COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Effect of Irrigation Treatment, Root Substrate, and Substrate Amendment On Carnation Growth

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Irrigation treatments, soil substrates, and soil amendments have been studied many times. However, we need to reinforce general principles in light of new practices and new materials that may be beneficial in carnation production. Over the years there have been many materials on the market that purport to increase growth if added to soil mixtures. One of these recently suggested as a possibility has been the hydrophyllic polymer, "Hydrogel," manufactured by Union Carbide Corporation. With funds provided by Union Carbide, an experiment was set up to see if Hydrogel, in some combination with a root substrate and an irrigation treatment, would significantly improve carnation production.

Methods and Materials

Twenty-seven treatments, replicated eight times, each replication consisting of two "Scania" carnations in an 8-inch plastic pot, were randomized on a single bench in a fiberglass greenhouse. Table 1 outlines the experiments and dates when the carnations were planted. The planting repetition was to obtain data under differing conditions of light and temperature. The irrigation treatments were selected to include the extremes. However, the same watering frequency could not be used through flowering in 8-inch pots as water loss increased with plant growth. Rather than complicate the experiment with a change, each trial was terminated when it was becoming obvious that differences between treatments were due to water stress caused by differing plant sizes, rather than the treatment. This usually occurred when buds were one centimeter in diameter in the more advanced treatments.

Table 1. Experimental treatments.

Irrigation treatment		Root substrate	Soil amendment[5]
1st planting[1]	2nd planting[2]		
1/day	3/day	Pea gravel	0-7.5-15.0
Every 2 days	2/day	Pea gravel	0-7.5-15.0
Every 3 days	1/day	Pea gravel	0-7.5-15.0
Every 2 days	2/day	1-1-1[3] 1-1[4]	0-7.5-15.0
Every 3 days	1/day	1-1-1 1-1	0-7.5-15.0
Every 4 days	every 2 days	1-1-1 1-1	0-7.5-15.0

[1]*Planted 11/6/72.*
[2]*Planted 3/27/73.*
[3]*Equal volumes of Fort Collins clay loam, sand, and peat moss.*
[4]*Equal volumes of Fort Collins clay loam and wood chips.*
[5]*Pounds of Hydrogel per cubic yard.*

Irrigation was automatic (through "Chapin" ooze tubes), with fertilizer injected at each irrigation. Pots were watered sufficiently to cause obvious drainage. Carnations were single pinched, and the height of a representative sample of the top breaks was measured weekly. At harvest, the plants were cut at the soil line; the fresh weight, the number of breaks for the first crop, and the number of breaks present for the second crop were counted on all plants. The dry weight was determined on a representative sample.

[1]*Royal Heins received a Junior Scientist Research Award from the Colorado Flower Growers' Association. This paper reports the work he did for that grant.*

Table 2. Effect of watering treatment, root substrate, and soil amendment on carnation growth — 1st planting. (See Table 1 for description.)

Measurement	Treatment water		Treatment soil		Treatment Amendment	
Fresh weight (grams)	Wet	119	Gravel	193	0.0	139
	Inter.	133	1-1-1	180	7.5	159
	Dry	113	1-1	72	15.0	149
	HSD[1]	13		13		N.S.[2]
Dry weight (grams)	Wet	31	Gravel	33	0.0	22
	Inter.	30	1-1-1	24	7.5	28
	Dry	13	1-1	20	15.0	24
	HSD	4		4		4
2nd crop breaks/pot	Wet	3.7	Gravel	3.3	0.0	1.9
	Inter.	1.4	1-1-1	2.2	7.5	2.1
	Dry	0.6	1-1	0.3	15.0	1.8
	HSD	0.9		0.9		N.S.
Final height (cm)	Wet	43	Gravel	46	0.0	41
	Inter.	40	1-1-1	45	7.5	39
	Dry	35	1-1	28	15.0	39
	HSD	5		5		N.S.

[1]*HSD — difference between means required for statistical significance.*
[2]*N.S. — means not significantly different.*

Table 3. Effect of watering treatment, root substrate, and soil amendment on carnation growth — 2nd planting. (See Table 1 for description.)

Measurement	Treatment water		Treatment soil		Treatment Amendment	
Fresh weight (grams)	Wet	265	Gravel	277	0.0	235
	Inter.	244	1-1-1	279	7.5	233
	Dry	196	1-1	150	15.0	237
	HSD[1]	7		7		N.S.
Dry weight (grams)	Wet	48	Gravel	50	0.0	41
	Inter.	42	1-1-1	51	7.5	42
	Dry	36	1-1	25	15.0	43
	HSD	7		7		N.S.
2nd crop breaks/pot	Wet	6.6	Gravel	7.0	0.0	4.7
	Inter.	5.1	1-1-1	7.5	7.5	5.0
	Dry	3.8	1-1	1.0	15.0	5.8
	HSD	1.5		1.5		N.S.
Final height	Wet	61	Gravel	63	0.0	56
	Inter.	53	1-1-1	54	7.5	56
	Dry	49	1-1	46	15.0	51
	HSD	4		4		4

[1]*HSD — difference between means required for statistical significance.*
[2]*N.S. — means not significantly different.*

Results

In general, differences between plantings were not remarkable except that the second planting, grown under a higher light, had higher fresh and dry weights and more breaks for the return from a single pinch. Tables 2 and 3 summarize the main treatments. The results emphasize the basics; that is, soil mixture and watering frequency are among the most important factors to be considered in cut flower production. The results further show that while soil additives will not cure problems resulting from a poor soil selection or a poor watering frequency, if conditions are already ideal Hydrogel will result in a significant improvement.

Table 4. Effect of watering treatment and substrate on fresh weight (g) of carnations.

Root substrate	Watering treatment		
	Wet	Inter.	Dry
1st planting			
Gravel	258	188	134
1-1-1	231	151	155
1-1	104	59	51
HSD — 30			
2nd planting			
Gravel	341	267	222
1-1-1	289	283	262
1-1	163	181	103
HSD — 53			

Table 5. Effect of soil amendment and substrate on fresh weight (g) of carnations — 1st planting.

Root substrate	Soil amendment		
	0	7.5	15.0
Gravel	162	213	206
1-1-1	179	190	168
1-1	75	70	70
HSD — 30			

During both plantings (Tables 2 and 3), gravel and the 1-1-1 mixture (soil, sand, and peatmoss) gave similar results, while the 1-1 mixture (soil and wood chips) did poorly. The most frequent watering regime resulted in much better growth with a high yield potential (Table 4). Hydrogel increased fresh and dry weight in the first planting, while showing little effect in the second planting. Moreover, it showed a significant effect at 7.5 lbs/yd^3 when used in combination with frequent irrigation regime and an "open" medium such as gravel (tables 5 and 6).

Table 6. Effect of soil amendment and watering treatment on dry weight (1st planting) and final height (2nd planting) of carnations.

Dry weight	Soil amendment	Watering treatment		
		Wet	Inter.	Dry
Dry weight (grams) (1st planting)	0.0	24	31	12
	7.5	38	31	13
	15.0	32	27	13
HSD — 9				
Height (cm) (2nd planting)	0.0	54	58	56
	7.5	65	52	51
	15.0	62	50	40
HSD — 14				

The polymer has been suggested for use as a water reservoir under dry conditions; the possiblity of conserving water was the main reason for our interest. It may be that conditions in 8-inch pots with large plants were changing so rapidly that the water supplying powers of Hydrogel could not be adequately tested.

The differences between treatment extremes are graphically illustrated in Figures 1 and 2, which plot the accumulated weekly elongation of top breaks of carnations for the first and second plantings. In each case the best treatment showed a continual gain over the worst treatment throughout the experiment's duration. Midway through the experiment in the first planting, the growth rate was 3.9 cm/week in the best treatment and 2.1 cm/week in the poorest treatment. Comparable growth rates in the second planting were 6.6 cm/week for the best and 2.9 cm/ for the poorest. Once a mistake in soil selection or watering practice has been made, the difference is difficult to correct.

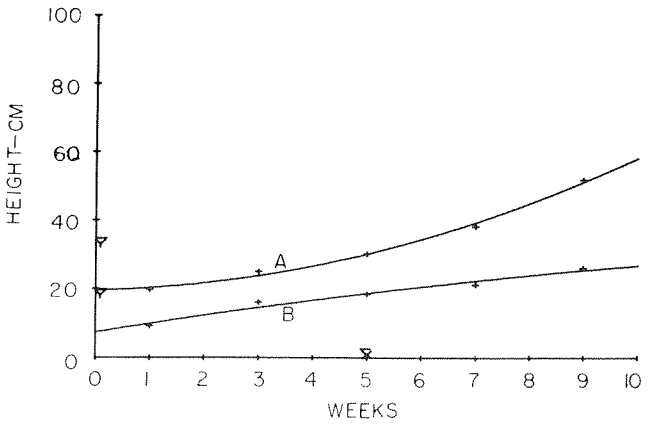

Figure 1. Accumulated weekly height of carnations grown in gravel with 7.5 lbs/yd^3 Hydrogel and watered 2 times/day (A) compared with carnations grown in 1-1 mixture of Fort Collins clay loam plus wood chips, 7.5 lbs Hydrogel, and watered every 4th day (B) (1st planting).

Summary

As has been shown in the past, well aerated root substrates with frequent irrigation will usually yield best carnation growth. Soil additives, such as Hydrogel in this case, will not correct problems in the basic physical soil structure or watering practice, but will provide better growth if the above factors are not limiting. Addition of wood chips in large quantities to a basic field soil such as Fort Collins clay loam, when in raised benches, does not appear desirable.

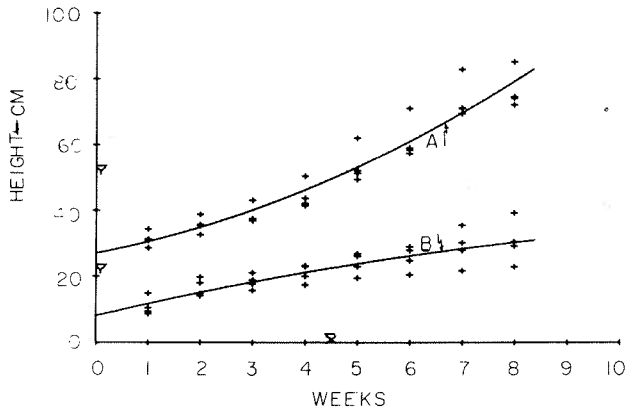

Figure 2. Accumulated weekly height of carnations grown in gravel with 7.5 lbs/yd³ Hydrogel and watered 3 times/day (A) compared with carnations grown in 1-1 mixture of Fort Collins clay loam plus wood chips, 7.5 lbs/yd³ Hydrogel, and watered every 2 days (B) (2nd planting).

Figure 3. Extreme effects of water, soil, and Hydrogel treatments during first crop planted Nov. 6, 1972. Gravel watered twice daily with 7.5 lbs Hydrogel per cubic yard, 1-1 mixture of wood chips, and soil watered once every 4 days with no Hydrogel.

Your Editor,

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