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Impact of integrated nutrient management on performance of rice under system of rice intensification (SRI)

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ABSTRACT

Field experiment was conducted during season 2008-09 on up-medium land situation at 'C' Block (Incheck) Farm, Kalyani, BCKV to study the effect of combination of organic manures and inorganic fertilizers on rice production using SRI technology. The experimental results revealed that the best result was obtained with application of 75% N (Enrich Adhar) + 25% N (Urea) + PK and consequently an increase in grain yield by 27.63%, 28.98% and 20.94% was observed over full NPK (60:30:30), 75% N (urea) + PK and farmers' practice treated plots respectively. The corresponding increases in straw yields were 23.38 24.4 and 17.73% respectively. Organic sources of plant nutrient also showed positive effect on other yield attributes such as panicle length, tiller number and filled grains per panicle. The effect of different treatments on availability of soil nutrients also showed that application of integrated plant nutrients showed better results and application of 75% N (Enrich Adhar) + 25% N (urea) + PK resulted in highest nitrogen percentage, available phosphorus and potassium respectively, while the lowest was from sole application of NPK through inorganic nutrient sources.

***Keywords*:** Integrated nutrient management, SRI, yield attributes, yield

Rice cultivation is the most important agricultural operation in the country, not only in terms of food security but also as an assurance to livelihood. Rice contributes to nearly 15 per cent of India's annual gross domestic product (GDP) and provides 43 per cent of the calorie/protein requirement for more than 70 per cent Indians. The country need to increase its food grain production to 450 million tonnes by the year 2050 to sustain its food security. This means the future of rice production has to come by improving yields. The System of Rice Intensification (SRI) introduced in India in 2000 provides an option to improve yields besides reducing input use. Available data from SRI experiments across the country show an increase in grain yield up to 68.3 per cent (Gujja and Thiyagarajan, 2008).

In any system, productivity can be achieved by increasing the efficiency of factors of production such as land, labour, capital and water which is judiciously exploited in SRI system involving adoption of a set of agronomic practices. In recent times, it is gaining importance as a promising system to attain higher productivity and profitability by conserving natural resources. Integrated nutrient management provides an approach for feeding rice plant with nutrients as and when needed. SRI increases the productivity per unit area with proactive interactions between the plant, soil, water and nutrient. Building up of soil organic matter and acceleration of microbial activity are subjects of SRI strategy research. Hence supply, availability and uptake of nutrients, changes in the soil profile and the changes occurring in the soil and crop scenario in SRI under organic manure and inorganic fertilizer applications have been studied.

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MATERIALS AND METHODS

The field experiment was conducted at Kalyani 'C' Block Farm, BCKV, West Bengal (22°56' N latitude, 88°32' E longitude and at an altitude of 9.75 m above MSL). The soil was typical Gangetic alluvial (*i.e.,* inceptisol), sandy loam in texture with a soil pH of 6.77, of medium fertility status with low water holding capacity having carbon content (5.9 g kg^{-1}), total nitrogen (0.06%), available phosphrous (18.9 kg ha^{-1}) and available potassium (132.5 kg ha^{-1}).

The experiment was carried out in a randomized block design having seven treatments with four replications and the size of each plot was 4 x 3m. The treatments consisted of T_1 – full NPK (60:30:30); T_2 – 75% N (urea) + PK; T_3 – 50% N (enrich adhar) + 50% N (urea) + PK; T_4 – 50% N (enrich adhar) + 40% N (urea) + PK; T_5 – 75% N (enrich adhar) + 25% N (urea) + PK; T_6 – 75% N (enrich adhar) + 20% N (urea) + PK and T_7 – farmers practice (60:30:30 kg N, P and K) + neem cake 1 t ha^{-1}.

The rice variety Khitish (IET 4094) was used as test variety and the seeds were treated with *Trichoderma viride* @ 4g kg^{-1} before being sown in a sand bed for germination. Enrich adhar is a bio-fertilizer prepared from the sea weed, *Ascophylum*

nodosum, very rich in macro and micro nutrients enriched with different enzymes. It contains C (16.2%), N (2.7%), P_2O_5 (2.5%) and K_2O (3.0%). Single transplanting was done in puddled soil using 10 days old rice seedlings with a spacing of 20 x 20 cm in the first week of July. The soil was fertilized according to the treatments. Enrich adhar was applied at the time of final land preparation along with full doses of 30 kg ha $^{-1}$ phosphorus through single super phosphate and 30 kg ha $^{-1}$ potassium through muriate of potash. The nitrogen @ 60 kg ha^{-1} through urea was applied in four equal splits; at basal, 15, 40 and 70 DAT. For nitrogen application, urea was mixed with soil and top dressing was done one day after irrigation. For the control of weeds, pretilachlor 30.7 EC @ 500 g ha^{-1} was applied at 1 DAT along with two hand weedings at 15 and 40 DAT respectively. The crop was harvested in the first week of November.

Observations on biometric and yield attributing characters were taken from five selected hills of each plot. Total nitrogen was estimated by modified micro-kjeldahl method as described by Jackson (1973). The available P_2O_5 was estimated by the Bray and Kurtz method (1945) and the available K_2O was estimated by flame photometer (Jackson, 1973). Data were analyzed using ANOVA and the significance was tested by Fisher's least significance difference (p= 0.05).

RESULTS AND DISCUSSION

There were positive and significant effects of organic and inorganic combination of fertilizers on system of rice intensification (SRI). The results in Table 1 show that the maximum yield of 4.85 t ha^{-1} was obtained from treatment 75% N (enrich adhar) + 25% N (urea) + PK which was significantly higher than all the other treatments to the tune of 27.63, 28.98 and 20.94% grain yield increase over full NPK (60:30:30), 75% N (Urea) + PK and farmers' practice (60:30:30) + neem cake 1 t ha^{-1} applied plots respectively. Treatments T_3, T_4 and T_6 also recorded higher grain yields of 4.29, 4.27 and 4.58 t ha^{-1} respectively. Treatment 75% N (Urea) + PK recorded the lowest grain yield of 3.76 t ha^{-1} and was *at par* with treatment Full NPK (60:30:30). The prime factors for increased rice yield were attributed to improved yield attributing characters like increased panicle length, filled grains per panicle and increased number of productive tillers which were also the highest in the integrated nutrient applied plots. The straw yield was also increased by 23.38, 24.42 and 17.73% over full NPK (60:30:30), 75% N (urea) + PK and farmers' practice (60:30:30) + neem cake 1 t ha^{-1} applied plot. It was also observed from the data that maximum harvest index (45.07) was observed in 75% N (enrich adhar) + 25% N (urea) + PK. Lowest value (44.18) of harvest index was recorded from the treatment T_2 *i.e.* 75% nitrogen through urea along with phosphorus and potash. It has been observed that comparatively more biomass of the vegetative plant parts was accompanied with T_2 treatment. However, the treatments T_3 and T_6 were statistically *at par* with T_5 treatments. Similar kind of result was also observed by Hossain *et al.* (2003) from an experiment where they studied the performance of rice cv. BRRI Dhan 32 grown under a system of rice intensification (SRI) and conventional planting techniques using organic and inorganic fertilizer with different root placement methods. Lokanadhan (2008) reported higher grain yield to the tune of 20.6% in CORH3 rice hybrid and 17.2% in ADT43 rice variety with application of both organic and inorganic fertilizer together.

The data on soil nutrients (Table 1) revealed that the highest nitrogen percentage of 0.0724% was recorded from treatment 75% N (enrich adhar) + 25% N (urea) + PK and was *at par* with 75% N (enrich adhar) + 20% N (urea) + PK. The plots where inorganic fertilizers were applied showed the least increase in residual nitrogen. Similar trends were also observed in case of available phosphorus and potassium (23.83 kg ha^{-1} and 175.27 kg ha^{-1}) respectively. However, the overall available phosphorus and potassium after crop harvest decreased from initial level in case of inorganic plant nutrient applied plots. Positive balances of nutrients *i.e.* increase in nitrogen %, available Phosphorus (kg ha^{-1}) and available Potassium (kg ha^{-1}) after harvesting of paddy was found in all cases of organic plant nutrient applied plots. This might be due to increased enzymatic activity and lower fixation of nutrients like P and K due to addition of organic matters, crop residues during the crop growth period (Ghosh *et al*, 2008).

It was found that the combined application of organic and inorganic sources of plant nutrients as 75% N (enrich adhar) + 25% N (urea) + PK gave better results in improving the growth parameters and increased grain yield subsequently. Other treatments like 50% N (enrich adhar) + 50% N (urea) + PK, 50% N (enrich adhar) + 40% N (urea) + PK and 75% N (enrich adhar) + 20% N (urea) + PK also showed better results. Thus, the performance of the rice variety IET-4094 through SRI was best when the organic manure enrich adhar was combined with the inorganic sources of plant nutrients in respect of grain production, plant

Table 1: Performance of SRI rice and soil nutrient status under different nutrient management technique

Treatment	Tiller per m^{-2}	Panicle length (cm)	Test weight (g)	Filled grain $panicle^{-1}$	Yield (t ha^{-1})		
					Grain	Straw	Harvest index (%)
T_1: Full NPK (60:30:30)	442.11	23.17	20.35	80.30	3.80	4.79	44.24
T_2: 75% N (urea) + PK	435.25	23.36	20.72	74.70	3.76	4.75	44.18
T_3: 50% N (EA) + 50% N (urea) + PK	466.13	24.84	20.99	95.50	4.29	5.29	44.78
T_4: 50% N (EA) + 40% N (urea) + PK	470.75	24.77	21.44	93.26	4.27	5.34	44.43
T_5: 75% N (EA) + 25% N (urea) + PK	499.24	26.31	21.96	101.60	4.85	5.91	45.07
T_6: 75% N (EA) + 20% N (urea) + PK	481.27	25.97	21.34	96.25	4.58	5.62	44.90
T_7: farmers practice (60:30:30) + Neem cake 1 t ha^{-1}	452.50	24.50	20.92	88.42	4.01	5.02	44.41
S.Em (±)	**5.01**	**0.37**	**0.81**	**3.79**	**0.09**	**0.11**	**0.21**
LSD (0.05)	**14.89**	**1.11**	**NS**	**11.25**	**0.26**	**0.32**	**0.63**

Table 2: Effect of nutrient management options on total N and available P and K in rhizosphere soil after harvest of SRI rice

Treatment	Total nitrogen (%)	Available phosphorus (Kg ha^{-1})	Available potassium (Kg ha^{-1})
T_1: Full NPK (60:30:30)	0.0572	16.17	117.24
T_2: 75% N (Urea) + PK	0.0575	16.45	119.36
T_3: 50% N (EA) + 50% N (Urea) + PK	0.0663	22.14	168.30
T_4: 50% N (EA) + 40% N (Urea) + PK	0.0652	21.87	161.27
T_5: 75% N (EA) + 25% N (Urea) + PK	0.0724	23.83	175.27
T_6: 75% N (EA) + 20% N (Urea) + PK	0.0683	22.67	170.63
T_7: Farmers practice (60:30:30) + Neem cake 1 t ha^{-1}	0.0609	20.49	142.66
S.Em (±)	**0.003**	**0.63**	**6.12**
LSD (0.05)	**0.008**	**1.86**	**18.19**

EA+ Enrich adhar, 0.0564, 18.91 and 132.5 are the initial NPK status of the soil.

growth performance and soil health improvement rather than the NPK applied through inorganic sources only.

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