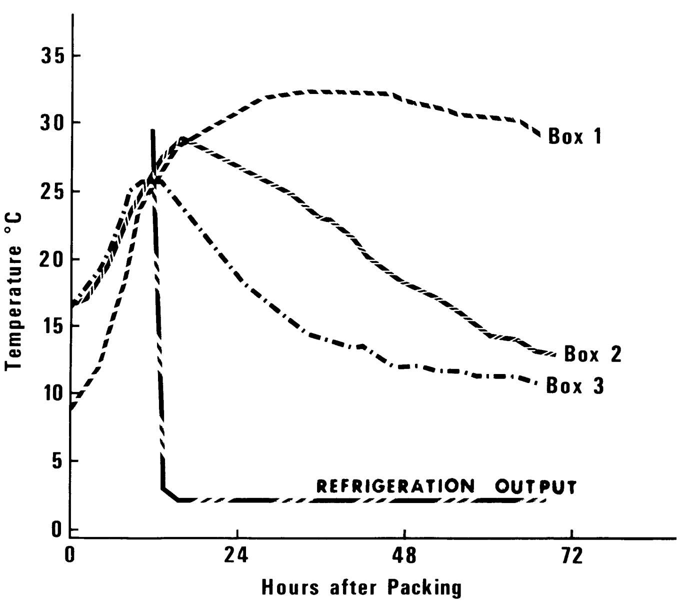

Fig. 3. Transit temperatures in fiberboard containers of non-cooled carnations located on a non-precooled refrigerated truck-trailer among different sized fiberboard containers of mixed flowers. Shipment made during a high temperature stress period, California to Illinois, July 1977.

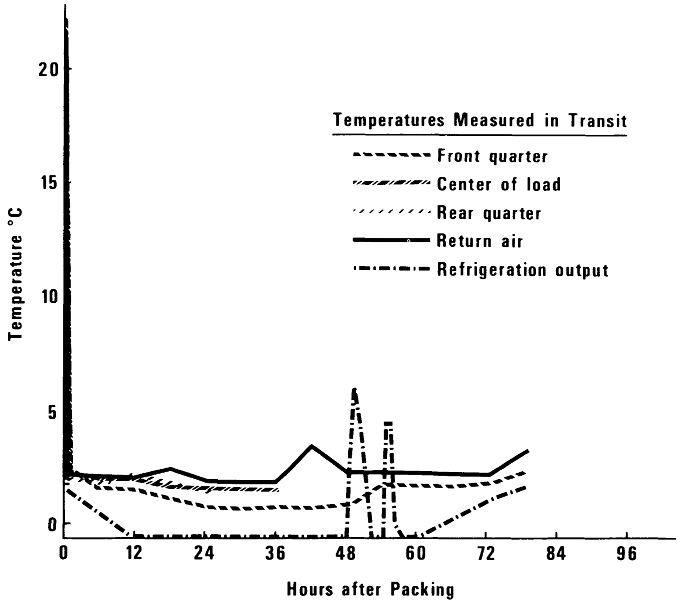

Fig. 4. Transit temperatures measured by thermorecorders located in full telescope fiberboard containers of mixed cut flowers. Standardized containers of cut flowers were precooled with forced-air, California to South Carolina, September 1977.

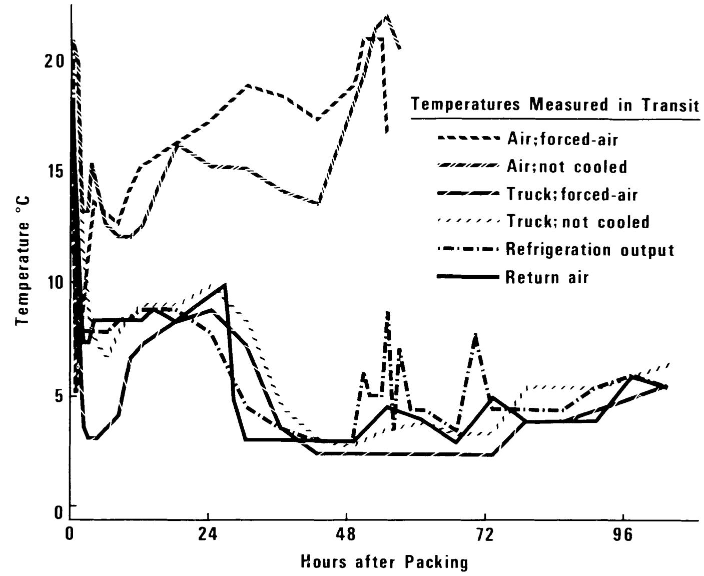

Fig. 5. Transit temperatures measured in fiberboard containers of carnations shipped by air or refrigerated truck. Entire truck load precooled with forced-air except where noted, California to Florida, October 1977.

within the boxes occurred when the temperatures of the truck rose a few degrees near the end of the trip. It is not known whether the refrigeration unit malfunctioned or if the driver adjusted the thermostat.

The receiver observed some bruising of chrysanthemum petals, but the flowers were not cold-injured during shipment. No attempt was made to evaluate flower longevity in this experiment. These temperature data indicate that flowers can be delivered to distant markets by refrigerated trucks with acceptable temperatures being maintained within the load (2°C) provided the flowers are precooled to that temperature before the truck is loaded.

Tests 3 and 4

Comparison of transcontinental air and refrigerated truck shipments of 4 major cut flower crops. Representative transit temperatures measured when roses and carnations were shipped in October to Bradenton are illustrated in Fig. 5. Temperatures measured in precooled flower boxes shipped by refrigerated truck to Hampton in the preceding experiment (Fig. 4) were more uniform than those measured in this shipment. Excessive rewarming in the Bradenton shipment occurred during the first 24 hr of truck transit time, indicating that the thermostat was set too high or the refrigeration equipment malfunctioned. The temperature of the noncooled boxes dropped to levels maintained within the trailer within 6 hr, illustrating that the pigeonhole stacking pattern (Fig. 2) permitted adequate air flow for cooling the boxes in a relatively short time.

Forced-air cooling of flowers shipped by air freight lowered temperatures for only a short period of time (Fig. 5). The temperatures increased rapidly after the air-freighted box was removed from refrigeration and remained high throughout the transit period.

Roses. The influence of preshipment conditioning and temperature management, method of shipment and use of floral preservative during evaluation on the longevity of 'Cara Mia' roses is summarized in Table 1. Overnight conditioning treaments at the greenhouse had no affect on longevity. In addition, neither preshipment temperature management nor methods of transit influenced longevity. An exception was observed in the non-shipped roses evaluated in floral preservative. Those not cooled after packing kept much better than the others. The reason for this is not known. The use of floral preservative in the evaluation vase greatly increased longevity of roses regardless of other treatment. Floral preservative also virtually eliminated bent neck in all treatments (Table 2). Conditioning at the greenhouse or cooling with forced-air, on the other hand, did not prevent bent neck (Table 2).

Carnations. The influence of preshipment conditioning and storage treatment, temperature management, method of shipment, and use of floral preservative during evaluation on the longevity of 'White Sim' carnations is summarized in Table 3. Floral preservative in the evaluation vase exhibited a greater influence on carnation longevity than preshipment conditioning, temperature management or shipping method. Overnight conditioning in DI water with Su and Physan improved longevity of nonshipped carnations compared to that of similar blooms conditioned in DI water.

Carnations conditioned in DI water containing Su and Physan kept longer at San Jose (not shipped) than those conditioned in DI water whether or not preservative was used. Those cooled with forced-air, shipped by truck and evaluated in floral preservative also kept longer when conditioned in Su and Physan rather than DI water. Carnations handled dry and shipped by truck or air kept as well or better than similar blooms conditioned in DI water containing Su and Physan whether or not floral preservative was used. Carnations handled dry and not shipped did not perform as well as those conditioned in Su and Physan unless cooled with forced-air.

Chrysanthemums. The influence of preshipment conditioning and temperature management and method of shipment on longevity of 'Albatross' chrysanthemums is summarized in Table 4. Recutting stems increased the longevity of shipped chrysanthemums conditioned overnight in DI water. Flowers conditioned in DI water, shipped by air and not trimmed never regained their turgidity and lasted less than 1 day. Flowers similarly handled but shipped by truck lasted 3 to 5 days. Recutting the stems of non-shipped chrysanthemums conditioned

Table 1. Vase life of 'Cara Mia' roses as influenced by overnight conditioning solutions at the greenhouse, preshipment temperature management, method of shipment and the use of floral preservative during evaluation.

	Days of vase life					
	Deionized (DI) water vase solution			DI plus preservative[z] vase solution		
	California	Florida		California	Florida	
Temperature management and overnight conditioning treatments	Not shipped	Shipped by air	Shipped by truck	Not shipped	Shipped by air	Shipped by truck
Cooled with forced-air after packing:						
300 ppm citric acid (Cit)[y]	4.6a[x]	3.0a	3.0a	8.3b	5.5b	7.0b
Rogard preservative (10 ml/liter)	5.4a	3.3a	3.0a	8.6b	5.0b	6.7b
300 ppm Cit + 0.5% sucrose	4.4a	3.0a	3.0a	8.7b	5.5b	6.3b
Not cooled after packing:						
300 ppm Cit	4.6a	3.0a	3.0a	11.9c	6.0b	6.7b
Rogard preservative (10 ml/liter)	4.6a	3.0a	3.0a	10.9c	7.0b	6.7b
300 ppm Cit + 0.5% sucrose	4.0a	3.0a	3.0a	12.3c	7.0b	6.7b
Not packed and not cooled:						
300 ppm Cit	4.2a	–	–	8.2b	–	–
Rogard preservative (10 ml/liter)	4.3a	–	–	8.1b	–	–
300 ppm Cit + 0.5% sucrose	3.9a	–	–	8.0b	–	–
DI water only	4.3a	–	–	8.9b	–	–
Tap water only	4.3a	–	–	8.5b	–	–

[z]Oasis (20 g/liter).

[y]Conditioning solutions made with DI water unless otherwise specified.

[x]Mean separation by Duncan's multiple range test, 5% level; CA and FL data analyzed separately.

Table 2. Incidence of bent neck of 'Cara Mia' roses as influenced by overnight conditioning solutions at the greenhouse, preshipment temperature management, method of shipment and the use of floral preservative during evaluation.

	Bent neck after 5 days in vase (%)					
	Deionized (DI) water vase solution			DI plus preservative[z] vase solution		
	California	Florida		California	Florida	
Temperature management and overnight conditioning treatments	Not shipped	Shipped by air	Shipped by truck	Not shipped	Shipped by air	Shipped by truck
Cooled with forced-air after packing:						
300 ppm citric acid (Cit)[y]	75.0b[x]	87.5cd	95.8d	0.0a	4.2a	0.0a
Rogard preservative (10 ml/liter)	40.0b	70.8bc	91.7d	0.0a	0.0a	0.0a
300 ppm Cit + 0.5% sucrose	75.0b	79.2cd	95.8d	0.0a	4.2a	0.0a
Not cooled after packing:						
300 ppm Cit	70.0b	54.2b	87.5cd	0.0a	0.0a	0.0a
Rogard preservative (10 ml/liter)	90.0b	70.8bc	83.3cd	0.0a	4.2a	0.0a
300 Cit + 0.5% sucrose	90.0b	95.8d	87.5cd	0.0a	0.0a	0.0a
Not packed and not cooled:						
300 ppm Cit	80.0b	–	–	0.0a	–	–
Rogard preservative (10 ml/liter)	100.0b	–	–	0.0a	–	–
300 ppm Cit + 0.5% sucrose	75.0b	–	–	0.0a	–	–
DI water only	80.0b	–	–	0.0a	–	–
Tap water only	100.0b	–	–	0.0a	–	–

[z]Oasis (20 g/liter).

[y]Conditioning solutions made with DI water except as specified.

[x]Mean separation by Duncan's multiple range test, 5% level; CA and FL data analyzed separately.

in DI water had a favorable influence on longevity only when the flowers were not cooled after packing.

Chrysanthemums conditioned in $AgNO_3$ and not recut lasted as long as or longer than similar flowers conditioned in DI water and trimmed.

Recutting 20 cm of stem from chrysanthemum flowers conditioned in DI water improved longevity, but recutting 20 cm from flower stems conditioned in $AgNO_3$ did not. Moreover, flowers with $AgNO_3$ conditioned stems recut 20 cm kept better than those similarly treated that were not recut upon arrival at Florida.

Cooling the chrysanthemums with forced-air had no effect on longevity except when stems were conditioned in DI water and the stems were recut after air shipment. Chrysanthemums shipped by truck were as good or better than those shipped by air.

Gladioli. The influence of preshipment conditioning and storage treatment, early harvest-pulse treatment, temperature

Table 3. Vase life of 'White Sim' carnations as influenced by overnight conditioning solutions or storage treatment by the wholesale shipper, preshipment temperature management, method of shipment and the use of floral preservative during evaluation.

	Days of vase life					
	Deionized (DI) water vase solution			DI plus preservative[z] vase solution		
	California	Florida		California	Florida	
Temperature management and overnight conditioning treatments	Not shipped	Shipped by air	Shipped by truck	Not shipped	Shipped by air	Shipped by truck
Cooled with forced-air after packing:						
Dry	6.8cd[y]	6.8b	6.6ab	12.8h	14.3cd	14.7d
DI water	6.3bc	5.7a	6.3ab	11.1ef	13.6cd	13.1c
DI water + 200 ppm Physan-20 + 10% sucrose	7.0d	6.5ab	6.4ab	13.0h	14.1cd	14.5d
Not cooled after packing:						
Dry	5.6a	6.4ab	6.8b	11.5f	14.5d	15.4e
DI water	5.9ab	6.3ab	5.8a	10.9e	13.4c	14.3d
DI water + 200 ppm Physan-20 + 10% sucrose	6.9d	5.7a	6.5ab	12.6gh	13.6cd	14.1d
Not packed and not cooled:						
Dry	5.9ab	–	–	11.5f	–	–
DI water	6.1ab	–	–	11.5f	–	–
DI water + 200 ppm Physan-20 + 10% sucrose	7.0d	–	–	12.2g	–	–

[z]Oasis (20 g/liter).

[y]Mean separation by Duncan's multiple range test, 5% level; CA and FL data analyzed separately.

Table 4. Vase life of 'White Albatross' chrysanthemums as influenced by overnight conditioning solutions at the greenhouse, preshipment temperature management, method of shipment and after-shipment stem treatment.

		Days of vase life		
		California	Florida	
Temperature management and overnight conditioning treatments	After-shipment stem treatment	Not shipped	Shipped by air	Shipped by truck
Cooled with forced-air after packing:				
Deionized (DI) water	recut 5 cm	9.8cd[z]	10.1efg	10.4efg
	not recut	8.9abc	0.2a	3.4b
DI water + 25 ppm silver nitrate ($AgNO_3$)	recut 5 cm	15.1fg	9.7ef	10.2efg
	not recut	16.3g	11.6efg	12.8g
Not cooled after packing:				
DI water	recut 5 cm	10.9cde	7.0cd	9.9ef
	not recut	7.1a	0.6a	5.8bc
DI water + 25 ppm $AgNO_3$	recut 5 cm	16.6g	8.8de	10.7efg
	not recut	16.7g	10.8efg	12.4fg
Not packed and not cooled:				
DI water	recut 5 cm	9.2bcd	–	–
	recut 20 cm	11.7de	–	–
	not recut	7.6ab	–	–
DI water + 25 ppm $AgNO_3$	recut 5 cm	13.1ef	–	–
	recut 20 cm	14.8fg	–	–
	not recut	16.8g	–	–

[z]Mean separation by Duncan's multiple range test, 5% level; CA and FL data analyzed separately.

management and method of shipment on longevity of 'Snow Velvet' gladioli is summarized in Table 5. Florets opened well in all treatments, and the rate of floret opening was influenced by shipping method. Air-shipped "commercial harvest" stage gladioli arrived open. Similar blooms shipped by truck arrived closed and required 1 – 1½ days to open. Truck-shipped "tight bud" stage gladioli opened in 2½ days whether or not they were cooled with forced-air. Air-shipped "tight bud" stage gladioli opened in a similar amount of time when precooled, but in less time if not cooled with forced-air prior to shipment.

Longevity of the basal floret was influenced by shipping method. Gladioli cooled with forced-air and shipped by air lasted longer than cooled gladioli shipped by truck. Cooling with forced-air increased longevity of basal florets of air-shipped "commercial harvest" stage gladioli, but decreased the basal floret longevity of "tight bud" stage gladioli. Cooling with

Table 5. Vase life in deionized (DI) water of 'Snow Velvet' gladioli as influenced by initial overnight treatment, preshipment temperature management and method of shipment.

Maturity at harvest, temperature management and initial overnight conditioning treatment	Number of florets opened per spike			Days until basal floret opened			Days longevity of basal floret		
	Calif.	Florida		Calif.	Florida		Calif.	Florida	
	Not shipped	Air shipped	Truck shipped	Not shipped	Air shipped	Truck shipped	Not shipped	Air shipped	Truck shipped
"Commercial harvest" stage									
Cooled with forced-air after packing:									
Dry	9.8a[z]	8.7a	9.1a	2.0b	0.0a	1.4ab	2.3a	4.1c	3.1a
DI water	9.7a	9.7a	9.6a	1.7ab	0.0a	1.6b	3.3b	4.2c	2.9a
Not cooled after packing:									
Dry	9.5a	9.3a	9.3a	1.7ab	0.0a	1.1a	2.7ab	3.4ab	3.3ab
DI water	9.7a	10.0a	8.9a	2.0b	0.0a	1.5ab	2.9b	3.3ab	3.1a
Not packed and not cooled:									
Dry	9.7a	–	–	1.7ab	–	–	3.0b	–	–
DI water	9.8a	–	–	1.0a	–	–	3.1b	–	–
"Tight bud" stage[y]									
Cooled with forced-air after packing:	9.9a	10.0a	10.0a	3.0c	2.3c	2.5c	4.0c	2.9a	2.9a
Not cooled after packing:	10.0a	10.0a	9.5a	3.0c	1.4b	2.5c	2.9b	3.9bc	3.1a
Not packed and not cooled:	10.0a	–	–	3.0c	–	–	3.3b	–	–

[z]Mean separation by Duncan's multiple range test, 5% level; CA and FL data analyzed separately.

[y]Flowers harvested two days prior to "commercial harvest" stage and conditioned overnight in DI water containing 25 ppm silver nitrate; 200 ppm 8-hydroxyquinoline citrate; 300 ppm aluminum sulfate and 20% sucrose.

forced-air had no influence on basal floret longevity of truck-shipped gladioli. However, cooling with forced-air had an adverse effect on the basal floret longevity of dry-handled, non-shipped gladioli.

Discussion

The data derived from these cut flower test shipments illustrate that temperature management on refrigerated truck-trailer loads of cut flowers is best achieved if the flowers are cooled prior to loading. 'Cara Mia' roses, 'White Sim' carnations, 'Albatross' chrysanthemums and 'Snow Velvet' gladioli shipped from California to Florida by refrigerated truck-trailer during a period of moderate heat stress (October and November) lasted as long as or longer than similar flowers delivered by air even though truck delivery took longer than air. Cooling with forced-air was not injurious to the 4 types of cut flowers shipped but it did not improve flower longevity in these tests except in the case of "commercial harvest" stage gladioli shipped by air.

Preshipment conditioning treatments utilized for the 'Cara Mia' roses did not affect flower longevity. Halevy et al. (9) observed an increase in 'Cara Mia' rose flower longevity following transcontinental truck shipment when 100 ppm 6-(benzylamino)-9-(2-tetrahydropyronyl) 9-H-purine (PBA) was included as part of an overnight "pulse" treatment. PBA was not included in these tests because it is not currently available for use by the flower industry. 'Snow Velvet' gladioli harvested 2 days early and conditioned overnight in a 20% Su solution arrived unopened whether shipped by air or by truck. They also opened well, as previously reported (3, 15, 16).

Although Physan-20 has been found to be an effective substitute for $AgNO_3$ in carnation overnight conditioning experiments (7), conditioning with Physan-20 and Su did not increase the longevity of most of the shipped 'White Sim' carnations in this experiment. The only exception occurred when conditioned carnations were cooled with forced-air, shipped by truck and evaluated in floral preservative. Those conditioned with Physan and Su lasted 1½ days longer. The lack of response in this trial to Physan-20 and Su may have been caused by low ambient temperatures and the absence of light during the overnight conditioning period. It is also possible that the Su concentration may not have been high enough. Paul et al. (22) found 25% sucrose to be necessary to get a consistent longevity response from 'White Sim' carnations when the flowers were pulsed on a year-round basis. Conditioning of 'Albatross' chrysanthemum stems in $AgNO_3$ solution eliminated the need to recut stems for the blooms to regain turgidity when they arrived in Florida, thus substantiating results obtained in simulated shipments (4).

The use of floral preservative after shipment had more effect on longevity of roses and carnations than any preshipment conditioning treatment, cooling or shipping method. The value of preservatives for both crops has been well established by other workers (25). It is not known, however, whether the commercial preservative used in these evaluations is representative of others now available on the market.

Dry handling of carnations and gladioli when combined with precooling might make it feasible for flower growers and shippers to handle the 2 crops more efficiently. Besemer (1, 2) reported dry handling of California carnations was feasible when test shipments were made to New York in 1961. The flowers can be harvested, graded, boxed, and precooled with forced-air, and then stored dry under refrigeration until shipped. The need for buckets containing water or preservative is eliminated. Dry handling may also reduce costs, breakage and other types of damage associated with the present handling of these 2 floral products.

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Role of the Various Seed Parts in Peach Seed Dormancy and Initial Seedling Growth[1]

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Additional index words. embryo, seed coat, endocarp, stratification, leaching, *Prunus persica*

Abstract. **Cold requirement for germination of excised 'Kakamas' peach (*Prunus persica* (L.) Batsch) embryos was satisfied after 2 weeks at 4.4°C; embryos with testas intact required 4 weeks, while seeds with intact endocarps required 12 weeks stratification. Leaching of unstratified excised embryos stimulated germination. The endocarp affected germination by delaying water uptake. Supplying additional O_2 during stratification or germination of seeds with intact endocarps did not improve germination. Cracking the endocarps stimulated germination of stratified seeds, but sealing the cracks with lanolin paste prevented this effect. The endocarps may interfere with the leaching of inhibitors from the testa and embryo. Initial seedling growth of embryos with or without testas increased linearly with increasing time of stratification in terms of shoot length, dry weight of shoots and leaves, dry weight of roots and leaf area, length and width. Seedlings arising from embryos with intact testas were taller and had a greater dry mass of shoots, leaves and roots compared to seedlings arising from embryos without testas.**

Considerable attention has been given to the role of the embryo and testa in the dormancy of peach seeds (1, 2, 4, 5). During stratification there is a decrease in free abscisic acid (ABA) in peach seed (2). However Bonamy and Dennis (1) found that ABA content decreased at both high and low temperatures, suggesting that ABA content is not the only factor responsible for dormancy. According to Lipe and Crane (4) seeds with intact seed coats germinated more slowly than those without integuments, and seedlings were stunted compared with those from excised embryos. The paper reports on the role of the various structures in the dormancy, germination and initial seedling growth of peach seeds.

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