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Impact of Integrated Nutrient Management in Rice (*Oryza sativa*) on Grain and Protein Yield of Succeeding Wheat (*Triticum aestivum*) in Long Term Rice-Wheat Cropping System

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ABSTRACT: Long-term sustainability is the major concern in the scenario of today's agriculture. Continuous use of suboptimal doses of nutrients in intensive cropping system has resulted in severe depletion of nutrient reserves in soil, leading to multiple nutrient deficiencies. Combined use of organic and chemical fertilizers significantly improved crop yield and soil physical properties over the recommended dose of inorganic fertilizers alone. A field experiment was conducted at research farm of Bihar Agricultural University, Sabour, Bhagalpur during the *rabi* season of 2020-21 in a randomized block design with eleven treatments and three replications using three sources of organic manure that were farm yard manure (FYM), wheat straw, green manure (GM) to study the impact of variable integrated nutrient management (INM) in rice (*Oryza sativa*) and application of inorganic nutrient in wheat on protein content and protein yield of wheat (*Triticum aestivum*). The results revealed that grain yield (4291 kg ha^{-1}), protein content (9.46%) and protein yield (405.80 kg ha^{-1}) of wheat were found highest with application of 50% recommended dose through fertilizers (RDF) and 50% N (nitrogen) through (FYM) in rice followed by 100% RDF in wheat. Thus, substitution of 50% inorganic N by FYM and application of 50% RDF in rice followed by 100% RDF in wheat resulted in significant increase in grain yield, protein content and protein yield of wheat.

Keywords: Farm yard manure, Green manuring, Integrated nutrient management.

INTRODUCTION

Wheat (*Triticum aestivum*) is the major cereal crop grown globally and is staple food of nearly 2.5 billion of the world population. About 85 million tonnes (90%) of wheat is produced from traditional wheat-growing are as like Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Bihar and Rajasthan.The heavy use of chemical fertilizers for increasing crop production is leading to decline in yield, deterioration in soil health and environmental hazards. The decline in soil health and quality is associated with the excessive use of inorganic and organic fertilizers (Beshir and Abdulkerim 2017). Restricted availability of land for cultivation of crops, beside diminishing productivity of main food crops are the main concerns in this era of increasing population. To deal with this challenge, there is a necessity to adopt the concept of integrated nutrient management. Nutrient applied either through chemical fertilizers or organic manures cannot fulfil the whole nutrient requirement of a crop in modern intensive agriculture (Kumara *et al*., 2013). The use of organic manure alone resulted in less yield of wheat which showed that application of only organic matter in different forms cannot meet the nutrient requirement of wheat (Sheoran *et al.*, 2017). INM infers the most competent use of organic as well as inorganic sources of nutrients along with micronutrients to achieve optimum crop productivity and to sustains oil fertility (Bhaduri *et al*., 2014; Ali *et al.*, 2018). Thus, an experiment was conducted to assess the impact of long-term integrated nutrient management in rice on grain yield, protein content and protein yield of wheat.

MATERIAL AND METHODS

The experiment was conducted during *rabi* season of the year 2020-2021 at the Bihar Agricultural College Research Farm, Sabour, Bhagalpur, India. Bhagalpur comes under Middle Gangetic plains of India at latitude of 25°15′4″N and longitude 78°2′45″E with an altitude of 37.19 meter above the mean sea level. Since a permanent experiment was carried out in the experimental plot since 1984 only rice and wheat were grown in *kharif* and *rabi* seasons, respectively and fallow in *zaid*. The experiment was laid out in randomized block design with eleven treatments which were replicated thrice. The treatments were: T_1: Control (No fertilizer, no organic manure) in both rice and wheat., T_2: 50% RDF in both rice and wheat., T_3: 50% RDF in rice and 100% RDF in wheat., T_4: 75% Rec. NPK dose through fertilizers in both rice and wheat.,T_5: 100% RDF in both rice and wheat., T_6: 50% RDF and 50% N through FYM in rice and 100% RDF in wheat, T_7: 75% RDF and 25% N through FYM in rice and 75% RDF in wheat., T_8: 50% RDF and 50% N through wheat straw in rice and 100% RDF in wheat.,

T_9: 75% RDF and 25% N through wheat straw in rice and 75% RDF in wheat, T_{10}: 50% RDF and 50% N through GM in rice and 100% RDF in wheat and T_{11}: 75% RDF and 25% N through GM in rice and 75% RDF in wheat. The recommended dose of fertilizer was 120:40:60 kg N, P_2O_5 and K_2O per hectare.

RESULTS AND DISCUSSION

The observations regarding grain yield, protein content and protein yield were recorded and estimated as per the standard procedures. Results showed that INM in rice showed considerable effect on grain yield of wheat during the study. The treatment T_6 (50% RDF and 50% N through FYM in rice and 100% RDF in wheat) recorded the maximum grain yield (Fig. 1). The substitution of 50% inorganic N by FYM with application of 50% RDF in rice and 100% RDF in wheat recorded 25% increased grain yield over that of 100% RDF in both rice and wheat and application of other organic sources i.e. wheat straw or green manuring in rice followed by 100% NPK in wheat also performed better than T_5 in respect of grain yield of wheat. Similarly, protein content and protein yield was also found maximum with application of 50% RDF and 50% N through FYM in rice and 100% RDF in wheat (Table 1). Combined use of organic and inorganic combinations performed better in comparison to inorganic treatment alone.

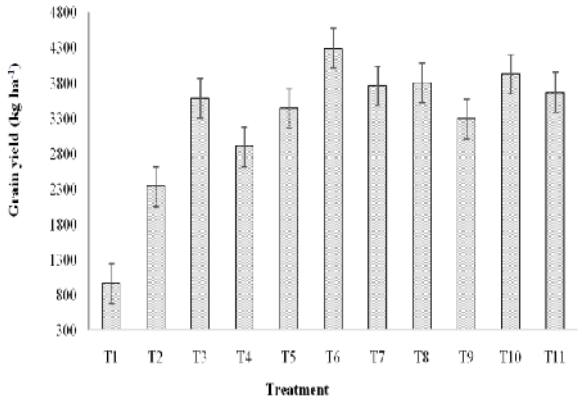

Fig. 1. Effect of integrated nutrient management on grain yield of wheat.

Table 1: Effect of integrated nutrient management practices on protein content (%) & protein yield (kg ha^{-1}) of wheat.

Treatment	Protein content	Protein yield
T_1	9.33	89.86
T_2	9.34	218.13
T_3	9.27	331.98
T_4	9.40	272.63
T_5	9.40	323.48
T_6	9.46	405.80
T_7	9.35	351.51
T_8	9.29	353.05
T_9	9.40	309.49
T_{10}	9.33	366.20
T_{11}	9.33	342.06
SEm(±)	0.03	15.61
CD at 5%	0.10	46.06

This can be due to cumulative residual effect of organic manures applied over the years. Organic sources increase efficient use of present as well as added nutrients. Among different organic sources, FYM had benefit over wheat straw and green manuring with *Sesbania aculeata* because decomposition of wheat straw is a slow process due to the presence of waxes, silica etc. and in case of *Sesbania aculeata* its total organic matter content on per unit nutrient basis is less. FYM has supremacy of highly humified state (fulvic acid) of organic matter and comparatively greater availability of macro andmicro nutrients for improving the physical and chemical properties of soil (Bhaduri *et al.*, 2014; Kumari *et al.*, 2017; Puniya *et al.*, 2019). So, due to these reasons FYM have gained advantage over other organic sources in increasing grain yield of wheat. The maximum protein yield with application of 50% RDF and 50% N through FYM in rice and 100% RDF in wheat (T_6) can be due to higher grain yield. It is very likely that organic matter applied along with chemical fertilizers checks loss of nutrient. Subsequently, combined use of organic manure and inorganic sources of nutrient may increase the efficacy of applied inorganic fertilizers therefore improve crop productivity (Bhaduri *et al.*, 2014; Kavinder *et al.*, 2019; Jat *et al.*, 2020). The grain yield resulted a positive high correlation with protein yield ($Y = 0.0938X - 0.6966$, $R^2 = 0.9995$) and it might be due to application of inorganic fertilizer along with organic source of nutrients (Fig. 2). Likewise, Kakraliya *et al.*, (2017); Sheoran *et al.*, (2017) also found a strong positive relationship between growth dynamics and yield due INM in wheat.

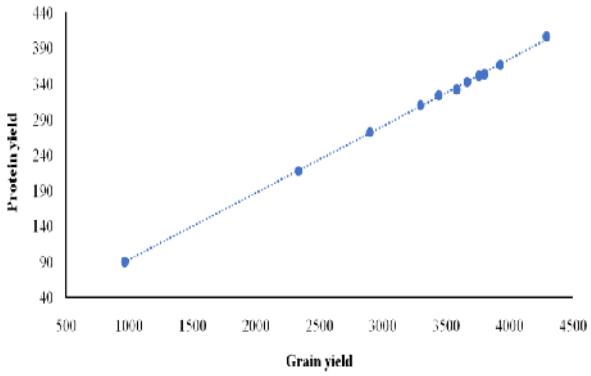

Fig. 2. Relationship between grain yield and protein yield of wheat.

CONCLUSION

Integrated nutrient management is an approach that seeks to increase crop productivity without compromising the quality of the produce and thereby help to meet future food demands. Therefore, from long term experiment of 36 years it may be concluded that substitution of 50% inorganic N by FYM and application of 50% RDF in rice followed by 100% RDF in wheat may be adopted for achieving higher productivity, protein content and protein yield in rice-wheat cropping system.

FUTURE SCOPE

1. Effect of different ratio of inorganic and organic sources of nutrients should be experimented with different crops.
2. Different green manuring crop should be tested for sustaining crop productivity, quality of produce and improving soil properties.

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Conflict of Interest. All authors have declared that there is no conflict of interest.

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