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Effect of Farmyard Manure and Bio-digester Liquid Manure on Soil Health under Aerobic Rice – Field Bean Cropping Sequence

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A B S T R A C T

Field experiments were conducted from 2010 to 2012 at Zonal Agricultural Research Station, Mandya to study the effect of farmyard manure and bio-digester liquid manure on the performance of aerobic rice – field bean cropping sequence. Soil was red sandy loam in texture, low in organic carbon (0.38 %) and available nitrogen (215.5 kg ha^{-1}), medium in available P_2O_5 (26.2 kg ha^{-1}) and K_2O (162.3 kg ha^{-1}). Significantly higher organic carbon content (0.51 %) after harvest of aerobic rice was found with FYM 12.5 t + BDLME to 150 kg N ha^{-1} and 0.55% with FYM 10 t + BDLME to 35 kg N ha^{-1} after harvest of field bean. Significantly higher available nitrogen (356.2 kg ha^{-1}), P_2O_5 (69.5 kg ha^{-1}) and K_2O (208.0 kg ha^{-1}) after harvest of aerobic rice were noticed by the application of FYM 12.5 t + BDLME to 75 kg N ha^{-1} as compared to recommended practice. Similarly, higher available nitrogen (362.3 kg ha^{-1}), P_2O_5 (87.2 kg ha^{-1}) and K_2O (227.8 kg ha^{-1}) after harvest of field bean were noticed with of FYM 10 t + BDLME to 20 kg N ha^{-1} as compared to recommended practice. Significantly higher population of bacteria (24.2 cfu X 10^5 g^{-1} of soil), fungi (16.4 cfu X 10^3 g^{-1} s of soil) and actinomycetes (11.2 cfu X 10^4 g^{-1} of soil) after harvest of aerobic rice was found with FYM 12.5 t + BDLME to 150 kg N ha^{-1} as compared to the recommended practice but was on par with FYM 12.5 t + BDLME to 125 kg N ha^{-1}. In the same context, higher population of bacteria (25.8 cfu X 10^5 g^{-1} soil), fungi (17.4 cfu X 10^3 g^{-1} soil) and actinomycetes (12.2 cfu X 10^4 g^{-1} soil) after harvest of field bean were found with the application of FYM 10 t + BDLME to 35 kg N ha^{-1} as compared to that of recommended practice but was on par with FYM 10 t + BDLME to 30 kg N ha^{-1} but, was on par with FYM 10 t + BDLME to 30 kg N ha^{-1}.

Introduction

Soil is the medium for life's support system. It is the foundation upon which we rely to sustain us. Out of the soil comes our food, which provides the nutrients that nourish us as individuals and as a civilization. The more we seek to improve long-term soil fertility, the more we are supporting a healthy, well-fed population in the future. Healthy, fertile soils lay the groundwork for a strong and resilient food system. Legumes are wonderful gifts of nature. Their unique ability of biological nitrogen fixation, deep root system, mobilization of insoluble soil nutrients and bringing qualitative changes in soil physical properties makes them as soil fertility restores and thereby benefits the succeeding non leguminous crop (Morey and Bagde, 1982). The practice of cereal – cereal rotation continuously might have an adverse effect on physico-chemical properties and fertility

status of soil. Inclusion of legumes in the rotation improves the soil fertility better than cereal – cereal rotation.

Soil organisms are responsible, to a varying degree depending on the system, for performing vital functions in the soil. Soil organisms make up the diversity of life in the soil. This soil biodiversity is an important but poorly understood component of terrestrial ecosystems. Soil biodiversity is comprised of the organisms that spend all or a portion of their life cycles within the soil or on its immediate surface (including surface litter and decaying logs). Further, soil organisms represent a large fraction of global terrestrial biodiversity. They carry out a range of processes important for soil health and fertility in soils of both natural ecosystems and agricultural systems.

As farmers, we care deeply about the lands that we cultivate and want to keep them fertile for many years to come. However, for the past sixty or so years, our large-scale, "conventional" soil management techniques have largely ignored one the most fundamental requirements of the soil health *i.e*. life in the soil. Keeping these points in view, the field trials were carried out to study the effect of farmyard manure and bio-digester liquid manure on soil health under aerobic rice – filed bean cropping sequence.

Materials and Methods

Field experiments were conducted from 2010 to 2012 at Zonal Agricultural Research Station, Mandya of the University of Agricultural Sciences, Bangalore to study the "Effect of farmyard manure and bio-digester liquid manure on the performance of aerobic rice – field bean cropping sequence". The experimental site is situated between 11^0 30' to 13^0 05' North latitude and 76^0 05' to 77^0 45' East longitude and an altitude of 695 meters above mean sea level. Soil of the experimental site was red sandy loam in texture, low in organic carbon (0.38 %) and available nitrogen (215.5 kg ha^{-1}), medium in available P_2O_5 (26.2 kg ha^{-1}) and K_2O (162.3 kg ha^{-1}).

Representative soil samples from 0 to 30 cm depth were collected from each experimental plot after harvest of every crop. Soil samples thus collected were air dried in shade, powdered with wooden mallet and passed through 2 mm sieve and chemically analyzed for nitrogen, phosphorus, potassium content.

Available nitrogen was determined by alkaline permanganate method as outlined by Subbaiah and Asija (1959). Available phosphorus was determined by Olsen's method as outlined by Jackson (1967). Available potassium was determined by Neutral normal ammonium acetate solution using flame photometer as outlined by Jackson (1967).

Soil samples were collected from the rhizosphere of the plants at harvest. The soil samples collected were placed in a polyethylene bag and brought to laboratory and stored in refrigerator at 5^0 C until used for analysis. Samples were analyzed for different soil micro organism *viz*., total bacteria, total fungi and total actinomycetes using standard dilution plate count technique and plating on specific nutrient media.

Group of microorganism	Media used
Bacteria	Soil Extract Agar
Fungi	Martin's Rose Bengal Agar (MRBA)
Actinomycetes	Kuster's Agar (KA)

Results and Discussion

Soil properties: Significantly higher organic carbon (0.51 %) content after harvest of

aerobic rice was observed with FYM 12.5 t + BDLME to 150 kg N ha^{-1} closely followed by FYM 12.5 t + BDLME to 125 kg N ha^{-1} (0.49 %) and both were superior than recommended practice (FYM 10 t + 100:50:50 N:P_2O_5:K_2O kg ha^{-1}) and other treatments (Table 1). Similarly, significantly higher organic carbon (0.55 %) content after harvest of field bean was observed with FYM 10 t + BDLME to 35 kg N ha^{-1} closely followed by FYM 10 t + BDLME to 30 kg N ha^{-1} (0.52 %) and both were superior than recommended practice (FYM 7.5 t + 25:50:25 N:P_2O_5:K_2O kg ha^{-1}) and other treatments (Table 2). This was mainly attributed to the contribution of carbon to soil through farmyard manure. Naveed *et al.,* (2010) indicated that maximum value of organic matter (1.21 %) was obtained with FYM 40 t ha^{-1} followed by 1.06 per cent with FYM 20 t ha^{-1} against the minimum value (0.93 %) in recommended NPK. Reddy *et al*. (2011) also observed the higher soil organic carbon after harvest of rice where higher doses of FYM and BDLM were applied at Mandya, Naganahally, Bramhavar and Kathalegere. Further, Rajnish and Subhash (2011) observed that soil organic carbon was 13 per cent higher with organic nutrient management (0.907 %) than the inorganic nutrient management (0.803 %). These findings hold well in the present context.

In general, availability of nutrients in soil increased from first to second year of cultivation of both the crops. Significantly higher available nitrogen (356.2 kg ha^{-1}), P_2O_5 (69.5 kg ha^{-1}) and K_2O (208.0 kg ha^{-1}) after harvest of aerobic rice were noticed by the application of FYM 12.5 t + BDLME to 75 kg N ha^{-1} as compared to recommended practice which had lower nutrients (262, 38 and 137) (Table 1). Similarly, higher available nitrogen (362.3 kg ha^{-1}), phosphorus (87.2 kg ha^{-1}) and potassium (227.8 kg ha^{-1}) after harvest of filed bean were noticed with of FYM 10 t + BDLME to 20 kg N ha^{-1} as compared to recommended practice which had 219, 52 and 122 kg ha^{-1}, respectively (Table 2). The increase in available nitrogen content of soil could be ascribed to the increased organic matter and total nitrogen content of soil. This might also be attributed to greater multiplication of soil microbes caused by the addition of organic materials for the conversion of organically bound nitrogen to inorganic form. Nitrogen in organic form is less prone to leaching and volatilization losses. Higher P could be ascribed to the dissolution of native phosphorus compounds by decomposition of FYM.

Besides FYM itself could contribute considerably to this available pool upon mineralization as it contained 0.27 per cent P_2O_5. Higher K could be due to the direct effect of liquid manure and contribution from applied FYM to the soil pool. FYM has been reported to be a direct and ready source of potassium and also helps in minimizing the leaching loss of potassium by retaining potassium ions on exchange sites of the decomposition products. Similar results were also reported by Gopalakrishnan and Palaniappan (1992), Dikshit and Khatik (2002) and Rajshree *et al*., (2005).

Further, the improvement in N, P and K status of soil could be supported by the studies of Gajanana *et al.,* (2005) who indicated that the soil health was sustainable for 25 years in FYM (10 t ha^{-1}) applied plots or integrated plots as compared to only NPK applied plots.

Further, these treatments also recorded higher DTPA extractable Zn, Cu, Mn and Fe contents in the soil as compared to fertilizers only. Reddy *et al.,* (2010) reported that at Mandya and Naganahally, soil nutrients and organic carbon status was improved by the application of FYM and bio-digester liquid manure to rice.

Table.1 Soil properties after harvest of aerobic rice as influenced by FYM and bio-digester liquid manure

Treatments	Organic carbon (%)			Available nitrogen (kg ha^{-1})			Available P_2O_5 (kg ha^{-1})			Available K_2O (kg ha^{-1})		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	0.37	0.39	0.38	262.3	333.3	297.8	48.5	57.8	53.2	164.3	171.7	168.0
T_2	0.38	0.40	0.39	258.3	331.0	294.7	48.0	56.7	52.4	162.0	170.3	166.2
T_3	0.36	0.38	0.37	256.0	325.3	290.7	46.7	55.2	51.0	161.3	168.3	164.8
T_4	0.38	0.41	0.40	280.0	329.7	304.8	45.2	54.5	49.9	158.3	165.0	161.7
T_5	0.37	0.37	0.37	284.0	354.7	319.3	56.8	66.4	61.6	174.3	185.3	179.8
T_6	0.38	0.40	0.39	282.3	350.7	316.5	54.6	64.1	59.4	171.0	181.7	176.3
T_7	0.38	0.42	0.40	275.0	344.0	309.5	54.0	63.9	58.9	170.3	179.0	174.7
T_8	0.39	0.44	0.41	280.3	347.0	313.7	51.2	61.4	56.3	167.0	177.7	172.3
T_9	0.40	0.44	0.42	317.0	395.3	356.2	64.8	74.1	69.5	202.3	213.7	208.0
T_{10}	0.42	0.46	0.44	301.0	379.3	340.2	61.5	71.5	66.5	188.0	198.0	193.0
T_{11}	0.46	0.52	0.49	283.7	342.3	313.0	42.5	51.9	47.2	155.0	161.7	158.3
T_{12}	0.48	0.54	0.51	281.0	337.7	309.3	40.8	50.1	45.5	153.7	160.3	157.0
T_{13}	0.40	0.45	0.42	235.0	289.7	262.3	36.4	39.5	38.0	141.7	132.3	137.0
T_{14}	0.34	0.31	0.33	158.7	64.0	111.0	16.2	3.3	9.8	114.0	48.3	81.2
Initial		0.38			215.5			26.2			162.3	
S.Em±	0.02	0.02	0.02	9.9	12.2	11.0	2.1	1.8	2.0	8.0	7.0	7.4
C.D. at 5%	0.05	0.07	0.06	28.7	35.5	31.1	6.2	5.4	5.6	23.3	20.5	21.0

T_1 : FYM 7.5 t + BDLME to 75 kg N ha^{-1}
T_2 : FYM 7.5 t + BDLME to 100 kg N ha^{-1}
T_3 : FYM 7.5 t + BDLME to 125 kg N ha^{-1}
T_4 : FYM 7.5 t + BDLME to 150 kg N ha^{-1}
T_5 : FYM 10 t + BDLME to 75 kg N ha^{-1}
T_6 : FYM 10 t + BDLME to 100 kg N ha^{-1}
T_7 : FYM 10 t + BDLME to 125 kg N ha^{-1}
T_8 : FYM 10 t + BDLME to 150 kg N ha^{-1}
T_9 : FYM 12.5 t + BDLME to 75 kg N ha^{-1}
T_{10} : FYM 12.5 t + BDLME to 100 kg N ha^{-1}
T_{11} : FYM 12.5 t + BDLME to 125 kg N ha^{-1}
T_{12} : FYM 12.5 t + BDLME to 150 kg N ha^{-1}
T_{13} : FYM 10 t + 100:50:50 kg N:P_2O_5:K_2O ha^{-1}
T_{14} : Absolute control
BDLME - Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure

Table.2 Soil properties after harvest of field bean as influenced by FYM and bio-digester liquid manure

Treatments	Organic carbon (%)			Available nitrogen (kg ha^{-1})			Available P_2O_5 (kg ha^{-1})			Available K_2O (kg ha^{-1})		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	0.38	0.40	0.39	268.7	345.0	306.8	55.1	86.1	70.6	181.3	193.0	187.2
T_2	0.39	0.41	0.40	265.0	340.0	302.5	53.8	85.5	69.7	178.7	188.7	183.7
T_3	0.36	0.39	0.38	263.7	335.3	299.5	52.3	83.9	68.1	176.0	186.3	181.2
T_4	0.39	0.42	0.40	255.3	330.7	293.0	51.8	83.3	67.6	172.7	181.7	177.2
T_5	0.37	0.38	0.38	292.7	371.7	332.2	63.3	94.3	78.8	193.7	209.0	201.3
T_6	0.39	0.42	0.40	287.0	370.3	328.7	60.8	92.2	76.5	191.0	204.7	197.8
T_7	0.40	0.44	0.42	282.0	363.0	322.5	59.7	90.7	75.2	188.3	202.0	195.2
T_8	0.40	0.47	0.44	274.3	359.0	316.7	57.8	89.1	73.5	185.7	197.3	191.5
T_9	0.42	0.48	0.45	321.0	403.7	362.3	70.2	104.3	87.2	220.3	235.3	227.8
T_{10}	0.43	0.50	0.46	308.0	397.0	352.5	68.1	100.4	84.2	206.0	221.0	213.5
T_{11}	0.47	0.56	0.52	250.7	328.0	289.3	49.3	81.6	65.5	170.0	178.7	174.3
T_{12}	0.51	0.59	0.55	244.3	319.3	281.8	47.4	79.1	63.3	167.3	175.3	171.3
T_{13}	0.43	0.47	0.45	198.0	240.3	219.2	38.4	66.5	52.4	125.7	119.0	122.3
T_{14}	0.33	0.27	0.30	110.7	24.3	67.5	10.8	1.9	6.4	82.2	14.2	48.2
S.Em±	0.02	0.02	0.02	7.2	9.0	8.4	2.1	2.3	2.2	8.3	7.6	8.5
C.D. at 5%	0.06	0.07	0.07	21.0	26.1	23.7	6.0	6.6	6.1	24.2	22.1	24.1

T_1 : FYM 5 t + BDLME to 20 kg N ha^{-1}
T_2 : FYM 5 t + BDLME to 25 kg N ha^{-1}
T_3 : FYM 5 t + BDLME to 30 kg N ha^{-1}
T_4 : FYM 5 t + BDLME to 35 kg N ha^{-1}
T_5 : FYM 7.5 t + BDLME to 20 kg N ha^{-1}
FYM - Farmyard manure

T_6 : FYM 7.5 t + BDLME to 25 kg N ha^{-1}
T_7 : FYM 7.5 t + BDLME to 30 kg N ha^{-1}
T_8 : FYM 7.5 t + BDLME to 35 kg N ha^{-1}
T_9 : FYM 10 t + BDLME to 20 kg N ha^{-1}
T_{10} : FYM 10 t + BDLME to 25 kg N ha^{-1}
CFU – Colony Forming Unit

T_{11} : FYM 10 t + BDLME to 30 kg N ha^{-1}
T_{12} : FYM 10 t + BDLME to 35 kg N ha^{-1}
T_{13} : FYM 7.5 t + 25:50:25 kg N:P_2O_5:K_2O ha^{-1}
T_{14} : Absolute control
BDLME - Bio-Digester Liquid Manure Equivalent

Table.3 Population of soil microorganisms after harvest of aerobic rice as influenced by FYM and bio-digester liquid manure

Treatments	Bacteria (cfu x 10^5 g^{-1} of soil)			Fungi (cfu x 10^3 g^{-1} of soil)			Actinomycetes (cfu x 10^4 g^{-1} of soil)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	12.1	14.3	13.2	9.5	11.0	10.3	6.5	7.4	7.0
T_2	13.0	15.5	14.3	10.1	11.6	10.9	6.7	7.8	7.3
T_3	13.3	15.9	14.6	11.2	12.5	11.9	7.2	7.9	7.6
T_4	13.6	16.5	15.1	11.7	13.1	12.4	7.3	8.3	7.8
T_5	14.1	17.0	15.6	11.9	13.3	12.6	7.4	8.7	8.1
T_6	14.3	17.4	15.8	12.3	13.9	13.1	7.7	8.9	8.3
T_7	15.8	18.6	17.2	12.5	14.5	13.5	8.1	9.3	8.7
T_8	16.3	20.7	18.5	12.7	14.5	13.6	8.4	9.7	9.1
T_9	18.5	21.4	20.0	13.1	14.8	14.0	8.5	10.0	9.3
T_{10}	19.4	22.8	21.1	13.2	15.1	14.2	8.8	10.3	9.5
T_{11}	21.3	24.9	23.1	14.8	16.7	15.8	9.9	11.5	10.7
T_{12}	22.5	25.8	24.2	15.2	17.5	16.4	10.2	12.1	11.2
T_{13}	11.7	12.2	11.9	8.9	9.5	9.2	6.2	6.7	6.4
T_{14}	9.2	7.2	8.2	4.9	4.0	4.5	3.9	3.3	3.6
Initial		11.2			8.6			6.1	
S.Em±	0.8	0.7	0.8	0.5	0.6	0.6	0.4	0.4	0.5
C.D. at 5%	2.2	2.2	2.2	1.4	1.7	1.6	1.0	1.2	1.4

T_1 : FYM 7.5 t + BDLME to 75 kg N ha^{-1}
T_2 : FYM 7.5 t + BDLME to 100 kg N ha^{-1}
T_3 : FYM 7.5 t + BDLME to 125 kg N ha^{-1}
T_4 : FYM 7.5 t + BDLME to 150 kg N ha^{-1}
T_5 : FYM 10 t + BDLME to 75 kg N ha^{-1}
T_6 : FYM 10 t + BDLME to 100 kg N ha^{-1}
T_7 : FYM 10 t + BDLME to 125 kg N ha^{-1}
T_8 : FYM 10 t + BDLME to 150 kg N ha^{-1}
T_9 : FYM 12.5 t + BDLME to 75 kg N ha^{-1}
T_{10} : FYM 12.5 t + BDLME to 100 kg N ha^{-1}
T_{11} : FYM 12.5 t + BDLME to 125 kg N ha^{-1}
T_{12} : FYM 12.5 t + BDLME to 150 kg N ha^{-1}
T_{13} : FYM 10 t + 100:50:50 kg N:P_2O_5:K_2O ha^{-1}
T_{14} : Absolute control
BDLME - Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure
CFU – Colony Forming Unit

Table.4 Population of soil microorganisms after harvest of field bean as influenced by FYM and bio-digester liquid manure

Treatments	Bacteria (cfu x 10^5 g^{-1} of soil)			Fungi (cfu x 10^3 g^{-1} of soil)			Actinomycetes (cfu x 10^4 g^{-1} of soil)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	13.6	15.7	14.7	10.6	12.1	11.4	7.1	8.1	7.6
T_2	14.4	16.5	15.5	11.0	12.8	11.9	7.2	8.5	7.9
T_3	14.7	17.0	15.9	12.1	13.5	12.8	7.6	8.6	8.1
T_4	15.3	17.8	16.5	12.5	14.3	13.4	7.7	9.1	8.4
T_5	15.8	18.6	17.2	12.8	14.4	13.6	7.8	9.5	8.7
T_6	15.8	19.0	17.4	13.2	14.9	14.1	8.4	9.8	9.1
T_7	17.3	20.1	18.7	13.7	15.3	14.5	8.8	10.4	9.6
T_8	19.5	22.1	20.8	13.8	15.6	14.7	9.2	10.5	9.8
T_9	20.1	22.8	21.4	14.2	15.9	15.0	9.3	11.0	10.2
T_{10}	21.4	24.1	22.8	14.8	16.2	15.5	9.5	11.1	10.3
T_{11}	23.8	26.0	24.9	15.9	17.7	16.8	10.8	12.4	11.6
T_{12}	24.5	27.2	25.8	16.6	18.2	17.4	11.1	13.3	12.2
T_{13}	13.0	11.5	12.3	10.2	9.1	9.7	7.0	6.4	6.7
T_{14}	8.5	6.5	7.5	4.4	3.7	4.1	3.6	3.0	3.3
S.Em±	0.82	0.82	0.83	0.44	0.64	0.64	0.30	0.64	0.50
C.D. at 5%	2.40	2.38	2.36	1.28	1.85	1.82	0.86	1.86	1.42

T_1 : FYM 5 t + BDLME to 20 kg N ha^{-1}
T_2 : FYM 5 t + BDLME to 25 kg N ha^{-1}
T_3 : FYM 5 t + BDLME to 30 kg N ha^{-1}
T_4 : FYM 5 t + BDLME to 35 kg N ha^{-1}
T_5 : FYM 7.5 t + BDLME to 20 kg N ha^{-1}
T_6 : FYM 7.5 t + BDLME to 25 kg N ha^{-1}
T_7 : FYM 7.5 t + BDLME to 30 kg N ha^{-1}
T_8 : FYM 7.5 t + BDLME to 35 kg N ha^{-1}
T_9 : FYM 10 t + BDLME to 20 kg N ha^{-1}
T_{10} : FYM 10 t + BDLME to 25 kg N ha^{-1}
T_{11} : FYM 10 t + BDLME to 30 kg N ha^{-1}
T_{12} : FYM 10 t + BDLME to 35 kg N ha^{-1}
T_{13} : FYM 7.5 t + 25:50:25 kg N:P_2O_5:K_2O ha^{-1}
T_{14} : Absolute control
BDLME - Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure
CFU – Colony Forming Unit

While, at Kathalagere, application of FYM 7.5 t ha^{-1} + cattle urine (equivalent to 75 kg N ha^{-1}) had significantly higher available nitrogen, phosphorus and potassium (293, 27 and 216 kg ha^{-1}, respectively) as compared to recommended practice (FYM 10 t +100:50:50 NPK kg ha^{-1}) (272, 21 and 182) after harvest of rice. Hanumathappa *et al*., (2012) in coastal zone of Bramhavar, found that application of FYM 10 t ha^{-1} + cattle urine equivalent to 75 kg ha^{-1} increased the soil organic carbon, available phosphorus and potassium (1.19 %, 296 kg ha^{-1} and 195 kg ha^{-1}, respectively) as compared to initial status (0.55, 180 and 135). Surekha *et al.*, (2011) found that, there was an increase in soil organic carbon, available N, P and K by 28, 7, 21, and 21 per cent with organics as compared to inorganics at the end of fourth year.

Soil microbial population

Significantly higher population of bacteria (24.2 cfu X 10^5 g^{-1} of soil), fungi (16.4 cfu X 10^3 g^{-1} s of soil) and actinomycetes (11.2 cfu X 10^4 g^{-1} of soil) after harvest of aerobic rice was found with FYM 12.5 t + BDLME to 150 kg N ha^{-1} as compared to the recommended practice but was on par with FYM 12.5 t + BDLME to 125 kg N ha^{-1} (Table 3). In the same context, higher population of bacteria (25.8 cfu X 10^5 g^{-1} soil), fungi (17.4 cfu X 10^3 g^{-1} soil) and actinomycetes (12.2 cfu X 10^4 g^{-1} soil) after harvest of field bean were found with the application of FYM 10 t + BDLME to 35 kg N ha^{-1} as compared to that of recommended practice but was on par with FYM 10 t + BDLME to 30 kg N ha^{-1} but, was on par with FYM 10 t + BDLME to 30 kg N ha^{-1} (Table 4).

The possible reason for relatively higher rate of multiplication of bacteria in FYM treated plot is that as FYM acted as organic substrate for stimulation of bacterial growth. Moreover, in the present investigation, the population of bacteria, fungi and actinomycetes were higher under field bean than under aerobic rice crop. This might be due to the fact that as field bean is a legume component which is known to release a part of unused NO_3 fixed through symbiotic nitrogen fixation into the soil and also a lot of low molecular weight organic compounds are released to the soil as exudates. These serve as a substrate to soil microbes and their population builds-up in the soil (Masood Ali *et al*., 2002). These results are in conformity with findings of Badole and More (2001) who reported that application of FYM 25 t ha^{-1} recorded higher population of *Rhizobium, Azatobactor,* fungi, actinomycetes, PSB and bacteria (10.5 x 10^3, 0.38 x 10^3, 6.7 x 10^3, 14.9 x 10^4, 29.1 x 10^4 and 62.5 x 10^4 cells g^{-1} soil, respectively) as compared to control treatment.

Field trials at Kathalagere revealed that population of total bacteria (63.6 x 10^6 cfu g^{-1} soil), fungi (34 x 10^4 cfu g^{-1} soil), actinomycetes (53.7 x 10^4 cfu g^{-1} soil), nitrogen-fixers (59.2 x 10^5 cfu g^{-1} soil) and P-solublizers (51.9 x 10^5 cfu g^{-1} soil) were maximum with FYM 12.5 t ha^{-1} + cattle urine (equivalent to 125 kg N ha^{-1}) and minimum of the same was found with recommended practice (FYM 10 t +100:50:50 NPK kg ha^{-1}). Similarly, at the end of third year of organic farming in Naganahally, phenomenal increment in the population of *Rhizobium*, *Azotobactor*, *Azospirillum* and PSB's in irrigated soils was observed. Mean increase in *Rhizobium* from 0.4 to 3.4 cfu x 10^6 per g soil. Similarly, *Azotobactor*, *Azospirillum* and PSB's increment was 0.8 to 2.2, 2.1 to 3.1 and 1.7 to 3.9 cfu x 10^6 per g soil, respectively (Reddy *et al.*, 2010 and 2011). Further, in 30 years farming system trial at Rodale institute, USA, the soil health was highly improved in terms of soil aggregation, porosity, water holding capacity, nutrient balance and soil microbial biomass (*Anon*., 2011).

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