Impact of long-term application of urban composts on soil organic and inorganic phosphorus dynamics

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Introduction

- In recent years, use of urban composts as fertilizers or organic amendements has been widespread.
- They represent a significant resource of P for agriculture soils (3.5 to 5.7 g P/kg dw) mainly as inorganic P (InorgP) forms (Cabrera et al., 1991).
- Many studies showed positive effects of urban composts in soils properties and plants P nutrition (Cabrera et al., 1991; Mkhabela et al., 2005; Annabi et al., 2007).
- However, little is known about the impact of their long term application on dynamics of soils organic P (orgP) and inorganic P (inorgP).

Objective

- To investigate the effect of repeated applications of urban composts and manure on the dynamics of soil orgP and inorgP stocks in relation to the P input/output balance at the plot scale.

Materials and Methods

- A long term field experiment (1998-2013) was conducted in Yvelines (France). It was a randomized block with 4 replicates, grown in a corn / wheat succession.
- Five treatments were used: control without P (0P), cattle manure (MANURE) and three urban composts: compost green waste + sludge (GWS), biowaste (BIOW) and municipal solid waste (MSW). Products were applied approximately at 4 t C /ha /2 yrs.
- Soils in plough layer (0-28cm) were sampled before each application. Total P contents were analysed for six dates between 1998-2013 by the HF dissolution method. OrgP was determined by ignition method (Saunders and Williams (SW), 1955) and InorgP = totP-HF - orgP-SW. They were converted to stocks using soil bulk density for each date.
- P in applied products between 1998-2013 (9 application dates) was determined by the same methods.
- P balance (1998-2013) was calculated as : P applied - P export. Cumulative P balance = Σ(P applied)- Σ(P export)

References

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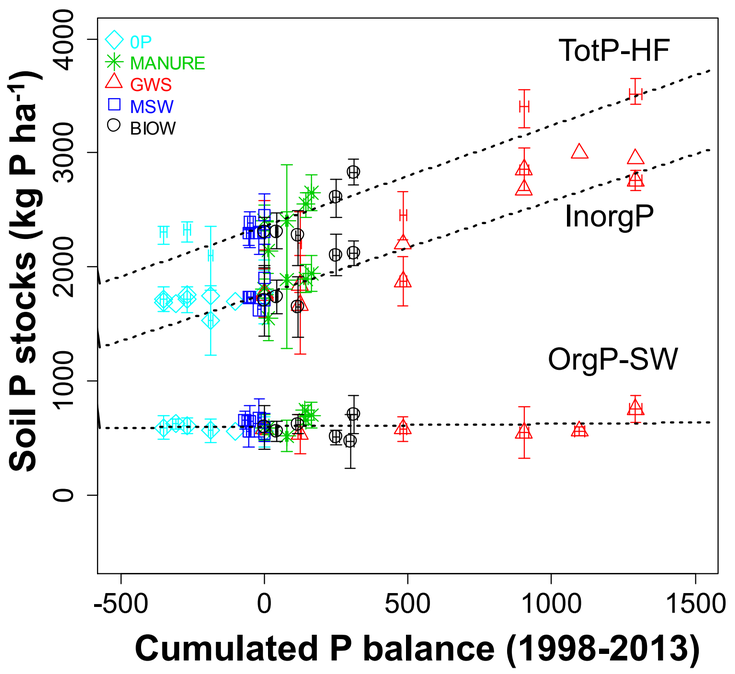
Results and discussion

Characteristics of applied products (means of 9 years)

	TotP-HF g kg^{-1}	inorgP g kg^{-1}	orgP-SW g kg^{-1}
MANURE	5.5 ± 1.1	3.7 ± 0.7	1.9 ± 0.5
GWS	13 ± 3.7	10.4 ± 3.6	2.1 ± 0.7
MSW	3.5 ± 0.8	3.3 ± 0.8	0.3 ± 0.2
BIOW	4.8 ± 1.7	3.9 ± 0.9	0.3 ± 0.2

- P contents varied between organic products. In average, all products mainly contained inorgP (82%) and orgP-SW averaged 18%. This agree with previously studies (Cabrera et al., 1991; Requejo and Eichler-Löbermann, 2014).

Dynamics of soil P stocks (15 years)



Statistics parameters of soil P stocks dynamics

P forms	Intercept	Slope	*P value*	R^2
InorgP	1764	0.82	<0.0001	0.55
PorgP-SW	601	0.02	0.44	0.005
TotP-HF	2358	0.88	<0.0001	0.65

- After 15 years, cumulated P balance is highly positive for the GWS (1292 ± 21 kg P ha^{-1}) than other treatments.
- Considering all treatments, variations of totP-HF stock accounted for 88% (0.88x100) of the P budget. 93% (0.82/0.88 x 100) of these total changes was explained by inorgP stock and only 2 % (0.02/0.88 x 100) by orgP-SW.
- Slope of totP-HF vs bilan is less than 1. This might be due to a significant increase of P content in the firsts cm of soil beneath plowing (Morel, 2002).
- Stock of total orgP-SW was invariant. This might be due to the more stable forms of organic P in the soils, like phytate (Condron et al., 2005) and easlily mineralizable forms in applied products. Moreover, added of urban composts may have no or little influence on the amount of phytate in soils (Requejo and Eichler-Löbermann, 2014).

Conclusions

- Application of composted GWS in soils based in C led to an highly positive cumulated P balance.
- Variations in inorgP and totP stocks reflected differences in P balance.
- Stability of soil orgP-SW in 0P indicated that soil organic P contributed little or not at all to crop phosphate nutrition.