

Original Research Article

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Soil Biological and Biochemical Properties in Rice-maize System under Different Nutrient and Weed Management Practices

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ABSTRACT

Keywords

INM, Bacteria, Fungi, Actinomycetes, Dehydrogenase activity, Topramezone

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A two year field experiment was conducted at Central Research Station of College of Agriculture, OUAT, Bhubaneswar, during two consecutive *kharif* and *rabi* seasons of 2017-18 and 2018-19 title Integrated nutrient management in rice (*Oryza sativa* L.) and its residual effects on maize (*Zea mays* L.) under different weed management practices to assesses the performance of the system and nutrients and microbial status of soil at the end of rice-maize cropping system The field experiment was laid out in a RBD design for rice with four treatments and 15 replications and split-plot design for maize with four(4) main plot treatment five(5) subplot treatments and three replications. The four INM treatments for rice were D1=100% STBN, D2=50%STBN+50%FYM, D3=50%STBN+50%VC and D4=50%STBN+50%PM. There were altogether 20 treatment combinations for maize with Main Plot (Nutrient management, *i.e.* residual effects of treatments given to rice crop) and Sub-Plot (Weed management): W1= Topramezone @ 25g a.i./ha, W2=Tembotrione@105g a.i./ha, W3=Topramezone @ 25ga.i.+Atrazine @ 250ga.i./ha as tank mix, W4= Tembotrione@ 105g a.i. + Atrazine@ 250g a.i./ha and W5=Weedy check. Integrated application of nutrients through inorganic and organic sources (such as FYM, Vermicompost and poultry manure) found to be significantly improves the soil microbial population as well as dehydrogenase enzyme activity over sole inorganic fertilizer application in Rice-maize system.

Introduction

Rice-maize systems are emerging all around South Asia but in particular are developing quite rapidly in Bangladesh and South and North India. However, data from different research in several environments in India reveal productivity of the system is either stagnant or in a declining trend. Experiments show gaps between potential and attainable yields of maize of up to 100% and between

attainable and actual yields of up to 25–50%. On application one other hand continuous application of chemical fertilizers resulted deterioration of soil health with reduced organic carbon and increased micronutrients deficiencies (Swarup, 2002). Thus indirectly contributing to the loss of beneficial soil microbial population and many enzyme activities. It has been evidenced through research that combined application of organic manure with chemical fertilizers improves the

physical properties of soil like water holding capacity, infiltration rate, available soil moisture, liable C and microbial count, penetration resistance reduces bulk density (Walia, 2016).

Mahajan *et al.*, (2007) found that the bacterial, fungal and *Azotobacter* populations were maximum in plots treated with mineral fertilizers and FYM (100%NPK+FYM).

Panda *et al.*, (2015) while studying the comparative efficacy of FYM, poultry manure and Vermicompost on soil properties established the fact that the soil biological properties like soil dehydrogenase activity was significantly varied under different treatments and was noticed higher in *Azospirillum* with vermicompost treated plots because of high soil respiration activity) and soil bacterial population.

Nagaraj *et al.*, (2018) observed higher bacterial population of ($27.27 \text{ cfu} \times 10^5 \text{ g}^{-1}$ of soil) in the treatments consisting of Package of practices (POP- FYM 5 t + 60:30:45 kg N:P₂O₅:K₂O ha⁻¹) + 50 % N through vermicompost followed by POP + 50 % N through goat manure ($26.30 \text{ cfu} \times 10^5 \text{ g}^{-1}$ of soil) and POP + 50 % N through poultry manure ($24.23 \text{ cfu} \times 10^5 \text{ g}^{-1}$ of soil).

Kumar *et al.*, (2017) Observed maximum DH activity ($136.90 \mu\text{g TPF g}^{-1}\text{soil h}^{-1}$) under INM practice with 50% recommended dose of NPK + vermicompost @ 2 t ha⁻¹ (mixed with microbial consortium) after okra cultivation.

Gupta. *et al* (2019). Soil dehydrogenase (DH) involved in oxidative phosphorylation, and is an important indicator of microbial activity in the soil which has been found to increase significantly in soils applied in combination of organic, inorganic and bio-fertilizer. It increased in all the treatments over control with the highest value in treatment with 100%

NPK + 25 t vermicompost ha⁻¹.

Materials and Methods

A two year field experiment was conducted during 2017-18 and 2018-19 at Central Research Station of the College of Agriculture, OUAT- Bhubaneswar, taking two crops, rice in *kharif* and maize in *rabi*. The soil of the experimental plot was loamy sand in texture, low in available nitrogen (198 kg/ha), high in available phosphorus (51 kg/ha) and low in available potassium (182 kg/ha), organic carbon 0.46 % and pH (4.68), EC dsm-1 (046). The field experiment was laid out in a RBD design for rice with four treatments and 15 replications and split-plot design for maize with three replications. The four INM treatments for rice were D1=100% STBN, D2 = 50% STBN + 50% FYM, D3=50%STBN + 50% VC and D4 = 50% STBN + 50%PM. There were altogether 20 treatment combinations for maize with Main Plot (Nutrient management, *i.e.* residual effects of treatments given to rice crop) and Sub-Plot (Weed management): W1= Topramezone @ 25g a.i/ha, W2 = Tembotrione @ 105g a.i./ha, W3 = Topramezone @ 25g a.i. + Atrazine@ 250g a.i./ha as tank mix, W4 = Tembotrione@105g a.i./ha ++ Atrazine @ 250g a.i./ha and W5=Weedy check. Tested varieties are Nabeen (Rice) and DHM 117 (maize). Rice was transplanted at 20cmX10cm spacing and maize was sown with spacing of 45cm×25cm on opening of shallow furrows of 5 cm deep. Inorganic nutrients to both the crops were provided with Urea, Single Super Phosphate and Murate of Potash. Herbicides in maize was applied at 15 DAS. The soil microbial population (heterotrophic bacteria, fungi and actinomycetes) was determined by serial dilution and spread plate technique.

One g of the collected soil samples were added to each of ten tubes containing 9 ml

distilled water thoroughly mixed and spread over petriplates containing nutrient agar and potato dextrose agar for enumeration of total heterotrophic bacteria and fungi population respectively. The plates were incubated at 30°C for 24 hours for bacterial isolation and at 30°C for 48 hrs for growth of fungi. For actinomycetes soil samples were incubated for 5mins at 55°C. Then one gram of each soil sample was taken in three different test tubes containing 10ml of distilled water. From each test tube 0.1ml of sample solution was spread on three different sterile plates containing actinomycetes isolation agar. To minimise bacterial and fungal contamination, all plates were supplemented with 50 µg/ml of Nystatin and Ampicilin. All plates were incubated at 28°C for five days and colonies were counted.

Calculation

$$\text{CFU / ml} = \frac{\text{No. of colony} \times \text{inverse of dilution taken}}{\text{Vol. of inoculums taken}}$$

Determination of soil dehydrogenase activity is generally done by adding alternative electron acceptors to soil samples. Water-soluble tetrazolium salts are the preferred oxidants because they form water-insoluble coloured formazans which can be measured spectrophotometrically. Dehydrogenase activity in the soil sample was determined by following the procedure as described by Klein *et al.*, in 1971.

One gram of air dried soil was taken in an air tight screw capped test tubes (15 ml capacity) and 0.2 ml of 3 % solution of 2,3,5-triphenyl tetrazolium chloride (TTC), 0.5 ml of 1 % glucose solution were added to each test tube. The bottom of the tube tapped gently to drive out all trapped oxygen, and thus a water seal is formed above the soil.

Ensure that no air bubbles are formed. The tubes were incubated at 30°C for 24 h. After

incubation, 10 ml methanol was added and shaken vigorously. Then it was allowed to stand for 6 h. clear pink coloured supernatant was withdrawn and readings were taken with a spectrophotometer at a wave length of 485 nm. The concentration of formazon formed in the soil sample was determined using graded concentrations of formazon. The results were expressed in microgram of triphenyl formazon (TPF) formed per gram of soil per hour ($\mu\text{g TPF h}^{-1} \text{g}^{-1} \text{soil}$).

Results and Discussion

Data pertaining to soil microbial population and dehydrogenase activity in soil is provided in the table-1. It is observed that, nutrient management practices have influential effect on soil microbial population, however weed management practices unlike on dehydrogenase activity do not found to significantly affect soil microbial count.

Among the nutrient management (residual nutrients of previous rice crop), 50%STBN+50%FYM has shown the maximum improvement on soil bacterial population, 25.3×10^5 CFU/g soil and the least improvement has seen in case of 100% STBN i.e. 15.6×10^5 . Highest imprudent on fungal population was found in 50%STBN+50%VC, 9.2×10^3 , followed by 50%STBN+50%PM, 8.9×10^3 and least in case of 100% STBN, 3.4×10^3 .

Soil actinomycetes population was significantly improved at the end of the cropping system, maximum being under 50% STBN + 50%FYM, 37.9×10^3 . This increase in microbial population in combined sources of nutrients over the inorganic nutrient sources might be due to the fact that INM plots have provided a steady source of organic carbon to support the microbial community compared to 100% NPK treated plots.

Table.1 Microbial population and dehydrogenase activity as influenced by nutrient and weed management practices in Rice-maize system

Treatment	Soil Bacteria count (10 ⁵ CFU/g Soil)			Soil Fungal population (10 ³ CFU/g Soil)			Soil Actinomycetes population (10 ³ CFU/g Soil)			Dehydrogenase activity (µg TPF/g soil/h)		
	2017 Initial: 57 x 10 ⁵			2017 Initial: 43 x 10 ³			2017 Initial: 66 x 10 ³			2017 Initial: 6.18		
	2017	2018	Change	2017	2018	Change	2017	2018	Change	2017	2018	Change
Nutrient management												
100% STBN	72.2	72.6	15.6	45.7	46.4	3.4	97.2	98.0	32.0	6.7	7.4	1.22
50%STBN+50%FYM	82.5	82.3	25.3	53.6	50.0	7.2	103.9	103.9	37.9	8.10	8.13	1.95
50%STBN+50%VC	80.4	80.7	23.7	51.4	52.2	9.2	102.8	103.2	37.2	7.83	8.13	1.95
50%STBN+50%PM	81.4	80.6	23.6	51.4	51.9	8.9	103.5	103.4	37.4	8.10	8.10	1.92
SEm±	1.21	0.94	-	1.21	0.73	-	1.22	0.88	-	0.22	0.20	-
CD(5%)	4.21	3.26	-	NS	NS	-	4.23	3.03	-	0.76	0.68	-
Weed management												
Topramezone	79.5	78.9	21.9	51.5	51.1	8.1	100.0	98.44	99.26	6.19	7.53	1.13
Tembotrione	77.9	79.2	22.2	51.2	50.1	7.1	101.3	103.9	102.6	5.93	8.39	2.21
Topramizone.+Atrazine	74.5	78.8	21.8	49.7	51.4	8.4	97.08	97.61	97.35	9.49	9.12	2.94
Tembotrione+Atrazine	80.2	79.1	22.1	48.7	49.4	6.4	99.08	96.69	97.89	7.43	7.70	1.52
Weedy Check	81.4	80.2	23.2	51.9	51.7	8.7	108.1	109.1	108.6	8.17	7.79	1.61
SEm±	2.17	1.73	-	1.97	1.36	-	2.71	3.38	-	0.44	0.29	-
CD(5%)	NS	NS	-	NS	NS	-	NS	NS	-	1.27	0.83	-
Interaction non significant												

Soil dehydrogenase activity influenced by both nutrient as well as weed management practices. Among nutrient management practices maximum improvement of soil dehydrogenase activity was recorded in case of 50% STBN + 50% FYM and 50%STBN + 50% VC treatment, ($1.95 \mu\text{g TPF h}^{-1} \text{g}^{-1}$ soil). Followed by 50% STBN + 50% PM ($1.92 \mu\text{g TPF h}^{-1} \text{g}^{-1}$ soil) and least recorded in 100% STBF ($1.22 \mu\text{g TPF h}^{-1} \text{g}^{-1}$ soil). Among the weed management practices maximum improvement in soil dehydrogenase activity is observed in mixed application of Topramizone + Atrazine, ($2.94 \mu\text{g TPF h}^{-1} \text{g}^{-1}$ soil). Nayak *et al.*, (2007) also described a generalized short to medium term increase in DH activity following organic matter addition. Gupta *et al.*, (2019), use of chemical fertilizer i.e. 100% NPK alone exhibited lower dehydrogenase activity compared with conjoined use of inorganic and organic treatments. It was increased by 77% in 100% NPK + 25 t vermicompost ha^{-1} over 100% NPK fertilizer alone. The inorganic source of nutrient simulated the activity of microorganisms to utilize the native pool of organic carbon as a source of carbon, which acts as substrate for dehydrogenase activity. Secondly, the addition of nitrogen doses solely and partially through chemical fertilizers resulted in accumulation of nitrate in soil, thus inhibiting the activity of enzyme through interfering in the process of electron acceptors as reported by Goyal *et al.*, (1992)

No interaction effect of nutrient and weed management practices have been observed for soil microbial population and dehydrogenase activity.

References

Goyal S, Mishra MM, Hooda IS, Singh R. 1992. Organic matter-microbial biomass relationships in field experiments under tropical conditions: Effects of inorganic

fertilization and organic amendments. *Soil Biol. Bio chem*24(11):1081-1084. doi.org/10.101 6/0038-0717(92)90056-4.

- Gupta, R. Rai, A.P. and Swami, S. 2019. Soil enzymes, microbial biomass carbon and microbial population as influenced by integrated nutrient management under onion cultivation in sub-tropical zone of Jammu. *Journal of Pharmacognosy and Phytochemistry* 2019; 8(3): 194-199
- Klein DA, Loh TC, Goulding RL. A rapid procedure to evaluate the dehydrogenase activity of soils low in organic matter. *Soil Biol. Bio chem.* 1971; 3(4):385-387.
- Kumar, S., Saha, B., Saha, S., Das, A., Poddar, P. and Prabhakar, M. 2017. Integrated nutrient management for enhanced yield, nutrient uptake and their Use Efficiency in Rice under Intensive Rice-Wheat Cropping System. *International Journal of Current microbiology and applied sciences*.ISSN:2319-7706. Volume 6, Number 10. pp 1958-197
- Lokose, R.Y.P 2017. Weed and nutrient management in maize (*Zea mays* L.) and cowpea (*Vigna unguiculata* L.) intercropping and residual effects on sesame (*Sesamum indicum* L.) Ph.D. thesis submitted to department of agronomy,ouat,Bhubaneswar, Odisha, India
- Mahajan, S. Kanwar, S.S. and Sharma, S.P. 2007. Long term effect of mineral fertilizers and amendmends on microbial dynamics in an alfisols of western Himalayas. *Indian journal of microbiology* 47(1), 86-89.
- Nagaraj, R., Hanumanthappa, M. and Kamath, K.V.S. 2018. Integrated Nutrient Management in Paddy at Coastal Zone of Karnataka, India. *International Journal of Current Microbiology and Applied Sciences*

ISSN: 2319-7706 Volume 7 Number 06.

Panda, N., Dhal, A. And Sangram Singh, S.P. 2009. Varietal performance of rice [Oryza sativa (L.)] cultivars grown under coastal saline soil of Orissa. International Journal of Agricultural Sciences. Vol. 5 Issue 1. Jan.-May, 2009.

Walie, A.W. and Admassu, M.A. 2016.

Effects of Integrated Nutrient Management on Rice (Oryza sativa L) Yield and Yield Attributes, Nutrient Uptake and Some Physico-Chemical Properties of Soil: A Review. Journal of Biology, Agriculture and Healthcare. ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) Vol.6, No.5.

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