CIGR - International Conference of Agricultural Engineering
XXXVII Congresso Brasileiro de Engenharia Agrícola

Brazil, August 31 to September 4, 2008

SOIL SALINITY UNDER THREE CALCIUM NITRATE CONCENTRATIONS OF IRRIGATION WATER FOR TWO TRICKLE IRRIGATION SYSTEMS

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Presented at
CIGR INTERNATIONAL CONFERENCE OF AGRICULTURAL ENGINEERING
XXXVII CONGRESSO BRASILEIRO DE ENGENHARIA AGRÍCOLA – CONBEA 2008
Brazil, August 31 to September 4, 2008

ABSTRACT: Fertilizers are salts that may increase irrigation water salinity, therefore, fertirrigation management should consider aspects like the injection solution. The electrical conductivity of soil solution (ECs) or the soil saturation extract (ECs) may be used to quantify the amount of salts in soil. The objective of this work was to evaluate the effect of calcium nitrate concentration of the irrigation water on the soil electrical conductivity along the first cycle of banana crop. Treatments consisted of using three calcium nitrate concentrations of the solution (1.0; 2.5 and 4.0 g L^{-1}) to be injected into a drip and a microsprinkler irrigation system during the first cycle of Terra banana crop. There was no significant difference among soil extract saturation means for the two irrigation systems. The absolute values of the electrical conductivities were larger in the wetted volume under drip irrigation system. There was difference among electrical conductivities related to the concentrations of calcium nitrate of the irrigation water. The 4 g L^{-1} concentration means were larger than the ones of other concentrations in most of the cases. The use of 4 g L-1 concentration resulted electrical conductivities of soil solution and of soil extract saturation larger than 1.0 dS m-1 for at least 80% and 20% of measurements along of cycle, respectively.
KEW WORDS: irrigation water concentration, drip irrigation, microsprinkler irrigation soil electrical conductivity.

INTRODUCTION: Fertirrigation has been more and more used mainly due to its practical**,** small labor and efficient use of fertilizers. Studies about monitoring soil electrical conductivity become important tools as guidelines for fertirrigation management. These studies should allow corrections in the pro ECs of fertilizing by irrigation water and contribute for minimizing environment impacts due to fertirrigation technique. The soil solution and soil saturation extract electrical conductivity may be used to quantify amount of salts in the soil. The larger the amount of salts in the soil solution the larger the value of the electrical conductivity. Studies using soil electrical conductivity has pointed its potential for measurement of soil water content (KACHANOSKI et al., 1988) and soil salinity (CAMINHA JUNIOR et al., 1998). The management of fertirrigation must to attempt for injection solution concentration, since fertilizers are salts that increase irrigation water salinity. Burgueño (1996) suggests the monitoring of soil salinity or the ionic concentration by means of systematic measurements of soil solution electrical conductivity that will help to decide about the time to fertilize and the amount to apply by irrigation water. The irrigation water, if not suitably managed, even under low salinity levels may cause a salinization proECss (Ayers & Westcot, 1985). Therefore ion monitoring in the soil becomes one of the most important tools for fertirrigation management that has been based on soil samples or in soil solution extracted with water samplers (RHOADES & OSTER, 1986). The objective of this work was to evaluate the effect of calcium nitrate concentration in the irrigation water on the soil electrical conductivity along the first cycle of Terra cultivar banana crop.

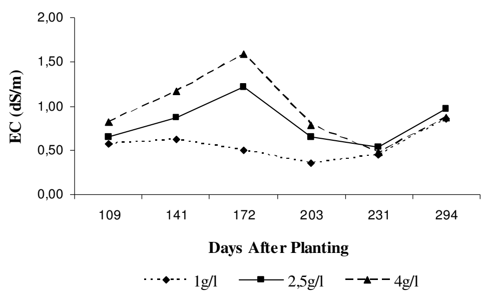
METHODOLOGY: The work was carried in a experimental field of Embrapa Cassava & Tropical Fruits, at Cruz das Almas city, Bahia State (12º48`S; 39°06`W; 225m), whose climate is classified as humid to sub humid with 1.143mm of rain per year (D`Angiolella et al., 1998). The soil chemical characteristics at the begining of the experiment were: pH 6.3; 11 mg/dm^3 of P; 0.06 cmolc/ dm^3 of K; 3.4 cmolc/ dm^3 of Ca+Mg; 0.09 cmolc/ dm^3 of Na; 1.32 cmolc/dm^3 of H+Al; 3.56 cmolc/ dm^3 of S; CTC 4.88 cmolc/dm^3; V 73% and M.O 5.01 g/kg). Treatments regarded about use of three calcium nitrate concentrations (1.0; 2.5 and 4.0 g/l) in the injection solution that was applied in the field by two irrigation systems (drip and microsprinkler) during the first cycle of Terra cv banana crop. The experimental plots had six plants each. The drip irrigation system had one lateral line per plant row with three 4 L h^{-1} emitter per plant and the microsprinkler one lateral line in between two plant rows with one 47 L h^{-1} emitter per four plants. Urea and calcium nitrate were used as source of nitrogen fertilizers and potassium chloride as source of potassium. They were applied at a frequency of twice a week. Calculation of amount of fertilizer of the injection solution followed recommendations of Borges et al. (2007). Samples of soil solution were monthly collected in each plot by water samplers for monitoring soil solution electrical conductivity (ECs). Water samplers were installed at 0.30 m from the plant at depths of 0.20; 0.40 e 0.60 m for the microsprinkler system. In case of drip system, the water samplers were installed between two emitters, near to the plant at same soil depths. Soil samples were collected at three locations per plot between two emitters near the plant, also at the same depths. In case of microsprinkler system, samples were collected at 0.30 m from plant in the direction of the emitter at same depths as used for the drip system. Soil samples were dried at the air and sieved. The saturation extract was obtained following EMBRAPA (1997). Readings of electrical conductivity of soil solution (ECs) and of soil saturation extract (ECs) were accomplished by using a table EC meter. Soil bulk electrical conductivity (ECa) was evaluated during the crop cycle by using TDR technique. TDR probes were built according to Coelho et al. (2006). The ECa values considered in this work belonged to a range of 0.29 ± 0.02 m^3 m^{-3} where 0.29 is the upper limit of soil available water.

RESULTS AND DISCUSSION: There was no difference among the means of ECs for the two irrigation systems for the same calcium nitrate concentration. The result was the same for the means of ECs, except for 4 g L^{-1} concentration. The absolute values of electrical conductivity obtained for drip irrigation system was larger than the ones obtained for the microsprinkler system, despite the non statistical difference among the electrical conductivity means of the two systems. The ECa means for the two irrigation systems differed statistically each other ($P<0.05$), except for 1 g L^{-1} irrigation water concentration. ECa was larger under drip system. This might be explained by the smaller wetted volume under drip that concentrates more the soil solution compared to the one under microsprinkler. Values of ECa were much smaller than ECs and ECs that were closer each other. Values of mean ECa varied from 21 to 24% of mean ECs and ECes, respectively. ECa depends upon EC of soil solution that is a function of the wetted porous media and EC of the surface of soil particles. ECs regards about the ions that are not strongly linked to the soil particles and the ones free in the soil solution and ECs is related to the ions free in the soil solution. Therefore it is expected larger ion concentration in the saturation extract and in the soil solution ad larger electrical conductance compared to the EC of the bulk soil. This difference was also obtained in other works (SANTANA et al., 2006; MUÑOZ-CARPENA et al., 2001). It was noticed a significant difference among ECa means of the three irrigation water concentrations, by fixing irrigation system and varying irrigation water concentrations. Mean ECs for 1 g L^{-1} concentration differed from the means for 2.5 and 4 g L^{-1} concentration that did not differ each other. ECs means behaved differently according to the irrigation system. The means under 4 g L^{-1} irrigation water concentration were larger than the others and statistically similar to the means under 2.5 g L^{-1} concentration. Figure 1 depicts evolution of ECs, ECs, ECa during the crop cycle. The data show some stability without tendency for reduction or increasing of EC. EC values were larger for 4 g L^{-1}concentration followed by EC values of 2.5 e 1.0 g L^{-1}concentrations.

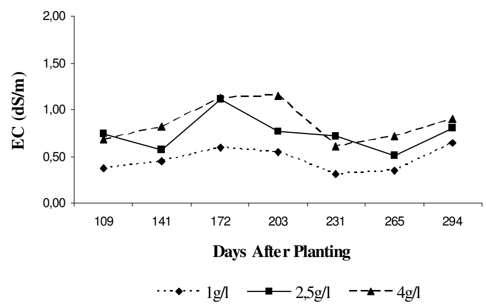
TABLE 1. Mean values of ECa, EECs and ECs for the three irrigation water concentrations and for drip and microsprinkler irrigation systems.

Concentration	ECes		ECa		ECs	
	Microsprinkler	Drip	Microsprinkler	Drip	Microsprinkler	Drip
1.0 g L^{-1}	0.461 Aa	0.562 Aa	0.127 Aa	0.125 Aa	0.588 Aa	0.727 Aa
2.5 g L^{-1}	0.743 Ab	0.813 Ab	0.143 Ab	0.194 Bb	0.786 Ab	0.830 Aa
4.0 g L^{-1}	0.854 Ab	0.951 Ab	0.208 Ac	0.278 Bc	0.822 Ab	1.358 Bb

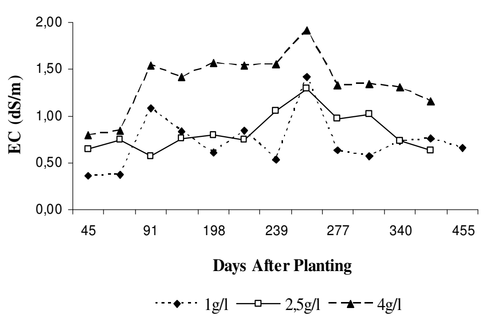
ECs had been above 1.0 dS m^{-1} for at least 80% of measurements taken for the drip irrigation system. Also, ECs had been above 1.0 dS m^{-1} for at least 20% of measurements taken as for drip irrigation as for microsprinkler system for 4.0 g L^{-1}. Banana crop is recommended for soils with ECs smaller than 1.1 dS m^{-1}(OLIVEIRA, 1999), therefore, the use of 4 g L^{-1} irrigation water concentration might be a risk for the soil salinity and for banana crop.



(1a)



(1b)



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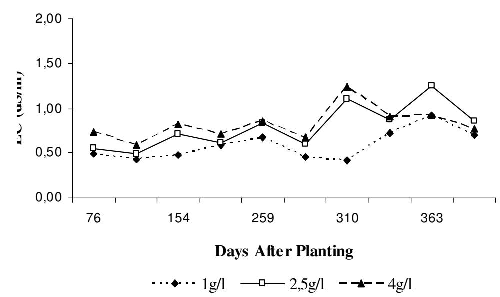
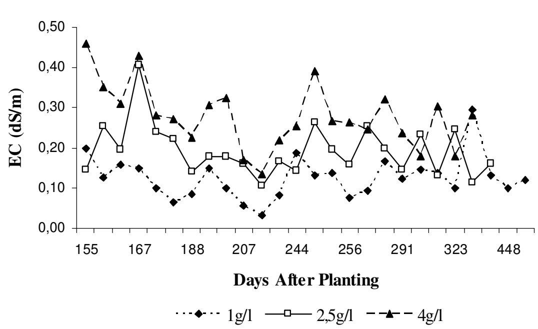
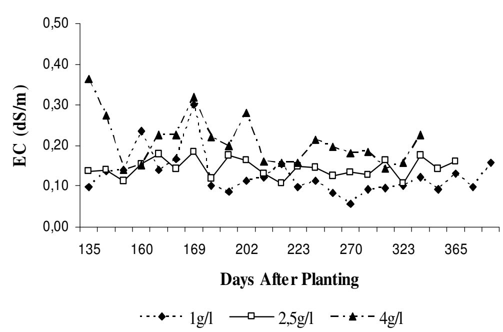


(1d)



(1e)



(1f)

Figure 1. Values of electrical conductivity of saturation extract (1a and 1 b), soil solution (1c and 1 d) and estimated by TDR (1e and 1 f) for drip (left graphics) and microsprinkler (Right graphics) irrigation systems**.**

CONCLUSION: There was no difference among ECs means for the two irrigation systems. The absolute values of EC in the wetted volume under drip irrigation were larger the ones for microsprinkler irrigation system. The calcium nitrate concentration in the irrigation water affected EC and the 4 g L^{-1} concentration resulted in larger EC values than the ones obtained for the others concentrations. The use of 4 g L^{-1} concentration resulted in ECs and ECs larger than 1.0 for at least 80% e 20% of measurements, respectively, taken along the crop cycle.

REFERENCES:

AYERS, R.S.; WESTCOT, D.W. (1985). "**Water quality for agriculture**" Roma: FAO, Irrigation and Drainage Paper, 29, Rev.1, 174 p.

BURGUEÑO, H. **La fertirrigacion en cultivos hortícolas com acolchado plástico**. Culiacan, 1996. v.1, 45p.

CAMINHA JUNIOR, I.C.; SERAPHIM, O.J.; GABRIEL, L.R.A. Caracterização de uma área agrícola irrigada com efluente agroindustrial, através de análises químicas e da resistividade do solo. *Energia na Agricultura*, Botucatu, v.13, n.4, p.40-54, 2000.

COELHO, E.F.; OR, D. A parametric model for two-dimensional water uptake by corn roots under drip irrigation. Soil Science Society of America Journal, Madison, v.60, n.6, p.1039-1049, 1996.

D'ANGIOLELLA, G. L. B.; CASTRO NETO, M. T.; COELHO, E. F. **Tendências climáticas para os Tabuleiros Costeiros da região de Cruz das Almas**. In: CONGRESSO BRASILEIRO DE ENGENHARIA AGRÍCOLA, 27., 1998, Poços de Caldas. **Anais**... Lavras: UFLA, 1998. v. 1, p. 43-45.

EMBRAPA. **Manual de métodos de análise de solo**. Rio de Janeiro: Centro Nacional de Pesquisa de Solo, 1997. 212 p.

KACHANOSKI, R.G.; GREGORICH, E.G.; WESENBECK, I.J. Van. Estimating spatial variations of soil water content using noncontacting electromagnetic inductive methods. *Canadian Journal of Soil Science*, Toronto, v.68, p.715-22, 1988.

MUÑOZ-CARPENA, R.; REGALADO, C.M.; ALVAREZ-BENEDÍ, J.; SOCORRO, A.R.; PÉREZ, N. **Determinación simultánea mediante TDR del transporte de agua y un soluto salino em el suelo.** In: LÓPEZ, J.J.; QUEMADA, M. (Ed.). *Temas de Investigación en Zona no Saturada*. Pamplona: Universidade Pública de Navarra, 2001. p.1-7.

RHOADES, J.D.; OSTER, J.D. Solute content. In: KLUTE, A. (Ed.) *Methods of soil analysis*. 2.ed. Part 1. Agronomy. Madison: ASA/SSSA, 1986. p.995-1006.

SANTANA, G. DA S., COELHO, E. F., SILVA, T. S. M. da, RAMOS, M. M. **Estimativa da condutividade elétrica da solução do solo a partir do teor de água e da condutividade elétrica aparente do solo.** *Eng. Agríc., Jaboticabal, v.26, n.3, p.672-685, set./dez. 2006*