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Effect of bio enriched FYM on growth, yield and economics of finger millet (*Eleusine coracana* (L.) Gaertn) under dryland condition

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ABSTRACT

Crop suffers from the slow release of nutrients from organic manures at initial stages, which may cause a significant reduction in crop yield and farm income. This can be overcome by enrichment of organic manures with beneficial microbial culture and a judicious combination of inorganic fertilizers with such enriched organic manures. Finger millet was grown at AICRP for dryland Agriculture field during Kharif -2019 to study the effect of bio-enriched FYM viz., nitrogen fixers, phosphorus solubilizers, potassium solubilizers, PGPR and microbial consortia with 60 and 80 per cent RDF on growth, yield and economics of finger millet. Application of bio enriched FYM with microbial consortia + 80 per cent RDF (T_{10}) recorded significantly higher plant height (86.38, 111.52 and 115.33 cm), number of tillers per plant (4.42, 5.20 and 5.42) and dry weight per plant (5.50, 15.05 and 27.27 g) at 60, 90 DAS and at harvest, respectively. Whereas, higher grain yield (2999 kg ha^{-1}) and straw yield (4274 kg ha^{-1}) were recorded in T_{10} treatment Which received 80 per cent RDF with microbial consortia and sème trématent recorded additional return of rupees 12683 per hectare over recommended use of fertilizers. The overall result showed that the bio enrichment of FYM with microbial consortia tended to reduce the application rate of chemical fertilizer and thus microbial consortia along with 80 per cent RDF could be recommended for finger millet.

Keywords: Bio-enriched FYM, dry land, microbial consortia, yield attributes, finger mille

INTRODUCTION

Millets play an important role in farming and food culture in semi-arid zones of the world for millions of people in Africa and Asia. It can withstand varied conditions of heat, drought, humidity and tropical weather. *Alfisol* forms major soil order in Karnataka for finger millet and the crop serves as a staple food. In a country like India, where 44 per cent of the total food production is being supported by dryland and thereby playing a critical role in the nation's food security. Most of the deficiencies observed in today's plants, animals and people are due to soil conditions not being conducive to nutrient uptake. The minerals are present in excess but simply not plant available. Adding inorganic elements to correct these deficiencies is an inefficient practice. In dryland situations, the major problems accounting with the soil are nutrient deficiency, low organic matter, less water holding capacity, poor soil structure due to poor aggregation, low soil p^{H}, less moisture retentivity, low cation exchange capacity (CEC), higher infiltration rate, susceptible for causing erosion and runoff. Dryland soils need the addition of organic matter to maintain productivity and soil health, but the availability of quality organic manure is of great concern. Crop suffers from the slow release of nutrients from organic manures at initial stages, which may cause a significant reduction in crop yield and farm income. This can be overcome by enrichment of organic manures with beneficial microbial culture and a judicious combination of inorganic fertilizers with such enriched organic manures. The biofertilizer enrichment of organic manures will further contribute to the enhancement of P solubilization, K solubilizer, nitrogen fixers and also in the release of nutrients at different periods and controlling the soil borne pathogens. Hence, integration of organic, inorganic and biofertilizers (single strain and consortia) play a pivotal role to enhance crop productivity, sustaining soil health and decreasing environmental impact. Adoption of appropriate strategies holds great potential in effectively boosting finger millet yield.

MATERIALS AND METHODS

The field experiment was carried out during *Kharif*-2019 at ACIRP for Dryland Agriculture, UAS, GKVK, Bengaluru. The

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average maximum and minimum temperatures during cropping season were 29.8ºC and 18.2ºC, respectively and the total rainfall received during cropping year was 899.1 mm. The experimental soil was *Alfisol* having a sandy loam texture with 6.06 pH (Jackson, 1973), electrical conductivity of 0.040 dS m^{-1} (Jackson, 1973) and organic carbon of 0.31 per cent (Walkley and Black, 1934). The available nitrogen (148.60 kg ha^{-1}) (Subbaiah and Asija, 1956) and potassium (111.93 kg ha^{-1}) (Jackson, 1973) was found low, while available phosphorus status was higher (118.40 kg ha^{-1}) (Bray and Kurtz, 1945). The experiment was conducted with finger millet variety GPU-28 in a randomized complete block design replicated thrice with ten treatments comprising of T_1: control, T_2: 7.5 t ha^{-1} FYM + 100 % RDF, T_3: 7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 60 % RDF, T_4: 7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 80 % RDF, T_5 : 7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR) + 60 % RDF, T_6: 7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR) + 80 % RDF, T_7: 7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR) + 60 % RDF, T_8: 7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR) + 80 % RDF, T_9: 7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF and T_{10}: 7.5 t ha^{-1} enriched FYM (microbial consortia) + 80 % RDF. The recommended fertilizer dose of 50: 40: 37.5 kg NPK ha^{-1} was applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP). 50 per cent nitrogen and a full dose of phosphorus and potassium were applied as basal dose at the time of sowing and the remaining 50 per cent nitrogen was applied as a top dressing at 30 days after sowing (DAS) as per the treatment. Bio enrichment of FYM was done 15 days in advance for maintaining uniform growth of microorganisms with one kilogram of N fixers (*Azotobacter chroococcum*), P solubilizer (*Bacillus megaterium*), K solubilizer (*Frateuria aurantia*), microbial consortia and 500 grams of PGPR (Plant growth promoting rhizobacteria) (*Pseudomonas fluorescens*) to 1 ton of FYM and applied one week before sowing. The tagged five plants in the net plot were used for reordering plant height and number of tillers per hill. Dry matter accumulation was analyzed from five randomly selected plants in border rows and dried, till constant weight was obtained and recorded. The crop was harvested at physiological maturity. The tagged five plants were harvested separately and used for recording the number of ear heads per plant, a number of fingers per plant and 1000 grain weight. The ear heads in the net plot were harvested separately from each treatment and sun-dried, threshed, winnowed, cleaned and weighed were recorded. Similarly, the straw yield was recorded and expressed in kg ha^{-1}. The cost of cultivation for each treatment was worked out. Gross return was calculated based on the current market price of the produce, whereas net returns were obtained after deducting the cost of cultivation from gross return. Later, benefit: cost ratio was worked out by net return to cost of cultivation.

RESULTS AND DISCUSSION

Plant height

Plant height is an important parameter related to the growth and development of the crop. There was no significant difference in plant height at 30 DAS due to the application of bio-enriched FYM with different levels of fertilizers. Among treatments, significantly higher plant height was observed with the application of MC +80 per cent RDF (T_{10}: 86.38, 111.52 and 115.33 cm) and was on par with MC+ 60 per cent RDF (T_9: 82.15, 106.05 and 110.19 cm) and nitrogen fixers + PGPR + 80 % RDF (80.64, 104.94 and 108.02 cm) at 60, 90 DAS and at harvest, respectively. A shorter plant was observed in absolute control 60 DAS (46.30 cm) 90 DAS (55.42 cm) and at harvest (57.79 cm). The results are in line with, Singh *et al.* (2016) who reported that the application of different biofertilizers did not affect the plant height at the early stages of growth. This might be due to the slower rate of mineralization of nutrients, because at an early stage the nutrients are better utilized by microorganisms for multiplication and establishment, thus lowering the availability of nutrients for plant growth. Plant height was significantly increased with the combined application of both biofertilizer and inorganic fertilizers at 60, 90 DAS and at harvest. The highest height observed with the application of microbial consortia (NFB + PSB + KSB and PGPR) may be attributed to continuous uptake of nutrients by the plant, which was made available through nitrogen fixation, P and K solubilization which helped in increasing plant height. A similar result was observed by Singh *et al.* (2016) in pearl millet. According to Narula and Guptha (1986) application of nitrogen fixers such as *Azotobacter* synthesizes and secretes a considerable amount of biologically active substances like B vitamin, nicotinic acid, pentothenic acid, biotin, heteroauxins, and gibberellins *etc*., which enhance the growth of plants. The increased availability of nutrients in the soil through mineralization of organic sources could have triggered cell elongation and multiplication resulting in the higher growth rate of shoots and in turn plant height of finger millet over control (Pallavi *et al.* 2017). Singh *et al.* (2016) reported that, increase in plant height may be attributed to increased uptake of nitrogen and phosphorus by the plants, which was made available through nitrogen fixation and phosphate solubilization by the microorganisms. A similar result was also observed by Roy (2018).

Table 1: Plant height (cm) of finger millet at different growth stages as influenced by different bio-enriched FYM treatments

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1-Control	16.30	46.30^{d}	55.42^{d}	57.79^{f}
T_2-7.5 t ha^{-1} FYM + 100 % RDF	23.65	70.72^{c}	88.07^{c}	90.00^{e}
T_3-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 60 % RDF	26.05	74.53^{bc}	99.73^{abc}	104.23^{abcd}
T_4-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 80 % RDF	27.48	80.64^{ab}	104.94^{ab}	108.02^{abc}
T_5-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 60 % RDF	24.20	71.35^{c}	87.74^{c}	90.68^{e}
T_6-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 80 % RDF	25.74	75.69^{bc}	92.42^{c}	97.02^{cde}
T_7-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 60 % RDF	25.24	72.28^{c}	91.08^{c}	93.89^{de}
T_8-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 80 % RDF	26.24	77.57^{bc}	99.08^{bc}	102.56^{bcde}
T_9-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	28.50	82.15^{ab}	106.05^{ab}	110.19^{ab}
T_{10}-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	28.76	86.38^{a}	111.52^{a}	115.33^{a}
S.Em.±	2.54	2.81	4.16	4.24
LSD @ 5 %	NS	8.36	12.36	12.60

Number of tillers per hill

The data on the number of tillers per hill of finger millet as influenced by different biofertilizers enriched FYM and levels of fertilizers at different growth stages are presented in Table 2. The number of tillers per hill differed significantly at all growth stages except at 30 DAS with different treatment combinations of biofertilizers enrichment and inorganic fertilizers. Among different treatments application of MC + 80 per cent, RDF (T_{10}) recorded significantly highest number of tillers (5.20 and 5.42) compared to absolute control (T_1) (2.54 and 2.67) and 100 per cent RDF (T_2) (4.53 and 4.69) at 90 DAS and at harvest, respectively. Whereas, at 60 DAS, application of MC + 80 per cent RDF (4.42) recorded on par result with the application of 100 per cent RDF (3.73), but it was found significant with absolute control (2.47). The number of tillers per hill varied significantly with the application of different biofertilizers and levels of RDF at 60, 90 DAS and after harvest. The process of nitrogen fixation and solubilization of P and K increased the availability of nutrients to plant with the application of microbial consortia.

The increased NPK in plants plays an important role in nutrient and sugar translocation in the plant, maintenance of turgor pressure of plant cells and increasing the plant growth and the number of tillers per plant. Monisha *et al.* (2019) reported that higher availability of NPK during the crop growth period might have improved the plant growth characters like plant height and number of tillers per hill. The PGPR include regulating hormonal and nutritional balance, inducing resistance against plant pathogens, solubilizing nutrients for easy uptake by plants and indirectly boosting plant growth rate (Vejan *et al.* 2016). The improved physico-chemical properties and availability of nutrients at a slow rate for a longer time with the use of organics might be responsible for more number of tillers (Pallavi *et al.* 2017). While, Yuvaraj (2016) reported that combined inoculation of microbial consortia with inorganic fertilizer increased the number of tillers per plant compared to single strain biofertilizer in paddy and similar result was observed by Shruthi (2014) with the application of 100 per cent NPK (POP) + FYM + P and K solubilizer compared to 100 per cent NPK (POP) + FYM + P solubilizer and 100 per cent NPK (POP) + FYM + K solubilizer in finger millet.

Table 2: Number of tillers per hill of finger millet at different growth stages as influenced by different bio-enriched FYM and levels of fertilizer

Treatments	Number of tillers per hill			
	30 DAS	60 DAS	90 DAS	At harvest
T_1-Control	1.16	2.47^b	2.54^c	2.67^c
T_2-7.5 t ha^{-1} FYM + 100 % RDF	1.73	3.73^a	4.53^b	4.69^b
T_3-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 60 % RDF	1.76	3.89^a	4.64^{ab}	4.83^{ab}
T_4-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 80 % RDF	1.86	4.22^a	4.99^{ab}	5.22^{ab}
T_5-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 60 % RDF	1.73	3.79^a	4.56^{ab}	4.75^{ab}
T_6-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 80 % RDF	1.83	4.13^a	4.90^{ab}	5.12^{ab}
T_7-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 60 % RDF	1.80	3.92^a	4.69^{ab}	4.88^{ab}
T_8-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 80 % RDF	1.87	4.27^a	5.04^{ab}	5.23^{ab}
T_9-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	1.90	4.35^a	5.12^{ab}	5.33^{ab}
T_{10}-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	1.94	4.42^a	5.20^a	5.42^a
S.Em.±	0.12	0.23	0.22	0.25
LSD @ 5 %	NS	0.70	0.64	0.73

Dry weight per plant

The data on dry matter production of finger millet at different growth stages as influenced by biofertilizers enriched FYM and different levels of inorganic fertilizers are presented in Table 3. There was a significant effect due to the application of biofertilizer enriched FYM along with inorganic fertilizers on dry matter production of finger millet at 30, 60, 90 DAS and at harvest. Application of MC enriched FYM + 80 per cent RDF (T_{10}) recorded significantly higher dry matter accumulation per plant (1.15, 15.05 and 27.27 g) compared to absolute control (0.53, 5.44 and 9.97 g) and 100 per cent RDF (0.99, 12.76 and 23.38 g) at 30, 90 DAS and at harvest, respectively. Whereas at 60 DAS application of MC enriched FYM + 80 per cent RDF (5.50 g plant^{-1}) recorded on par result with 100 per cent RDF (4.66 g), but it was found significantly higher compared to absolute control (2.69 g plant^{-1}). Significantly higher dry matter production might be due to fact that biofertilizers can mobilise nutrients from non-useable form to useable form and increase the availability of nutrients to plant during their growth period, which might result in increased dry matter production. Abdullahi *et al.* (2014) recorded similar results with the application of bio-fertilizer alone or in combination with cow dung (CD) or poultry manure (PM) on the growth of pearl millet and observed a significant increase in dry matter production compared to control. Similarly, Cleyet-Marel *et al.* (2001) found that inoculation of plant with plant growth promoting rhizobacteria at an early stage of development made positive impact on biomass production through a direct effect on root growth, production of phytohormones by bacteria, mineral enhancement uptake and transfer of nutrient to plants.

Yield attributes

A significant increase in ear head per plant was observed in the treatment which received microbial consortia + 80 per cent RDF (5.13) compare to bio enriched FYM with phosphate solubilizer and PGPR + 60 % RDF (4.72), bio enriched FYM with nitrogen fixer and PGPR) + 60 % RDF (4.60), 100 pe cent RDF (4.45) and absolute control treatment (3.33) (Table 4). Whereas, application of different bio enriched FYM with different levels of fertilizers recorded no significant influence on the number of fingers per ear head and test weight of 1000 grains of finger millet. There was significant difference found with the application of different biofertilizers and levels of fertilizers. Higher yield attributes were recorded with the application of microbial consortia, followed by the application of K solubilizers. Microbial consortia not only increased nitrogen fixation and solubilization of P and K, but it also improved relative microorganisms in soil which helped in mineralization.

Table 3: Dry weight (g plant^{-1}) of finger millet at different growth stages as influenced by different bio-enriched FYM and levels of fertilizer

Treatments	Dry weight per plant (g)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1-Control	0.53^c	2.69^b	5.44^d	9.97^e
T_2-7.5 t ha^{-1} FYM + 100 % RDF	0.99^b	4.66^a	12.76^c	23.38^d
T_3-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 60 % RDF	1.04^{ab}	4.83^a	13.43^{bc}	24.11^{cd}
T_4-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 80 % RDF	1.09^{ab}	5.28^a	14.16^{abc}	25.71^{abc}
T_5-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 60 % RDF	1.02^{ab}	4.69^a	12.98^c	23.83^{cd}
T_6-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 80 % RDF	1.07^{ab}	4.94^a	13.85^{abc}	25.67^{abc}
T_7-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 60 % RDF	1.05^{ab}	4.80^a	13.58^{abc}	24.27^{abc}
T_8-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 80 % RDF	1.10^{ab}	5.17^a	14.30^{abc}	26.16^{ab}
T_9-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	1.12^{ab}	5.31^a	14.69^{ab}	26.58^a
T_{10}-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	1.15^a	5.50^a	15.05^a	27.27^a
S.Em.±	0.05	0.33	0.53	0.66
LSD @ 5 %	0.16	0.98	1.59	1.95

NPK are essential nutrients required for the promotion of the meristematic and physiological activities, these activities promote higher photosynthetic activities leading to the production of enough assimilates for subsequent translocation to various sinks thereby leading to the production of higher sink components like productive tillers, number of fingers per plant, the weight of grains and test weight per plant (Pallavi *et al.* 2017) PGPR helped in regulating hormones and improved nutrient uptake by the plant by reducing pest and disease incidence. However, it was found that K solubilizer when applied along with PGPR helped in increasing potassium uptake by plants and helped to regulate enzymatic activity and translocation of photosynthates which improved yield attributes. This result has conformity with Shruthi (2014) who observed similar results in finger millet crop.

Table 4: Yield attributes of finger millet as influenced by different bio-enriched FYM and levels of fertilizers

Treatments	No. of Ear heads hill^{-1}	No. of Fingers ear head^{-1}	1000 grain weight (g)
T_1-Control	3.33^e	4.90	2.47
T_2-7.5 t ha^{-1} FYM + 100 % RDF	4.45^d	5.96	2.76
T_3-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 60 % RDF	4.60^{cd}	6.11	2.80
T_4-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 80 % RDF	4.93^{abc}	6.41	2.98
T_5-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 60 % RDF	4.72^{bcd}	6.24	2.85
T_6-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR)+ 80 % RDF	4.97^{abc}	6.67	3.02
T_7-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 60 % RDF	4.83^{abcd}	6.39	2.90
T_8-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR)+ 80 % RDF	5.00^{ab}	6.70	3.12
T_9-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	5.03^{ab}	6.83	3.16
T_{10}-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	5.13^a	6.77	3.25
S.Em.±	0.13	0.40	0.15
LSD @ 5 %	0.38	NS	NS

Grain and Straw yield

Significantly higher grain yield was observed in treatment with combined application of MC + 80 per cent RDF (2999 kg ha^{-1}) which was found to be on par with treatment which received MC + 60 per cent RDF (2905 kg ha^{-1}) and lower was found in absolute control (1132 kg ha^{-1}), followed by 100 per cent RDF (2524 kg ha^{-1}). Among single strain, biofertilizers application of bio enriched FYM with potassium solubilizer and PGPR + 80 % RDF recorded higher grain yield of 2837 kg ha^{-1}. Application of different biofertilizers enriched FYM and levels of fertilizers significantly varied the straw yield at harvest. Among treatments higher straw yield was recorded in treatment which received MC + 80 per cent RDF (4274 kg ha^{-1}) and was on par with treatment which received MC + 60 per cent RDF (4183 kg ha^{-1}) and bio enriched FYM with potassium solubilizer and PGPR + 80 % RDF (4141 kg ha^{-1}). It was found significantly higher compared to straw yield in absolute control (1528 kg ha^{-1}) and 100 per cent RDF (3710 kg ha^{-1}). Application of different biofertilizers enriched FYM and levels of fertilizers, application of microbial consortia increased availability of all the nutrients for uptake by plant throughout the growth period while PGPR regulated hormones and nutrient balance and also induced resistance against plant pathogen. Similarly, Vessey (2003) cited that microbial consortia often reveal multiple ways of benefiting plant health like fixation of nitrogen for the host plant, mobilization or solubilization of phosphorus, production of phytohormones and plant fungal symbiosis as supportive bacteria or a combination of those. Among single strain, biofertilizers application of KSB showed higher straw and grain yield (Fig. 1) as they help in numerous enzymatic activities, formation of organic acid substances and build-up of compounds such as carbohydrates as it helps in cell development and trigger young tissues and help in meristematic growth. Potassium solubilizers also can solubilize phosphorus and increase its availability to plant. A similar result was observed by Neeraj (2014), Yuvaraj (2016) and Rangesh Kumar *et al.* (2018).

The increased availability of nutrients especially nitrogen due to the combined application of FYM, inorganic fertilizers and biofertilizers, led to enhancement of the photosynthetic rate resulting in more vegetative growth and dry matter production (Roy *et al.* 2018). Organic manure and bio-fertilizers increased the formation of the root hairs and lateral root which helps in higher nutrient uptake and resulted in higher biomass production (Thumar *et al.* 2016). This could also be attributed to the higher availability of NPK during the crop growth period which might have improved the plant height, the number of tillers eventually increase the straw yield (Monisha *et al.* 2019). The yield increase in the same crop was reported in field trials using a combination of *B. megaterium* and *A. chroococcum* was 10–20 per cent (Brown, 1974). Similarly, Rekha *et al.* (2018) recorded higher straw yield in the plants of the pots inoculated with microbial consortia +75 per cent RDF + FYM. Shruthi (2014) found that combined application of PSB + KSB + inorganic fertilizer increased grain and straw yield compare to single strain inoculation of biofertilizers with inorganic fertilizer.

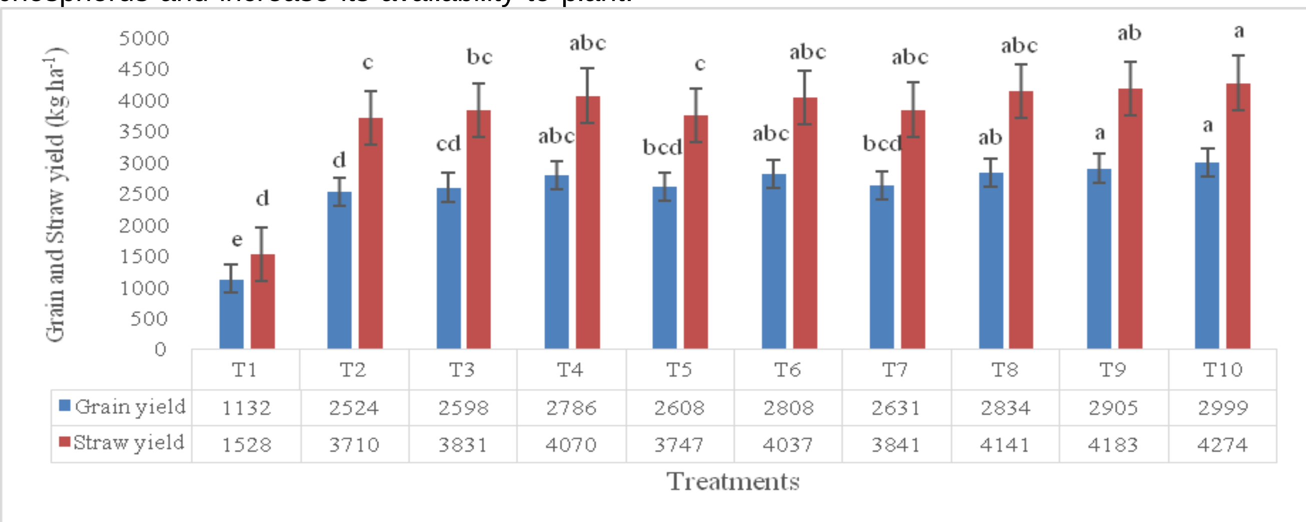

Fig. 1: Grain and straw yield of finger millet as influenced by different bio-enriched FYM and levels of fertilizers (error bar are critical difference @ 5 %)

Economics

Cost of cultivation was found lower in absolute control (Rs. 13038) and higher cost of cultivation (Rs. 27692) was observed in treatment which received NFB+ PGPR + 80 per cent RDF (T_4), PSB+ PGPR + 80 per cent RDF (T_6) and KSB + PGPR + 80 per cent RDF (T_8). Whereas, higher gross returns (Rs. 90373) and net returns (Rs. 62981) was recorded with the application of MC + 80 per cent RDF (T_{10}) and lower (Rs. 33975 and 20937, respectively) was observed in absolute control (T_1). Similarly, a higher B: C ratio (2.30) was observed in MC + 80 per cent RDF (T_{10}), followed by MC+ 60 per cent RDF (T_9) (2.24) and least (1.61) was observed in absolute control (T_1) (Table 5). A higher level of biomass accumulation and efficient translocation to the reproductive parts due to the supply of adequate nutrients might be responsible for greater yield. Which resulted in higher monetary returns and B: C ratio (Roy *et al.* 2018). The differences in the B: C ratio is attributed to yield differences and varying costs when different organic manures were added. Organic manures such as FYM and bio compost can be used in combination for more profitable income (Thumar *et al.* 2016).

Table 5: Economics of finger millet as influenced by different bio-enriched FYM and levels of fertilizers

Treatments	Cost of cultivation (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	B: C ratio
T_1-Control	13038	33975	20937	1.61
T_2-7.5 t ha^{-1} FYM + 100 % RDF	27171	76237	49066	1.81
T_3-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 60 % RDF	27313	78498	51185	1.87
T_4-7.5 t ha^{-1} enriched FYM (nitrogen fixers + PGPR) + 80 % RDF	27692	84109	56417	2.04
T_5-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR) + 60 % RDF	27313	78636	51323	1.88
T_6-7.5 t ha^{-1} enriched FYM (phosphate solubilizer + PGPR) + 80 % RDF	27692	84672	56980	2.06
T_7-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR) + 60 % RDF	27313	79437	52124	1.91
T_8-7.5 t ha^{-1} enriched FYM (potassium solubilizer + PGPR) + 80 % RDF	27692	85560	57868	2.09
T_9-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	27013	87619	60606	2.24
T_{10}-7.5 t ha^{-1} enriched FYM (microbial consortia) + 60 % RDF	27392	90373	62981	2.30

It may be concluded from the results modern sustainable agriculture prefers biofertilizers for plant growth promotion and biocontrol as these are eco-friendly and cost-effective. Application of bio-enriched FYM (microbial consortia) + 80 per cent RDF recorded higher grain and straw yield with additional returns of rupees 12683 per ha^{-1} over recommended use of fertilizers and saved application of inorganic fertilizer by 20 per cent. Thus, the application of biofertilizer with conventional fertilizer is a sustainable way of increasing growth and yield.

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