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Effect of nutrients management practices on yield, nutrients uptake and quality characteristics of rice (*Oryza sativa* L.) in central alluvial tract of Uttar Pradesh

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ABSTRACT

Field and laboratory studies were conducted during three consecutive kharif season 2015-2017 on Oil Seed Farm Kalyanpur, C.S. Azad University of Agriculture and Technology, Kanpur to evaluate the response of nutrients management practices on the yield, economics, nutrients uptake and various quality parameters of rice 'NDR-359'. The amplitude of variation in mean value of three years of grain and straw yield of rice significantly differ with control treatment. Application of N, P, K, Zn, Fe and Mn on the basis of state recommendation, site specific nutrient management as per nutrient expert and nitrogen addition on the basis of leaf colour chart under SSNM condition significantly increased the grain and straw yields and nutrients uptake over control. Although maximum grain (6.10 t ha^{-1}) and straw (7.61 t ha^{-1}) yield and nitrogen (85.8 kg ha^{-1}), phosphorus (23.3 kg ha^{-1}), potassium (29.0 kg ha^{-1}) and zinc (150.3 g ha^{-1}) uptake by grain and uptake of 64.1 kg ha^{-1} N, 11.3 kg ha^{-1} P_2O_5, 126.7 kg ha^{-1} K_2O and 142.2 g ha^{-1} zinc uptake by straw, respectively were recorded with ½ N and full dose of PK Zn Fe and Mn on soil test basis and remaining ½ N in two splits as per leaf colour chart (T_3). Application of N_{120} P_{60} K_{60} (T_1) significantly enhanced the grain and straw yield, net profit, BC ratio and N P K and Zn uptake by grain and straw than those obtained from absolute control and farmers fertilizer practices viz., N_{150} P_{30} K_0. Maximum net return of Rs. 33245 ha^{-1} with 2.09 BC ratio was recorded. Omission of N, P and K showed decreasing response on the grain, straw yield, nutrient uptake, net return per unit. Nitrogen omission effect was more pronounced than those of phosphorus and potassium omission. Lowest grain and straw yield, N, P, K and Zn uptake by grain and straw, net return were noticed in absolute control plot. Balanced use of nutrients beneficially improved the hulling, milling percentage, length of grains, water uptake, volume of grain after cooking, expansion kernel elongation of rice grain after cooking, crude protein, true protein, starch, mineral matter and amylose content of rice grain. The SSNM markedly improved the physical-chemical properties of post harvest soil. Imbalanced use of fertilizer nutrients either through farmer fertilizer practice or omission of N P and K had negative response on the availability of N P K and Zn, organic C and EC.

Key words: Rice, Yield, Nutrients uptake, Quality, Net profit, Soil fertility.

INTRODUCTION

Rice the staple food of more than 60% of world population, is primarily a high energy food containing 78-79% carbohydrates, 6-8% protein, 2-2.5% fat, 1-3% mineral matter and well with other cereals in respect of amino acid and vitamin B complex. It is one of the most important crop in our country and plays a major role in Indian economy. It occupies highest area among the crop grown in the country. Rice production accounted for 43.5 percent of total cereal production and 40.6 percent of total food grain production. The projected requirement of rice by the year 2050 for consumption purpose alone is 136 million tons for an expected population of 162 million. Since the scope to bring additional areas under rice cultivation is limited; the increase in production has to come from less land. In Uttar Pradesh it is grown an area of 60 lakh hectare with annual production of 131 lakh tones. But for productivity being low (21.70 q ha^{-1}) it ranks 7^{th} position in India. Intensive cultivation, growing exhaustive crop use of imbalance and in adequate fertilizers accompanied by restricted use of organic manure and bio-fertilizer have made the soil not only deficient in nutrient but also deteriorate soil health along with microbial activities Under such situation, integrated plant nutrient systems (IPNS and SSNM) have assumed great importance for the maintenance of soil productivity. Organic manure not only supply micronutrient but also meet the requirement of micronutrient in sufficient quantity to the crops, reduce production cost and improve soil health. The conventional blanket fertilizer recommendation causes low fertilizer use efficiency and imbalanced use of fertilizers. Estimation of field specific fertilizer requirements needs site specific knowledge of crop nutrient requirement indigenous nutrient supply and recovery efficiency of applied fertilizer. Fertilizer plays a crucial role in increasing crop productivity through their judicious application by increasing the supply of deficient plant nutrients in soil. Farmers in general, are applying generalized quantities of nitrogen, phosphorus and to some expect potassium with the fest deficiency of other nutrients are spreading in space and with increasing level of soil nutrient depletion and higher demand of food grain production in further the nutrient use will have to be increased at higher level. No doubt, chemical fertilizer due to definite place in soil fertility and management with fertilizer in necessary for sustaining responses of chemical fertilizer and maintain soil health. The aim of SSNM is to apply nutrients at optimal rates and times to achieve with good quality characteristics high yield and high efficiency of nutrient use by rice crops along with improving the physic-chemical parameters of such type of rice soils and leading to high cash values of the harvest per unit of fertilizer nutrients invested. Keeping this fact present investigation was planned and conducted.

MATERIALS & METHODS

The present investigation was conducted during kharif season of 2014-15 to 2016-17 in a fixed layout in sandy loam soil of Oil Seed Rsearch farm, Kalyanpur, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.). The initial physico-chemical and mechanical characteristics of the experimental soil were: sand 56.87%, silt 22.92% and clay 20.18%, pH 7.55%, E.C. 0.75 dSm^{-1}, CEC 24.8 c mol (p^+) Kg ha^{-1}, Org. carbon 4.5 g Kg ha^{-1}, bulk density 1.22 Mgm^{-3}, particle density 2.65 M gm^{-3}, porosity 48.2%. The texture of soil was sandy loam under inceptisol taxonmical class having available N, P_2O_5, K_2O 235, 19.5, 165 Kg ha^{-1}, respectively. DTPA extractable Zn, was .0.18mgKg-', Fe 4.0 and Mn 0.95 mg Kg^{-1}, respectively. Treatments viz. T_1- RFD (N_{120} P_{60} K_{60}), T_2- SSNM (N_{150} P_{60} K_{40}, $ZnSO_4$ 25kg, $FeSO_4$- 25 and $MnSO_4$- 25 kg ha^{-1}) on the nutrient expert recommendation. T_3- SSNM (1/2 N and full dose of N, P, Zn, Fe and Mn) as basal and remaining ½ N on the basis of leaf colour chart), T4 - T_2 minus nitrogen, T_5 - T_2 minus phosphorus, T_6 - T_2 minus potassium (N_{150} P_{30} K_0 Kg ha^{-1}), T_7 optional and T_8 absolute control. All the treatments were evaluated in randomized block design with three replication. Twenty one days old seedlings of 'NDR-359' rice were transplanted in first week of July in each years with 20 x 10 cm row to row and plant to plant spacing. The half dose on nitrogen and full doses of P, K, Zn, Mn and Fe were applied as basal at the time of transplanting through urea, single super phosphate, muriate of potash $MnSO_4$ and $FeSO_4$, respectively and remaining nitrogen was applied in two equal splits at maximum tillering and panicle initiation stage or on the basis of leaf colour chart. Agronomic cultural practices were performed as per requisite. At maturity grain and straw yield of rice crop were recorded. Grain and straw samples were analyzed for their nitrogen content by modified Kjddahl method (Jackson 1973), phosphorus was determined by vanadomolybdate, yellow colour method and potassium by flame photometer in di-acid digest. Zinc, iron and manganese contents were determined on atomic absorption spectrophotometer. Organic cation in post harvest soil was determined by Walkely and Black method. Available nitrogen, phosphorus and potassium in soil samples were determined by the methods described by Subbiah and Asija (1956), Olsen's and flame photometer (Jackson, 1973), respectively.

RESULTS AND DISCUSSION

Yield and nutrients uptake

Data (Table 1) revealed that the mean grain and straw yield of rice varied from 2.44 to 6.10 t ha^{-1} and 3.05 to 7.61 t ha^{-1}, respectively. The maximum grain and straw yields were recorded with ½ N + full dose of P, K, Zn, Mn and Fe as basal at the time of transplanting and remaining ½ N was applied on the leaf colour chart basis. The minimum grain and straw yields were noticed under absolute control. Although, in general, each treatment responded significantly higher than that of absolute control but the SSNM (T_2) and SSNM on LCC (T_3) were statistically at par in respect of yield. The responses of nitrogen, phosphorus and potassium omisson on grain yields over that of control were found 31.7, 87.4 and 127.9 per cent, respectively resulting that yield of rice decreased more due to nitrogen omisson followed by phosphorus and potassium. The treatments responses over control varied from 31.7% (T_4) to 149.7% (T_3) which indicated that integrated response of NPK Zn, Mn and Fe under site specific nutrient management practices was more pronounced than that of omisson of N, P, K. Imbalanced use of nutrients by farmers caused poor soil fertility status resulting lower grain and straw yields showing 101.3% response corresponding over absolute control. Therefore, nutrient management strategies for augmenting rice production were received and showed similar trends of responses of nutrients applied through soil test crop response by Tripathi *et al.* (2016) and Mishra *et al.* (2015).

Table 1: Response of nutrient management on yield, economics and nutrients uptake by rice (Mean of 03 years)

Treatments	Yield (t ha^{-1})		Net return ($Rs.ha^{-1}$)	Treatment response (%)	Nutrients uptake (kg ha^{-1})								BCR (Rs^{-1})
	Grain	Straw			Nitrogen		Phosphorus		Potassium		Zinc (g ha^{-1})		
					Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
T_1	5.99	6.78	32645	121.7	73..7	57.6	19.3	10.1	24.8	112.1	130.5	125.5	1.82
T_2	5.86	7.39	31937	141.3	81.3	64.1	21.9	11.3	27.6	122.9	144.5	138.0	1.93
T_3	6.10	7.61	33245	149.7	85.8	66.2	23.3	11.7	29.0	126.7	150.3	142.2	2.09
T_4	3.21	4.02	17494	31.7	43.4	33.6	11.5	5.7	14.7	65.8	76.7	71.0	1.52
T_5	4.58	5.71	24961	87.4	62.6	48.2	16.2	7.8	21.3	93.8	110.6	103.9	1.68
T_6	5.56	6.95	30302	127.9	76.2	59.3	20.3	10.5	25.1	97.0	135.1	128.5	1.87
T_7	4.91	6.14	26759	101.3	67.1	51.8	17.6	8.7	22.7	99.8	115.2	105.9	1.35
T_8	2.44	3.05	13298	-	30.7	25.1	8.4	4.1	10.9	49.1	54.5	50.3	1.12
G mean	4.76	5.96	26330	-	65.13	50.79	17.34	8.78	22.05	95.96	114.71	108.19	1.67
CD(D 0.05)	0.245	0.310	-	-	2.23	1.97	0.57	0.32	0.78	2.78	2.95	2.87	-

It is clear from the data (Table 1) that uptake of nitrogen, phosphorus, potassium and zinc by grain varied from 30.7 to 85.8, 8.4 to 23.3, 10.9 to 29.0 g ha^{-1} and 54.5 to 150.3 g ha^{-1}, respectively and by straw 25.1 to 66.2, 4.1 to 11.7, 49.1 to 126.7 kg ha^{-1} and 50.3 to 142.2 g ha^{-1}, respectively, under the influence of various treatments. Application of nutrients on the expert in term of SSNM recorded significantly maximum N P K and Zn uptake by both grain and straw (Table 1). However addition of ½ dose of nitrogen in standing rice crop on the basis of leaf colour chart and other nutrients on the basis of SSNM (T_3) showed significantly highest uptake of these nutrients. Omisson of nitrogen, phosphorus and potassium from SSNM recorded lower their uptake by both grain and straw. Lowest N P K and Zn uptake by grain and straw of rice were noticed in absolute control plots, which may be due to poor availability of these nutrients. Imbalanced use of nutrients by farmers caused lower availability of nutrients. These findings have close conformity with those reported by Tripathi *et al.* (2012) and Kumar *et al.* (2017).

Quality characteristics of rice

It is obvious from the data (Table 2) that physical characteristics *viz.,* hulling, milling percentage, length of grains and length/breath ratio varied from 70.5-75.6%, 52.3-59.3%, 6.45-6.90 mm and 3.18-3.62 with general mean value of 73.72%, 56.72%, 6.71 mm and 3.37, respectively. Application of nutrients on the basic recommendation of nutrient expert i.e. N_{150} P_{60} K_{40}, $ZnSO_4$ 25, $FeSO_4$-25 and $MnSO_4$-25 kg ha^{-1} as SSNM (T_3) showed markedly improvement in these quality parameters. Although, addition of half dose of N with P, K, Fe, Zn and Mn as basal at the time of transplanting and remaining half nitrogen in two equal splits according to leaf colour chart recorded highest improvement in length of grain milling and hulling percentage of rice (T_3). These characters were recorded lowest in absolute control plot. Omission of N, P, K reduced these quality parameters markedly. Omisson of nitrogen noticed most adverse effect on hulling, milling and length of rice grains than those of P and K omission. Addition of nitrogen in large quantity under farmers fertilizer practice increased these physical quality parameters but for, not reach at desirable levels that of SSNM treated plots. However, length/breath ratio of rice grains under the influence of these various treatments showed reverse trend. The highest (3.62) and lowest (3.18) L:B ratio were noticed in absolute control (T_8) and SSNM (T_2) treatments. These findings have close conformity with those reported by Das and Patra (2014). In general, omisson of nitrogen, phosphorus and potassium showed remarkable decreasing response on aforesaid quality parameters in comparison to RDF (T_1) and SSNM (T_2). Response of nitrogen omisson on length: breath ratio was more pronounced than that of phosphorus and potassium omisson plots values.

Table 2: Response of site nutrients management on quality characteristics of 'NDR-359' rice (Mean of 03 years)

Treatment	Physical characteristics				Thermal characteristics								
	Hulling (%)	Milling (%)	Length of grain (mm)	Length (breath ratio)	Volume expansion of its original volume	Water uptake (ml)	Kernel elongation (mm)	Crude protein (%)	True protein (%)	None protein nitrogen (%)	Starch (%)	Amylose (%)	Mineral matter (%)
T_1	74.2	57.2	6.76	3.25	4.15	372	1.47	8.14	7.81	0.074	78.98	19.48	1.66
T_2	75.0	59.2	6.88	3.20	4.12	366	1.50	8.25	7.98	0.079	79.15	19.65	1.78
T_3	75.6	59.3	6.90	3.18	4.10	362	1.52	8.37	8.08	0.082	79.20	19.68	1.80
T_4	72.8	55.8	6.59	3.57	4.22	382	1.40	8.07	7.67	0.064	79.02	18.43	1.59
T_5	73.2	56.1	6.65	3.49	4.20	378	1.42	8.09	7.82	0.066	78.92	19.32	1.64
T_6	73.8	56.5	6.70	3.38	4.8	376	1.45	8.15	7.80	0.069	78.08	18.38	1.62
T_7	74.4	57.3	6.78	3.30	4.17	374	1.48	8.16	7.83	0.076	78.23	18.28	1.68
T_8	70.5	52.3	6.45	3.62	4.27	3.87	1.37	7.50	7.10	0.062	78.20	17.97	1.56
G mean	73.72	56.72	6.71	3.37	4.18	374.6	1.45	8.09	7.76	0.071	78.72	18.18	1.67
CD(D 0.05)	1.35	1.27	0.03	0.02	0.025	5.15	0.01	NS	NS	NS	1.48	0.016	0.102

The thermal characteristics *viz.,* water uptake, volume expansion of its original volume and kernel elongation of rice under various treatments ranged from 362-387 ml, 4.10-4.27 and 1.37-1.52 mm with mean values of 374.6 ml, 4.18 and 1.45 mm, respectively. Maximum water uptake (387 ml) and volume expansion 4.27 were recorded in absolute control followed by omisson of nitrogen, phosphorus and potassium. It might be due to negative correlation of these thermal characteristics with higher amount of fertilizer nutrients, resulting lower quantity of water uptake (362 ml) and volume expansion of its original volume (4.10) followed by SSNM (T_2) and RDF (T_1) respectively. The kernel elongation of cooked rice grain was highest (1.52 mm) with N_{150} P_{60} K_{40} $ZnSO_4$ 25 kg $FeSO_4$ 25 and $MnSO_4$ 25 kg ha^{-1} (T_3) followed by SSNM (T_2) and RDF (T_1) showing positive coordination with fertilizer nutrients. Lowest kernel elongation of cooked rice grain (1.37 mm) was recorded in absolute control followed by omission of nitrogen (1.40 mm), phosphorus (1.42 mm) and potassium (1.45 mm). Imbalance use of fertilizer nutrients under farmers fertilizer practices did not show any definite trend in respect of these thermal quality parameters. These findings have close conformity with those reported by Druva *et al.* (2013), Hardev *et al.* (2015) and Krishna Nath *et al.* (2014).

In general, percentage concentration of crude protein, true protein, non protein nitrogen, starch, amylose and mineral matter differed from 7.50-8.37, 7.1-8.05, 0.062-0.082, 79.08-79.20, 17.97-19.68 and 1.56-1.80 with mean value of 8.09, 7.76, 0.071, 78.72, 18.19 and 1.67, respectively (Table 2). Although application of N_{150} P_{60} K_{40} $ZnSO_4$ 25kg $FeSO_4$ 25 and $MnSO_4$ 25 kg ha^{-1} under SSNM (T_2) recorded more improvement in these chemical quality characteristic. However, addition of aforesaid nutrient along with ½ N as basal and remaining ½ N as top dressed according to leaf colour chart in two equal dose noticed maximum (75.2%, 59.3%, 6.90, 3.18, 4.10, 362 ml, 1.52 mm, 8.37%, 8.08%, 79.20%, 19.68% and 1.80%) these quality parameters viz., hulling, milling, length of grain, length : breath ratio, volume expansion, water uptake, kernel elongation, crude protein, true protein, non protein nitrogen, starch, amylose and mineral matter, respectively but could not differ significantly than that of T_2. The effect of each fertilizer treatments was markedly superior than that of absolute control (T_7) but response of these nutrients was more pronounced in (T_3) treatment which received all nutrients on soil test crop response basis. Omission of nitrogen, phosphorus and potassium showed decreasing effect on these chemical quality characteristics. It is obvious from the data that omission of nitrogen and phosphorus responded negatively more on crude protein in rice grain while potassium omission on starch and amylaoe content. Imbalanced use of fertilizer nutrients under farmers fertilizer practices could not show any definite trend of response on these quality parameters. These are conformity with the results recorded by Baishya *et al.* (2010), Bhowmick *et al.* (2011) and Hardev *et al.* (2015).

Table 3: Response of site nutrients management on fertility of post harvest soil (Mean of 03 years)

Treatment	pH (1:2.5)	EC (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	Avail. N ($kg\ ha^{-1}$)	Avail. P ($kg\ ha^{-1}$)	Avail. K ($kg\ ha^{-1}$)	Avail. zinc ($mg\ kg^{-1}$)
T_1	7.52	0.79	4.58	240.3	20.0	175.0	0.48
T_2	7.50	0.85	4.92	246.9	20.9	177.7	0.54
T_3	7.51	0.82	4.94	248.5	20.5	177.4	0.55
T_4	7.57	0.70	4.76	232.5	19.83	171.3	0.53
T_5	7.56	0.72	4.79	235.4	17.67	173.7	0.52
T_6	7.55	0.74	4.89	242.3	20.3	164.0	0.50
T_7	7.53	0.76	4.82	238.3	20.2	173.3	0.46
T_8	7.58	0.73	4.71	224.7	19.61	171.1	0.35
G mean	7.54	0.76	4.83	238.52	19.84	172.96	0.49
CD (D 0.05)	0.05	0.06	0.09	2.83	0.92	1.92	0.02

Soil fertility

It is palpable from the data (Table 3) that pH, E.C., organic carbon, available N, P_2O_5, K_2O and zinc varied from 7.50-7.58, 0.70-0.85 dSm^{-1}, 4.58 to 4.94 g kg^{-1}, 231.5 to 248.5 kg ha^{-1}, 17.67 to 20.90 kg ha^{-1}, 164.0 to 177.7 kg ha^{-1}, and 0.35 to 0.55 mg kg^{-1}, with mean value of 7.54, 0.76 dSm^{-1}, 4.83 g kg^{-1}, 238.5 kg ha^{-1}, 19.84 kg ha^{-1}, 172.9 kg ha^{-1}, and 0.49 mg kg^{-1}, respectively. Balanced use of nitrogen, phosphorus, potassium along with micronutrients *viz.,* zinc, iron and manganese on the soil test basis as SSNM on nutrient expert recommendation recorded more improvement in the physico-chemical characteristics of post harvest soil. However, omisson of nitrogen, phosphorus and potassium showed decreasing effect on their availability. The availability of nutrients were observed lowest in absolute control plots. Imbalanced use of fertilizer nutrients under farmer fertilizer practices could not show any remarkable beneficial improvement in soil health. These findings are comparable to those reported by Kumar *et al.* (2017).

REFERENCES

Baishya, S.; Pathak, K.; Baruah, A.M. and Pathi, S. (2010) Starch and protein profile of hill rice cultivars of Assam. *Oryza* **47**(3) : 237-242.

Bhowmick, M.K.; Dhara, M.C.; Bag, M.K.; Adhikari, B. and Kundu, C. (2011) Integrated nutrient management for aerobic rice in West Bengal. *Oryza* **48**(3) : 276-277.

Das, D. and Patra, H. (2014) Effect of organic and inorganic sources of nitrogen on yield, milling and nutritional quality of rice. *Trends in Biosciences* **7**(12) : 1285-1290.

Druvashree, Chandru, R. and Rajanna, M.P. (2013) Eight rice genotypes physic-chemical characteristics and cooking quality on post harvest technology. *UAS Bangalore* **47**(3) : 498-501.

Hardev, R.; Singh, J.P.; Bhora, J.S.; Yadav, A.S. and Sutaliya, J.M. (2015) Asses of productivity, profitability and quality of rice under system of rice intensification in eastern Uttar Pradesh. *Indian Journal of Agricultural Sciences* **85**(1) : 38-42.

Jackson, M.L. (1973) Soil and Chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi, pp. 498.

Krishnanath, B.; Kumar, M.N.; Edukondalu, L. and Patnaik, A.A. (2014) Physical and milling characteristics of different varieties of paddy. *Environment and Ecology* **32**(2A) : 651-653.

Kumar, A.; Tripathi, B.N.; Kumar, M. and Tomar, S.S. (2017) Effect of crop establishment methods and nutrient management on soil health and productivity of Basmati rice (*Oryza sativa* L.). *Progressive Agriculture* **17**(2) : 311-314.

Mishra, S.K., Tripathi, B.N., Dixit, R.N. and Singh, A. (2015) Production potential of rice-wheat crops nutrients uptake and soil properties as influenced by fertilizer nutrients and FYM under five years Rice-wheat cropping system. *Annals of Plant and Soil Research* **17**(special issue) : 193-192.

Subbiah, B.V. and Asiza, G.L. (1956) A rapid procedure for the determination of available nitrogen in soils. *Current Science* **25** : 259-260.

Tripathi, B.N. and Kumar, R. (2013) Effect of zinc and sulphur levels in rice in partially reclaimed Typic Natrustalf sodic soil. *Annals of Plant and Soil Research* **15**(1) : 27-30.

Tripathi, B.N., Singh, A., Ram, H. and Tripathi, A. (2016) Response of nitrogen and phosphorus levels on rice in partially reclaimed sodic soils of Uttar Pradesh. *New Agriculturist* **27**(1) : 91-96.

Tripathi, B.N.; Kumar, R. and Kumar, A. (2013) Effect of phosphorus and potash levels alone and in conjunction with FYM on the rice wheat cropping system. *Annals of Plant and Soil Research* **15**(2) : 32-36.

Tripathi, B.N.; Tripathi, A.K.; Aslam, M. and Dixit, R.N. (2012) Response of rice varieties to graded levels of zinc sulphate in partially amended sodic soils. A *Current Advances in Agricultural Sciences* **5**(1) : 29-32.