Optimizing rose crop nutrient status and productivity through balanced cation and anion ratios:

Flower Productivity and Quality

Raúl I. Cabrera
AgriLife Research and Extension Center
Texas A&M University System
1619 Garner Field Road
Uvalde, Texas 78801

Now at Rutgers University
Cabrera@aesop.rutgers.edu

Report Date: December 31, 2012 (2012-13 Midterm Report)
Funded by the Joseph H. Hill Memorial Foundation, Inc.
ICFG-HILL, P.O. Box 99, Haslett, MI 48840
ICFG.HILL@yahoo.com

As indicated in previous reports we are growing ‘Avalanche’ rose plants, grafted on ‘Natal Briar’, in a peat based substrate, and subjected them to fertigation with nutrient solutions based on a modified half-strength Hoagland solution. These solutions contain eight different cation (Mg^{+2}, K^{+} and Ca^{+2}) concentrations and ratios, while holding fixed the anions and micronutrients concentrations. The cation ratios and concentrations used in this study are listed on Table 1 (on the first columns). The first seven solutions are the actual treatments, where the total sum of Mg^{+2}, K^{+} and Ca^{+2} cations adds up to 9 meq/L (plus 1 meq/L of ammonium added to all). The last solution (T8) is considered the reference or control (a modified ½ Hoagland) against which we’ll be comparing the flower productivity and quality of the treatment solutions.

Last time we presented data on the first flower flush (harvest), and we did not find any discernible differences in flower productivity and quality among the treatments. This was expected, as our previous studies and experience indicate that at least two flushes of growth and flowering need to elapse before any differential responses to nutrition/fertilization and salt stress treatments can be observed and measured. This response was verified in the present study, and it is readily observed in the graphical data displayed in Figure 1.

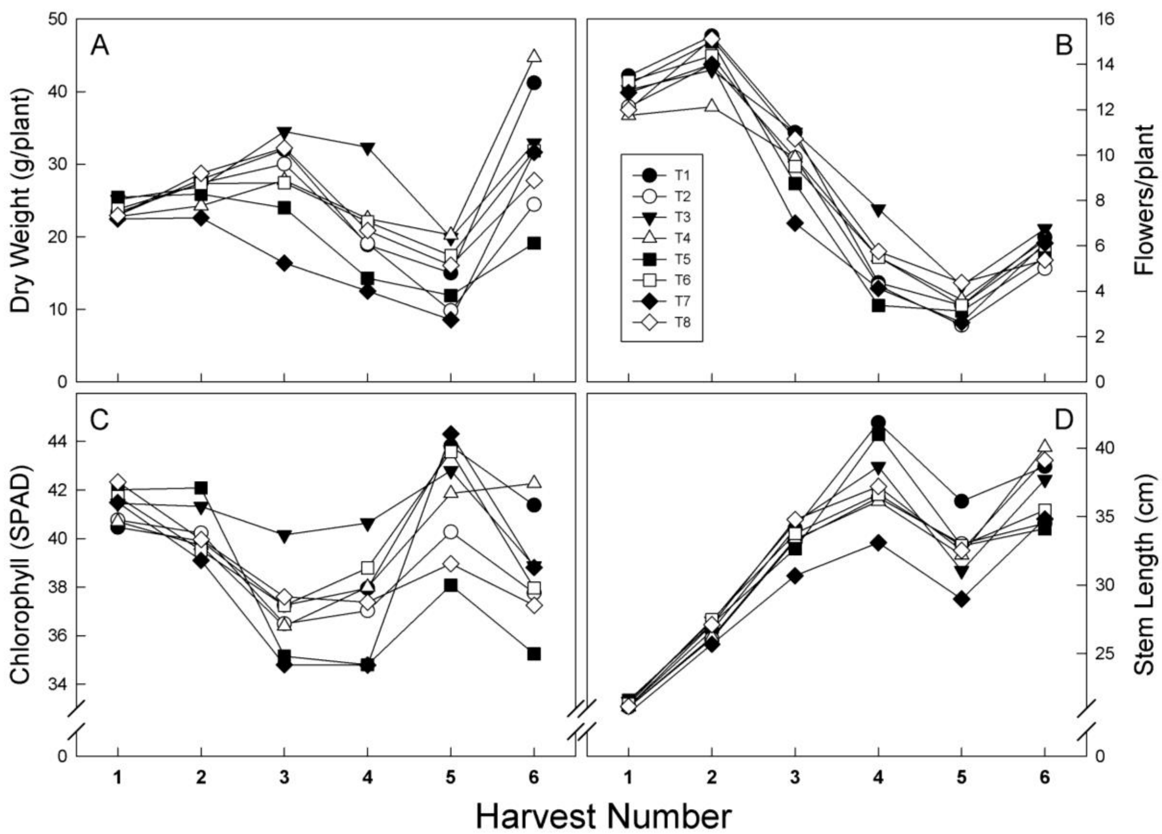

Figure 1. Productivity and quality responses of Avalanche roses (on ‘Natal Briar’) over six consecutive growth and flowering cycles when subjected to fertigation with eight nutrient solutions having varying cation (Mg-K-Ca) ratios. Details on these treatments (T1 to T8) are shown in Table1.

Observe that a separation of harvested dry (weight) biomass, chlorophyll and stem length values (Fig. 1A,C,D) among nutrient solution treatments is effectively evident until the third flush (Harvest 3). Interestingly, the number of harvested flower per plant did not show a discernible separation pattern among treatments over time. Along with other researchers, we have attributed this characteristic response delay in roses to their carbon and nutrient reserves, which can sustain productivity and quality over this length of time, before expressing the actual effects of the imposed fertilization treatments.

Based on this observation, we have considered pertinent to evaluate the actual response of the rose plants to the cation ratio treatments used in the present study using only the data collected since the third flowering flush. The cumulative and average values for flower productivity and quality observed across these harvests (H3 to H6) are presented in Table 1.

Table 1. Biomass, flower yield and quality of 'Avalanche' roses (on 'Natal Briar') fertigated with nutrient solutions containing different cation (Mg, K, Ca) ratios. Results are the sums and/or averages for the last four harvests events in this study (H3 to H6).

Nutrient	**Cation ratio**	**[Cation] - meq/L**			**Biomass**	**Flowers**	**Stem**	**Chlorophyll**
Solution	**Mg-K-Ca**	**Mg**	**K**	**Ca**	g/plant	#/plant	**Lgt** - cm	SPAD
T1	0.81 - 0.08 - 0.11	7.25	0.75	1.00	107	25	38	40.1
T2	0.06 - 0.83 - 0.11	0.50	7.50	1.00	83	22	34	37.9
T3	0.06 - 0.08 - 0.86	0.50	0.75	7.75	120	30	36	40.6
T4	0.43 - 0.46 - 0.11	3.88	4.12	1.00	110	25	36	39.5
T5	0.06 - 0.46 - 0.48	0.50	4.12	4.38	69	21	35	35.8
T6	0.43 - 0.09 - 0.48	3.87	0.75	4.38	97	24	35	39.2
T7	0.31 - 0.33 - 0.36	2.75	3.00	3.25	68	20	32	38.0
T8 (control)	0.23 - 0.33 - 0.44	2.00	3.00	4.00	93	25	36	37.8

Notes: All solutions had the same fixed anion concentration.

Rose plants fertigated with solution T3, which has the highest concentration of Ca^{+2} (86% of the total sum of cations, compared to 6% Mg^{+2} and 8% K^{+}) had the highest dry biomass and cut flower yields, as well as the higher chlorophyll readings. While this certainly highlights an apparently high requirement of calcium for greenhouse roses, as reported by other authors, however, the nutrient solution treatments T1 and T4, which had the lowest Ca^{+2} concentrations and proportions (11%), had closely similar yields and chlorophyll levels (Table 1). Treatment 1 had the highest proportion of Mg^{+2} (81%), whereas T4, a "binary blend", had equally high levels of Mg^{+2} and K^{+} (43% and 46%, respectively). These three treatments (T1, T3, T4) had biomass and flower yields, and chlorophyll levels that were equal or higher that the reference Hoagland solution formulation (T8).

Interestingly, the solution in which all three cations had similar concentrations and proportions ("tertiary blend"), treatment T7, had the lowest yields and chlorophyll readings, closely followed by T5 ("binary blend" with higher proportions of K^+ and Ca^{+2}). Both of these solution treatments had lower biomass yields, harvested flowers and less chlorophyll values than those observed for plants fertigated with the Hoagland solution (the control T8).

We are currently analyzing leaf tissues from flowers harvested for all the flushes, to determine their mineral nutrient content, to correlate these later with their respective fertigation solution formulations. In the next report we'll also show data on the chemical analyses of the leaches that were collected from this study. We hope that this additional information will help us elucidate the nature of the observed yield and quality responses reported here, and allow us to make sound and practical recommendations to commercial rose growers as to help them to enhance their overall fertilizer use efficiency and crop productivity.

REFERENCES

Applied Plant Research, 2001. Handbook for Modern Greenhouse Rose Cultivation. The Netherlands.

Cabrera, R.I. 2003. Mineral Nutrition. In: A. Roberts, S. Gudin, and T. Debener (Eds.), Encyclopedia of Rose Science, p. 573-580. Academic Press. London, UK.

Cadahia, C., I. Hassan and E. Eymar. 1995. Incidence of the potassium/calcium plus magnesium ratio on the conifer fertigation for peat substrates. J. Plant Nut. 18(1): 1-23.

Cornell, J. 2002. Experiments with Mixtures: Designs, Models, and the Analysis of Mixture Data. John Wiley and Sons, Inc., New York.

Marchner, H. 1995. Mineral Nutrition of Higher Plants. Academic Press, New York.

Torre, S., T. Fjeld and H.R. Gislerod. 2001. Effects of air humidity and K/Ca ratio in the nutrient supply on growth and postharvest characteristics of cut roses. Scientia Hort. 90: 291-304.