

Determination of Nutrient Concentrations in Soil Solution and Tomato Plant Sap

Fertigation management requires rapid and accurate methods to determine nutrient concentrations in soil solution and plant sap. Folegatti et al (2005) found that the concentrations of nitrate, potassium, and sodium ions in soil solution and tomato plant sap determined by LAQUAtwin ion pocket meters showed good correlations with those obtained in soil solution and in leaf dry matter, respectively, determined by standard methods in laboratory, and concluded that LAQUAtwin ion pocket meters are useful low-cost tools in fertigation management.



Introduction

Plants take nutrients from soil for their growth. Nutrient levels in soil and plant tissues give an indication of the nutrient requirements of crop. Folegatti et al (2005) developed a study to evaluate the performance of Cardy ion meters on the determination of nitrate (NO_3^-), potassium (K^+), and sodium (Na^+) ion concentrations in soil solution and tomato plant sap for fertigation management purposes. The sodium ion (Na^+) is not an important ion for tomato, but its concentration in soil solution and plant sap gives valuable information when using saline irrigation water.

Cardy ion meters were superseded by LAQUAtwin B-700 series ion pocket meters, which have replaceable sensors, upgraded software, and enhanced user interface. The LAQUAtwin B-722, B-731, and B-743 ion pocket meters measure sodium ion (Na^+), potassium ion (K^+), and nitrate ion (NO_3^-), respectively. Like Cardy ion meters, the LAQUAtwin B-700 series ion pocket meters require only few drops or micro-volume of sample and deliver results in just few seconds. These advantages allow users to analyze a large

number of samples in a short period of time while in the field.

Method

Tomato was cultivated in a greenhouse in Piracicaba, SP, Brazil with different levels of nitrogen (N), potassium (K) and salinity in the irrigation water. Fertilizers and salts used were ammonium nitrate (NH_4NO_3), potassium chloride (KCl), calcium chloride (CaCl_2), and sodium chloride (NaCl), which were applied by drip fertigation. Soil solution samples were collected every 15 days (on average) beginning 24 hrs after irrigations by suction at the 15 cm depth with porous ceramic cups and the concentrations of nitrate (NO_3^-), potassium (K^+), and sodium (Na^+) ions were determined by Cardy ion meters. The results were compared with those determined in laboratory by standard methods—flame photometry for K^+ and Na^+ and steam-distillation for NO_3^- .

Fifty samples of young fully expanded leaves corresponding to the different treatments were also

collected. The base of the petioles was squeezed using a garlic press and nutrients in sap were determined by Cardy ion meters. The leaves were oven-dried at 60°C for 48 hrs and the total N, K, and Na^+ were determined in laboratory by methodology proposed by Malavolta et al (1997). Concentrations of the nutrients in petiole sap were compared with those in leaves.

Cardy ion pocket meters were calibrated with two standard solutions before use and after every 10 samples. To prevent contamination by carry-over, sensors were washed with distilled water between samples.



Figure 1A: Greenhouse experimental pot

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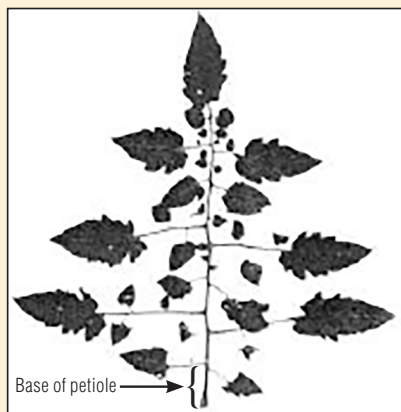


Figure 1B: Base of petiole used for sap nutrient determination

Table 1 - Values of paired-t test for concentrations of NO_3^- , K^+ and Na^+ determined by CIM and by standard methods, in the soil solution and tomato petiole sap.

Statistic	NO_3^-	K^+	Na^+
	Soil solution		
t	-12.1**	12.3**	26.4**
	Petiole sap		
t	13.4** ^ε	13.9**	14.0**

**Significant at 0.01.

^ε NO_3^- in sap tested against total-N in leaf dry matter.

Results and Benefits

Concentrations of NO_3^- , K^+ , and Na^+ in soil solution determined by Cardy ion meters and by standard methods in laboratory were found strongly correlated (Figure 2). The NO_3^- concentrations measured by Cardy ion meters were about 39% lower than those determined by distillation method, while the K^+ and Na^+ concentrations were 21% and 67% higher, respectively, than those determined by flame photometry. The coefficients of determination (r^2) were high for all ions and the relationships were significant at 1% (Table 1).

Concentrations of NO_3^- , K^+ , and Na^+ in petiole sap determined by Cardy ion meters were reasonably well correlated with those determined in

leaf dry matter and relationships were significant for all ions (Table 1). The values of r^2 for the concentrations in the petiole sap and in leaf dry matter were close to those observed by other studies. Comparisons of Na^+ measured in petiole sap and dry matter were not found in the available literature.

Discrepancies observed between the Cardy ion meters and standard method measurements were probably due to the influence of other ions present in soil solution and plant sap. Nevertheless, Folegatti et al (2005) concluded that the Cardy ion meters, now called LAQUAtwin ion pocket meters, which were found to give good correlations with the values obtained by standard methods, are suitable for determining nutrient concentrations in soil solution and petiole sap.

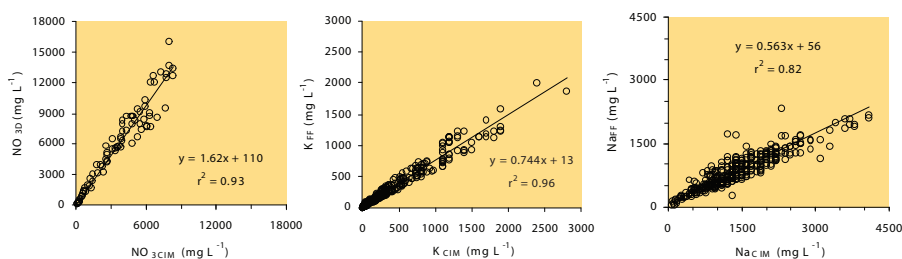


Figure 2 - Relationships between concentrations of nitrate, potassium and sodium in the soil solution measured by cardy-ion meters (CIM) and by standard methods. FF = flame fotometry; D = steam-distillation.

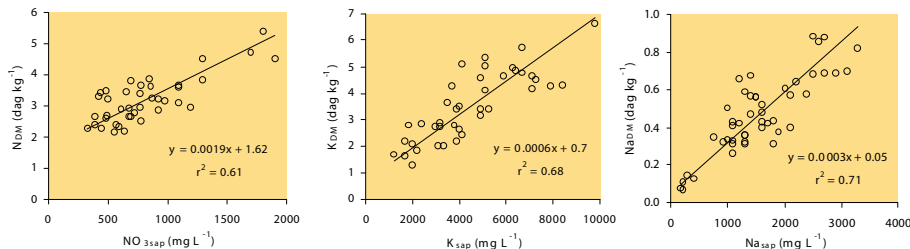


Figure 3 - Relationships between the concentrations of nitrate, potassium and sodium in petiole sap and total-N, potassium and sodium in the dry matter (DM) of tomato leaves, hybrid Facundo.

References and Suggested Readings

- Folegatti, M.V., Blanco, F.F., Boaretto, R.M. and Boaretto, A.E. (2005) Calibration of cardy-ion meters to measure nutrient concentrations in soil solution and in plant sap. Sci. Agric. (Piracicaba, Braz.), v.62, n.1, pp 8-11.
- Malavolta, E., Vitti, G.C.; Oliveira, S.A. Avaliação do estado nutricional das plantas: princípios e aplicações. 2.ed. Piracicaba: POTAFOS, 1997. 201p.

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LAQUAtwin Pocket Ion Meters Lineup



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