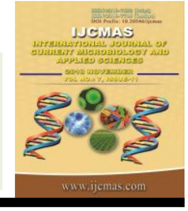
Int.J.Curr.Microbiol.App.Sci (2018) *7*(11): 1531-1537



International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 11 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.711.176

Effect of Integrated Nutrient Management on Soil Biological Properties in *Kharif* Rice

M. Mallikarjun* and S.K. Maity

Department of Agronomy, Institute of Agriculture, Visva-Bharati University, Sriniketan - 731 236, West Bengal, India

**Corresponding author*

Keywords

Organic manures, Inorganic, INM, Microorganisms

Article Info

Accepted:
12 October 2018
Available Online:
10 November 2018

A B S T R A C T

A field experiment was conducted during *kharif* season of 2015 and 2016 to study the effect of integrated nutrient management (INM) practices on soil biological properties in rice. The experiment was laid out in randomized block design with eight treatments including six INM practices, one chemical practice and one control (i.e. no N) with three replications. The results revealed that biological properties of soil were significantly enhanced by the application of combined use of organic and inorganic fertilizers after harvest of crop during both the years of experimentation. The population of bacteria, fungi and actinomycetes decreased in higher proportion in control. Application of 100% RDN through chemical fertilizers alone showed a relatively less increase in population of microbes. However, application of organics in the form of farm yard manure (FYM), mustard oil cake (MOC), Green manuring (GM), Brown manuring (BM) and Azolla helped to increase bacteria, actinomycetes, fungi and enzymatic activity in soil over 100% RDN through chemical fertilizers during both the years of experimentation. The results revealed that treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping), recorded the maximum load of total bacteria, actinomycetes, fungi and enhanced the activity of urease and dehydrogenase along with soil microbial biomass carbon. Hence replacement of either 25% RDN or 50% RDN of chemical fertilizers through organics is desirable to improve soil health by increasing microbial load and enzymatic activity in the lateritic belt of west Bengal.

Introduction

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) and moreover chemical fertilizers will play a major role and will remain the most important component of INM system under intensive cropping system as these contribute about 50% to the increase in food grain production for the increased population of our country (Mahajan and Gupta 2009). Long-term experiments have shown that neither organic sources nor mineral fertilizers alone can achieve sustainability in crop production and integrated use of organic and mineral fertilizers has been found to be more effective in maintaining higher productivity and stability through correction of deficiencies of secondary and micronutrients in the course of mineralization on one hand and favorable physical and soil ecological conditions on the other (Mallikarjun and Maity, 2017). Intensive cultivation, growing of exhaustive crops, use of imbalanced and inadequate fertilizers, restricted use of organic manures has made the soils not only deficient in nutrients but also deteriorate soil health resulting decline in crop response to recommended dose of NPK fertilizers. To supply recommended dose of nutrients, large quantities of organic material is needed and also slow release of plant nutrients upon decomposition from organic material deprive crop growth (Goutami *et al.*, 2018). Microorganisms play a definitive and very crucial role in soil fertility. They also play an important role in the decomposition of organic matter and also in decomposition of toxic waste and other pollutants. This living phase is greatly stimulated by organic manure addition which acts as carbon and energy source for proliferating micro-organisms and they may in turn alter the accompanying enzyme status accordingly. Interest in soil enzyme activity has increased recently since their activities are believed to reflect the potential capacity of soil to perform nutrient transformations. Since, soil microbial and enzyme systems are associated with organic manure management, incorporation of organic manures into soil not only plays an important role in soil chemical and biological activity, but also affects the rate at which nutrients become available to crop plants as well as other forms of life. To achieve the sustained soil fertility and crop productivity the role of organic manures are very important. These organic manures, in addition to nutrient supply they have microbial load and growth promoting substances which helps in improving the plant growth, metabolic activity and resistance to pest and diseases. The information on effect of integrated nutrient management practices on biological properties of soil is new under the lateritic belt of West Bengal. Keeping these aspects in view, the present research work was undertaken to study the effect of integrated nutrient management practices on biological properties of soil.

Materials and Methods

The field experiment was conducted during kharif seasons of 2015 and 2016 at Agricultural Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal (23°39′ N latitude, 87°42′ E longitude and an altitude of 58.9 m above sea level), to study the effect of Integrated Nutrient Management on soil microorganisms and enzymatic activity in rice. The experimental soil is fragile, lateritic and sandy-loam in texture (60% sand, 23.2% silt and 16.3% clay). The experiment was laid out in the randomized block design with three replications each consisting of eight treatments applied to kharif rice. These were T_1 = Control (No nitrogen), T_2 = 100% recommended dose of nitrogen (RDN) through chemical fertilizers, T_3 = 75% RDN (chemical fertilizer) +25% RDN as farm yard manure (FYM), T_4 = 75% RDN (chemical fertilizer) +25% RDN as mustard oil cake (MOC), T_5 = 75% RDN (chemical fertilizer) + dhaincha green manuring, T_6 = 75% RDN (chemical fertilizer) + dhaincha brown manuring, T_7 = 75% RDN (chemical fertilizer) + Azolla dual cropping, T_8 = 50% RDN (chemical fertilizer) + 25% RDN as FYM + Azolla dual cropping. The recommended dose of fertilizer for kharif rice was 80 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1} (RDF). The rice variety used under study was MTU 1010. The average nutrient composition of different organic sources applied and their NPK content are presented in Table 1.

Soil samples were collected after harvest of rice during both the years from a depth of 0-15 cm with the help of soil auger from 10 different points within the individual replicated plots of respective treatments. These samples were preserved, processed and analyzed following the standard procedures as indicated in Table 2. The data were statistically analyzed by the analysis of variance method as suggested Gomez and Gomez (1984). The significance of different sources of variations was tested by error mean square of Fisher and Snedecor's 'F' test at probability level of 0.05. Fisher and Yate's tables were consulted for the determination of least significant difference (LSD) at 5% level of significance. The value standard error of mean (SEm +) and the LSD was used to compare the difference between the treatment means.

Results and Discussion

Bacteria

The bacterial load in the soil was significantly influenced by different N management practices after harvest of the crop in either of the two years of experimentation (Table 3). The nitrogen receiving treatments (T_2 to T_8) recorded significantly higher bacterial count than control during both the years of experimentation. During both the years of experimentation the highest bacterial count (39.4 X 10^5 CFU g^{-1} and 40.5 X 10^5 CFU g^{-1} in the year 2015 and 2016, respectively) was observed with treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping) being statistically at par with treatment T_7 (75% N as chemical fertilizer along with Azolla dual cropping). The application of organics along with chemical fertilizers registered a significant increase in bacterial population over control. These results are in confirmative with those of Krishnakumar *et al.*, (2005) and Kumari *et al.*, (2017). They have reported an increase in bacterial count with application of different organic N sources compared to control (Krishnakumar *et al.*, 2005) with justification to the findings of present experimentation.

Fungi

All the treatments receiving nitrogen application (T_2 to T_8) recorded at par fungal population with each other being significantly higher than control (i.e. no N) during both the years of experimentation. Among the treatments receiving nitrogen (T_2 to T_8) the highest fungal population (14.06 X 10^3 CFU g^{-1} and 15.08 X 10^3 CFU g^{-1} in the year 2015 and 2016, respectively) was observed with treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping). Kumari *et al.*, (2017) and Kuttimani *et al.*, (2017) revealed that the fungal population had a positive correlation with addition of organic sources of nutrients in the treatments.

Actinomycetes

All the treatments involving nitrogen application (T_2 to T_8) recorded at par actinomycetes population with each other being significantly higher than control (i.e. no N) during both the years of experimentation. Among the treatments receiving nitrogen (T_2 to T_8) the highest actinomycetes population (30.2 X 10^2 CFU g^{-1} and 32.8 X 10^2 CFU g^{-1} in the year 2015 and 2016, respectively) was observed with treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping). The lowest actinomycetes population (25.4 X 10^2 CFU g^{-1} and 25.8 X 10^2 CFU g^{-1} in the year 2015 and 2016, respectively) was observed with treatment T_2 (100% N as chemical fertilizer) among all the treatments involving nitrogen application (T_2 to T_8). In the soil profile bacterial population are predominant followed by actinomycetes and fungi.

Urease activity

The data (Table 4) revealed that, urease activity increased over the years except in treatment T_1 (i.e. control). All the treatments receiving nitrogen application either in the form of chemical alone or combination of chemical and organic recorded significantly higher urease activity than T_1 (i.e. control) after harvest of rice during both the years. During the first year of experimentation (2016), the highest urease activity was observed with treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping) and it was significantly superior over all other treatments. During the second year of experimentation (2017), though the highest urease activity was observed with treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping) but it remained at par with treatments T_3 (75% N as chemical fertilizer with 25% FYM) and T_6 (75% N as chemical fertilizer with dhaincha brown manuring). The higher urease activity under INM practices in rice might be due to presence of extra cellular urease adsorbed on finer components of organic matter or may be because of higher organic matter in soil that stimulates the ureolytic micro-organisms by serving as source of carbon, energy and other nutrients essential for microbial growth and multiplication (Reddy, 2002). The treatment T_2 i.e. 100% N as chemical fertilizer recorded lower urease activity than the INM treatments which might have been attributed due to lack of sufficient substrate *i.e.* organic carbon which acts as an energy source and food for proliferating the microbial population (Nagendra, 2015).

Table.1 N, P and K content (%) of organic materials used

Materials used	Content (%)					
	N		P		K	
	2015	2016	2015	2016	2015	2016
FYM*	0.58	0.72	0.12	0.15	0.58	0.66
Mustard oil cake*	5.22	5.16	0.86	0.80	1.10	1.05
Dhaincha* green manuring*	3.21	3.43	0.23	0.26	0.99	0.95
Dhaincha* brown manuring*	3.32	3.50	0.28	0.27	1.01	0.95
Azolla* (T_7)*	4.47	4.24	0.51	0.53	2.43	2.58
Azolla* (T_8)*	4.64	4.78	0.49	0.61	2.37	2.53

***Nutrient content on air dry basis, ** Nutrient content on dry weight basis.**

Table.2 Standard procedures flowed for determination of biological properties of soil

S. No	Particulars	Standard method followed/ Media used
1	Bacteria	Thorntons media for Total bacterial count (Thornton 1930)
2	Fungi	Rose streptomycin Bengal media for fungi (Rao 1988)
3	Actinomycetes	Caseinate Agar Media for Actinomycetes (Rao 1988)
4	Urease	Release of NH4-N from the hydrolysis of urea as described by Tabatabai and Bremner (1972)
5	Dehydrogenase	production of tri-phenyl formazan (TPF) from triphenyl tetrazolium (Casida *et al.*, 1964)
6	Soil microbial biomass carbon	Fumigation extraction method by Beck *et al.*, (1997)

Table.3 Effect of integrated nutrient management practices on soil bacteria, soil fungi and soil actinomycetes

Treatments	soil bacteria (CFU × 105 g^{-1})		soil fungi (CFU × 103 g^{-1})		soil actinomycetes (CFU × 102 g -1)	
	2016	2017	2016	2017	2016	2017
T1:Control	20.4	20.2	4.91	4.83	17.1	16.7
T2:100% RDN	26.0	26.9	12.22	13.25	25.4	25.8
T3:75% RDN+25%FYM	32.3	33.1	13.13	13.91	26.6	27.5
T4:75% RDN+25%MOC	29.5	29.9	12.45	12.88	25.5	26.1
T5:75% RDN+Dhaincha GM	32.6	35.3	13.67	14.03	28.4	29.3
T6:75% RDN+ Dhaincha BM	32.1	33.6	13.19	14.02	26.7	28.4
T7:75% RDN+Azolla	34.7	35.6	13.66	14.00	28.3	28.4
T8:50% RDN+25%FYM+Azolla	39.4	40.5	14.06	15.08	30.2	32.8
SEm (±)	2.2	1.6	1.55	1.34	1.8	2.4
$LSD_{0.05}$	6.6	4.9	4.69	4.06	5.3	7.3

T_1: Control, T_2:100% RDN, T_3:75% RDN+25%FYM, T_4:75% RDN+25%MOC, T_5:75% RDN + *dhaincha* GM, T_6:75% RDN+ *dhaincha* BM, T_7:75% RDN + *Azolla*, T_8:50% RDN+25%FYM+*Azolla*, RDN: Recommended dose of nitrogen (80 KG N ha^{-1}).

Table.4 Effect of integrated nutrient management practices on soil urease activity, soil dehydrogenase activity and Soil microbial biomass carbon

Treatments	soil urease activity (µg NH_4^+- N g^{-1} soil h^{-1})		soil dehydrogenase activity (µg of TPF g-1 soil Day-1)		Soil microbial biomass carbon (mg kg^{-1} of soil)	
	2016	2017	2016	2017	2016	2017
T1:Control	24.76	20.57	219.6	214.1	178.0	175.4
T2:100% RDN	29.34	30.98	327.2	323.7	319.8	315.9
T3:75% RDN+25%FYM	38.15	40.10	352.5	362.2	333.7	340.0
T4:75% RDN+25%MOC	32.71	32.90	342.5	361.3	327.0	330.3
T5:75% RDN+Dhaincha GM	35.50	37.37	371.9	384.0	328.8	334.4
T6:75% RDN+ Dhaincha BM	37.92	38.70	371.1	387.4	352.4	359.9
T7:75% RDN+Azolla	36.01	36.61	359.6	378.0	329.4	337.8
T8:50% RDN+25%FYM+Azolla	42.26	42.98	411.2	414.5	358.8	366.2
SEm (±)	1.19	1.37	12.7	18.8	24.37	22.81
$LSD_{0.05}$	3.61	4.14	38.5	57.2	73.91	69.19

T_1: Control, T_2:100% RDN, T_3:75% RDN+25%FYM, T_4:75% RDN+25%MOC, T_5:75% RDN + *dhaincha* GM, T_6:75% RDN+ *dhaincha* BM, T_7:75% RDN + *Azolla*, T_8:50% RDN+25%FYM+*Azolla*, RDN: Recommended dose of nitrogen (80 KG N ha^{-1}).

Dehydrgenase

Dehydrogenase is involved in the respiratory chain of micro organisms and their activities often serve as an index of microbial biomass. The dehydrogenase activity increased over the years except in treatment T_1 (i.e. control) and T_2 (100% N as chemical fertilizer) where these two treatments showed decrease in urease activity over first year. All the treatments receiving nitrogen application either in the form of chemical alone or combination of chemical and organic sources recorded significantly higher dehydrogenase activity than T_1 (i.e. control). The highest dehydrogenase activity during both the years was observed in treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping), where it recorded significantly higher dehydrogenase activity over all other treatments in first year, whereas the INM treatments with 25% replacement of chemical nitrogen by organic sources (i.e. T_3-T_7) remained at par withhighest value for dehydrogenase activity during the second year of experimentation. The increase in dehydroenase activity in INM treatments might be due to formation of humic acids that enhanced the activity of micro-organisms in soil that ultimately resulted in increase of dehydrogenase activity in soil (Bajpai *et al.*, 2006). The application of organic manures along with inorganic fertilizers increased the dehydrogenase activity (Liu *et al.*, 2010).

Soil microbial biomass carbon

Soil microbial biomass carbon in soil samples showed a significant effect among different treatments (Table 4). The treatment T_8 (50% N as chemical fertilizer with 25% FYM along with Azolla dual cropping) had recorded the highest SMBC and the control treatment recorded the lowest SMBC contents during both the years of experimentation. All the treatments involving nitrogen application (T_2-T_8) recorded significantly higher SMBC than T_1 (i.e. Control). All the INM treatments (T_3-T_8) recorded slightly higher values of SMBC than treatment T_2 (100% RDN through chemical fertilizers). The increase in SMBC in treatments with added organic sources (T_3-T_8) could be attributed to an increase in microbial biomass compared to other treatments due to availability of substrates for growth of microbial population. Similar reports of increased SMBC in treatments where balanced fertilization with organic amended was observed Kumari *et al.,* (2017).

Hence it can be concluded that replacement of a part of recommended dose of nitrogen by addition of organic manures can be an ideal option for sustaining of soil fertility in terms of soil biological properties of lateritic belt of West Bengal.

References

Bajpai, R.K., Chitale, S., Upadhyay, S.K. and Urkurkar, J.S., 2006. Long-term studies on soil physico-chemical properties and productivity of rice-wheat system as influenced by integrated nutrient management in Inceptisol of Chhattisgarh. *Journal of the Indian Society of Soil Science*, *54*(1), pp.24-29.

Beck, T., Joergensen, R.G., Kandeler, E., Makeschin, F., Nuss, E., Oberholzer, H.R. and Scheu, S., 1997. An inter-laboratory comparison of ten different ways of measuring soil microbial biomass C. *Soil Biology and Biochemistry*, *29*(7), pp.1023-1032.

Casida Jr, L.E., Klein, D.A. and Santoro, T., 1964. Soil dehydrogenase activity. *Soil science*, *98*(6), pp.371-376.

Gomez, K.A., Gomez, K.A. and Gomez, A.A., 1984. *Statistical procedures for agricultural research*. John Wiley & Sons.

Goutami, N., Ch. Sujani Rao, A. Sireesha, Ch. Pulla Rao and Vijaya Gopal, A. 2018. Effect of Long-Term Use of Inorganic Fertilizers, Organic Manures and Their Combination on Soil Properties and Enzyme Activity in Rice-Rice Cropping System. *Int.J.Curr.Microbiol.App.Sci*. 7(09): 469-486.

Kumari, S., Chattopadhyaya, N., Mandal, J. and Singh, M., 2017. Integrated Nutrient Management boost the soil biological properties in rice rhizosphere. *Journal of Crop and Weed*, *13*(1), pp.116-124.

Kuttimani, R., Somasundaram, E. and Velayudham, K., 2017. Effect of Integrated Nutrient Management on Soil Microorganisms under Irrigated Banana. *International Journal of Current Microbiology and Applied Science*, *6*(11), pp.2342-2350.

Liu, E., Yan, C., Mei, X., He, W., Bing, S.H., Ding, L., Liu, Q., Liu, S. and Fan, T., 2010. Long-term effect of chemical fertilizer, straw, and manure on soil chemical and biological properties in northwest China. *Geoderma*, *158*(3-4), pp.173-180.

Mahajan A and Gupta R D. 2009. Integrated nutrient management (INM) in a sustainable rice-wheat cropping system. Springer Science & Business Media. pp 140.

Mallikarjun, M. and Maity, S.K., 2017. Energetic Evaluation of Integrated Nutrient Management for Nitrogen in Kharif Rice and its Residual Effect on Yellow Sarson. *Research Journal of Agricultural Sciences*, *8*(6), pp.1362-1365.

Mandal, A., Patra, A.K., Singh, D., Swarup, A. and Masto, R.E., 2007. Effect of long-term application of manure and fertilizer on biological and biochemical activities in soil during crop development stages. *Bioresource technology*, *98*(18), pp.3585-3592.

Mondal S, Mallikarjun M, Ghosh M, Ghosh D C and Timsina J. 2016. Influence of integrated nutrient management (INM) on nutrient use efficiency, soil fertility and productivity of hybrid rice. *Archives of Agronomy and Soil Science* 62(11): 1521-1529.

Nagendra, V., 2015. *Influence of Rice Production Systems and Nutrient Management Practices on Rice Yield and Soil Properties* (Doctoral Dissertation, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad).

Rao, N.S., 1988. Biofertilizers in Agriculture Published by Oxford and IBH Publishing Company private limited, New Delhi.

Reddy, M.S., 2002. Relationship between organic carbon and soil enzymes. *J. Res. ANGRAU*, 30(2), 143-146.

Tabatabai, M.A. and Bremner, J.M., 1972. Assay of urease activity in soils. *Soil Biology and Biochemistry*, 4(4), 479-487.

Thornton, H.G., 1930. The early development of the root nodule of lucerne (Medicago sativa, L.). *Annals of Botany*, 44(174), pp. 385-392.

How to cite this article:

Mallikarjun, M. and Maity, S.K. 2018. Effect of Integrated Nutrient Management on Soil Biological Properties in *Kharif* Rice. *Int.J.Curr.Microbiol.App.Sci.* 7(11): 1531-1537.
doi: https://doi.org/10.20546/ijcmas.2018.711.176