MOBILITY OF FUNGICIDES IN UNDISTURBED VINEYARD SOIL COLUMNS: EFFECT OF SOIL AMENDMENT AND AGING ON THIS PROCESS

Marín-Benito, J.M.[1]; Rodríguez-Cruz, M.S.[1]; Andrades, M.S.[2]; Sánchez-Martín, M.J.[1]

[1] Institute of Natural Resources and Agrobiology (IRNASA), CSIC. P.O. Box 257, 37071 Salamanca, Spain
[2] Agriculture and Food Department. University of La Rioja, 51 Madre de Dios, 26006. Logroño, Spain

INTRODUCTION

Mushroom farming is looking for environmental, agricultural and industrial uses for spent mushroom substrates (SMS) generated on the farm in increasing quantities. In La Rioja region (NW Spain), production of mushroom represents the second major activity after vineyard farming. This organic waste, owing to its high organic matter (OM) content and availability of essential plant nutrients, could be exploited as a soil fertilizer and amendment to increase the OM contents of vineyard soils in this region, which generally are low. However, the SMS contains high amount of solid and liquid OM, which could modify the dynamics (adsorption, mobility and degradation) of fungicides widely applied in vineyard soils with implications on their persistence in soil and transport to groundwater.

OBJECTIVE

The aim of this work was to study the mobility of the fungicides, metalaxyl and penconazole, with different characteristics, in three unamended and amended with fresh or composted SMS vineyard soils using undisturbed soil cores. Experiments were performed under non-saturated flow conditions in non-incubated and incubated soil cores to study the influence of aging on the mobility of fungicides.

MATERIALS

SPENT MUSHROOM SUBSTRATE

•Crop: *Agaricus bisporus*
•Dose: 25 t/ha
•Characteristics:

-Fresh (F-SMS)
pH = 6.7; 28.8 % OC ; 13.3 % DOC[a]

-Composted (C-SMS)
pH = 7.4; 27.4 % OC ; 4.34 % DOC[a]

[a] Expressed as % of total OC

FUNGICIDES

Penconazole:
•Water solubility = 73 μg mL^{-1}
•log K_{ow} = 3.72

Metalaxyl:
•Water solubility = 8400 μg mL^{-1}
• log K_{ow} = 1.75

Metalaxyl metabolites:
-Metabolite 1: *N*-(2,6-dimethylphenyl)-*N*-(methoxyacetyl)alanine
-Metabolite 2: *N*-methoxyacetyl-2,6-dimethyl-aniline

PHYSICOCHEMICAL CHARACTERISTICS OF UNAMENDED AND AMENDED WITH FRESH (F-SMS) OR COMPOSTED SMS (C-SMS) SOILS

Soil	pH	OM (%)	$CaCO_3$ (%)	Sand (%)	Silt (%)	Clay (%)
AL	7.8	1.04	11.3	64.4	14.2	21.4
AL+C-SMS	7.8	1.41	11.3	59.1	15.2	25.7
AL+F-SMS	7.8	1.46	11.2	56.3	18.3	25.4
SA	7.7	1.74	27.9	57.9	10.5	31.6
SA+C-SMS	7.8	1.74	32.0	51.3	23.3	25.4
SA+F-SMS	7.8	1.81	29.9	54.7	10.4	34.9
V	7.8	2.54	34.6	51.8	13.5	34.7
V+C-SMS	7.7	2.83	30.7	50.5	14.3	35.2
V+F-SMS	7.6	2.96	30.3	48.8	13.9	37.3

METHODS

CORE COLLECTION:
•36 soil cores (40 cm x 9 cm i.d.) in total
•4 soil cores in each site/treatment (3 x 3):
- 2 soil non-incubated cores
- 2 soil incubated cores

PESTICIDE AND TRACER ION APPLICATION:
•10 mg of each fungicide (concentration close to 2.5 mg/kg)
•250 mg of tracer ion (KCl)

LEACHING EXPERIMENT:
•Leaching beginning:
-Non-incubated columns: 24h after adding the fungicides
-Incubated columns: 77 days after adding the fungicides

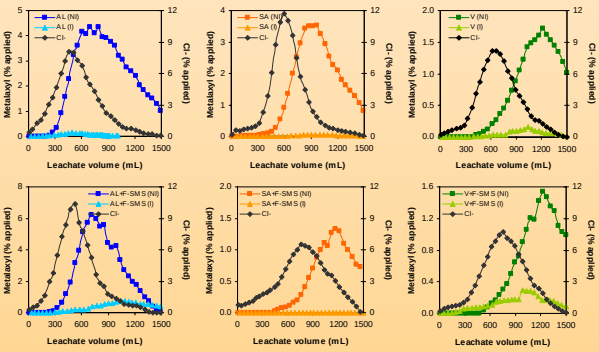
•Conditions:
-Adding 50 mL of water every day (Total water=1500 mL)
-Unsaturated flow

•Determination in the leachates:
-Fungicides and metalaxyl metabolites: HPLC-DAD-MS
-Tracer ion (Cl^-): Ion Chromatograph

EXTRACTION EXPERIMENT:
•Cutting into 5 segments each soil core (8 cm intervals)
•Shaking 5 g soil + 10 mL MeOH at 20ºC for 24 h
•Determination of fungicides and metalaxyl metabolites in the soil extracts : HPLC-DAD-MS

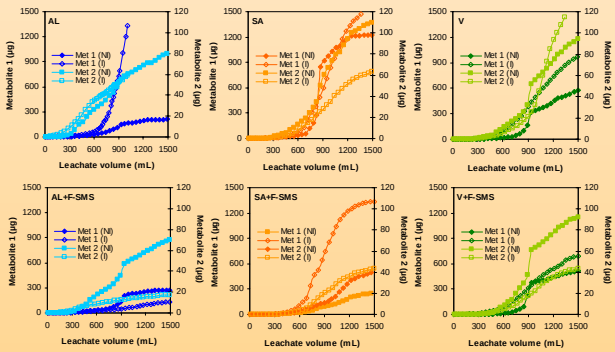
RESULTS

BREAKTHROUGH CURVES FOR METALAXYL AND THE ION CHLORIDE LEACHING IN NON-INCUBATED (NI) AND INCUBATED (I) SOILS (AL, SA, V) UNAMENDED OR AMENDED WITH F-SMS



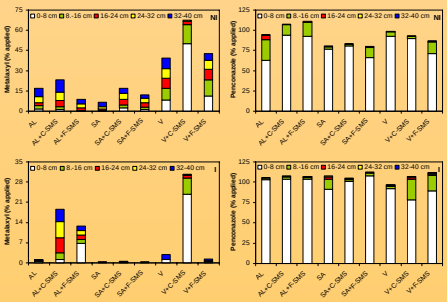
NON-INCUBATED CORES

CUMULATIVE CURVES FOR METALAXYL METABOLITES LEACHING IN NON-INCUBATED (NI) AND INCUBATED (I) SOILS (AL, SA, V) UNAMENDED OR AMENDED WITH F-SMS



INCUBATED CORES

AMOUNTS OF METALAXYL AND PENCONAZOLE RETAINED IN NON-INCUBATED (NI) AND INCUBATED (I) SOILS (AL, SA, V) UNAMENDED OR AMENDED WITH C-SMS OR F-SMS



PARAMETERS OF SOIL CORES, ADSORPTION CONSTANTS (Kf) AND RETARDATION FACTORS (R) FOR FUNGICIDES IN UNAMENDED AND F-SMS OR C-SMS SOILS

core	PV (mL)	ρ (g cm^{-3})	Θ (cm^3 cm^{-3})	Metalaxyl		Penconazole
				Kf	R	Kf
AL	435	1.408	0.171	0.26	3.14	4.33
AL+C-SMS	527	1.395	0.207	0.29	2.95	5.19
AL+F-SMS	465	1.456	0.183	0.34	3.71	10.2
SA	310	1.337	0.122	0.36	4.95	7.72
SA+C-SMS	385	1.359	0.151	0.47	5.22	5.72
SA+F-SMS	355	1.403	0.140	0.40	5.01	8.27
V	650	1.184	0.256	0.54	3.50	8.44
V+C-SMS	600	1.007	0.235	0.67	3.86	13.4
V+F-SMS	510	1.200	0.200	0.60	4.59	10.4

CONCLUSION

Results from this study highlight the influence of the SMS amendment and aging time on the leaching of two fungicides with different hydrophobic character. Understanding of fungicides leaching in soils amended with SMS is important and allows assessment of the potential risk of ground and surface water contamination. Effect of SMS on pesticide leaching could contribute to prevent groundwater contamination by metalaxyl, but it could contribute to increase the surface water contamination by penconazole, since adsorption protects this fungicide from degradation, increasing its persistence in soils.

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