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Full Research Article

Evaluation of Different Nutrient Management Options for Soil Properties, Ground Water Quality and Factor Productivity of Basmati Rice (*Oryza sativa* L.) in Light Textured Soil

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Abstract

A four replicated field experiment was conducted during *kharif* season 2012 at Crop Research Centre of SVPUA & T Meerut, Uttar Pradesh to evaluate SSIPNMon scented rice.Findings revealed that customized fertilizer (TATA PARAS) recorded significantly maximum tiller, dry matter at 60 DAT, 1000 seed weight (24.26 g), grain yield (39.99 q ha^{-1}), straw yield (63.73 q ha^{-1}) and production efficiency (35.38 kg day^{-1} ha^{-1}), besides average yield (39.99 q ha^{-1}), yield increase (48.48%) and cost over control (67.30). Moreover, 66% of RDN+RDPK+34% N by *Sesbania rostreta* 0.9 t ha^{-1} not only resulted maximum protein (7.37%), protein yield (291.63 kg ha^{-1}), milling (72.26%) and head rice recovery (52.18%) and minimum broken (6.54%) and LB ratio (4.25) but also fetches highest net profit (₹ 80161 ha^{-1}), extra income over control (29302 Rs ha^{-1}) and cost benefit ratio (1:4.3) besides, it was also improved aggregate stability (59.58%) and porosity (42.51%). Furthermore, control plot recorded highest BD (1.51 g cm^{-3}), PD (2.39 g cm^{-3}) and soil texture such as sand (47.94%) and silt (17.28%), whereas, clay (35.71%) was shown maximum under 66% of RDN+RDPK+34% N by vermicompost 1.25 t ha^{-1}along with infiltration rate (0.17 cm hr^{-1}) and hydraulic conductivity (0.74 cm hr^{-1}), however soil texture class (clay loam) remained unaffected by various treatments. Moreover, ground water quality (BIS) viz., pH (6.5−8.5), EC (<0.7),Ca^{++}+Mg^{++}(<20 me L^{-1}), Carbonate (<2.5 me L^{-1}), Bicarbonate (<1.5 me L^{-1}) and RSC (<1.25 me L^{-1}) in terms of irrigation water during growing period at different stages was remained safe.Consequentlythere is an imperative need to discourage farmer practices and encouraging the SSIPNM in India.

1. Introduction

Rice is one of the most important staple food crops of the world and its area is concentrated mostly in South East Asia. Rice contributes around 45% of India's total food grain production and it continues to hold the key for food sufficiency in the country. In India, rice is being grown on an area of 44.62 ma with a production of 93.08 mt.The crop ranks first in the use of land (>44 mha) and water resources (>50% irrigation water), and inputs (38–40% of fertilizers and 17–18% of pesticides) though the use efficiency is considerably low (Anonymous 2014). Moreover, Aromatic varieties command a higher price in rice market than the non-aromatic ones. Demand for aromatic rice in recent years has increased to a great extent for internal consumption as well as for export (Chander and Pandey, 2001).

The response to fertilizers use has decreased from 17 kg grain kg^{-1} nutrient in 1951 to 5–6 kg grains now, which ideally should be in the range of 18–25 kg kg^{-1} nutrient. Data from farmers' fields (1999–2003) showed cereals responding around 8–10 kg grain kg^{-1} fertilizer (average). Traditional practices of organic manuring and growing of soil fertility restoring crops have gradually declined while nutrient outflows through crop production indicated an apparent negative balance of nearly 10 million tons at the national level. The recovery efficiency of fertilizer nutrients is about 20–40, 15–20 and 40–50% for N, P and K, respectively while for secondary and micronutrients, it is substantially low ranging 5-12%. Major factors contributing to the low and declining crop responses to fertilizer nutrients are continuous nutrient mining from the soil due to imbalanced nutrient use (6:2.9:1 NPK) leading to depletion of some of the major, secondary and micro nutrients like N, K, S, Zn, Mn, Fe, B etc., decreasing use of organic nutrient sources such as FYM, compost and integration of green manures in the cropping systems leading to serious soil degradation qualitatively (Debabrata and Mondal, 2010). Site specific nutrient management and use of customized fertilizers integrated with organic sources could be the best option to minimize the multi nutrient deficiencies and similar problems arising due to application of imbalance chemical fertilizers and maximize the sustainability and farmers income by reducing the cost of production and finally food security of India (Singh et al., 2015).

Gradual climate change resulted significant increase in frequency and extremity of meteorological and hydrological events that lead to distinct excess or lack of water in landscape. These phenomena affect not only actual quantity of water but also environmental impact like drought events are considered to be more dangerous due to their medium-term to long-term characteristics and large spatial impacts (Hrdinka et al, 2012). Major ion concentrations were higher in ground water than in spring and tap water. The relationship between alkaline metals (Na^+ and K^+), alkaline-earth metals (Ca^{2+} and Mg^{2+}), and HCO_3^- showed little difference between deep and shallow ground water. The calculated total dissolved solid values were below 300 mg l^{-1} for all water sources and met World Health Organization (WHO) water quality guidelines (NaharandJing, 2012). However, continuous cropping with sodic water and inorganic fertilizer use for 10 years slightly decreased the soil pH and sodium adsorption ratio (SAR).

2. Materials and Methods

2.1. Experimental details and site descriptions

A four replicated field experiment was conducted during *kharif* season 2012 at Crop Research Centre (Chirauri) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.), located at a latitude of 29° 40′ North and longitude of 77° 42′ East with an elevation of 237 metres above mean sea level. The soil of experimental field was Clay loam in texture (47.8% sand, 16.6% silt and 35.86% clay), alkaline pH 8.2, EC 0.21 dS m^{-1}, OC 0.58%, Available Nitrogen 228.30 kg ha^{-1}, Available Phosphors 17.60 kg ha^{-1}, Available Potassium 252.70 kg ha^{-1}, DTPA extractable Zinc (0.91 ppm) and Boron (37.4 ppm). All the physic-chemical properties were analyzed as per the slandered procedures (Jackson, 1973). The experiment comprises six treatment *viz.,* Control without N P K (T_1), 100% RDF of N, P, K, Zn and B @ 90; 40; 30; 05; 1.5 kg ha^{-1} respectively (T_2), 66% of RDN+RDPK+34% N by vermicompost -1.25 t ha^{-1} (T_3), 66% of RDN+RDPK+34% N by *Sesbania Rostreta* @ 0.9 t ha^{-1} (T_4), TATA PARAS- 11; 32;13; 0.9;0.24 % NPKZnB, respectively (T_5) and Farmer Practices 100:50 kg ha^{-1} N P, respectively (T_6)weretested in RBD with a plot size of 12 m^2 andits nutrient application are varied to different treatments. Rice (Pusa Basmati-1121) was grown as per recommended package of practices with 20×15 cm^2 (R×P) spacingwith a transplanting date of 19th July 2012 and harvested on 9th November 2012. A thin layer of water (approximately 3.0 cm) was maintained during the initial stage of crop growth for better establishment of seedlings and maximum 5.0 cm at tillering stage and later an intermittent irrigation at the time of panicle initiation, flowering and grain formation stage were applied by using 1.5 m wide irrigation channel. In order to control insect, the recommended insecticide as Cartap hydro chloride 4G and to control the disease recommended fungicide as Carbendazim @ 0.1% etc were applied on the basis of economic threshold level (ETL).

2.2. Data collection

Observations on various growth parameters viz. plant height (cm); number of tillers m^2 and dry matter accumulation/ plant were recorded at 60 DAT of the crop. Yield attributes was recorded by selecting 10 plants from 12 m^2 and yield was estimated by the produce obtained from net plot area, treatment wise and finally expressed at 14% moisture, whereas Production efficiency was calculated by following formula (Kumawat et al., 2012).

2.3. Plant sampling and analysis

The plants measured for growth and yield were used for analyzing the N, P and K content (Page, 1982) in plant (at 30 and 60 DAT, grains and straw). The samples were dried at 70 °C in a hot air oven. Zinc (ppm) was determined DTPA extractant and estimated on atomic absorption spectrophotometer (GBC Avanta PM Modal) and Boron (ppm) was determined by Azomethine-H Colour Method (Lindsay and Norvell, 1978).

2.4. Physical quality of grains

2.4.1. Milling yield determination

Duplicate 125 g rough rice samples were used for milling determinations. Rough rice samples were dehulled with a laboratory sheller (Adair, 1952). The percentages of husk of rough rice were calculated as follows: Husk (%)=husk weight (g)/paddy weight (g)×100; Total milled rice=total milled rice weight (g)/paddy weight×100; Head rice recovery (%)=head rice weight (g)/paddy weight (g)×100; Broken rice (%)= broken rice weight (g)/paddy weight (g)×100.

2.4.2. Evaluation of grain quality

Seeds harvested from individual plants were analyzed for quality characters of length and width of milled rice. For the determination of the length to breadth ratio, average length and breadth of 15 grains was measured and expressed in mm. L:B ratio was obtained by dividing the length of a single kernel/ grain by the corresponding breadth.

2.5. Physico-chemical properties of water

The pH of water sample was measured by immersing an electrode of calibrated pH meter (Jackson, 1973).Conductivity of water sample was determined by Conductivity meter calibrated with Potassium Chloride solution. Moreover, Calcium and Magnesium content and alkalinity of water were determined by the method described in USDA Handbook. The infiltration rate of a soil was measured by double ring infiltrometer.Likewisethe hydraulic conductivity of a soil is measured by constant head method by an instrument of EijkelkampAgrisearchequipment.The root penetration power was determined by penetrometer by an instrument of EijkelkampAgrisearchequipment. The aggregate stability of a soil was determined by wet sieving method by an instrument of EijkelkampAgrisearch equipment. Though, residual Sodium Concentration was calculated as.

$RSC=[(CO_3^{-}+HCO_3^{-}) - (Ca^{++}+Mg^{++})]$

3. Results and Discussion

3.1. Growth parameters

The plant height, number of tillers m^{-2} and dry matter accumulation at 60 DAT varied significantly due to effect of different sources of nutrient (Table 1). Maximum plants height (103.62 cm) was observed in T_2. It was at par with treatments with T_5, T_4 and T_3, while it was significantly higher than T_1 and T_6. All other treatments were significantly higher than T_1, however treatment T_5 recorded the maximum number of tillers m^{-2} (308.30) and was followed by T_2, T_4, T_3 and T_6 treatment T_1 recorded the lowest number of tillers (210.50) and T_1 was followed by T_6, T_3, T_2, T_4 and T_5. Similarly treatment T_5 recorded the highest value of 6099.98 kg ha^{-1} and T_1 recorded the lowest value of 4033.34 kg ha^{-1}. The results so obtained in this study might be due to nutrients were responsible for increased cell division and growth, photosynthesis, and protein synthesis which were responsible for quantitative increase in plant biomass. The results of present study are in agreement with the findings of several other investigators Tomar and Das (2011); (Tharmaraj et al., 2011).

3.2. Test weight

Data on the test weight are presented in Table 1.The thousand grain weight varied from 24.26 g (T_5) to 19.10 g (T_1). Treatment T_5 was significantly superior over T_1 and T_6 whereas it was on par with treatments T_2, T_3 and T_4. All these four treatments T_5, T_2, $T_4$and T_3 were significantly at par with each other and found superior over T_1 with respect to 1000 grain weight. This might be due to short supply of nutrients at the time of grain fillings. Many other investigators have also reported the similar results in their studies

Table 1: Effect of SSIPNM on growth, 1000 seed weight, yield and Production efficiency

Treatments	Plant height at 60 DAT (cm)	Tillers m^{-2} at 60 DAT	Dry matter accumulation ($kg\ ha^{-1}$) at 60 DAT	1000 seed weight (g)	Grain yield ($q\ ha^{-1}$)	Straw yield ($q\ ha^{-1}$)	Production efficiency ($kg\ day^{-1}\ ha^{-1}$)
T_1	58.32	210.5	4033.34	19.1	20.6	47.52	18.23
T_2	103.62	306.31	6089.47	23.7	39.57	62.45	35.01
T_3	98.3	298.51	5949.43	23.62	39.15	61.35	34.64
T_4	98.79	300.8	6073.48	23.57	39.57	62.38	35.01
T_5	103.15	308.3	6099.98	24.26	39.99	63.73	35.38
T_6	91.7	286.3	5033.31	21.1	28.2	59.85	24.95
SEm±	2.76	3.81	103.12	0.42	1.66	0.92	1.46
CD (p=0.05)	5.95	11.5	313.67	1.27	4.19	2.37	3.70

3.3. Yield and production efficiency

Results on the yield and harvest index are given in Table 1. The highest grain yield 39.99 q ha^{-1} and production efficiency (56.40 kg day^{-1} ha^{-1}) was recorded in T_5 and the lowest yield 20.60 q $ha^{-1}$and production efficiency 42.05 kg day^{-1} ha^{-1} in T_1. T_5 was on par with T_2, T_3 and T_4 and was significantly superior over all other treatments. T_6 was significantly superior over T_1. The highest straw yield was recorded in T_5 (63.73 q ha^{-1}) followed by T_2, T_4, T_3 and T_6. T_5 was on par with T_3 and T_4 and was significantly superior over all other treatments. T_6 was significantly superior over T_1. Treatment T_1 recorded the lowest straw yield (47.52 q ha^{-1}). The reason for the increased rice yield might be due to sustained availability of nutrients throughout the cropping period, increase in the water holding capacity, soil microbial activity, the conversion of unavailable form of nutrients to available form, availability of micronutrients, photosynthetic rate and chlorophyll content in leaf, which intern increased the yield per hectare, consequently production efficiency increased .

3.4. Nutrients content in plant at different growth stages (N, P, K, Zn and B)

Data on (N, P and K) content are presented in Table 2. The

Table 2: Effect of SSIPNM on N, P and K (%) content in plant, grains and straw of rice

Treatments	Nitrogen (%)				Phosphorus (%)				Potassium (%)			
	Plant		Grains	Straw	Plant		Grains	Straw	Plants		Grains	Straw
	30 DAT	60 DAT			30 DAT	60 DAT			30 DAT	60 DAT		
T_1	0.91	0.56	1.07	0.324	0.11	0.06	0.091	0.052	1.14	0.7	0.112	0.94
T_2	1.06	0.9	1.205	0.418	0.16	0.11	0.161	0.071	2.04	0.92	0.310	1.29
T_3	1.03	0.67	1.277	0.408	0.19	0.14	0.184	0.086	1.78	1.43	0.366	1.4
T_4	1.04	0.75	1.283	0.475	0.2	0.15	0.189	0.094	1.61	1.16	0.408	1.42
T_5	1.05	0.8	1.21	0.404	0.17	0.12	0.169	0.073	1.76	1.06	0.334	1.37
T_6	0.93	0.65	1.15	0.363	0.13	0.1	0.129	0.063	1.17	0.76	0.171	1.02
SEm±	0.004	0.004	0.006	0.004	0.003	0.001	0.003	0.001	0.014	0.011	0.004	0.008
CD (p=0.05)	0.013	0.012	0.019	0.013	0.01	0.004	0.009	0.003	0.042	0.032	0.011	0.025

nitrogen content in plant was highest at 30 DAT in all the treatments and after that it showed a gradual decrease up to 60 DAT. Concentration of nitrogen at harvest stage was found more than that at 30 and 60 DAT. At harvest stage, nitrogen content in grain was higher than that in straw. At 30 DAT, the plant N content varied from 1.06% in T_2 to 0.91% in T_1. T_2 was on par with treatments T_5 and T_3 were at par with T_4. $T_2$was significantly higher than T_4, T_3 and T_6. All the treatments from T_2 to T_6 were significantly superior over control (T_1). At 60 DAT, the N content in plant ranged from 0.90% to 0.56% in T_2 and T_1, respectively. The highest N content was found in T_2 followed by T_5, T_4, T_3 and T_6. At harvest stages, N content in grain varied from 1.283% to 1.07% and in straw it varied from 0.475% to 0.324% in T_4 and $T_{1,}$ respectively. The highest N content in grain was found in T_4 followed by T_3, T_5, T_2 and T_6. T_4 was on par with treatments T_3 and $T_2$was at par with T_5 and was superior over T_1 and T_6. All the treatments from T_2 to T_5 were significantly superior over control (T_1). In straw N content varied from 0.475 to 0.324. The highest N (0.475) was found in T_4 and minimum N content (0.324) was found in T_1. It may be inferred that when organics manure are applied along with inorganic fertilizers to soil, complex nitrogenous compounds slowly breakdown and make steady N supply throughout the crop growth period, which might have resulted in adequate availability of nitrogen (Kondapa Naidu et al., 2009).

The plant recorded the maximumphosphorus content value and thereafter it showed a gradual decrease up to 60 DAT in all the treatments. P concentration at harvest stage was higher than that at 30 DAT and at 60 DAT. At harvest stage, the P content in grain was higher than P content in straw. At 30 DAT the P content varied among the treatments and varied from highest value of 0.20% (T_4) to lowest value of 0.11% (T_1). T_4 was significantly at par with T_3 but was superior over all other treatments. All the treatments were significantly higher over T_1 (control). At 60 DAT, the P content ranged from 0.15% (T_4) to 0.06% (T_1). T_4 was followed by T_3, T_5, T_2 and T_6. At harvest P content in grain varied from 0.189% (T_4) to 0.091% (T_1). T_4 was significantly at par with T_3 and was higher than T_5, T_2, T_6 and T_1. All the treatments were significantly superior over T_1. The 'P' content in straw varied from 0.094% (T_4) to 0.052% (T_1). Treatment T_4 was significantly superior over all treatments and it was followed by T_3, T_5, T_2 and T_6. All the treatments were significantly superior over control (T_1). The higher value might be due to addition of FYM and other liquid organic manures (beejamruth, jeevamruthandpanchagavya) along with chemical fertilizers increased the activity of micro organisms and hence P contribution to the available pool.

In general, the K content in straw was higher than K content in grain. At 30 DAT, K content varied from 2.04% (T_2) to 1.14% (T_1) and T_2 was significantly superior over all treatments. All the treatments were significantly higher over T_1 (control). At 60 DAT, K content varied from 1.43% (T_3) to 0.70% (T_1) and T_3 was significantly superior over all other treatments. All the treatments were significantly higher over T_1 (control) except T_6. The concentration of K in grain varied from 0.408 (T_4) to 0.112 (T_1). T_4 gave significantly higher K content in grain over all the treatments. All the treatments were significantly superior over T_1 (control). In straw, treatment T_4 (1.42) recorded the highest K content and it was followed by T_3, T_5, T_2 and T_6. T_3 and T_4 were at par with each other. Treatment T_1 recorded the lowest K content of 0.94% followed by T_6, T_2, T_5, $T_3$and T_4. All the treatments were significantly superior over T_1.This might be due to continuous and steady supply of K from organic and inorganic treated plots

Data pertaining to (Zn and B) are given in Table 3. The Zinc concentration in plant decreased from 30 DAT to 60 DAT and then increased at harvest stages. At 30 DAT and 60 DAT, the maximum concentration was recorded in T_5whereas at harvest stage maximum concentration was recorded in T_4. At 30 DAT the maximum content was found in T_5 (97.55 ppm) and was

Table 3: Effect of SSIPNM on Zn and B (ppm) content in plant, grains and straw of rice

Treatments	Zn (ppm)				B (ppm)			
	Plant		Grains	Straw	Plant		Grains	Straw
	30 DAT	60 DAT			30 DAT	60 DAT		
T_1	79.05	49.25	76	7.45	16.60	8.30	5.60	6.62
T_2	96.5	69.22	89.20	14.97	25.16	14.92	8.70	9.95
T_3	94.45	63.90	93.40	15.05	21.12	13.67	8.20	9.22
T_4	95.40	68.47	94.7	15.15	19.97	13.35	7.80	9.00
T_5	97.55	70.42	92.6	15.05	22.70	14.70	8.50	9.60
T_6	91.52	56.92	81.4	14.05	18.65	10.50	7.17	8.00
SEm±	0.41	0.37	0.32	0.15	0.12	0.10	0.05	0.05
CD (p=0.05)	1.26	1.14	0.99	0.47	0.28	0.23	0.16	0.18

followed by T_2, T_4, T_3, T_6 and T_1. At 60 DAT the maximum concentration was recorded in T_5 (70.42 ppm) followed by T_2, T_4, T_3 and T_6. The minimum concentration was recorded in T_1 in all the stages. Zinc content trend observed at harvest stage was slightly different than at 30 and 60 DAT, where maximum zinc content was found in T_4 (94.7 and 15.15 ppm in grain and straw, respectively) followed by T_3, T_5, T_2, T_6 and T_1All the treatments were significantly superior over T_1 at all the growth stages of crop.

The Boron concentration in plant decreased from 30 DAT to harvest stages. The maximum concentration was recorded in T_2 at all the growth stages (25.16, 14.92 and 18.65 ppm) followed byT_5, T_3, T_4 and T_6, respectively).The minimum concentration was recorded in T_1 in all the stages. All the treatments were significantly superior over T_1.The beneficial effect of organic manure when it applied in conjunction with chemical fertilizer helped in increasing the nutrient availability and sustains it over a long period. The results were in conformity with the findings of Dikshit and Khatik (2002).

3.5. Grain quality parameters

3.5.1. Protein (%) and protein yield (kg ha^{-1})

The maximum protein percent and protein yield (kg ha^{-1})was recorded in T_4 (7.37 and 459.74, respectively) followed by T_3, T_2, T_5 and T_6. T_2 and T_5, T_3 and T_4 were at par with each other while T_3 and T_4 were found at par with each other (Table 4). The lowest protein percent and protein yield (kg ha^{-1})was recorded in T_1 (3.91 and 185.80, respectively). All the treatments were significantly superior over T_1 (control).Several investigators have reported the increase in protein content due to balanced use of NPK with organic manure. The present findings are in consonance with those workers Patil and Padmani (2007).

3.5.2. Milling (%)

The maximum milling percent was recorded in T_4 (72.26) followed by T_2, T_5, T_3 and T_6. T_4 was at par with T_2, T_3 and T_5.

Table 4: Effect of SSIPNM on grain quality of rice

Treat-ments	Pro-tein (%)	Protein yield (kg ha^{-1})	Mill-ing (%)	Head rice recovery (%)	Bro-ken (%)	LB ratio
T_1	6.14	126.48	26.48	50.70	6.54	4.25
T_2	6.95	275.01	72.25	52.17	4.40	4.20
T_3	7.33	286.97	72.15	52.16	4.39	4.20
T_4	7.37	291.63	72.26	52.18	4.38	4.18
T_5	6.90	275.93	72.18	52.17	4.44	4.21
T_6	6.60	186.12	70.45	51.20	6.02	4.22
SEm±	0.04	0.07	0.03	0.02	0.02	0.07
CD (p=0.05)	0.24	1.01	0.11	0.06	0.07	0.21

The lowest total milling percent was recorded in T_1 (68.54). All the treatments were significantly superior over T_1 (control).

3.5.3. Head rice recovery (%)

The maximum head rice recovery percent was recorded in T_4 (52.18) followed by T_2, T_5, T_3 and T_6. T_4 was at par with T_2, T_3 and T_5, while T_2 and T_5 were non significant. The lowest head rice recovery percent was recorded in T_1 (50.70). All the treatments were significantly superior over T_1 (control).

3.5.3. Broken (%)

The maximum broken percent was recorded in T_1 (6.54%) followed by T_6, T_5, T_2, T_3 and T_4. T_2, T_3, T_4 and T_5 were at par with each other. The lowest broken percent was recorded in T_4 (4.38%). All the treatments were significantly superior over T_1 (control).

3.5.4. LB ratio

The maximum LB ratio percent was recorded in T_1 (4.25) followed by T_6, T_5, T_2, T_3 and T_4. T_2 and T_3 were non significant. T_2, T_3, T_5 and T_6 were at par with each other. The lowest LB ratio percent was recorded in T_4 (4.18). T_6. All the treatments were significantly superior over T_1 (control). Better physical environment and sufficiency of water and nutrients helped in better uptake of water and nutrients which could improve the quality of rice.

3.6. Response to physical properties

3.6.1. Bulk density

The bulk density of the soil decreased from initial value after harvest of rice (Table 5). The minimum and maximum bulk density was recorded in treatments T_4 and T_1 (1.42 g cm^{-3}, and 1.51 g cm^{-3}, respectively). T_4 was found at par with T_3 and T_2 was at par with T_5. All the treatments were significantly over on T_1 except T_6. This might be attributed to addition of organic matter or production of more above ground biomass which may affect soil physical properties. Similar results were noticed by several researchersHaynes and Naidu (1988).

3.6.2. Particle density

The particle density of the soil increased from initial value after harvest of rice. The maximum and minimum particle density was recorded in treatments T_4 and T_1 (2.47 g cm^{-3}, and 2.39 g cm^{-3}, respectively). However,no significant difference among the treatments was observed in PD.

Table 5: Effect of SSIPNM on physical properties after rice harvest

Treatments	BD (g cm^{-3})	PD (g cm^{-3})	Porosity (%)	Aggregate stability (%)	Infiltration rate (cm hr^{-1})	Hydraulic conductivity (cm hr^{-1})	Soil texture			Soil texture class
							Sand (%)	Silt (%)	Clay (%)	
T_1	1.51	2.39	36.82	53.45	0.1	0.61	47.94	17.28	34.78	Clay loam
T_2	1.47	2.42	39.25	54.52	0.12	0.7	47.56	16.94	35.50	Clay loam
T_3	1.43	2.45	41.63	58.4	0.17	0.74	47.5	16.79	35.71	Clay loam
T_4	1.42	2.47	42.51	59.58	0.15	0.73	47.58	16.91	35.51	Clay loam
T_5	1.46	2.41	39.41	55.01	0.11	0.68	47.45	16.93	35.62	Clay loam
T_6	1.49	2.41	38.17	54.41	0.1	0.66	47.49	16.86	35.65	Clay loam
SEm±	0.01	0.03		0.41	0.01	0.01				
CD (p=0.05)	0.03	NS		1.27	0.03	0.03				
Initial	1.57	2.38	35	54	0.25	0.82	47.8	16.64	35.83	Clay loam

3.6.3. Porosity (%)

The porosity percent of the soil increased from initial to harvest of rice. The maximum and minimum porosity percent was recorded in treatments T_4 and T_1 (42.51, and 36.82, respectively). T_4 was followed by T_3, T_5, T_2 and T_6. The addition of combine use of organic and inorganic or balance use of inorganic fertilizers promotes the total porosity and aggregation of the soils as the microbial decomposition products of organic manures such as polysaccharides and bacterial gums are known to act as soil particle binding agents. These binding agents increase the porosity and decrease the bulk density of the soil by improving the aggregation. Increase in soil porosity with fertilization has also been reported by Bhatia and Shukla (1982).

3.6.4. Aggregate stability (%)

The aggregate stability of the soil increased from its initial to harvest of rice. The maximum and minimum aggregate percent was recorded in treatments T_4 and T_1 (59.58 and 53.45%, respectively). T_4 was found at par with T_3 and significantly higher than T_5, T_2 and T_6. T_5 and T_2 were recorded at par with each other. All the treatments were significantly over on T_1.

3.6.5. Infiltration rate (cm hr^{-1})

The infiltration rate of the soil significantly decreased from initial value after harvest of rice. The maximum and minimum infiltration rate was recorded in treatments T_3 and T_1 (0.17, and 0.10, respectively). T_3 was followed by T_4, T_5, T_2 and T_6. T_6 and T_1, T_3 and T_4, T_2 and T_5 were recorded at par with each other. All the treatments were significantly over on T_1 except T_6.Though the balanced application of inorganic fertilizers enhanced the organic carbon restoration probably due to higher root biomass but the enhancement in OC was low in traditional fertilizer treated plot than customized treated plots which resulted low aggregation, slightly high bulk density and low infiltration rate in inorganic fertilizer alone plot than combine use of organic and inorganic treated plots.

3.6.6. Hydraulic conductivity (cm hr^{-1})

The hydraulic conductivity of the soil significantly decreased from initial to harvest of rice. The maximum and minimum hydraulic conductivity was recorded in treatments T_3 and T_1 (0.74, and 0.61, respectively). T_3 was followed by T_4, T_2, T_5 and T_6. T_3, T_4, T_2, T_5 and T_1 and T_6 were recorded at par with each other. All the treatments were significantly over on T_1. Application of organic manures or balance use of fertilizers could be responsible for improving the hydraulic conductivity. Similar results were obtained by Mandal et al. (1999).

3.7. Soil class and soil texture

There was no significant change on soil texture class was observed from its initial value to harvest of rice.

3.8. Ground water quality

Quality of ground water with respect to irrigation purpose was also studied under this investigation. pH of the water slightly increase from 7.43 to 7.49 in the first 70 days after transplanting than remain constant or very slightly decreased to 7.48 upto harvest (Table 6). This might be because of release of OH ions on possible N nutrition in nitrate form.This shows that activity of rice production did not affect the ground water quality within 130 days and remain safe for irrigation purpose. Whereas in case of EC , during first 70 days after transplanting it decrease to 0.60 from its initial value 0.62 and thereafter increase to 0.63. Ca^{++} +Mg^{++} concentration increase from initial 4.0 me L^{-1} to 4.4 me L^{-1} and decrease to 4.2 me L^{-1} at harvest. No carbonate was detected in water at all time and found to be safefor irrigation purpose. Similar tend as in case of EC was noticed for Bicarbonate. It decreased from its initial value 1.4 to 1.2 and then increase up to 1.4. No change was marked from its initial value to final value. RSC remain in safe limit at all the stage of sampling and ranged between –2.6 in the beginning to –3.2 in the middle and –2.8 at last date of sampling.

Table 6: Ground water quality in terms of irrigation at different stages during growing period

Particulars	Observed value			Standard value	
	At 0 DAT	At 70 DAT	At 130 DAT	BIS	Re-marks
pH	7.43	7.49	7.48	6.5- 8.5	Safe
EC	0.62	0.6	0.63	<0.7	Safe
Ca^{++}+Mg^{++} (me L^{-1})	4	4.4	4.2	<20	Safe
Carbonate (me L^{-1})	Ab-sent	Ab-sent	Absent	<2.5	Safe
Bicarbon-ate (me L^{-1})	1.4	1.2	1.4	<1.5	Safe
RSC (me L^{-1})	-2.6	-3.2	-2.8	<1.25 Safe	Safe

3.9. Economics

The treatments were highly remunerative and the practice appeared to be cost effective. Minimum net return of ₹ 39250 was recorded from the un-fertilizers plots (Table 7). All the treatments except Farmer practices yielded more than twice net monetary return than control, among them,treatments where combine use of fertilizers was applied gave the best net return with ₹ 80011 and ₹ 80161 in vermicompost and Sesbanisa R. treatments, respectively. Highest B:C ratio was obtained from combine use of fertilizers treatment (4.3 and 4.2 in sesbania R. and vermicompost treated plots, respectively), the next position for B:C ratio was occupied by balance use of inorganic fertilizers(4.0 and 3.7 in traditionally available fertilizers and customized fertilizers treated plots respectively). Although customized fertilizer treatment gave highest yield and gross income but it ranks third in net return (₹ 78785) and B:C ratio (1:3.7) because of high cost of customized fertilizers. Combine use of fertilizers with organic and inorganic gave the highest net return and B:C ratio with minimum cost of production . These treatments not only provide the good return but also improve the soil physical environment. Thus these treatments appeared to be highly economical. Moreover, maximum increases (48.48%) in yield over control were recorded in T_5 but with a highest increase in cost of cultivation (67.30%). Increase in yield over control in T_3 and T_4 was similar (47.94%) but cost of cultivation involve in T_4 was less than T_3. Highest extra income (₹ 29302) due to treatment was recorded in T_4, while lowest income was recorded in T_6.

Table 7: Effect of SSIPNM on economics of rice

Treatments	Cost of cultivation (₹ ha^{-1})	Average yield (q ha^{-1})	Yield increase (%)	Cost over control	Gross income (₹ ha^{-1})	Net profit (₹ ha^{-1})	Extra income over control (₹ ha^{-1})	Cost benefit ratio
T_1	12666	20.60	-	-	51516	39250	-	1:3.1
T_2	19767	39.15	47.48	56.06	97875	78108	27249	1:4.0
T_3	18914	39.57	47.94	49.33	98925	80011	29152	1:4.2
T_4	18760	39.57	47.94	38.67	98925	80161	29302	1:4.3
T_5	21190	39.99	48.48	67.30	99975	78785	27926	1:3.7
T_6	15667	28.2	26.95	23.69	70501	54834	17599	1:3.5

4. Conclusion

Use of customized fertilizer proved to be best as it improves the productivity of scented rice with maximum gross income. Whereas, the integration of different sources improved the soil and grain quality parameters along with net return and B:C ratio. Moreover, SSIPNM also maintains the ground water quality at different stages of crop growthi.e., there is an urgent need to discourage farmer practices and encouraging the SSIPNM in India.

5. References

A.O.A.C., 1960. Methods of Analysis. Association of Official agricultural Chemists, Washington, D.C. 9th edition, 15–16.

Adair, C.R., 1952. The McGill miller method for determining the milling quality of small samples of rice. Rice Journal 55(2), 21–23

Anonymous, 2014. Agricultural statistics at a glance, Ministry of Agriculture, 46–53. www.cimmet.nic.in. Accessed on March 1, 2014.

Barik, A.K., Raj, A., Saha, R.K., 2008, Yield performance, economics and soil fertility through organic sources (vermicompost) of nitrogen as substitute to chemical fertilizers in wet season rice. Crop Research 36(1/3), 4–7.

Bhatia, K.S., Shukla, K.K., 1982, Effect of continuous application of fertilizers and manures on some physical properties of (eroded) alluvial soil. Journal of Indian Society of Soil Science 30, 33–36.

Chander, S., Pandey, J., 2001. Effect of rice (*Oryza sativa*) culture, nitrogen and weed control on nitrogen competition between scented rice and weeds. Indian Journal of Agronomy 46, 68–74.

Debabrata Acharya, Mondal, S.S., 2010, Effect of integrated nutrient management on the growth, productivity and quality of crops in rice (*Oryza sativa*) - cabbage (*Brassica oleracea*) greengram (*Vigna radiata*) cropping system. Indian Journal of Agronomy 55(1), 1–5.

Dikshit P.R., Khatik, S.K., 2002, Influence of organic manures in combination with chemical fertilizers on seed yield. Legume Research 25(1), 53–56.

Gomez, K.A., Gomez, A.A., 1984. Statistical procedure for Agricultural Research An international Rice Research Institute Book. John Willey and sons, 2nd edition, 329.

Haynes, R.J., Naidu, R., 1998, Influence of lime, fertilizer and manure applications on soil organic matter content and soil physical conditions: a review. Nutrient Cycling in Agroecosystems 51, 123–137.

Hrdinka, T., Novicky, O., Hanslik, E., Rieder, M., 2012, Possible impacts of floods and droughts on water quality. (Special Issue: Ecohydraulics: Recent research and applications.) Journal of Hydro-Environment Research, 6(2), 145–150.

Kondapa-Naidu, D., B.M. Radder, P.L. Patil, N.S. Hebsur, S.C. Alagundagi 2009, Effect of integrated nutrient management on nutrient uptake and residual fertility of chilli (Cv. Byadagi dabbi) in a vertisol. Karnataka Journal of Agricultural Science 22(2), 306–309.

Kumawat, N., Singh, R.P., Kumar, R., Kumari, A., Kumar, P., 2012. Response of intercropping and integrated nutrition on production potential and profitability on rainfedpigeonpea. Journal of Agricultural Science 4(7), 154–162.

Lindsay, W.L., Norvell, W.A., 1978. Development of a DTPA soil test for Zn, Fe, Mn and Cu. Soil Science Society of America journal 42, 421–428.

Mandal, U.K., Sharma, S.N., Gurcharan Singh Das, D.K., 1999, Effect of *Sesbania* green manuring and greengram (*Phaseolus radiatus*) residue incorporation on physical properties of soil under rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. Indian Journal of Agricultural Sciences 69(9), 615–620.

Nahar, M.S., Zhang Jing, 2012, Assessment of potable water quality including organic, inorganic, and trace metal concentrations. Environmental Geochemistry and Health, 34(1), 141–150.

Page, A.L., 1982. Methods of Soil Analysis: Part 2. Chemical and Microbiological Properties. American Society of Agronomy, Soil Science Society of America, Madison, WI, USA.

Patil, A.B., Padmani, D.R., 2007, Effect of INM practices on yield, quality and economics of pigeonpea (*Cajanus cajan* L. Millsp.) under rainfeed conditions. International Journal of Agricultural Sciences 3(2), 202–204.

Pooniya, V., Shivay, Y.S., Bana, R.S., 2012, Zinc fertilisation in conjunction with green manuring on productivity and nutrient uptake in basmati rice. Indian Journal of Fertilisers 8(8), 54–58.

Tharmaraj, K., Ganesh, P., Kolanjinathan, K., Suresh, K.R., Anandan, A., 2011, Influence of vermicompost and vermiwash on physico chemical properties of rice cultivated soil. Current Botany 2(3), 18–21.

Tomar, J.M.S., Anup Das, 2011, Influence of trees leaf green manuring on low land rice (*Oryza sativa*) productivity in mid-altitudes of Meghalaya. Indian Journal of Soil Conservation 39(2), 167–170.