COLORADO CARNATIONS

COLORADO FLOWER GROWERS ASSOCIATION

Bulletin 327 | Edited by David E. Hartley | September 1977

EFFECTS OF SALINITY IN WATER SUPPLIES ON ROSE PRODUCTION: Experiment 2:

Howard E. Hughes and Joe J. Hanan[1]

In a previous paper (CFGA Bul. 323), we showed that unnecessarily high salts in the water supply, particularly bicarbonate (HCO_3^-), drastically reduced rose yield and grade. In this experiment, the objective was to test other solution combinations, and compare the effects when roses were grown in soil versus gravel.

New 2X, 'Forever Yours' were planted, half of the plants in soil, half in gravel and irrigated with ten different solution treatments (Table 1). Each treatment was divided into 3 replications of 6 plants each in a randomized, complete block arrangement (18 plants per treatment). They were given two soft pinches and allowed to flower with data collection

Table 1: Nutrient solutions supplied in Experiment 2, starting June 18, 1975.

Treatment	Ion ($meq\ l^{-1}$)										Total	Salinity
Number	K	Ca	Mg	NH_4	Na	NO_3	SO_4	H_2PO_4	HCO_3	Cl	$meq\ l^{-1}$	$mhos\ cm^{-1}$
Control												
1.	4	6	1	1	0	10	1	1	0	0	24	1300
'Balancing' $NaHCO_3$ Series												
2.	4	6	2	1	4	10	2	1	4	0	34	1550
3.	6	8	3	1	4	12	5	1	4	0	44	1970
4.	8	10	4	1	4	14	8	1	4	0	54	2465
'Balancing' NaCl Series												
5.	4	6	1	1	4	10	1	1	0	4	32	1600
6.	6	8	3	1	4	10	1	1	4	6	44	2130
7.	8	10	5	1	4	10	5	1	4	8	56	2550
'Balancing' High Mg Series												
8.	4	6	10	1	0	10	6	1	4	0	42	1810
9.	6	8	10	1	0	12	8	1	4	0	50	2180
10.	8	10	10	1	0	14	10	1	4	0	58	2580

[1]Graduate student and professor respectively.

starting on September 5, 1975, and ceasing on June 13, 1976. Treatments were started immediately after planting.

All plants in the inert medium broke dormancy about the same time. Plants in soil were slower and broke dormancy unevenly. This variation never evened out, so that considerable problems were encountered with watering. Small plants were watered too much, other large plants were too dry. All leaf symptoms, such as necrosis or chlorosis, appeared on plants in gravel at least three weeks ahead of symptoms on plants in soil. Intensity of the symptoms, however, were often much greater on plants growing in soil.

Treatments 1 through 4 (increasing salinity with $NaHCO_3$) showed typical yield reduction (Fig. 1). As with Experiment 1, Treatment 1 (Control) produced the greatest number of flowers. Addition of sodium bicarbonate ($NaHCO_3$) significantly reduced stem length. Weight was only slightly reduced. Addition of potassium (K), Calcium (Ca) and Nitrate (NO_3) to Treatments 3 and 4 did not reduce the number of unsaleable flowers.

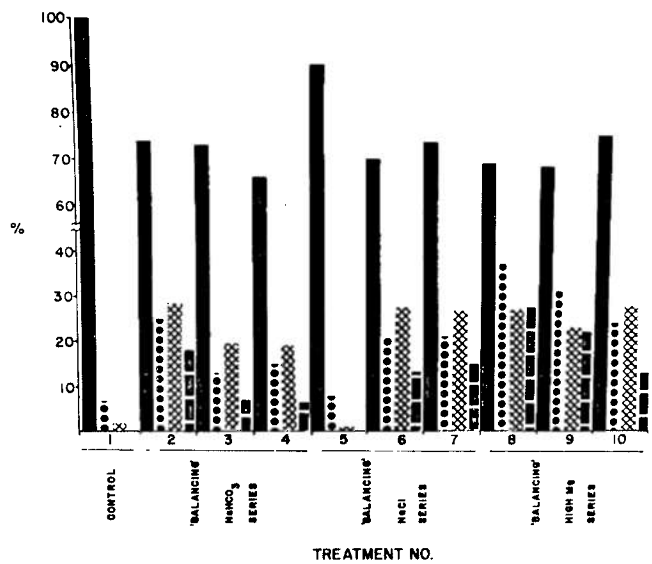

Fig. 1: Comparison of total yield as a percentage of the control, Treatment 1, from 'Forever Yours' roses grown in gravel; percent unsaleable, percent chlorotic but saleable, and percent unsaleable, chlorotic flowers. For each treatment, left to right:

Solid bar — Total yield
Solid circles — Percent unsaleable
Hatched bars — Percent chlorotic but saleable
Solid dashes — Percent chlorotic, unsaleable
See Table 1 for Treatments

Adding sodium chloride (NaCl) (Treatments 5 through 7) had varied results. Eight meq l^{-1} (232 ppm) NaCl added to the check solution reduced total yield 10%. Additional increases of Cl, K and Ca to balance ion ratios caused a 20% decrease in yield in Treatment 6 and a 17% reduction in Treatment 7. Mean length (Fig. 2) and flower weight for Treatment 5 was significantly higher than for the control, the difference between Treatments 1 and 5 being the addition of 8 meq l^{-1} NaCl to Treatment 5(Fig. 2). At a chloride concentration of 6 meq l^{-1} (210 ppm) (348 ppm NaCl) (Treatment 6), stem length and weight were less by 4 cm and 6 g respectively. Treatments 6 and 7 were highly chlorotic, with over 27% of the saleable cut flowers showing chlorosis.

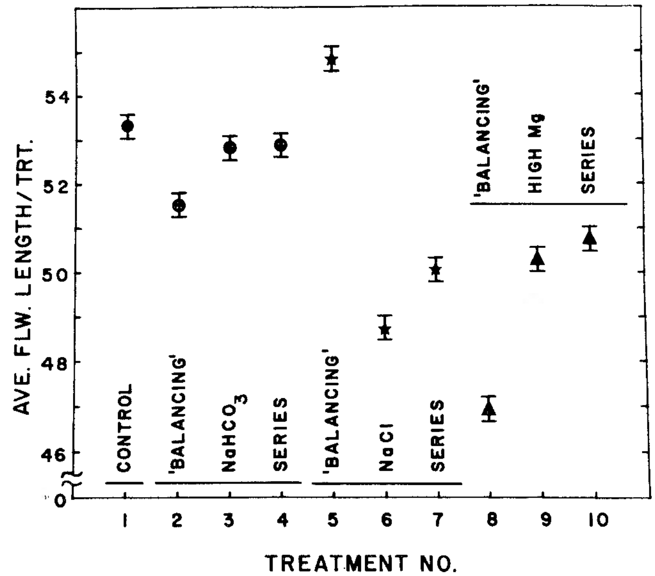

Fig. 2: Effect of solution treatments on average flower stem length (cm) of 'Forever Yours' roses grown in gravel.

Treatments 8 through 10 contained high magnesium (Mg), a common ion in shallow well waters. Where the K and Ca concentrations were lower than the Mg level (Treatments 8 and 9), total yields were reduced by 31 and 32% respectively. With the Ca-to-K ratio equal to the Mg concentration, the effect of high Mg was less apparent. A highly imbalanced magnesium solution caused 37% of the flowers to be culled. Chlorosis was not corrected by increasing K and Ca.

Extreme chlorosis was the major reason for culling roses in this experiment. Several leaves, painted with the micronutrients iron, zinc, copper and maganese, showed iron corrected the chlorosis. Copper caused a slight greening, and zinc and maganese had little or no effect. Sodium toxicity symptoms consisted of numerous brownish-black, necrotic lesions, slightly back from the leaf margins.

With the exception of total yield and percentage of saleable flowers, soil plots were similar in all respects to the plants grown in inert media. As indicated before, due to the variability of plants in soil, production figures were not usable. Indicators, such as chlorotic flowers, mean stem length and weight of cut flowers, were similar to those in gravel. The soil plots produced less than half the total number of flowers cut from plants in gravel.

As with Experiment 1, Fig. 3 shows what happened to yield and timing of roses when salts were raised, particularly with $NaHCO_3$. The days for peak cropping were extended and delayed each cycle by 1 to 6 days. By the end of the experiment, sharp peaks for rose plants in saline treatments could no longer be observed, and the lower yield was rapidly becoming more apparent.

Summary

The two experiments showed that marked differences in rose yield and quality are likely to occur with saline water, depending upon total solution concentration and the particular ions in the water supply. We can make the following general summation:

1. Total salinity of the applied nutrient solution should be restricted to 1800 μmhos cm^{-1} if care is taken to "balance" the solution based upon a reliable water analysis.
2. If salinity is largely due to a single salt, such as sodium bicarbonate or sodium chloride, total salinity should be restricted to 1300 μmhos cm^{-1}.
3. Individual ions in order of decreasing toxicity were:
   Bicarbonate (HCO_3) —
   maximum limit 2 meq l^{-1} (112 ppm)
   Sodium (na) —
   maximum limit 4 meq l^{-1} (92 ppm)
   Chloride (Cl) —
   maximum limit 4 meq l^{-1} (140 ppm)
4. Attempting to balance a solution containing high concentrations of Mg, Ca, HCO_3, Na or SO_4, to increase yield, was marginal.
5. Sulfate (SO_4), other than adding to total salinity, had no effect on 'Forever Yours'.

A previous analysis of shallow wells in the Denver region by Hanan (CFGA Bul. 280) showed an average total salinity of 1169 μmhos cm^{-1}, with a range from 422 to 2687. Other ions were:

	meq l^{-1}	
Ion	Average	Range
Calcium	4.1	0 to 10
Magnesium	4.6	1 to 14
Sodium	4.7	1 to 15
Bicarbonate	5.0	2 to 9
Chloride	1.1	0 to 7
Sulfate	6.3	1 to 23

This short table from Bulletin 280 shows that bicarbonate, on the average, will be most dominant in the majority of shallow wells. It is also the ion that will cause most problems of chlorosis and pH control. It can be eliminated from solutions by resorting to acidification with sulfuric acid, phosphoric acid or nitric acid. Depending upon the amount of bicarbonate present, only enough acid is added to

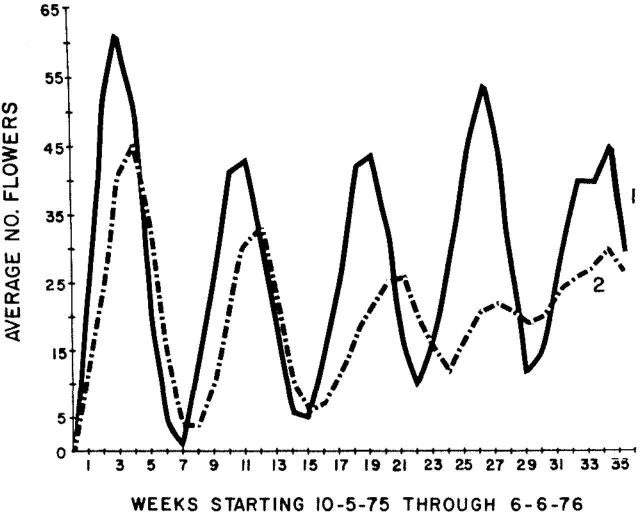

Fig. 3: Effect of extreme treatments on average number of flowers produced per week from 'Forever Yours' grown in gravel. No. 1 was the control, No. 2, Treatment 2, contained 8 meq l^{-1} $NaHCO_3$, 1130 versus 1550 μmhos cm^{-1} total salinity.

neutralize and drive off bicarbonate as CO_2. Sulfuric acid will increase total salinity due to the sulfate ion. Phosphoric or nitric acids, however, have the benefit of adding an essential nutrient (H_2PO_4 or NO_3) to the solution. If muriate of potash (KCl) is employed as a potassium source, the cloride ion will add to total salinity. Therefore, a water analysis is particularly important to determine existance of high chloride already present in the water supply. Obviously, if calcium and magnesium are already present in the water, there should be no need to add them in an injection system. Unrestricted addition of salts through an injection system without taking into account salts already present, can seriously aggravate chlorosis and reduce yield. We suspect that high salinity in Colorado is effecting rose yield, and the cost of a purification system may be more than offset by a 10 to 20% increase in yield.