Phosphorus Availability in Soils - Biological, Chemical and Physical Approaches for a Sustainable Agriculture

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Phosphorus (P) plant availability is determined by the concentration of phosphate ions in the soil solution and the soil replenishing ability after root uptake. The replenishing of phosphate ions depends on soil characteristics such as mineralogy, soil chemical reactions, plant biological interactions and soil physical conditions. Soils rich in alumina or iron oxihydroxides or clay minerals like kaolinite, predominant in tropical regions, react chemically with P to form insoluble compounds, inaccessible to plant roots. Crop demands may be adequately supplied when readily available P pools are maintained at a critical level in the soil solution and with constant P inputs by fertilizer to compensate plant uptake, leaching and/or runoff. Improving our mechanistic understanding of soil P dynamics—involving soil-rhizosphere-plant interactions and how they influence P availability—is important for improving a future sustainable P management. In Europe, a 5R strategy has been proposed to improve the stewardship of P and to act as a blueprint for national and global P sustainability: Realign P inputs more precisely to maximize efficiency, Reduce P losses to the streams and oceans, Recycle more P in bioresources, Recover and reuse P from wastes and Redefine P requirements in the food chain (Withers et al. 2015). This 5R strategy should also be more deeply understood in other regions of the world for getting a more agroenviromentally friendly use of his precious nutrient. Moreover, more efficient, reliable and sustainable ways should be sought for 'feeding the crop, not the soil', improving crop recovery of fresh P applications and better using the legacy P remaining in the soil from previous cropping. There appears to be scope for innovations across a broad range of technologies including machinery for placement, chemistry to inhibit soil sorption, foliar P stabilization and absorption and both micro- and macro-germplasm to improve uptake and reduce P demands. Such innovations are encouraged in a 4R approach to nutrient stewardship at the farm level, seeking to apply the right source, at the right rate, at the right time, and in the right place.