NUTRIENT SALT BALANCE DIFFERENCES ON THE GROWTH OF POTTED BANANA, ORANGE OR TOMATO PLANTS GROWING IN SAND OR SAND/CALCIUM CARBONATE AND WHERE CONDITIONS WERE HIGHLY SALINE

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**Introduction & Objective**

**Plants** take up nutrients directly from or with the water surrounding soil particles. Only specific chemical forms of nutrients are taken up. Nitrogen is taken up either as nitrate \((\text{NO}_3^-)\) or ammonia \((\text{NH}_4^+)\). Phosphorus is taken up as orthophosphate \((\text{HPO}_4^{2-}\) or \(\text{H}_2\text{PO}_4^-\)). Potassium, calcium, magnesium, copper, iron, manganese and zinc and taken up in the cationic forms \(\text{K}^+\), \(\text{Ca}^{++}\), \(\text{Mg}^{++}\), \(\text{Cu}^{++}\), \(\text{Fe}^{++}\), \(\text{Mn}^{++}\), and \(\text{Zn}^{++}\), respectively. Sulphur is taken up as the anion sulphate \((\text{SO}_4^{2-})\). Boron is taken up as boric acid \((\text{H}_3\text{BO}_3)\), which is known to be an extremely weak acid, dissociating little in water in relative terms. Molybdenum is taken up as the anion molybdate \((\text{MoO}_4^{2-})\). The anion chloride \((\text{Cl}^-)\) is taken up readily even though it is generally only required in trace amounts. Cationic sodium \((\text{Na}^+)\) is also readily taken up, but is not an essential nutrient in most crop plants. Soil or irrigation water may be marginally or highly concentrated in \(\text{NaCl}\). Excessive \(\text{Na}^+\) or \(\text{Cl}^-\) uptake can be injurious, plants varying greatly in tolerance to presence of these ions.

**In** considering different solutions with respect to nutrient ion constitution made up to contain the same quantities of plant-essential elements, the \(\text{NO}_3^-/\text{NH}_4^+\) ratio of solutions made up with \(\text{KNO}_3\) will always exceed that of solutions made up with \(\text{KCl}\) or \(\text{K}_2\text{SO}_4\). Moreover, solutions made up with \(\text{KCl}\) will inevitably contain more \(\text{Cl}^-\) and solutions made up with \(\text{K}_2\text{SO}_4\), more \(\text{SO}_4^{2-}\).

**In** the present study, differences in vigour of banana, citrus or tomato plants potted in river sand or river sand/calcium carbonate (80:20 v/v) was assessed in relation to solution nutrient- ion composition, the solutions having been made up with either \(\text{KNO}_3\), \(\text{KCl}\) or \(\text{K}_2\text{SO}_4\). Solution N, P, K, Ca, Mg, Cu, Fe, Mn, Zn, B and Mo content were equal.
Materials and Methods

Williams banana plants, grafted Valencia orange trees or Rodade Tomato seedlings were grown under 40% shade in 2.7 L pots containing river sand or 80% river sand, 20% calcium carbonate (v/v). 150 ml of one of three nutrient solutions, each differing in nutrient salt constitution, but not absolute elemental nutrient content, except for S and Cl, was applied to each pot. Each solution (Solution K₁, K₂ or K₃) was fortified with an equal amount of NaCl to render solution EC’s of between 6 and 6.5 dS/m. These solutions did not contain calcium. They differed in either having been made up with KCl, K₂SO₄ or KNO₃. As a result, the NO₃⁻ to NH₄⁺ molar ratio differed, being three times greater where KNO₃ was used. Ammonium sulphate, mono-ammonium phosphate, magnesium sulphate, EDTA copper, zinc and manganese, EDDHA Fe, sodium borate, and sodium molybdate were also used to make up each solution. 150 ml of sodium chloride fortified calcium nitrate solution (Solution IV) was applied separately to each pot when one of the foregoing solutions was applied. Application was made on Monday, Wednesday and Friday of each week. Plant height growth was measured weekly, and final fresh weight of the plant components was measured on trial termination.
150 ml of K1, K2 or K3 was applied + 150 ml of calcium nitrate solution was added per pot on Monday, Wednesday and Friday of each week.

Concentrations of the essential nutrients were equal except for that of S and Cl.

The ammonium / nitrate ratio was least in the solutions made up with KNO₃.
In banana, orange and tomato, growth was most vigorous when the solution made up with KNO₃ was applied to the plants. In general, the plants fertigated with the solution made with KCl was least. The effects were similar with respect to potting medium, being either sand or sand/calcium carbonate.
Conclusions

It is generally considered that the deleterious effects of salinity are caused by non-specific, osmotic-related dehydration and the impact of accumulation of chloride, sodium, magnesium, sulfate, or boron in plant cells and their adverse effects on crucial physiological processes. Studies (Bar et al., 1997; Feigin, 1985; Kafkafi et al. 1971, 1982) show that appropriate nitrate nutrition can prevent the adverse effects of chloride. Achilea (2002) argued that managing salinity particularly involves combating plant uptake of Na$^+$ and Cl$^-$ as opposed to reducing the salt concentration of the soil solution. Attention was specifically paid to the presence of sufficient NO$_3^-$ and K$^+$ for adequate inhibition of Cl$^-$ and Na$^+$ uptake.

Superior vigour may also have resulted from promoted cationic nutrient uptake due to the increased quantity of NO$_3^-$ in the solution made up with KNO$_3$. Ernst and Knight (1977) similarly found increased dry matter production associated with increased nitrate nutrition in tomato. They suggested that increasing the level of NO$_3^-$ stimulates cation uptake and translocation to the upper plant parts where NO$_3^-$ reduction mainly takes place.

The current study suggests that plant health in desert environments, where the water is generally saline and the soil is typically sand containing appreciable calcium carbonate (as much as 20%), is better assured in using KNO$_3$ as opposed to K$_2$SO$_4$ or KCl as the K source in making up nutrient solutions.
Important literature


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