COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY

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Progress Report:

Influence of Nutrient Solution Concentration

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Plant response to increased salt concentration of nutrient solutions varies among species. Salt concentrations, which may kill some species, may have little effect on the growth of others. The ratio of individual nutrients in the solution, as well as the total concentration, can affect plant growth (4). An imbalance of certain nutrients can decrease plant growth.

Investigations by Green (1) and Hartman and Holley (3) have established desirable nutrient concentrations for carnation production in Colorado. However, most irrigation waters available for carnations already contain some chemicals in greater concentrations than the recommended levels (2). Because of this, the final nutrient solution concentration may be imbalanced or can exceed recommended levels. The purpose of this experiment was to investigate the effect of increasing nutrient solution concentration on carnation growth and yield.

Materials and Methods

Rooted CSU Red carnation cuttings were planted in 8-inch plastic pots containing idealite on July 16, 1968. The plants were pinched between July 31 and August 6.

The nutrient solution selected as the base solution was Green's number three solution (1). Two nutrient solution series were evaluated (Table 1). The first series evaluated the effect of increasing the total concentration of Green's solution while maintaining ionic balance. Concentrations were 0.5, 1.0, 1.5, 2.0, and 4.0 times Green's solution. Because of the high level of sodium and sulfate ions in some of the Denver water samples, a second series evaluated the effect of increased sodium sulfate concentration on carnation growth. Concentrations of sodium sulfate solutions were 2.0, 4.0, 10.0, and 20.0 times the total salt concentration of Green's solution.

Above ground portions of all plants were harvested December 19, 1968, and total fresh and dry weight yields were obtained from each plot. Analysis of the tissue from each treatment was determined by the Colorado State University Soil Testing Laboratory.

Results and Discussion

Total fresh and dry weight yields decreased as the concentration of the nutrient solution increased (Fig. 1). White (5) observed similar reductions in carnation yield and quality as soluble salts in the soil solution increased. Significant reduction in fresh and dry weight yields occurred in the plants treated with sodium sulfate even though all other essential elements were present at supposedly optimum ratios. The addition of sodium sulfate apparently resulted in an imbalance in solutions 6 and 7, so that yield of plants in those solutions was less than yield in solutions 4 and 5--even though the total concentration of ions in solutions 4 and 6, and 5 and 7, were the same (2 and 4 times solution 1). Carnation plants apparently adjust more readily to increased salt concentrations if the solution contains an appropriate ion balance.

Treatment 9 was very stunted throughout the study. The high yield of solution 4 was attributed to the location of the treatment on the greenhouse bench. Randomization was such that shading from other plants was at a minimum in this treatment in all replicates.

Total flower yield also decreased as nutrient solution concentration increased (Fig. 2). Time until flowering increased as the concentration of the nutrient solution increased. Plants in nutrient treatment 9

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were just beginning to elongate flower stalks at the time of harvest.

The importance of maintaining a high (C-A) content has been discussed by Green (1). As the nutrient solution concentration increased, the (C-A) content of the plants decreased (Fig. 2). The decrease in absorption of potassium and calcium was not completely compensated by increased absorption of other cations (Table 2). The relationship between nutrient solution balance and (C-A) content is emphasized in Fig. 2. The (C-A) content of plants grown in all solutions (6 through 9) to which sodium sulfate had been added was usually less than the (C-A) content of any of the balanced solutions. Similarly, total flower yield of plants grown in solutions 6 and 7 was less than the yield obtained from carnations grown in solutions 4 and 5, although total ion concentrations were comparable. The addition of sodium sulfate resulted in an imbalanced solution.

The tissue analysis (Table 2) indicated that sodium ions, in solutions where the balance between sodium, potassium and calcium is disrupted, are absorbed by carnations in proportion to the concentration of sodium in the solution. In solutions 1 through 5, where the ion ratios were maintained, the increased sodium concentration did not cause a corresponding increase in sodium uptake. The opposite occurred in solutions 6 through 9. Sulfate uptake appeared to level off at a relatively low sulfate concentration in solution, and further increased concentration in solution did not result in increased uptake (solutions 1 through 5), except where sodium concentration in solution was quadrupled or more in the imbalanced series (solutions 6 through 9).

Data from the experiment show that the total concentration of salts in solution should be as low as possible for maximum carnation yield. These are essentially the results obtained by White (5) in 1957. Unfortunately, few water supplies contain negligible amounts of chemicals (2) to which we may make modifications at will. The results of this study suggest that, within limits, high concentrations of some ions in a water supply may be partially compensated by appropriate modification in order to achieve optimum ionic balance. When this is done, yield may be increased, and is then limited by the total ion concentration.

Fig. 1. Average fresh and dry weight yields in grams of carnation plants subjected to various concentrations of nutrient solutions.

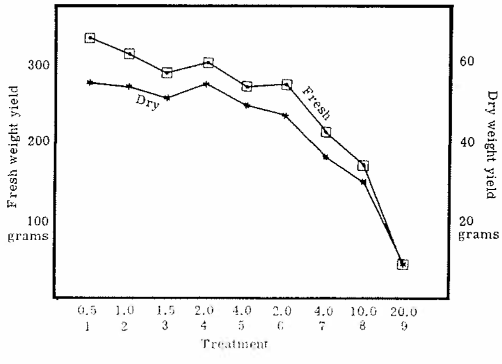

Fig. 2. Total flower yield and (C-A) content of carnation plants grown at various nutrient solution concentrations.

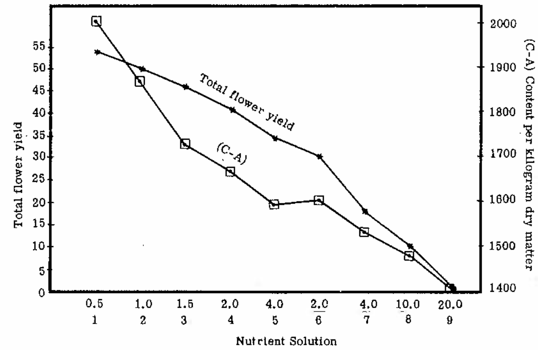

Table 1. Nutrient concentrations of solutions applied to carnation plants. Series A maintained ion ratios while increasing concentration. Series B increased concentration by addition of sodium sulfate.

Solution	Milliequivalent weights per liter of solution						
	K	Ca	Mg	Na	NO_3	SO_4	H_2PO_4
A) Balanced nutrient series							
1 (0.5)	3.0	3.0	0.5	0.25	6.0	0.5	0.25
2 (1.0)	6.0	6.0	1.0	0.5	12.0	1.0	0.5
3 (1.5)	9.0	9.0	1.5	0.75	18.0	1.5	0.75
4 (2.0)	12.0	12.0	2.0	1.0	24.0	2.0	1.0
5 (4.0	24.0	24.0	4.0	2.0	48.0	4.0	2.0
B) Sodium sulfate series							
6 (2.0)	6.0	6.0	1.0	16.0	12.0	16.5	0.5
7 (4.0)	6.0	6.0	1.0	47.0	12.0	47.5	0.5
8 (10.0)	6.0	6.0	1.0	140.0	12.0	140.5	0.5
9 (20.0)	6.0	6.0	1.0	295.0	12.0	295.5	0.5

Table 2. Tissue analyses in milliequivalents per kilogram of dry matter of carnation plants subjected to various ion concentrations of nutrient solutions.

Solution	K	Ca	Mg	Na	H_2PO_4	SO_4	Cl	NO_3-N[1]
A) Balanced nutrient series								
1--0.5	1061	898	290	46	89	23	85	94
2--1.0	1061	880	255	37	105	80	75	98
3--1.5	1100	711	242	28	116	80	75	83
4--2.0	1100	693	242	28	126	87	75	108
5--4.0	1215	549	232	22	134	98	75	118
B) Sodium sulfate series								
6--2.0	1036	443	275	283	126	133	75	99
7--4.0	1023	337	286	348	136	136	85	103
8--10.0	806	187	295	565	154	126	85	110
9--20.0	499	31	72	1131	134	109	47	39

1. Nitrogen present in nitrate form.

Literature cited

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