Degradation of Crop Protection Products in Brazilian soils

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Introduction

- Crop protection products (**CPPs**) = Chemicals **protecting** agricultural systems from weeds, pests and disease
- Stringent regulations control the use of CPPs ensuring there is no unacceptable risk to the environment, human and animal health[1] Need for in-depth understanding of the environmental fate of CPPs including microbial **degradation** in soil
- Most of the chemical fate studies in soil use temperate soils
- Little is known about the behaviour in tropical soils and the physico-chemico-biological interactions leading to these differences are unclear
- Brazilian soils are highly weathered soils that vary widely in key properties, such as pH, clay and organic matter content
- **Aim of this work = Study degradation and mobility of Thiabendazole in 4 different Brazilians soils and 1 temperate soil**

Brazilian Soils

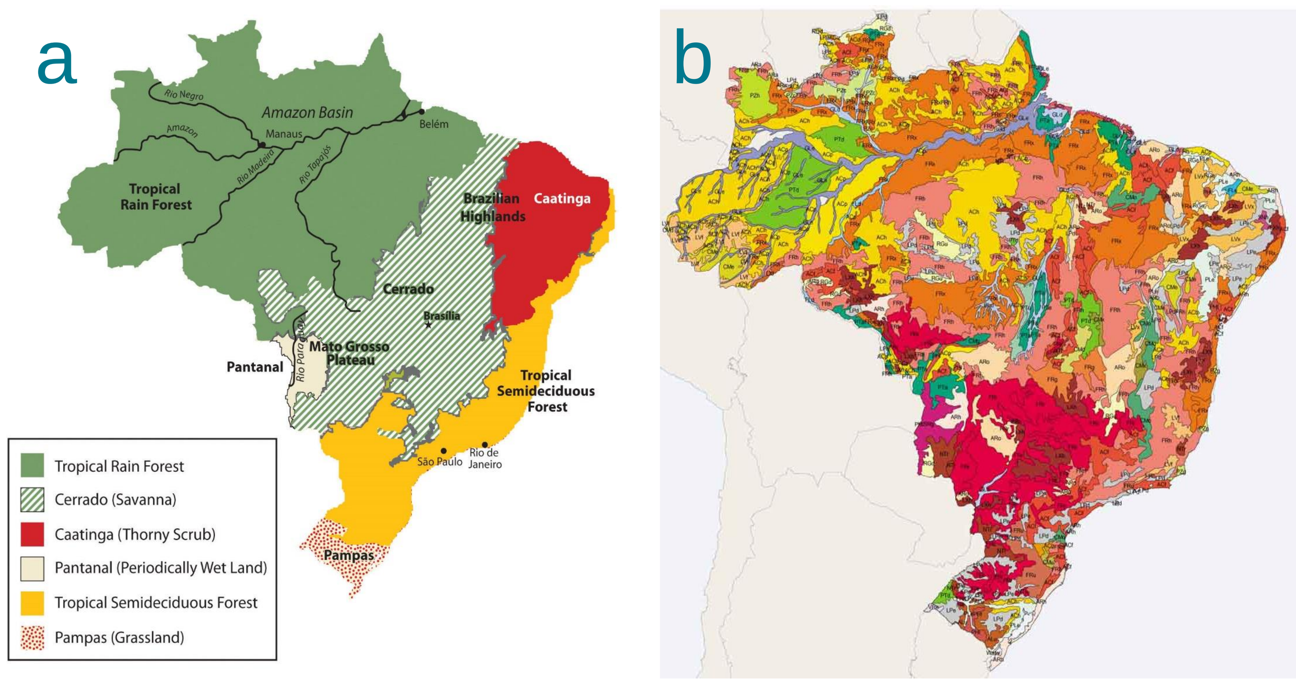


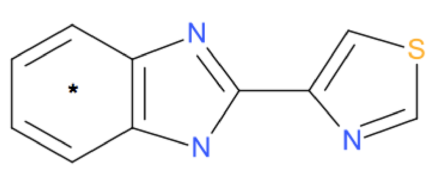
Fig. 1: **Maps showing the diversity of (a) biomes and (b) soils in Brazil** Soils map (b) is based on World Reference Base qualifiers [2] Colours represent the type of soil based on physico-chemical properties and geological history

	PV	GM	LVD	RQ	18 Acres
% Clay	38	50	52	4	19
% OM	5.0	19.5	5.1	1.5	5.0
pH	5.2	4.1	4.0	4.0	5.2
CEC	28.7	18.6	9.8	3.5	15

Fig.2: **Appearance and properties** (sand, clay and organic matter content) of Gleissolo (GM), Latossolo (LVD), Neossolo (RQ), Argissolo (PV) and temperate (18 Acres) soils

Degradation Study

- ^{14}C Thiabendazole (structure shown) was applied to soils shown above at 500 g ai/ha



- Systems containing 700g soil were incubated under aerobic conditions in the dark at 20°C and in a flow-through system
- Recovery was determined over a 120 day time course
- Extracts, unextracted residues, NaOH traps were quantified

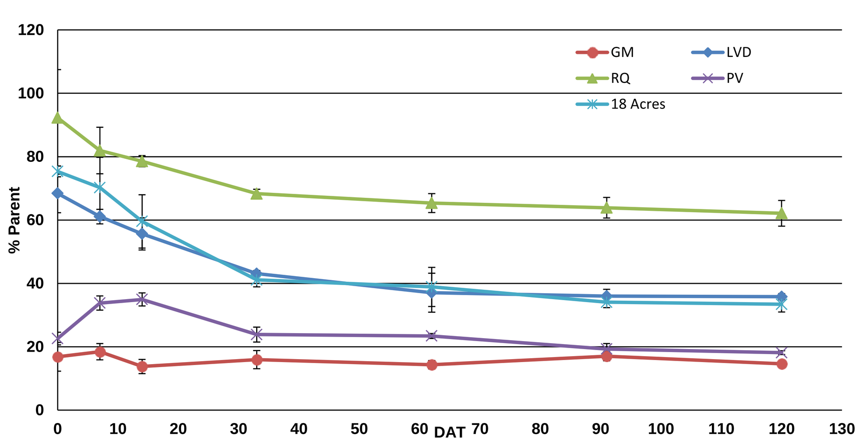


Fig. 3: Graph showing recovery of Thiabendazole in soil extracts in 4 Brazilian soils; Gleissolo (GM), Latossolo (LVD), Neossolo (RQ), Argissolo (PV) and one temperate soil (18 Acres)

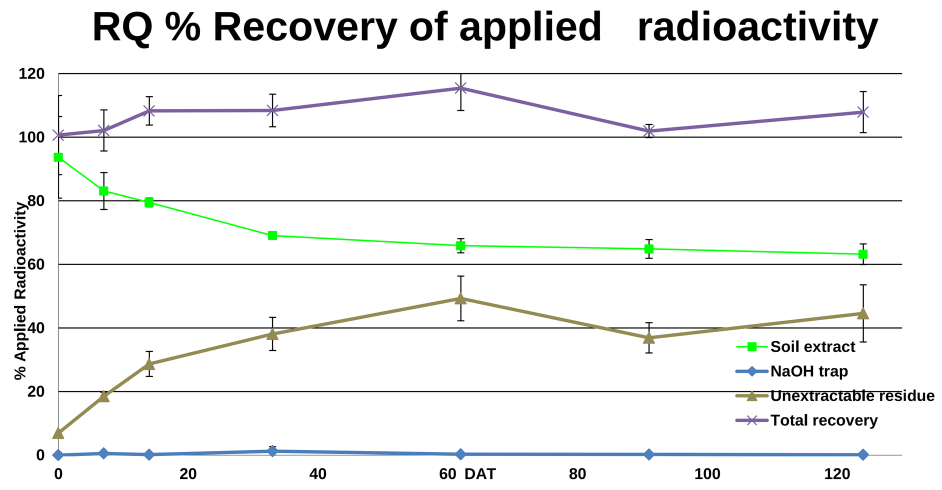


Fig. 4: Distribution of total recovered radioactivity over time
Shown as % AR in soil extract, CO_2 and the unextracted residue for Brazilian Neossolo soil (RQ)

Mobility Study

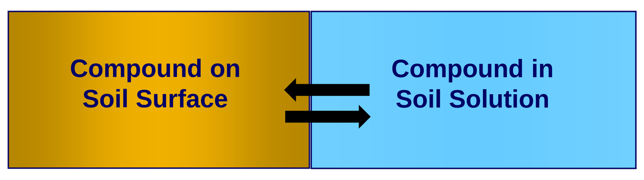


Fig. 5: K_d is the soil-water partition coefficient, it is measured by quantifying the distribution of chemical between the concentration sorbed to soil and the concentration in the aqueous phase

K_{oc}	Mobility class
0-50	Very high
50-150	High
150-500	Medium
500-2000	Low
2000-5000	Slight
>5000	Immobile

Fig. 6: Kd values give an indication of the propensity of a compound to move in soil, Kd values are often normalised by the organic matter content of the soil (Koc)

Soils	Ads K_d	Ads K_{oc}	Des K_d	Des K_{oc}
GM	373	3299	750	6634
LVD	96	3256	255	8636
RQ	9	1036	19	2234
PV	405	13962	769	26529
18 Acres	65	2238	105	3622

Fig. 7: The table shows adsorption partition coefficient and desorption partition coefficient for GM, LVD, RQ, PV and 18 Acres soils

Desorption Study

- Systems contain 1g soil, 2 ml water, 3mL ethylhexanol
- ^{14}C Thiabendazole was applied to soils at 20 µg ai/g and aliquots taken on 0.04, 0.13, 1, 3, 7 and 14 DAT from the ethylhexanol layer. Aliquots were analysed by LSC

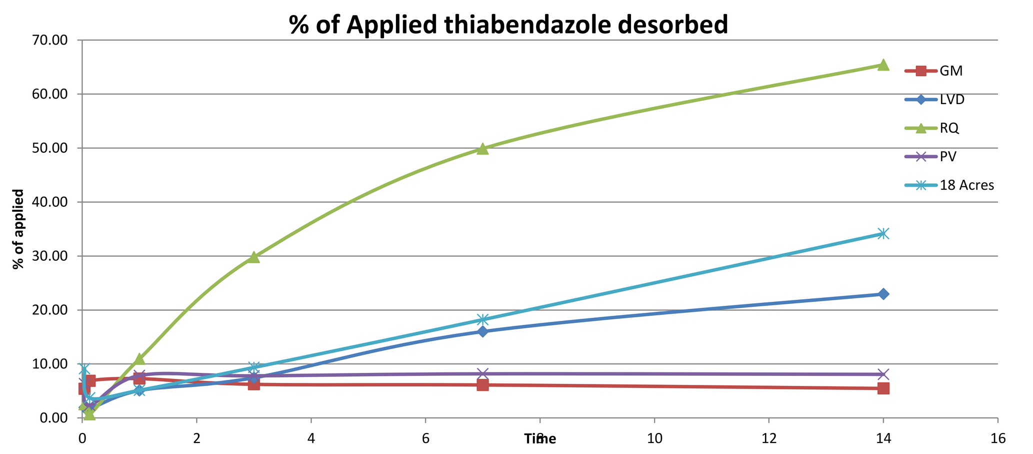


Fig. 8: % of thiabendazole released in the organic layer

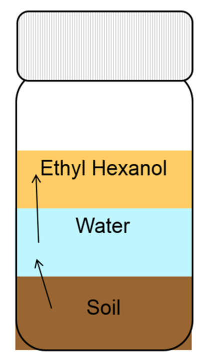


Fig.9: **3 phase experiment**
The compound desorbs from the soil and moves into the water layer. Then it is taken up by the solvent sink layer. The sink continuously pulls compound out of the water layer allowing more to desorb from the soil

Conclusions

- The decline of Thiabendazole over time was due to Thiabendazole binding to soil rather than degradation ie Dissipation. Therefore, Thiabendazole was less available in the pore water over time
  - HPLC analysis of soil extracts up to 120 DAT revealed that 100% of the extracted radioactivity constituted unaltered parent compound (Fig 3,4)

AND

  - No radioactivity was found in the NaOH traps (no Thiabendazole mineralization)

Therefore there had been no breakdown of Thiabendazole by 120 DAT

- Clear differences in the behaviour of Thiabendazole in soil were observed between the different soils
- Adsorption K_d are in increasing order 9 (RQ), 65 (18 acres), 96 (LVD), 373 (GM) and 405 (PV) and % of recovery at 120 DAT 62.1% (RQ), 33.8% (LVD), 33.4% (18 Acres), 18.1% (GM) and 14,6% (GM)
- These differences in mobility and dissipation may reflect differences in physico-chemical properties such as clay content, organic matter content, pH and cation exchange capacity

Future Work

- Calculation of Thiabendazole DissT50 and comparison with K_d
- Further studies of the degradation and adsorption characteristics across a range of model compounds
- Interrogation the combined soil physico-chemical properties and compound fate data for any correlations
- Microbial community structure analysis: comparison of microbial communities in different Brazilian soils, differences between Brazilian soils and temperate soils, and correlations with the soil physico-chemical properties

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[2] Food and Agriculture Organization of the United Stated. 2004. Fertiliser use by Crop in Brazil. www.fao.org