

TOXICITY OF SURFACE AND GROUND WATER IN AGRICULTURAL AREAS OF COSTA RICA



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Introduction

Costa Rica's economy is to a large extent agricultural-based (448 632 ha cultivated). Agriculture activities are often noted as an important source of pollution, due to the intensive use of agrochemicals to improve productivity. This, together with the soil properties, the type of application and the high precipitation favor the exchange of pollutants between ground water and surface water, and may have a significance impact to drinking water quality.

The assessment of water quality in the country has been largely based on physical-chemical analysis and bacteriological examination. However, harmful substances such as heavy metals and pesticides can contaminate drinking water. Toxicity tests can be used as practical, rapid and early warning techniques to detect changes in the water quality.

Aim

The purpose of this study was to use three simple toxicity tests to evaluate drinking water quality in different agricultural areas.



Sampling

The following samples were collected:

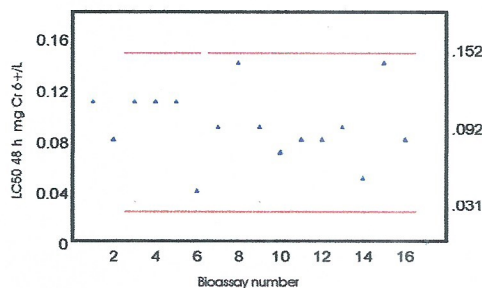
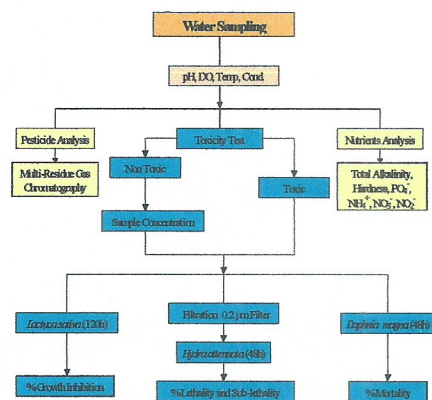
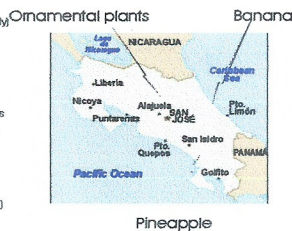
- Pineapple area: 6 surface water
- Ornamental plants area: 4 spring water (used for drinking water supply)
- Banana area: 5 well water

Toxicity tests

All tests were started 24 hours after sampling. When no toxic response was observed samples were concentrated 500x using solid phase extraction disks.

The battery of bioassays performed were:

- *Daphnia magna* 48 h survival test (Dutka, 1989)
- *Hydra attenuata* 48 h sublethality and lethality test (Trotter et al., 1997)
- *Lotuca sativa* 120 h seed germination test (Dutka, 1989)



Results

- The percentage of non-concentrated samples with toxic effects is shown in Figure 1 (only the samples with at least 20 % response were considered).
- All concentrated blanks were toxic to the organisms.
- The herbicide bromacal was detected in all the water samples from the pineapple area; in concentrations ranged from 0.7-7.2 µg/L.
- No other pesticide residues were detected in the samples.
- Nitrate in the water samples from the ornamental area ranged between 11.7-12.1 mg/L.

Results of applied bioassays

Sampling Areas	Samples Codes	Bioassays (response in %)				
		<i>D. magna</i> Mortality	<i>H. attenuata</i> Sub-lethal	<i>H. attenuata</i> Lethal	<i>L. sativa</i> Growth Inhibition	
					Root	Seed
Pineapple	P1	50	100	0	41	41
	P2	52	0	0	neg.	38
	P3	63	0**	0**	48***	40***
	P4	70	0	0	-	-
	P5	17	0	0	neg.	27
	P6	-	-	-	neg.	29
Ornamental	O1	20	0	0	27	neg.
	O2	9	0	0	neg.	36
	O3	23	0	0	neg.	neg.
	O4	0	0	0	neg.	18
Banana	B1	3	10	0	48	38
	B2	10	0	0	33	28
	B3	100	0	0	53	41
	B4	0	0	0	0	17
	B5	100*	0	0	27	24

*sample aerated, **faded, ***inhibition: root 6.25%, seed 12.5% dilution

Discussion

Almost all samples from the pineapple area showed toxic response to daphnia (mortality from 17 to 70%), and caused 48 and 41% inhibition in root and seed growth respectively. The growth inhibition found in the seed was probably caused by the presence of the herbicide bromacal in those samples.

The LC50 of bromacal for daphnia (119 mg/L) is much higher than the found concentrations, indicating that mortality observed in daphnia was probably caused by other contaminants not analyzed.

In the ornamental area nitrate concentrations seem slightly higher than those normally found in natural water (1-10 mg/L). This could indicate infiltration of nitrogen-containing fertilizers into the aquifer. However the levels are still below the drinking water limit of 25 mg/L in Costa Rica.

In water samples from the banana area no pesticide residues were detected, nevertheless almost all samples gave positive response to daphnia and seed, which suggest some type of contamination.

The toxicity found in all concentrated blanks is probably caused by a combination of the used materials like the methanol and the solid phase disk. The methanol concentration proposed in the original protocol was reduced from 2 to 1%.

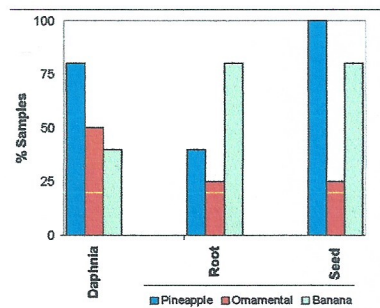


Fig2. Percentage of samples with toxic response

Conclusions

- *D. magna*, *L. sativa* were the most sensitive organisms, while *H. attenuata* showed low sensitivity.
- Due to the different source of contaminants and the different sensitivity between organisms, it is useful to have a battery of tests to estimate toxicity from environmental samples.
- More research is needed to test the suitability of a concentration step in case of organic contaminants like pesticides.



References

- Dutka B.J. Methods for Toxicological Analysis of Waters, Wastewaters and Sediments. National Water Research Institute (NWRI), Environmental Canada, Burlington, Ontario, 1989.
- Trotter S, Blaise C, Kasai T, Johnson EM. Environ Toxicol Water Qual 1997;12: 265-271.
- Castillo LE, Pinnock M, Martinez E. Environ Toxicol 2000; 15: 312-321.

Acknowledgements