



REMOVAL OF PESTICIDES BY PINE AND OAK WOOD SORPTION

M.S. Rodríguez-Cruz, M.S. Andrades*, M.J. Sánchez-Martín, M. Sánchez-Camazano

Instituto de Recursos Naturales y Agrobiología, CSIC, Apdo. 257, 37071 Salamanca, Spain

* Dpto. Agricultura y Alimentación. Universidad de La Rioja. Madre de Dios, 51. 26006 Logroño, Spain



INTRODUCTION

The presence of pesticides and other organic contaminants in water is becoming more and more frequent and it has given rise to many studies about use of conventional sorbents (natural clays, peat, active carbon...) to remove these compounds from water, as well as the finding of new materials to protect soil and water of contamination by these compounds. Wood waste is a material with a low cost and although it has been scarcely considered as sorbent, it could be a potential sorbent of hydrophobic pesticides due to its lignin content (hydrophobic component of wood).

OBJECTIVE

The objective of this work was to know the influence of wood wastes on the sorption of pesticides by soils. Two kinds of wastes were used, which were obtained from pine and oak wood. Sorption studies of five pesticides with different hydrophobicity, chlorpyrifos, linuron, alachlor, metalaxyl and dicamba, by sawdust samples (<1 mm) from two wood wastes and sorption-desorption studies of linuron, alachlor and metalaxyl by two soils, natural and amended by both sawdust samples at two doses of 5% (D1) and 50% (D2), were carried out. Influence of incubation time of amended soils was also studied.

CHARACTERISTICS OF WOOD SAMPLES USED

Sample	Humidity %	Ash %	Total C %	Soluble C %	Lignin %	Surface m ² g ⁻¹
Pine	6.4	0.2	41.6	0.67	24.4	<1
Oak	5.9	0.4	38.5	2.64	18.2	<1

CHARACTERISTICS OF THE NATURAL SOILS USED

Soil	pH	OM (%)	Sand (%)	Silt (%)	Clay (%)
S1	7.5	0.85	74.5	13.6	11.8
S2	6.9	1.79	56.1	5.80	38.1

MATERIALS AND METHODS

PESTICIDE CHARACTERISTICS

Name	Water solubility (mg / L)	Log Kow	Concentration range used (µg / mL)	Analytical determination
¹⁴ C-Linuron	81	3.00	1 - 25	LSC ^a
¹⁴ C-Alachlor	240	2.63	1 - 25	LSC ^a
¹⁴ C-Metalaxyl	8400	1.75	1 - 25	LSC ^b
Chlorpyrifos	2	4.70	0.2 - 1	HPLC-MS ^b
Dicamba	6500	-0.55	50 - 250	HPLC-MS ^b

a, Liquid Scintillation Counting; b, High Performance Liquid Chromatography coupled to a mass spectrometer

PREPARATION OF SOILS

•Soils S1 and S2 were amended with pine and oak sawdust (< 1 mm) at two doses: D1 = 5% equivalent at 40 t C/ha and D2 = 50% equivalent at 400 t C/ha.
•Soils amended with D1 were incubated during 5 months at 20°C and 60% of water holding capacity.

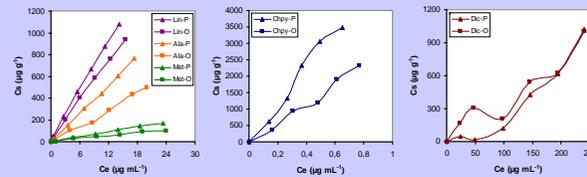
ADSORPTION-DESORPTION EXPERIMENTS

•Wood sawdust / Pesticide solution ratio:
1:100 (linuron, metalaxyl, alachlor and dicamba)
1:10000 (chlorpyrifos)
•Soil / Pesticide solution ratio: 1:10
•Treatment conditions: 24 h at 20°C
•Desorption process was from initial concentration of 25 µg/mL. Desorption cycles were repeated four times by replacing 50% of equilibrium solution.

RESULTS

PESTICIDE ADSORPTION BY WOOD SAMPLES

ADSORPTION ISOTHERMS OF PESTICIDES BY PINE (P) AND OAK (O) WOOD SAWDUST



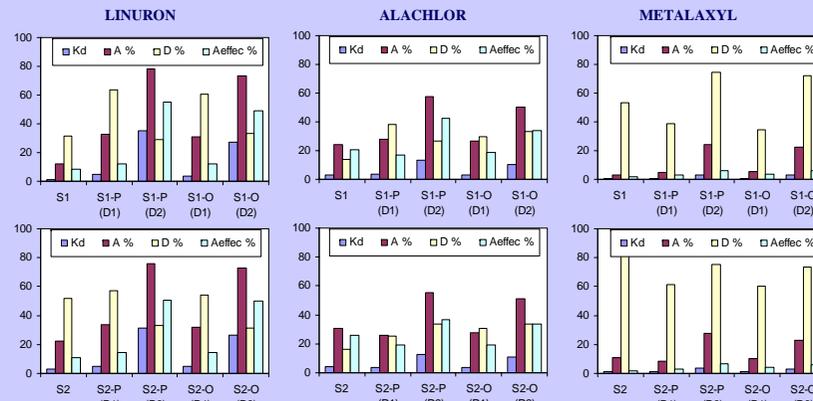
FREUNDLICH ADSORPTION CONSTANT (Kf, nf) AND ADSORBED AMOUNT (A %)

Pesticide	PINE WOOD			OAK WOOD		
	Kf	nf	A %	Kf	nf	A %
Linuron (Lin)	96.2	1.00	43.4	74.4	0.93	37.7
Alachlor (Ala)	41.4	1.02	30.6	22.4	1.03	20.0
Metalaxyl (Met)	8.28	0.99	6.81	4.95	0.98	3.95
Chlorpyrifos (Chpy)	6559	1.18	34.8	3176	1.15	23.4
Dicamba (Dic)	0.53	1.32	40.8	1.78	1.12	40.1

PESTICIDE ADSORPTION BY SOILS AMENDED WITH PINE AND OAK WOOD SAWDUST

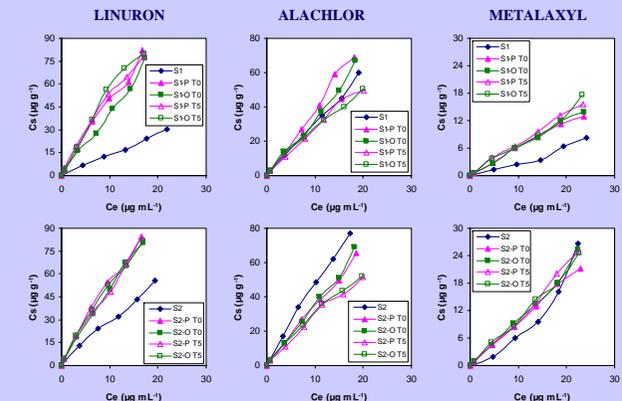
INFLUENCE OF THE WOOD DOSE ADDED

Kd, distribution coefficient; A%, sorbed amount; D%, desorbed amount; Aeffec%, sorbed amount after desorption



INFLUENCE OF INCUBATION TIME OF THE AMENDED SOILS

(T0 = 0 months and T5 = 5 months)



DISCUSSION AND CONCLUSIONS

Sorption isotherms of the pesticides studied by pine and oak wood were linear (linuron, alachlor and metalaxyl), type C (chlorpyrifos), and type S (dicamba) in the range of concentrations used.

Freundlich constants Kf were higher for the sorption of pesticides by pine wood than those by oak wood, indicating the possible relationship of these constants with the wood lignin content.

A linear relationship (r>0.99) between Kf constants and pesticide Kow values was obtained, indicating the influence of the pesticide hydrophobicity on the sorption of these compounds by wood wastes.

Distribution coefficients of pesticides in soils amended with wood residues for a initial concentration of 25 µg/mL, increased 1.66-3.14 times (D1) and 9.26-25.5 times (D2) for linuron, 0.79-1.21 times (D1) and 2.37-4.27 times (D2) for alachlor, and 0.78-1.60 times (D1) and 2.48-9.35 times (D2) for metalaxyl comparing with those in natural soils. Sorption of pesticides was higher by pine amended soils than by oak amended soils and sorption was also higher by amended sandy soil than by amended clayey soil.

Sorbed amounts by soils amended with the high dose of wood were >70% for linuron, >50% for alachlor and >20% for metalaxyl.

Effective sorbed amounts (after desorption) by soils amended (doses D1 and D2) were always higher than by natural soils for linuron and metalaxyl, and for alachlor were only higher than in natural soils when soils were amended with a high wood dose.

Sorption isotherms of pesticides by soils S1 and S2 amended with the low dose of wood (D1) indicated an increase in the sorption coefficients for linuron and metalaxyl after an incubation time of 5 months. This increase was lower for S2. Sorption of alachlor by both amended soils decreased after this incubation time.

Results indicate the influence of characteristics of pesticides and properties of soils on the sorption of these compounds by soils amended with wood residues. Interaction of wood soluble components with soil and its evolution with the time will be an important factor to take into account when these wastes are used as potential sorbents of pesticides.