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Farmers’ and academia’s views”

Advances in the development of localised P-dipping technique as a simultaneous solution to phosphorus overuse and sustainable lowland rice production in sub-Saharan Africa (SSA)

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Abstract

A global challenge for agricultural production is to meet the needs of a growing population while addressing environmental concerns related to the overuse of fertilisers and unstable growing conditions due to climate change. At the same time, soil P deficiency and insufficient P application due to the limited purchasing capacity of smallholder farmers are major constraints for rice production in SSA. Our studies provide a practical approach to addressing these issues for smallholders’ lowland rice production in SSA.

First, our pot experiments identified that: (1) a short dipping duration of rice seedlings (30 min) in P-enriched soil slurry at the optimal P concentration of 4.3%-5.0% P_2O_5 or the P-dipping technique enhances early rice growth; (2) the P-dipping creates a soluble P hotspot around the root system, which induces vigorous surface roots and facilitates P uptake from the spot, thus increasing P use efficiency even in high P-fixing soils; (3) rice genotype with a shallow root system has a positive combination with P dipping, which significantly improves P use efficiency and initial rice growth.

Second, we conducted on-farm trials (2018–2020) to confirm the effectiveness of P-dipping in rice fields in Madagascar, where acid and P-deficient soils, typical in SSA, are widely found. Twenty-two field trials have demonstrated that P-dipping is a novel technique for increasing rice yield with improved P use efficiency in high P-fixing soils. In addition, P-dipping significantly shortens days to heading than conventional P application via broadcasting, thereby avoiding late-season low-temperature stress at high-altitude sites. Moreover, P-dipping avoids submergence stress after transplanting by accelerating initial plant growth and achieving high yields in the affected fields. Thus, this technique will be one of the major adaptation strategies for smallholder farmers to increase rice yields with little fertiliser inputs and reduce the risk of environmental stresses.

Third, a large-scale pilot trial (2020–2021) confirmed the significant effect of P-dipping on rice yield under a range of environmental and farmers’ management practices in the central highlands of Madagascar. Currently, the practice is being disseminated to hundreds of farmers’ fields to ensure sustainable rice production and improve the livelihood of farmers in SSA.

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