Only white lights are used on decorations because they are bright and show off the ornaments better than colored ones. Most items are scaled up to fit the surroundings. Therefore accessories must be large and often grouped to be in proportion to the other parts of the setting. Many items are custom-made using ribbons, pearls and permanent materials.

The success of this seasonal display department is certainly related to the careful year round planning and attention that is given to this specialized service. I was impressed with the sensitivity of Betty Newman, who directs this department. She was aware of the special situations created by large numbers of seasonal employees, who must work many hours during a fraction of the year. She looks for individuals who can fit well into this situation and those who are likely to find personal reward as team members. Motivation comes in the form of a sincere interest in employees and showing appreciation for their valuable contribution to the total task.

I left Phillip's Flowers and Gifts with a sense of inspiration. The work ethic is alive and well. Positive and futuristic thinking is balanced with sound, conservative evaluation. There is pride in the accomplishments of the past and a keen awareness of why these forward strides were made. Amid the complexities of this large flower business, there is a refreshing straightforward approach to the matters at hand. At Phillip's Flowers and Gifts, one is never far from the realization that the flower business deals with nature's most beautiful product and provides a service that touches people in a most special way.

Effect Of Aqua-Gro Wetting Agent On The Growth, Flowering, And Postproduction Quality Of Potted Chrysanthemum

Several nonionic, cationic, and anionic wetting agents, and blends of these compounds have been demonstrated to facilitate the movement of water into and through growing media (Letey et al., 1962; Pelishek et al., 1969; and Powell 1986). These chemicals control water infiltration, distribution, and drainage, thus affecting moisture reserves, nutrient availability, and aeration. At an optimum concentration, these wetting agents improve the rewetting potential of growing media, decrease root stress related problems, allow greater control of plant growth, and improve the quality of finished products. This is accomplished by the adsorption of hydrophobic ends of the molecules to materials used in growing media, which leaves the hydrophilic ends exposed (Valoras et al., 1969). Their effectiveness would, therefore, depend on the extent of their adsorption by the growing media.

Aqua-Gro (Aquatrols Corporation of America, Pennsauken, NJ) is one of the most commonly utilized wetting agents in soilless growing media. It has been shown to be irreversibly adsorbed to growing media particles, resulting in relatively longer residual activity (Valoras, et al., 1969). The longer lasting quality makes it an ideal wetting agent in container plant production. Both granular and liquid formulations are being used in the greenhouse industry.

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Although considerable research has been reported for field crops and turf, very little is known about its application in container plant production. In the present investigation, its effect on growth, flowering, and postproduction quality of potted chrysanthemum was examined.

MATERIALS AND METHODS

Production. The potting medium consisted of equal volumes of sphagnum peat moss and vermiculite which were mixed uniformly for five-minutes in a cement mixer. Granular Aqua-Gro (40% a.i.) at 0, 0.56, 1.13, 2.25, 4.5, or 9.00-ounces per cubic foot was added to the medium during mixing. Five 4.5-inch plastic pots constituted an experimental unit. With six-rates of each granular and liquid Aqua-Gro formulations and three-replications of each treatment, there was a total of 36-experimental units. Fifteen-plastic pots were filled with each of the above media. In addition, 90 4.5-inch pots were filled with the above media that did not contain Aqua-Gro. One-rooted 'Bright Golden Anne' cutting (Yoder Brothers, Inc., Barberton, OH) was planted in each pot on January 31, 1989, and the medium was topdressed with 0.5-teaspoon of Osmocote containing 14N-14P-14K. The medium was irrigated thoroughly with 200 ppm each of N and K using 20-10-20 Peters' fertilizer (Grace/Sierra Co., Fogelsville, PA) and the cuttings were allowed to establish under a long day photoperiod and intermittent mist (6-seconds per 3.25-minutes) for four-days. Plants were then transferred to another greenhouse and provided with supplemental night lighting from 60-watt incandescent bulbs from 10:00 PM to 2:00 AM for ten-days before subjecting them to short days. The plants were pinched to seven-leaves when the roots reached the sides and bottom of the container (two-weeks after planting). Liquid Aqua-Gro at 0, 5, 10, 20, 40, or 80 ppm was applied at every irrigation to the 90-plants which were grown in medium into which granular Aqua-Gro was not previously incorporated. The other 90-plants were irrigated with only fertilizer solution. All the plants were grown at 62°F (night). Height control was achieved with three-spray applications of 5,000 ppm daminozide (B-Nine SP). B-Nine was first applied when lateral shoots, developed after pinching, were 1.5 to 2-inches long, and thereafter at 15-day intervals. Lateral buds were removed when terminal flower buds measured approximately 0.2-inches in diameter. The plants were harvested when inflorescences developed 8 to 10-rows of opened ray florets (approximately 1/2 to 2/3-open). Height and spread of plants in two-directions and size and number of flowers were recorded at the end of the production phase.

Nutrient analysis. Two-fully expanded and recently matured leaves from each shoot on three-subsample plants were excised and pooled from each replication at the end of the production phase. Similarly, growing medium samples from three-subsample pots were gathered and pooled for each replication. The leaf and growing medium samples were analyzed for nutrient status at the Research and Extension Analytical Laboratory, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH.

Postproduction evaluation. One subsample plant from each replication was randomly selected, sleeved, boxed, and held for 48-hours at 70 ± 1.0°F prior to postproduction evaluation. Plants were then removed to a postproduction environment room maintained at 68 to 70°F with a relative humidity of 50 to 55% and 12-hours of light during a 24-hour period from cool white fluorescent lamps. Plants were irrigated with distilled water as required. Flowers were considered senesced when 5 to 6-rows of ray florets lost turgidity. Beginning two-weeks after being placed in the postproduction room, plants were observed weekly for necrotic leaves. In the second experiment, days to wilting of flowers were determined by saturating the medium with tap water following the removal of the plants from the production area and then withholding irrigation in the postproduction environment until the plants wilted.

The experiment was repeated on March 14, 1989, and the production data from both experiments were combined for analysis of variance with planned orthogonal comparisons.

Table 1. Effect of Aqua-Gro on growth and flowering in potted 'Bright Golden Anne' chrysanthemum.

Aqua-Gro conc./method of Application[2]	Height (cm)	Spread[1] (cm)	Days to flower	Flower number	Flower diameter (cm)
0.56 oz/cu ft	34.3	26.3	70.5	4.2	12.2
1.13	33.6	26.6	70.5	3.8	12.6
2.25	32.5	25.8	69.8	4.2	12.3
4.50	32.1	25.5	70.8	3.8	12.4
9.00	32.0	23.3	71.2	3.8	11.9
5 ppm	35.0	27.4	70.5	3.8	11.9
10	33.5	27.2	70.5	4.0	12.7
20	34.4	27.5	71.0	4.1	12.4
40	34.4	26.6	71.3	3.8	12.6
80	32.7	26.4	71.0	4.0	12.1
Control[3]	33.4	27.2	70.8	4.1	12.3
SEM[4]	1.33	0.47	0.2	0.05	0.1
F-test[5]					
Granular	NS	NS	NS	NS	NS
Liquid	NS	NS	NS	NS	NS
Rate Granular	L*	L**	L**	L*,Q*	L*
Rate Liquid	NS	NS	NS	NS	NS
Avg. Granular vs Avg. Liquid	**	**	NS	NS	NS

[1] Average of width of plant in two-directions.
[2] Aqua-Gro was either incorporated into the media or the plants were irrigated with fertilizer solution amended with Aqua-Gro at various concentrations. Peter's fertilizer was used for preparing the stock solution.
[3] Control plants received no Aqua-Gro either through irrigation or media incorporation.
[4] Standard error of mean.
[5] Orthogonal comparisons - significant at 5 (*) or 1% (**) levels, linear (L), quadratic (Q), or nonsignificant (NS).

Table 2. Effect of Aqua-Gro on foliar nutrient status in potted chrysanthemum.

Aqua-Gro Conc./method[1]	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe ppm	Cu ppm	Mn ppm	B ppm	Zn ppm
0.56 oz/cu ft	5.6	1.0	7.5	0.91	0.60	117.3	11.3	306.9	51.7	52.1
1.13	5.6	1.2	7.2	0.90	0.56	117.3	11.7	295.1	50.4	55.0
2.25	5.6	1.3	7.1	0.93	0.56	130.3	11.8	279.9	49.2	60.3
4.50	5.5	1.4	7.2	0.91	0.52	125.6	11.8	268.9	49.7	57.7
9.00	5.7	1.5	6.8	0.83	0.48	120.7	10.5	273.7	45.6	57.2
5 ppm[2]	5.5	1.1	7.1	0.95	0.56	169.1	12.3	293.8	50.2	55.3
10	5.6	1.1	7.0	1.00	0.56	120.2	11.5	290.5	50.2	47.8
20	5.6	1.1	7.2	0.98	0.56	131.3	11.5	296.5	48.4	51.4
40	5.5	1.1	7.1	0.94	0.56	125.7	12.2	298.8	48.4	51.0
80	5.6	1.2	7.1	0.83	0.53	118.2	10.8	251.4	48.6	54.3
Control[3]	5.5	1.1	7.2	0.91	0.59	165.0	10.3	290.4	52.1	52.1
SEM[4]	0.02	0.01	0.13	0.01	0.0	15.4	0.61	6.4	8.0	19.2
F-test[5]										
Granular	NS	NS	NS	NS	*	NS	**	NS	**	NS
Liquid	NS	NS	NS	NS	NS	*	NS	*	NS	NS
Rate Granular	NS	L**Q**	NS	NS	L**	NS	L**	L**	L*	L**
Rate Liquid	NS	NS	NS	L*	NS	NS	NS	L*	NS	NS
Avg. Granular vs Avg. Liquid	NS	**	NS	NS	NS	NS	NS	NS	NS	**

[1] Aqua-Gro was applied either as a one-time media incorporation at various rates or the plants were irrigated with fertilizer solution amended with Aqua-Gro at various concentrations. Peter's fertilizer was used for preparing stock solution.
[2] Aqua-Gro was applied with every irrigation.
[3] Control plants received no Aqua-Gro either through irrigation or media incorporation.
[4] Standard error of mean.
[5] Orthogonal comparisons - significant at 5 (*) or 1% (**) levels, linear (L), quadratic (Q), or nonsignificant (NS).

RESULTS AND DISCUSSION

Growth and flowering. The average effects across all concentrations of incorporated and liquid applications of Aqua-Gro on plant growth and flowering were not significantly different from control plants (Table 1). The relationship between growth and flowering parameters and the concentrations of incorporated Aqua-Gro was linear except for flower number which was both linear and curvilinear. The highest rate of granular Aqua-Gro, 9.0-ounces (which is 10-times greater than the recommended rate of 0.90 kg) reduced final plant height by 4.2%, spread by 14.3%, delayed flowering by nearly one-day, and reduced the number and size of flowers by 3.0%, compared to control plants. Increasing the concentration of liquid applications had no effect on any of the observed parameters.

Nutrient uptake. The highest rate, 9.00-ounces (which is 10-times greater than the recommended rate) resulted in an increase in foliar concentrations of phosphorus (36.4%), zinc (10%), and copper (14.6%), and a decrease in levels of potassium (5.5%), magnesium (18.6%), iron (11.0%), manganese (5.7%), and boron (12.5%), compared to the control plants (Table 2). The application of liquid Aqua-Gro did not significantly alter leaf nutrient status except for a 7 to 10% increase in the level of calcium in plants which received less than 40 ppm at every irrigation as compared to control plants.

At the end of the production phase, there was no difference in nutrient levels in the control medium and the media into which granular Aqua-Gro was incorporated. Drench applications of 80 ppm Aqua-Gro 'L' (recommended rate is 100 ppm), however, resulted in higher (20%) potassium levels in the growing medium as compared to the control (Table 3). Relatively high soluble salts levels were observed in the control medium and media which received liquid applications compared to media that had higher rates of incorporated Aqua-Gro.

Postproduction quality. The relationship between the postproduction quality and Aqua-Gro concentration was linear. The highest rate, 9.0-ounces (which is 10-times greater than the recommended rate of 0.9 ounce per cubic foot) reduced the postproduction life of plants by 3.7-days (16.6%) compared to the control (Table 4).

Table 3. Effect of Aqua-Gro on growing medium nutrient status in potted 'Bright Golden Anne' chrysanthemum.

Aqua-Gro Conc./method of application	NO_3-N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Soluble salts (m mhos)
0.56 oz/cu ft[1]	158.5	28.1	182.9	68.4	2.3
1.13	138.3	23.3	167.1	56.6	2.0
2.25	159.7	27.6	192.6	58.5	2.2
4.50	135.7	25.1	183.4	45.2	2.0
9.00	145.5	27.5	212.7	34.7	2.0
5 ppm[2]	157.8	32.9	204.5	59.3	2.3
10	175.0	32.8	192.5	60.5	2.5
20	150.0	30.3	194.4	61.5	2.4
40	159.8	29.6	196.4	61.5	2.2
80	182.5	38.3	250.3	56.9	2.6
Control[3]	171.5	33.4	208.2	66.6	2.7
SEM[4]	10.5	27.7	8.5	19.6	0.2
F-test[5]					
Granular	NS	NS	NS	NS	*
Liquid	NS	NS	NS	NS	NS
Rate Granular	NS	NS	NS	NS	NS
Rate Liquid	NS	NS	L*	L*	NS
Avg. Granular vs Avg. Liquid	NS	**	NS	NS	NS

[1] One-time media incorporation at various rates.
[2] Plants were irrigated with fertilizer solution amended with Aqua-Gro at various concentrations. Peter's fertilizer was used for preparing stock solution.
[3] Control plants received no Aqua-Gro either through irrigation or media incorporation.
[4] Standard error of mean.
[5] Orthogonal comparisons - significant at 5 (*) or 1% (**) levels, linear (L), quadratic (Q), or nonsignificant (NS).

Table 4. Effect of Aqua-Gro on the postproduction quality in potted 'Bright Golden Anne' chrysanthemum.

Aqua-Gro Conc./method of application[2]	Flower senescence (days)	Days to wilt[1]	Number of necrotic leaves on day 14	21	28
0.56 oz/cu ft	23.9	9.3	3.0	12.0	24.7
1.13	23.3	10.7	5.0	12.7	18.0
2.25	22.2	9.7	3.3	11.7	21.7
4.50	22.3	10.0	3.0	18.0	23.7
9.00	19.4	8.7	7.0	19.0	19.0
5 ppm	21.4	9.0	6.0	16.0	19.7
10	23.1	11.3	3.3	11.3	24.3
20	22.7	10.7	5.7	17.0	24.0
40	22.3	10.0	3.7	7.3	25.7
80	23.1	10.7	1.0	3.7	24.0
Control[3]	23.1	8.0	2.7	22.0	25.7
SEM[4]	1.8	0.5	2.3	25.2	10.7
F-test[5]					
Granular	NS	**	NS	NS	NS
Liquid	NS	**	NS	NS	NS
Rate Granular	L**	NS	NS	NS	NS
Rate Liquid	NS	NS	L*	L*	NS
Avg. Granular vs Avg. Liquid	NS	NS	NS	NS	NS

[1] Days to wilting represent the duration between the last irrigation and the wilting of flower. Days to wilting were determined only in the second experiment.
[2] Aqua-Gro was applied either as a one-time media incorporation or the plants were irrigated with fertilizer solution amended with Aqua-Gro at various concentrations. Peter's fertilizer was used for preparing stock solution.
[3] Control plants received no Aqua-Gro either through irrigation or media incorporation.
[4] Standard error of mean.
[5] Orthogonal comparisons - significant at 5 (*) or 1% (**) levels, linear (L), quadratic (Q), or nonsignificant (NS).

Shelf life of flowers was correlated with nitrogen (r=−0.88), phosphorus (r=−0.42), potassium (r=−0.6), magnesium (r=0.53), copper (r=−0.73), manganese (r=−0.52), and zinc (r=−0.83) levels at the end of the production phase. Similarly, shelf life was correlated with nitrogen (r=−0.50), potassium (r=−0.79), calcium (r=0.63), and soluble salts (r=−0.23) concentrations in the growing medium at the end of the production phase.

Under water stress conditions, both formulations delayed wilting of inflorescences and delayed foliage necrosis. Plants drenched with 10 ppm of liquid Aqua-Gro at every irrigation (recommended rate is 100 ppm) exhibited wilting symptoms 3.3-days after control plants (Table 4). The foliage of plants that were treated with 40 or 80 ppm liquid Aqua-Gro applications senesced relatively slowly compared to the control plants, especially during the first two-weeks.

In the present study, the greatest advantage of Aqua-Gro appeared to be related to an improvement in postproduction longevity. Repeated drench applications of liquid Aqua-Gro appeared to be more effective than a one-time medium incorporation. Drench applications did not result in undesirable effects, especially reduction in height and spread of plants that were noted at the highest rate of incorporated Aqua-Gro. Positive effects of Aqua-Gro on turf quality were noted by Tattar (1985).

Delays in floral senescence and foliage abscission because of Aqua-Gro treatment might be the result of optimum nutrient concentrations in leaves and growing medium (Tables 2 and 3). A significant correlation between floral senescence and nutrient levels in leaves and growing medium supports this conclusion.

Moisture reserves in the growing medium had a significant impact on root environment and nutrient uptake both in the production and postproduction phases. Therefore, maintenance of proper moisture levels in the growing medium is important in order to achieve optimum plant growth which would result in maximum 'on the bench' and postproduction quality (delivered). Wetting agents facilitate the distribution of water in growing medium. By breaking surface tension, these chemicals also encourage removal of excess water from the medium (Powell, 1986). This improves wetting potential of hydrophobic growing media but at the same time, prevents a build-up of excessive soluble salts, thus leading to a creation of a root environment favorable to optimum growth 'on the bench' and postproduction quality. The fact that control medium had a higher soluble salts level than treated media, and a negative correlation was observed between nitrogen and soluble salts concentrations in growing media and floral senescence supports this conclusion.

CONCLUSIONS

At the recommended rate (0.9-ounce per cubic foot), Aqua-Gro 'G' did not affect growth, flowering, and postproduction quality in chrysanthemum. However, granular Aqua-Gro, at rates above 4.5 ounces per cubic foot (five-times the recommended rate) affected number and size of flower, and postproduction quality. Visual observation also revealed a drastic reduction in root growth at rates higher than 4.5-ounces per cubic foot. On the other hand, drench applications of 10 ppm of liquid Aqua-Gro at every irrigation (recommended rate is 100 ppm) was effective in improving flowering and postproduction longevity in potted chrysanthemum without being toxic to plant growth. Therefore, drench applications could be a more desired method of Aqua-Gro treatment than a one-time media incorporation.

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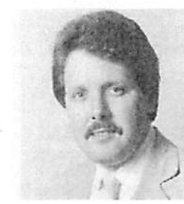
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