AGRICULTURAL EXTENSION UNIVERSITY OF CALIFORNIA

FLOWER AND NURSERY REPORT

FOR COMMERCIAL GROWERS

CARNATION BUDS OFFER EXCITING PROSPECTS FOR MERCHANDISERS AND CONSUMERS

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INTRODUCTION

Feasibility of harvesting carnations in the bud stage was first demonstrated by Kohl (8) and elaborated upon by Holley (4, 5). Hardenburg (3) showed that bud shipments from California and Colorado to Maryland can be made on a year-round basis. Recently, Farnham and Halevy (1) found that 10 percent sugar concentrations are optimum for carnation bud opening and that flowers opened in these solutions are larger and have better vase life than comparable blooms opened on the plant. Carnation buds can also be successfully stored for extended periods at 32° F. (2, 6). Coupled with extended storage, truck delivery of California carnation buds to distant markets can conceivably permit new marketing approaches. Conditioning treatments at the grower level would be desirable if they simplified handling requirements for the consumer.

PURPOSE OF THE STUDIES

Experiments were conducted at Watsonville in 1972 to determine if the grower or grower-shipper could condition the stems of carnation buds so that flowers with excellent quality and vase life could be opened at distant markets with minimum effort. Silver nitrate, which prevents plugging of the stem's water conducting system, was used in the stem dips.

Kofranek and Paul (7) showed that carnation flower longevity increased when stems were dipped in 1,200 ppm silver nitrate for 10 minutes. The Watsonville experiments were designed to determine if: (a) 10-minute 1,200 ppm silver nitrate dips would be effective in carnation bud opening when combined with 10 percent sugar solutions; and (b) 5-second in-and-out stem dips of a different concentration could be substituted for the longer dip period. Silver nitrate solutions used in these experiments are expressed as parts per million (ppm) silver nitrate rather than as silver ion.

The investigations also included the role of water quality, the relationship of silver stem dips to storage, the need for stem recutting, and the question of whether a complete Modified Cornell or commercial preservative solution would give additional benefits or detract from the silver nitrate stem dip.

TEN-MINUTE STEM DIPS WITH AND WITHOUT STORAGE

Procedures Used

Four-hundred 'Scania' carnation buds were harvested from the greenhouse on September 20, 1972, and bunched into groups of ten. The buds were placed on a table for 6 hours after harvest and were allowed to wilt before the 1,200 ppm silver nitrate stem dip was applied. Half of the buds were placed in opening solutions the same day, and the other 200 buds were stored at 34° F. for 36 days. Three waters were used in these experiments: deionized (DI); and two tap waters

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high in bicarbonate (table 1). Bicarbonate combines readily with silver to precipitate it as an insoluble salt. Five opening solutions were used:

- Everbloom® (2 oz./gal. plus sugar to 10 percent) in deionized water
- Modified Cornell Solution containing 200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, 50 ppm aluminum ion from aluminum sulfate, plus 10 percent sugar in deionized water
- Deionized water plus 10 percent sugar
- Watsonville tap water plus 10 percent sugar
- Pajaro Valley Greenhouse Company tap water plus 10 percent sugar

Half of the nonstored buds and half of those to be stored were dipped for 10 minutes in a deionized water solution containing 1,200 ppm silver nitrate before they were opened or placed in storage. Each treatment was duplicated to compare recut stems with those that were not recut. For nonstored buds, stems were recut immediately after the silver dip and before they were placed in the 10 percent sugar opening solutions. Stems of stored buds were recut after the 36-day storage period just before they were placed in the opening solutions. Vase life for all flowers was determined in deionized water after a 24-hour simulated shipment period.

Results With Nonstored Buds

Longevity of 'Scania' blooms opened from nonstored buds (table 2) was adequate for all five opening solutions when flower stems had been conditioned in 1,200 ppm silver nitrate solution for 10 minutes. Flowers with stems not dipped in silver nitrate had an unsatisfactory vase life when they were opened in deionized water or the two tap waters containing 10 percent sugar. Flowers opened in Everbloom® or Modified Cornell Solution performed equally well with or without the silver dip. Stem recutting had little or no effect on bud opening, which indicated that the 6-hour delay from harvest to treatment was not a limiting factor.

® Registered trade name.

Results With Stored Buds

'Scania' blooms opened after 36-day storage at 34° F. (table 3) had adequate vase life when stems were dipped in silver before storage and the stems were recut before the buds were placed in the opening solutions. Buds conditioned in silver nitrate before storage and opened without stems being recut performed well in all treatments except in Watsonville tap water plus 10 percent sugar.

Buds stored without the silver nitrate stem conditioning did not open properly in either of the two tap waters tested. The flower longevity of buds opened in deionized water plus 10 percent sugar was also reduced when the silver stem dip was not used.

FIVE-SECOND DIPS FOR FRESHLY HARVESTED BUDS

Procedures Used

'Scania' carnation buds were harvested from the greenhouse on November 9, 1972, and were kept out of water for 5 hours before bud opening treatments began. Two groups of 10 buds each were placed in deionized water solutions containing 0, 600, 1,200, 2,400 or 4,800 ppm silver nitrate. The stems were dipped in the silver nitrate solutions for 5 seconds and were drained but not rinsed before being placed in 10 percent sugar solutions prepared with deionized or Watsonville tap water.

Similar undipped buds were placed in complete opening solutions of Everbloom® (2 oz./gal. plus 10 percent sugar) or Modified Cornell Solution (200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, 50 ppm aluminum ion from aluminum sulfate, plus 10 percent sugar).

After opening, all flowers were transferred to a shipping box and held 24 hours out of water in a cool packing shed. Longevity was determined after the blooms were placed in clean Mason jars containing deionized water.

Results

All the 5-second silver nitrate treatments increased flower longevity (table 4). Where 1,200 or 2,400 ppm stem dips were used, flower performance was similar for both deionized and Watsonville tap water. The longevity of flowers

opened in deionized water plus 10 percent sugar solution increased with progressively higher silver nitrate concentrations. In most cases, flower longevity in tap water was somewhat less than that obtained in deionized water. However, flowers in the successful tap water treatments were of acceptable commercial quality.

FIVE-SECOND DIPS FOLLOWING COMMERCIAL STORAGE

Procedures Used

'Scania' carnation buds harvested November 7, 1972, were commercially stored at 34° F. on November 8. The buds were removed from refrigeration on November 28 and subjected to a series of opening treatments. Each opening group was subdivided and stems were handled by one of two methods after storage, with five buds placed in each treatment: (1) ½ to ¾ inch of stem removed with a sharp knife, or (2) stems not recut.

Stems were dipped for 5 seconds in deionized water solutions with 600, 1,200, 2,400, and 4,800 ppm silver nitrate and were drained but not rinsed after the dip treatment. They were then transferred to containers of deionized water plus 10 percent sugar for bud opening. Three complete bud opening solutions were also included to serve as controls. Buds were opened in 10 percent sugar solutions and the flowers were then subjected to a simulated 24-hour shipment period. Longevity was determined in clean Mason jars containing deionized water.

Results

Table 5 summarizes the longevity of carnation flowers opened after application of silver nitrate stem dips following commercial storage. Flower performance was uniform where stems were recut before application of the silver nitrate stem dip. The longevity was best when the highest silver nitrate rate (4,800 ppm) was used and the stems were not recut. Flower longevity obtained by opening buds in the three complete opening solutions tested was slightly better than that obtained with silver nitrate stem dips alone. All treatments had acceptable flower quality and longevity.

DISCUSSION

These experiments demonstrate that silver nitrate stem dips are an effective way to condition carnation buds for uniform opening. A number of factors affect the use of the dips.

Concentration

Stems dipped in deionized water with 600 to 4,800 ppm silver nitrate following commercial storage performed well if the stems were recut before the silver dip. It was also demonstrated that 10-minute, 1,200 ppm silver nitrate dips were effective when fresh buds were opened without storage or when buds were stored for 36 days at 34° F. before opening.

Duration

Ten-minute silver nitrate stem dips were effective. Subsequent experiments showed that 5-second dips of silver nitrate concentrations between 600 and 4,800 ppm were also effective.

Timing

Silver nitrate stem dips may be applied at more than one point in the distribution system. Choices include application: (1) immediately after harvest to open freshly cut buds or to dip stems of buds to be stored for extended periods; (2) after buds have been stored for extended periods and just before placement in 10 percent sugar opening solutions; or (3) when buds are unpacked at eastern markets after being shipped dry from California.

Need To Recut Stems

The need to recut varies with the time of the silver nitrate dip. Stem recutting immediately after the silver nitrate dip application had little or no effect on flower longevity (table 2) of freshly opened buds. Some of the silver nitrate solution was probably carried over into the 10 percent sugar opening solutions.

Except when tap water was used in the opening solution, similar buds dipped in silver nitrate and then stored 36 days performed well when stems were not recut after storage. The flowers opened in tap water performed somewhat better when the stems had been recut than when they had not been recut after storage (table 3).

When silver nitrate stem dips were applied after commercial storage, the blooms performed better if the stems were recut before silver nitrate treatment (table 5).

COMMERCIAL USE OF STEM DIPS

Ten-Minute Stem Dips

The 10-minute silver nitrate stem dip is an easy way to ensure uniform carnation bud opening immediately after harvest. Deionized water is not necessary to open flowers with good longevity. However, flower color and size are better if deionized water is used. Blooms from buds stored 36 days have a longevity comparable to that of blooms from freshly harvested buds.

For the grower, grower-shipper, and mass market merchandiser, deionized water would give the most consistent results whether or not a complete preservative, like Everbloom® or Modified Cornell Solution, is used. Watsonville growers find that bacterial activity occurs in Everbloom® solutions within a week to 10 days after preparation so that the solution becomes unusable. Since these experiments were conducted under very sanitary conditions, the data for Everbloom®-opened buds without a silver nitrate dip are probably optimistic in terms of what a commercial grower or wholesaler could expect.

Since the data demonstrate that flowers opened in Everbloom® (2 oz./gal. plus 10 percent sugar) solutions are not injured by the silver nitrate stem dip, application of silver nitrate after harvest could improve the sanitation and provide better quality flowers for the consumer where this proprietary product is currently used. Further tests to explore this concept are planned.

Five-Second Dips

Five-second silver nitrate dips before opening freshly harvested or stored carnation buds produced acceptable flower longevity when 10 percent sugar opening solutions prepared with either deionized or Watsonville tap water were used. Flower performance, size, and color were better in deionized water but were acceptable in most cases where the tap water sugar solution was used.

Flowers opened in 10 percent sugar solutions after stems were dipped in silver nitrate solutions for 5 seconds performed as well as or better than flowers opened in the complete opening solutions of Everbloom® or the Modified Cornell Solution. The 5-second silver nitrate dip offers the grower a simplified method for opening fresh carnation buds.

NEW MARKET CHANNELS MADE POSSIBLE

Five-second silver nitrate stem dips applied after extended carnation bud storage could have direct application for growers who wish to store buds for holiday markets. However, it is important to remember that stems should be recut after storage before the silver nitrate is applied. The same practice would be useful for mass market distribution of carnation buds.

Silver nitrate stem dips make direct marketing of carnation buds to the consumer feasible. The buds could be dipped either by the grower in California or upon receipt at distribution points in eastern markets. Once the silver is applied, there would be no need to recut the stems. Buds could be maintained dry in a refrigerated showcase and sold to the consumer with simple instructions to add a few tablespoons of sugar to a quart of water. Data indicate that flowers would perform satisfactorily in most tap waters. The longevity of flowers treated with a silver nitrate stem dip was not evaluated in softened water. The effects of softened water would probably limit consumer acceptance of the practice. Further experiments will be necessary to answer this question.

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NOTE: Silver nitrate is poisonous and, when used, contact with skin and mucous membranes must be avoided.

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TABLE 1. Composition of Tap Water Used in Flower Longevity Experiments.

Source	Total Dissolved Salts (TDS) (ppm)	pH	CO_3 + HCO_3 (me/L.)
Watsonville	356	8.0	4.6
Pajaro Valley	448	7.7	5.9

TABLE 2. Longevity of 'Scania' Carnation Flowers as Affected by a 10-Minute, 1,200 ppm Silver Nitrate Stem Dip, 10 Percent Sugar Solutions, and Stem Recutting. Flowers Harvested in the Bud Stage, Conditioned and Opened the Same Day. September 20, 1972. Sunbay Farms, Watsonville, California.

10 Percent Sugar Opening Solutions	Average Longevity of Flowers (Days)[1]			
	10-minute post-harvest silver dip		No post-harvest silver dip	
	stems recut[2]	stems not recut	stems recut[2]	stems not recut
Everbloom® 2 oz./gal. (deionized water)	10.1	10.9	10.0	9.75
Modified Cornell Solution[3] (deionized water)	10.9	11.7	9.95	10.55
Deionized water	10.05	10.75	8.65	7.4
Watsonville tap water	10.65	9.7	8.4	4.9
Pajaro Valley tap water	10.2	9.4	9.6	7.95
Average	10.38	10.49	9.32	8.11

[1] Longevity determined in deionized water following a 24-hour simulated shipment period after buds were opened.

[2] Three inches cut from stems after silver dip treatment but before stems were placed in 10 percent sugar opening solution.

[3] Modified Cornell Solution contained 200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, 50 ppm aluminum ion from aluminum sulfate.

TABLE 3. Longevity of 'Scania' Carnation Flowers as Affected by a 10-Minute, 1,200 ppm Silver Nitrate Stem Dip, 10 Percent Sugar Solutions, and Stem Recutting. Flowers Harvested in the Bud Stage, Conditioned in Silver Nitrate, Before Storage at 34° F. for 36 Days. September 20, 1972. Sunbay Farms, Watsonville.

10 Percent Sugar Opening Solutions	Average Longevity of Flowers (Days)[1]			
	10-minute post-harvest silver dip		No post-harvest silver dip	
	stems recut[2]	stems not recut[3]	stems recut[2][3]	stems not recut[3]
Everbloom® 2 oz./gal. (deionized water)	11.6	11.8	12.2	12.7
Modified Cornell Solution[3] (deionized water)	13.2	13.2	14.0	12.7
Deionized water	11.4	10.4	8.7	1.5(4)
Watsonville tap water	11.4	6.8(7)	3.3(3)	3.4(3)
Pajaro Valley tap water	9.3	9.8	5.5(7)	1.6(2)
Average	11.4	10.4	8.5	5.3

[1] Longevity determined in deionized water following a 24-hour simulated shipment period after buds were opened.

[2] Three inches cut from stems after silver dip treatment but before stems were placed in 10 percent sugar opening solution.

[3] Figures in parenthesis ( ) denote number of buds that opened properly. The longevity figure corresponding to each figure in parentheses is the mean of 10 buds in the treatment regardless of number opened.

[4] Modified Cornell Solution contained 200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, 50 ppm aluminum ion from aluminum sulfate.

TABLE 4. Effect of 5-Second Silver Nitrate Stem Dip Concentration on Longevity of 'Scania' Carnations Opened in Two Water Qualities as Compared to Flower Performance in Two Standard Opening Solutions. November 9, 1972. Sunbay Farms, Watsonville, California.

Water Quality	Average Longevity of Flowers (Days)[1] 10 Percent Sugar Opening Solutions						
	5-second silver nitrate dip[2] (ppm)					Complete opening solutions	
	0	600	1,200	2,400	4,800	A[3]	B[4]
Deionized water	5.0	8.4	8.8	9.2	10.4	8.8	11.8
Watsonville tap water	5.4	7.6	8.7	9.1	8.7	5.0	9.3

[1] Longevity in days determined in deionized water after freshly harvested buds were opened and subjected to a 24-hour simulated shipping period.

[2] Silver nitrate solution prepared with deionized water.

[3] Opening solution A was 2 oz. Everbloom®/gal. plus sugar to 10 percent.

[4] Opening solution B was 200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, and 50 ppm aluminum ion from aluminum sulfate, plus 10 percent sugar.

TABLE 5. Longevity of 'Scania' Carnations When Opened From Commercially Stored Buds as Affected by 5-Second Post-Storage Silver Nitrate Dip Concentrations and Stem Recutting When Compared With Three Standard Opening Solutions. November 28, 1972. Sunbay Farms, Watsonville, California.

Stem Handling Before Treatment	Average Longevity of Flowers (Days)[1] 10 Percent Sugar Opening Solutions						
	5-second silver nitrate dip applied after storage[2] (ppm)				Complete opening solutions		
	600	1,200	2,400	4,800	A[3]	B[4]	C[5]
Stems recut	13.6	12.8	12.2	12.2	14.2	13.6	14.2
Stems not recut	9.6	9.6	9.8	15.8	9.6	14.2	14.2

[1] Longevity in days determined in deionized water after buds were opened and subjected to a 24-hour simulated shipping period.

[2] Silver nitrate dip solutions prepared with deionized water.

[3] Opening solution A was 2 oz. Everbloom®/gal. plus sugar to 10 percent.

[4] Opening solution B was 200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, and 50 ppm aluminum ion from aluminum sulfate, plus 10 percent sugar.

[5] Opening solution C was 200 ppm 8-quinolinol citrate, 25 ppm silver nitrate, and 75 ppm citric acid, plus 10 percent sugar.