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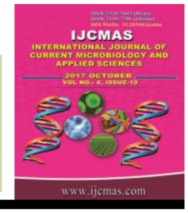

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Microbial Properties of Lowland Rice Soil as Affected by Nutrient Management Practices and Microbial Inoculants

Parkash Verma, Y.V. Singh*, Anil K. Choudhary and Sunita Gaind

Indian Agricultural Research Institute, New Delhi 110 012, India
**Corresponding author*

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A B S T R A C T

A field study was conducted during *Kharif* 2016 at the research farm of ICAR Complex for NEH Region (Umiam) Barapani, Meghalaya to find out the effect of different nutrient management practices and microbial inoculants on microbial properties in soil of lowland rice in Eastern Himalayas. The experiment was laid out in split plot design with 12 treatment combinations and 3 replications. The main plots consisted of 3 different nutrient management practices *viz.* 100% organic, 100% inorganic (recommended dose of fertilizer-RDF) and integrated nutrient management- INM (75% RDF+ 25% FYM) while in the sub plot there were 4 treatments *viz.* control, *Azospirillum*, *Azospirillum* + PSB, *Azospirillum* + PSB + ZnSB. Results showed that soil alkaline phosphatase activity was found to be higher at 60 days after transplanting (DAT) and it declined at harvesting stage. The highest value of alkaline phosphatase activity was recorded under organic nutrient management at 60 DAT (162.58 µg p-NP/g soil/ hr) and at harvest (105.92 µg p-NP/g soil/ hr) and at both the stages it was significantly higher than INM and inorganic treatment. Similarly the highest value (174.49 µg/g dry soil) of MBC was recorded at 60 DAT and it declined at crop harvest stage (90.73 µg/g dry soil). Values of Fluorescein diacetate activity (FDA) were the highest (11.80 µg fluorescein/g soil/hr) at 60 DAT and declined further at crop harvest stage (8.84 µg fluorescein/g soil/hr). The lowest values of all the three parameters were observed in case of inorganic nutrient management practices. The results clearly indicated that organic nutrient management was responsible for higher microbial activities in the soil.

Introduction

Rice is India's prominent crop, and is also the hub of food security of the global population (Kumar *et al.,* 2014). Rice supplies 20 and 31% of total calories required by world and the Indian population, respectively. After the green revolution the continuous use of dwarf varieties responsive to the fertilizers in intensive agriculture enhanced the agriculture production but at the same time it deteriorated the soil quality and total factor productivity (Vaid *et al.,* 2014). Rice crop plants are able to use about 30-50% of the applied fertilizer N while more than 50% is lost from the soil-plant system through leaching, volatilization and denitrification (Tiwari *et al.,* 1998). With a view to reduce the losses and indiscriminate use of chemical fertilizers, substitution of a part of the chemical fertilizer by microbial inoculants is inevitable. Under the present situations organic and microbial nutrient sources could be important components of the nutrient management in different agro ecosystems since they are cost-efficient (Das *et al.,* 2014). In addition to supply of nutrients, these organic and microbial inoculants improve the physical condition and biological health of soil, which improves the availability of applied and native nutrients (Shahane *et al.,* 2013; Meena *et al.,* 2014).

Generally higher enzymatic activity is associated with high quantity of organic matter in soil, which is directly related higher microbial activity in soil. Rose *et al.,* (2014) in Vietnam also observed that the biofertilizer can replace between 23 and 52 % of nitrogen (N) fertilizer without loss of yield. Keeping this in view, the present study was undertaken to study the effect of nutrient management practices and microbial inoculants on microbial properties in soil of lowland rice.

Materials and Methods

Study area

The field experiment was conducted during *Kharif* 2016 at the research farm of ICAR Complex for NEH Region (Umiam) Barapani, Meghalaya, situated at 950 m above mean sea level at latitude of 25 41'-21" N and longitude of 91 55'-25 E. The soil of the experiment site was sandy clay loam in texture, acidic (5.0) in nature and having low available N (252.98 kg/ha) and P (8.19 kg/ha), but high in available K content and soil organic carbon (2.51%) content.

Treatments and experimental design

The experimental treatments were consisted of 3 main plot treatment *viz.* 100% organic, 100% inorganic (RDF) and integrated nutrient management INM (75% RDF+ 25% FYM) while in the sub plot there were 4 treatments *viz.* control, *Azospirillum*, *Azospirillum* + Phosphate solubilizing bacteria (PSB), *Azospirillum* + PSB + Zinc solubilizing bacteria (ZnSB). For organic, FYM was taken as a source of nutrition. The experiment was laid out in split plot design with 3 replications. N, P and K were applied through urea, single super phosphate and muriate of potash in the ratio of 80:60:40 kg/ha, respectively for inorganic nutrient management. While nutrient in organic plot was applied through FYM and through rock phosphate. In INM plots it was applied through 75% RDF and 25% FYM. Biofertilizers were applied as per the recommended concentration and after dissolving in water roots of the seedlings were dipped in the solution. Popular rice variety ‘Shahsarang 1’ was taken in the experiment.

Soil samples collection and analysis

Soil samples were collected at 60 days after transplanting (DAT) and at harvest stage from all the plots of the experiment from 0-15 cm of soil layer. Then samples were analyzed as per the standard procedures in the lab for the estimation of microbial activity.

Microbial biomass carbon (MBC)

Microbial biomass carbon in soil samples was estimated by the method described by Vance *et al.,* (1987).

Alkaline phosphatase activity

The activity of alkaline phosphatase in soil was assayed by a method developed by Tabatabai and Bremner (1969).

Fluorescein diacetate (FDA) activity

The activity of alkaline phosphatase in soil was assayed by a method developed by Tabatabai (1994).

Results and Discussion

Nutrient management practices and microbial inoculants showed significant influence on the soil microbial biomass carbon (MBC) at 60 DAT and at crop harvest stage (Table 1). The organic nutrient treatment was having significantly higher MBC as compared to INM and inorganic treatment at 60 DAT and at crop harvest. The maximum (174.49 µg/g dry soil) value of MBC was recorded with organic nutrient management at 60 DAT and it declined at crop harvest stage (90.73 µg/g dry soil).

This might be due to higher microbial activities in those plots where organic sources of nutrients were applied and lower value were observed in inorganic plots because inorganic sources of nutrients have some inhibitory effect on the microbial activity. Rao (1978) also found the similar result and reported that biological nitrogen fixation in the soil was low when the concentration of added nitrogen fertilizer was increased. Among the treatment with microbial inoculants, highest value of MBC was observed with combined inoculation of *Azospirillum* + PSB+ ZnSB treatment at 60 DAT (164.74µg/g dry soil) and at harvest (85.69 µg/g dry soil). Control treatment showed significantly lowest MBC compared to treatment having microbial inoculants at both the observations. There was gradual increase in MBC due to the inoculation of sole *Azospirillum* and combined inoculation of *Azospirillum*+ PSB and *Azospirillum*+ PSB+ ZnSB. Alagappan and Venkitaswamy (2016) also reported higher microbial population, when nutrients were applied through organic treatments compared to application through RDF through mineral fertilizers and INM. Meena *et al.,* (2014) also reported significantly enhanced MBC with application of 2/3 N+ bacterial inoculants + cyanobacterial inoculants + Compost @ 5.0 t/ha over N control and chemical fertilizer application at recommended dose.

Table.1 Microbial properties of soil as affected by nutrient management practices and microbial inoculants in lowland rice

Treatment	Alkaline phosphatase activity at harvest (µg p-NP/g soil/ hr)		FDA enzyme activity (µg fluorescein/g soil/hr)		MBC (µg/g dry soil)	
	60 DAT	Harvest	60 DAT	Harvest	60 DAT	Harvest
Nutrient management practices						
Organic*	162.58	111.83	11.80	8.84	174.49	90.73
Inorganic**	113.93	73.93	10.01	7.41	136.40	70.96
INM***	131.23	84.73	11.54	8.64	151.01	78.60
S Em±	4.07	2.98	0.16	0.14	3.29	1.63
CD (P=0.05)	16.08	11.92	0.63	0.56	12.94	6.48
Microbial inoculants						
Control	113.95	67.83	10.32	7.55	138.54	72.08
Azospirillum	117.97	75.75	11.15	8.32	153.64	79.96
Azospirillum+ PSB	149.15	104.15	11.40	8.56	158.95	82.65
Azospirillum+ PSB+ ZnSB	160.59	115.59	11.59	8.74	164.74	85.69
S Em±	4.44	4.25	0.11	0.11	2.44	1.24
CD (P=0.05)	13.18	12.77	0.33	0.34	7.27	3.75
Interaction	NS	NS	NS	NS	NS	NS

* Organic: FYM and rock phosphate ** Inorganic: 80:60:40 kg/ha N, P_2O_5 & K_2O; *** INM: 75% Mineral fertilization at RDF (80:60:40 kg/ha) +25% FYM

Like MBC, the similar trends were also observed in case of Fluorescein diacetate activity (FDA) as well as alkaline phosphatase activity. The highest value of soil FDA was recorded under organic nutrient management at 60 DAT (11.80 µg fluorescein/g soil/hr) and at crop harvest (8.84 µg fluorescein/g soil/hr) and those were significantly higher than INM and inorganic treatment. The highest value of alkaline phosphatase activity was recorded under organic nutrient management at 60 DAT (162.58 µg p-NP/g soil/ hr) and after harvesting (105.92 µg p-NP/g soil/ hr) and at both the observations it was significantly higher than INM and inorganic treatment. A gradual enhancement in soil alkaline phosphatase activities was found due to the inoculation of sole *Azospirillum* and combined inoculation of *Azospirillum*+ PSB and *Azospirillum*+ PSB+ ZnSB. Yadav (2015) also reported increase in enzymatic activities in soil at harvest stage of rice crop due to the integrated application of microbial inoculants (PSB and AMF) over P control. The lowest values were recorded with inorganic practice at both the stages.

It was concluded that among the different nutrient management practices, organic sources of nutrient was responsible for the higher microbial activity in soil. Among the different microbial inoculants, combined application of *Azospirillum*+ PSB+ ZnSB resulted into higher microbial activity over the other treatments.

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