Soil Nitrogen Storage and Availability to Crops are Increased by Conservation Agriculture Practices in Rice–based Cropping Systems in the Eastern Gangetic Plains

Md. Khairul Alam[1,2*], Richard W. Bell[1], A.T.M.A.I. Mondol[2], M.E. Haque[1], M.A. Islam[2] and M.A. Kader[1, 5]

[1]Agriculture Discipline, College of Science, Health, Education and Engineering, Murdoch University, Western Australia; [2]Bangladesh Agricultural Research Institute, Bangladesh; [5]School of Agriculture and Food Technology, University of South Pacific, Samoa.
Email: khairul.krishi@gmail.com

Abstract

The changes in nitrogen (N) forms and N availability for crops in rice-based systems under conservation agriculture practices have not been determined. Field experiments were conducted at Alipur and Digram in the Eastern Gangetic Plains to examine N cycling under conventional tillage(CT), strip planting(SP)/non-puddled rice(NP) and bed planting(BP) with increased (HR) or low residue retention (LR). The SP/NP, together with HR, altered the N cycling by reducing the N level available to plants in the early growing season but increasing total N and N uptake by enhancing the synchrony between crop demand and N supply.

Keywords: available N, paddy–upland rotation, rice–based cropping system.

1. Introduction

The benefits of conservation agriculture(CA) practices in upland cropping for soil properties are destroyed during puddled transplanting of rice. Non–puddled transplanting of rice (NP), a novel rice establishment practice designed for CA cropping systems (Bell et al., 2019), along with zero or strip tillage are CA-compatible practice. There is limited understanding of N cycling in soils under the CA practices in intensive cropping systems. The study was conducted to determine the effect of crop establishment and increased residue retention on N dynamics in rice–upland triple–crop rotations.

2. Materials and methods

Conventional (CT), strip (SP) and bed planting (BP) with increased (HR) or low residue retention (LR) were tested on Calcareous Brown Flood Plain and Grey Terrace soils. At Alipur and Digram, the cropping systems were mustard-rice-rice and wheat-jute-rice, respectively. After 5 years, N stocks, available N, N uptake and N use efficiency were measured following standard methods. Parallel first–, zero–order kinetic model was applied to estimate potentially mineralisable N (PMN) and its decay rate. All data were statistically assessed with SPSS software.

3. Results and discussion

N-stocks

At Alipur, N-stocks in SPHR and BPHR treatments were 1.17, 1.12 and 1.03 Mg N/ha, which were higher than respective soil N–stocks under CTHR, CTLR and SPLR. At Digram, SPHR also had increased N–stocks (Fig. 1).

N-availability

In general, the cumulative available N in soils under CTHR was higher than other practices. Nitrogen availability in the initial phase of crop growth (0–60DAS) was generally higher with CT than SP and BP (Fig. 2).

N-uptake

The SPHR/NPHR increased crop N uptake. The increased crop N uptake in SP/BP can be attributed to improved soil water storage in the dry season which may enhance soil N availability (Fig. 3).

Cycling of N fractions

For all crops, the estimated PMN was higher and its decay rate was lower under SPHR than other practices (Fig. 4). This suggests that more available N is lost in CTHR/CTLR.

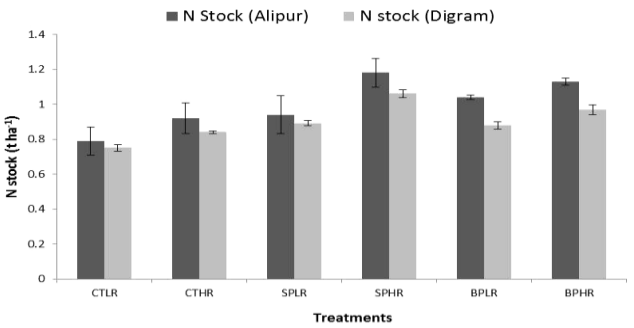

Fig. 1: Soil N stocks (0-10 cm) after 14 crops at Alipur and 13 crops at Digram under crop establishment and residue retention practices. Vertical bars indicate standard error of the mean (±). [Legends: BP – bed planting, CT – conventional tillage, and SP – strip planting; HR – increased residue retention and LR – farmers' practice]

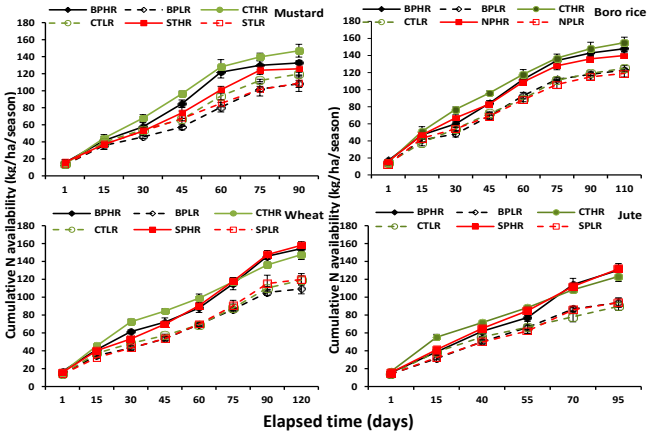

Fig. 2: Cumulative N availability in soils treated with different crop establishment practices and residue retention levels. [Legend: See in Fig. 1.]

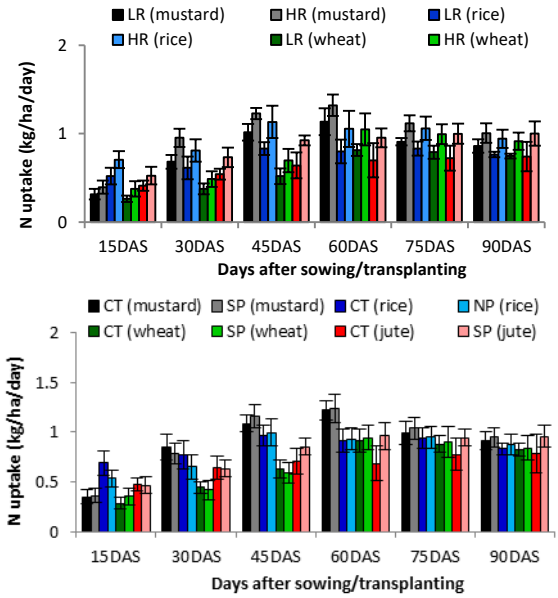

Fig. 3: Effect of residue level and crop establishment practices (below: conventional and strip planting) on daily N uptake rate by all crops at Alipur and Digram. Legend: see Fig. 1.

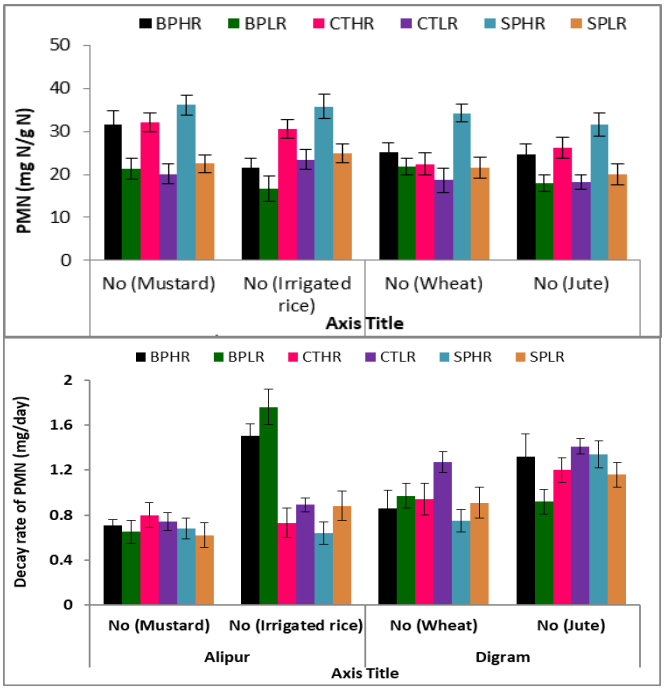

Fig. 4: Potentially mineralisable N (PMN) and decay rate of PMN in soils under crop establishment and residue retention practices. Legend: see Fig. 1.

4. Conclusions

Increased crop residue retention and minimum soil disturbance sequester more soil N while improving the efficiency of N uptake due to better synchrony between soil N availability and crop demand.

5. Acknowledgment

Grateful to BARI and ACIAR (Project LWR-2010/080 and JAF award) for research support.

6. References

Bell RW, Haque ME, Jahiruddin M, Rahman MM, et al. 2019.Conservation Agriculture for rice-based intensive cropping by smallholders in the EGP *Agriculture* **9** 5.