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Crop growth and productivity of finger millet (*Eleusine coracana* L.) influenced by organic nutrient sources under Guni method of cultivation

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Abstract
Finger millet now commonly called as “nutritious millet” have made the recognition of their role in life. A new technique called ‘Guni’ or ‘Guli’ with wider establishing and spot application of farm yard manure has been established in finger millet in line with “System of Crop Intensification.” An investigation was carried out in the *Kharif* season 2019 at farmers field of Mylandahalli in Chikkaballapura distict of Karnataka, to study the impact of organic nutrient sources on development and productivity of finger millet under Guni method. The testing was framed out in Randomized Blocked Design with twelve treatments reproduced thrice. The study exposed that significantly supplement of SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + PG spray @ 3% (T_9) was found to performed improved growth and yield determinants *viz.*, plant height (107.25 cm), leaf area (11138 cm^2), tillers counts/hill (17.72) and dry matter production/hill (51.73 g), counts of productive tillers/hill (17.13), ear heads numbers/hill (14.67), no. of fingers/hill (8.22) grain yield/hill (147.00 g), 1000 grain weight (3.94 g) of Ragi over more transplanting or direct sowing. Similarly, maximum grain yield of 4087 kg/ha and straw yield of 5760 kg/ha, gross returns of 108242 ₹/ha, net returns of 78326 ₹/ha and Benefit cost ratio with value to the tune of 2.16 were recorded with the similar treatment during cropping period of *Kharif* 2019.

Keywords: Enriched bio-digested liquid manure, farm yard manure, panchagavya, sericulture waste compost, vermiwash, yield

Introduction
Finger millet is usually known as "African millet" or "Ragi" in India (Shashikala et al., 2021). Unlike all the millets, finger millet is unique in that it can be grown under a range of agroclimatic conditions and used for both food (as a grain) and fodder (as a straw). It is grown in Jharkhand, Maharashtra, Tamil Nadu, Uttaranchal Karnataka, Andhra Pradesh and Orissa in an extent of 11.63 lakh tones with a potential of 16.91 lack tones and a productivity of 1454 kg ha^{-1}. Karnataka is one of the principle maker of Ragi in India and cultivated in 8.12 lakh tones with an annual yield of 11.48 lakh tons, where as in terms of productivity Tamil Nadu leads the highest with maximum value of 2967 kg ha^{-1} (Indiastat 2023-24). Finger millet made as prominent dry land crop due in part to its remarkable ability to tolerate extreme weather conditions such as drought and other climatic variations. It can be grown on soils with characteristics like low water retention capacity, drought tolerance, and quick restoration from moisture stress. Among the finger millet seeding techniques, broadcasting and random transplanting are the most widely used. However, adhering to these tenets results in an uneven plant distribution, which intensifies competition for nutrients and moisture (Shashikala et al., 2021) [20]. In current times have seen farmers in the Karnataka districts of Kolar, Bengaluru rural, and Haveri employ a novel technique known as the "Guni" or "Guli" approach (Hebbal et al., 2018) [7]. Though "System of Ragi Intensification," an SRI system of rice farming, is similar to the "Guni" technique, also called scooping in square planting practice, it uses bigger spaced (0.3 x 0.3 m to 0.6 × 0.6 m) combined with spot application of FYM to respectively (Shashikala et al., 2021) [20].

Using a basic ox-drawn plow driven over the field perpendicularly, furrows spaced 20 inches (60 cm) apart are incised on the soil. That will intersection at a designated spot and create a little Guni, or pit, with a depth of 20 cm. Farmers maintained a 60 cm × 60 cm spacing and feed FYM to Guni on-site (0.75 kilogram per Guni) and thoroughly mixed it with soil. Subsequently, two immature seedlings in each guni, aged between 20-21 days (seedlings older than 30 days should not used), are transplanted. When a koradu is passed over a field during the first three to six weeks of plant growth, it promotes the production of more tillers and an adventitious root system that makes panicles larger and improves grain filling. The ear heads' size and quality also improved as a resultant of consistent nutrient and moisture availability (Sukanya et al., 2021) [21]. Farmers can attain yields of up to 18 to 20 quintals per acre by increasing the number of ear heads/hill and filling the grain to a higher degree.

In addition to these, have more advantages, farmers can also use drip irrigation because it has a wider planting of 0.6 x 0.6 m compared to the traditional method of planting (30 cm x 10 cm). Other benefits include low seed rate (1 kg/ha), easy inter cultivation, better weed management, and higher water use efficiency (Biswas and Das, 2023) [3]. Thus, the guni method of growing finger millet is becoming more and more common among Karnataka farmers. In recent years, the organic carbon content in Indian soil has been low, ranging from 0.30 to 0.45%. Additionally, essential major nutrients such as NPK, and various micronutrients are deficient. To address this issue and increase soil organic carbon levels, supplementation with organic manures is necessary. Additionally, effective organic manureal sources must be produced using FYM, vermiwash, panchagavya and sericulture waste, locally accessible on-farm biomass, and weeds that are commonly found in organic farming (Gafoor et al., 2021) [5]. Research on the advantages of panchagavya, vermiwash, and cow urine in addition to enhanced bio-digested liquid manure is required. For this technique to increase productivity, extensive and thorough research is required for scientific confirmation. With this in mind, the current test was supported to evaluate the effects of organic nutrient sources on the growth, yield, and economics of ragi using the Guni way of cultivation.

Materials and Methods

Field trial was agreed out in *Kharif* 2019 at farmers field of Mylandahalli in Chikkaballapura distict of Karnataka. The texture of research plot was sandy clay loam, neutral in response (pH 7.41), diminished levels of organic carbon (0.38%), moderate level of accessible nitrogen (284.75 kg/ha), elevated levels of accessible phosphorous (32.98 kg/ha) and moderate levels of available potassium (195.70 kg/ha). The 12 treatments in the research were arranged in a randomized block design, and was duplicated thrice. ML-365 variety was used in the trial and transplanted @ spacing of 0.6 x 0.6 m. Treatments used in the research were T_1: FYM @ 100% N eq. ha^{-1}, T_2: SWC @ 100% N eq. ha^{-1}, T_3: BDLM @ 100% N eq. ha^{-1}, T_4: EBDLM @ 100% N eq. ha^{-1}, T_5: Cow urine @ 100% N eq. ha^{-1}, T_6: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + VW spray @ 3%, T_7: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + PG spray @ 3%, T_8: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + VW spray @ 3%, T_9: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + PG spray @ 3%, T_{10}: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + VW spray @ 3%, T_{11}: SWC @ 50% N eq. + Cow urine @ 50% N eq. + PG spray @ 3% and T_{12}: Recommended FYM (10 t) + 100:50:50 kg NPK ha^{-1}.

The raised nursery beds were set up, gaging 3.0 m x 1.5 m and 10 cm high. On the beds, one kilogram of seeds was dispersed per acre. With the Guni method, each plot was levelled evenly, and at 0.6 × 0.6 m intersection, tiny gunis or scoops were manually prepared with a spade. Two seedlings per guni were planted in each of the plots after twenty-one days after transplanting the seedlings. In 100% RDF treatment (T_{12}), urea, single super phosphate and muriate of potash were used to augment the nutrients (100:50:50 kg NPK ha^{-1}). The annotations on growth metrics *viz.*, plant height (cm), tillers counts/hill, leaf area/hill (cm^2), dry matter accumulation (g) were noted at harvest by adopting standard procedure. Based on the yield variable from independent plot, the yield of grains and straw was computed and converted interpreted to kg ha^{-1}. To figure out the economic variables, notably the cost of cultivation, gross and net returns per hectare, prices of products in the current local markets and the cost of various inputs utilized were taken into consideration. The cultivation cost was deducted from the total gross returns to get the net return. The benefit-cost ratio was computed as the ratio of gross returns to cultivation expenses. The data was statistically analyzed at 5% level of probability (LSD) by subsequent procedure drawn by Gomez and Gomez (1984) n SPSS software (Statistical Package for the Social Sciences).

Results and Discussion

Growth components

Growth metrics in terms of plant height, leaf area, tillers counts and dry matter accumulation were shown notable influence by various treatments (Table 1). Consistently, increased plant height (107.25 cm), leaf area (11138 cm^2), tillers count/hill (17.72) and dry matter production per hill (51.73 g) was attained with the application of SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + pancha gavya spray @ 3% (T_9) and shown at par outcomes with SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + VW spray @ 3% (T_8) (103.05 cm, 10945 cm^2, 17.15 and 49.65 g hill^{-1}, respectively) followed by SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + PG spray @ 3% (T_7) (101.25 cm, 10649 cm^2, 16.35 and 48.38 g, respectively) and T_6 (98.50 cm, 10123 cm^2, 15.86 and 46.86 g hill^{-1}, respectively). Invariably, recommended FYM (10 t ha^{-1}) + 100:50:50 kg NPK ha^{-1} (T_{12}) obtained significantly lesser growth parameters (85.10 cm, 891 cm^2, 6.41 and 33.63 g at harvest, respectively).

The enhanced growth metrics, such as plant height, tiller count, and leaf area, could perhaps be ascribed to the broader spacing (60 cm x 60 cm) that enhances photosynthetic rate and intercepts more solar energy. Due to the spot application of organic manure, which lessens nutrient leaching and volatilization when it is spread in line-sown treatments, guni may conserve water and boost nutrient availability (Ananda, 2017) [1]. Furthermore, because there was less competition for resources due to the larger spacing, each plant was able to grow a vast root structure. Better aeration at broader spacing led to robust plant development. Wider spacing and improved aeration led to robust plant growth. Additionally, beneficial bacteria in the root zone are increased by organic and liquid manures. This aids in the mineralization of nutrients, which ultimately favors the continuous release of nutrients to the plants. This was consistent with the research findings of Prakash, 2015 [15]. Protozoplasmic elements N, P, and K were supplied by humic acid sources (BDLM and EBDLM), and these elements indirectly improved plant physiochemical processes including protein synthesis and chlorophyll production, which increases the accumulation of dry matter. Panchagavya is made up of coconut water, which has kinetin in it, which helps to improve the cytokinin in leaves. This, in turn, causes a synthesis of chlorophyll in leaves and prolongs photosynthetic activity, which may be the reason why finger millet dry matter accumulation has increased (Ananda, 2017 and Sweta Shikta, 2017) [1, 22]. Significantly taller plants, a leaf area index, and the production of dry matter were seen when the prescribed quantity of Farm yard manure was combined with vermicompost (4 t/ha) on a nitrogen equivalent basis, according to Ullasa et al. (2020) [20].

Yield attributes

Yield determinants, *viz*., no. of effective tillers per hill, ear heads number per hill, finger length (cm), grain yield per hill (g) and 1000 grain weight (g) were meaningfully affected by various organic nutrient sources in ragi except fingers numbers/ear head (Table 2). The pattern followed the same trajectory as the growing features. Application of SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + Panchagavya spray @ 3% (T_9) resulted in substantially greater yield variables, such as the number of effective tillers per hill (17.13), ear heads counts/hill (14.67), finger length (9.05 cm), grain yield per hill (147.00 g), and 1000 grain weight (3.94 g). This was found to be statistically on par with SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + VW spray @ 3% (T_8), and SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + PG spray @ 3% (T_7) and SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + VW spray @ 3% (T_6), which were statistically at par with each other. Nevertheless, least number of effective tillers $hill^{-1}$ (17.13), ear heads counts $hill^{-1}$ (14.67), finger length (9.05 cm), grain yield $hill^{-1}$ (147.00 g) and test weight (3.94 g) obtained with recommended FYM (10 t ha^{-1}) + 100:50:50 kg NPK ha^{-1} (T_{12}). However, the maximum value of 8.22 and minimum value of 7.70 fingers counts ear $head^{-1}$ was found with T_9 and T_{12} tested plots, respectively.

Improved growth and yield characteristics in the treatments receiving SWC @ 50% N eq.+EBDLM @ 50% N eq. ha^{-1}+Panchagavya spray @ 3% (T_9) might be attributable to an extended and appropriate supply of nutrients that match with the critical crop growth stages (Ananda et al., 2017 and Aparna et al., 2019) [1, 2]. It could be because of better nutrition, better vegetative development, and yield-related characteristics like the number of effective tillers, finger counts per ear head, the total counts of grains per finger, and the crop's test weight (Radha et al., 2019) [16]. These factors may have prevented the crop from experiencing nutrient stress at any stage of its growth. According to Ullasa et al. (2020) [20], the application of FYM (7.5 t ha^{-1}) and the replacement of the prescribed nutrient dose with vermicompost on a N equivalent basis led to a considerable increase in the number of productive tillers, finger length, finger per ear head, and yield. Improved shoot and root uptake of nutrients was promoted by the mineralisation of organic nutrient sources (Pallavi et al., 2016; Kumar et al., 2021: Gafoor et al., 2021) [13, 5, 10].

Yield

Meaningfully maximum grain and straw yield (4087 and 5760 kg ha^{-1}) were registered under treatment receiving SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + Panchagavya spray @ 3% (T_9) (Table 3) followed by T_8 (4022 and 5712 kg/ha, respectively) and T_7 (3905 and 5632 kg/ha, respectively), which were comparable to each other. Invariably, recommended FYM (10 t/ha) + 100:50:50 kg NPK ha^{-1} (T_{12}) recorded decreased levels of grain and straw yield (3138 and 4638 kg/ha). There was insignificance difference in harvest index. However, numerically the maximum (0.42) and minimum (0.34) harvest index was obtained with treatment T_9 and T_{12}, respectively.

Yield variables and yield of finger millet could be the result of improved growth factors, which have a direct impact on how well nutrients, water, and sunlight are assimilated and used to synthesize additional photosynthates. Obtaining greater yield components was also aided by the increased dry matter accumulation. Since, yield is a function of yield components hence, higher values of yield components lead to in higher yield. Similar outcomes are found by Reddy et al. (2012) [18]; Prakash (2015) [15]; Ananda (2017) [1], Sweta Shikta (2017) [22]; Radha et al. (2019) [16]. In addition to providing macronutrients (NPK), enriched bio-digested liquid manure additionally delivers micronutrients, growth-promoting hormones, and larger concentration of beneficial microbes in the rhizosphere, which force have lead to greater yield and its attributes. Similar findings were reported by Ravikumar (2009) [17]; Reddy et al. (2012) [18]; Latha (2014) [11]; Ananda (2017) [1] in finger millet cropping system. According to Hebbal et al. (2018) [7], increased nutrient absorption lead to improved photosynthate translocation from source to sink was likely responsible for the study's improved yield with a treatment involving of conjunctive submission of inorganics + 25% N as organics (Aparna et al., 2019) [2]. Hemalatha et al. (2020) [8] investigated how organic additives affected finger millet productivity. They believed that the large production rise in response to organics was caused by the organic manures' mineralization and solubilization effects, which improved the availability of nutrients to crops. According to Maitra et al. (2020) also noted that applying 100% RDF as an organic fertilizer source to finger millet resulted in higher production and growth.

Economics

The acceptance by farmers in any improved technology ultimately depends on the higher returns and least cost of production than the existing technology. Outcomes of this testing on the impact of various organic nutrient sources indicated that application of SWC @ 50% N eq.+ EBDLM @ 50% N eq. ha^{-1} + Panchagavya spray @ 3% (T_9) obtained greater amount of gross returns (₹ 1,37,381 ₹/ha), net returns (73,830 ₹/ha) and profit of one rupee investment (2.16) with reduced cost of cultivation (72,860 ₹/ha) (Fig 1).

Higher returns and profit of one rupee investment was attributed combining augmenting of enriched bio-digested liquid manure combine with pancha-gavya by Saunshi, 2012; Latha, 2014 [11]; Ananda, 2017 [1]; Prakasha et al. (2018) [14]. Because the crop was not subjected to nitrogen stress during any stage and because nutrients were applied organically, vegetative development was enhanced and yield characteristics and yield rose, all of which contributed to higher gross returns and net returns (Radha et al., 2019) [16]. The higher benefit: cost ratio in conjuctive application of nutrients might be due to higher gross returns over rest of the treatments less cost of cultivation and optimum grain and straw yield. These results were in conformity with those earlier reported by Triveni et al., 2018 [23].

Table 1: Influence of various organic nutrient sources on growth attributes of finger millet crop under Guni method

Treatments	Plant height (cm)	Leaf area (cm^2)	Number of tillers hill^{-1}	Dry matter accumulation (g)
T1: FYM @ 100% N eq. ha^{-1}	88.60	4006	11.82	42.23
T2: SWC @ 100% N eq. ha^{-1}	92.10	6546	12.95	43.48
T3: BDLM @100% N eq. ha^{-1}	95.40	7813	14.09	45.23
T4: EBDLM @ 100% N eq. ha^{-1}	96.95	9442	14.34	46.10
T5: Cow urine @ 100% N eq. ha^{-1}	87.25	3846	11.73	41.18
T6: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + VW spray @ 3%	98.50	10123	15.86	46.86
T7: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + PG spray @ 3%	101.25	10649	16.35	48.38
T8: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + VW spray @ 3%	103.05	10945	17.15	49.65
T9: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + PG spray @ 3%	107.25	11138	17.72	51.73
T10: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + VW spray @ 3%	89.25	5423	12.34	43.14
T11: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + PG spray @ 3%	93.95	7051	13.71	44.20
T12: Recommended FYM (10 t) + 100:50:50 kg NPK ha^{-1}	85.10	891	6.41	33.63
S.Em±	3.20	358.64	0.68	1.65
C.D at 5 %	9.39	1051.86	1.99	4.83

Note: FYM @ 10 t ha^{-1} was applied for all the treatments except T_{12} and foliar application of VW & PG at 45 and 60 DAT.
FYM : Farm Yard Manure; SWC: Sericulture Waste Compost; BDLM : Bio-Digested Liquid Manure; EBDLM : Enriched Bio-Digested Liquid Manure; VW: Vermiwash; PG : Panchagavya and DAT : Days After Transplanting

Table 2: Influence of various organic nutrient sources on yield components of finger millet crop under Guni method

Treatments	No. of productive tillers hill^{-1}	No. of ear heads hill^{-1}	No. of fingers ear head^{-1}	Finger length (cm)	Grain yield hill^{-1} (g)	1000 grain weight (g)
T1: FYM @ 100% N eq. ha^{-1}	11.23	9.80	7.90	8.03	112.97	3.48
T2: SWC @ 100% N eq. ha^{-1}	12.36	10.40	8.05	8.15	118.00	3.61
T3: BDLM @100% N eq. ha^{-1}	13.50	11.10	8.15	8.28	123.00	3.72
T4: EBDLM @ 100% N eq. ha^{-1}	13.75	11.38	8.17	8.33	127.67	3.77
T5: Cow urine @ 100% N eq. ha^{-1}	11.14	9.10	7.90	7.95	111.00	3.34
T6: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + VW spray @ 3%	14.75	12.86	8.17	8.60	130.67	3.81
T7: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + PG spray @ 3%	15.82	13.00	8.19	8.63	140.67	3.83
T8: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + VW spray @ 3%	16.56	13.70	8.20	8.95	144.67	3.89
T9: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + PG spray @ 3%	17.13	14.67	8.22	9.05	147.00	3.94
T10: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + VW spray @ 3%	11.75	10.30	7.94	8.05	117.00	3.55
T11: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + PG spray @ 3%	13.12	10.80	8.14	8.25	121.00	3.69
T12: Recommended FYM (10 t) + 100:50:50 kg NPK ha^{-1}	5.82	6.80	7.70	7.85	66.00	3.28
S.Em±	0.84	0.63	0.29	0.22	5.80	0.05
C.D at 5 %	2.45	1.85	NS	0.64	17.02	0.15

Note: FYM @ 10 t ha^{-1} was applied for all the treatments except T_{12} and foliar application of VW & PG at 45 and 60 DAT.
FYM : Farm Yard Manure; SWC: Sericulture Waste Compost; BDLM : Bio-Digested Liquid Manure; EBDLM : Enriched Bio-Digested Liquid Manure; VW: Vermiwash; PG : Panchagavya and DAT : Days After Transplanting

Table 3: Influence of different organic nutrient sources on grain, straw yield and harvest index of finger millet crop under Guni method

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
T1: FYM @ 100% N eq. ha^{-1}	3138	4638	0.40
T2: SWC @ 100% N eq. ha^{-1}	3277	4754	0.41
T3: BDLM @100% N eq. ha^{-1}	3416	5056	0.40
T4: EBDLM @ 100% N eq. ha^{-1}	3542	5184	0.41
T5: Cow urine @ 100% N eq. ha^{-1}	3083	4614	0.40
T6: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + VW spray @ 3%	3625	5421	0.40
T7: SWC @ 50% N eq. + BDLM @ 50% N eq. ha^{-1} + PG spray @ 3%	3905	5632	0.41
T8: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + VW spray @ 3%	4022	5712	0.41
T9: SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + PG spray @ 3%	4087	5760	0.42
T10: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + VW spray @ 3%	3250	4695	0.41
T11: SWC @ 50% N eq. + Cow urine @ 50% N eq. ha^{-1} + PG spray @ 3%	3363	4905	0.41
T12: Recommended FYM (10 t) + 100:50:50 kg NPK ha^{-1}	3138	3564	0.34
S.Em±	140.94	189.05	NS
C.D at 5 %	413.36	554.47	

Note: FYM @ 10 t ha^{-1} was applied for all the treatments except T_{12} and foliar application of VW & PG at 45 and 60 DAT. FYM: Farm Yard Manure; SWC: Sericulture Waste Compost; BDLM: Bio-Digested Liquid Manure; EBDLM: Enriched Bio-Digested Liquid Manure; VW: Vermiwash; PG: Panchagavya and DAT: Days After Transplanting

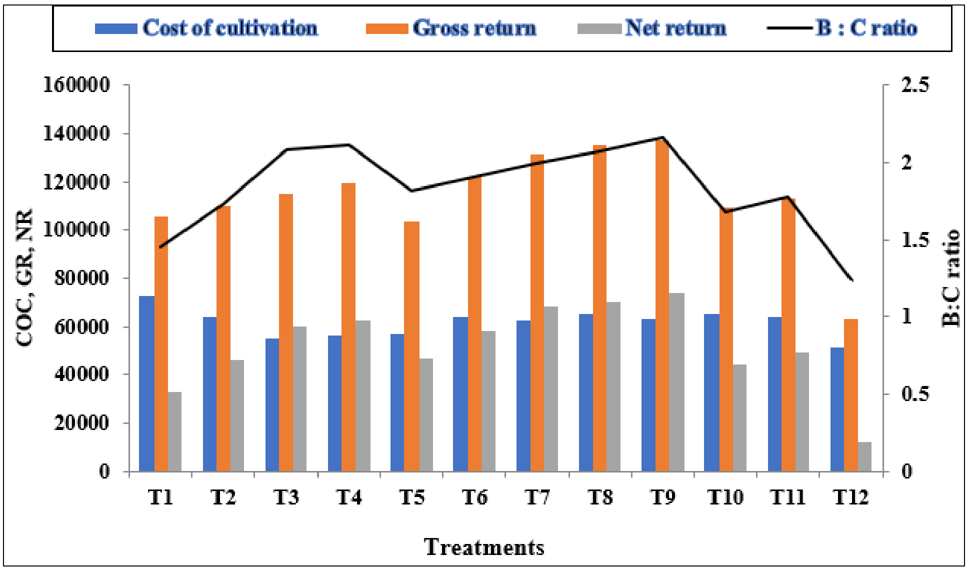

Fig 1: Economics of finger millet crop under Guni method as influenced by various organic nutrient sources

Conclusion

The findings of the field testing conclude that supplementation of SWC @ 50% N eq. + EBDLM @ 50% N eq. ha^{-1} + Panchagavya spray @ 3% was confirmed to be the best for determining better growth and yield in finger millet with higher net return and reduced cost of cultivation. This technology can be well adopted by farmers because liquid organic manures are easily prepared by using available farm inputs which improve soil health and productivity of the finger millet.

Abbreviations

EBDLM: Enriched bio-digested liquid manure; BDLM: Bio-digested liquid manure SWC: sericulture waste compost; FYM: Farm yard manure; VC: Vermi compost; PG: Pancha gavya; RDF: Recommended dose of fertilizer; LSD: Least significant difference; CD: Critical difference; ₹/ha: Rupees per hectare; kg/ha: Kilo grams per hectare; NPK: Nitrogen, Phosphorus, Potassium; °C: Degree Celsius; mm: milli metre; @: at the rate; %: Percent; NS: Non-significant; cm: centi metre; m: metre; B: C ratio: Benefit cost ratio; N eq. ha^{-1}: Nitrogen equivalent per hectare; VW: Vermi wash; t/ha: tones per hectare.

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Competing interests-The authors have said that there were no conflicting agendas.

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