Fundamentals for Improving Phosphorus Cycle in Soil-Plant Systems

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Among natural resources used as fertilizers, P and K are major concern due to their economically available amount in the world. Phosphorus is considered more limited than K although new P resources may be found.

Seventy to eighty percent of P resources are input in agricultural soils as P fertilizers. However, P recovery rate is generally low, less than 20 percent in many cases, in crop production in the agricultural fields due to fixation by soils. The P recovery rate depends on many factors such as soil properties, kind of crops, management of soils and fertilizers, etc.

In order to improve P cycling in the agricultural soil-plant systems, one method may be to prevent P fixation and increase P uptake by plants. Brassica plants and buckwheat show interesting root growth in P-deficient Andosols. Roots of these plants cover slow release P fertilizer particles and these roots separate P fertilizer particles and Andosols to prevent P fixation by soil. P recovery rate by Japanese radish can be improved up to around 40% and the radish growth is good enough to be marketable. As the slow release P fertilizers, pelletized chicken manure and pelletized swine manure are effective. These fertilizers contain well-crystalized struvite ($MgNH_4PO_4 \cdot 6H_2O$) that contain not only P but also N.

Another method may be harvesting of vivianite ($Fe_3(PO_4)2 \cdot 8H_2O$) from paddy field soils. Plow layer soil is gradually reduced after flooding the paddy fields. Under the reducing conditions, vivianite crystals form on the aged rice roots, old plant debris and in the bulk soil. Lowland soils are suitable for vivianite formation. The many crystal aggregates of vivianite are larger than 0.05 mm in diameter. However, the vivianite crystals disappear with the development of oxidizing conditions after drainage. Thus, it is important to collect the crystal aggregates under reducing conditions from soil. Further challenging point is to separate the vivianite crystal aggregates effectively from soils to improve purity.