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Nutrient optimization on growth and productivity of rice in the red and lateritic belt of West Bengal

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Rice is the most important and extensively cultivated food crop, which provides half of the daily food for one of every three persons on the earth. In Asia alone, more than two billion people obtain 60 to 70 per cent of their energy intake from rice and its derivatives. The major rice growing areas are West Bengal, Andhra Pradesh, Odisha, Jharkhand and Tamil Nadu. Rice production in India is an important factor for food security. However, little is known about the sustainability of the current production systems, particularly systems with triple cropping under minimum practice. Among the various cropping systems, rice based cropping systems are the predominant systems in India. Managing the variability in soil nutrient supply that has resulted from intensive rice cropping is one of the challenges for sustaining and increasing rice yield in India. Site Specific Nutrient Management (SSNM) provides an approach for "feeding" rice with nutrients as needed. Researchers developed the SSNM approach in the mid-1990s and evaluated it from 1997 to 2000. SSNM was evaluated and promoted with farmers at about 20 locations in tropical and subtropical Asia. Each is representing an area of intensive rice farming on more than 100,000 ha with similar soils and cropping systems. The SSNM approach does not provide one universal nutrient management practice for rice, instead, enables the tailoring of nutrient management to field and location specific conditions. Site-specific nutrient management through soil-test recommendation based should be adopted to improve upon the existing yield levels obtained at farmers' field for effective management of natural resources, integrated approach to plant-water- nutrient management. Not much work have been done to study the SSNM practice in Hybrid rice in the lateritic soil of West Bengal. In this context, the present investigation was carried out to study the effect of site specific nutrient management on the physiological basis of yield variation of Hybrid Rice and to study the effect of site specific nutrient management on the yield and productivity of Hybrid Rice. There is great variation in the indigenous nutrient supply among soils within a rice growing domain, although the general perception used to be that irrigated rice lands are rather homogeneous in their natural resources. This variability depends on a number of factors, such as the method of land preparation, irrigation management practices, condition of the soil during fallow period, the activities of micro organisms in the soil, etc. (Cassman *et al.,* 1995, Kundu and Ladha, 1995) whereas fertilizer recommendation to rice are generally provided uniformly on provincial or regional basis. Therefore, grain yield and fertilizer use efficiency of farmers' fields, which followed the regional fertilizer recommendation, were lower than that achieved in research stations (Tan, 1996). Raised an issue whether site - (field-) specific recommendation for NPK fertilizer management will perform better over the short and long run than the current practices of rice farmers in the Mekong Delta (Vietnam). The purpose of this study was to quantify the magnitude of variation in the indigenous nutrient supply. to compare the productivity and nutrient efficiency of site-specific nutrient management (SSNM) and farmers' fertilizer practices (FFP) in intensive irrigated rice production systems in the Mekong Delta of Vietnam.

The objective is to study the effect of site specific nutrient management on the physiological basis of yield variation of Rice. A field experiment was conducted in the *Boro* season of 2013-2014 at the farmers' field, Binuria, Birbhum, West Bengal. to study the effect of nutrient optimization on growth and productivity of rice under the red and lateritic soil of West Bengal. The Hybrid rice variety was 'TEJ' and the HYV local improved variety were used. The field was situated at 23° 39'N latitude and 87° 42'E longitudes with an average altitude of 58.9 m above mean sea level under sub-humid, sub-tropical belt of West Bengal. The soil of the experimental plot was sandy loam in texture (60.0% sand, 23.2% silt and 16.7% clay), acid in reaction (pH 5.7) medium in

Short Communication
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organic carbon (0.63%) and available N (193.4 kg ha^{-1}), low in available P (12.4 kg ha^{-1}) and available K (171.0 kg ha^{-1}) status. The experiment was laid out in Randomized Block Design with five replications in 5 m x 5 m plots with nine nutrient management treatments- (T_1) :Ample dose of N+P+ K+ S + Zn, (T_2) P+K + S + Zn, (T_3) N+K + S + Zn, (T_4) N+P + S + Zn, T_5: N+P+K + Zn T_6: N+P+K +S, (T_7) Local variety under the unfertilized check, (T8) Local variety under ample fertilizer treatment, (T9) Control (without any fertilizer, but plant protection measures will be taken in hybrid rice). The rice varieties 'TEJ' and local improved variety were transplanted on February 12, 2014 taking single seedling per hill at spacings of 20cm x 15 cm where both the varieties transplanted with single seedlings. Both the varieties matured in 100-110 days after transplanting during *Boro* season under lateritic belts of West Bengal. The crop was irrigated as and when required. Insects were controlled by chemicals to avoid biomass and yield loss. No fungicide was applied during the study. The weeds were removed manually at 20 and 40 days after transplanting (DAT). Harvesting was done on 24th May 2014.

The fertilizers were applied in the plots after layout as per treatments. The sources of fertilizers for Nitrogen, phosphorus and potash was urea, DAP and MOP respectively. Sulphur was applied with source of elemental sulphur and zinc with cheated zinc. Half dose of nitrogen was given at the time of planting and remaining half in two equal splits at tillering and panicle initiation stage of crop growth. The first top dressing of nitrogen was done at mid-tillering (20 days after transplanting) on March 4, 2014. After top dressing of remaining nitrogen was done in two equal application one each at maximum tillering (35 DAT) and at panicle initiation stage (55 DAT).

The observations on growth parameters were analyzed statistically and presented in the table 1. The results showed that the plant height of rice at 90 DAT attained up to 96 cm. SSNM practice showed positive and favourable effect on improving almost all the growth attributes of rice varieties recorded under the study. It exerted significant effect on increasing the growth attributes such as plant height, tiller_m^{-2}, leaf area index (LAI) and dry matter accumulation (DMA) of rice varieties. T1 and T8 treatments with ample dose (N+P+K+Zn+S) show significantly higher yield than other treatments (omission –N,-P,-K,-Zn,–S and control) from SSNM management point of view.

The variety TEJ receiving ample dose (N+P+K+Zn+S) show significantly higher growth attributes compared to that crop variety IR36 receiving same ample dose. The SSNM practices significantly outperformed most of the other treatments (omission –N,-P,-K,-Zn,–S and control) in respect of the growth attributes of rice varieties. In case of supply of nutrient either by omitting the N,P,K,Zn,S considerably reduce the growth attributes which ultimately reduce the growth and yield of the crop Similar results were also reported by several workers Yadav *et al.* (2007) and Ge Li el.al. (2013). The yield attributes like number of panicles m^{-2}, panicle length, number of spikelets $panicle^{-1}$, number of filled grains $panicle^{-1}$ and test weight (1000-grain weight) recorded at maturity were presented (Table 2). Yield attributes increased with ample dose of NPK along with application of Zn and S (as per treatments) as to no fertilizer application. The SSNM treatment gave the highest values of yield attributes and yield of rice. Omission of –N,-P,-K,-Zn and -S from SSNM treatment resulted in reduction in yield attributes of rice. Similarly NPK Zn and S also influenced yield attributes of rice positively during season and if omitted, a notable reduction in yield attributes was observed which ultimately decreased the yield. These results are in also conformity with the works reported by Nanjappa *et al.* (*2013*)

Table 1: Effect of site specific nutrient management on growth attributes of hybrid rice

Treatment	Plant Height (cm)	Dry matterg m^{-2}	Tiller m^{-2}	LAI
	90 DAT	**90 DAT**	**90 DAT**	**60 DAT**
NPKSZN	96.55	1167	773.63	5.80
-N 87.02	988	582.23	5.07	
-P 92.38	1142	767.91	5.64	
-K 92.54	1150	706.31	5.71	
-S 94.91	1121	703.23	5.68	
-Zn	91.44	1148	732.71	5.70
Unfert local	86.09	882	565.51	4.95
Fert local	96.25	1165	746.79	5.81
Control	81.84	983	546.32	4.40
Sem(±)	**2.11**	**20.04**	**32.97**	**0.12**
LSD(0.05)	**6.07**	**60.07**	**94.97**	**0.36**

The performance of site specific nutrient management treatment was better over omission plot practice for rice. It indicates that we need to revise the recommendation domain of rice owing to ever declining soil health, especially for some of the macronutrients particularly primary and secondary nutrients and micro nutrient.

Ample dose of nutrient probably exerted a positive effect on the development of source and sink relationship of plant which is ultimately resulted in higher yield attribute. Grain and straw yield increased significantly where ample dose of NP K Zn and S was applied.

The maximum grain yield of TEJ (6.73 t/ha) and IR36 (4.19 t/ha) was obtained with SSNM treatment. T1 and T8 treatments with ample dose (N+P+K+Zn+S) recorded significantly higher yield than other treatments (omission –N,-P,-K,-Zn,–S and control) from SSNM management point of view. Similar finding was also reported by Singh *et al.* (2008), Khurana *et al*. (2008), and Singh & Bansal (2010).

Grain yield advantage with treatment T1 and T8 was higher over the omission plots and unfertilized local variety (control). Omission of -N,-P,-K,-Zn and -S from SSNM resulted decrease in grain yield by 22-25 percent. Grain yield was found positively correlated with yield attributing trait namely number of panicles m^{-2}, panicle length, number of spikelets $panicle^{-1}$, number of filled grains $panicle^{-1}$ and test weight.

Table 2: Effect of site specific nutrient management on yield attributes of hybrid rice

Treatment	Number of panicles m^{-2}	Number of filled grains panicle^{-1}	Number of spikelets Panicle^{-1}	Length of panicle (cm)	Test weight (g)
NPKSZN	278.22	145.30	153.03	31.37	23.74
-N	254.42	121.71	133.29	23.79	21.64
-P	274.68	136.05	153.15	28.85	23.30
-K	274.31	132.68	147.49	29.10	22.74
-S	276.42	136.72	146.59	28.97	23.24
-Zn	272.53	135.93	153.86	28.98	23.42
Unfertlocal	252.69	121.46	124.06	26.21	14.14
Fert local	281.38	137.27	158.13	30.79	23.23
Control	235.18	101.16	122.98	21.09	20.16
SEm (±)	**4.90**	**1.89**	**11.09**	**0.33**	**0.57**
LSD (0.05)	**14.11**	**5.67**	**13.29**	**0.98**	**1.70**

Table 3: Effect of site specific nutrient management on yield of hybrid rice

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
NPKSZN	6.73	7.48	47.25
-N	3.91	5.08	43.47
-P	5.78	6.41	47.36
-K	5.94	6.28	48.41
-S	6.27	7.15	46.92
-Zn	6.37	7.39	46.46
Unfert local	3.54	4.53	43.98
Fert local	6.19	6.27	49.65
Control	2.74	4.08	40.60
Sem(±)	**0.33**	**0.39**	**1.74**
LSD (0.05)	**0.97**	**1.18**	**5.23**

Increase in grain yield with NPK along with the application Zn and S might be attributed to significantly increase in the yield of rice were also reported by Gill (2006) advocated the use of balance site specific nutrient management in combination with micronutrients which may break the yield barrier which is similarly reported by Kumar and Yadav (2010). Pramanik *et al.* (2012),Mauriya *et al.* (2013). It can be concluded that in this Lateritic region of West Bengal, the rice crop variety 'TEJ' and local improved variety gave good responses to the application of Site specific nutrient management during the critical growth stages like plant height, dry matter, LAI, yield parameter and yield. Yield target for the *Boro* season was 7.0 t ha^{-1}. The dose of nutrients in T1 was 200:80:90:20:5 kg ha^{-1} of N: P_2O_5: K_2O: S: Zn, whereas T2 to T6 were omission plots like (-N, -P, -K, -S, -Zn) to estimate indigenous nutrient supplies. Enhancement of growth attributes, yield components and yield were recorded where ample dose of N + P + K + S + Zn was applied as compared to control. The ample dose of nutrient supplied in high yielding rice increased grain yield by 22 % as compared to the omission plot and also the same case for indigenous rice variety.

REFERENCES

Cassman, K. G., Datta, S. K. De., Olk, D. C., Alcantara, J. M., Samson, M. I., Descalsota, J. P and Dizon, M. A. 1995. Yield decline and nitrogen economy of long- term experiments on continuous, irrigated rice systems in the tropics. In: (R. Lal and B. A. Stewart Edis.), *Soil Management: Experimental basis for Sustainability and Environmental Quality.* Lewis/CRC Publishers, BocaRaton, Florida, pp. 181-222.

Ge Li, Li Ma, YiHu Bian, JinLong Wang, ZhiQin Yang, Jian Chang and Liu LiJun, 2013. Effects of returning maize straw to field and site-specific nitrogen management on grain yield and quality in rice.*Chinese J. Rice Sci.* **27**:153-60.

Gill,M.S.2006. Sustaining high yield of rice- wheat system through site-specific nutrient management in Punjab. *Indian J. Ferti.* ***2**:45-50*

Khurana, H. S., Singh B Boverman., Phillips, A., Siddhu, S.B., and Singh, Y. 2008. Site-specific nutrient management rice-wheat cropping system: *Better Crops,* **92***:*26-28.

Kumar, A. and Yadav, V. K. 2010.Effect of site specific nutrient management on maximizing yield of rice-wheat. *Green Farm.;* **1**:165-66.

Kundhu, D K and J K Ladha. 1995. Efficient use of soil and biologically fixed nitrogen in intensively cultivated rice fields. *Soil Biol.Biochem.* **27**: 431-39.

Mauriya, A. K., Maurya, V. K., Tripathi, H. P., Verma, R. K. and Radhey Shyam. 2013. Effect of site-specific nutrient management on productivity and economics of rice(*Oryza sativa*)-wheat (*Tritucum aestivum*) system. *Indian J. Agron..* ***58**:*282-87.

Nanjappa, A. S., Ramachandrappa, H. V., Hittalmani, B. K. and Shailaja Basavaraj, P. K. 2013. Performance of aerobic rice (*Oryza sativa* L.) genotypes under site specific nutrient management (SSNM).*Res.Crops.* **14**:350-56.

Pramanik, K. and Bera, A.K. 2012. Response of different nitrogen levels and homo-brassinolide on yield and economics of hybrid rice (*Oryza sativa* L.). *J. Crop Weed*. **8**: 86-90

Singh, H. and Bansal, S.K. 2010. A review of crop production and soil fertility as releted to nutrient management in the Indo-Gangatic plane of India. *Better Crop-South Asia:* 27-29.

Singh, V.K., Tiwari K.N., Gill, M.S., Sharma S.K., Dwivedi,B.S., Shukla A.K., and Misra, P.P. 2008. Economic viability of site-specific nutrient management rice(*Oryza sativa*)-wheat (*Tritucum aestivum*) cropping system: *Better Crops.* **92**:28-30.

Tan, P. S. 1996. Nitrogen use efficiency in relation to indigenous soil N supply in Mekong Delta intensive lowland rice systems. Paper presented at the workshop on: *"Reversing Trends of Declining Productivity in Intensive Irrigated rice System"* at IRRI from 28 October to 01November 1996.

Yadav, M. P., Tiwari, U. S. and Raj, J. 2007. Studies on site specific nutrient management (SSNM) for maximization of yield and economics in hybrid rice (*Oryza sativa*). *Pl. Archives;* **7**:795-98