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Physico-chemical properties of soil under organic and inorganic nutrient management planted with aromatic rice in a Vertisol

Saloni Garg, SS Sengar, Chetan Deep Kashyap and Anurag Tomar

Abstract
A field experiment was conducted to evaluate the physico-chemical properties of soil in response to organic and inorganic nutrient management with aromatic rice cultivars during *kharif* season of 2021 at National Seed Project Farm, IGKV, Raipur (C.G.). The experiment comprised four aromatic rice varieties *viz.* V1: Gandhari, V2: Srimanta, V3: Bharati and V4: JR-16 and three nutrient management practices *viz.* N1: Control, N2: State recommended dose of NPK fertilizer (60:40:20 NPK kg/ha) and N3: 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium*. Experiment was laid out in factorial randomized block design, replicated four times and consisting 12 treatment combinations. The results revealed that pH, EC and OC were not affected due to varieties but the OC in soil enhanced due to organic nutrient management. Available N, P, K, Fe status of soil not affected due to varieties but were significantly affected due to organic and inorganic nutrient management. Available Mn, Cu and Zn were influenced remarkably due to varieties and but had no affect due to different nutrient management except for Zn.

Keywords: organic nutrient management, inorganic nutrient management, FYM, *Azospirillium*, aromatic Rice

Introduction
The adage "Rice is life" is especially applicable to India because this crop is vital to our country's food security and provides a livelihood for millions of rural communities. Asian nations produce and consume 90% of the world's rice. Fertilizers, both organic and inorganic, are necessary for plant development. Both fertilizers and manures supply plants with the nutrients needed for optimum performance. Nutrient supply is the most limiting factor next to the water for crop production. Sustaining rice production has become a great challenge, particularly in areas where rice productivity declines in spite of following recommended nutrient management practices. Nutrient management by integrating organic sources of nutrients along with inorganic fertilizers may play an important role in improving and sustaining rice productivity (Mondal *et al*., 2016) [9], moreover, chemical fertilizers will play a major role as these contribute about 50% to the increase in food grain production for ever increasing population of our country (Mahajan and Gupta, 2009) [6].

Successful nutrient management can optimize crop yields, increase profitability and minimizes nutrient losses. It has become increasingly recognized around the world that N, P and K fertilizers alone are not always sufficient to provide balanced nutrition for optimal rice yields and quality, therefore, application of secondary and micronutrient elements has to be made. It is widely recognized that neither use of organic manures alone nor chemical fertilizers can achieve the sustainability of the yield under the modern intensive farming. Contrary to detrimental effects of inorganic fertilizers, organic manures are available indigenously which improve soil health resulting in enhanced crop yield. However, the use of organic manures alone might not meet the plant requirement due to presence of relatively low levels of nutrients. Therefore, in order to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manures in conjunction with inorganic fertilizers to obtain optimum yields (Ramalakshmi *et al*., 2012) [12]. Nitrogen is the most important nutrient and varying organic and inorganic nitrogen sources have significant effect and crucial role on quality of rice grain. Integrated nutrient management including biofertilizers, organics and chemical fertilizers may improve productivity and the quality of rice grain.

The state of Chhattisgarh, also referred to as the "Rice Bowl of India," covers an area of about 3.67 million hectares and produces 8.37 million tonnes of rice per year at a productivity of 1517 kg per hectare. Chhattisgarh, the state has traditionally been referred to in central India as "the bowl of scented rice" particularly due to several varieties of its aromatic rice (Marothia, 2003) [7].

Material and Methods

A field experiment was conducted during *kharif* season of 2021 at National Seed Project Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The soil of experimental field was clayey in texture having soil organic carbon (0.6%), low available N (215.83 kg ha^{-1}), medium available P (19.53 kg ha^{-1}), K (356.75 kg ha^{-1}), available Fe (14.23 $mgkg^{-1}$), available Mn (10.52 mg kg^{-1}), available Cu (1.85 mg kg^{-1}) and available Zn (1.92 mg kg^{-1}) with neutral pH 7.3 (1:2.5 soil: water ratio) and EC (0.22 dSm^{-1}). Soil samples for various soil physico-chemical i.e. pH, electrical conductivity, organic carbon, available nitrogen, available phosphorous, available potassium, available micronutrients were analyzed after harvest of crop.

Results and Discussion

Soil reaction and Electrical conductivity

There was a minute increase in soil pH (Table 1) after application of different N level through various sources at harvest of crop. The pH of soil ranged from 7.37 to 7.44 among different varieties and from 7.38 to 7.40 among nutrient management treatments but did not differed significantly. However higher pH value was recorded with variety V4: JR-16 and lowest under V3: Bharati. Whereas, in different nutrient management, highest pH was recorded with N1: Control and N3: 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium*. This was also true for the interaction effect of varieties and nutrient management. The results are in close confirmative with Harish *et al*. (2018) [4] who reported non-significant effect on soil pH due to the influence of promising rice (*Oryza sativa*) varieties and nutrient-management.

The data on electrical conductivity (EC) (Table 1) were recorded at initial (0.22 dS m^{-1}) and harvest stage of crop. It was revealed from the data that there was a minute decrease in soil EC from initial value. The electrical conductivity of soil ranged from 0.19 to 0.21 and found to be not significantly affected due to varieties as well as nutrient management. Among varieties highest EC of soil was recorded under variety V2: Srimanta whereas, highest EC was observed with application of inorganic sources i.e., state recommended dose of NPK fertilizers (60:40:20 NPK kg/ha). This might be due to the effect of inorganic fertilizers on electrical conductivity which was increased with increase in recommended inorganic fertilizers levels. The interaction effect of different nutrient management and varieties gave non-significant effect. This might be due to release of electrolytes upon the decomposition of applied manure and fertilizers. The similar result was collected by Bhatt *et al*. (2019) [1] due to organic and inorganic fertilizers on soil EC.

Organic Carbon

Data on soil organic carbon (SOC) presented in Table 1. Soil organic carbon was not influenced by the different rice varieties. In varietal treatments soil organic carbon varied between 0.60-0.62% in all four varieties. However, there was significant increase in SOC due to the application of organic source over inorganic source and control. SOC was 0.63% under the application of 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium*, 0.60% under state recommended dose of NPK fertilizer (60:40:20 NPK kg/ha) and 0.6% with control. There was no significant interaction effect on SOC due to the varieties and nutrient management. The increase in organic carbon with addition of FYM attributed to more stimulation of root growth with better root biomass and activity of micro-organisms. Islam *et al.* (2012) [5] reported that organic nutrient management increased soil organic carbon whereas, a decreasing trend observed due to application of inorganic nutrients.

Table 1: Effect of variety and nutrient management on pH, EC and OC of soil after crop harvest

Treatment	Soil pH	EC (dS m^{-1})	OC (%)
Variety			
V1: Gandhari	7.40	0.20	0.6
V2: Srimanta	7.39	0.21	0.62
V3: Bharati	7.37	0.20	0.61
V4: JR-16	7.44	0.20	0.60
SEm±	0.03	0.01	0.007
CD (P=0.05)	NS	NS	NS
Nutrient management			
N1: Control	7.40	0.20	0.6
N2: State recommended dose of NPK fertilizer (60:40:20 NPK kg/ha)	7.38	0.21	0.60
N3: 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium*	7.40	0.20	0.63
SEm±	0.02	0.01	0.006
CD (p=0.05)	NS	NS	0.018
Interaction (Variety x Nutrient management)			
SEm±	0.05	0.01	0.012
CD (p=0.05)	NS	NS	NS

EC, Electrical conductivity; OC, organic carbon; NS, non-significant

Available N

Available Nitrogen status of soil after harvesting of rice are shown in Table 2. The data pertaining to available N status in soil clearly shows that it was not significantly affected due to different rice varieties at harvest and varied between 230.08-243.08 kg/ha in different varieties. Application of organic sources i.e., N3:33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium* (247.75 kg/ha) helped to accumulate the significantly higher N in soil over the application of inorganic sources *viz*., N2: state recommended dose of NPK fertilizer (60:40:20 NPK kg/ha) (225.06 kg/ha) and N1: control (221.25 kg/ha total N). Interaction effect between nutrient management and varieties was also found non-significant. The increase in available N in soil might be due to mineralization of organic N from FYM and enhanced microbial activity which enhanced the conversion of organic bound soil N to mineral form. The findings on available N can be correlated with Yadav *et al*. (2019) [16].

Available P

The data on available phosphorus status in soil is presented in Table 2, which clearly shows that different rice varieties have no significant effect in terms of P status of soil after harvest of crop. As far as nutrient management factor is concerned, application of organic sources 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium* (22.86 kg/ha) significantly recorded higher amount of P in soil over inorganic sources and control treatment. The interaction effect of nutrient management application through different sources and varieties on available P didn't reached the level of significance and found to be non-significant. Results are closely in confirmation with Harikesh *et al.* (2017) [3] continuous application of 100% nutrients, either through various organic manures (FYM, VC) or chemical fertilizers alone or a combination of both (FYM + fertilizers), increased phosphorus in soil.

Available K

Data presented in Table 2 reveal that all varieties was found to be non-significant in respect to available K status in soil after harvest. However, application of N3: 33% RDN through FYM + 16 kg PSB+20kg *Azospirillium* (360.31 kg ha^{-1}) recorded higher potassium in soils over N2: state recommended dose of NPK fertilizer (60:40:20 NPK kg/ha) (354.00 kg ha^{-1}) while the lowest was obtained in N1: Control (341.75 kg ha^{-1}). The interaction between nutrient management and varieties fail to exert any significant effect on available K status in soil. The availability of K increases due to the interaction of organic matter with clay which may be ascribed to the reduction in K fixation and release of K in soil. Similar results in increase of available potassium in soil due to addition of organic manures was observed by Pant *et al*. (2017) [10].

Table 2: Effect of variety and nutrient management on available N, P and K of soil after crop harvest

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Variety			
V1: Gandhari	224.16	21.19	351.92
V2: Srimanta	239	21.57	352.17
V3: Bharati	230.08	21.55	349.33
V4: JR-16	243.08	21.88	354.67
SEm±	5.65	0.20	1.84
CD (p=0.05)	NS	NS	NS
Nutrient management			
N1: Control	229.5	20.15	341.75
N2: State recommended dose of NPK fertilizer (60:40:20 NPK kg/ha)	225.06	21.63	354.00
N3:33% RDN through FYM + 16 kg PSB+20 kg *Azospirillium*	247.68	22.86	360.31
SEm±	234.08	21.55	352.02
CD (p=0.05)	4.89	0.17	1.60
Interaction (Variety x Nutrient management)			
SEm±	9.78	0.35	3.19
CD (p=0.05)	NS	NS	NS

NS, non-significant

Available Fe

Result presented on available Fe in soil (Table 3) indicated that there was no considerable variation in available Fe on different varieties. In varietal treatments the Fe content in soil varied between 13.39 mg kg^{-1} to 14.10 mg kg^{-1}. Among the different nutrient management, no significant effect was found in respect to available Fe status in soil. However, the application of organic sources reported highest available Zn in the soil over inorganic sources. No significant effect was exerted on available Fe content due to interaction effect. This might be because in soil Fe cycle associated with decomposition of organic matter. The results are close conformity with findings of Parven *et al*. (2020) [11] who reported highest available Zn in organic sources.

Available Mn

The data on available Mn content in soil (Table 3) of different varietal treatments showed significant difference among the four varieties of rice. Hence, the available Mn content in soil varied from 9.59 mg kg^{-1} to 10.00 mg kg^{-1} among the different varieties of rice. Variety Gandhari showed significantly superior available Mn (10.00 mg kg^{-1}) than those Srimanta (9.83 mg kg^{-1}), Bharati (9.68 mg kg^{-1}) and JR-16 (9.59 mg kg^{-1}). As regards with the Mn availability in soil, it was not affected significantly due to the application of various nutrient management but organic sources resulted in higher Mn availability in the soil. The interaction between nutrient management and varieties failed to exert any significant effect on available Mn content in soil. Organic manuring increases the Mn availability in soils because of decomposition it liberates a number of organic acids, which lowers the soil reaction and increases the intensity of reduction in soil. The results are supported with findings of Dhaliwal (2008) [2] and Walia *et al*. (2010) [15].

Available Cu

The data presented on the available Cu content in soil (Table 3) revealed that the variety Srimanta showed a significantly higher value of available Cu (2.09 mg kg^{-1}) in soil which was at par with Gandhari (1.99 mg kg^{-1}) but superior over Bharati

(1.88 mg kg^{-1}) and JR-16 (1.89 mg kg^{-1}). The availability of Cu doesn't influence significantly due to organic and inorganic nutrient management. The results also revealed that there was an increase in available Cu content with the application of organic fertilization (1.97 mg kg^{-1}) and inorganic fertilization (1.94 mg kg^{-1}) when compared with initial Cu content (1.85 mg kg^{-1}). No significant effect was exerted on available Cu content in soil due to interaction between nutrient management and varieties.

Increment of available Cu may be associated with the chelating action of organic sources (FYM, GM and WS) that are liberated due to decomposition of organic source that advantages in availability of micronutrients through the prevention of some particular processes like fixation, oxidation, precipitation and leaching. These results were supported with the findings of Walia *et al*. (2010) [15].

Available Zn

As far as available Zn content of soil (Table 3) is concerned, it was significantly affected due to the varietal treatments. Among the four varieties, Srimanta resulted in significantly highest Zn (1.66 mg kg^{-1}) content in soil over Gandhari (1.62 mg kg^{-1}), Bharati (1.41 mg kg^{-1}) and JR-16 (1.37 mg kg^{-1}). Inorganic source i.e. N2: state recommended dose of NPK fertilizer (60:40:20 NPK kg/ha) resulted in higher Zn content (1.58 mg kg^{-1}) in soil as followed by organic source i.e. N3: 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium* (1.51 mg kg^{-1}) and control (1.45 mg kg^{-1}). The interaction effect gave non-significant results. Due to higher amount of organic matter, it favors decreases in the available form of Zn through chelation. Significant changes were recorded in the status of Zn content of by Parven *et al*. (2020) [11] with the combination of inorganic and organic nutrient management.

Table 3: Effect of variety and nutrient management on available micronutrients in soil after crop harvest

Treatment	Available Fe (mg/kg)	Available Mn (mg/kg)	Available Cu (mg/kg)	Available Zn (mg/kg)
Varieties				
V1: Gandhari	13.39	10.00	1.99	1.62
V2: Srimanta	13.87	9.83	2.09	1.66
V3: Bharati	13.74	9.68	1.88	1.41
V4: JR-16	14.10	9.59	1.89	1.37
SEm±	0.20	0.08	0.03	0.05
CD (p=0.05)	NS	0.22	0.09	0.15
Nutrient management				
N1: Control	13.52	9.73	1.97	1.45
N2: State recommended dose of NPK fertilizer (60:40:20 NPK kg/ha)	13.86	9.78	1.94	1.58
N3: 33% RDN through FYM + 16 kg PSB + 20 kg *Azospirillium*	13.95	9.82	1.97	1.51
SEm±	0.17	0.07	0.03	0.04
CD (p=0.05)	NS	NS	NS	0.13
Interaction (Variety x Nutrient management)				
SEm±	0.34	0.14	0.05	0.09
CD (p=0.05)	NS	NS	NS	NS

NS, non-significant

Conclusion

The use of organic sources has significantly enhanced the available N, available P and available K whereas, soil pH, EC, available Fe, Mn and Cu status in soil had no effect due to organic and inorganic application. The highest organic carbon was found under the treatment of organic sources that received the combined application of FYM, PSB and *Azospirillium.* However, the status of available Zn in soil had significantly enhanced due to the application of inorganic sources.

References

1. Bhatt M, Singh AP, Singh V, Kala DC, Kumar V. Long-term effect of organic and inorganic fertilizers on soil physico-chemical properties of a silty clay loam soil under rice-wheat cropping system in Tarai region of Uttarakhand. Journal of Pharmacognosy and Phytochemistry. 2019;8(1):2113-2118.
2. Dhaliwal SS, Walia S. Integrated nutrient management for sustaining maximum productivity of rice-wheat system under Punjab conditions. J. Res. Punjab Agric. Univ. 2008;45:12-16.
3. Harikesh AA, Singh G, Kumar S, Shivam R, Yadav P, Tiwari A, Yadav A. Effect of integrated nutrient management and plant geometry on soil properties and availability of nutrients under SRI technique of rice. Journal of Pharmacognosy and Phytochemistry. 2017;6(5):86-89.
4. Harish MN, Choudhary AK, Singh YV, Pooniya V, Das A, Varatharajan T. Influence of promising rice (*Oryza sativa*) varieties and nutrient-management practices on micronutrient biofortification and soil fertility in Eastern Himalayas. Indian Journal of Agronomy. 2018;63(3):377-399.
5. Islam MR, Sikder S, Bahadur MM, Hafiz MHR. Effect of different fertilizer management on soil properties and yield of fine rice cultivar. Journal of Environmental Science and Natural Resources. 2012;5(1):239-242.
6. Mahajan A, Bhagat RM, Gupta RD. Integrated nutrient management in sustainable rice-wheat cropping system for food security in India. SAARC J. Agric. 2008;6:1-13.
7. Marothia DK. Domestic trade in aromatic rice: Lessons from an exploratory study of Chhattisgarh in: A Treatise on the Scented Rices of India. Int. J. Curr. Microbiol. App. Sci. 2018;7(12):907-914. Eds:
8. Singh RK, Singh US. Ludhiana & New Delhi: Kalyani Publishers, pp. 189-210.
9. Mondal S, Mallikarjun M, Ghosh M, Ghosh DC, Timsina

J. Influence of integrated nutrient management (INM) on nutrient use efficiency, soil fertility and productivity of hybrid rice. Archives of Agronomy and Soil Science. 2016;62(11):1521-1529.

10. Pant PK, Ram S, Singh V. Yield and soil organic matter dynamics as affected by the long-term use of organic and inorganic fertilizers under rice–wheat cropping system in subtropical *mollisols*. Agricultural research. 2017;6(4):399-409.
11. Parven H, Kumar S, Shambhavi S, Kumar S, Kumar R, Kumari D. Long Term Effect of Integrated Nutrient Management on Secondary and Micronutrient of Alluvial Soils. Int. J Curr. Microbiol. Appl. Sci. 2020;9:1990-1999.
12. Ramalakshmi Ch S, Rao PC, Sreelatha T, Mahadevi M, Padmaja G, Rao PV, *et al*. Nitrogen use efficiency and production efficiency of rice under rice-pulse cropping system with integrated nutrient management. J Rice Res. 2012;5(1-2):42-51.
13. Singh A, Dass A, Singh CV, Dha S, Sudhishri S, Das K, *et al*. Growth, Productivity and nutrient concentration of aerobic rice (*Oryza sativa* L.) under different planting methods, irrigation schedules and soil adjuvant applications, 2017.
14. Singh YV, Singh BV, Pabbi S, Singh PK. Impact of Organic Farming on Yield and Quality of BASMATI Rice and Soil Properties. Paper at: Zwischen Tradition und Globalisierung-9. Wissenschaftstagung Ökologischer Landbau, Universität Hohenheim, Stuttgart, Deutschland, 20.23.03, 2007.
15. Walia MK, Walia SS, Dhaliwal SS. Long-term effect of integrated nutrient management of properties of Typic Ustochrept after 23 cycles of an irrigated rice *Oryza sativa* L. – wheat Triticum aestivum L. system. Journal of Sustainable Agriculture. 2010;34(7):724-743.
16. Yadav SK, Benbi DK, Rajendra Prasad. Effect of Continuous Application of Organic and Inorganic Sources of Nutrients on Chemical Properties of Soil. Int. J. Curr. Microbiol. App. Sci. 2019;8(04):2455-2463.