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Research Article

Effect of Different Rice-based Cropping System on Chemical Properties of Soil under Various Nutrient Management Practices

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ABSTRACT

The present investigation was conducted during two consecutive years of 2019-20 and 2020-21, the entitled effect of different rice-based cropping system chemical properties of soil under various nutrient management practices. The maximum organic carbon (0.73%) was found in 100% and 75% organic nutrient management practices with rice-vegetable pea-sorghum (fodder) cropping systems. The electrical conductivity and pH of the soil were slightly changed by nutrient management and the cropping system. In contrast, organic carbon was not significant under the rice-based cropping system. During the research, pH, EC of soil and organic carbon gradually changed by initial status value but were not significantly affected by the rice-based cropping system.

Keywords: *Cropping system, Organic carbon, pH, EC, INM.*

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most crucial stable food crops. It is the major source of calories for 40 per cent of the world population (Virdia & Mehta, 2009). In India, it occupies an area of ~43.8 million ha and a production of ~105 million tonnes (mt), with average productivity of ~2.21 t/ha.

Rice-based cropping systems performed better under green manure, and farmyard manure applied fields than those without organic manure. Similarly, the Integrated Nutrient Management system refers to a balanced use of chemical fertilizers in combination with organic manures, crop residues, bio-fertilizers and other biological sources.

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Nutrient management in different seasons also plays an important role in the productivity of systems pH, EC of soil, as well as resource availability, particularly physical, chemical properties and water availability of soil. (Kumar et al., 2016). Organically soil management practices improve soil physical conditions to keep the land productive on a sustainable basis (Ali et al., 2012). Organic nutrient management can play a vital role in the improvement of physical properties like, pH, organic carbon, CEC, nutrient use efficiency as well as fertility status of soil in rice-based cropping system for remunerative changes the economics of crop sequences (Gangwar et al., 2004; & Swapana et al., 2012,).

In the cropping system, using the farm yard manure, potassium and zinc increase the grain yield when wheat is planted after pigeon pea. Khalid et al. (2011). The application of different organic sources enhances the yield of rice. Uptake of iron, zinc and manganese in the grains of rice, wheat and green gram increase when two or more organic sources of nutrient were applied together. Rice-based cropping system affects the chemical properties of soil. Rice-potato-mungbean cropping system gives higher productivity, protein content, energy output, available P and higher CO_2 evolution in the soil compared to the cereal-cereal cropping system. Sharma et al. (2009).

MATERIALS AND METHODS

A field experiment was conducted during 2019-20 to 2020-21 at Instructional Research Farm, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. The region's soil is medium to deep in depth and black in colour with Sandy Clay loam in texture with pH 7.19, electrical conductivity 0.381 dSm^{-1}, Available nitrogen 260 kg ha^{-1}, Available phosphorus 12.5 kg ha^{-1} and Available potassium 283 kg ha^{-1} content. The varieties and hybrids that were popular among local farmers concerning their yield potential and insect-pest resistance were used. The varieties of different crops and their duration in the field, recommended fertilizer dose applied and planting spacing. The experiment was laid out in split-plot design with twenty-four treatment combinations of six different nutrient management and four rice-based cropping system. The various treatments were allocated to different plots using a random distribution with three replications. Nutrient management practices were taken as the main plot, and the cropping system was taken as the subplot. Main plot, NM_1 (100% organic), NM_2 (75% organic), NM_3 (50% organic + 50% inorganic), NM_4 (75% organic + 25% inorganic), NM_5 (Farmer practices), NM_6 (100% inorganic). Subplot CS_1 (Rice (PB-1)-Wheat-Green manure (Sunhemp), CS_2 (Rice (PB-1) – Chickpea (JG-14) – Maize (African Tall), CS_3 (Rice (PB-1)–Egyptian clover, F+S (JB-1)) CS_4 (Rice (PB-1) – Vegetable pea (Arkel)–Sorghum (MP chari). The row-to-row spacing was 20 cm for rice, wheat, 30 cm for chickpea, maize, sorghum, sun hemp, and vegetable pea, while *the Egyptian clover* crop was broadcasted. All the recommended package of practices was adopted for the irrigated condition in all the *Kharif, rabi* and *zaid* crops. In soil samples, soil organic carbon, Electrical conductivity meter, glass electrode pH meter, N,P, and K and microbial population were estimated by the following methods; Walkley and Black method (1934), Electrical conductivity meter (Jackson, 1973), respectively.

RESULT AND DISCUSSION

Electrical conductivity and pH of soil

Data is presented in Table 1. The EC was higher (0.387 dS m^{-1}) in integrated nutrient management (INM 50:50) followed by 100% inorganic nutrient management (0.385 dS m^{-1}) and 75% organic nutrient management (0.384 dS m^{-1}) during final year, respectively.

The EC was not significantly affected by different rice based cropping system during both the year, but higher value found in rice-wheat-green manuring cropping system (0.386 dS m^{-1}) which was higher overall cropping systems, and no significant difference was observed between rice-chickpea-maize cropping system (0.381 dS m^{-1}) and rice-berseem (fodder+seed) cropping system (0.381

dS m^{-1}) but slightly higher EC was found in rice-vegetable pea-sorghum (fodder) cropping system (0.383 dS m^{-1}), during the final year, respectively. Solaiappan et al. (2007). Similar findings were also reported by Baishya et al. (2015). The effect of rice-based cropping systems on EC and pH of soil over initial values might be due to the continuous intensive cropping without applying sufficient external source of nutrients (fertilizers) in organic treatment has led to an increase in bulk density. Such results closely conform with the findings of Ghose and Pathak (2006).

Study of soil properties with respect to soil EC it was found that higher value in rice-wheat-green manuring cropping system which was higher over other cropping system and no difference was observed between rice-chickpea-maize cropping system rice-vegetable pea-sorghum (fodder) cropping system rice-berseem (fodder+seed) cropping system.

The interaction effect between different nutrient management and cropping sequence was found not significant under both the years of investigation. The pH slightly changed owing to different nutrient management, but statistically, pH not change to rice based cropping systems, during both the years of experimentation, as shown in Table 2. The pH was higher noted (7.30) in farmer practices nutrient management which was superior over 100% inorganic nutrient management (7.27) followed by integrated nutrient management (INM 50:50) (7.20) and 100% organic nutrient management (7.19) but statistically at par with integrated nutrient management (INM 75:25) (7.18) and 75% organic nutrient management (7.18) during final year, respectively. Similar results also reported by Pattanayak et al. (2001) and Upadhyay et al. (2011) also observed the decrease in soil pH after the use of organic materials. The legume cropping sequence and legume as a component cropping system retain the pH to be neutral side.

The data revealed that pH was not significantly changed with different rice-based cropping systems. On average, it was noted that the value of pH. The rice-berseem (fodder+seed) cropping system recorded the pH value of (7.22). In contrast, no differences were observed rest of the rice-based cropping systems, *i.e.* rice-vegetable pea-sorghum (fodder) cropping system (7.22) and rice-wheat-green manuring cropping system (7.21) and (7.22) under rice-chickpea-maize cropping system during final year, respectively.

Singh (2004) also reported reduced soil pH due to the inclusion of legume in sequences. The higher pH value is obtained in farmer practices nutrient management with rice-berseem (fodder+seed) cropping system (7.30) and farmer practices nutrient management with rice-vegetable pea-sorghum (fodder) cropping system (7.30). However, it was statistically at par with farmer practices nutrient management combination with rice-wheat-green manure and rice-chickpea-maize (7.29), followed by 100% inorganic nutrient management with rice-chickpea-maize cropping system (7.27). The lowest pH value was recorded (7.17) under INM (75+25) nutrient management with a rice-vegetable pea-sorghum cropping system. Yaduvanshi et al. (2001), Smiciklas et al. (2002).

Table1. Electrical conductivity of soil is affected by different nutrient management practices and rice-based cropping system

Nutrient Management	**Cropping System**				
	Initial Status – 0.381 dS/m^{-1}				
	CS_1	CS_2	CS_3	CS_4	**Mean**
100% Organic	0.378	0.377	0.378	0.377	0.378
75% Organic	0.387	0.387	0.380	0.383	0.384
INM (50% organic+50%inorganic)	0.393	0.387	0.383	0.385	0.387
INM (75% organic+25% inorganic)	0.387	0.377	0.373	0.370	0.377
Farmer Practices	0.382	0.378	0.383	0.383	0.382
100% Inorganic	0.382	0.380	0.390	0.390	0.385
Mean	0.386	0.381	0.381	0.383	
	Nutrient Management	Cropping System	Interaction		
			Factor B at same level of A	Factor A at same level of B	
Sem±	0.003	0.003	0.006	0.005	
CD (*p* =0.05)	NS	NS	NS	NS	

Where, CS_1 is Rice-wheat-green manure, CS_2 is Rice-chick pea-maize, CS_3 is Rice-berseem (F+S), CS_4 is Rice-vegetable pea-sorghum

Table2. pH of the soil as affected by different nutrient management practices and rice-based cropping system

Nutrient Management	Cropping System				
	Initial Status- 7.19				
	CS_1	CS_2	CS_3	CS_4	**Mean**
100% Organic	7.19	7.19	7.20	7.20	7.19
75% Organic	7.18	7.18	7.18	7.19	7.18
INM (50% organic+50%inorganic)	7.20	7.20	7.20	7.20	7.20
INM (75% organic+25% inorganic)	7.20	7.19	7.18	7.17	7.18
Farmer Practices	7.29	7.29	7.30	7.30	7.30
100% Inorganic	7.27	7.27	7.27	7.27	7.27
Mean	7.22	7.22	7.22	7.22	
	Nutrient Management	Cropping System	Interaction		
			Factor B at same level of A	Factor A at same level of B	
Sem±	0.00	0.00	0.01	0.01	
CD (*p* =0.05)	0.01	0.01	0.03	0.02	

Where, CS_1 is Rice-wheat-green manure, CS_2 is Rice-chick pea-maize, CS_3 is Rice-berseem (F+S), CS_4 is Rice-vegetable pea-sorghum

Soil Organic Carbon

Further, applying an organic source of nutrients significantly affected soil organic carbon recorded during both years of experimentation. Amongst the organic, inorganic and integrated nutrient management, 100% organic nutrient management registered significantly higher values of (0.73) followed by 75% organic nutrient management but it was at par with integrated nutrient management (50:50) during final pooled data and integrated nutrient management (INM 75:25) (0.70) respectively. However, lowest organic carbon present in farmer practices (0.68). It is evident from the Table 3 that the organic carbon in soil gradually increased over initial value (0.71%) and subsequently completion of different nutrient management during both the years. The increase in SOC was might be due to the beneficial effect of organic manures which were incorporated in the soil and increase the microbial counts and activities of microflora as well as better regulation of organic carbon dynamics in soil (Kumar et al., 2007) and Upadhyay et al. (2011) also reported that at the end of 5 cropping cycles, application of organic manures resulted in high soil organic carbon.

These data revealed that the cropping system failed to significantly affect organic carbon during both years. However, the rice-berseem (fodder+seed) cropping system possessed greater values over rice-wheat-green manure and initial content. This might be due to the addition of a relatively large amount of crop biomass over period of time. Because most of the pulse crop residues contain a higher amount of nitrogen and bacteria in the soil which facilitates the decomposition of crop residues. After the addition of pulse rice-berseem (fodder+seed) in cropping system increase organic carbon content over rice-wheat and initial value is possibly due to a higher contribution of biomass to the soil in the form of green biomass, crop residues and better root growth (Ortega et al., 2008, & Ghathala et al., 2007).

The interaction between cropping systems and sources of different nutrient management was found to be significant in both the years as well as pooled data. It shows that higher organic carbon is obtained in 100% organic nutrient management with rice-vegetable pea-sorghum (fodder) cropping system and rice-wheat-green manure, rice vegetable pea sorghum (0.73) it was statistically at par with 100% organic nutrient management and rice-chickpea-maize cropping system (0.72) and 75% organic nutrient management with rice-wheat-green manure cropping system and INM (50+50) with rice-berseem (fodder+seed) cropping system (0.72) similar result found by Thind et al. 2007 followed by 100% inorganic nutrient management with all the rice-based cropping systems However, The lowest organic carbon was found in farmer practices nutrient management combination with rice-chickpea-maize (0.67) and rice-vegetable pea-sorghum cropping system. Similar results have been reported by Chaudhary et al. (2011).

Table3. Organic carbon of soil as affected by different nutrient management practices and rice-based cropping system

Nutrient Management	Cropping System				
	Initial Status-0.71 %				
	CS_1	CS_2	CS_3	CS_4	**Mean**
100% Organic	0.73	0.72	0.73	0.73	0.73
75% Organic	0.71	0.71	0.72	0.72	0.71
INM (50% organic+50%inorganic)	0.71	0.70	0.72	0.71	0.71
INM (75% organic+25% inorganic)	0.70	0.70	0.70	0.70	0.70
Farmer Practices	0.68	0.67	0.68	0.67	0.68
100% Inorganic	0.70	0.70	0.70	0.70	0.70
Mean	0.71	0.70	0.71	0.71	
	Nutrient Management	Cropping System	Interaction		
			Factor B at same level of A	Factor A at same level of B	
Sem±	0.002	0.003	0.005	0.004	
CD (*p* =0.05)	0.007	NS	0.018	0.017	

Where, CS_1 is Rice-wheat-green manure, CS_2 is Rice-chick pea-maize, CS_3 is Rice-berseem (F+S), CS_4 is Rice-vegetable pea-sorghum.

CONCLUSION

On the basis of the present study it can be concluded that among different nutrient management and rice-based cropping system maximum available organic carbon, EC and pH of soil under 100% organic nutrient management with rice-berseem (F+S) cropping system. These nutrient management practices soil health improvement under a present scenario of existing rice-berseem (F+S) cropping system.

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All authors contributed equally to establishing the research and design experiment topic.

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