RELEASE OF P AND SUSPENDED SOLIDS TO ASSESS THE REAL RISK OF EUTROPHICATION

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INTRODUCTION

In over fertilized ecosystems P losses from soil to waters occur especially via runoff and as particulate P. Aim of this work is to evaluate the effect of agronomic management on particulate P losses and to assess the real risk of eutrophication determined by the P enriched particles that could reach waters from a middle term field experiment.

MATERIALS AND METHODS

The field experiment is based on two maize cropping systems (maize for grain, MG, and maize for silage, MS) with application of mineral fertilizers (NPK and PK) and organic fertilizers (slurry, S, and manure, M) since 1992. The system is based on N control, thus S and M have an unbalanced N/P ratio compared to crop needs. To obtain the suspended solids from soil, a water dispersion test was applied and the different P forms characterized. On soil and on suspended solids the degree of P saturation, the Hedley P fractionation and isotopic techniques were applied to estimate the P availability and thus the risk of P losses in the short and long-term.

RESULTS

Intensive P addition, mineral vs organic, and unbalanced nutrient ratio caused important modifications on soil dispersibility, P cycling and then P mobilization.

	TSS	TP	Ca	C	Fe_{ox}	PER	CER	ζ
	g L^{-1}	mg kg^{-1}		g kg^{-1}				mV
NPK	1.15	1.6	11	15	6.4	1.6	1.3	-27
PK	1.07	1.7	9	16	5.3	1.6	1.4	-20
S	0.89	1.8	13	18	4.2	1.7	1.4	-18
M	0.96	2.2	12	20	3.9	1.8	1.5	-16

Mineral vs organic fertilization strongly modified the P biogeochemical processes which drive P build-up and mobilization in both MG and MS systems. The M soil presented a lower dispersibility, related to the aggregating effect of organic material, but the dispersed particles were more P enriched (PER).

Syst	Manag	Fert	P balance	Total P	Olsen P	OM	TOC/TN
			kg ha^{-1} y^{-1}	mg kg^{-1}		g kg^{-1}	
MG	Min	NPK	30^{b}	1015^{b}	22.3^{b}	19.4^{b}	10
		PK	37^{b}	1031^{b}	11.3^{b}	19.7^{b}	10
	Min mean		***33***	***1023***	***16.8***	***19.5***	***10***
	Org	S	85^{ab}	1087^{ab}	23.6^{ab}	24.4^{a}	11
		M	109^{a}	1167^{a}	52.3^{a}	22.9^{a}	10
	Org mean		***97***	***1135***	***38.0***	***23.6***	***10***
	MG mean		***65***	***1074***	***27.4***	***21.6***	***10***
MS	Min	NPK	16^{b}	827^{b}	20.2^{b}	16.7^{b}	10
		PK	22^{b}	882^{b}	5.0^{b}	17.8^{b}	10
	Min mean		***19***	***855***	***12.6***	***17.3***	***10***
	Org	S	66^{ab}	909^{ab}	26.2^{ab}	22.8^{a}	11
		M	87^{a}	1047^{a}	42.9^{a}	19.5^{a}	11
	Org mean		***76***	***978***	***34.6***	***21.5***	***11***
	MS mean		**48**	**916**	**23.6**	**19.2**	**10**

	$[^{31}P]$		$^{33}P_{(1)}/^{33}P_{(o)}$		*exchanged P*	
	soil	TSS	soil	TSS	soil	TSS
	mg L^{-1}				mg kg^{-1}	
NPK	0.11^{c}	0.06^{c}	0.42^{c}	0.73^{b}	2.89^{c}	146^{c}
PK	0.70^{b}	0.24^{b}	0.57^{b}	0.69^{b}	11.8^{b}	351^{b}
S	0.63^{b}	0.23^{b}	0.56^{b}	0.88^{c}	10.7^{b}	323^{b}
M	3.25^{a}	0.57^{a}	0.73^{a}	0.38^{a}	43.5^{a}	2688^{a}

$[^{31}P]$ concentration of phosphate ions in solution
$^{33}P_{(1)}/^{33}P_{(0)}$ radioactivity after 1 minute/total introduced radioactivity ratio
exchanged P, amount of P isotopically exchanged within 1 minute

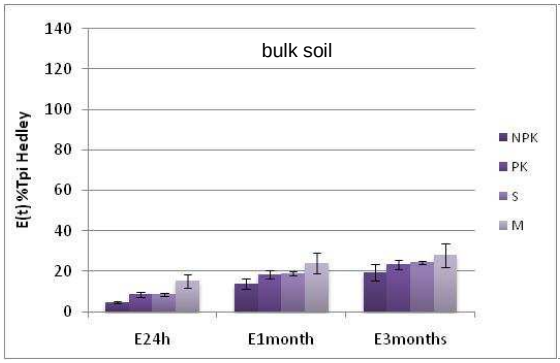
In the organic plots, P isotopically exchanged derived mostly from P already present in the soil solution and followed a fast reaction kinetics.

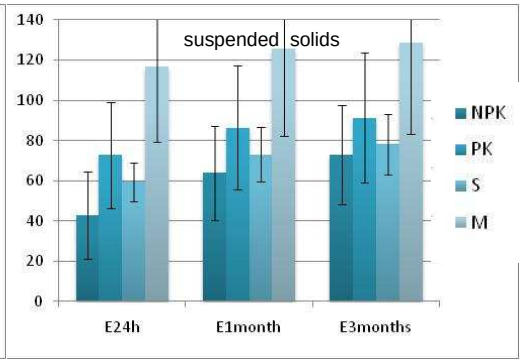
In the manured plot, bulk soil exchanged less P, but not the suspended solids where a quite larger P exchangeability occurred in the short time, involving also more non-labile forms.

The dispersed solids from slurried or PK systems had a similar behaviour, while in those from NPK system the P exchangeability involved only the more labile P forms, also in the longer term.

$$E(t) = \frac{a * [^{31}P]}{^{33}P_{(t)}/^{33}P_{(0)}}$$

$$E(t)\%\ T_p\text{inorganic Hedley} = \frac{E(t)}{\Sigma\ (\text{resin-P; } NaHCO_3\text{-P; NaOH-P; HCl-P})}$$





CONCLUSIONS

The key factors acting in P mobilization are related to fertilization management. In the manured plots and, to less extent, in the slurried ones, the contrasting effect of dispersion/aggregation processes resulted in minor losses of particulate P than those expected from the P increase and high Olsen P, but the risk of eutrophication is higher as the amount of P that becomes available rather than total amount reaching the water bodies, is much greater in the M than in the other plots.