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Synergistic effects of localised application of organic and phosphorus fertiliser on rice growth and yield in P-deficient upland soils of Madagascar

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Abstract

Rice is a crucial crop for Madagascar's agriculture, but upland rice farmers face challenges due to limited access to fertilisers and weathered soils that bind plant-available forms of phosphate. Effective fertiliser management is necessary to increase rice production. Low-cost strategies like P micro-dosing show promise for sustainable intensification, but they are underused due to a lack of awareness and technical capacity. Uncertain soil moisture conditions due to climate change can harm early rice growth through localised P application. Combining and localised application of farmyard manure (FYM)/vermicompost (VC) and P fertiliser can mitigate the risk of chemical injury to seedlings, and increase grain yield, making it a more effective solution.

In a pot trial, both individual treatments and a combination of FYM/VC at 0.8 t ha⁻¹ and P fertiliser at 5 kg and 10 kg P ha⁻¹ applied in the planting hole had a positive impact on early rice growth under consistent and adequate soil moisture conditions. However, when a farmer's field trial was conducted to evaluate the same treatments on shoot biomass and grain yield, applying P locally had a negative effect on the seedlings' initial growth. This was attributed to low soil moisture levels that caused chemical damage to the rice seedlings. However, when localised FYM/VC was used, no negative effects were observed, and shoot biomass increased. When FYM/VC and P were combined, FYM/VC helped to reduce the chemical injury caused by the P fertiliser. This combination further improved early rice growth, even under field conditions with high fluctuations in soil moisture.

At harvest, the response of grain yield to localised P application depended on the P rate. A high P rate (10 kg ha⁻¹) increased grain yield by 7%, while a P rate of 5 kg ha⁻¹ did not show any difference. Grain yield increased by 24% with localised application of FYM/VC than the control. There was no interaction between organic and P fertiliser, and their combined application additively increased grain yield by 51–82% than the control. In conclusion, utilising local organic resources along with localised P micro-dosing promotes sustainable upland rice production in P-deficient soils of Madagascar.

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