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

Brazil, August 31 to September 4, 2008

ENVIRONMENTAL IMPACTS OF AGRICULTURAL ACTIVITIES IN IRRIGATED AREA GROWING GRAPES IN THE SUBMÉDIO SÃO FRANCISCO RIVER VALLEY, BRAZIL

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Presented at
CIGR INTERNATIONAL CONFERENCE OF AGRICULTURAL ENGINEERING
XXXVII CONGRESSO BRASILEIRO DE ENGENHARIA AGRÍCOLA – CONBEA 2008
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ABSTRACT: This research aimed at characterizing soil physical and chemical parameters, pesticide and heavy metal occurrence in the soil and water collected in a grapevine irrigated orchard in the Submédio San Francisco River Valley, Brazil. Soil and water samples were collected at 15-25 days after pruning (DAP), 40-55 DAP, and 70-85 DAP. The chemical analysis for pesticides and heavy metals were made according to the standard methods for the examination of water, wastewater and soil. The results showed that the nutrient content of the soil reduced towards the end of the phenological phase of the grapes. There was increase of the electrical conductivity of the soil and of the drainage water in comparison with the irrigated water, as well as in the content of some toxic elements. This trend can be unsustaintable for the ecosystem where the use of pesticides and fertilizers is frequent. However, the high levels of organic compounds on the soil have an important play to avoid or reduce metal mobility and contribute to a lower content of metals and pesticides.
KEYWORDS: water resources; contamination; irrigation; drainage.

INTRODUCTION: The search for high agricultural yields and the consequent demand for management practices intensified the land use and increased the amount of agrochemicals used in agriculture. These inputs generally contain impurities, like heavy metals, which can cause risks to human health and to the environment. Many efforts have been made to reduce environmental pollution in a lot of countries.
In Brazil, occurrence of ground contamination by metals has been shown in several research studies (Magalhães & Pfeiffer, 1995; Silva et al., 2000, cited by Guillermo et al., 2005). Alencar et al. (1996) identified that 5% of the rural employees of irrigated areas presented severe intoxication, with percentage of colinesterase oscillating between 25 and 50%.
The transportation processes of contaminants in the environment have great importance on the understanding of their dynamics, since, generally, they are degraded, volatilized or decayed by photolysis. The predominant soils in the irrigated areas in the São Francisco River Valley favour the leaching of agrochemical products, being able to cause contamination of the water table, due to intensive application of inputs in the production systems, associated to inadequate management of the irrigation water and/or the intense and continuous rain occurrence. Studies carried out in irrigated plots of the Salitre watershed have identified high nitrate levels in surface and underground water, as well as high levels of heavy metals in the sediments of that river bed, probably as a result of the use of fertilizers and pesticides in irrigated agriculture (Brito et al., 2005).

METHODOLOGY: This research was carried out in a table grape orchard located at the Experimental Station of Embrapa Tropical Semi-Arid, Petrolina-PE, Brazil. Twelve drainage lysimeters were installed. The amount of irrigation water was applied in two intermittence managements: 1. without intermittence of the irrigation time and 2. with three intermittence times.
The samples of irrigation (A_I) and drainage (A_D) water and of the soil at 0-20 cm and 80-100 cm profile were obtained at 15-25 days after pruning (DAP), 40-55 DAP, and 70-85 DAP. The analyses of pesticides, heavy metals and other chemicals on the water samples were made according to Standard Methods for the Examination of Water and Wastewater (ed. 18ª, 1992). These analyses were made at Instituto Tecnológico de Pernambuco – ITEP, in Recife-PE. The physico-chemical analyses of the soil and water were made according to Embrapa Methodologies (1999).

RESULTS AND DISCUSSION: It was observed that the values of electrical conductivity – CE measured on the soil saturation extract, at 80-100 cm of the soil profile, reached 2.5 $dS.m^{-1}$, at the end of the productive phase of the grapes. For a non-cultivated soil, the values of CE were 0.15$dS.m^{-1}$ (Fig. 1). However, it was raining at the end of the productivity season and the final values of CE were reduced to 0.30 $dS.m^{-1}$. By comparing cultivated soil with irrigated grapes with non-cultivated soil, it was observed that the irrigated crop increases the CE values. Considering that many plants show sensitivity to soil or water salinity, as grapevine, the value of 2.5 $dS.m^{-1}$ of CE can induce losses of up to 10% in the productivity potential (Ayers & Westcot, 1999). So, it is necessary to adopt preventive ways regarding control of salinization in irrigated soils.
It was observed that the phosphorus content (P), measured at 0-20cm in the cultivated soil, at the beginning of the productivity phase (phase of pruning - F1), was 286$mg.dm^{-3}$ and it was reduced to 150$mg.dm^{-3}$ at budding phonological phase (F2). It reached 250$mg.dm^{-3}$ at the end of the harvest. This behavior was associated, possibly, to the high absorption of this nutrient during the intense vegetative development of the plants, mainly until the budding/first growth phase of the fruit, as well as the fertilizer application of phosphorus through fertirrigation during the productive cycle of the grapevine. However, for 80-100 cm profile, the P content remained at 15$mg.dm^{-3}$, except at the beginning of the productivity cycle, when the value was 50$mg.dm^{-3}$ (Fig. 2).
For Fe, Cr and Al metals, it was observed that their contents increased in depth, throughout the different development phases of the grapevine, while for others, it was observed accumulation only in the superficial layer of the soil (Table 1).

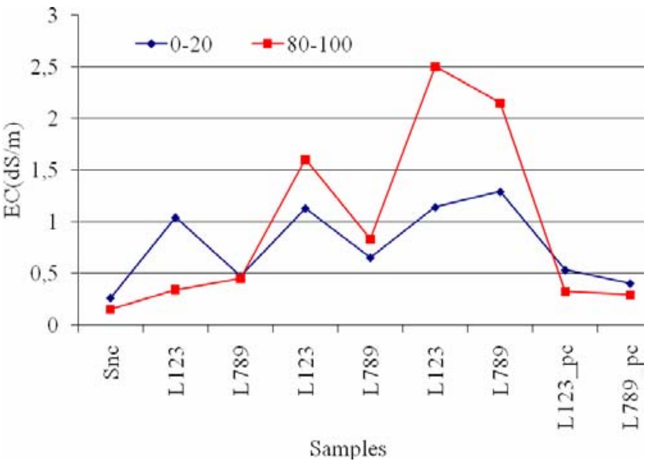

Fig. 1. Variation of the electrical conductivity (CE) of the saturation extract for cultivated and non-cultivated soil (CEsnc) at 0-20 and 80-100cm soil profile, throughout the productivity cycle of the grapevine. Petrolina-PE.

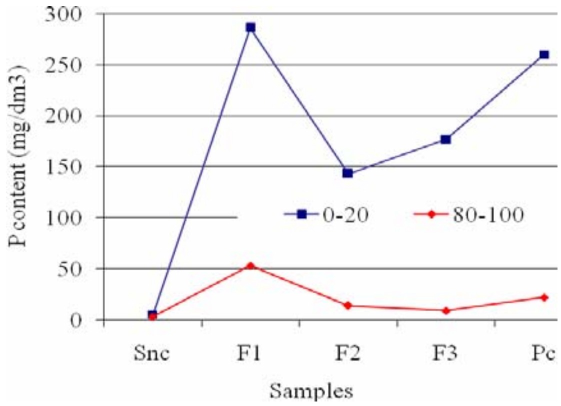

Fig. 2. Phosphorus content (P) in the soil cultivated with grapes and in the non-cultivated soil (Ssnc) at 0-20 and 80-100cm profile, throughout the productivity cycle of the grapes. Petrolina-PE.

However, at the end of the rainy season and of the productivity cycle of the grapes, it was verified that the content of the elements in the soil was reduced, leached to the deeper soil layers (Table 1). This implies in a potential trend of contamination of the watertable with heavy metals.

CONCLUSION: There was a trend of increase the content of some toxic elements, electrical conductivity and heavy metals on the soil and drainage water collected on the lysimeters planted with table grapes. Those elements can be leached towards the water table during the productive cycle. Also, it was observed reduction on nutrient content on the soil from pruning to harvest of the grapes. Pesticide content on soil and water was not observed.

ACKNOWLEDGMENTS: The authors thank Etene/Fundeci, Protocol Number 22400-05/0035-1, for the financial support.

REFERENCES:

ALENCAR, J.A.; HAJI, F.N.P.; COSTA, E.L.; PREZOTTI, L. Diagnóstico preliminar do uso de agrotóxicos em perímetros irrigados do Submédio do São Francisco. In: Simpósio Internacional de Tecnólogia de Aplicação de Agroquímicos, 1. 1996, Águas de Lindóia-SP. Resumos. Águas de Lindóia-SP: IAC/UNESP, 1996.

AYERS, R.S.; WESTCOT, D.W. A qualidade da água na agricultura. Tradução GHEYI, H.R.; MEDEIROS, J.F.; DAMACENO, F.A.V. Campina Grande: UFPB,1991. 218p. (FAO: Irrigação e Drenagem; 29) Revisado 1.

AMARAL SOBRINHO, N.M.B. et al. Metais pesados em alguns fertilizantes e corretivos. R Bras Ci Solo, v.16, p.271-276, 1992.

BRASIL, Ministério da Saúde. Portaria n^{o}. 518, de 25 de março de 2004. Diário Oficial da União, Brasília, DF, 26 mar. 2004. Seção 1, p. 266.

BRITO, L.T. de L.; SRINIVASAN, V.S; SILVA, A.S.; GHEYI, H.R ; GALVÃO, C.O.; HERMES, L.C. Influência das atividades antrópicas na qualidade das águas da bacia hidrográfica do rio Salitre. Revista Brasileira de Engenharia Agrícola e Ambiental, Campina Grande,PB, v. 9, n. 4, p. 596-602, 2005.

Companhia de Tecnologia de Saneamento Ambiental – CETESB. Valores orientadores para solos e águas subterrâneas no estado de São Paulo, 2005. Disponível em: <http://www.cetesb.sp.gov.br/Solo/relatorios/ tabela_valores_2005.pdf>. Acesso em: ago. 2007.

GUILHERME. et al. Elementos Traços em Solos e ambientes aquáticos. In: Tópicos de Ciências do Solos. V. 4: 345-390, 2005.

RAMALHO, J.F.G.P. et al. Acúmulo de metais pesados em solos cultivados com cana-de-açúcar pelo uso contínuo de adubação fosfatada e água de irrigação. R Bras Ci Solo, 23:971-979, 1999.
SANTOS, F.S. et al. Influência de diferentes manejos agrícolas na distribuição de metais pesados no solo e em plantas de tomate.
TAVARES, M.C.H. et al. - Química Nova, v. 19, nºROSS, S.M. Toxic metals in soil-plant-systems. New York: John Wiley & Sons, 1994. 469p.

Table 1- Content of heavy metals in the soil profile cultivated with grapes and in a non-cultivated soil in Petrolina-PE.

Plots	Prof. (cm)	Al	Cd*	Pb**	Co	Cu	Cr	Fe	Mn	Ni***	Zn
		....				mg/L					....
					15-25DAP						
S_{nc}	0-20	14.767,6	ND	ND	6,0	ND	14,0	10.353,8	251,1	ND	111,9
S_{nc}	80-100	59.535,3	ND	ND	6,0	12,0	40,0	24.984,0	166,7	ND	8,0
L_{123}	0-20	20.032,0	ND	ND	6,0	20,0	16,0	1.142,1	208,0	ND	24,0
L_{123}	80-100	21.585,8	ND	ND	8,0	12,0	34,0	19.792,0	153,7	ND	32,0
L_{789}	0-20	25.617,1	ND	ND	8,0	16,0	20,0	14.389,6	211,6	ND	40,0
L_{789}	80-100	72.224,9	3,2	ND	14,0	16,0	62,0	31.083,8	175,9	20,0	28,0
					40-50DAP						
L_{123}	0-20	20.427,0	2,8	ND	12,0	20,0	29,9	10.991,0	239,8	ND	143,6
L_{123}	80-100	42.783,0	ND	ND	6,0	ND	35,9	19.085,0	138,1	ND	8,0
L_{789}	0-20	21.737,0	0,0	ND	6,0	16,0	27,9	11.697,0	210,8	ND	37,9
L_{789}	80-100	52.807,0	1,0	ND	6,0	ND	46,4	25.814,0	126,4	ND	24,0
					70-85DAP						
L_{123}	0-20	25.220,0	4,0	ND	10,0	63,9	36,0	12.719,0	233,8	ND	265,6
L_{123}	80-100	51.400,0	6,0	ND	14,0	20,0	54,0	20.220,0	171,4	10,0	78,0
L_{789}	0-20	22.409,0	3,0	ND	10,0	49,9	32,0	1.184,0	230,7	ND	159,8
L_{789}	80-100	58.033,0	5,8	ND	12,0	16,0	65,9	25.802,0	157,8	12,0	69,6
					Pc (Raining season)						
L_{123}	0-20	23.200,0	0,5	9,0	ND	30,7	25,6	9.090,0	69,7	7,0	142,0
L_{123}	80-100	25.600,0	0,5	9,9	5,3	15,6	38,6	14.600,0	17,6	9,6	50,0
L_{789}	0-20	26.200,0	0,5	9,4	403,0	34,3	27,4	100.400,0	64,5	8,0	96,7
L_{789}	80-100	44.600,0	0,7	10,8	604,0	ND	44,7	19.600,0	30,5	11,7	81,5

* ND = not observed. Starting threshold of the equipment < 7 mg/L; ** Starting threshold of the equipment <500 mg/L; *** Starting threshold of the equipment <20 mg/L; DAP – days after pruning.