Proc. Fla. State Hort. Soc. 90:297-299. 1977.

CONTROL OF BACTERIA IN GYPSOPHILA VASE WATER[1]

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Additional index words. Sodium dichloroisocyanurate, flower quality and longevity.

Abstract. **The bacterial population in water containing gypsophila stems reached 1.9 x 10^8 cells/ml. After 3 days at 75°F, stem ends rotted and had a putrid odor. The bacterial population of water containing gypsophila was less than 100 cells/ml with the slow-release chlorine derivative, sodium dichloroisocyanurate (DICA). Water containing DICA was clear and stem ends did not rot.**

Gypsophila held in water containing 400 mg DICA/liter during a simulated shipping test at 50°F and subsequently held in 400 mg DICA + 20 g sucrose/liter at room temperature showed no symptoms of stem rotting or floret deterioration. Water remained clear and had a chlorine activity equivalent to 40% of initial activity. Gypsophila held in water without DICA during simulated shipping and subsequently held at room temperature had rotted stems. Water was extremely turbid and had a putrid odor. Under the test conditions utilized, DICA was not phytotoxic to gypsophila florets.

Gypsophila flowers are extremely sensitive to moisture deficiency and wilt very rapidly when shipped or stored dry (4). Various shipping and handling procedures have been used for gypsophila. Currently, the typical shipping procedure in practice is to place 20 flower bunches in a crate or box with the stem ends immersed in a bucket of water. The transit method is restricted to surface transportation requiring 2-3 days for the flowers to reach their destination. Under these circumstances water becomes contaminated with bacteria and stem ends rot and have a putrid odor.

Although floral preservatives enhanced gypsophila flower quality and longevity, they do not control bacterial growth (3). Marousky and Nanney (3) reported that 8-hydroxyquinoline citrate (8-HQC) and sodium benzoate inhibited but did not control bacterial growth. Marousky (2) reported that 50 mg sodium dichoroisocyanurate (DICA) per liter did not control bacteria in water containing gypsophila stems. He reported that water holding gypsophila stems reached 1.5 x 10^6 bacterial cells/ml. DICA at 300 mg per liter controlled bacteria in water holding roses, carnations, snapdragons, gladiolus, and chrysanthemums (2). This level of DICA was not tested on gypsophila. This paper reports the results of DICA and sucrose on bacterial population and post harvest quality of gypsophila flowers under simulated shipping and handling conditions.

Methods and Materials

The experiments were undertaken in February-March, 1977. Flowering gypsophila (*Gypsophila paniculata* L. 'Perfecta') stems were harvested at midday. Stems were grouped to make 6-7 oz (0.17 to 0.2 kg) bunches and taken to the laboratory. Laboratory was held at constant temp of 75°F with 1.5 Klx light supplied by cool white fluorescent tubes for 12 hr daily.

Experiment 1. Quart mason jars were filled with water containing 0, 100, 200, or 400 mg sodium dichloroisocyanurate per liter. Each jar was inoculated with 1 ml of water which previously held cut flowers (circa 10^6 bacterial cells/ml). A single bunch of flowers was placed in each jar and held for 3 days in darkness at 50° or 75°F (10° or 24°C) to simulate shipping. After 3 days, the jars and bunches at 50° were placed in the laboratory at 75°F. At the time jars were transferred, a water and solution sample was collected, and bacterial population determined. Dilutions (tenfold) were made and sodium thiosulphate was used to eliminate chlorine residues. Diluted samples were plated on nutrient agar and incubated at 75°F for 48 hr. Solution clarity was determined after 3 days and daily thereafter. Jars were held up to a fluorescent light and incidence of cloudiness determined: 1 = clear, 2 = some or incipient cloudiness, 3 = extreme cloudiness, 4 = extreme cloudiness with precipitation.

Experiment 2. Flowers were harvested and bunched as previously outlined. Flower bunches were placed in jars containing water or 400 mg DICA/liter and held at 50°F in darkness for simulated shipping. After 3 days, flowers previously held in water or DICA were factorially arranged in jars containing water, or floral preservatives 200 mg 8-HQC + 20 g sucrose/liter, 200 mg DICA + 20 g sucrose/liter or 300 mg DICA + 20 g sucrose/liter. One hr and 48 hr after bunches were transferred to water or floral preservatives, a relative estimation of bacterial population was determined. Flower bunches were temporarily removed from jars and a sterile loop was inserted into the water or solution. The loop and contents were used to inoculate test tubes containing nutrient broth. All transfers were made using aseptic technique. Test tubes were incubated for 48 hr at 75°F and an estimation of bacterial growth was determined as follows: 1 = clear broth, no evidence of bacterial growth, 2 = slightly turbid broth, 3 = very turbid broth with sedimentation. After 6 days free chlorine was determined in all solutions using the orthotolidine method (1). Samples from each solution were appropriately diluted and compared to known chlorine standards from sodium hypochlorite. Comparisons were made on a Beckman Model B spectrophotometer at 430 mμ. Flower quality was rated as previously published (3).

Results

Experiment 1. The bacterial population in water holding gypsophila stems at 50° and 75°F for 3 days were 2.5 x 10^5 and 1.9 x 10^8 cells/ml respectively (Table 1). DICA was bactericidal; water containing DICA had less than 100 cells/ml. Water or solution which had the highest bacterial population was also the cloudiest. After 7 days, water containing 100 and 200 mg DICA held at 75°F was slightly cloudy but similar solutions held at 50°F were clear. Water containing 400 mg DICA/liter and held at 50° or 75°F was clear.

Experiment 2. DICA used during the simulated shipping and holding periods inhibited bacterial growth (Table 2) and maintained solution clarity (Table 3). The floral preservative, 8-HQC + sucrose, did not maintain bacterial control or solution clarity. Holding solution clarity was maintained better by 8-HQC + sucrose when DICA was used during simulated shipping. The preservative 200 mg DICA + 20 g sucrose/liter inhibited bacteria and maintained solution clarity better than 8-HQC + sucrose. Bacteria in-

[1]Florida Agricultural Experiment Stations Journal Series No. 724.

Table 1. Influence of temp and DICA on bacterial population and clarity of water holding gypsophila stems.

Temperature[z] (°F)	DICA (mg/liter)	Bacterial[y] population	Water clarity after day[x] 3	4	5	6	7
50	0	2.5×10^5	2.0	3.0	4.0	4.0	4.0
50	100	$< 10^2$	1.0	1.0	1.0	1.0	1.0
50	200	$< 10^2$	1.0	1.0	1.0	1.0	1.0
50	400	$< 10^2$	1.0	1.0	1.0	1.0	1.0
75	0	1.9×10^8	3.7	4.0	4.0	4.0	4.0
75	100	$< 10^2$	1.0	1.3	2.0	2.0	2.0
75	200	$< 10^2$	1.0	1.0	1.3	1.7	2.0
75	400	$< 10^2$	1.0	1.0	1.0	1.0	1.0

[z]Flowers held at these temperatures for 3 days, then at 75°F from days 4 to 7.
[y]Number of colonies from 1 ml sample after 3 days.
[x]Water clarity: 1 = clear, 2 = some cloudiness, 3 = very cloudy, 4 = extreme cloudiness with precipitation.

Table 2. Influence of DICA during simulated shipping and various floral preservatives on clarity of water and solutions holding cut gypsophila stems.

Simulated shipping solution (mg/liter)[z]	Holding solution[y] (mg + g sucrose/liter)	Water or solution clarity after day[x] 4	5	6	7
Water	Water	2.0	3.3	4.0	4.0
Water	200 mg 8-HQC + 20 g sucrose	1.3	2.3	3.7	4.0
Water	200 mg DICA + 20 g sucrose	1.0	1.0	2.0	2.0
Water	400 mg DICA + 20 g sucrose	1.0	1.0	1.0	1.0
400 mg DICA	Water	1.0	1.7	2.7	3.3
400 mg DICA	200 mg 8-HQC + 20 g sucrose	1.0	1.0	1.0	2.3
400 mg DICA	200 mg DICA + 20 g sucrose	1.0	1.0	1.0	1.0
400 mg DICA	400 mg DICA + 20 g sucrose	1.0	1.0	1.0	1.0

[z]Flowers held in these solutions for 3 days at 50°F.
[y]Flowers held in these solutions from 4th to 7th day.
[x]Water clarity, 1 = clear, 2 = incipient cloudiness, 3 = very cloudy, 4 = extremely cloudy with precipitation.

creased in water during the simulated shipping period but treatment with 200 or 400 mg DICA + 20 g sucrose/liter for 1 hr was sufficient to eliminate bacteria (Table 3). Holding solutions containing DICA maintained relatively high chlorine levels. There was a slight chlorine residue with water and 8-HQC solutions when DICA was used during the simulated shipping period. Flowers treated with DICA during simulated shipment had better quality than those not treated (Table 4). Flowers treated with DICA during simulated shipment and held in DICA + sucrose showed no signs of deterioration after 7 days. Flowers treated with DICA and subsequently held in water or 8-HQC had better quality than flowers not treated.

Table 4. Influence of DICA during simulated shipping and various floral preservatives on gypsophila flower quality.

Simulated shipping solution (mg/liter)[z]	Holding solution[y] (mg + g sucrose/liter)	Flower quality after day[x] 5	6	7
Water	Water	3.0	4.0	5.0
Water	200 mg 8-HQC + 20 g sucrose	2.3	3.0	4.0
Water	200 mg DICA + 20 g sucrose	2.0	2.3	4.0
Water	400 mg DICA + 20 g sucrose	2.3	2.3	3.7
400 mg DICA	Water	1.0	1.0	2.0
400 mg DICA	200 mg 8-HQC + 20 g sucrose	1.0	1.0	2.0
400 mg DICA	200 mg DICA + 20 g sucrose	1.0	1.0	1.0
400 mg DICA	400 mg DICA + 20 g sucrose	1.0	1.0	1.0

[z]Flowers held in these solutions for 3 days at 50°F.
[y]Flowers held in these solutions (per liter) from 3rd to 7th day.
[x]Flower quality, 1 = no deterioration, 2 = incipient floret wilting or petal browning, 3 = moderate floret wilting or petal browning (20%), 4 = severe wilting or petal browning (75%), 5 = severe wilting or petal browning (100%).

Discussion

Gypsophila cut flowers are normally shipped with the stem ends in water. The stems are very succulent and bacteria proliferate in the water under the present shipping conditions. The net result is rotted stems with a putrid odor. In these tests, the bacterial population was 1.9×10^8 cells/ml of water after 3 days at 75°F. A 400 mg DICA solution maintained bacteria-free water for 1 week. At this level, water remains clear and odor-free with no evidence of rotted stems. Earlier research indicated that 50 mg DICA/liter did not control bacteria (2). The present research agrees with an earlier report that 200-400 mg DICA is necessary for control of cut flower bacteria (2). Most cut flowers were slightly injured by DICA. Slight injury was also apparent to gypsophila. Stem ends in DICA solutions were slightly bleached; no other injury was apparent to stem, leaves or flowers. The slight injury was considered as insignificant. A 400 mg DICA solution provided sufficient residual chlorine for 6 days (Table 3). Although DICA controlled bacteria in cut flower water, the inclusion of sucrose was necessary for maintenance of flower quality and

Table 3. Influence of DICA during simulated shipping and various floral preservatives on bacterial growth and residual chlorine levels in water holding cut gypsophila stems.

Simulated shipping solution (mg/liter)[z]	Holding solution[y] (mg + g sucrose/liter)	Bacterial growth after[x] 3 days	3 days + 1 hr	5 days	Chlorine after 6 days (mg/liter)
Water	Water	4.0	4.0	4.0	0
Water	200 mg 8-HQC + 20 g sucrose	4.0	4.0	4.0	0
Water	200 mg DICA + 20 g sucrose	4.0	1.0	1.0	13
Water	400 mg DICA + 20 g sucrose	4.0	1.0	1.0	129
400 mg DICA	Water	1.0	1.0	3.3	< 1
400 mg DICA	200 mg 8-HQC + 20 g sucrose	1.0	2.3	2.3	< 1
400 mg DICA	200 mg DICA + 20 g sucrose	1.0	1.0	1.3[w]	28
400 mg DICA	400 mg DICA + 20 g sucrose	1.0	1.0	1.0	109

[z]Flowers held in these solutions for 3 days at 50°F.
[y]Flowers held in these solutions from 3rd to 7th day.
[x]Bacterial growth, 1 = no growth, 2 = incipient turbidity, 3 = very turbid, 4 = extremely turbid with sedimentation.
[w]One test tube out of 3 showed indications of incipient turbidity.

longevity. Flowers held in DICA during simulated shipment and subsequently in DICA + sucrose had excellent flower quality for 7 days.

Additional research is needed to establish all the parameters responsible for the release of chlorine by DICA in cut flower water.

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Proc. Fla. State Hort. Soc. 90:299-301. 1977.

PROBLEMS IDENTIFIED IN AN EXTENSION-OPERATED CLINIC FOR COMMERCIAL FOLIAGE PLANT PRODUCERS

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Abstract. **In an effort to better service some of the production problems generated by the concentrated foliage plant industry in central Florida, a clinic was initiated in January 1976 by extension personnel to operate one-half day per week. Since that time, findings from the clinic have been tabulated according to plant type, nature of problem and seasonal distribution of problem. Major problem plants and problem categories—cultural problems, diseases, insect, mite and related pest injury, and phytotoxicity are presented in tabular form.**

The clinic has evolved into an efficient mechanism for handling the volume of plant problems and questions which are generated by a large industry.

The concept of a clinic to serve primarily the commercial foliage plant producers in central Florida was formulated to more efficiently serve the foliage industry which has grown from an estimated 11.7 million dollar industry in 1966 (1) to an estimated 110.6 million dollar wholesale value produced in central Florida during 1976 (2). Since the expansion rate was not paralleled with additional supporting positions and facilities in the areas of Extension, it was felt necessary to pool identifiable resources and proceed to assist the industry with their numerous problems. This young industry has experienced many problems due to a very diverse product mix, in terms of plant species, container sizes, systems of environmental control, and cultural techniques employed.

The initial plan for the clinic, which is still in effect, consists of concentrating the effort of Extension personnel staffing the clinic into one 3-hour period each week, Wednesday afternoons. By informing the central Florida growers in Orange, Seminole, Polk, Volusia, Lake, Brevard and Marion Counties of the clinic plan their participation in diagnostic services offered by Extension was successfully channelled into the 1 time frame per week. Since many of the central Florida foliage growers frequently sought technical advice from Extension and Research faculty stationed at the Agricultural Research Center, Apopka and due to its central location, this center was selected as the most appropriate clinic location. The clinic has been operated by the county extension horticulturists cooperating on a regional basis.

The data presented in this paper were collected from January 1976 when the clinic was initiated through June 1977. The data was generated from information provided to the staff by the growers completing the clinic form. This clinic form provided a format for inquiring about cultural, environmental, pest control, and other techniques utilized by the grower. These forms were then completed by the Extension staff with diagnostic information and recommendations.

The data were organized into quarterly periods and then subdivided into 4 major categories of foliage plant problems. The designated categories were cultural, diseases, phytotoxicity, and insect, mite and related pest injury. This information is given in Table 1 as a percentage of the total problems examined during the quarterly periods. No particular trend was observed for any of the problem categories in relation to quarterly time periods.

The data were also analyzed by plant genera (Table 2). The diverse nature of the plant material being grown in the central Florida area is shown by the 29 genera listed. The 29 genera listed were submitted by the growers and diagnosed 10 or more times during the 18 months. These

Table 1. Major categories of foliage plant problems listed by frequency and season (January 1976-June 1977).

Period	Distribution of problems (% of 6-quarter total)				
	Cultural	Diseases	Phyto-toxicity	Insect, mite etc. injury	All problems
1976					
Jan.-March	15.6	13.6	17.4	13.7	15.0
April-June	16.5	15.7	16.9	27.4	17.4
July-Sept.	20.0	20.8	16.9	22.2	20.0
Oct.-Dec.	21.0	21.1	23.2	13.7	20.6
1977					
Jan.-March	15.0	16.4	13.4	6.0	14.3
April-June	11.9	12.3	12.2	17.1	12.6
Total problems	461	389	172	117	1139