Determination of phytase labile organic phosphate in organic manure

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Effect of long-term fertilization on greenhouse gases emission in paddy soils, China

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Two long-term fertilizer experiments initiated in 1980s were used in this study to investigate the effect of rice straw or organic manure application on greenhouse gases (GHGs) emission and soil carbon sequestration. The experiment sites are in Hunan and Jiangxi province with double rice-cropping systems. Methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) fluxes were measured in situ using closed chamber method during early rice growing season. Flux of greenhouse gases was monitored at about 7 day’s interval. Soil water regime was flooding after seedling transplantation till panicling and drainage during spiking followed by a subsequent moist condition without irrigation till harvest. Treatments in Hunan include CK (no fertilizer), chemical fertilizer only (CF), chemical fertilizer plus pig manure (CFM) and chemical fertilizer plus rice straw (CFS). Jiangxi has the same treatments with Hunan excluding CFS.

Comparing with no fertilizer treatment, fertilization increased soil organic carbon (SOC) content and GHGs emission in both sites. Furthermore, SOC contents in CFM and CFS were significantly higher than CF treatment. In Hunan, total emission of CH_4, N_2O and CO_2 ranged from 45.61 kg CH_4-C/ha to 133.45 kg CH_4-C/ha, from 0.16 kg N_2O-N/ha to 2.11 kg N_2O-N/ha, from 1354.92 kg CO_2-C/ha to 1731.54 kg CO_2-C/ha, respectively. Long-term rice straw return and pig manure application did not increase the total emission of GHGs compared to chemical fertilizer only plot. However, application of pig manure significantly enhanced GHGs emission compared to CF plot in Jiangxi. These results suggest that rice straw return with chemical fertilizer has the potential to mitigate climate change during rice production in Hunan; the effect of organic manure application is highly dependent on soil fertility and climatic conditions.

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In Japan, almost half of the cropland soil is Andosol which is characterized by strong phosphate adsorption capacity. Therefore, crops can’t use phosphorus fertilizer efficiently. According to previous research, phosphate in compost is more likely to be efficiently used by crops than chemical fertilizer. This may partly ascribed to mineralization of organic phosphate by micro-organisms. Mineralization of organic phosphate may increase availability of phosphate by crops. Major organic phosphate in organic manure is assumed to be phytic acid, but few report has been analyzed the concentration of the phytic acid in organic manure.

In this study, we tried to determine phytic acid in organic manure using phytic acid hydrolysis enzyme; phytase. Using a commercial wheat phytase, we examined incubation conditions including enzyme concentration, incubation temperature and incubation time, and following method was selected. Finely ground sample (100mg) in a test tube was incubated in 5 ml of 0.04 unit / ml enzyme solution for 12 hours at 30˚C. The enzymatic reaction was terminated with trichloro acid. Inorganic phosphate in the solution was determined by modified malachite green method.

Phytic acids concentrations in some organic manures were determined. Proportions of phitic acid (phytase labile phosphorus) in total phosphate were 5 % in a poultry manure from egg farm, 46 % in a poultry manure from a broiler house, 10 % in a green manure made by above-ground part of buck-wheat and 55 % in a rice bran. Most of the organic phosphate in seeds; soybean and buck-wheat, was phytase labile.

References

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Effects of water management on vivianite crystallization on paddy rice roots

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【Introduction】The availability of phosphate (P) for paddy rice plants is higher than that for upland plants because of enhanced P solubility under reducing conditions. In recent years, vivianite aggregates, ferrous phosphate crystals, have been identified on thin roots of paddy rice (Nanzyo et al.,2010). Recognition of vivianite will improve understanding P dynamics under reducing condition like paddy fields. In this article, we describe (i) effects of water management on vivianite crystallization and (ii) a quantitative method to estimate the content of vivianite.

【Materials & methods】(i) Rice plants (Oryza sativa, L.) were grown in three small paddy field plots (1m×1m). Water management for each was (1) intermittent irrigation after mid-summer drainage, (2) continuous flooding during cultivation, and (3) re-flooding after mid-summer drainage. Rice roots were separated from soil blocks by washing with fresh water, and air-dried. After drying, we observed vivianite attached to roots by optical microscope and scanning electron microscope (SEM)-energy dispersive X-ray analysis (EDX).

(ii) After rapid oxidation with heating, vivianite dissolves little in dilute hydrochloric acid. The difference in P solubility between before and after heating at 105˚C was used for estimation of the quantity of vivianite aggregate.

【Results & Discussion】The longer the term of flooding, the more vivianite aggregates are observed by optical microscope. The aggregates crystallized mainly on the thin roots, and were identified to be vivianite by EDX. The crystal aggregates appeared like laminae from the root surface to bulk soils by SEM, and they suggests mobilization of P in soil. On the other hand, the amount of the crystal aggregates reduced after drainage under oxidizing conditions. These observations suggest the changes in redox status by water management affect crystallization and dissolution of vivianite.

Synthetic vivianite dissolve little after heating at 105˚C for 48h. The decrement of P in the root extractant after heating showed a correlation with the abundance of vivianite found by optical microscope observation.