EFFECT OF OPTIMAL, SUB OPTIMAL AND INTEGRATED NUTRIENT MANAGEMENT ON PRODUCTIVITY AND ENERGETICS OF RICE (*ORYZA SATIVA*) IN RICE-WHEAT (*TRITICUM AESTIVUM*) CROPPING SYSTEM

Chandrashekhar Khare [1], Shrikant Chitale [2*], Manish Kumar Singh [3], Kanhaiya Lal Patel [4] and Priyanka Singh [5]

[1,2,3,4] Deptt. Of Agronomy, I.G.K.V., Raipur, Chhattisgarh - 492 006
[5] S.O.S. in Chemistry, Pt. R.S.U., Raipur, Chhattisgarh - 492 010
** Corresponding author Email: shrikantchitale029@gmail.com*

Abstract : The present investigation was carried out at the Research Cum Instructional Farm IGKV., Raipur (C.G.) having *Inceptisols* (*Matasi*) soil during *kharif* season of 2010. The experiment was laid out in randomized block design with 3 replications. The results revealed that amongst the different optimal, sub-optimal and integrated nutrient management practices using green manure, farmyard manure and chemical fertilizers, T_{10} consisting of 50% RDF + 50% N through green manuring recorded the highest growth, yield attributing characters and grain yield of rice (56.19 qha^{-1}). T_{10} also recorded maximum net return (Rs. 46,117 ha^{-1}), energy output (178.38 MJ x 10^3) and NPK content in soil. Application of 100% RDF (80:60:40 kg NPK ha^{-1}) also proved superior over other integrated nutrient management systems consisting farmyard manure and rice residues for yield (55.19 qha^{-1}) and energy output (176.75 MJ x 10^3).

Keywords : Energetic, Integrated nutrient management, Productivity, Rice-wheat cropping system, Yield potential

INTRODUCTION

The state is considered as "rice bowl" and the livelihood of almost 83% of rural population is depending only on rice cultivation. Although, during favorable monsoon years, the state relishes good production of an ever time record of 6.0 mt and 1.7 t.ha^{-1} productivity in the year 2010-11; the long-term productivity of rice in the state is remained below (1.3 t.ha^{-1}) to the national average.

In Chhattisgarh, the status of soil nitrogen is very low and addition of organic matter to the soil is not very much practiced and rice crop is completely depends upon soil and applied nutrient. Therefore to sustain as well as to increase the productivity of the crop, replenishment of nutrients drawn out from the soil system by the crop harvest becomes imperative. Incorporation of organic sources *viz*. green manures, FYM and recycling of crop residues along with NPK fertilizers in an integrated (nutrient) manner is effective in alleviating the nutrient deficiency in soil and enhances the yield potential as well. Moreover, such integration ameliorates the properties of the soil further for sustaining the productivity and profitability in a long-term basis. Hence, it is necessary to judiciously manage the inflow of organic sources of nutrients and their interaction with fertilizers in soil system.

MATERIAL AND METHOD

Grain and straw yield (q ha^{-1})

The crop from each net plot was harvested separately. The grains were separated from straw by threshing. The weight of grains was recorded and expressed in q ha^{-1} and the straw weight was worked out by subtracting the weight of grains from the bundle weight of the produce and expressed in q ha^{-1}.

Harvest index (%)

The harvest index was calculated by dividing the grain yield with biological yield (grain + straw yield) and multiplied by 100.

$$\text{HI}\ (\%) = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Energetics

Energy inputs were calculated and estimated in Mega Joule (MJ) ha^{-1} with reference to the standard values prescribed by Mittal *et al*. (1985).These inputs were taken to each treatment of rice. Energy values, which were taken for energy estimation. The standard energy coefficient for seed and straw of rice crop multiplied with their respective yields and summed up to obtained the total energy output. The Energy input for rice was calculated by adding the respective values. Energy output and input ratio, and energy productivity were calculated as per the following formula-

$$\text{Energy output input ratio} = \frac{\text{Energy Output (EO)}}{\text{Energy Input (EI)}}$$

$$\text{Energy productivity}\ \left(\text{g MJ ha}^{-1}\right) = \frac{\text{Mean grain yield, g}}{\text{Total energy input, MJ}}$$

RESULT AND DISCUSSION

Grain yield

The data presented in Table 1 clearly revealed that the yield of rice increased with increasing the levels of nitrogen from 50 to 100 % of RDF. Treatment T_{10} consisting of 50% RDF + 50% N as received from green manuring registered significantly highest grain

yield of rice (56.19 q ha^{-1}) which was significantly superior to the sub optimal doses of 50 % of RDF (T_2 and T_3), farmers' practice (T_{12}) and the control treatment (T_1). Painkray *et al*. (2001) also obtained significantly higher rice yield with *Sesbania* green manure Higher yield attributes *i.e.* number of effective tillers m^{-2}, grains $panicle^{-1}$ panicle length (cm) and panicle weight (g) in 100% RDF and/or integrated nutrient treatments led to differential yield of the various treatments (Kumari *et al*. (2007). The rice grain yield of other integrated nutrient treatments using GM or FYM or RR was also similar amongst them and was found to be significantly higher over farmer's practice with respect to rice yield. Integration of organic manure with inorganic fertilizer either with FYM at 50% N level (T_6) or with GM at 25% N level (T_{11}) or with rice residues of 50% N under T_8 and 25% N under T_9 respectively produced grain yield comparable to that of 100% chemical fertilizer treatment (T_5).

Superiority of combined application of urea and FYM over recommended fertilizer application was also reported by Choudhary and Thakur (2007). Even, the inorganic fertilizers treatment (50% dose of fertilizer under T_3) performed significantly to that of farmer's practice might be due to the residual effects of 100% NPK dose in wheat in same treatment during previous *rabi* season. While, the lowest yield of rice (13.63 q ha^{-1}) was recorded with no manures and fertilizers i.e. control. These findings indicated that integrated use of chemical fertilizers with FYM or GM or RR facilitates to curtail the use of expensive chemical fertilizers upto 50% and is a better alternative to use of full dose of recommended fertilizers (Gupta *et al*., 2006, Gill *et al*., 2008).

Straw yield

The Table 1 showed that the straw yield also followed almost same trend as of grain yield and the maximum straw yield (76.63 and 77.11 q ha^{-1}) was recorded in T_{10} and T_{11} consisting of 50% or 75% RDF + 50% or 25% N as received from green manuring respectively. This was significantly superior over T_1, T_2, T_3, T_4, T_8, T_9 and T_{12} and at par with T_5, T_6, and T_7. However, unlike to grain yield, application of rice residue as a source of N did not show its effect on straw yield and failed to produce as good as straw to that of GM and FYM. Pandey *et al*. (2007) also found higher straw yield with the application of FYM in conjunction with fertilizer NPK as compared to those where it was not supplemented.

Harvest index

Although, the highest harvest index (43.31) was calculated in sub-optimal dose of N (50% of recommended) in T_3 but it was remained at par with all the optimal doses of nutrients either applied in integrated manner or given as 100% from NPK fertilizer because proportionate increase in grain and straw yield under all these treatments remained same. Furthermore, all the optimal doses showed significantly higher values of harvest index over control and farmers' practice (Table 1).

Energy analysis

The data related to energy input, energy output and energy parameters viz. energy output -input ratio and energy productivity are presented in Table 2. The data revealed that energy output and energy parameters of rice were significantly affected due to different nutrient management options used. The lowest values of all energy parameters were obtained under control where rice was grown without fertilizers and manures. As regard to the response of energy parameters to different optimal, sub-optimal and integrated nutrient management adopted in rice, in general, owing to the higher yields the total output energy, recorded significantly the maximum (178.38 MJ x 10^3) where integration of 50% N through GM with 50% RDF (T_{10}) were opted and closely followed by 50% N integration with FYM (T_6) and 75% N through GM (T_{11}). However, in case of 100% RDF level (T_5), input: output energy ratio was significantly lower (9.50) as compared to integrated nutrient management options due to higher energy input in terms of inorganic fertilizers. Interestingly, despite of lowest grain and straw yield and output energy recorded, the input; output ratio and energy productivity were significantly maximum under T_1 as compared to all the other optimal, sub-optimal and integrated treatments due to not applying any of the nutrient under this treatments which resulted in smaller amount of energy

Table 1. Effect of different nutrient management on No. of tillers, grain yield, straw yield and harvest index of rice

Treatment		Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	HI
T_1	No fertilizer, no manure (control)	13.63	22.73	37.52
T_2	50% RDF	34.79	49.97	40.55
T_3	50% RDF	39.63	51.95	43.31
T_4	75% RDF	42.58	61.17	41.04
T_5	100% RDF	55.19	76.50	41.90
T_6	50% RDF+50% N (FYM)	55.10	76.75	41.79

T_7	75% RDF+25% N (FYM)	53.42	74.06	41.89
T_8	50% RDF+50% N (RS)	54.29	72.36	42.87
T_9	75% RDF+25% N (RS)	53.54	71.44	42.83
T_{10}	50% RDF+50% N (GM)	56.19	76.63	42.25
T_{11}	75% RDF+25% N (GM)	54.50	77.11	41.40
T_{12}	Farmers' practice 50:30:20 NPK kg ha^{-1}	30.27	49.04	38.15
SEm±		2.24	1.29	1.66
CD 5%		6.58	3.79	4.88

Table 2. Energy analysis of different nutrient management systems

Treatment		Input energy (MJ x 10^3)	Out put energy (MJ x 10^3)	Input: output energy ratio	Energy productivity
T_1	No fertilizer, no manure (control)	3.58	48.44	13.55	381.12
T_2	50% RDF	11.09	113.61	10.25	313.83
T_3	50% RDF	11.09	123.18	11.11	357.43
T_4	75% RDF	14.84	139.06	9.37	286.93
T_5	100% RDF	18.60	176.75	9.50	296.74
T_6	50% RDF+50% N (FYM)	16.29	176.94	10.86	338.19
T_7	75% RDF+25% N (FYM)	17.45	171.10	9.81	306.20
T_8	50% RDF+50% N (RR)	16.29	170.26	10.45	333.20
T_9	75% RDF+25% N (RR)	17.45	168.01	9.63	306.92
T_{10}	50% RDF+50% N (GM)	16.29	178.38	10.95	344.84
T_{11}	75% RDF+25% N (GM)	17.45	176.50	10.12	312.41
T_{12}	Farmers' practice 50:30:20 NPK kg ha^{-1}	12.39	105.80	8.54	244.36
SEm±		-	3.23	0.30	18.66
CD 5%		-	9.48	0.90	54.74

REFERENCES

Mittal, V.K., Mittal, J.P. and Dhawan, K.C. (1985). Resource digestion on energy requirement in agriculture sector (1972-82). ICAR/AICRIP/ERAS/85 (1), Ludhiana pp 159-163.

Paikray, R.L., Mahapatra, B.S. and Sharma, G.L. (2001). Integrated nitrogenmanagement in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Indian J. Agron.* **46** (4): 592-600.

Choudhary, S.K. and Thakur, R.B. (2007). Efficient farmyard manure management for sustained productivity of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Indian J. of Agric. Sciences* **77** (7): 443-444.

Gill, M.S, Pal S.S. and Ahlawat I.P.S. (2008). Approaches for sustainability of rice rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system in Indo-Gangetic plains of India. *Indian J. Agron.* **53** (2): 81-96.

Gupta, V., Sharma, R.S. and Vishwakarma, S.K. (2006). Long-term effect of integrated nutrient management on yield sustainability and soil fertility of rice (*Oryza sativa*)- wheat (*Triticum aestivum*) cropping system. *Indian J. Agron.* **51** (3): 81-96.

Kumari, N., Singh, A.K., Pal, S.K. and Thakur, R. (2007). Effect of organic nutrient management on yield, nutrient uptake and nutrient balance sheet in sented rice (*Oryza sativa*). *Indian J. Agron.* **55** (3): 220-223.

Pandey, N. and Verma, A.K., Anurag and Tripathi R.S. (2007). Integrated nutrient management in transplanted hybrid rice (*Oryza sativa*). *Indian J. Agron.* **52** (1): 40-42.