Increase sorption endosulfan by soil amendments and its effects on retention and leaching from soil

Mostafa Chorom[A] and Shazad Shrifi[B]

[A, B]Soil Science dept., University of Shaid Chamran, Ahvaz, Khuzstan, Iran
mchorom@yahoo.com

Abstract
Sorption of pesticides to substrates used in biopurification systems is an important control on the system's efficiency. Ideally, pesticide sorption should occur fast so that leaching of the pesticide in the biopurification system is minimized. This study investigated the sorption and leaching of endosulfan on substrates commonly used in a biopurification system, i.e. manure, sugar cane compost and clay loam soil. The distribution of endosulfan along the soil profile, obtained from soil column experiments, indicated that the amount endosulfan retained ranged from 68.4% for the column filled with the original soil to 92.4% for that filled with the organic amended soil. Amounts of endosulfan recovered in the leachates, which ranged from 7.7% (organic amended soil) to 23.7% (unammended soil) of that applied, depended upon the loading rate and the source of organic amendment. Organic amendments significantly reduced the leaching of endosulfan and compost amended soil showed a higher potential than manure. It can be concluded that organic amendment may be an effective management practice for controlling pesticide movement. In fact, organic matter with strongly adsorbing sites can prevent endosulfan movement.

Key Words
Biopurification, Endosulfan, soil amendments, sorption, leaching.

Introduction
Endosulfan is a chlorinated pesticide of the cyclodiene group. It is being used extensively throughout the world for the control of numerous insects in a variety of food and non-food crops. It is extremely toxic to fish and aquatic invertebrates, and is a priority pollutant for international environmental agencies. It has also been detected in the atmosphere, soils, sediments, estuaries, surface and rain waters, and food stuffs. As endosulfan is found in ground waters, it is apparent that there is significant mobility of these chemicals through the soil (Kumar *et al*. 2006). The displacement of pesticides from soil to water strongly depends on the extent to which they are retained in soils, which in turn depends on the adsorption and desorption properties of the soil (Si *et al*. 2006). A possible approach to reduce the direct contamination of water bodies by pesticides using on-farm biopurification systems. The matrix in a biopurification system is composed of a material with a good porosity retaining water and air (e.g. soil, peat, green waste compost), an easily degradable organic material as the source of nutrients. Knowledge of the pesticide adsorption characteristics of soil is necessary for predicting their mobility and fate in soil environments and also to understand whether bioremediation is a feasible option for the clean up of contaminated soil. It has not been studied in detail for endosulfan which is the most commonly used pesticide in Iran. The objectives of the study were 1-Adsorption of endosulfan by soil with sugar cane compost and manure 2-Leaching of endosulfan by soil with Sugarcane compost and manure.

Methods
The soil chosen for this study was collected from the surface of Ahvaz agricultural college field, air-dried, and passed through 2-mm sieve. The composition of the soil was: sand 22.5%, silt 38.3%, clay 39.2%, and organic matter 0.63%, cation exchange capacity (CEC) 17.39 cmol kg^{-1}, pH (1:1, H2O) 7.41. Soil columns treatments were prepared by adding organic amendments in 2 levels of 0, 50 T/h equivalent to field application. The organic amendments manure and sugar cane compost were used. The samples of the amended soil so obtained were analyzed for organic carbon (OC), pH, and cation exchange capacity (CEC) and some chemico-physical soil properties. Irrigation was performance according two pore volume of distil water; the leachate from each column was collected for 8 weeks. The concentrated extract was analyzed for endosulfan by GC-ECD. The adsorption experiments were carried out as follows: endosulfan solutions containing initial pesticide concentration (C0) between 2 mg/L and 4 mg/L were prepared. Spiked soil samples were prepared by adding 25 mL of each endosulfan solutions to 10 g of each soil sample. Then, 10 ml of acetone was added and suspension was mixed for 30 min with a mechanical shaker. After the bulk of

the solvent was evaporated at room temperature, the sample was stored at 4 ºC in stopper conical flask for 3 day. Then, the extractions were carried out and the amount of extracted endosulfan was determined by GC-ECD.

Results

Adsorption isotherms of endosulfan on soil and manure and sugarcane compost amended soil are shown in Figure 1. The adsorption data are fitted to the Freundlich equation: Cs= $K_f C_e^n$. Where Cs (mg/kg) is the amount of endosulfan adsorbed, Ce (mg/L) is the equilibrium concentration in solution, and K_f and n are empirical constants which are presented in Table1. Adsorption capacity (K_f) values range from 4.36 for the original soil to 5.74 for compost amended soils. In Table 1, the Kd values which have been calculated from the fit of the experimental sorption isotherms ($Cs=K_dC_e$) are presented. The K_{OC} constants are calculated for the herbicide and the soils studied [KOC= (K_d/OC %) ×100]. K_{OC} values of sugarcane compost is higher than of manure amended soil (Table 1). Similar results were obtained by Barriuso *et al.* (1997) for eight pesticides in freshly amended soil, and by Sluszny *et al.* (1999), for three pesticides in freshly amended and incubated soils.

Table 1-Parameters of the Freundlich equation, Kd, and K_{OC} values for endosulfan in soil, manure, sugarcane compost

Sorbent	OC%	K_f	n	r	K_d	r	K_{OC}
Soil control	0.63	4.36	0.76	0.971	1.98	0.935	314
Sugarcane compost	1.22	5.23	0.72	0.991	2.42	0.992	198
Manure	1.38	5.74	0.73	0.992	2.44	0.983	180

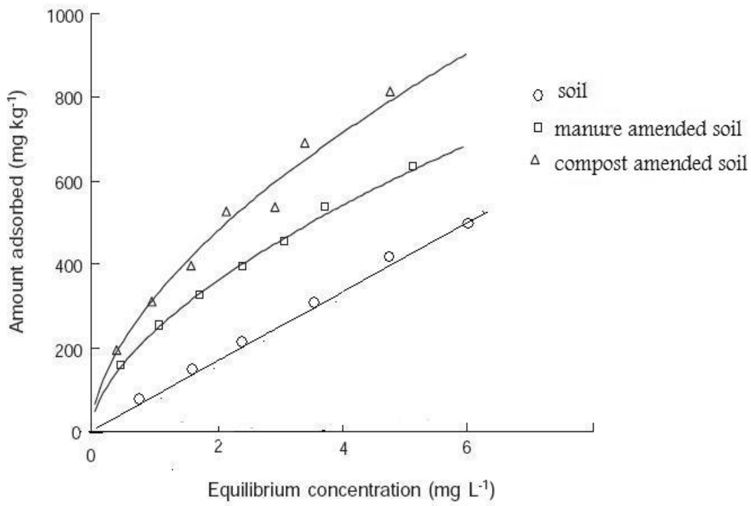

Figure 1. Adsorption isotherm of endosulfan on soil, manure and sugar cane compost amended soil.

The amount of endosulfan retained range from 34.5% for the original soil to 72.4% for sugarcane compost amended soil (Figure 2).Recoveries of endosulfan in leachate range from 23.7% from the soil without amendment to 7.7% from the soil amended with sugarcane compost soil. The amount of endosulfan in leachate decreases with the increase sugarcane compost addition to soil. Similar results are obtained from the soil amended with manure (Figure 2). For organic amended treatments, most of the residual endosulfan is retained in the upper soil column after leaching. In Figure 2, it can also be seen that the highest recovery efficiencies of endosulfan are obtained in the first 15 cm of the column for sugar cane amended soil and15 cm of column for manure amended soils. This result may be attributed to stronger adsorption by sugarcane compost than by manure.

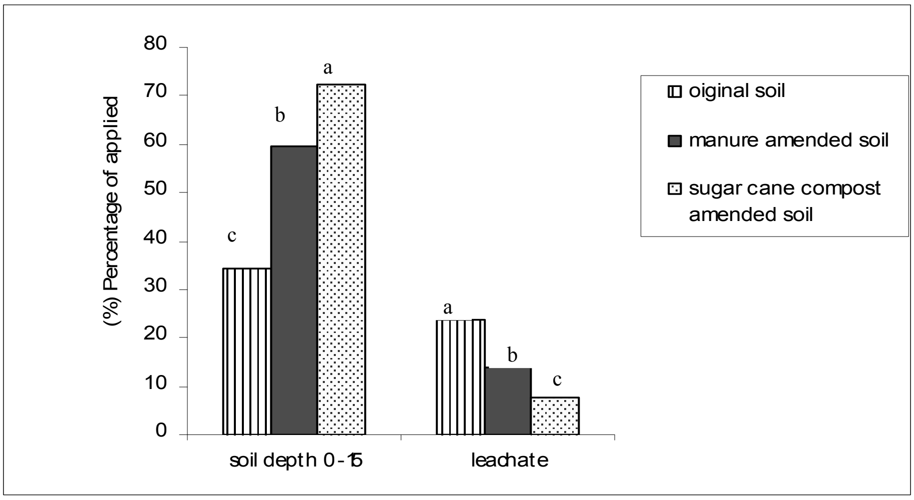

Figure 2. Distribution of endosulfan in the columns filled with original soil, sugar cane compost amended soil and manure amended soil and in leachate.

Conclusion

The results showed that the effects of sugar cane compost and manure addition to soil increase endosulfan adsorption, due to the high adsorption capacity of the added organic matter. Organic amendments effectively reduced endosulfan movement in the soil. The reduction in leaching is achieved through increases in sorption. Manipulation of sorption potential in the soils relatively poor in organic matter by amendment with C-rich waste may be an effective management practice for controlling pesticide movement.

Reference

Barriuso E, Houot S, Serra-wittling C (1997) Influence of compost addition to soil on the behavior of herbicides. *Pesticide Science* **49,** 65–75.

Kumar M, Philip L (2006) Adsorption and desorption characteristics of hydrophobic pesticide endosulfan in four Indian soils. *Journal of Chemosphere* **62,** 1064–1077.

Si Y, Zhang J, Wang S, Zhang L, Zhou D (2006) Influence of organic amendment on the adsorption and leaching of ethametsulfuron-methyl in acidic soils in China. *Geoderma* **130,** 66– 76.

Sluszny C, Graber ER, Gerstl Z (1999) Sorption of s-triazine herbicides in organic matter amended soils: fresh and incubated systems. *Water, Air and Soil Pollution* **115,** 395–410.