

Soil phosphorus status and natural growth of *Azolla* in irrigated lowland rice

Azolla is a genus of water fern that assimilates atmospheric nitrogen in symbiosis with the nitrogen fixing blue-green alga *Anabaena azollae* (that live in the cavities of *Azolla*'s upper lobes). The *Azolla*-*Anabaena* complex offers potential for increasing yields of irrigated lowland rice, especially in situations where chemical nitrogen fertilizers are in short supply¹.

We have been conducting experiments since 1993 under irrigated lowland conditions at the Mbe (near Bouake) in Ivory Coast, located in the guinea savanna zone at 5°06'W, 7°52'N, to determine the status of mineral reserves in a lowland soil. Soil at the experimental site was an alfisol (pH 6.2, clay 320 g kg⁻¹; sand 240 g kg⁻¹; organic C 1.02%; CEC 8.9 cmol kg⁻¹; exchangeable K 0.2 cmol kg⁻¹; exchangeable Ca 1.02 cmol kg⁻¹; exchangeable Mg 0.67 cmol kg⁻¹; DTPA extractable Zn 0.8 mg kg⁻¹) clay loam in texture. Soil analysis was carried out using standard methods². The experimental treatments included a complete fertilizer (CF) application (100 kg N ha⁻¹

as urea, 100 kg P₂O₅ ha⁻¹ as TSP, 100 kg K ha⁻¹ as KCl, 50 kg Ca ha⁻¹ as hydrated lime, 50 kg Mg ha⁻¹ as MgCO₃ and 10 kg Zn ha⁻¹ as ZnSO₄) and treatments in which N, P, K, Ca, Mg and Zn (CF-N, CF-P, CF-K, CF-Ca, 4CF-Mg and CF-Zn) were individually omitted. The treatments were arranged in a randomized complete block design with four replications. Each plot measured 15 m².

We observed a good growth of native population of *Azolla pinnata* var. africana in all plots that had received P application, but there was no growth of the fern in non P-amended plots. *Azolla* growth was due exclusively to natural inoculation. During the 1994 wet season (July-October), we quantified the biomass accumulated by *Azolla* under various plant nutrient treatments by collecting the fern from 1 m² area in each replication. The sampling of *Azolla* was done at 11 weeks after transplanting of the rice crop (cv Bouake 189).

Biomass production, expressed on a dry weight basis, in CF, CF-N and CF-K treatments was similar. There was no

growth of *Azolla* in the CF-P treatment (Table 1). The biomass of *Azolla* in CF-Mg treatment was significantly lower than in other treatments. There was no significant difference in the biomass accumulation in other nutrient treatments. The elemental composition of *Azolla* dry matter for N, P, K and Zn contents was similar in various plant nutrient treatments (Table 1). The results were confirmed in the 1995 wet season: there was no growth of *Azolla* in CF-P treatment plots and the biomass of *Azolla* was significantly lower in CF-Mg treatment. The biomass of *Azolla* was similar in all other nutrient treatments.

Bray 1 extractable P (NH₄F-HCl solution) in soil in the treatments that had received fertilizer P was 14 mg P kg⁻¹ soil compared to 6 mg P kg⁻¹ soil Bray 1 P in the CF-P treatment. The content of water soluble P in the soil with added P was 0.038 mg P l⁻¹ while no detectable amount of water-soluble P was found in the CF-P treatment.

The results underscore the importance of P nutrition for *Azolla* growth in the typical lowlands of West Africa deficient in available P. Among other plant nutrients, Mg seemed important.

Table 1. *Azolla* biomass (g m⁻²) and its elemental composition under various plant nutrient treatments in a lowland Alfisol planted to rice at Mbe (near Bouake), Ivory Coast in 1994

Nutrient treatment	<i>Azolla</i> biomass (g dry wt m ⁻²)	Nutrient content in <i>Azolla</i> (mg kg ⁻¹)			
		N	P	K	Zn
CF (all nutrients)	72	40600	4500	26600	38
CF-N	76	32400	4600	23600	39
CF-P	0	-	-	-	-
CF-K	80	42700	3900	22900	26
CF-Ca	92	41500	4250	25000	40
CF-Mg	35	39500	4350	24800	36
CF-Zn	87	42500	4600	24800	30
Mean	63				
LSD (0.05)	27.5				

1. Lumpkin, T. A. and Plucknett, D. L., *Azolla as a Green Manure: Use and Management in Crop Production*, Westview Press, Colorado, 1982, p. 230.
2. Page, A. L., Miller, R. H. and Keeney, D. R. (eds), *Methods of Soil Analysis*, Part 2, American Society of Agronomy, Wisconsin, 1982, p. 1159.

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