www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 5613-5616

www.thepharmajournal.com
Received: 16-10-2022
Accepted: 18-11-2022

Sheru Kumar
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

VN Mishra
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

TD Sahu
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

C Chandrakar
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Anjali Patel
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Sheru Kumar
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Differential responses of rice (*Oryza sativa* L.) to nutrient omission in Vertisol and Inceptisols under Kanker district of Chhattisgarh

Sheru Kumar, VN Mishra, TD Sahu, C Chandrakar and Anjali Patel

Abstract
Nutrient omission trial was conducted at IGKV GRS technical farm, Department of Soil Science and Agricultural Chemistry, IGKV, Raipur (Chhattisgarh) during *Kharif*, 2017 on rice crop in Inceptisol and Vertisol. Trials were framed as pot culture in Completely Randomized Design where eleven treatments were replicated trice. Results revealed that maximum number of effective tillers pot^{-1}, filled grain panicle^{-1}, and highest thousand grain weight was observed in the treatment which was supplied with all the nutrients in both Vertisol and Inceptisol. Lowest values for the aforesaid parameters were found in the treatment where nitrogen was omitted. Omission of N, P and S in both the soil types caused significant reductions in grain and straw yields of rice. Grain and straw yields in the treatment receiving all the nutrients (66.86 and 78.08 g pot^{-1}, respectively in Inceptisol and 62.62 and 75.75 g pot^{-1}, respectively in Vertisol) were significantly higher than the yields with omission of N, P and S (36.45, 40.72 and 52.86 g pot^{-1} respectively and 46.67, 47.53 and 63.13 g pot^{-1} respectively in Inceptisol and 37.91 and 41.56, 57.10 and 46.32, 48.03 and 64.79 g/pot respectively in Vertisol). Grain yield reductions of rice were found more with omission of N (45.48% in Inceptisol and 39.46% in Vertisol) followed by P and S omission. Nutrient uptake by rice was significantly reduced with omission of N, P and S in both the soil types. On the basis of nutrient omission pot trial the identified yield limiting nutrients in Inceptisol and Vertisol were in the order of N > P > S.

Keywords: Inceptisols, nutrient, omission, uptake, Vertisol

Introduction
Rice is one of the India's main foods, covering an area of 43.77 million hectares with production of 112.76 million tones and productivity of 25.76 q ha^{-1} (Anonymous, 2019). For food security in India rice production is an important factor. However, sustainability of rice based current production systems is uncertain. Rice is usually supplied with N, P and K fertilizer in extensive areas in India. Such fertilizer practice suggests that requirement of nutrients for any cereal crop is constant for long time and for large areas, however, the variable nature of climatic and growing conditions, agricultural management practices, growth stage of plant and supplemental need of nutrients can vary largely from one field to another field and from one season to another season. Therefore, nutrient management includes such approaches that allow for modification in nitrogen (N), phosphorus (P) and potassium (K) applications to meet the plants field specific needs for supplemental nutrients.

A new site-specific nutrient management (SSNM) approach for rice has been evaluated recently at numerous locations in Asia (Dobermann *et al*., 2004) [2]. In this approach in a particular field balanced quantity of nitrogen (N), phosphorus (P) and potassium (K) are recommended on the basis of estimates of the indigenous supply of nitrogen, phosphorus and potassium and by modeling the expected yield of crops as a function of nutrient interactions and climatic yield potential. Adoption of SSNM requires understanding and quantification of the indigenous supply of macronutrient for a larger fertilizer recommendation domain or for a specific rice field. Effective indigenous supply (IS) is defined as the cumulative amount of that nutrient originating from all indigenous (non-fertilizer) sources that circulates through the soil solution surrounding the entire root system during one complete crop cycle. In an irrigated system, IS includes plant available nutrients derived from (i) chemical and biological transformations of soil solids, (ii) biological N_2 fixation in the floodwater–soil system, (iii) atmospheric deposition, and (iv) solutes and sediments deposited by irrigation and/or naturally occurring flooding.

For practical purposes, IS can be measured as plant nutrient accumulation at crop maturity in a nutrient omission plot under well-managed field conditions, i.e., when all other nutrients except one are amply supplied and other limitations to growth such as water or pests are absent.

Material and Methods

The present study was undertaken as nutrient omission trials to assess the fertility status of two representative soil groups of Pathari village in Kanker district. Soil samples from two representative soil groups *i.e.,* Vertisol *s* and Inceptisols locally known as *Kanhar* and *Matasi*, respectively were collected in bulk from the farmer's fields to assess the fertility status. Pot culture nutrient omission experiments were carried out in these soil samples at IGKV GRS technical farm, Department of Soil Science and Agricultural Chemistry, IGKV, Raipur (C.G.) during *Kharif* season, 2017 with rice as test crop. Soil sample was taken from a depth of 15 cm, thoroughly mixed, made free from plant residues and unwanted material and filled in plastic pots at the rate of 20 kg pot^{-1}. The climatic condition of experimental site was humid subtropical, receiving an average rainfall of 1200-1300 mm annually with an average temperature of 25±27 °C. Most of the rainfall is received during the months from June to September. Typic Haplustept and Typic Rhodustalf are the major sub-soil group of Kanker. The experiment was conducted in Completely Randomized Design consisting eleven treatments, each replicated trice. Treatment consisted of omission of one of the nutrient elements from the treatment receiving all the nutrients. T_1- all nutrients (N, P, K, S, Fe, Mn, Cu, Zn, B, Mo) supplied, T_2- N omission, T_3- P omission, T_4- K omission, T_5- S omission, T_6- Fe omission, T_7- Mn omission, T_8- Cu omission, T_9- Zn omission, T_{10}- B omission and T_{11}- Mo omission in both soil types.

Table 1: Source and rates of application of nutrient used in nutrient omission pot trials:

Nutrient	Source of nutrient	Rate of application (kgha^{-1})
N	[1]Urea	150 kg N/ha
P	TSP/[2]DAP	(100 kg P_2O_5/ha)
K	*MOP	(80 kg K_2O/ha)
S	[3]Bentonite Sulphur	45
Ca	[4]$CaCl_2$. $2H_2O$	110
Mg	MgO	55
Fe	$FeSO_4.7H_2O$ [5]$FeCl_2$	20
Mn	$MnSO_4.H_2O$, [6]$MnCl_2$	15
Cu	$CuSO_4.5H_2O$ [7]$CuCl_2.2H_2O$	7.5
Zn	$ZnSO_4.7H_2O$,[8]$ZnCl_2$	7.5
B	H_3BO_3	3
Mo	$NaMoO_4.2H_2O$	0.75

Composited soils collected from different sites were air dried and filled in polyethylene lined pots at the rate of 20 kg per pot. The pots were maintained with 3 cm standing water and twenty one days old seedlings of rice variety MTU-1010 were transplanted on 22nd July, 2017. Three hills per pot were maintained in all the pots. Complete dose of all the nutrients except nitrogen was then added to the soil in the form of solution. Nitrogen as urea was added in three splits at transplanting, tillering and panicle initiation stage. Crop was grown till maturity and harvested on October 31, 2017. During *Kharif* season, Rice MTU-1010 was under observation for growth. Deficiency symptoms as well as an ancillary character such as total tillers, effective tillers and plant height was recorded. After harvesting total grain per panicle, grain and straw yield and test weight are recorded per pot. Statistical analysis of the recorded data in CRD for both soils with different variables was done in OPSTAT online statistical tool for data analysis developed by O. P. Sheoran Associate Professor, Computer Section CCS HAU, Hisar.

Result and Discussion

Omission of different nutrient elements significantly affected yield attributing parameters of rice in Inceptisol and Vertisol (Table 2). Effective tillers, filled grains and 1000 grain weight of rice were significantly reduced in both the soil types with omission of nitrogen, phosphorus and sulphur. Effective tillers pot^{-1} ranged from 18.67 to 32.33 and 17.25 to 30.66 in Inceptisol and Vertisol, respectively. Filled grains panicle^{-1} ranged from 72.34 to 137.52 and from 69.35 to 121.73 in Inceptisol and Vertisol, respectively while 1000 grain weight of the rice grain ranged from 22.02 to 25.23 g in Inceptisol and varied from 21.09 to 23.03 g in Vertisol. Maximum values for the aforesaid parameters *i.e.,* 32.33 in Inceptisol and 30.66 in Vertisol effective tillers per pot, 137.52 in Inceptisol and 121.73 in Vertisol filled grains panicle^{-1} and 25.23 gram in Inceptisol and 23.03 gram in Vertisol, thousand grain weight were observed with the treatment that received all the nutrients and minimum with N omission followed by P and S omission. Grain and straw yields of rice was significantly reduced with omission of nitrogen, phosphorus and sulphur in both the soil types (Table 2). Grain and straw yields with omission of N, P and S (36.45, 40.72 and 52.86 g pot^{-1}, respectively and 46.67, 47.53 and 63.13 g pot^{-1}, respectively in Inceptisol and 37.91 and 41.56, 57.10 and 46.32, 48.03 and 64.79 g pot^{-1}, respectively in Vertisol) were significantly lower than the treatment receiving all the nutrients (66.86 and 78.08 g pot^{-1} respectively in Inceptisol and 62.62 and 75.75 g pot^{-1} respectively in Vertisol). Nitrogen omission caused maximum grain yield reductions of rice *i.e.,* 45.48% in Inceptisol and 39.46% in Vertisol followed by P and S omission. Omission of P reduced the grain yield by 39.10% in Inceptisol and by 33.62% in Vertisol whereas omission of S caused 20.93% grain yield reduction in Inceptisol and 8.81% in Vertisol. Omission of Mo, B, Fe, Mn, Ca, Mg, Cu, Zn and K did not result in significant reductions in grain and straw yields of rice. Similar observations were also reported by Islam *et al.,* 2013 [4] for grain and straw yield of rice. Nitrogen is found to be the most limiting nutrient therefore the extent of grain and straw yield reductions were seen maximum with nitrogen omission. Next limiting nutrient in the order were phosphorus and sulphur which caused much reductions in grain and straw yield of rice in both the soil types. In soils with high amount of clay adsorption and immobilization of sulphur is observed. So in Vertisol *s* (heavy textured black soil), straw and grain yields were lower.

Total uptake by rice in relation to macronutrients were in the order K > N> P> S in both the soil types (Table 3). Uptake of K was more in straw in comparison to grain whereas N, P and S uptake was more in grain compared to straw. Treatment receiving all the nutrients resulted in maximum N uptake (1.09 in Inceptisol and 1.10 mg pot^{-1} in Vertisol) and minimum in the treatment where nitrogen was omitted (0.56 mg pot^{-1} in Inceptisol and 0.61 mg pot^{-1} in Vertisol). Omission of nitrogen in Inceptisol and omission of phosphorus in Vertisol caused least uptake of P (0.12 mg pot^{-1} in Inceptisol and 0.11 mg pot^{-1} in Vertisol). Potassium uptake by rice ranged from 0.70 to 1.31 mg pot^{-1} in Inceptisol and 0.80 to 1.36 mg pot^{-1} in Vertisol and application of all nutrients caused maximum K uptake. Highest S uptake by rice was found in the treatment which received all the nutrients and minimum with N omission (0.10 in Inceptisol and 0.14 mg pot^{-1} in Vertisol) which was closely followed by P and S omission in both the soils. Lowest calcium uptake by rice was observed with N omission (0.36 mg pot^{-1}) whereas highest in the treatment where all the nutrients were applied (0.66 mg pot^{-1}). Mg uptake also followed the same trend. However, the amount of Ca uptake was more than that of Mg. Uptake of micronutrients by rice followed the order Cu < B < Zn < Fe <Mn. Comparatively less nitrogen uptake were also observed by Kumar *et al*., 2018 when nitrogen was omitted in a nutrient omission trial. Nitrogen uptake with omission of nitrogen was lowest obviously due to the fact it was the most yield limiting nutrient and it caused less growth and less yields and hence minimum nitrogen uptake. Mishra *et al*., 2007 have also observed lower phosphorus uptake when nitrogen, phosphorus and sulphur were omitted. Phosphorus omission resulted in minimum phosphorus uptake because it was the next most yield limiting nutrient after nitrogen, which caused less yields and less phosphorus concentrations. Increased potassium uptakes with addition or application of potassium together with other nutrients have been observed by Sakeena and Salam, 1989 [7]. In linseed Singh and Singh, 1990 [8] observed increased uptake of magnesium when $MgCl_2$ was used as a source of magnesium. Singh *et al.*, 2006 [9] have reported that sulphur uptake by rice crop has been found to be more with sulphur application along with other nutrient elements. Application of boron together with other nutrients caused higher amount of available boron in soil solution favouring more boron absorption by rice and higher boron removal in plant tissues (Girish *et al.*, 2007) [3].

Table 2: Yield attributes, Grain and straw yield of rice as influenced by different treatments in an Inceptisol and Vertisol

Treatments		Effective tillers pot^{-1}		Filled grains panicle^{-1}		Test weight (g)		Grain yield (g pot^{-1})		% yield reduction		Straw yield (g pot^{-1})	
		Inceptisol	Vertisol	Inceptisol	Vertisol	Inceptisol	Vertisol	Inceptisol	Vertisol	Inceptisol	Vertisol	Inceptisol	Vertisol
T_1	All	32.33	30.66	137.52	121.73	25.23	23.03	66.86	62.62	0.00	0.00	78.08	75.75
T_2	All-N	18.67	17.25	72.34	69.35	22.02	21.09	36.45	37.91	45.48	39.46	46.67	46.32
T_3	All-P	21.32	20.54	94.57	82.49	22.84	21.32	40.72	41.56	39.10	33.62	47.53	48.03
T_4	All-K	31.27	29.53	130.32	116.51	25.03	22.73	65.89	61.05	1.45	2.51	77.79	76.39
T_5	All-S	27.23	26.45	124.65	105.44	23.67	20.87	52.86	57.10	20.93	8.81	63.13	64.79
T_6	All-Ca/Fe[a]	29.57	29.24	135.79	114.33	24.74	22.56	64.05	61.01	4.19	2.56	75.03	72.91
T_7	All-Mg/Mn[b]	31.64	29.33	131.32	115.29	24.75	22.79	64.14	60.13	4.07	3.97	77.27	74.41
T_8	All-Cu	30.41	29.67	134.51	114.53	24.86	22.83	65.48	60.61	2.06	3.20	75.57	70.29
T_9	All-Zn	29.33	28.87	130.66	114.36	24.93	22.68	64.04	59.26	4.21	5.37	73.90	71.81
T_{10}	All-B	29.45	29.24	132.45	116.85	25.01	22.94	64.85	60.03	3.01	4.13	75.75	76.54
T_{11}	All-Mo	31.32	29.38	134.33	117.42	25.05	23.01	66.41	61.98	0.66	1.01	78.69	75.21
CD at 5%		3.91	2.47	10.83	13.16	0.98	0.87	8.60	5.51	-	-	9.57	7.79
SE(m)±		1.13	0.77	3.12	3.56	0.32	0.26	2.88	1.86	-	-	3.24	2.64

[a]means All-Ca for Inceptisol, All–Fe for Vertisol [b]means All-Mg for Inceptisol, All –Mn for Vertisol
***Per cent yield reduction was calculated considering the rice grain yield in the treatment where all the nutrients were applied (T_1) as 100 per cent

Table 3: Total nutrient uptake by rice (grain + straw) (g/pot) as influenced by different treatments in an Inceptisol and Vertisol

Treatments		N (g pot^{-1})		P (g pot^{-1})		K (g pot^{-1})		Ca (g pot^{-1})	Fe (mg pot^{-1})	Mg (g pot^{-1})	Mn (mg pot^{-1})	S (g pot^{-1})		Zn (mg pot^{-1})		B (mg pot^{-1})			Cu (mg pot^{-1})
		I.	*V.*	*I.*	*V.*	*I.*	*V.*	*I.*	*V.*	*I.*	*V.*	*I.*	*V.*	*I.*	*V.*	*I.*	*V.*	*I.*	*V.*
T_1	All	1.09	1.10	0.27	0.24	1.31	1.36	0.66	19.31	0.38	28.12	0.21	0.21	4.22	4.13	1.16	1.12	0.89	0.88
T_2	All-N	0.56	0.61	0.12	0.13	0.70	0.80	0.36	11.66	0.21	16.67	0.10	0.10	2.36	2.47	0.62	0.66	0.48	0.54
T_3	All-P	0.64	0.71	0.15	0.11	0.76	0.83	0.38	12.21	0.22	17.33	0.11	0.11	2.55	2.61	0.69	0.75	0.52	0.57
T_4	All-K	1.06	1.07	0.26	0.23	1.21	1.32	0.63	19.12	0.35	26.96	0.19	0.19	4.00	3.98	1.10	1.05	0.80	0.85
T_5	All-S	0.85	0.95	0.20	0.18	1.02	1.18	0.50	16.39	0.29	23.85	0.14	0.14	3.24	3.41	0.87	0.94	0.66	0.72
T_6	All-Ca/Fe[a]	1.04	1.05	0.24	0.21	1.20	1.29	0.60	18.11	0.35	26.05	0.18	0.18	3.90	3.84	1.03	1.01	0.82	0.83
T_7	All-Mg/Mn[b]	1.07	1.03	0.25	0.21	1.26	1.29	0.62	19.07	0.35	26.49	0.19	0.19	4.03	3.93	1.05	1.03	0.83	0.85
T_8	All-Cu	1.04	1.06	0.24	0.23	1.24	1.24	0.61	17.74	0.34	25.27	0.18	0.19	3.98	3.82	1.10	1.01	0.80	0.81
T_9	All-Zn	1.06	1.01	0.24	0.22	1.20	1.26	0.60	18.10	0.33	25.63	0.19	0.18	3.76	3.64	1.05	1.03	0.78	0.83
T_{10}	All-B	1.05	1.04	0.25	0.23	1.23	1.31	0.61	19.09	0.33	28.02	0.17	0.19	4.01	3.94	1.01	1.02	0.80	0.84
T_{11}	All-Mo	1.08	1.05	0.25	0.23	1.25	1.30	0.63	18.94	0.37	26.80	0.18	0.19	4.09	4.01	1.14	1.04	0.82	0.86
CD at 5%		0.13	0.10	0.04	0.03	0.17	0.14	0.08	2.62	0.06	3.86	0.03	0.03	0.56	0.53	0.19	0.13	0.12	0.10
SE(m)±		0.04	0.03	0.013	0.009	0.05	0.04	0.02	0.84	0.01	1.24	0.008	0.009	0.18	0.16	0.06	0.04	0.04	0.03

Conclusion

Straw and grain yields as well as nutrient uptake by rice were significantly reduced when nitrogen, phosphorus and sulphur were omitted in both *Vertislol* and Inceptisol. Among these three nutrients, the nutrient element which limited the yields to maximum extent in both Inceptisol and Vertisol was nitrogen. Extent of yield limitations by omission of nutrients were found in the order N > P > S. On the basis of the experiment conducted conclusions can be drawn that the soils (Inceptisol and Vertisol) of Kanker district were low in N, P and S which must be taken in to account and efficiently used for yield maximization of crops.

References

1. Anonymous. Agricultural Statistics at a glance; c2019. p. 48
2. Dobermann A, Witt C. Introduction In: Doberman, A., C. Witt and D. Dawe (Eds.) Increasing Productivity of

Intensive Rice Systems through Site; 2003.
3. Girish, Chander, Verma TS, Sandeep Sharma. Influence of boron and farmyard manure on available boron and exchangeable calcium and their removal by cauliflower in the boron deficient soils of Himachal Pradesh. Journal of the Indian Society of Soil Science. 2007;55(1):62-66.
4. Islam MSh, Mahmud MNH, Rahman F, Saleque MA. Farmer's participatory site specific nutrient management in tidal flooded soil for high yielding Aus rice. Bangladesh Rice J. 2013;17(1&2):1-6.
5. Kumar B, Sharma GK, Mishra VN, Pradhan A, Chandrakar T. Assesment of Nutrient Deficiencies Based on Response of Rice to Nutrient Omission in Inceptisols of Kondagaon District of Chhattisgarh in India. International Journal of Current Microbiology and Applied Sciences Interdisciplinary and Multidisciplinary Studies. 2018;7(09):350-359
6. Mishra VN, Patil SK, Das RO, Shrivastava LK, Samadhiya VK, Sengar SS. Site-specific nutrient management for maximum yield of rice in Vertisol and Inceptisol of Chhattisgarh. A paper presented in South Asian Conference on "Water in Agriculture: management options for increasing crop productivity per drop of water", during November, 15-17, 2007 held at IGKV, Raipur (C.G.), India; c2007. p. 136.
7. Sakeena I, Salam MA. Influence of potassium and kinetin on growth, nutrient uptake and yield of rice. Journal of Potassium Research. 1989;5(1):42-46.
8. Singh RP, Vinay Singh. Effect of sulphur, magnesium and potash on yield and uptake by linseed. Journal of the Indian Society of Soil Science. 1990;38:169-170.
9. Singh VS, Agrawal HP, Prasad S. Distribution of DTPA – extractable micronutrients in the soils of district Ghazipur, Uttar Pradesh. Journals of Indian Society of Soil Science. 2006;57(3):370-372.