

Dynamics of extractable P in soil after application of manure-derived ashes

Peter Sørensen and Gitte H. Rubæk, Institute of Agroecology and Environment, Aarhus University, Denmark.

E-mail: Peter.sorensen@agrsci.dk



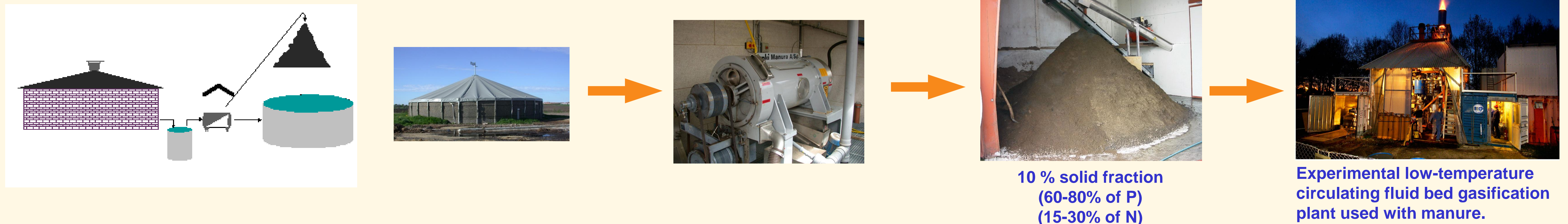
Introduction

It is advantageous to be able to transport the solid manure fraction from slurry separation to areas where plant nutrients P and K are in demand. By combustion or gasification of solid manure energy is produced and P and K is concentrated and therefore easy to transport. However, studies have indicated that the plant availability of P is decreased by the treatment.

Objectives

- To analyse the temporal changes of P availability in soil after application of different manure-derived ashes measured by three soil extraction methods.
- To identify factors that influence the potential plant availability of ash P.

Slurry separation and gasification/combustion of solid manure fraction



Methods

Ash from gasification derived from a fluidised bed reactor where temperature is well controlled about 730 C. Two manures were used: Manure 1 derived from a biogas plant where pig and cattle slurry is co-digested with waste from food industry. A solid fraction of the slurry was separated by centrifugation and dried before gasification. Manure 2 was a dry poultry manure (laying hens). Manure used for co-combustion with straw and for pyrolysis at controlled temperatures derived from the same biogas plant (manure 1). Pyrolysis of the dry manure was made at controlled temperatures (250-500 C) in an oven.

Soil incubation: The ashes were well mixed with two agricultural soils (26 mg P/kg soil) and incubated for 112 days at constant moisture and temperature (10 C). Soil 1 was a sandy soil (5% clay) with a low level of P (8.9 mg Olsen P/kg) and pH 7.3. Soil 2 was a loamy sand (9% clay) with a normal P level (46 mg Olsen P/kg) and pH 6.3.

Soil P extractions: Extractions were made 1, 4, 8 and 16 weeks after ash/manure application.

Water-extractable P: Samples were extracted for 1 h with water.

Bicarbonate-extractable P (Olsen P): Samples were extracted for 0.5 h with 0.5 M NaHCO₃ solution.

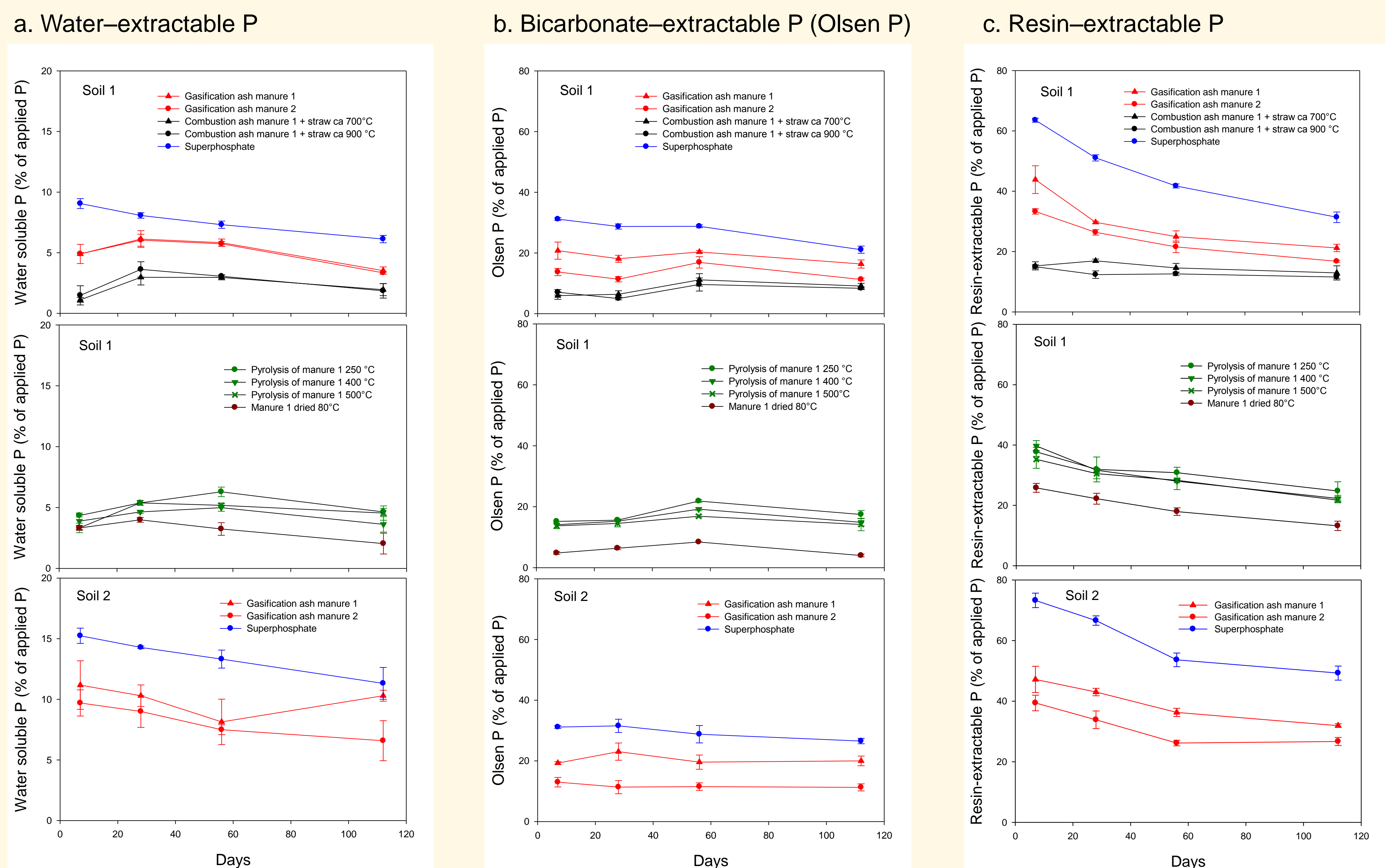
Resin-extractable P: Soil samples were mixed with water and extracted with resin strips (anion exchange membrane) for 17 h. This method is assumed to give a good measure of plant available P.

Table. Experimental ashes and manure.

Ash /manure	P content (g P/kg)
Gasification ash, manure 1 730 C	40.9
Gasification ash, manure 2 730 C	50.2
Combustion ash, manure 1 + straw 700 C	87.7
Combustion ash, manure 1 + straw 900 C	87.8
Pyrolysis of manure 1 250 C	46.5
Pyrolysis of manure 1 400 C	63.0
Pyrolysis of manure 1 500 C	62.9
Manure 1, dry	36.4
Superphosphate	110.4

Results

Figure 1. Extra water-, bicarbonate- and resin-extractable P in two soils due to application of manure-derived ashes, dry manure and superphosphate. Extractable P in an unamended control soil was subtracted and extractable P was related to total P applied. Standard errors are indicated (n=3).



Conclusions

- More P was extractable after superphosphate application than after ash application.
- More ash P was extracted by the resin method than by the bicarbonate method.
- Resin extractable P declined from day 7 to day 112 whereas bicarbonate- and water-extractable ash P was nearly constant.
- Manure pyrolysis at different temperatures (250-500 C) had no influence on ash P availability
- The manure type used for gasification influenced ash P availability.
- The availability of ash P from co-combustion of straw + manure was significantly lower than that from gasification/pyrolysis of manure.
- The soil properties influenced water-extractable and resin-extractable ash P but had little influence on Olsen P.