# INFLUENCE OF VARIOUS COMMERCIAL FLORAL PRESERVATIVES AND 8-HYDROXYQUINOLINE CITRATE PLUS SUCROSE ON DEVELOPMENT AND LASTING ABILITY OF FLOWER BUDS OF SEVERAL CHRYSANTHEMUM CULTIVARS

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ABSTRACT

Several commercial floral preservatives and 8-hydroxyquinoline citrate (8-HQC) plus sucrose were evaluated as opening solutions for standard chrysanthemum flower buds. Preservatives which produced the largest increases in stem fresh weight also produced the largest flowers with the greatest longevity. Several commercial preservatives were found to be as effective as 8-HQC plus sucrose for opening the flower buds.

Spray chrysanthemum cultivars "Shasta," "Iceberg," and "Beauregard" were harvested at the "tight" and "opened" bud stage and held in an opening solution of 200 ppm 8-HQC plus 2% sucrose. Flower buds held in the opening solution gained more fresh weight and increased in diameter more than flower buds held in water.

## INTRODUCTION

Marousky (13) recently reported that standard chrysanthemums could be harvested in the bud stage (45-55 mm diameter) and successfully opened off the plant in 8-hydroxyquinoline citrate (8-HQC) and sucrose solutions. The technique appeared sufficiently promising to warrant further exploration for commercial application. The above tests used large flowering incurve and spider cultivars. Information on how to handle spray type (pompon) cultivars would be helpful to Florida flower growers.

Commercial floral preservatives might be used as an adjunct or as a substitute for quinoline salts and sucrose in opening bud-cut chrysanthemums. Floral preservatives have been used successfully to open bud-cut carnations (2, 4, 5) and chrysanthemums (3, 15). Waters (15) showed that 'Iceberg' chrysanthemum flowers harvested at the tight-bud stage increased in diameter and fresh weight when held in Everbloom. He also reported that Everbloom had a deleterious effect on foliage.

Quinoline salts and sucrose solutions have been reported to have beneficial effects on many flowers (7, 8, 9, 11, 14). Possible functions and mechanism of quinoline salt and sucrose have been elucidated elsewhere (1, 10, 12, 6, 14).

This paper reports the influence of commercial floral preservatives on bud-cut flowers of incurved chrysanthemum cultivars and the influence of 8-HQC and sucrose on flower bud opening of spray type (pompon) chrysanthemums.

## METHODS AND MATERIALS

*Experiment 1.* On November 15, 1968 commercially grown 'Albatross' standard chrysanthemum flowers were harvested as buds when 50-55 mm in diameter. Flowers were immediately transferred to the laboratory and stems were trimmed to 18 inches in length. Foliage was removed from the lower third of the stem. Stems were placed in quart class jars containing water or various floral preservatives listed in Tables 1 and 2. Distilled water was used for preparing all solutions.

Flower diameter and stem fresh weight were determined initially and at 4 and 7 days. Vase-life was measured from the day flowers were fully opened until the day petals lost turgidity or decorative value or both. Foliage condition was not used as a criterion for vase-life. Six replications were used for each treatment with 1 flower constituting a single replication.

Flowers were held in treatment solutions in a laboratory maintained at 74° F $\pm$ 2° and at a continuous light intensity of 200 ft-c supplied by fluorescent tubes. During the experiment relative humidity ranged from 50 to 75%.

*Experiment 2.* 'Mrs. Roy' standard chrysanthemums were grown in a greenhouse and harvested on December 17, 1968 when flower buds

References to specific commercial products do not constitute an endorsement.

were 50-55 mm in diameter. Stems were placed in water and floral preservative solutions listed in Tables 3 and 4. Handling procedures, laboratory environment, and data collection were similar to those in the previous experiment.

*Experiment 3.* Chrysanthemum stems of 'Shasta', 'Iceberg', and 'Beauregard', cultivars of the spray category, were harvested from commercial plantings on May 18, 1969. Stems bearing buds that were "tight" or "open," 20-30 mm and 40-50 mm in diameter, respectively, were harvested. Stems were brought to the laboratory, trimmed to 30-inch lengths, and foliage was removed from the lower third of the stem. Stems bearing flowers from each stage of development were placed in plastic containers (15 in. high by 10 in diameter) containing water or 200 ppm 8-HQC + 2% sucrose.

Flower diameter and stem fresh weight were determined initially and at 3, 7, and 10 days. For flower diameter measurements, a single flower was selected randomly from each stem. There were 3 replications per treatment with a single stem considered as 1 replication.

Stems were held in the laboratory as in the previous experiments.

All data were treated by analysis of variance and statistical differences between means determined by Duncan's Multipel Range Test.

## Results

*Experiment 1.*—Flowers held in 8-HQC-sucrose or Everbloom were larger than flowers held in other preservatives or water (Table 1). Flowers held in F M Super or Roselife for 7 days were larger than flowers held in water or Bloomlife. Flowers held in water or Bloomlife were flat in appearance while flowers held in other preservatives were fully developed and globular in form after 6 days. All flowers, except those held in water or Bloomlife, would have been commercially acceptable.

Stems held in 8-HQC+sucrose or Everbloom weighed more after 4 and 7 days than stems held in other preservatives or water (Table 2). Stems held in Roselife or F M Super weighed more than stems held in water or Bloomlife. Stems held in Roselife for 7 days were heavier than stems held in F M Super. Stems held in water or Bloomlife did not increase in weight after 3 days; whereas, stems held in 8-HQC+sucrose, Everbloom, Roselife, F M Super continued to increase in weight for 7 days.

Table 1. Diameters of 'Albatross' chrysanthemum flowers harvested as buds and held in solutions of various floral preservatives for 7 days.[1]

| Floral Preservatives | Concentration | Diameter after 4 days | Diameter after 7 days |
|---|---|---|---|
| | | mm | mm |
| Control (water) | - | 93 c[2] | 96 c[3] |
| Bloomlife | 2% | 96 c | 90 c |
| F M Super | 8 ml/liter | 96 c | 107 b |
| Roselife | 3% | 105 b | 114 b |
| 8-HQC+sucrose | 200 ppm+2% | 116 a | 121 a |
| Everbloom | 3% | 116 a | 124 a |

[1]Flower buds harvested when 50-55 mm in diameter

[2]Means within a column followed by different letters differ significantly at the 1% level.

[3]Means within a column followed by different letters differ significantly at the 5% level.

Vase-life paralleled the changes that occurred in fresh weight and flower size (Table 2). The largest flowers with the heaviest stems (8-HQC +sucrose and Everbloom treatments) lasted the longest, whereas, the smallest flowers (control and Bloomlife treatments) had short vase-life. Foliage on stems held in all preservatives became chlorotic after 15 days but the most severe chlorosis appeared on foliage from stems held in Roselife. Foliage on stems held in water did not become chlorotic.

*Experiment 2.*—'Mrs. Roy' chrysanthemum flowers responded to various floral preservatives in a manner similar to that of 'Albatross' flowers in the previous experiments. Flowers held in preservatives were larger than flowers held in

Table 2. Fresh weight and vase-life of 'Albatross' chrysanthemum flowers harvested as buds and held in solutions of various floral preservatives.[1]

| Floral preservatives | Concentration | Changes in weight after[2] 4 days | Changes in weight after[2] 7 days | Vase-life |
|---|---|---|---|---|
| | | % | % | days |
| Control (water) | - | 123.1 c[3] | 120.7 d[3] | 5.2 d[4] |
| Bloomlife | 2% | 125.2 c | 117.7 d | 2.2 e |
| F M Super | 8 ml/liter | 135.6 b | 140.4 c | 9.0 c |
| Roselife | 3% | 135.2 b | 156.6 b | 15.0 b |
| 8-HQC+sucrose | 200ppm+2% | 144.4 a | 168.9 a | 18.8 a |
| Everbloom | 3% | 148.4 a | 179.2 a | 16.2 ab |

[1]Flower buds harvested when 50-55 mm in diameter

[2]Weights are expressed as percentage values of initial weight. Initial fresh weight equals 100%.

[3]Means within a column followed by different letters differ significantly at the 5% level.

[4]Means within a column followed by different letters differ significantly at the 1% level. Vase-life was recorded from the day flowers were determined to be fully open (6 days).

Table 3. Diameters of 'Mrs. Roy' chrysanthemum flowers harvested as buds and held in solutions of various floral preservatives.[1]

| Floral preservatives | Concentration | Diameter after 3 days | Diameter after 7 days |
|---|---|---|---|
| | | mm | mm |
| Control (water) | - | 80 c[2] | - [2,3] |
| Roselife | 2% | 102 b | 115 cd |
| Roselife | 4% | 105 b | 117 bcd |
| F M Super | 2 ml/1 | 108 b | - [3] |
| F M Super + sucrose | 2 ml/1+2% | 111 ab | 114 cd |
| F M Super | 4 ml/1 | 101 b | 112 d |
| F M Super + sucrose | 4 ml/1+2% | 112 ab | 116 bcd |
| Everbloom | 2% | 111 ab | 123 ab |
| Everbloom | 4% | 111 ab | 120 abc |
| 8-HQC+sucrose | 200ppm+2% | 120 a | 126 a |

[1]Flower buds harvested when 50-55 mm in diameter.

[2]Means within a column followed by different letters differ significantly at the 1% level.

[3]Flowers from control and F M Super (2 ml/1) wilted after 6-7 days and were not included in analysis.

water (Table 3). Flowers held in water or F M Super (2 ml/1) wilted before they were fully open. No differences in diameter were evident for flowers held in 2 and 4% Roselife, 2 ml F M Super plus 2% sucrose, and 4 ml F M Super with and without 2% sucrose. Flowers held in 8+HQC-sucrose were larger than flowers held in other preservatives except 2 and 4% Everbloom.

All stems held in solutions continued to increase in fresh weight for 7 days except those held in 2 or 4 ml F M Super or water which reached their maximum weight in 3 days (Table 4). Stems held in the latter 3 solutions lost weight after the third day. Stems held in 8+HQC-sucrose gained more weight after 7 days than stems held in other preservatives. Two percent Everbloom, 2 and 4% Roselife, and 2 and 4 ml FM Super plus 2% sucrose were equally effective in increasing fresh weight.

Table 4. Fresh weight and vase-life of 'Mrs. Roy' chrysanthemum flowers harvested as buds and held in solutions of various floral preservatives.[1]

| Floral preservatives | Concentration | Fresh weight after 3 days | Fresh weight after 7 days | Vase life |
|---|---|---|---|---|
| | | % | % | days |
| Control (water) | - | 115.9 cd[3] | 83.5 e[3] | 0[4] |
| Roselife | 2% | 118.3 bcd | 146.6 b | 14.0+ |
| Roselife | 4% | 110.0 d | 132.3 bc | 14.0+ |
| F M Super | 2 ml/1 | 127.4 a | 114.3 d | 1.0 |
| F M Super + sucrose | 2 ml/1+2% | 126.2 ab | 139.0 b | 4.0 |
| F M Super | 4 ml/1 | 128.2 a | 117.5 cd | 7.0 |
| F M Super + sucrose | 4 ml/1+2% | 122.1 abc | 144.0 b | 4.5 |
| Everbloom | 2% | 129.3 a | 147.9 b | 14.0+ |
| Everbloom | 4% | 114.3 cd | 124.1 cd | 14.0+ |
| 8-HQC+sucrose | 200ppm+2% | 129.5 a | 165.4 a | 14.0+ |

[1]Flower buds harvested when 50-55 mm in diameter. Initial stem fresh weights were 27-37 gms.

[2]Weights are expressed as percentage values of initial weight. Initial weight equals 100%.

[3]Means within a column followed by different letters are significant at the 1% level.

[4]Data allow for 6 days to open flowers. Experiment terminated after 20 days of vase life.

*Experiment 3.*—Generally, flower diameter of all spray cultivars was greater when stems were held in 8-HQC+sucrose than in water (Fig. 1). Flowers that developed from "tight" buds and were held in 8-HQC+sucrose had similar diameter and form as flowers that developed from "open" buds. Maximum flower diameter of "tight" and "open" buds occurred at 7 days, but the rate of flower development was greater for "tight" buds. 'Shasta' had the largest flowers followed respectively by 'Iceberg' and 'Beauregard' with smaller flowers. Flowers from 'open' buds of 'Beauregard' decreased slightly in diameter after 3 days. Decrease in diameter was due to outer petals reflexing and was not due to premature wilting. Although flowers from all cultivars held in water increased in diameter, flower form was not typical of flowers which open on the plant. Flowers of each cultivar held in 8-HQC+sucrose were similar in form and appearance to those which develop on the plant.

Stems of all cultivars held in 8-HQC+sucrose increased in fresh weight for 10 days (Fig. 2). Stems held in water reached their maximum fresh weight in 3 days. Stage of flower bud development did not influence changes in fresh weight as did 8-HQC+sucrose. Eight-hydroxyquinoline citrate plus sucrose not only produced the largest flowers but also produced the heaviest stems.

Flowers held in 8-HQC+sucrose were fully turgid and of excellent quality after 2 weeks but foliage showed incipient chlorosis. Flowers held in water for 2 weeks were beginning to wilt but foliage did not show signs of chlorosis.

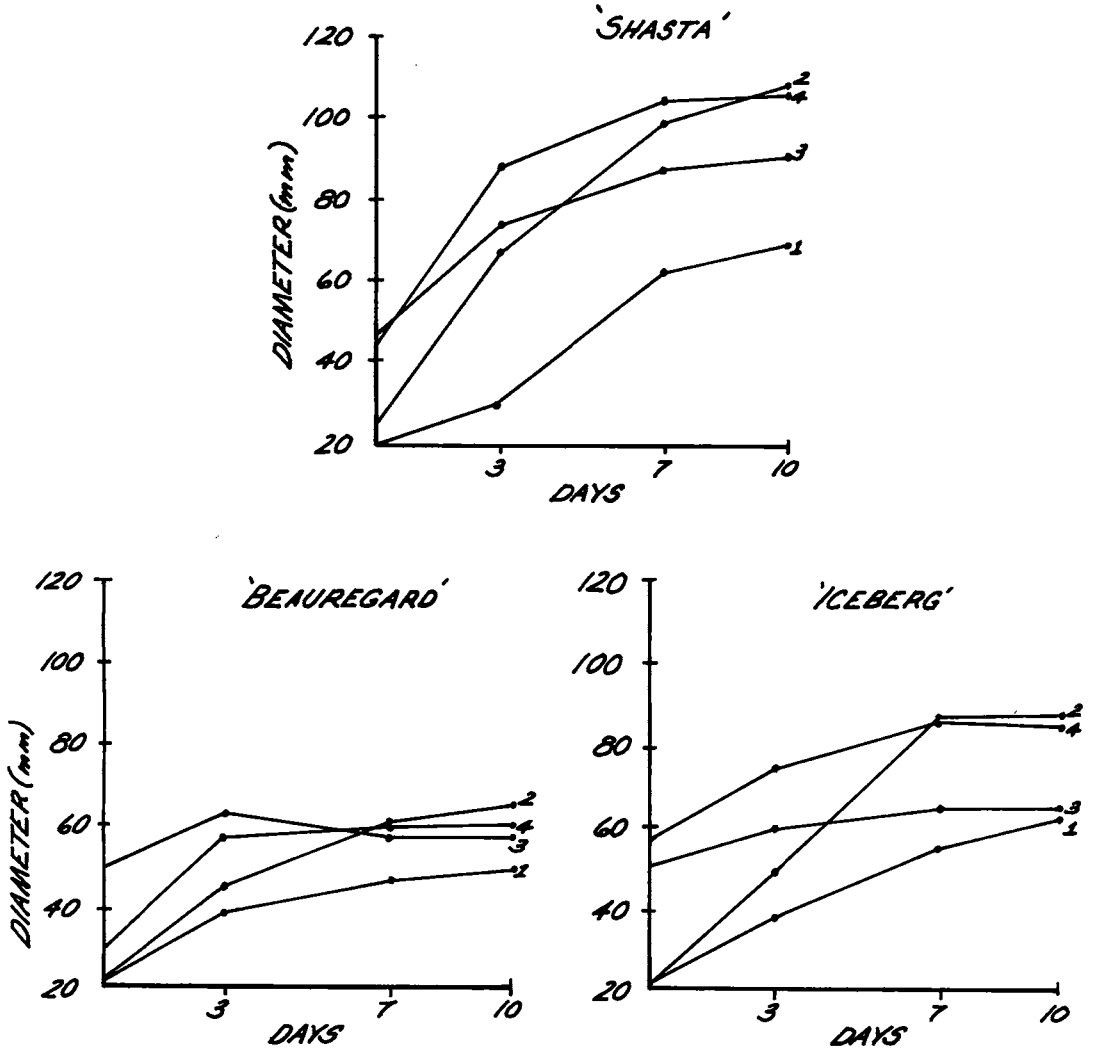


Figure 1.—Flower diameter of several chrysanthemum cultivars harvested at 2 stages of development and held in water or 200 ppm 8-hydroxyquinoline citrate plus 2% sucrose. 1) tight bud held in water, 2) tight bud held in 8-HQC+sucrose 3) open bud held in water, 4) open bud held in 8-HQC+sucrose.

## Discussion

These experiments indicate that chrysanthemum flowers could be harvested as buds and opened in commercial floral preservatives. Considering flower diameter, fresh weight, and vase life, the best floral preservatives were 8-HQC+sucrose and Everbloom. Flowers opened in Roselife were commercially acceptable but did not attain the weight or size as flowers held in 8-HQC+sucrose. Flowers opened in F M Super had much shorter vase-life than those opened in 8-HQC+sucrose or Everbloom. Possibly different concentrations of F M Super or Roselife might increase flower longevity or size. Flowers held in Bloomlife or water opened poorly and did not have commercially acceptable symmetry. Chlorosis was evident on foliage of stems held in preservatives. Chlorosis appeared 17-20 days after harvest. This agrees with Waters' report (15) that Everbloom induced chlorosis in chrysanthemum foliage. Marousky (13) reported that 8-HQC+sucrose induced chrysanthemum foliar

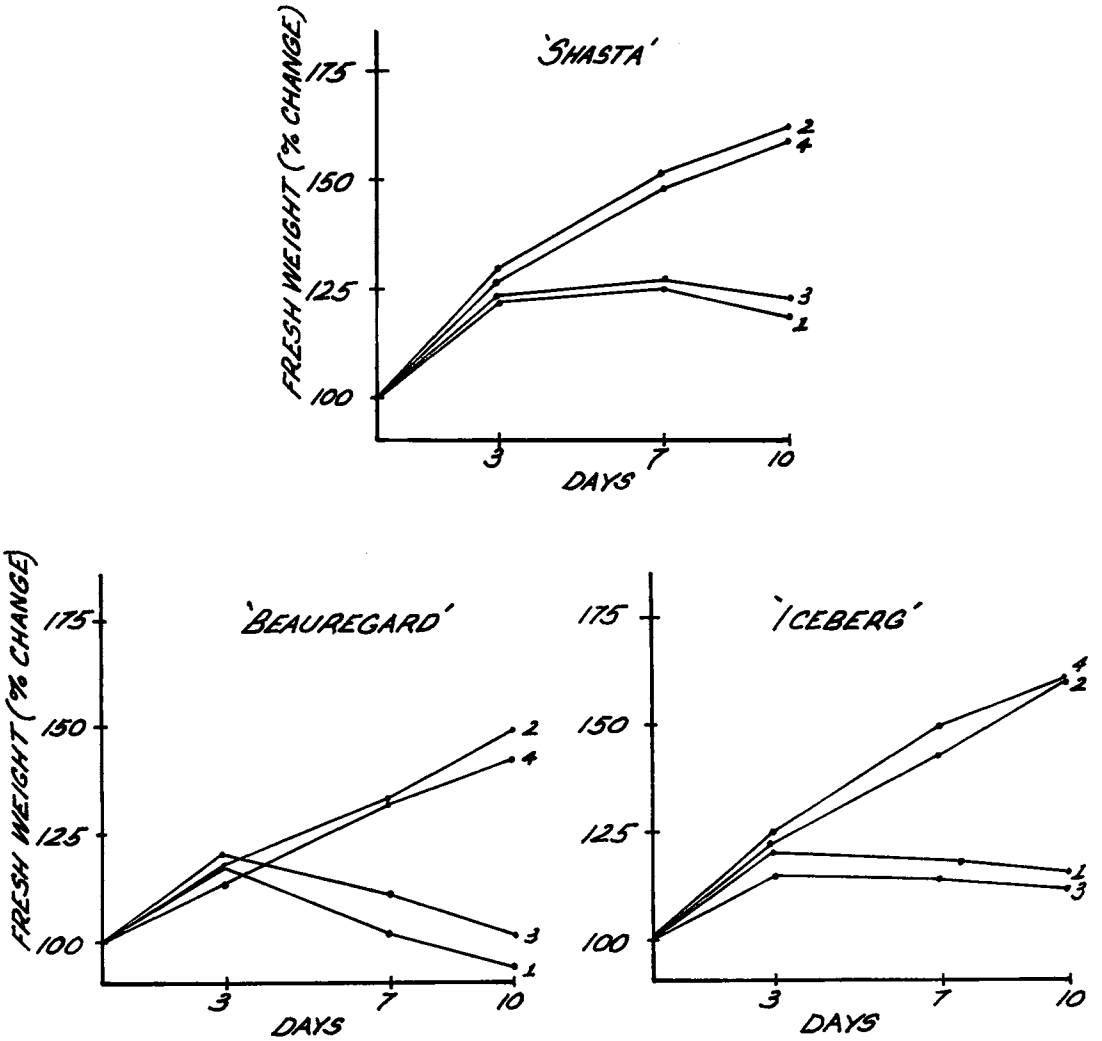


Figure 2.—Fresh weight of several chrysanthemum cultivars harvested at 2 stages of development and held in water or 200 ppm 8-hydroxyquinoline citrate plus 2% sucrose. 1) tight bud held in water, 2) tight bud held in 8-HQC+sucrose, 3) open bud held in water, 4) open bud held in 8-HQC+sucrose.

chlorosis after 10-18 days and indicated that sucrose was responsible for foliar chlorosis.

Flower buds of spray chrysanthemum cultivars held in 8-HQC+sucrose followed similar patterns of development reported for large incurved flowers (13). Flower buds of spray cultivars held in 8+HQC-sucrose opened and weighed more than flowers held in water. Flowers on stems held in 8-HQC+sucrose were similar in semmetry to flowers which developed on the intact plant.

These data suggest that flowers of spray cultivars could be harvested, handled, and opened in a manner similar to that used with the large incurved chrysanthemum cultivars. Commercially available floral preservatives might be used for opening bud-cut chrysanthemums in a possible new marketing procedure. Commercial application of this procedure could reduce cost of transportation, facilitate harvest, and reduce damage. Because of the range of bud size that can be opened successfully, mechanically harvesting might be considered.

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# EFFECT OF RATIOS OF $NH_4$ TO $NO_3$ AND LEVELS OF N AND K ON CHEMICAL CONTENT OF CHRYSANTHEMUM MORIFOLIUM. "BRIGHT GOLDEN ANN"

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ABSTRACT

Three 5x3 factorial experiments in randomized block design with 4 replications were initiated under soil culture conditions to test effects of 5 ratios of $NO_3$ versus $NH_4$ nitrogen at 3 N-K levels on growth and chemical composition of *Chrysanthemum morifolium* 'Bright Golden Ann'. Only 8 of the 15 treatments survived. Samples of leaf tissue from plant mid-section were taken for chemical analyses 6 and 8 weeks after potting and at experiment termination. Termination samples also were analyzed for total oxalate content.

Plants receiving higher ratio of $NO_3$ to $NH_4$ at high N-K level and those receiving higher ratio of $NH_4$ to $NO_3$ at low N-K were tallest.

Plants receiving $NH_4$-N had higher N contents than those receiving $NO_3$-N. Increasing $NH_4$ ions depressed uptake of Ca. Increasing $No_3$ ions depressed P uptake. K was least effected by form of N. $NO_3$-N promoted oxalate formation.

INTRODUCTION

Effects of different levels of N fertilization had been studied and reported for a large variety of plants, but the form of N supplied to plants has received less consideration. A few investigators have reported differences in growth responses and chemical composition of plants given $NO_3$- versus $NH_4$-N.

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