SPATIAL VARIABILITY OF MECOPROP-P BIODEGRADATION IN SUBSOIL AND TOPSOIL

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INTRODUCTION

- Studies on pesticide biodegradation in topsoils are commonly available, but less information is available on microbial processes involved in pesticide transformation in subsoils.
- The understanding of degradation kinetics of pesticides under the conditions found in subsoil is necessary to estimate the implications of the use of these compounds for groundwater contamination.
- Mecoprop-p is widely used in agriculture and poses environmental concern because its high mobility and susceptibility to leaching from soil to water.
- The objective of this study was to compare the scale of spatial variability in the biodegradation of mecoprop-p in topsoil and subsoil and the extent to which variation is controlled by the distribution of the specific organisms and genes contributing to catabolism.

MATERIALS AND METHODS

- Samples were collected from Long Close field, Wellesbourne, UK, which had not received mecoprop for at least 10 years. 20 samples were collected from 0-15 and 50-60 cm depth from a 160 x 80 m portion of the field, using grid sampling. In a further experiment, samples were collected from 5 depths between 0 and 80 cm at 3 separate locations within the field.
- Mecoprop-p was applied at 5 mg kg^{-1} soil and soils were incubated at 15 ºC and –33 kPa.
- Genstat software was used to calculate the model of best fit to the degradation kinetics, to obtain time to 50% degradation (DT_{50}) and the length of lag phase prior to exponential degradation. The number of mecoprop-p catabolising organisms was estimated by Most Probable Number (MPN) analysis, and the number of tfdA genes by real time PCR.

RESULTS

Fig 1. Kinetics of mecoprop-p degradation in the fastest (◆), slowest (■) and average (▲) of 20 topsoil (0-15 cm) and 20 subsoil (50-60 cm) samples. Bars represent ± standard error of the mean.

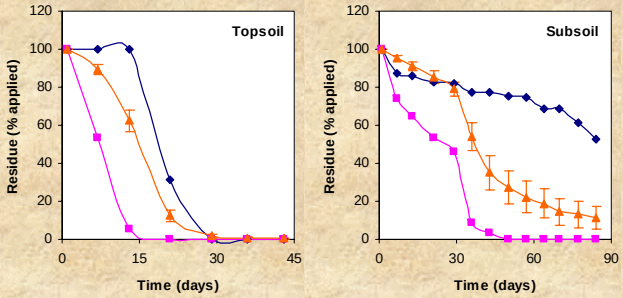

Table 1. DT_{50} (days) values of mecoprop-p in topsoil (0-15 cm) and subsoil (50-60 cm) samples

	Topsoil DT_{50}				Subsoil DT_{50}			
Sample	A	B	C	D	A	B	C	D
1	18.92	18.48	14.50	16.97	63.4	113.9	38.45	23.82
2	10.85	14.13	17.20	19.11	27.87	47.74	nd	nd
3	15.90	15.54	17.54	15.37	32.14	36.43	35.57	23.36
4	14.34	11.23	19.66	15.92	28.09	31.2	37.83	40.38
5	12.52	10.01	13.62	7.383	30.64	63.46	51.67	35.35
Av	15.0				42.3			
CV(%)	22.1				50.6			

nd, no degradation

Table 2. Microbial and mecoprop-p degradation characteristics of topsoil and subsoil samples (average of 3 samples at each depth)

Soil depth	Biomass (mg C kg^{-1})	Lag phase (days)	DT_{50} (days)	Log MPN (g dw^{-1} soil) (at DT_{100})	tfdA copy number (at DT_{100})
0-10 cm	65.5	-	12.3	5.24	76590.5
20-30 cm	64.5	-	12.7	6.05	47368.9
40-50 cm	36.4	28.0	30.8	5.81	70800.0
60-70 cm	21.5	23.3	61.5	4.03	67155.6
70-80 cm	19.1	33.4	83.6	4.68	51244.4

MPN of degraders at time 0 <100 g dw^{-1} soil; tfdA copy number at time 0 <400 g dw^{-1} soil

CONCLUSIONS

- Degradation was faster in topsoil (DT_{50} = 7.4 to 19.7 days) relative to subsoil (DT_{50} = 27.9 to 114 days).
- The coefficient of variation (CV) for mecoprop DT_{50} was 22.1 % in topsoil and 50.6 % in subsoil, indicating far greater variability in subsoil.
- The variability was shown to arise from a greater range of degradation kinetics in subsoil relative to topsoil.
- Degradation of mecoprop was shown to be associated with proliferation of tfdA genes. However, neither the number of tfdA genes nor the Most Probable Number of mecoprop degrading organisms in soil prior to or following degradation could account for the variability in DT_{50} rates.

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