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"Filling gaps and removing traps
for sustainable resource management"

Effect of Soil Aeration and Genotype on the Response of Rice to Increasing Arsenic in Mining Soils from Ghana

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Abstract

Arsenic pollution of soils is typically associated with gold mining activities in Ghana. Opportunities for reclaiming former mining sites for crop production depend on the level of As pollution, the soil aeration status (dominance of As-3 vs. As-5 species) and genotype-specific tolerance mechanisms (mainly related to P efficiency). Soils were collected from the strongly polluted centre and a largely unaffected field site at the fringe of a former artisanal gold mine in Ghana. The samples represent five positions along a gradient with soil As contents of 0, 19, 36, 57 and 76 ppm As. Potted soils were transplanted with rice genotypes with contrasting P-efficiencies (IR 64 and Mudgo) and incubated under aerobic (field capacity) and anaerobic (flooded) conditions in a greenhouse. After 6 weeks of growth, rice plants were harvested and analysed for As and P contents. Increasing soil As from 0.2 to 76 ppm negatively affected rice growth, irrespective of the soil aeration status or genotype. However, increasing soil As concentrations enhanced As uptake up to >70 ppm in case of the P-inefficient IR 64 but only up to 40 ppm in case of the P-efficient Mudgo. Increasing As uptake resulted in a concomitant reduction in plant P contents from 0.3 to <0.1 %. The As-induced decline in rice P accumulation was more in aerobic (predominance of arsenate – As^{5+}) than in flooded soil (predominance of arsenite – As^{3+}), and rice P uptake by the P-efficient genotype at moderate soil pollution of 19 to 40 ppm As was nearly twice that of the inefficient one. As a result, plant As and P showed a highly significant negative correlation. However, the P/As ratio was higher (more favourable) in anaerobic soil and in the P-efficient genotype. We conclude that for reclaiming as-polluted mining areas it may be advisable to cultivate P-efficient lowland rice rather than non-P-efficient upland crops.

Keywords: Arsenate, arsenite, *Oryza sativa*, P transporters, soil reclamation

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