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Effect of organic and inorganic sources of plant nutrients on growth and yield of rice (*Oryza sativa*) and soil fertility

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ABSTRACT

A field experiment was conducted in randomized block design during the rainy (*kharif*) season of 2012 at Varanasi, Uttar Pradesh to study the effect of organic and inorganic sources of nutrients on soil quality and productivity of rice (*Oryza sativa* L.). The highest grain and straw yields (5.03 and 7.18 t/ha) were recorded under the treatments 100% recommended dose of fertilizer (RDF) + S-Zn-B and 75% RDF + 25% N through sewage sludge, respectively. Application of S (40 kg/ha), Zn (5 kg/ha) and B (1.5 kg/ha) along with NPK (120:60:60) in rice increased plant height, tiller number, grain yield and 1,000-grian weight 22, 99, 62 and 22%, respectively, over the control, but did not show any significant increase in these parameters over 100% RDF. Initial trends indicated that application of *Sesbania* perhaps increased N, P, B and Zn in soil while inorganic S, B and Zn fertilizers had residual effect in post-harvest soil.

Key words : Customized fertilizer, Rice, *Sesbania,* Sewage sludge, Vermicompost

Rice is one of the most important cereal crops of the world. Presently more than 90% of total rice production and consumption is in Asia. Nutrient management in soil is an important aspect for increasing yield of rice. The major plant nutrients (N, P, K and S) and micronutrients (Fe, Zn, Mn, B and Mo) are deficient in several regions of the country (Katyal and Rattan, 1995) which is a major challenge for sustainable rice production. Extractive farming has depleted inherent nutrient reserves and negative nutrient budget has been created. Consequently, both rice yield and response to applied chemical fertilizers have declined. Application of higher amount of high-analyses chemical fertilizers along with a minimal input of organic sources of nutrients is a major reason for deficiencies of secondary and micronutrients, particularly of S, Zn and Fe (Takkar, 1996). Data from long-term experiments showed that neither organic sources nor chemical fertilizers can alone sustain crop production. Therefore, an integrated approach on application of organic and inorganic sources of plant nutrients is a prudent strategy which can maintain higher productivity by alleviating nutrients deficiencies on one hand and creating favourable physical and soil ecological conditions on the other. Hence present study was carried out to assess the effect of organic and inorganic sources of nutrients on growth, yield and soil fertility under 'HUR 105' rice cultivation.

The field experiment was conducted at the Agricultural Research Farm, Banaras Hindu University, Varanasi, Uttar Pradesh during the rainy (*kharif*) season of 2012. The farm lies in the Northern Gangetic Alluvial plain (25°18' N, 83°03' E at 129 m above the mean sea-level). The soil was sandy loam having pH (8.18), electrical conductivity (0.18 dS/m), organic carbon (0.47%), available N (138.5 kg/ha), P (23.5 kg/ha), K (139.1 kg/ha) and S (20.7 mg/kg). The DTPA-extractable Fe, Mn, Cu, Zn and hot water-extractable B levels in soil were 32.7, 1.6, 1.4, 0.5 and 0.6 mg/kg, respectively. The population of bacteria, fungi and actinomycetes were 18×10^6, 14×10^6 and 13×10^5 CFU/g in initial soil. The sewage sludge, vermicompost and *Sesbania* had 1.4, 1.3 and 3.2% N, respectively. The experiment was laid out in a randomized block design in 8.0 m × 3.2 m net plot size, involving 3 replications. Seven

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treatments included control, recommended dose of fertilizer (RDF) NPK @ 120:60:60 kg/ha, RDF + S, Zn, B (40:05:1.5 kg/ha), customized fertilizer with composition of N:P:K:Zn:B;11:32:13:0.9:0.24% @ 312.5 kg/ha, 75% RDF + 25% N through sewage sludge, 75% RDF + 25% N through vermicompost, 75% RDF + 25% N through *Sesbania*. The N, P, K, S, Zn, and B were applied through urea, diammonium phosphate (DAP), muriate of potash (MOP), gypsum, zinc sulphate and borax, respectively. Half dose of N and full dose of P_2O_5 and K_2O was applied basal. Remaining N was applied in 2 equal splits at 30 and 60 days after transplanting (DAT). The quantities of organic manures were calculated on the basis of their nitrogen content and incorporated in plots on dry-weight basis 10 days before transplanting. Twenty-five-day old seedlings of rice were transplanted at a distance of 20 cm from row to row and 15 cm from plant to plant.

The soil samples were analysed for *p*H, EC, organic carbon, available N, P and K following standard methods. Available sulphur (0.15% $CaCl_2$-extractable) was estimated by turbidimetric method (Chesnin and Yien 1951). For analysis of Fe, Cu, Mn and Zn, soil samples were extracted by 0.005 M DTPA containing 0.01 M $CaCl_2$ and 0.1 M TEA (*p*H 7.3) (Lindsay and Norvell, 1978) and analysed by atomic absorption spectrometer (UNICAM 969). Available B in soil was extracted by hot water $CaCl_2$ and determined by using azomethine-H indicator (Sparks, 1996). Finely-ground plant, sewage sludge, vermicompost and *Sesbania* samples were digested in a di-acid mixture (HNO_3:$HClO_4$: 3:1 v/v). For determination of total N, samples were digested in concentrated H_2SO_4. The diacid digest was used for analysis of P, K, Zn and B (Tandon, 2001).

Plant height did not differ significantly among organic and inorganic sources of plant nutrients (Table 1). The tiller/hill increased significantly, minimum being in the control and the maximum in RDF + S Zn B at 60 DAT, which was 50% higher over the control. The tiller count was similar in RDF, customized fertilizer and 75% RDF + 25% N through sewage sludge treatments. Grain yield of rice increased significantly (Table 1), the maximum was in RDF + S Zn B which yielded 2, 16, and 39% higher than RDF, 75% RDF + 25% N through sewage sludge and control, respectively. Rice grain yields recorded under treatments 75% RDF + 25% N through vermicompost and 75% RDF + 25% N through *Sesbania* were statistically similar. The straw yield was maximum in 75% RDF + 25% N through sewage sludge which was about 47% higher than that in the control. The treatment 75% RDF + 25% N through vermicompost and 75% RDF + 25% N through *Sesbania* increased the straw yield by 34 and 33%, respectively over the control. The highest straw yield through application of sewage sludge may be owing to the availability of essential plant nutrients. Similar results were reported by Tamrabet *et al.* (2009).

The uptake of N in grains (Table 2) ranged from 27.4 to 51.4 kg/ha; the maximum N uptake was recorded in RDF + S Zn B followed that in RDF which were 46 and 44% higher than the control. The total N uptake was higher in RDF + S, Zn and B followed by 75% RDF + 25% N through sewage sludge being higher by 51 and 49%, respectively, over the control. The maximum P uptake in grain was observed in RDF + S Zn B followed by customized fertilizer and these values were higher by a 67 and 61%, respectively, over the control. The P uptake by rice straw was the highest in 75% RDF + 25% N through sewage sludge followed by 10.3 kg/ha in customized fertilizer and 10.1 kg/ha in RDF + S Zn B. The K uptake by grain being maximum in 75% RDF + 25% N through *Sesbania* followed by RDF + S Zn B were 63 and 62% higher over the control, respectively. The maximum K uptake by straw was in 75% RDF + 25% N through sewage sludge fol-

Table 1. Effect of organic and inorganic sources of plant nutrients on growth, yield attributes and yields of rice

Treatment	Plant height 60 DAT (cm)	Tillers/hill 60 DAT	Grain yield (t/ha)	Straw yield (t/ha)	1,000-grain weight (g)
Control	73.6	6.7	3.10	3.85	17.6
100% RDF	84.3	11.0	4.92	6.45	21.1
RDF + S-Zn-B	90.4	13.3	5.03	6.81	21.5
CF	82.8	12.0	4.77	6.35	20.9
75% RDF + 25% N through SW	84.8	12.3	4.19	7.18	20.3
75% RDF + 25% N through VC	84.3	10.0	4.50	5.83	20.5
75% RDF + 25% N through Sesb	86.4	10.7	4.56	5.77	20.6
SEm±	9.38	1.24	0.20	0.34	0.14
CD (P=0.05)	NS	3.81	0.63	1.07	0.45

DAT, Days after transplanting; RDF, recommended dose of fertilizer; S-Zn-B, sulphur, zinc and boron; CF, customized fertilizer; SW, sewage sludge; VC, vermicompost; Sesb, *Sesbania* lowed by customized fertilizer (77.2 kg/ha). This may be owing to enhancement in its availability by shifting the equilibrium among the forms of K from relatively exchangeable to soluble forms in the soil. The uptake of Zn in grain significantly increased over the control and RDF with the application of sewage sludge and *Sesbania*.

Application of organic and inorganic sources did not affect significantly soil *p*H (Table 3). However, a significant increase in electrical conductivity over the control was observed with application of chemical fertilizers in RDF, RDF + S Zn B and customized fertilizer. A significant increase in organic carbon content (Table 3) with the application of organic source of nutrients such as under 75% RDF + 25% N through sewage sludge (0.55%), 75% RDF + 25% N through vermicompost (0.53%) and 75% RDF + 25% N through *Sesbania* (0.56%) as compared to control (0.45%) was recorded. This may probably be due to the addition of organics in these treatments. The available N content of soil was the highest in 75% RDF + 25% N through *Sesbania*. The increase in N content with 75% RDF + 25% N through *Sesbania*, 75% RDF + 25% N through vermicompost and customized fertilizer was 34, 33 and 31%, respectively, over the control. Rinaudo *et al.* (1983) also observed that incorporation of *Sesbania* had positive effects on N content of soil. Increase in available N due to application of organic sources could also be attributed to a higher population of soil microbes, which could convert organically bound N to plant available inorganic form. The soil-available P increased by 56, 50 and 46% for customized fertilizer, RDF + S Zn B and 75% RDF + 25% N through *Sesbania*, respectively over the control. Significantly higher concentration of available P in customized fertilizer might be attributed to higher addition through customized fertilizer (100 kg/ha). The lowest K content in soil was in the control and the highest in 75% RDF + 25% N through vermicompost. The K content in soil under 75% RDF + 25% N through vermicompost, 75% RDF + 25% N through *Sesbania* and RDF + S-Zn-B was 19, 18 and 14% higher than the control.

The available S content in soil was maximum in RDF + S Zn B followed by RDF and 75% RDF + 25% vermicompost, being 51, 28 and 25%, higher than the control. The higher content of available S in RDF + S Zn B may be due to the application of S @ 40 kg/ha through gypsum. Thus, gypsum left residual effect which may be utilized for the following wheat crop. These results are in accordance with those reported by Yunas *et al.* (2010), who also observed that the S application significantly increased soil SO_4-S contents and the highest content was observed in the treatment involving application of gypsum

Table 2. Effect of organic and inorganic sources of plant nutrients on N, P, K, S, Zn and B uptake in grain and straw of rice

Treatment	N (kg/ha)			P (kg/ha)			K (kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control	27.4	23.3	50.7	10.4	3.2	13.6	7.5	22.9	30.4
100 % RDF	49.0	49.2	98.3	25.4	9.7	35.1	17.6	74.4	92.0
RDF + S-Zn-B	51.3	52.2	103.5	31.2	10.1	41.1	19.9	59.1	79.1
CF	48.0	48.3	96.3	27.2	10.3	37.5	18.6	77.2	95.9
75% RDF + 25% N through SW	43.1	57.6	100.7	22.1	10.6	32.7	18.0	94.1	112.2
75% RDF + 25% N through VC	48.8	49.8	98.7	22.8	8.9	31.7	18.5	55.3	73.9
75% RDF + 25% N through Sesb	48.9	47.9	96.8	25.2	9.0	34.2	20.4	66.5	86.9
SEm±	1.9	2.3	3.1	2.6	0.9	3.69	1.7	8.3	8.9
CD (0.05)	6.1	7.3	9.7	8.1	2.9	11.37	5.5	25.6	27.6
Treatment	**S (kg/ha)**			**Zn (g/ha)**			**B (g/ha)**		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control	9.2	8.8	18.1	71.4	93.7	165.1	ND	44.6	44.6
100% RDF	16.2	8.7	25.0	87.4	171.0	258.5	-	96.9	96.9
RDF + S-Zn-B	20.7	32.1	52.8	139.0	194.8	333.8	-	134.6	134.6
CF	11.7	32.1	43.8	117.7	184.5	302.2	-	109.3	109.3
75% RDF + 25% N through SW	18.7	26.5	45.3	99.4	224.0	323.4	-	74.7	74.7
75% RDF + 25% N through VC	12.1	31.6	43.7	91.7	156.4	248.2	-	67.7	67.7
75% RDF + 25% N through Sesb	11.5	34.9	46.5	115.6	248.5	364.2	-	83.2	83.2
SEm±	4.0	8.6	11.1	10.5	30.7	32.8	-	25.7	25.7
CD (P=0.05)	NS	NS	NS	32.4	NS	101.3	-	NS	NS

RDF, Recommended dose of fertilizer; S-Zn-B, sulphur; zinc and boron, CF, customized fertilizer; SW, sewage sludge; VC, vermicompost; Sesb, *Sesbania;* ND, not detectable

Table 3. Effect of organic and inorganic sources of plant nutrients on *p*H, electrical conductivity (EC), organic carbon (OC) and nutrients content in post harvest soil

Treatment	pH	EC(dS/m)	OC (%)	N (kg/ha)	P (kg/ha)
Control	8.35	0.159	0.45	86.5	14.6
100% RDF	8.31	0.187	0.49	127.1	24.8
RDF + S-Zn-B	8.16	0.183	0.49	125.0	29.4
CF	8.22	0.196	0.47	127.1	33.4
75% RDF + 25% N through SW	8.08	0.157	0.55	125.8	22.6
75% RDF + 25% N through VC	7.95	0.142	0.53	130.0	21.3
75% RDF + 25% N through Sesb	7.95	0.162	0.56	131.2	27.3
SEm±	0.10	0.007	0.01	2.38	3.3
CD (P=0.05)	NS	0.022	0.05	7.34	10.4

Treatment	K (kg/ha)	S (mg/kg)	B (mg/kg)	Zn (mg/kg)	Mn (mg/kg)
Control	121.7	12.2	0.41	0.74	3.22
100% RDF	135.5	16.9	0.84	0.87	3.50
RDF + S + Zn + B	141.1	24.9	1.14	1.74	3.42
CF	137.3	13.5	0.70	1.16	3.53
75% RDF + 25% N through SW	135.1	14.0	0.64	1.56	4.66
75% RDF + 25% N through VC	149.7	16.4	0.54	1.03	3.50
75% RDF + 25% N through Sesb	148.2	14.3	0.65	1.33	3.33
SEm±	4.6	2.3	0.12	0.16	0.25
CD (P=0.05)	14.3	7.1	0.38	0.48	0.77

RDF, Recommended dose of fertilizer; S-Zn-B, sulphur, zinc and boron, CF, customized fertilizer; SW, sewage sludge; VC, vermicompost; Sesb, *Sesbania*

(30 kg S/ha). The highest B content was observed in RDF + S Zn B (Table 3). Application of B through borax caused a residual buildup of B in soil.

The DTPA-extractable Mn and Zn increased significantly (Table 3) with the application of organics; however, fertilizer treatments had no effect on Fe and Cu content in soil (Table 3). The DTPA-extractable Mn content in soil was the maximum in 75% RDF + 25% N through sewage sludge, being 31% higher over the control. The maximum Zn content was observed in RDF + S-Zn-B being 57% higher over the control. The high concentration of Zn in RDF + S-Zn-B may be due to the application of $ZnSO_4$ @ 5 kg/ha. Higher content of Mn and Zn in soil might be due to higher content of these metals in sewage sludge and also due to chelation of these metals by organic matter. A significant change in soil fertility in one season observed under present study may be attributed to the reduced condition prevailing under rice cultivation during *kharif* season.

Results showed that application of 40 kg S, 5 kg Zn and 1.5 kg B/ha along with recommended dose of NPK increased plant height, tiller number, 1,000-grain weight and grain yield of rice. Inorganic fertilizer containing S, B and Zn had left residual effect in post-harvest soil.

REFERENCES

Chesnin, L. and Yien, C.H. 1951. Turbidimetric determination of available sulphur. *Soil Science of Society of America Proceedings* **15**: 149–51.

Katyal, J.C. and Rattan, R.K. 1995. Genetic variation in tolerance to nutrient deficiencies. (In) *Genetic Research and Education: Current Trends and Next Fifty Years,* pp. 468–79. Sharma, B. *et al.,* (Eds), Indian Society of Genetic and Plant Breading, New Delhi,

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for Zn, Fe, Mn and Cu. *Soil Science Society of America Journal* **42:** 421–28.

Rinaudo, G., Dreyfus, B. and Dommergu, Y. 1983. *Sesbania rostrata* green manure and the nitrogen content of rice crop and soil. *Soil Biology and Biochemistry* **15**(1): 111–13.

Sparks, D. L. 1996. Methods of soil analysis. Part 3-Chemical methods. *Soil Science Society of America Inc., American Society of Agronomy Inc*., Madison Wisconsin, USA.

Takkar, P.N. 1996. Micronutrient research and sustainable agricultural productivity in India. *Journal of Indian Society of Soil Science* **44**: 562–81.

Tamrabet, L., Bouzerzour, H., Kribaa, M. and Makhlouf, M. 2009. The effect of sewage sludge application on durum wheat (*Triticum durum*). *International Journal of Agriculture and Biology* **11** (6): 741–45.

Tandon, H.L.S. 2001. *Methods of Analysis of Soils, Plants, Waters, and Fertilizers*. Fertilizer Development and Consultation Organization, New Delhi, India.

Yunas, M., Yousaf, M., Khalid, R. and Nawaz, S. 2010. Effect of sulfur application on soil sulfur (SO_4-S) status in different textured soils of Pothwar. *Soil and Environment* **29** (1) : 7–10.