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Response of FYM and Bio Digester Liquid Manure (BDLM) on Productivity and Soil Properties of Finger Millet [*Eleusine coracana* (L.) Gaertn] under Dryland Condition

B. G. Vasanthi, Mudalagiriyappa, K. M. Puneetha, M. C. Harish and M. Madan Kumar
All India Co-ordinated Research Project for Dryland Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : mudal68@yahoo.com

Authors Contribution

B. G. Vasanthi : Investigation and drafting;
Mudalagiriyappa : Monitoring and reviewing;
K. M. Puneetha & M. Madan Kumar : Preparation of manuscript and review;
M. C. Harisha : Chemical analysis

Corresponding Author :
B. G. Vasanthi
All India Co-ordinated Research Project for Dryland Agriculture, UAS, GKVK, Bengaluru

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Abstract

A field experiment was carried out at ARS, Balajigapade in reddish brown sandy loam soil during *kharif*-2019 to study the 'Response of FYM and Bio digester liquid manure (BDLM) on productivity and soil properties of finger millet (*Eleusine coracana* (L.) Gaertn) under dryland condition'. The experiment was laid out in Factorial Randomised Block Design consisted of two different factors of organic manures *viz.*, FYM and BDLM applied at three different levels, nine treatments were replicated thrice. The results showed that among different levels of FYM application, application of FYM 10 t ha^{-1} gives significantly higher grain (3148 kg ha^{-1}) and straw yield (4458 kg ha^{-1}) and was on par with FYM 7.5 t ha^{-1}, whereas application of different levels of BDLM alone did not have significant implication on yield of finger millet. however significant effect on higher soil available nutrients *viz*, N, P, K, Ca, Mg, Mn, Fe and Cu and soil enzymatic activities was also recorded with conjugate application of FYM 10 t ha^{-1} (M3) and BDLM @ 125 per cent N equivalent.

Keywords : : FYM, Bio-digester liquid manure, Finger millet

Finger millet (*Eleusine coracana* L.) is one among the foremost important millet grown for both grain and fodder purpose and ranks third in importance among millets in India after sorghum and pearl millet. Finger millet is not only a major food grain crop but also an excellent fodder for cattle. The recent energy crisis, hike in the prices of the inorganic fertilizers and declining soil health and productivity requires the use of organic manures compulsorily in agricultural crop production. Use of chemical fertilizers has not only increased the crop yields but has caused many environmental hazards like soil, air and water pollution finally human health hazards, thereby making the crop productivity unsustainable. The increasing costs of fertilizers prevent their use by resource poor farmers.

Organic farming is the most effective approach to address all these concerns and the consumers need. It is resource conserving and helps to maintain soil health and fertility. With increasing hazards by using the synthetic chemicals in agro ecosystems, organic farming provides an alternative option for both sustaining productivity and retaining soil health with chemical residue free food. Today, organic farming is a well-researched science that combines the knowledge of soil fertility, plant pathology, entomology and other biological and environmental sciences. It does not use the non-renewable external inputs and energy. Since, no chemical are used for crop production there are low chances of pesticide residues in food. The decrease in cattle population in recent years and utilization of agricultural wastes into valuable by-products has made the availability of organic manure in agriculture questionable both in time and quantity.

In this context depletion of soil health, which results in decline or stagnation in yield of many staple food crops, the use of organics plays a predominant role in sustaining the soil fertility, besides offering avenue for converting wastes into wealth by effective recycling. Addition of organics will provide dual benefit of improving tropical soil by adding nutrients and improving soil moisture retention overall enhancing soil physical and biochemical properties. Greater opportunities exist for increased crop production by increasing the rate, timing and by improving management of mineral fertilizers (Ramachandrappa *et. al.,* 2013).

Farmyard manure is the most commonly used organic manure in India. It consists of a mixture of cattle shed wastes containing dung, urine, bedding material and some left-over straw and feeding wastes. The nutrient content of FYM varies with the constituents or composition of different organic materials used for its production.

Non-availability of sufficient quantity of farmyard manures has drawn the attention of many researchers and cultivators to utilize the on-farm wastes, green biomass of *Glyricidia maculata, Pongamia pinnata etc.* and ubiquitous weeds *viz., Parthenium histirophorous*, *euphotorium*, lantana, calatropis, *etc*., for biodigested liquid manure production can substitute the farmyard manure and compost (Ananda and Sharanappa., 2017).

Bio digester Liquid Manure (BDLM) is the low cost on farm input, capable of supplying the nutrients for the growing crop. It is prepared by mixing organic residues like cattle wastes, weed biomass, crop residues *etc.,* in large quantity which is allowed to ferment in the bio digester tank for mineralization. Within 20-30 days this liquid manure can be used as nutrient source. It is not only a good source of macro and micro nutrients to crop but also adds enormous beneficial microbial load to soil (Reddy *et al.,* 2008).

Liquid bio-digester manure has been used for finger millet, paddy, maize, redgram, groundnut, soybean, field bean and other crops along with the compost. High crop productivity and improved soil health are noticed with the application of BDLM alone or conjugation with FYM. Hence an investigation was carried out to study the efficacy of bio digested liquid manures on the yield potential of finger millet and its effect on soil properties.

Material and Methods

A field experiment was under taken at ARS, Balajigapade, during *Kharif* 2019 to study the 'Response of farm yard manure (FYM) and Bio-digester liquid manure (BDLM) on productivity and soil properties of finger millet (*Eleusine coracana* (L.) Gaertn) under dryland condition'. The experiment was laid out in a Factorial Randomized Complete Block Design consisting of nine treatments *i.e.,* T_1: 5 t ha^{-1} FYM + BDLM @ 75% N equivalent, T_2: 5 t ha^{-1} FYM + BDLM @ 100% N equivalent, T_3: 5 t ha^{-1} FYM + BDLM @ 125% N equivalent, T_4: 7.5 t ha^{-1} FYM + BDLM @ 75% N equivalent, T_5: 7.5 t ha^{-1} FYM+ BDLM @ 100% N equivalent, T_6: 7.5 t ha^{-1} FYM + BDLM @ 125% N équivalent, T_7: 10 t ha^{-1} FYM + BDLM @ 75% N equivalent, T_8: 10 t $^{-1}$ FYM+ BDLM @ 100% N equivalent, T_9: 10 t ha^{-1} FYM + BDLM @ 125% N equivalent, replicated thrice.

The initial soil sample was analyzed for various physical and chemical parameters by adopting standard procedures. The soil pH was neutral (7.59) and the electrical conductivity was normal (0.12 dSm-1). The organic carbon content was low (0.24%). The soil was low in available nitrogen (148.17 kg ha^{-1}), high in phosphorus (80.34 kg ha^{-1}), medium in potassium (175.8 kg ha^{-1}) and available sulphur (21.56 kg ha^{-1}) status.

Bio-digested liquid manure and FYM were analyzed initially for its chemical composition by adopting standard procedures. BDLM and FYM were applied to the experimental plots as per the treatments. The required quantity of liquid manures based on Nitrogen equivalent was applied to the soil. Liquid manures were applied in two equal splits at 15 and 45 days after sowing. Thinning and gap filling was done 15 days after sowing, to ensure uniform plant population and to maintain single plant at 10 cm apart. Two hand weeding and two inter- cultivations were carried out in order to keep the plots free from weed competition and to form soil mulch.

The observations *viz,* grain yield, straw yield, soil nutrient status after harvest and enzymatic activities were carried out, surface soil samples (0-15 cm) depth and plant samples were collected from each replication and each treatment. The analysis and interpretation of the data was carried out using Fisher's method of analysis technique (Gomez and Gomez, 2010). For computing the economics, different variable cost items were considered. The cost includes expenditure on land preparation, seeds, manures, fertilizers and labour charges as per calculated at prevailing market prices at the time of their use. Labour requirement was worked out on the basis of number of labours engaged for conducting different field operations.

Results and Discussion

Grain and Straw Yield of Finger Millet as Influenced by Application of Farm Yard Manure (FYM) and Enriched Bio-Digester Liquid Manure (BDLM) at Three Different Levels

Data pertaining to grain and straw yield of finger millet as influenced by application of farmyard manure and enriched bio-digester liquid manure is furnished in Table 1, Fig. 1 and Fig. 2. Results revealed that

Table 1

Influence of FYM and bio-digester liquid manure on productivity and economics of finger millet

Treatment	Grain yield	Straw yield	COC	Net return	B:C
	kg ha^{-1}		Rs ha^{-1}		
Level of FYM					
M1 : 5 t ha^{-1} FYM	2311	3268	25526	51017	3.00
M2 : 7.5 t ha^{-1} FYM	2831	3735	29337	64027	3.18
M3 : 10 t ha^{-1} FYM	3148	4458	33126	71149	3.15
S. Em. ±	134.13	194.09			
CD (p=0.05)	402.12	581.89			
Levels of BDLM					
B1: BDLM @ 75% N equivalent	2607	3695	28270	58090	3.05
B2: BDLM @ 100% N equivalent	2810	3790	29348	63447	3.16
B3: BDLM @ 125% N equivalent	2873	3976	30370	64657	3.13
S. Em. ±	134.13	194.09			
CD (p=0.05)	NS	NS			
Interactions					
M_1B_1	2204	3186	24470	48633	2.99
M_1B_2	2322	3280	25537	51360	3.01
M_1B_3	2408	3339	26570	53096	3.00
M_2B_1	2542	3473	28270	55742	2.97
M_2B_2	2958	3595	29370	67731	3.31
M_2B_3	2992	4136	30370	68575	3.26
M_3B_1	3075	4426	32070	69883	3.18
M_3B_2	3150	4454	33137	71256	3.15
M_3B_3	3218	4495	34170	72280	3.12
S. Em. ±	232.32	336.18			
CD (p=0.05)	696.48	NS			

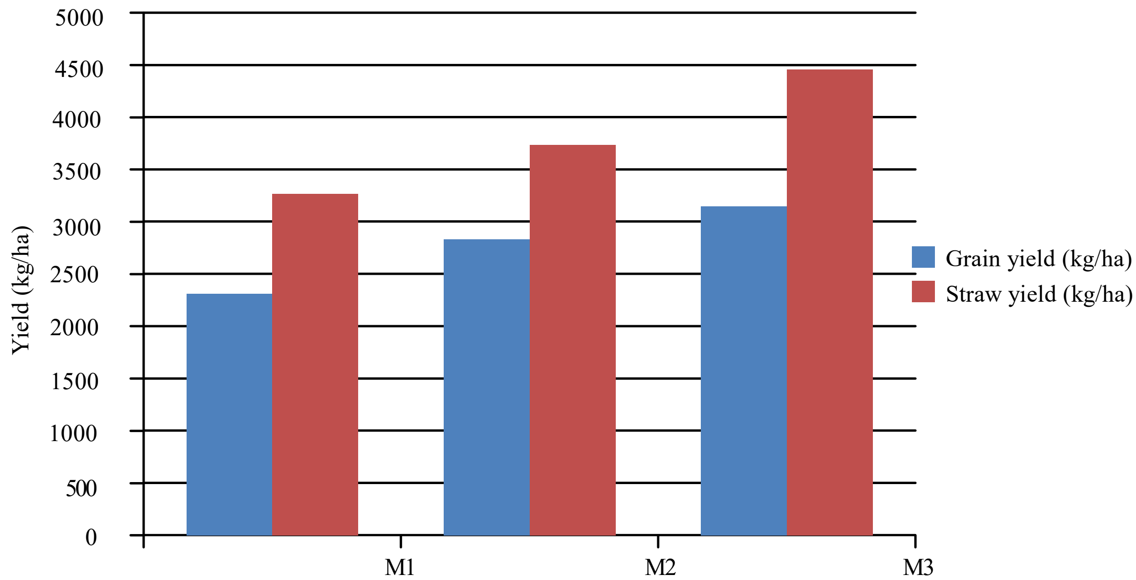

Fig. 1 : Influence of FYM on grain and straw yield of finger millet

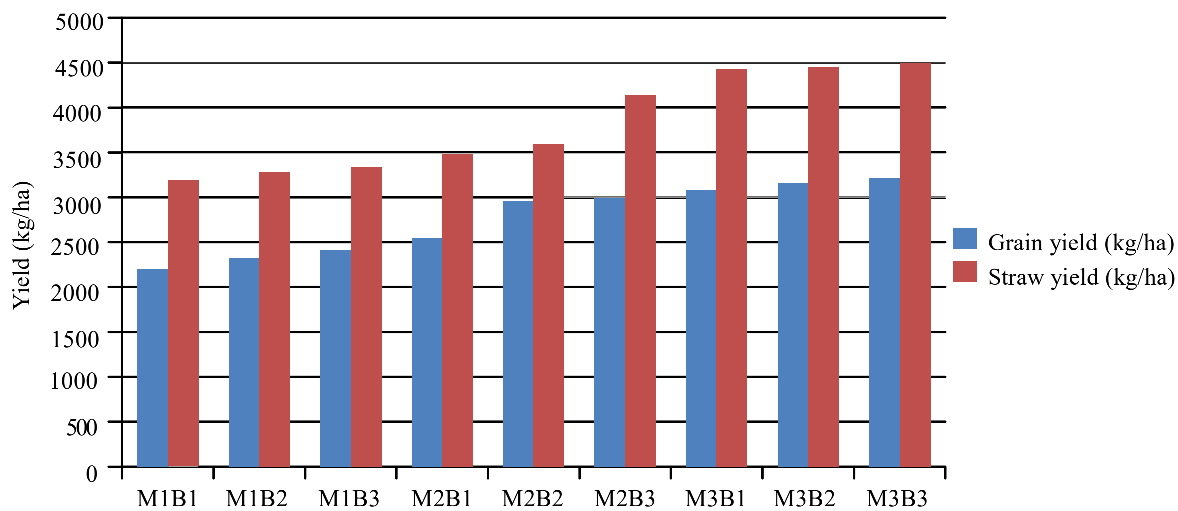

Fig. 2 : Influence of FYM and bio digester liquid manure on grain and straw yield of finger millet

among different levels of FYM application significantly higher grain yield (3148 kg ha^{-1}) was recorded with M_3 : 10 t ha^{-1} FYM over M_1 : 5 t ha^{-1} FYM and it was on par with M_2 : 7.5 t ha^{-1} FYM, while significantly higher straw yield (4458 kg ha^{-1}) was recorded in M_3 : 10 t ha^{-1} FYM. However there was no significant difference w.r.t grain and straw yield among different levels of BDLM application but relatively higher grain and straw yield (2873 kg ha^{-1} and 3976 kg ha^{-1} respectively) was recorded in B_3: BDLM @ 125 per cent N equivalent.

There was significant interaction between different levels of FYM and BDLM application. Significantly higher grain yield was recorded with application of 10 t ha^{-1} FYM and BDLM @ 125 per cent N equivalent (M_3B_3) and was on par with M_3B_2.

The increase in yield was attributed due to slow and steady rate of nutrient release into soil solution which matched with the absorption pattern by finger millet. Farm yard manure which supplies nitrogen, phosphorus and potassium in available forms to the plants through microbial decomposition, might have improved the plant growth parameters like plant height, number of tillers hill-1 and weight of the grains which eventually led to higher yield. This is in agreement with the findings of (Singh *et al*., 2019). Enriched bio-digester liquid manures supplies secondary and micro nutrients along with N, P and K and also acted as growth promoters which helped to enhance the yield (Ananda *et al*., 2017). This could also be attributed to the higher availability of NPK during crop growth period which might have improved the plant height, number of tillers and also due to higher enzymatic activity which helped in nutrient release and uptake by the crop eventually increases the straw yield (Monisha *et al*., 2019). The combined application of FYM and BDLM enhanced the microbial population in the rhizosphere and increased efficiency of crop production by nourishing and fortifying the host plant with required nutrients (Nuti and Giovannetti, 2015).

Economics of Finger Millet Influenced by Application of Farm Yard Manure (FYM) and Enriched Bio-Digester Liquid Manure (BDLM) at three different Levels

Data pertaining to economics of finger millet as influenced by different levels of farmyard manure and enriched bio-digester liquid manure is furnished in Table 1 among different levels of FYM application higher net returns (71149 Rs. ha^{-1}) was recorded in M_3: 10 t ha^{-1} FYM, while higher B:C ratio (3.18) was recorded with M_2 : 7.5 t ha-1 FYM. The higher B:C ratio and higher net returns might be due to lower cost of cultivation, higher benefit: cost ratio was the consequence of gross returns and cost of cultivation.

With respect to different levels of BDLM application higher net returns (64657 Rs. ha^{-1}) was recorded with B_3: BDLM @ 125 per cent N equivalent, while higher B:C ratio (3.16) was recorded with B_2:BDLM @ 100 per cent N equivalent.

Conjugate use of FYM and BDLM showed higher net returns (72280 Rs. ha^{-1}) was observed with application of 10 t ha^{-1} FYM and BDLM @ 125 per cent N equivalent (M_3B_3), while higher B : C ratio (3.31) was recorded with application of 7.5 t ha^{-1} FYM and BDLM @ 100 per cent N equivalent (M_2B_2) which was closely followed by (M_2B_3). Similar trend was observed w.r.t grain yield of finger millet where conjuctive use of both FYM and BDLM resulted in higher yield than application of only FYM or BDLM alone which is very well reflected in economics also.

Chemical Properties of Soil as Influenced by Application of Farm Yard Manure (FYM) and Enriched Bio-Digester Liquid Manure (BDLM) at Three Different Levels on Finger Millet

Data pertaining to soil nutrient status of finger millet as influenced by farmyard manure and enriched bio-digester liquid manures furnished in Table 2 and Table 3.

TABLE 2

Effect of FYM and bio digester liquid manure on soil primary nutrient status of finger millet

Treatment	pH 1:2.5	EC dSm^{-1}	OC %	Av. N	Av. P	Av. K
					kg ha^{-1}	
Level of FYM						
Initial	5.61	0.031	0.50	148.17	80.34	175.26
M1 : 5 t ha^{-1} FYM	5.65	0.043	0.53	153.93	89.17	182.92
M2 : 7.5 t ha^{-1} FYM	5.67	0.038	0.55	160.65	92.85	208.63
M3 : 10 t ha^{-1} FYM	5.66	0.041	0.58	173.87	96.43	219.49
S. Em. ±	0.07	0.001	0.01	2.22	1.11	1.11
CD (p=0.05)	NS	NS	NS	6.66	3.33	3.33

Treatment	pH 1:2.5	EC dSm^{-1}	OC %	Av. N	Av. P	Av. K
					kg ha^{-1}	
Levels of BDLM						
B1: BDLM @ 75% N equivalent	5.61	0.036	0.54	155.9	89.17	185.1
B2:: BDLM @ 100% N equivalent	5.65	0.043	0.55	163.7	92.85	201.6
B3: BDLM @ 125% N equivalent	5.73	0.043	0.57	168.8	96.43	224.3
S. Em. ±	0.07	0.002	0.01	2.22	1.11	1.11
CD (p=0.05)	NS	0.01	NS	6.66	3.33	3.33
Interactions						
M_1B_1	5.54	0.033	0.50	145.39	82.27	166.9
M_1B_2	5.69	0.047	0.54	154.90	89.81	175.5
M_1B_3	5.72	0.050	0.56	161.51	95.83	206.3
M_2B_1	5.78	0.040	0.54	156.67	91.63	191.3
M_2B_2	5.54	0.040	0.54	160.92	93.94	212.4
M_2B_3	5.69	0.033	0.56	164.35	95.90	222.2
M_3B_1	5.51	0.033	0.57	165.58	93.61	197.2
M_3B_2	5.71	0.043	0.58	175.36	94.79	216.8
M_3B_3	5.77	0.05	0.60	180.67	97.57	244.5
S. Em. ±	0.04	0.004	0.03	3.85	1.93	1.92
CD (p=0.05)	NS	NS	NS	11.53	5.77	5.77

TABLE 3

Effect of FYM and bio-digester liquid manure on soil secondary and micronutrient nutrient status

Treatments	Ca	Mg	Fe	Mn	Cu
	mg g^{-1}			ppm	
Level of FYM					
M1 : 5 t ha^{-1} FYM	2.42	1.32	16.54	28.70	1.97
M2 : 7.5 t ha^{-1} FYM	2.52	1.39	16.84	33.07	2.11
M3 : 10 t ha^{-1} FYM	2.51	1.48	17.35	35.19	2.30
S. Em. ±	0.10	0.05	0.29	1.06	0.14
CD (p=0.05)	NS	NS	NS	3.18	NS
Levels of BDML					
B1: BDLM @ 75% N equivalent	2.39	1.29	16.70	31.03	2.04
B2:: BDLM @ 100% N equivalent	2.49	1.40	16.89	32.50	2.14
B3: BDLM @ 125% N equivalent	2.58	1.50	17.13	33.44	2.20
S. Em. ±	0.10	0.05	0.29	1.06	0.14
CD (p=0.05)	NS	0.16	NS	NS	NS

Treatments	Ca	Mg	Fe	Mn	Cu
	mg g^{-1}		ppm		
Interactions					
M_1B_1	2.37	1.23	16.56	27.23	1.91
M_1B_2	2.40	1.33	16.69	28.84	1.96
M_1B_3	2.50	1.40	16.36	30.04	2.04
M_2B_1	2.40	1.27	16.56	31.49	1.99
M_2B_2	2.57	1.40	16.65	33.48	2.12
M_2B_3	2.60	1.50	17.30	34.24	2.22
M_3B_1	2.40	1.37	16.99	34.36	2.23
M_3B_2	2.50	1.47	17.34	35.17	2.33
M_3B_3	2.63	1.60	17.73	36.04	2.33
S. Em. ±	0.17	0.09	0.50	1.84	0.24
CD (p=0.05)	NS	0.28	NS	NS	NS

The results revealed that the conjunctive use of different levels of FYM and BDLM did not show significant effect on soil pH, electrical conductivity (EC) and organic carbon status of soils after the harvest of finger millet crop.

However, soil available nutrients after harvest of the crop w.r.t. different levels of FYM application showed significantly higher available nutrients, Nitrogen (173.87 kg ha-1), Phosphorous(96.43kg ha-1), Potassium (219.49 kg ha^{-1}) and manganese (35.19 ppm) content with application of FYM@ 10 t ha^{-1} (M3) but for secondary nutrients like Ca and Mg the result was found non-significant. Among different levels of BDLM application significantly higher available nitrogen (168.8kg ha^{-1}), phosphorous (96.43 kg ha^{-1}), potassium (224.30kg ha^{-1}) and calcium (1.50 mg kg^{-1}) were recorded with application of BDLM @ 125 per cent N equivalent (B_3) but magnesium content of soil did not show significant difference. Significantly higher available Nitrogen (180.67 kg ha^{-1}), Phosphorous (67.57 kg ha^{-1}) and Potassium (244.50 kg ha^{-1}) were recorded with application of 10 t ha^{-1} and BDLM @ 125 per cent N equivalent, while the secondary nutrients (Ca) and micronutrients (Fe, Mn and Cu) interaction was non- significant except for magnesium which was significantly higher in its availability (1.60 mg kg^{-1}) in M_3B_3. (10 t ha^{-1} FYM + BDLM @ 125 per cent N equivalent)

This may be attributed to the fact that nutrient status of post harvest soil sample is dependent on both supply of nutrients through various sources. The increase in available nutrients may be due to the effect of application of enriched of bio- digested liquid manure with microbial consortia that was more pronounced in increasing the post-harvest soil available nutrients. Application of organic manures at higher dose than the recommendation improved the N, P and K status of soil. It was mainly due to mineralization of nitrogen from organic manures through increased activity of soil microorganisms. Sudheendra Saunshi *et al*. (2014). This might also be due to slow and steady release of nutrients from FYM and enriched BDLM application. These results corroborate with the findings of Suresh Naik, 2011 and Manjunath, 2010. Higher nutrient availability due to enhanced microbial activity lead to mineralization and release of nutrients matching with crop demand and better uptake of nutrients by providing favourable environment.

Effect of Application of Farm Yard Manure (FYM) and Enriched Bio-Digester Liquid Manure (BDLM) On Soil Enzymatic Activities In Finger Millet Production

Data pertaining to soil enzymatic activity as influenced by application of farmyard manure and enriched bio-digester liquid manure is furnished in Table 4.

TABLE 4

Effect of FYM and bio-digester liquid manure on soil enzymatic activity under finger millet production in dryland condition

Treatments	Dehydrogenase (µg TPF/g per 24 hr)	Acid phosphatase µg PNP/g soil)	Alkaline phosphatase µg PNP/g soil)	Urease (µg NH4/ g soil/hr)
Level of FYM				
M1 : 5 t ha-1 FYM	50.00	30.88	15.07	21.60
M2 : 7.5 t ha-1 FYM	56.95	36.64	17.60	24.93
M3 : 10 t ha-1 FYM	58.91	38.98	19.16	26.86
S. Em. ±	1.21	0.09	0.06	0.43
CD (p=0.05)	3.63	0.27	0.19	1.29
Levels of BDLM				
B1: BDLM @ 75% N equivalent	50.17	32.14	16.01	22.06
B2:: BDLM @ 100% N equivalent	57.22	36.17	17.26	24.96
B3: BDLM @ 125% N equivalent	58.47	38.19	18.55	26.37
S. Em. ±	1.21	0.09	0.06	0.43
CD (p=0.05)	3.63	0.27	0.19	1.29
Interactions				
M1B1	45.94	27.81	14.27	18.48
M1B2	51.81	31.74	15.26	23.11
M1B3	52.25	33.09	15.66	23.22
M2B1	52.09	31.67	15.88	23.18
M2B2	59.16	37.97	17.34	25.02
M2B3	59.59	40.30	19.57	26.60
M3B1	52.48	36.93	17.87	24.53
M3B2	60.68	38.81	19.18	26.76
M3B3	63.59	41.19	20.42	29.30
S. Em. ±	2.10	0.16	0.11	0.75
CD (p=0.05)	NS	0.47	0.33	NS

10 t ha^{-1} FYM + BDLM @ 125% N equivalent

5 t ha^{-1} FYM + BDLM @ 75% N equivalent

General view of the experiment

Among different levels of FYM application, 10 t of FYM application per ha (M_3) resulted in significantly higher soil enzymatic activity *viz,* dehydrogenase, acid phosphatase, alkaline phosphatase and urease (58.91 µg TPF/g per 24 hr, 38.98 µg PNP/g soil, 19.16 µg PNP/g soil and 26.86 µg PNP/g soil respectively), among different levels of BDLM application significantly higher soil enzymatic activity of dehydrogenase (58.47 µg TPF/g per 24 hr), acid phosphatase (38.19 µg PNP/g soil), alkaline phosphatase (18.55 µg PNP/g soil) and urease (26.37 µg PNP/g soil was recorded with application of BDLM @ 125 per cent N equivalent.

Among interactions significantly higher soil enzymatic activity of acid phosphatase (49.19 µg PNP/g soil) and alkaline phosphatase (20.42 µg PNP/g soil) observed with M_3B_3 (10 t ha^{-1} FYM + BDLM @ 125 per cent N equivalent).

Enzymes play a key role in biochemical process of organic matter decomposition in soil. Enzymatic activity in soil is considered as an index of microbial activity, which is influenced by nature, age of crop and addition of fertilizers and manures. Soil quality refers to a soil's ability to sustain productivity in terms of agricultural production. The activities of soil hydrolytic enzymesis a common approach for estimating soil quality (Gil-Sotres *et al*., 2005). The dehydrogenase activity is proposed as the best indicator of microbiological redox system, which is considered as good and adequate parameter of microbial oxidative action in soil. The increase in soil organic matter content, resulting from the application of compost, in addition to the incorporation of stable enzymes contained in the compost (Díaz-Marcote and Polo 1995), favors the formation of complexes with free enzymes and therefore, the soil enzyme activities increase. Soil dehydrogenase activity reflects the total range ofoxidative activity of soil microflora and is consequently used as an indicator of microbial activity (Masciandaro *et al*. 1994 and Perucci 1992). The study by Smith and Powlson (2003) showed that the presence of added nitrogen source acts as readily available N pool stimulates the urease activity; there is a significant linear correlation between dehydrogenase and urease activities and soil organic matter contents.

In conclusion considering the above findings application of 10 t of FYM ha^{-1} (M_3) resulted in significantly higher grain yield (3148 kg ha^{-1}) and it was on par with M_2 : 7.5 t ha^{-1} FYM. Higher straw yield (4458 kg ha^{-1}) which fetched more profit was obtained with application of 7.5 t of FYM ha^{-1} to reduce the cost of cultivation. It might be due to improved plant growth characters like plant height, number of tillers hill-1, weight of the grains and also due to increased soil enzymatic activities which enhances the steady rate of nutrient release into soil solution to match the absorption pattern of finger millet which eventually led to higher yield.

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