Nitrogen forms differentially affect pH and response of rice on contrasting soil types

Jolibe Llido, Shyam Pariyar, Mathias Becker
University of Bonn, Institute of Crop Science and Resource Conservation (INRES) - Plant Nutrition, Germany

Introduction

- Rice is the most consumed staple food in the world.
- It is mostly cultivated under Rainfed and irrigated production systems.
- Current trend shows that lowland rice is cultivated in upland conditions.
- Soil physical and chemical properties change overtime during the shift in cultivation practices, i.e. from anaerobic and aerobic and vice-versa.
- These changes may alter rhizosphere pH dynamics and may affect rice plant performance.
- The rice plant performance attributes can be aggravated or improved by the application of different nitrogen forms.

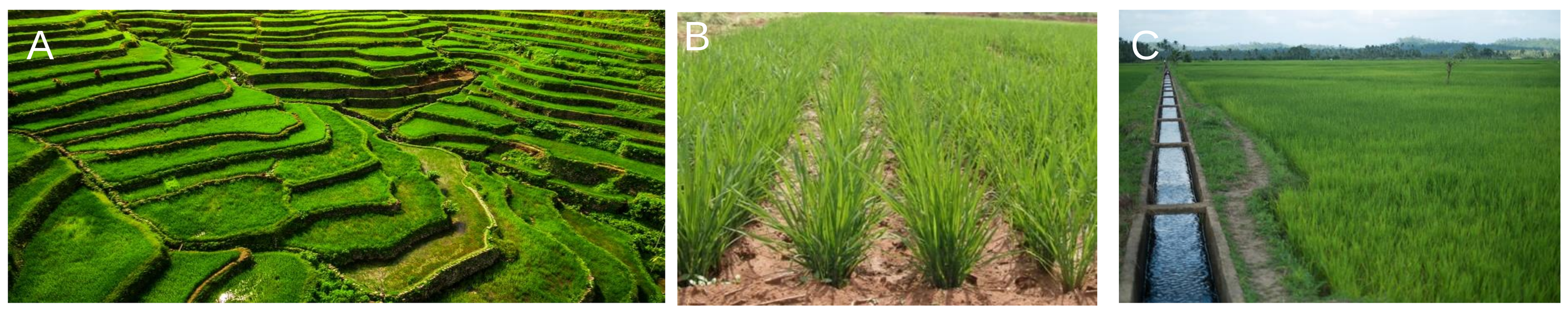

Figure 1: A. Banaue rice terraces in the Philippines, B. Aerobic rice cultivation, C. Anaerobic rice cultivation (Photos: https://images.app.goo.gl)

Materials and Methods

- The experiment was conducted in the greenhouse condition of the Institute of Crop Science and Research Conservation in the University of Bonn, Germany.
- A pot experiment with three soil types with contrasting inherent pH (acidic, neutral and alkaline), three nitrogen forms (NH_4^+, NO_3^-, NH_4NO_3) and two rice genotypes (IR64 and Nipponbare in aerobic condition.
- Roots were washed for the Bromocresol purple staining to semi-quantitatively measure pH dynamic in the rhizosphere.
- Soil solution was collected with Rhizon samplers and analyzed for pH.
- Roots and shoots were oven-dried for 48 hours for dry biomass and other parameters.

Conclusions and Outlooks

- **Nitrogen forms influence the pH change in rhizosphere of rice**
- **Rice performance is affected by acidification or alkalinization of rhizosphere (i.e. rhizosphere pH).**
- **Aerobic rice production requires appropriate soil types and pH to optimize its productivity.**

Results

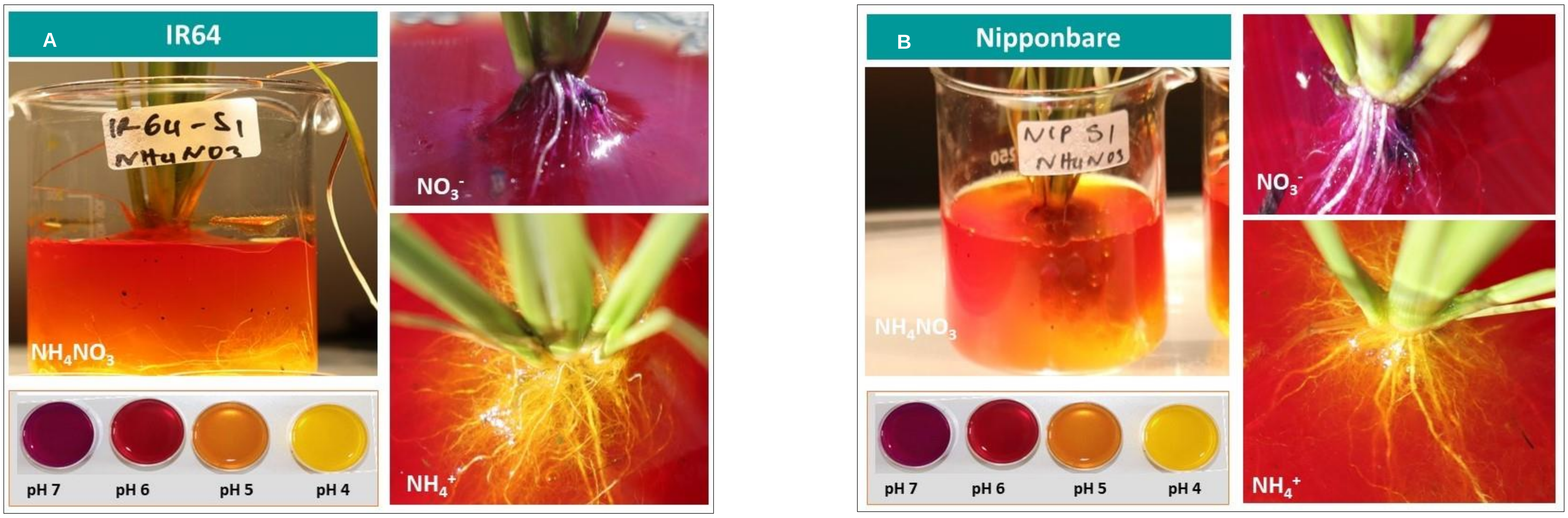

Figure 2: Bromocresol purple staining for semi-quantitative measurement of rhizosphere pH on IR64 (A) and Nipponbare (B). Both genotypes with ammonium treatment show clear reaction of acidification with pH value of 4 (A, B). Moderately acidic and strong alkalinization can be observed with NH_4NO_3 and NO_3^- treatments, respectively.

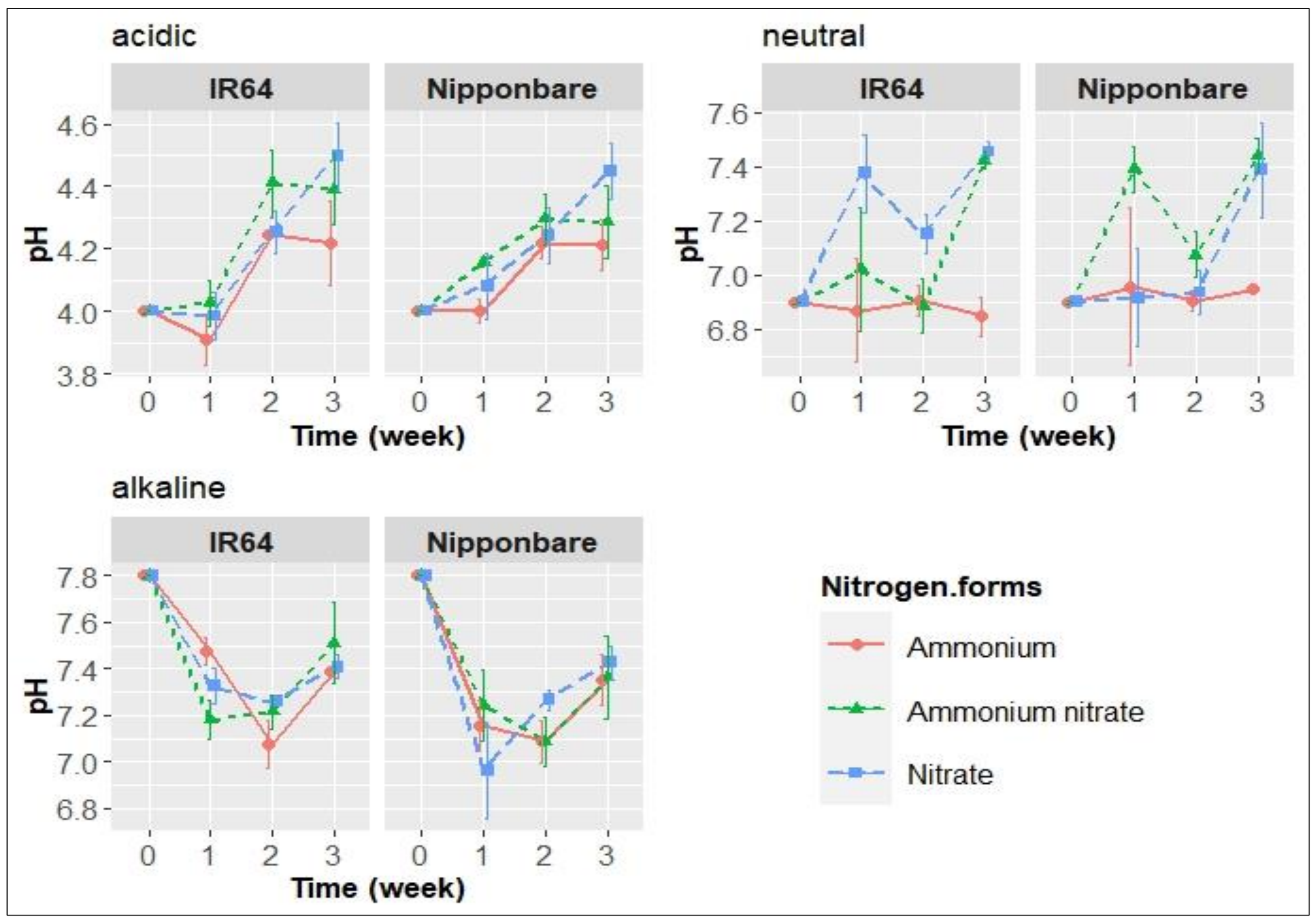

Figure 3: A temporal trend on pH dynamic of soil solution on contrasting soil types applied with different nitrogen forms. Each point is the mean of five individual plants. Week 0 is the initial pH of soil solutions (acidic= 4, neutral= 6, alkaline= 7.8). Graphs shows mean and standard error (n = 5).

Table 1: Mean shoot and root dry biomass and root/shoot ratio of rice on contrasting soil types applied with different forms of Nitrogen

Genotype	Soil type	Dry biomass (g plant⁻¹) Shoot	Root	Root/Shoot Ratio
IR64	Acidic	0.788 c	0.3784 c	46.1 a
	Neutral	0.661 b	0.2911 b	44.6 a
	Alkaline	0.115 a	0.0648 a	58.2 b
Nipponbare	Acidic	0.760 c	0.3905 c	51.5 a
	Neutral	0.564 b	0.2991 b	52.1 a
	Alkaline	0.112 a	0.0686 a	62.5 b
	Nitrogen forms			
IR64	NH_4^+	0.518 a	0.253 a	48.3 a
	NH_4NO_3	0.543 a	0.257 a	50.9 a
	NO_{3-}	0.504 a	0.225 a	49.7 a
Nipponbare	NH_4^+	0.503 a	0.286 b	62.0 b
	NH_4NO_3	0.485 a	0.259 ab	54.2a b
	NO_{3-}	0.448 a	0.213 a	49.8 a

Values are expressed by least square means (n=5). Significant differences (*p>0.05*) between treatment within the same genotype are denoted by different letters (test= Anova type II, post-hoc= adjusted Tukey).

Institute of Crop Science and Resource Conservation
Department of Plant Nutrition
University of Bonn
Karlrobert-Kreiten Straßen 13, 53115 Bonn

Deutscher Akademischer Austausch Dienst
Kennedyalle 50
53175 Bonn