Theme 1
Status and trends of global soil nutrient budget

Improving the soil fertility and crop productivity of intensive rice-wheat systems by crop residue recycling via integrating in nutrient management

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INTRODUCTION

Rice-wheat cropping system is the most extensively followed crop rotation in the Indo-Gangetic plain. It is a highly intensive cropping system with expensive energy inputs on tillage, irrigation water and fertilization. The farmers of the region have problem managing the crop residues, especially those of rice crop, and therefore burning of crop stubble is one of the major environmental issues. The residue of both crops are rich in nutrients (~ 0.5-1.5 % N). If recycled the residue can become a useful biofertilzer/soil conditioner. There can be various means of using these residues for soil fertility enhancement. Some of the means include, *in situ* residue retention and incorporation into soil after crop harvest, transforming the residues into compost via suitable composting method and applying to soils, and integrating these crop residue-based options with other options like green manuring. Crop wastes, farmyard manure, and green manure crops are all useful organic sources for increasing soil quality and reducing chemical fertilizer demand without harming crop yields. Integrated nutrient management provides balance as the organic sources release nutrients slowly into soil solution for plants to absorb, whereas inorganic fertilizers release nutrients quickly and may match plant needs throughout crop growth (Fig. 1).

METHODOLOGY

A field experiment was initiated in 2014-2015 at Central Soil Salinity Research Institute (CSSRI), Karnal, used to assess the suitability of eight INM-modules viz; RS-F100= *in situ* 1/3rd rice stubble retention and incorporation + 100 % recommended fertilizers, RS-F150= *in situ* 1/3rd rice stubble retention and incorporation + 150 % recommended fertilizers, WS-F100= *in situ* 1/3rd wheat stubble retention and incorporation + 100 % recommended fertilizers, WS-F150= *in situ* 1/3rd wheat stubble retention and incorporation + 150 % recommended fertilizers, PSC-F50=Paddy straw compost @ 5 t ha^{-1} + only 50 % of recommended fertilizers, PSC-FYM-F50= Paddy straw compost @ 5 t ha^{-1} + Farm-yard manure @ 5 t ha^{-1} + only 50 % of recommended fertilizers, GM-FYM-F50= Green manuring with *Sesbania aculeata* + Farm-yard manure @ 5 t ha^{-1} + only 50 % of recommended fertilizers, GM-PSC-F50= Green manuring with *Sesbania aculeata* + paddy straw compost @ 5 t ha^{-1} + only 50 % of recommended fertilizers, compared to F = 100 % recommended fertilizer, and O= absolute control.

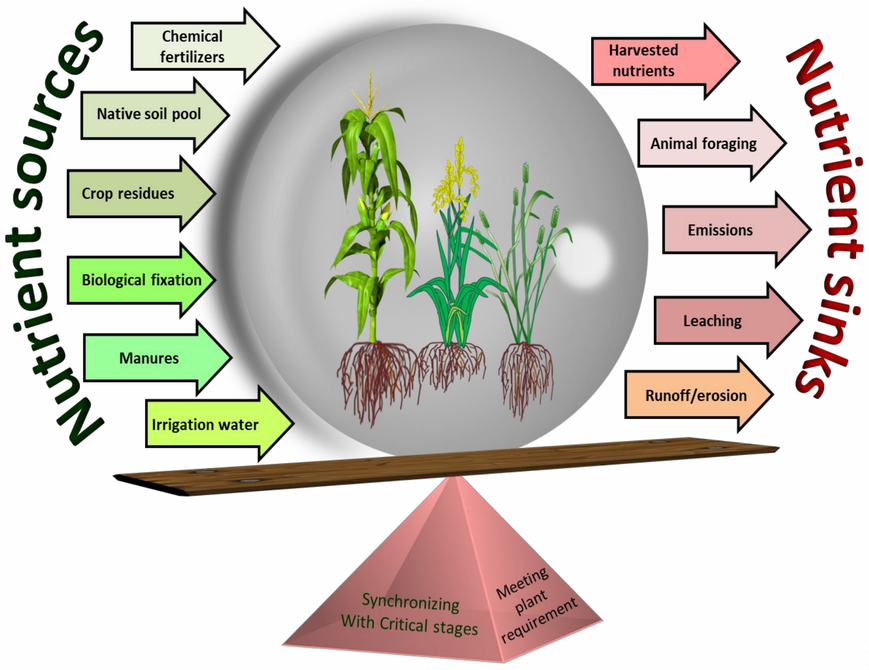

Fig. 1. Balancing the nutrient sources and sinks for meeting plant requirement and synchronizing plant availability in integrated nutrient management

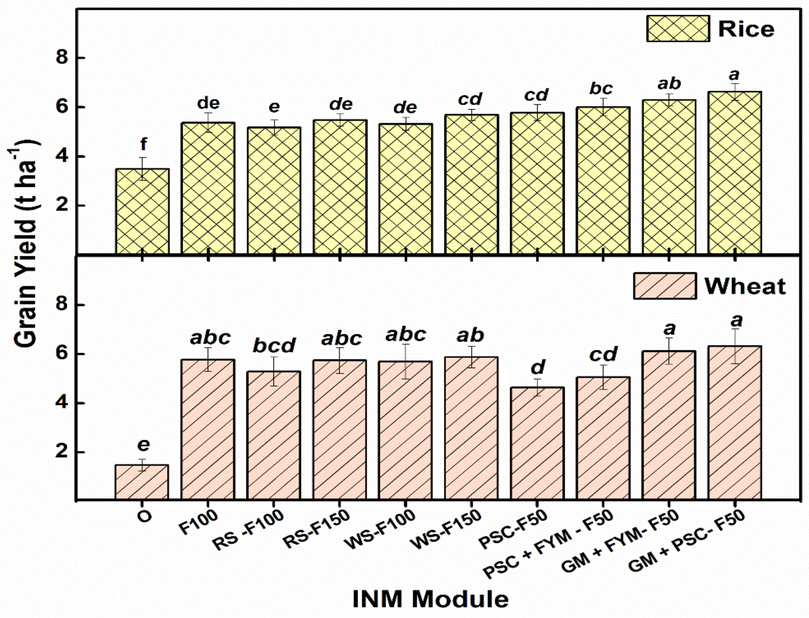

Fig. 2. Grain yields (t ha^{-1}) of rice and wheat crop under different nutrient management (Averaged of 5 years)

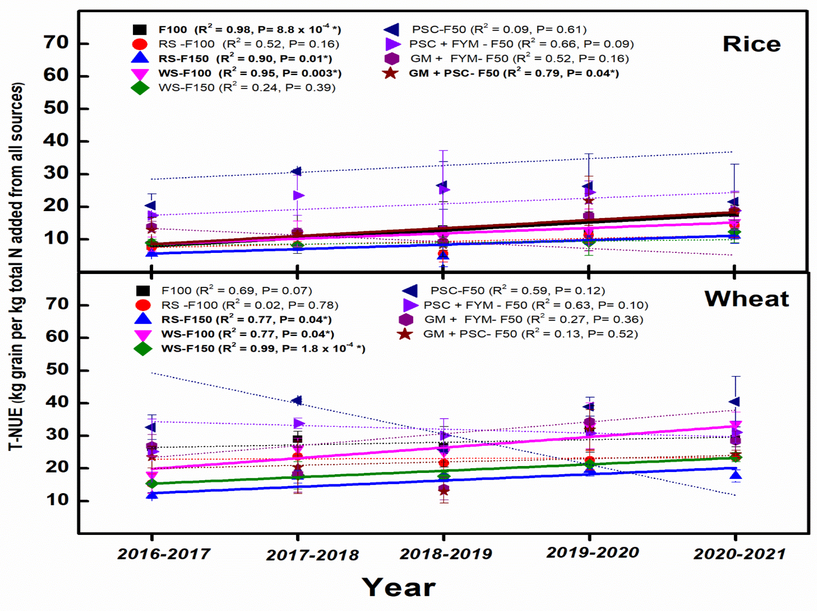

Fig. 3. Trends (2016-2021) in nutrient use efficiency (NUE) of rice and wheat crop under different nutrient management.

RESULTS

Grain yields (Fig. 2) and nitrogen use efficiency (NUE) (Fig. 3,4) increased significantly under GM-PSC-F50 (green manuring with application of paddy straw compost and only 50 % fertilizers), GM-FYM-F50 (green manuring with application of FYM and only 50 % fertilizers). These INM practices can afford cutting down of chemical fertilizer to 50 percent. In cereal residues (RS, WS) based INM, wheat stubble retention showed promising impacts on soil fertility and yield over the years while rice stubble retention could not match upto 100 % fertilizer (F) without addition of 50 % fertilizer as in RS- F150. Similar trends were also noted for N mineralization (Fig. 4).

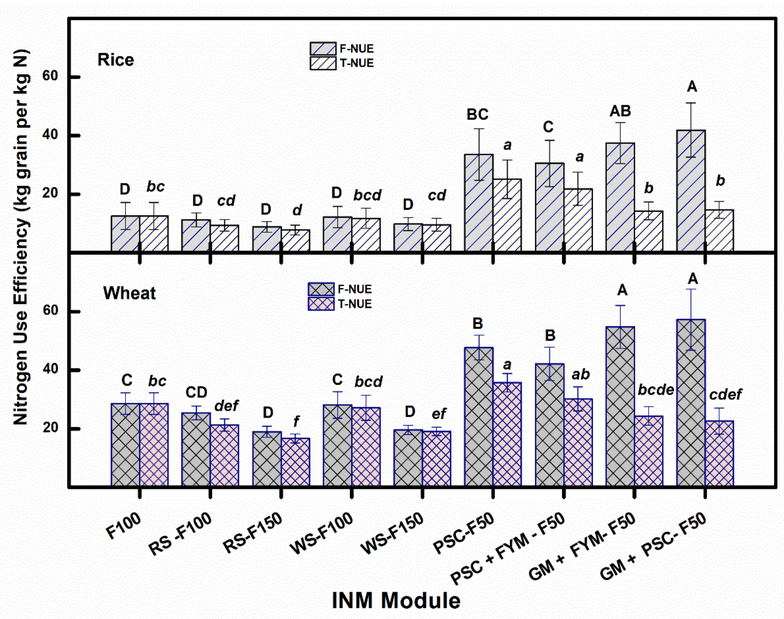

Fig. 5. Nutrient use efficiency (NUE) of rice and wheat crop as affected by different nutrient management (5 years averaged)

Fig. 4. Effect of nutrient management on Mineralized N (µg cm^{-2}) in soil during full season of rice and wheat crop

CONCLUSIONS

Overall, the study revealed that the green manuring with *Sesbania aculeata* + Paddy straw compost @ 5 t ha^{-1} + only 50 % of recommended fertilizers (GM-PSC-F50), 1/3rd wheat stubble retention and incorporation + 100 % recommended fertilizers (WS-F100), and 1/3rd rice stubble retention and incorporation + 150 % recommended fertilizers (RS-F150) are the promising INM technology modules for adoption by farmers in the Indo Gangetic plains.