LIÈGE université
Gembloux
Agro-Bio Tech

Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Madame ZHOU Xiaoyang,

Titulaire d'un *master degree in soil science*,

présentera en vue de l'obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 30 juin 2017, à 9h30 précises (personne ne sera admis après cette heure),

en l'auditorium GP (Géopédologie, bât. 52),

Avenue Maréchal Juin, 27, à 5030 GEMBLOUX.

Cette dissertation originale a pour titre :

« Soil Acidification in Southern China: Spatio-temporal Evolution and Effects on Phosphorus Availability ».

Le jury est composé comme suit :

Président: Prof. P. LEJEUNE, Président du Département BIOSE,
Membres : Prof. G. COLINET (Promoteur), Prof. M. XU (Copromoteur, CAAS – Chine), Prof. S. GARRE, Prof. J.-T. CORNELIS, Prof. B. BODSON, Prof. M. FULLEN (University of Wolverhampton, Royaume-Uni).

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Summary

Rapid industrial development and intensive agriculture induced serious soil degradation in recent decades worldwide and specifically in China. In cropland, soil acidification and nutrient deficiency are often associated with increased use of nitrogen (N) fertilizers. Soil acidification can lead to reduction of phosphorus (P) availability, even though with high inputs of P fertilizer. The studies presented in the thesis deal with spatio-temporal evolution of soil pH in different soil types and land uses in southern China and effects of soil acidification on soil P availability. Evolution of inorganic P fractions in Red Soil was characterized upon fertilization trials, as a response to long-term fertilization and soil acidity changes.

The first focus of the thesis deals with spatio-temporal evolution and main factors of soil acidification in different soil types, parent materials and land uses of Southern China. Firstly, data from 20 monitoring sites under 25-year fertilization on Paddy Soil were investigated to research changes of pH. Paddy Soil pH significantly declined from 1988-1998, then stabilized from 1998-2013 with conventional fertilization. Chemical N fertilization, manure application, soil available N and total N increases were significantly correlated with soil pH. Secondly, changes of pH in Red Soil and Paddy Soil were assessed in 32 monitoring sites of Hunan Province (Southern China) under 10-year fertilization in order to analyze soil acidification in different soil types and agro-systems. Soil pH decline was observed in Paddy Soils under rice-vegetable rotation but not observed in Paddy Soil under continuous cropping with rice. Soil pH significantly declined in Red Soil with high initial soil pH. Thirdly, spatio-temporal characteristics of soil pH were investigated by comparison of soil pH between 1982 and 2014 in Qiyang County (Hunan Province). Average topsoil pH declined of 0.58 units between the two surveys. Soil pH in the south was lower than in the north both in 1982 and 2014. Land use and parent materials are the main drivers of differences in the soil pH changes in Qiyang County. Soil pH declined significantly in forest and upland crop over non-alkaline parent materials during 1982-2014 period. Chemical N fertilizer application can have generated 12-42 kmol H^+ $ha^{-1}yr^{-1}$, which is much higher than removal by crop harvest. Reduction of chemical N fertilization and return of straws to field should be conducted to reduce H^+ production and supplement base cations in Qiyang County.

The second approach studied evolution of inorganic P fractions in Red Soil under 25-year fertilization, and available P and inorganic P fractions responses to various soil acidity levels. Inorganic P fractions increased under P fertilization from 1990-2015, especially Ca_2-P, Ca_8-P and Al-P, but inorganic P fractions significantly decreased without P fertilization. Contributions of soil properties (SOC, C:P ratio and N:P ratio) and cumulative P apparent balance (CPAB) to inorganic P fractions were ≥ 95%, while interaction of CPAB and soil properties made greater contributions than did any single factor. Soil dissolved inorganic P (DIP) decreased with rising pH value, and a minimum DIP was observed between pH 5.5 and 6.5. Olsen-P, Ca-P and Al-P increased significantly with pH between 3.4 and 5.0. Soil with pH <5.0 P availability was much lower than soil with pH ≥5.0. Managing soil acidity is a key issue regarding availability of P in Red Soil of China and our results suggest that at least a pH of 5.0 should be targeted.