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Soil microbial count and dehydrogenase activity of direct seeded rice as influenced by integrated nutrient management

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Abstract

The experiment was conducted at Agricultural College Farm, Raichur on medium black with clay loam texture during *kharif* season of 2016 and 2017 to know the effect of soil microbial count and dehydrogenase activity as influenced by integrated nutrient management in direct seeded rice. Pooled mean of two years indicated that among the integrated nutrient management practices significantly higher microbial count ($25.90 \text{ cfu} \times 10^6 \text{ g}^{-1}$ of bacteria, $8.79 \text{ cfu} \times 10^3 \text{ g}^{-1}$ of fungi and $10.31 \text{ cfu} \times 10^4 \text{ g}^{-1}$ of actinomycetes at harvest and dehydrogenase activity $101.96 \text{ of } \mu\text{g TPF formed g}^{-1} \text{ of soil hr}^{-1}$ at 45 and $109.70 \text{ of } \mu\text{g TPF formed g}^{-1} \text{ of soil hr}^{-1}$ at 60 DAS was recorded with the treatment, T₂ (100% of NPK + FYM @ 10 tonnes ha⁻¹) when compared to other treatments and was found on par with the treatments T₁ (100% NPK) and T₁₀ (50% of recommended N through composted poultry manure + 50% of recommended N through inorganic fertilizers).

Keywords: Direct seeded rice, varieties, fertilizer levels, nitrogen split applications, growth, yield and economics

Introduction

Rice (*Oryza sativa* L.) is a grain plant belonging to the family poaceae and genus *Oryza*. It is one of the most important food grains produced and consumed all over the world. Global rice demand was 439 million tonnes in 2010 and is expected to rise to 496 million tonnes in 2020 and further increase to 553 million tonnes in 2035 (Anon., 2013) [1]. Several long-term experiments all over India indicated a decrease in rice productivity due to continuous use of chemical fertilizers. Imbalanced nutrient management under intensive cropping system and decreased soil organic matter are the key factors responsible for decline in soil quality parameters (Kang *et al.*, 2005) [3]. Under such situation, integrated nutrient management (INM) aims to improve soil health and sustain high level of productivity and production (Prasad *et al.*, 1995) [6]. Integrated nutrient management system can bring about equilibrium between degenerative and restorative activities in the soil eco-system (Upadhyay *et al.*, 2011) [9].

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. Further, integrated nutrient management also found to influence on microbial community function and soil dehydrogenase activity.

Material and Methods

The experiment was conducted at Agricultural College Farm, Raichur on medium black with clay loam texture during *kharif* season of 2016 and 2017. Experiment II was laid out on fixed site in two consecutive years in Randomized Complete Block Design (RCBD) with twelve treatments, T₁: 100 percent of NPK, T₂: 100 percent of NPK + FYM @ 10 tonnes ha⁻¹, T₃: FYM equivalent to 100 percent of recommended N, T₄: vermicompost equivalent to 100

percent of recommended N, T₅: composted poultry manure equivalent to 100 percent of recommended N, T₆: FYM equivalent to 50 percent of recommended N + vermicompost equivalent to 50 percent of recommended N, T₇: FYM equivalent to 50 percent of recommended N + composted poultry manure equivalent to 50 percent of recommended N, T₈: 50 percent of recommended N through FYM + 50 percent of recommended N through inorganic fertilizers, T₉: 50 percent of recommended N through vermicompost + 50 percent of recommended N through inorganic fertilizers, T₁₀: 50 percent of recommended N through composted poultry manure + 50 percent of recommended N through inorganic fertilizers, T₁₁: 25 percent of recommended N through FYM + 25 percent of recommended N through vermicompost + 50 percent of recommended N through inorganic fertilizers and T₁₂: 25 percent of recommended N through FYM + 25 percent of recommended N through poultry manure + 50 percent of recommended N through inorganic fertilizers with three replications. The enumeration of total bacteria, fungi and actinomycetes in free rhizosphere was carried out after the harvest of crop by serial dilution and agar plate method (Pramer and Schmidt, 1964). Dehydrogenase activity in the soil samples was determined by following the procedure as described by Casida *et al.* (1964). This method involves colorimetric determination of 2,3,5-triphenyl formazon (TPF) produced by the reduction of 2,3,5-triphenyl tetrazolium chloride (TTC) by soil microbes. Tetrazolium salts are representative of a unique class of compounds as terminal e-accepter and possess a high degree of water solubility. The results are expressed as µg of triphenyl formazan (TPF) formed per gram of soil per day, at 45 and 60 DAS (Days after sowing).

Results and Discussion

The significant increase in microbial population *viz.*, bacteria, fungi and actinomycetes was observed with the addition of organic manures in combination with inorganic fertilizers *i.e.*, T₂ (100% NPK + FYM @ 10 tonnes ha⁻¹) (25.90 cfu × 10⁶ g⁻¹, 8.79 cfu × 10³ g⁻¹ and 10.31 cfu × 10⁴ g⁻¹) and was on par with T₁ (100% of NPK) (24.94 cfu × 10⁶ g⁻¹, 8.47 cfu × 10³ g⁻¹ and 9.92 cfu × 10⁴ g⁻¹) and T₁₀ (50% of recommended N through composted poultry manure + 50% of recommended N through inorganic fertilizers) (24.44 cfu × 10⁶ g⁻¹, 8.30 cfu × 10³ g⁻¹ and 9.73 cfu × 10⁴ g⁻¹) and lower microbial population was observed with FYM equivalent to 100 percent of recommended N (T₃) (14.42 cfu × 10⁶ g⁻¹, 4.93 cfu × 10³ g⁻¹ and 5.77 cfu × 10⁴ g⁻¹), respectively (Table 1). Significant improvement in the population of soil micro-organisms *viz.*, bacteria, fungi, actinomycetes, and dehydrogenase activity were recorded with integrated nutrient management practices. This was due to the presence of easily metabolizable

compounds at the beginning of the crop growth and also under active growth phase releasing higher amounts of root exudates, supporting numerous and diverse micro flora.

The dehydrogenase activity also followed similar trend as that of microbial load in soil. Among the integrated nutrient management practices, significantly higher dehydrogenase activity was recorded with T₂ *i.e.*, the application of 100 percent of NPK + FYM @ 10 tonnes ha⁻¹ (101.96 and 109.70 µg TPF formed g⁻¹ of soil hr⁻¹) and was on par with T₁ *i.e.*, 100 percent of NPK (98.16 and 108.41 µg TPF formed g⁻¹ of soil hr⁻¹) and T₁₀ *i.e.*, 50 percent of recommended N through composted poultry manure + 50 percent of recommended N through inorganic fertilizers (97.48 and 108.30 µg TPF formed g⁻¹ of soil hr⁻¹) where as significantly lower dehydrogenase activity was observed with the application of FYM equivalent to 100 percent of recommended N (T₃) (56.39 and 60.33 µg TPF formed g⁻¹ of soil hr⁻¹) (Table 93), respectively at 45 and 60 DAS. The higher dehydrogenase activity may be due to application of combination of inorganic fertilizers with organic manures as well as maximum moisture availability and higher microbial activities. These results are in accordance with Nagendra (2015) [5] who reported that the application of 100% recommended dose of NPK through chemical fertilizers recorded lower enzyme activities than the INM treatments which is attributed to lack of sufficient substrate *i.e.* organic carbon which acts as an energy source and food for proliferating the microbial population. Similar results are also reported by Sriramachandrakham *et al.* (1997) [7].

The lower activity of dehydrogenase at later stage compared to earlier stage could be due to decrease in moisture availability. The dehydrogenase activity showed an increasing trend with the age of the crop. It increased from mid tillering stage to panicle initiation stage, exhibited highest activity at panicle initiation stage and there after the activity decreased at maturity. The activities of dehydrogenase enzyme in the soil system is very important as it gives indications of the potential of the soil to support biochemical processes which are essential for maintaining soil fertility (Joychim *et al.*, 2008) [2]. Significantly higher dehydrogenase activity in integrated nutrient management practices was due to addition of organic matter which in turn increased microbial activity and microbial biomass and consequently increased activity of dehydrogenase (Tejada and Gonzalez, 2009) [8]. The applied organic sources were able to get mineralized rapidly in early days of incubation hence, there was more mineralization than immobilization which consequently provided sufficient nutrition for the proliferation of microbes and their activities in terms of soil dehydrogenase. Similar observations were noted by Joychim *et al.* (2008) [2], Lakshmi *et al.* (2014) [4] and Nagendra (2015) [5].

Table 1: Microbial activity of rice as influenced by integrated nutrient management practices

Treatments	Bacteria count (cfu × 10 ⁶ g ⁻¹)			Fungi count (cfu × 10 ³ g ⁻¹)			Actinomycetes count (cfu × 10 ⁴ g ⁻¹)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T ₁	24.77	25.10	24.94	8.30	8.63	8.47	9.76	10.09	9.92
T ₂	25.73	26.06	25.90	8.62	8.95	8.79	10.14	10.47	10.31
T ₃	14.26	14.59	14.42	4.76	5.09	4.93	5.60	5.93	5.77
T ₄	17.26	17.59	17.43	5.78	6.11	5.94	6.80	7.13	6.97
T ₅	17.62	17.95	17.78	6.23	6.56	6.40	7.33	7.66	7.50
T ₆	15.90	16.23	16.06	5.33	5.66	5.49	6.28	6.61	6.44
T ₇	16.51	16.84	16.68	5.53	5.86	5.69	6.51	6.84	6.67
T ₈	17.03	17.36	17.19	5.70	6.03	5.86	6.73	7.06	6.90
T ₉	22.36	22.69	22.52	7.16	7.49	7.33	8.43	8.76	8.59
T ₁₀	24.27	24.60	24.44	8.13	8.46	8.30	9.57	9.90	9.73

T ₁₁	19.89	20.22	20.05	6.66	6.99	6.83	7.84	8.17	8.00
T ₁₂	20.82	21.15	20.99	6.99	7.32	7.16	8.22	8.55	8.38
S.Em±	0.96	0.95	0.99	0.17	0.15	0.19	0.30	0.28	0.32
C. D. at 5%	2.89	2.84	2.96	0.51	0.46	0.58	0.89	0.84	0.96

<p>T₁: 100% of NPK T₂: 100% of NPK + FYM @ 10 tonnes ha⁻¹ T₃: FYM equivalent to 100% of recommended N T₄: vermicompost equivalent to 100% of recommended N T₅: composted poultry manure equivalent to 100% of recommended N T₆: FYM equivalent to 50% of recommended N + vermicompost equivalent to 50% of recommended N T₇: FYM equivalent to 50% of recommended N + composted poultry manure equivalent to 50% of recommended N</p>	<p>T₈: 50% of recommended N through FYM + 50% of recommended N through inorganic fertilizers T₉: 50% of recommended N through vermicompost + 50% of recommended N through inorganic fertilizers T₁₀: 50% of recommended N through composted poultry manure + 50% of recommended N through inorganic fertilizers T₁₁: 25% of recommended N through FYM + 25% of recommended N through vermicompost + 50% of recommended N through inorganic fertilizers T₁₂: 25% of recommended N through FYM + 25% of recommended N through poultry manure + 50% of recommended N through inorganic fertilizers</p>
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Table 2: Dehydrogenase activity ($\mu\text{g TPF formed g}^{-1}$ of soil hr^{-1}) of rice as influenced by integrated nutrient management practices

Treatments	Dehydrogenase activity ($\mu\text{g TPF formed g}^{-1}$ of soil hr^{-1})					
	45 DAS			60 DAS		
	2016	2017	Pooled	2016	2017	Pooled
T ₁	96.00	100.33	98.16	106.24	110.57	108.41
T ₂	99.80	104.13	101.96	107.54	111.87	109.70
T ₃	54.23	58.56	56.39	58.16	62.49	60.33
T ₄	66.30	70.63	68.46	71.06	75.39	73.23
T ₅	71.60	75.93	73.77	76.73	81.06	78.90
T ₆	60.90	65.23	63.06	65.22	69.55	67.38
T ₇	63.33	67.66	65.49	67.87	72.20	70.03
T ₈	65.37	69.70	67.54	70.08	74.41	72.24
T ₉	82.51	86.84	84.67	88.41	92.74	90.57
T ₁₀	95.31	99.64	97.48	106.14	110.47	108.30
T ₁₁	76.70	81.03	78.86	82.19	86.52	84.35
T ₁₂	80.39	84.72	82.56	86.13	90.46	88.30
S. Em±	2.21	2.20	2.23	2.40	2.39	2.42
C. D. at 5%	6.64	6.61	6.69	7.21	7.18	7.26

DAS – Days after sowing

<p>T₁: 100% of NPK T₂: 100% of NPK + FYM @ 10 tonnes ha⁻¹ T₃: FYM equivalent to 100% of recommended N T₄: vermicompost equivalent to 100% of recommended N T₅: composted poultry manure equivalent to 100% of recommended N T₆: FYM equivalent to 50% of recommended N + vermicompost equivalent to 50% of recommended N T₇: FYM equivalent to 50% of recommended N + composted poultry manure equivalent to 50% of recommended N</p>	<p>T₈: 50% of recommended N through FYM + 50% of recommended N through inorganic fertilizers T₉: 50% of recommended N through vermicompost + 50% of recommended N through inorganic fertilizers T₁₀: 50% of recommended N through composted poultry manure + 50% of recommended N through inorganic fertilizers T₁₁: 25% of recommended N through FYM + 25% of recommended N through vermicompost + 50% of recommended N through inorganic fertilizers T₁₂: 25% of recommended N through FYM + 25% of recommended N through poultry manure + 50% of recommended N through inorganic fertilizers</p>
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