RESEARCH ARTICLE

SITE SPECIFIC NUTRIENT MANAGEMENT AND NUTRIENT REMOVAL BY BASMATI RICE AND PHYSICO-CHEMICAL PROPERTIES OF SOIL

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Abstract: The present investigation was carried out at Crop Research Centre, Chirori of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) with eleven different treatments viz; T_1(Recommended NPK), T_2 (Recommended NP), T_3 (Recommended NK), T_4 (Recommended PK), T_5 (Recommended NPK+ wheat residue @ 5 ton ha^{-1}), T_6 (Recommended NPK + FYM @ 10 ton ha^{-1}), T_7 (SSNM 100 : 60 : 60: 25 : 30 : 5 i.e. N P K Zn S B), T_8 (SSNM-P), T_9 (SSNM-K), T_{10} (SSNM-K+ wheat residue @ 5 ton ha^{-1}) and T_{11} (SSNM + wheat residue @ 5 ton ha^{-1}) in three replications and in Randomized Block Design. The rice variety Pusa basmati 1509 was grown and nutrient uptake and soil properties as influenced by different treatments were assessed. Results obtained from the study revealed that with the use of balanced inorganic fertilizer alone or in combination with organic fertilizer, physical properties of soil due to improvement in OC gkg^{-1} through more biomass addition in the soil. Significant reduction in BD was noticed where more biomass was added into the soil. Treatments having integration of sources/ nutrients (T_6, T_7 and T_{11}) distinctly showed the improvement in OC %, availability of N, P, K, S, Zn, B, Fe and led to better soil environment over T_4. Uptake of N, P, K, S, Zn, B and Fe by rice under different treatments was also found to be significantly higher than T_4. The grain yield of rice was significantly higher in combined use of organic & inorganic fertilizer treated plot than only inorganic one. However, no significant variation was observed in the grain yield where N, P, K + wheat residue, N, P, K + FYM and SSNM package + wheat residue treated plots.

Keywords: Basmati rice, Nutrient removal, Physico-chemical properties of soil

INTRODUCTION

The most of Indian soils are low in available N and P but medium in available K (Jena *et al.,* 2008).The imbalanced and injudicious use of fertilizer is very important, which not only reduces nutrient use efficiency but also causes nutrient imbalance in soil resulting in decreased crop yield (Ladha*et al*., 2005). Therefore, nutrients application in rice-wheat cropping system on site-specific soil test basis including micronutrients along with major nutrients for higher productivity and profitability is most important (Mauriya *et al.*, 2013). Site-specific nutrient management (SSNM) provides guidelines, tools and strategies that allow farmers to determine when and how much nutrients they need to apply to their rice fields under actual growing conditions in a specific season and location. Moreover, SSNM is a plant-based approach that provides principles that can be used everywhere. SSNM provides a field-specific approach for dynamically applying nutrients to rice as and when needed (Dobermann *et al.*, 2002).
Nutrients interact when increasing one nutrient influences the nutrient uptake or translocation of another nutrient. N-P and N-K interactions are commonly observed. Though, the adequate application of chemical fertilizers has continue to increase the yield of paddy but the response in terms of kg grain kg^{-1} of nutrient declined (Tiwari, 2002). Moreover, crop residue is one of major sources of organic matter and plant nutrient if it is managed properly. Incorporation of crop residues preserved plant nutrients as well as improve physical, chemical and biological properties of soil, (Rao and Mikkelson, 1976).
Organic manures such as farmyard manure (FYM) applications improved soil physical properties through increased soil aggregation (Hati *et al.*, 2007). It also improves the chemical and biological conditions of soil, increasing cation exchange capacity and providing various vitamins, hormones and organic acids which are very important for soil aggregation and beneficial micro-organism which involved in various bio-chemical process and release of nutrients.

MATERIAL AND METHOD

Experimental details

A field experiment was conducted during *kharif* season 2012 and 2013 at Crop Research Centre of SardarVallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.), the area lie at a latitude of 29°40’ North and longitude of 77°42’ East with an elevation of 237 metres above mean sea level (MSL). Mean weekly maximum temperature varied from 34.9 ^{0}C in 30th week (July, 23-29) to 31.6 ^{0}C in 36th week (September, 3-9), and the mean weekly minimum temperature ranged from 21.1 ^{0}C.The total of 648 mm rainfall was received during the growing season. The treatments comprised T_1 (Recommended NPK), T_2 (Recommended NP), T_3 (Recommended NK), T_4 (Recommended PK), T_5 (Recommended NPK+ wheat residue @ 5 ton ha^{-1}), T_6

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(Recommended NPK + FYM @ 10 ton ha^{-1}), T_7 (SSNM 100 : 60 : 60: 25 : 30 : 5 i.e. N P K Zn S B), T_8 (SSNM-P), T_9 (SSNM-K), T_{10} (SSNM-K+ wheat residue @ 5 ton ha^{-1}) and T_{11} (SSNM + wheat residue @ 5 ton ha^{-1}) and were tested in Randomized Block Design with three replications.

Site descriptions

The soil of the experimental field was well drained, loam in texture (51.9 % sand, 28.2 % silt and 19.9 % clay) and slightly alkaline in reaction (pH 7.68). The experimental soil was low in available nitrogen and medium in available phosphorus and available potassium with an electrical conductivity (1:2.5, soil: water extract) of 0.25 dSm^{-1}. All the physico-chemical properties were analyzed as per the standard procedures given by Jackson (1973).

Crop growth

Rice (Pusa Basmati-1509) was grown as per recommended package of practices with 20 cm x 15 cm (R x P) apart and transplanted on 19th July 2015 and harvested on 9th November 2015. 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. Two days after transplanting Butachlore @ 1.3 liter ha^{-1} was applied to control the weed. 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). Grain yield was estimated from the produce of net plot area, treatment wise and finally expressed at 14 % moisture.

Plant sampling and analysis

The plants measured for growth and yield were used for analyzing the nutrient content in plant (at 30 and 60 DAT, grains and straw). The samples were dried at 70 °C in a hot air oven. The dried samples were ground in a stainless steel Thomas Model 4 Wiley ® Mill. The N content in plant was determined by digesting the samples in sulphuric acid (H_2SO_4), followed by analysis of total N by the Kjeldahl method using a Kjeltec™ 8000 auto analyzer (FOSS Company, Denmark). The P content in plant was determined by the vanadomolybdo-phosphoric yellow colour method and the K content was analyzed in di-acid (HNO_3 and $HClO_4$) digests by the flame photometeric method (Page, 1982). Sulphur was determined by Turbidmetric methods. Zinc was determined DTPA extractant and estimated on atomic absorption spectrophotometer (GBC Avanta PM Modal) and Boron was determined by Azomethine-H Colour Method (Lindsay and Norvell, 1978). The uptake of the nutrients was calculated by multiplying the nutrient content (%) by respective yield (kg/ha^{-1}) and was divided by 100 to get the uptake values in kg/ha^{-1}.

Soil sampling and analysis

Soil samples were collected at the start of the experiment from 0 to 15 cm soil depth using an auger of 5-cm diameter. Each sample was a composite from three locations within a plot. The freshly collected soil samples were mixed thoroughly, air-dried, crushed to pass through a 2-mm sieve and stored in sealed plastic jars before analysis. Available N (Alkaline permanganate method), Olsen P (0.5 mol/L $NaHCO_3$ extractable), NH_4OAc–extractable K were analyzed using the methods described by Page (1982). Sulphur was determined by Turbidmetric methods. Zinc 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). The samples for determination of soil physical properties like pH was determined with the help of glass electrode on a pH meter in 1:2.5 soil: water suspension at 25^0 C (Jackson, 1973). The electrical conductivity was estimated with the help of EC meter in 1:2.5 soils: water suspension at 25^0 C and expressed as d sm^{-1} (Bower & Wilcox, 1965). Bulk density was measured to a depth of 20-cm at intervals of 5-cm soil depth using the core-ring method and one core per layer of each plot was collected and the samples were oven-dried for 48 h at 105 °C, weighed and bulk density calculated as per the standard methods. The soil organic carbon was estimated by the procedure given by (Walkley and Black, method) rapid titration method (Jackson, 1973).

Statistical analysis

The data obtained were subjected to statistical analysis as outlined by Gomez and Gomez (1984). The treatment differences were tested by using “F” test and critical differences (at 5 per cent probability).

RESULT AND DISCUSSION

Nutrient uptake

Treatment T_{11} (SSNM package with wheat residue) removed significantly higher N by grain and straw and remained *at par* with T_6 at harvest stage (grain and straw). The uptake of N is the product of N content and dry matter yield. Since N content and dry matter yield was higher in T_{11} therefore, higher uptake is obvious.Similar opinion was also put forward for wheat residue incorporation reduced N content and the accumulations of N, P, and K in plants at the early growth stage, increased P and K contents in plants during the whole growth period Xu*et al*. (2008).

Maximum P uptake at harvest was recorded by the application of 100:60:60:25:30:5 kg ha^{-1} N: P: K: Zn: S: B with wheat residue while minimum where only recommended PK was applied. It was also mainly due to lack of application all nutrient and deficiency of such nutrients in soil of Western Uttar Pradesh. Moreover, increase in P uptake under T_{11} was might be due to fact that higher organic matter content in soil favour the high availability of nutrient to the crop, besides good activity of microbial biomass and hence P contribution to the available pool. These results are corroborated with the finding of Wanga *et al.* (2000).

Treatment which received SSNM package and wheat residue resulted significantly higher K uptake by grain and straw. It might be due to supplementation of addition K through added crop residue. The increase K uptake in organic along with inorganic treated plot over NP and PK fertilizer plot may be due to continuous and steady supply of K from wheat residue with inorganic treated plot. The results are consonance with the finding of Wanga *et al.* (2000). Whereas, minimum K uptake by grain and straw under T_4 (recommended PK).The results indicated that both wheat residue application and SSNM can increase absorption and use efficiency of N, P, and K by rice plants.

Application of wheat residue along with SSNM package noticed significantly higher uptake of Zn than recommend NPK. It was followed by $T_{6.}$ When wheat residue applied conjunction with chemical fertilizer help in increase the micro nutrients availability and sustained it over a long time. Microbial decomposition of organic manure (wheat residue) with simultaneous release of organic acid as a chelating agent might have favoured the availability of micro-nutrient in soil and their absorption by crop. Although recommended PK showed minimum Zn content followed by recommended NP at harvest stages.

Application of SSNM package along with additional sources of nutrients as wheat residue brought a significant difference in S uptake by plant at harvest stageswhere T_{11} (SSNM package with wheat residue) removed significantly higher sulphur by grain and straw, and lowest uptake in T_4 (recommended PK). The increase S content in (T_{11}) SSNM package (N, P, K, S, Zn and B) with incorporate wheat residue might be due to decay of organic matter (wheat residue) and additional sulphur application.

Boron uptake by grain and straw under T_4 was significantly lower than other treatments. Maximum uptake was noticed under inorganic as well as organic treated plots (T_{11}) followed by combine use of fertilizers NPK with FYM treated plots (T_6). The possible reason may be the beneficial effect of wheat residue when applied in conjunction with chemical fertilizer on the higher micro nutrients availability sustained for a long time. Boron uptake was influenced by different treatments significantly.

The maximum iron uptake g ha^{-1} found in T_{11} was significantly higher than the rest of the treatments and statistically at par to T_6 by grain and straw, while minimum iron uptake recorded in T_4 was significantly lower than the rest of the treatments.

Physico-chemical properties of soil

After harvesting the slight variation was observed in soil available nutrients (N, P, K Zn, S, B and Fe) organic carbon, pH, Electrical conductivity and Bulk density than the initial value. Soil is the vital recourses that non-renewable on human times scale.Available N, P, K, Zn, S, B and Fe decline with the advancement of crop age and reached to minimum at harvest stage was probably due to increase absorption of available nutrients with growth and development.

Moreover, maximum N was observed by the application of SSNM package along with wheat residue at all the stages might be due to additional application of N in the form of wheat residue apart from application of N through fertilizer under this treatment and exceed applied wheat residue, Beside improvement in organic carbon another most important factor to improve the nitrogen. Application of crop residue improved N availability, but not P availability according to Van *et al*. (2005). Organic carbon remained higher under application of wheat residue and FYM along with recommended dose.

Phosphorus availability was higher in T_1 at tillering in T_6 at P.I. and harvest stage, probably may be due to application of recommended NPK in case of T_1 and additional application of FYM with recommended NPK. Present finding is in conformity with the report of other investigator Pooniya *et al*., 2015. However more available K was observed under application of wheat residue along with 100 kg N, 60 kg P, 60 kg K, 25 kg Zn, 30 kg S and 5 kg B. Mixing of wheat residue and FYM was also brought significant improvement over recommended NP (T_2), recommended PK, (T_4) and recommended NK (T_3). The improvement of K was might be due to slow and steady supply of K from the decomposition of organic residue. Furthermore, T_4 and T_3 treatment observed significantly lower available Zn probably due to high removal from soil with high biomass production and without application of Zn fertilizer. High availability of zinc noticed with the application SSNM package along with wheat reside together was might be due to application of Zn in such treatment role of organic matter in increase the zinc availability. Mauriya *et al.* (2015) reported that application of N_{150} P_{60} K_{120} S_{40} B_5 Mn_{20} Zn_{25} kg ha^{-1} in rice left a substantial residual effect of Zn for succeeding wheat crop. Our results also find support from this work.

Moreover, available S was higher under application of wheat residue along with 100kg N, 60 kg P, 60 kg K, 25 kg Zn, 30 kg S and 5 kg B and statistically at par to T_6 and T_7. Mixing of wheat residue and FYM was also brought significant improvement compare to recommended PK (T_4) and recommended NK (T_3). Since rest of the sulphur in soil is of organic nature. The availability depends on level and type of organic sulphur. Elevated levels of organics in soil will certainty increase the organic sulphur therefore, high availability is well expected.

More Boron was available in combined (inorganic and organic) treated plots as compare to only chemically treat plots at all the stage of soil analysis. A significant difference in available boron was noticed between treated and untreated plot with wheat residue. Significantly higher available Boron was recorded in T_{11} (SSNM package with wheat residue) and lowest in T_4(recommended PK).This may be due to supplementation of boron through inorganic fertilizer Borax as well as wheat residue. Availability of iron in soil was significantly lower in T_4 (recommended PK).This may be due poor plant growth in said treatment by which the redox state of soil will not be favourable for reduction of ferric iron and thereby lower available. Higher available noticed by the application SSNM package with wheat residue might be due to application of wheat residue which will improve iron availability.

Without statistical analysis, data revealed that higher soil pH was found in T_{11}, T_4 and T_{10} and lower soil pH T_2, T_5 and T_1 treatment at tillering, P.I. and harvesting stage respectively. The Uttar Pradesh soil are lower in available nitrogen and somewhat in P therefore, less ammonical nitrogen is supposed to be present in soil for root absorption in control plot (T_4) therefore, decrease in soil pH under control treatment was slightly lower than rest of its level. Our results collaborate with the finding of Upadhyay *et al.* (2011).

Electrical conductivity was higher with the application of N, P, K, S, Zn, B and N, K, S, Zn, B while, lower was shown in recommended NK and recommended PK treatments. The improvement in electrical conductivity with SSNM package might be due to application of more nutrients which results in higher ionic strength that represents the higher electrical conductivity with increment of nutrient in the soil.

No significant change in bulk density g cm^{-3} was observed in different treatments. Lower value of bulk density of soil at harvest was found with the combine use of organic and inorganic or balance use of inorganic fertilizer. This may be attributed to the cementation effect of organic matter and better root growth after harvest of crop. This finding is in agreement with the observation of Upadhyay *et al.* (2011). The magnitude of increment was lower in combine use of organic manure and inorganic fertilizers treated plot as compare to inorganic fertilizers alone treated plots. Approximately 5 % increase in the bulk density g cm^{-3} was noticed from tillering stage to harvest stage due to addition of organic manure (FYM). However the change was not significant from those where inorganic fertilizers were added. The increased bulk density due to addition of organic manures has been also reported by Santhi *et al.* (1999).

Maximum organic carbon g kg^{-1} observed with the application of SSNM package along with wheat residue at all the stages might be due to additional application of wheat residue and higher biomass production. Organic carbon remained higher under application of FYM along with recommended dose while, lower in recommended PK treatments. Improvement in soil fertility with the use of organic has been reported by Mauriya *et al.* (2015).

Yields

Application of SSNM package along with wheat residue produced higher grain yield and remained statistically alike with T_5 (recommended NPK with wheat residue) and T_6 (recommended NPK with FYM). Maximum straw yield was noticed in T_2 (recommended NP) statistically *at par* with T_1, T_3, T_5, T_9 and T_{11} but significantly higher to all the rest treatments whereas, lowest yield was found under recommended PK at harvest stage. The yield increase under SSNM package along with wheat residue was probably due to beneficial effect of balanced nutrition which had promoted tillering and plant height with increased cell division, enlargement, photosynthesis and protein synthesis which are responsible for quantitative improvement in plant growth. The similar opinions were also forwarded by Mauriya *et al.* (2013).

Table 1. Effect of different fertility level on nutrient uptake of basmati rice

Treatment	N Uptake (kg ha^{-1})		P Uptake (kg ha^{-1})		K Uptake (kg ha^{-1})		Zn Uptake (g ha^{-1})		S Uptake (kg ha^{-1})		B Uptake (g ha^{-1})		Fe Uptake (g ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	54.27	36.36	5.07	5.07	9.80	105.51	119.78	282.34	2.29	22.65	20.76	35.87	348.93	430.73
T_2	40.78	33.72	4.51	4.51	7.81	81.52	87.82	262.67	1.65	19.17	16.96	30.13	283.94	290.24
T_3	47.00	34.19	4.16	4.16	8.37	93.85	87.09	262.15	1.68	20.05	17.53	31.69	258.09	302.18
T_4	26.19	24.05	3.17	3.17	6.16	68.12	60.21	197.21	0.89	14.37	12.42	22.50	196.58	214.27
T_5	54.89	39.97	5.40	5.40	11.30	130.59	144.33	338.66	3.58	27.18	23.13	41.32	483.98	684.61
T_6	59.15	42.93	5.68	5.68	10.95	129.91	148.23	368.91	3.97	28.43	23.14	46.32	502.49	694.12
T_7	55.15	38.35	5.32	5.32	10.93	123.12	145.23	350.81	4.14	27.00	22.17	42.37	488.81	661.68
T_8	51.22	34.94	4.80	4.80	9.48	117.18	110.85	272.82	2.55	21.98	20.53	34.98	357.26	498.28
T_9	50.74	35.93	4.56	4.56	8.96	97.63	90.65	278.53	1.84	20.96	19.00	34.59	313.93	411.06
T_{10}	55.99	35.76	5.20	5.20	10.57	117.79	137.72	271.65	3.11	22.58	22.08	35.55	446.77	606.49

T_{11}	64.55	45.52	6.13	6.13	12.64	136.37	168.35	379.91	5.50	31.55	28.51	47.81	554.32	732.03
SEm±	1.98	1.04	0.18	0.18	0.61	2.49	6.78	6.74	0.47	1.07	1.95	3.18	17.45	12.92
CD at 5%	5.89	3.07	0.52	0.52	1.82	7.41	20.25	20.03	1.39	3.19	5.84	9.29	52.26	38.42

Table 2. Effect of different fertility level on physical properties of soil

Treatment	**Bulk density (g cm^{-3})**			**Electrical conductivity (dSm^{-1})**			**pH (1:2.5 soil water)**			**Organic carbon (g kg^{-1})**		
	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage
T_{1}	1.33	1.37	1.41	0.28	0.26	0.25	7.45	7.20	7.31	4.19	4.04	3.84
T_{2}	1.35	1.38	1.43	0.36	0.33	0.30	7.29	7.39	7.36	4.05	3.93	3.81
T_{3}	1.36	1.37	1.40	0.24	0.27	0.23	7.39	7.23	7.43	4.19	4.10	3.90
T_{4}	1.35	1.39	1.43	0.25	0.24	0.25	7.36	7.47	7.59	3.94	3.81	3.31
T_{5}	1.32	1.34	1.36	0.32	0.28	0.26	7.30	7.17	7.32	4.42	4.52	4.05
T_{6}	1.29	1.31	1.35	0.31	0.29	0.26	7.41	7.23	7.35	4.59	4.48	4.01
T_{7}	1.33	1.36	1.39	0.45	0.42	0.40	7.45	7.32	7.45	4.09	4.05	3.97
T_{8}	1.34	1.37	1.43	0.48	0.45	0.38	7.39	7.36	7.50	4.04	3.90	3.41
T_{9}	1.34	1.37	1.42	0.43	0.41	0.32	7.44	7.41	7.59	4.01	3.85	3.28
T_{10}	1.32	1.34	1.43	0.45	0.37	0.31	7.43	7.29	7.61	4.53	4.36	3.86
T_{11}	1.31	1.32	1.35	0.28	0.25	0.24	7.57	7.27	7.36	4.64	4.54	4.10
SEm±	0.67	0.68	0.70	0.01	0.01	0.02	-	-	-	0.036	0.031	0.044
CD at 5%	N.S.	N.S.	N.S.	0.04	0.04	0.04	-	-	-	0.106	0.095	0.130

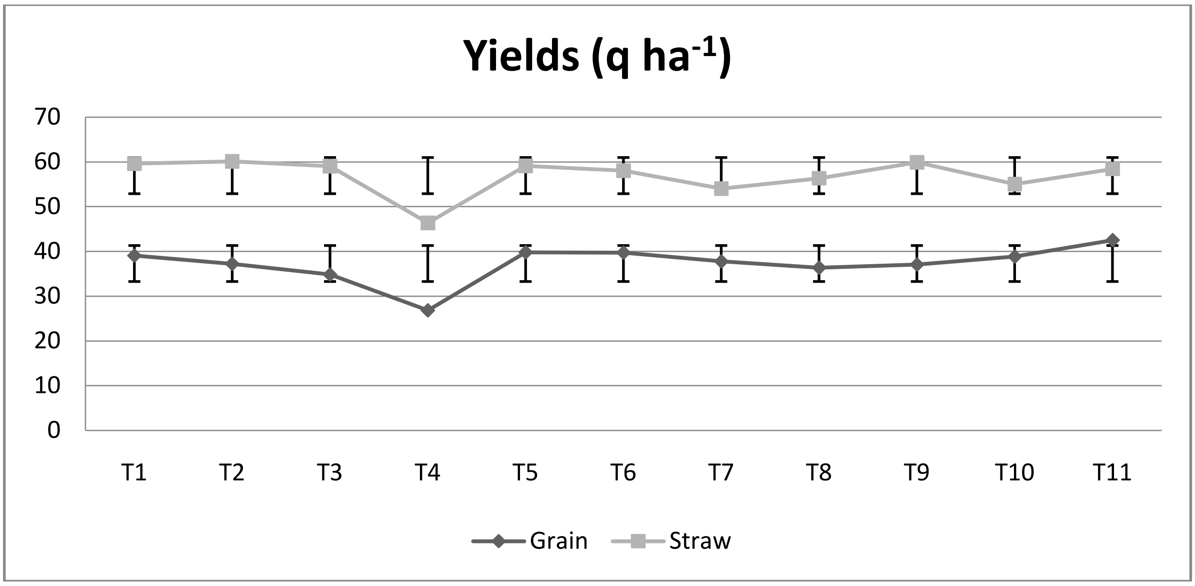
Table 3. Effect of different fertility level on primary and secondary nutrient (chemical properties) of soil

Treatment	**Available nitrogen (kg ha^{-1})**			**Available phosphorus (kg ha^{-1})**			**Available potassium (kg ha^{-1})**			**Available Sulphur (kg ha^{-1})**		
	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage
T_{1}	263.04	254.54	233.78	13.05	12.07	10.64	268.0	251.6	235.7	16.38	15.92	15.85
T_{2}	268.40	249.87	230.65	12.94	11.26	10.92	256.3	239.7	225.3	13.01	12.68	12.05
T_{3}	268.12	247.13	227.65	11.64	11.12	10.45	259.6	247.1	235.0	13.72	12.80	12.07
T_{4}	248.20	227.38	208.54	11.90	11.78	10.62	258.7	250.1	243.7	12.93	11.73	11.12
T_{5}	265.30	262.30	231.67	12.35	11.84	11.43	277.6	263.5	243.0	21.47	19.82	19.36
T_{6}	272.60	263.30	235.80	12.85	12.30	11.53	279.5	260.4	240.4	23.84	22.94	20.77
T_{7}	266.76	257.31	233.54	12.39	11.93	11.45	275.1	262.7	246.2	23.38	22.74	21.12
T_{8}	270.56	256.80	220.43	11.19	11.01	10.87	264.6	258.6	240.0	17.84	16.41	16.03
T_{9}	268.60	253.20	222.95	12.71	11.78	11.33	261.3	246.0	233.9	16.94	15.44	14.82
T_{10}	268.80	263.22	247.95	12.53	12.05	11.00	273.8	249.5	239.0	20.76	19.36	19.05
T_{11}	274.67	266.21	250.52	12.54	11.65	11.32	281.1	265.4	247.2	26.28	24.55	23.61
SEm±	1.51	1.00	0.92	0.09	0.09	0.04	1.7	1.0	0.6	1.01	0.78	0.95
CD at 5%	4.47	2.99	2.74	0.27	0.26	0.12	3.7	2.9	1.9	3.00	2.31	2.84

Table 4. Effect of different fertility level on micronutrient (chemical properties) of soil

Treatment	**Available zinc (mg kg^{-1})**			**Available Boron (mg kg^{-1})**			**Available Iron (mg kg^{-1})**		
	Tillering stage	P.I. Stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage
T_{1}	1.00	0.93	0.89	0.68	0.65	0.58	16.78	16.17	15.23
T_{2}	0.87	0.83	0.78	0.57	0.54	0.49	15.98	14.05	13.76
T_{3}	0.84	0.82	0.79	0.58	0.56	0.55	16.02	15.15	14.34
T_{4}	0.85	0.81	0.76	0.54	0.48	0.46	14.52	13.54	12.18
T_{5}	1.28	1.05	0.95	0.93	0.77	0.66	20.06	18.51	16.65
T_{6}	1.40	1.27	1.18	0.94	0.80	0.76	20.85	19.02	17.14
T_{7}	1.39	1.17	0.96	0.97	0.82	0.78	21.26	19.15	17.35
T_{8}	1.08	0.94	0.93	0.73	0.73	0.59	18.75	17.46	15.76
T_{9}	0.99	0.86	0.82	0.63	0.61	0.57	16.26	15.52	14.86
T_{10}	1.29	1.02	0.98	0.84	0.78	0.64	19.26	17.85	16.32
T_{11}	1.43	1.31	1.21	1.03	0.87	0.83	22.71	20.62	19.19

SEm±	0.02	0.02	0.01	0.03	0.03	0.02	0.56	0.71	0.73
CD at 5%	0.05	0.05	0.04	0.09	0.08	0.07	1.68	2.12	2.18



CONCLUSION

On the basis of experimental findings it can be concluded that for highest grain yield of rice along with wheat residue application of nutrients on SSNM base is best option. The SSNM based nutrient managements was found superior in term of nutrient uptake and gave more residual soil fertility. SSNM for rice is better than conventional practices of NPK application.

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