Effect of sugarcane coverage on the behavior of Tebuthiuron in soil in Brazil

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The region of Ribeirao Preto City located in Sao Paulo State, southeastern Brazil, is an important sugarcane, soybean and corn producing area. This region is also an important recharge area for groundwater of the Guarany aquifer, a water supply source of the city and region. The herbicide tebuthiuron (N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2 yl]-N,N'-dimethylurea) is regularly applied in the area. In order to understand the movement of tebuthiuron, the herbicide was applied at the recommended label rate with and without sugarcane coverage, on sandy soil area in Santa Rita do Passa Quatro County in Brazil, located in the region. Soil samples were collected at each 20 cm down to 120 cm and taken to the laboratory for determination of tebuthiuron. Tebuthiuron was measured at those depths mentioned before in ten intervals of time up to 300 days. Tebuthiuron half-lives varied from 69 days in sugarcane cropped area to 49 days in non-cropped area. After 180 days there were no measurable residues in the soil and tebuthiuron was not found below 40 cm depth in any time.

Key Words: Agriculture, Ground Water, Nonpoint Source Pollution, Solute Transport, Water Quality

INTRODUCTION

The region of Ribeirao Preto City (Figure 1), located in Sao Paulo State, southeastern Brazil, is an important sugarcane, soybean and corn producing area. This region is also an important recharge area for groundwater of the Guarany aquifer, a water supply source of the city and region. It has an intercontinental extension that comprises areas of eight Brazilian states, as well as significant portions of other South American countries like Argentina, Uruguay, and Paraguay, with a total area of approximately 1,200,000 Km^2.

Intensive cultivation in this area has required the constant use of pre-emergent herbicides and fertilizers. The risk of groundwater contamination by those chemicals, which are normally reapplied annually, has been a major concern. Due to the high permeability of some soils present in this region, the mobility of the herbicides and fertilizers applied, and being a recharge area, it is important to investigate the potential transport of applied herbicides to underlying aquifer. The herbicide tebuthiuron is regularly applied in the area. Tebuthiuron (N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2 yl]-N,N'-dimethylurea) is a phenylurea herbicide used in sugarcane culture for pre emergence control of weeds.

Although it was generally accepted that pesticides would not leach to groundwater, recent studies indicate agrochemical leaching as an important source of agricultural non-point-source pollution (Smith et al. 2001), particularly in the last decade (Bouwer 1990). Other studies have indicated that some American aquifers were contaminated with both inorganic and organic compounds, some of which were pesticides (Williams et al. 1988).

Figure 1. Map of South America showing the city of Ribeirao Preto, Brazil, where the recharge area is located.

MATERIALS AND METHODS

In order to understand the movement of tebuthiuron in the region it was chosen a sandy soil area located in the city of Santa Rita do Passa Quatro, Sao Paulo state, Brazil, with and without sugarcane cover. Soil samples were collected and taken to the laboratory. Soil density (Mg/m3), the relationship of soil mass to volume was measured using the Kopeck ring method described by Black (1965). Total porosity was measured based on the percentage of saturation in volume (Vomocil 1965). Microporosity was determined by the

tension table method at a potential of 0.006 Mega Pascal (Mpa). After saturation and drying under tension, the samples were oven dried at 105°C to obtain the volume of micropores ≤ 0.05 mm. Macroporosity was obtained by the difference between micro and total porosity. Also evaluated were the % organic matter and physical properties of the soils for each depth (Klute 1986). Soil samples were collected in trenches at 10 cm depths and their properties are shown in Table 1.

RESULTS AND DISCUSSION

The experiments conducted in Santa Rita area with sand soil have shown that tebuthiuron half-lives varied from 69 days in sugarcane cover area to 49 days where there was no cover crop. After 240 days there was no measurable residue in the soil and it was not found below 40 cm. depths, any time. (Tables 2 and 3, and Figures 2 and 3).

CONCLUSION

The half-life of tebuthiuron was much lower than expected. Literature indicates a period from 12 to 15 months (Weed Science Society of America) and we found a maximum of 69 days. There was an apparent effect of sugarcane coverage on the degradation, being quicker where there was no cover. The herbicide did not move deeper than 40 cm. depth anytime.

Table 1. Soil micro, macro, total porosity, density and moisture at various depths.

Depths (cm)	Macro (%)	Micro (%)	Total Porosity (%)	Density (kg/ dm3)	Moisture 0.1 bar (%)
0-10	11,88	30,72	42,59	1,51	8,6
10-20	11,30	30,23	41,53	1,55	8,4
20-30	8,68	30,64	39,32	1,64	7,6
30-40	11,32	30,31	41,63	1,56	8,8
40-50	10,40	31,07	41,46	1,57	9,1
50-60	10,60	31,50	42,10	1,54	10,8
60-70	12,65	29,19	41,84	1,54	10,4
70-80	13,13	29,14	42,27	1,52	9,7
80-90	14,90	27,57	42,47	1,49	9,4
90-100	15,38	27,55	42,93	1,44	9,2
100-110	16,20	25,93	42,13	1,46	9,2
110-120	14,11	28,76	42,87	1,42	9,8

Table 2. Amount (mg/kg) of tebuthiuron found at various depths and time with sugarcane cover.

Depth (cm)	Control	0[1]	3	30	60	90	120	150	180	240
0-20	ND[2]	0.33	0.115	0.12	0.080	0.075	0.08	0.025	0.035	ND
20-40	ND	ND	ND	0.02	0.02	ND	0.03	ND	0.02	ND
40-60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
60-80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
80-100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
100-120	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

[1]DAA=Days after application. [2]ND= No detection.

Table 3. Amount (mg/kg) of tebuthiuron found at various depths and time with no sugarcane cover.

Depth (cm)	Control	0[1]	3	30	60	90	120	150	180	240
0-20	ND[2]	0.41	0.39	0.08	0.12	0.07	0.06	0.025	0.025	ND
20-40	ND	0.15	0.02	ND	ND	ND	ND	ND	ND	ND
40-60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
60-80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
80-100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
100-120	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

[1]DAA=Days after application. [2]ND= No detection.

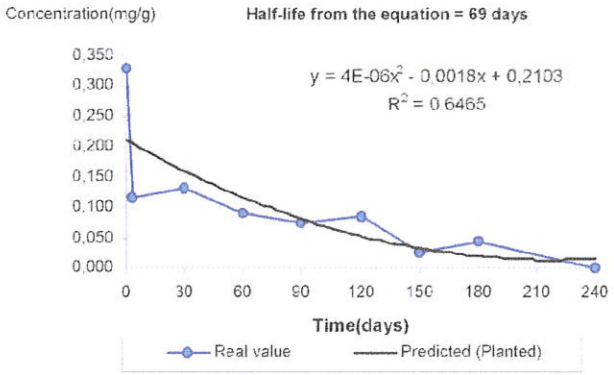

Figure 2. Tebuthiuron dissipation in sandy soil with sugarcane cover.

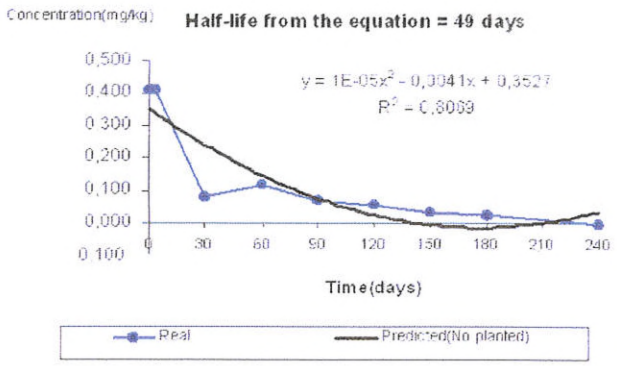

Figure 3. Tebuthiuron dissipation in sandy soil without sugarcane cover.

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