COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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EFFECTS OF IRRIGATION FREQUENCY AND NUTRIENT SOLUTION CONCENTRATION ON YIELD OF CARNATION

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The experiment reported on in this paper was developed to demonstrate the effects of watering frequency and nutrient solution concentration on the growth of carnation. Questions to be answered by the study were: (1) Will increased watering frequency compensate for reduced nutrient solution concentration? Will carnations in an inert medium produce maximum yield if the nutrient solution concentration is reduced but the watering frequency is increased? (2) Will increased nutrient solution concentration compensate for decreased watering frequency? If the watering frequency on carnations in an inert medium is reduced, will increasing the nutrient solution concentration produce optimum yield?

METHODS

Plants for this experiment were grown in a fiberglass-covered greenhouse oriented east and west. Supplementary CO_2 was added to the greenhouse by a natural gas-fired generator which supplied CO_2 only when the greenhouse was a closed system during the daylight hours. The night temperature was nearly constant at 54°F. The greenhouse was heated to 60°F and cooling initiated at 65°F during the day. Day temperatures varied, according to the external environment, between 65 and 70°F. Cooling was accomplished by the conventional fan, pad, and plastic tube system.

All of the treatments in this study were formulated using treatment 5 in C.F.G.A. Bull. 221 as the 1X concentration or the check treatment (Table 1). Treatment 5 of the previous study was selected as the check because it produced the highest yield of the study. The treatments consisted of four concentrations: ¼X; ½X; 1X; and 2X—the concentration of the check nutrient solution. There were also three watering frequencies: once in 2 days; once per day; and twice per day. Each concentration was used to water plants at each watering frequency, giving a total of 12 treatments. An additional treatment was included to see if untreated water could be used during the day when transpiration was maximum and the 1X concentration was used late in the day.

Table 1. Nutrient solution composition in meq/l.

Soln Conc	K	Ca	Mg	Na	NO_3	SO_4	H_2PO_4
¼X	1.5	0.88	0.88	0.13	3	0.13	0.25
½X	3.0	1.75	1.75	0.25	6	0.25	0.50
1X	6.0	3.50	3.50	0.50	12	0.50	1.00
2X	12.0	7.00	7.00	1.00	24	1.00	2.00

Rooted carnation cuttings, cv. CSU White, were planted in 8-inch plastic pots of perlite on October 24. There were two plants per pot and eight pots per treatment. The plants were watered the first 6 days three times per day and then according to prescribed watering frequency. Watering was auto-

matically timed at these frequencies for the duration of the experiment.

The nutrient solutions were made in 100-liter plastic containers. Each solution was pumped from the tank by an ITT Jabsco self-priming, positive pressure, lab pump with a capacity of 4.3 GPM at 0 ft head. One-half inch black polyethylene pipe carried the solutions from the pumps to and along the benches. Polyethylene capillary tubes connected the header pipes with the pots. Double ring Chapin Water-Loops distributed the solutions about the surface of the growing medium. An excess of nutrient solution was applied at each irrigation to leach the substrate. Periodic conductance and pH readings of the leachates were taken and indicated no build-up of salts.

The 6-month-old plants were harvested April 25. Fresh weights were taken and samples for tissue analysis removed, washed, and dried.

RESULTS AND DISCUSSION

In this study there were two variables: (1) watering frequency and (2) nutrient solution concentration. Both had independent effects on yield. Figures 1 and 2 illustrate the effect of watering frequency on carnations in an inert medium. Watering once in 2 days resulted in lower yields regardless of the concentration. Increasing the watering frequency to 1X/day increased yield at all concentrations. Watering once per day may have been adequate at the start of the experiment while the plants were small, light intensity low, and day length short. But progressing into the spring with longer days, as the plants grew larger, the 1X/day watering frequency was not adequate at any concentration. Watering 2X/day substantially increased yield at all concentrations (Table 2).

Table 2. Effect of watering frequency and solution concentration on yield of carnations in an inert medium.[a]

	Solution Concentration				
Watering Frequency	¼X	½X	1X	2X	mean
2X/day	327.9	392.1	435.8	431.5	397
1X/day	197.0	281.2	338.0	392.5	302
1X/2 days	135.0	252.4	313.2	300.6	250
mean	220.0	309.0	362.0	375.0	

[a]Fresh weight average of 16 plants per treatment.

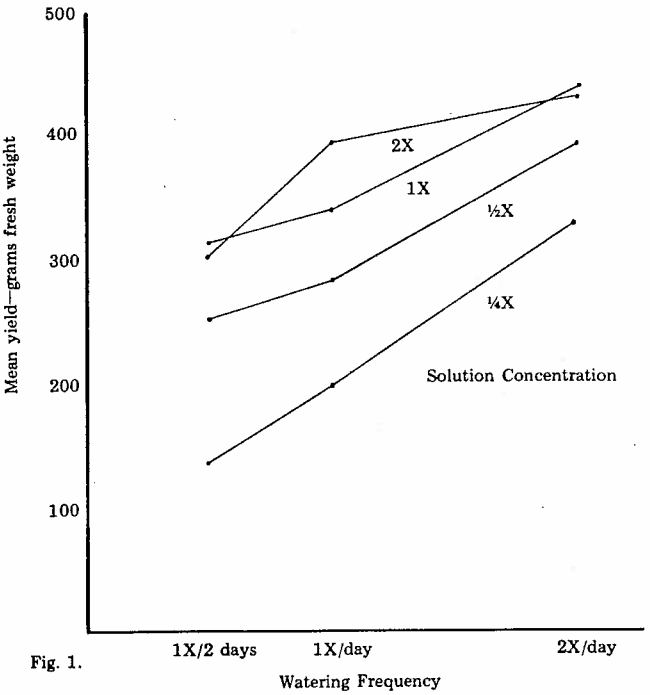


Fig. 1.

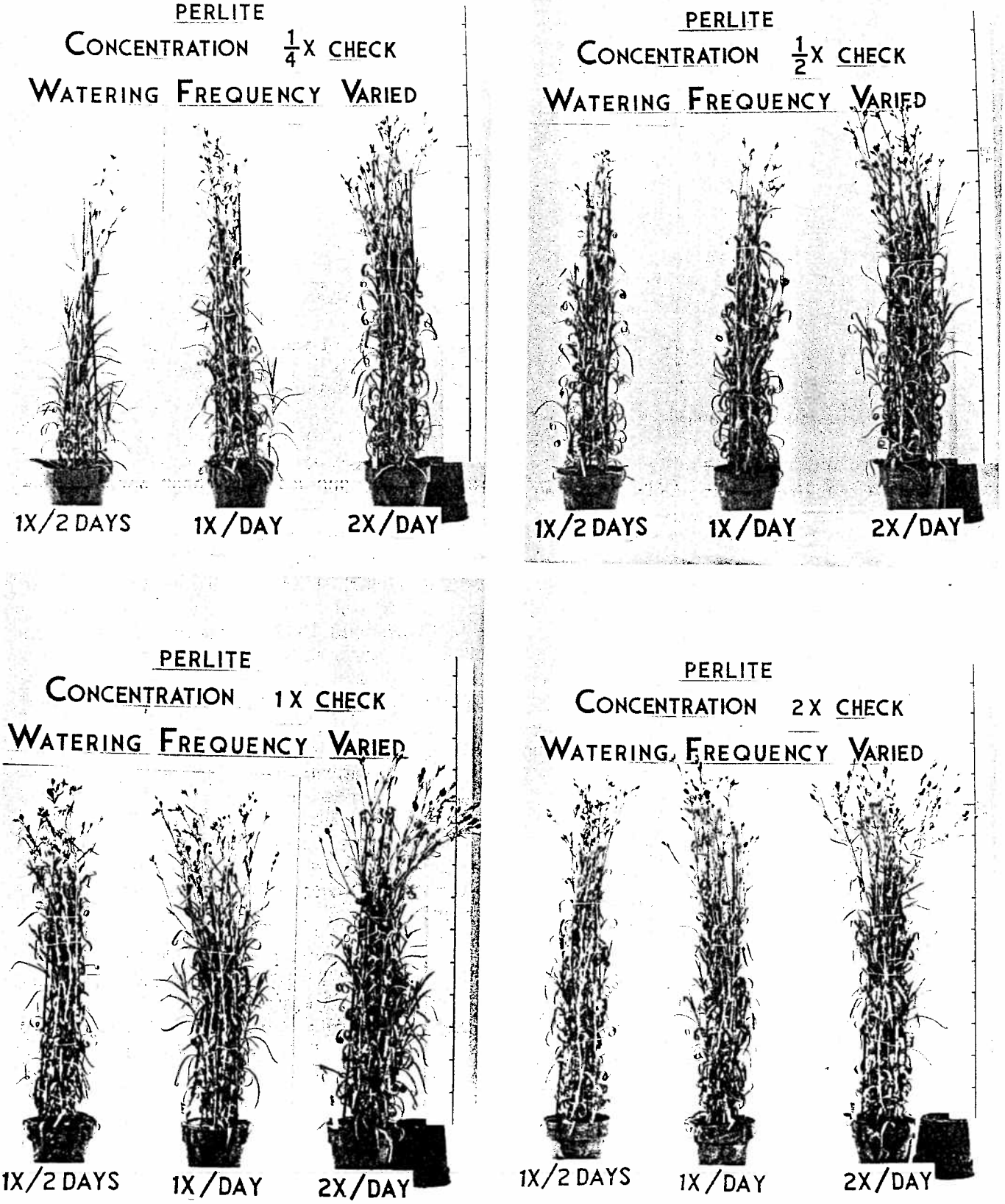
Fig. 1. Effects of watering frequency on yield of carnation at four nutrient solution concentrations.

The effect of nutrient solution concentration is illustrated in Figures 3 and 4. Solution concentrations of ¼X and ½X, the check concentration, produced sub-optimal yields at all watering frequencies. Increasing the nutrient solution concentration from ¼X to 1X concentration increased yield at all watering frequencies. Doubling the 1X concentration did not increase yield at the 2X/day and 1X/2 day watering frequencies. Yield was increased by the 2X concentration solution at 1X/day watering frequency; however, no significance is placed on this increase.

Table 3 is the tissue analysis of the plants in this study. All treatments produced tissue levels within the recommended levels presented in C.F.G.A. Bulls. 220 and 221, except for the ¼X concentration treatments. These results point out the fact that tissue levels of nutrients may be within the recommended range but yield can be limited by other factors.

The treatment alternating tap water and check solution (No 32) produced 326.4 grams fresh weight. The yield was equal to the check treatment watered once daily and the ¼X solution watered twice daily (Table 2). It was 17% less than ½X watered twice daily and 23% less than the check watered twice daily. It is obvious that even though

Fig. 2. Typical plants grown 6 months and grouped to show effects of watering frequency. Each group represents one nutrient solution concentration with the watering frequency indicated at the bottom of the pot.



the tissue analyses (Table 3) were within the recommended levels, constant liquid feeding is essential for optimal carnation production.

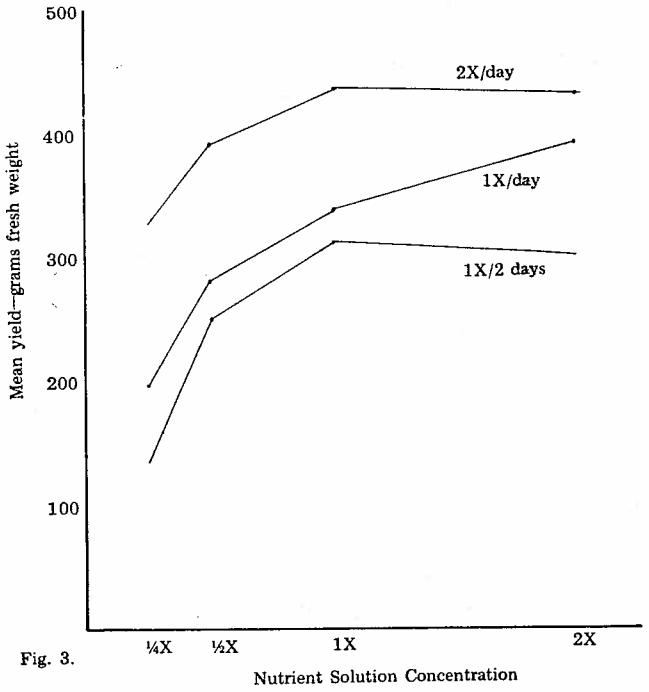


Fig. 3.

Fig. 3. Effects of nutrient solution concentration on yield of carnation at three watering frequencies.

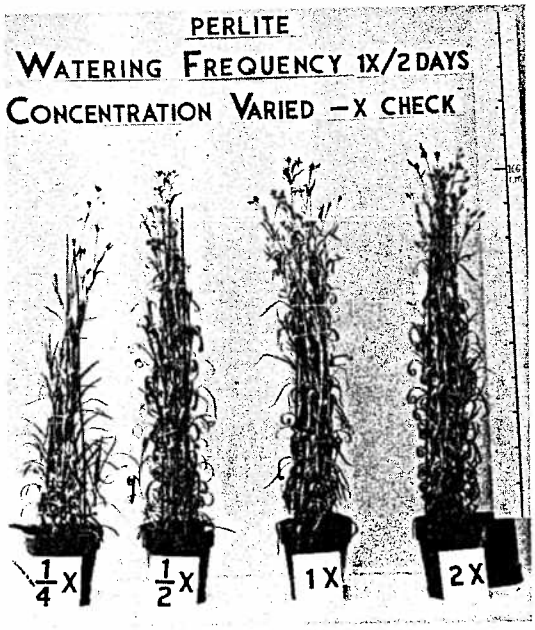
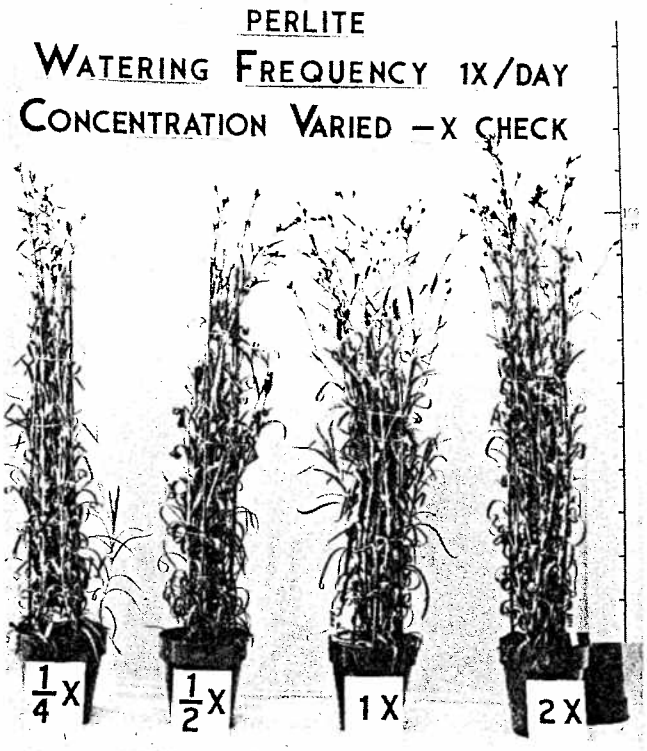


Fig. 4. Typical plants grown 6 months at four nutrient solution concentrations and three watering frequencies. Nutrient solution concentration is indicated on the bottom of pots.



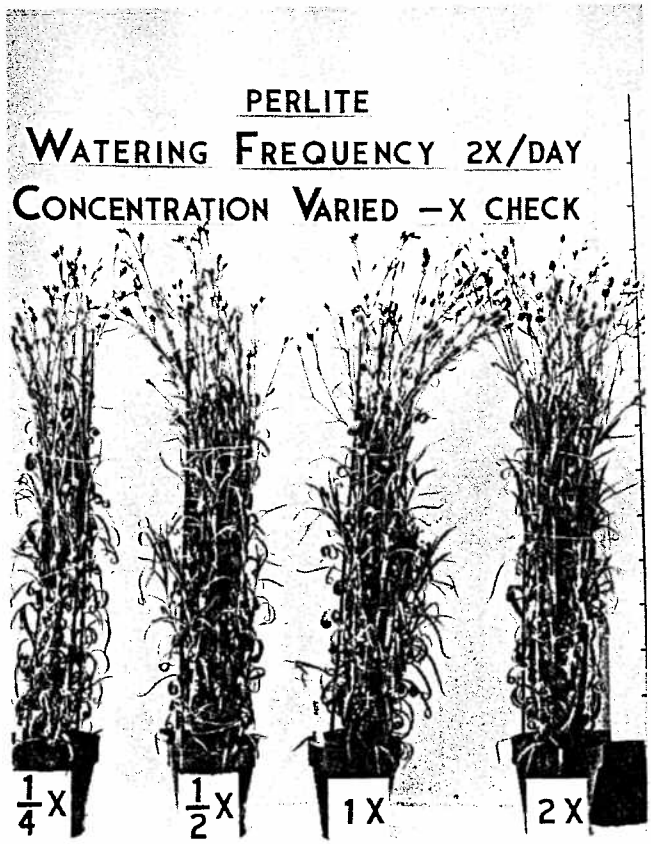


Table 3. Effect of watering frequency and solution concentration on tissue analyses of carnation.[a]

Watering frequency	Soln conc	Treat no	K	Ca	Mg	NO_3	SO_4	H_2PO_4	Total N
2X/day	¼X	20	3.28	1.58	.59	.42	.14	.36	3.16
	½X	21	3.50	1.57	.66	.68	.14	.47	3.11
	1X	22	4.13	1.37	.61	.91	.13	.47	3.45
	2X	23	4.44	1.36	.60	1.08	.17	.48	3.64
1X/day	¼X	24	2.35	1.51	.53	.19	.07	.28	2.76
	½X	25	3.10	1.34	.60	.50	.08	.33	3.22
	1X	26	3.44	1.36	.69	.80	.10	.42	3.44
	2X	27	4.19	1.23	.69	1.12	.18	.51	3.59
1X/2 days	¼X	28	1.84	1.38	.39	.18	.06	.25	2.57
	½X	29	3.22	1.25	.56	.47	.07	.29	2.92
	1X	30	3.44	1.45	.51	.93	.11	.36	3.32
	2X	31	3.75	1.18	.65	1.09	.19	.53	3.57
		32	3.41	1.48	.67	.68	.16	.36	3.23

[a]Each treatment is the average of two tissue samples per treatment.

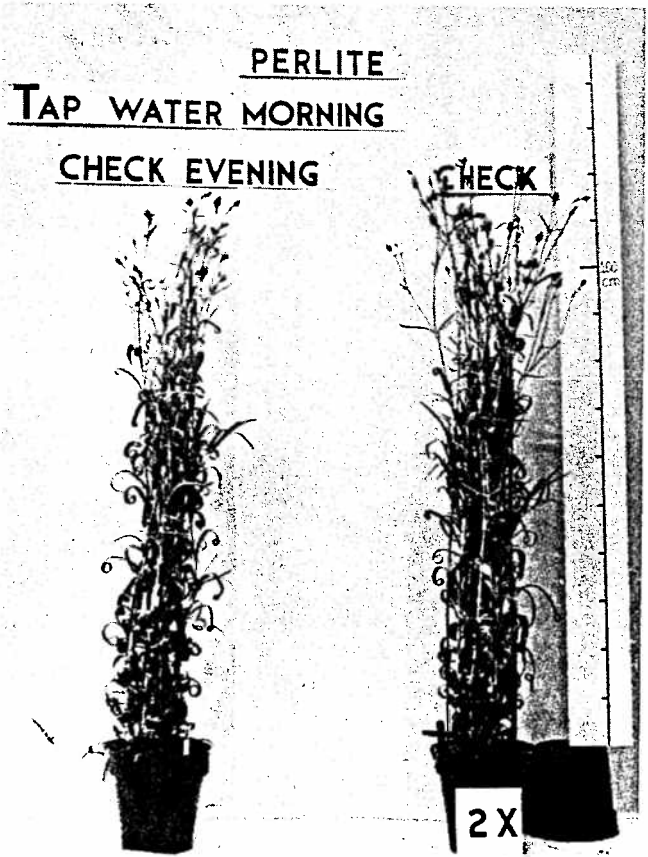


Fig. 5. A comparison of plants receiving water twice daily with plant on left receiving nutrient solution only once (No. 32).

CONCLUSIONS

Increased watering frequency did not compensate for reduced nutrient solution concentration. Yield was increased more by increased watering frequencies at the lower concentrations.

Increased nutrient solution concentration did not compensate for less frequent watering. Yield was influenced more by proper watering frequency than by exact concentration of the nutrient solution.