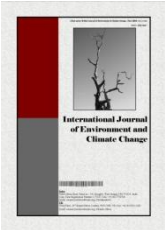

International Journal of Environment and Climate Change

12(11): 886-892, 2022; Article no.IJECC.90064
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Organic Manures and Organic Foliar Sprays on Yield Attributes and Yield of Barnyard Millet (*Echinochloa frumentacea* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2022/v12i1131054

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/90064

Original Research Article

Received 24 May 2022
Accepted 28 July 2022
Published 29 July 2022

ABSTRACT

A field experiment was conducted to study the effect of organic manures and organic foliar sprays on yield attributes and yield of barnyard millet during summer season (February-May) 2022 at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in factorial randomized block design (FRBD) with three replications comprising two factors. Factor I – organic manure with three levels *viz.,* Enriched farmyard manure (M_1), enriched vermicompost (M_2) and control (M_3). Factor II – organic foliar spray consisting of four levels *viz.,* 3% Panchagavya (F_1), 2 % pink pigmented facultative methylotrophs (PPFM) (F_2), 3% vermiwash (F_3) and water spray (F_4). From the experimental results, it was found that significant higher grain yield (2279 kg/ha) and straw yield (7204 kg/ha) were recorded by the application of enriched

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vermicompost @ 1 t ha^{-1} followed by application of enriched farmyard manure @ 1 t ha^{-1}. Significantly lower grain yield was produced in control (1717 kg/ha). Regarding organic foliar sprays, application of 3% panchagavya recorded maximum grain yield (2279 kg/ha). Among the nutrient sources used, enriched vermicompost @ 1 t ha^{-1} and foliar application of 3% panchagavya gave significantly superior yield.

Keywords: Barnyard millet; organic manure; panchagavya; enriched vermicompost; grain yield.

1. INTRODUCTION

Millets can grow well in a wide range of environmental conditions and they have more minerals and vitamins than the cereals and pulses. Hence they are called as “wonder crops”. The term millet is originated from the word “mil” meaning thousand. It denotes that 1000 number of grains can be obtained from one seed [1]. Cultivating millets helps in maintaining good biodiversity in agro-ecosystem as they are diversified cereals. Millets cultivation reduces the loss of soil and nutrients by providing a grassy cover with its dwarf stature [2]. Small millets are known for resilience and these crops have drought enduring capacity. It can be well suited for contingency crop planning and addressing the issues of climate change. These crops can withstand a certain degree of soil acidity and alkalinity, stress due to moisture and temperature and variation in soils from heavy to sandy infertile soils.

Small millets are cultivated with acreage of around 7.0 lakh ha with a productivity of 633 kg ha^{-1} in subsistence cropping system in India [3]. Barnyard millet grain consists of 49–65% carbohydrate. These carbohydrates primarily constitute dietary fibres that prevents constipation, lowers glycaemic load and reduces cholesterol level. It contains 14.7% crude fiber and 4% minerals. It has 18.6 mg/100g iron content which is the highest of all the millets. It contains 11.1% to 13.9% of protein [4]. It is a short-duration crop that can grow in adverse environmental conditions with almost no input and can withstand various biotic and abiotic stresses. Intensive cultivation of high nutrient demanding crops using synthetic inputs cause over exploitation of natural resources and affects health drastically. Organic farming proves to be an effective way to achieve sustainability and restoring soil fertility by eliminating the undesirable effects of conventional farming using inorganic inputs.

Balanced supply of nutrients through organic sources like farmyard manure, vermicompost, green manuring helps to sustain soil fertility, to produce maximum crop yield with optimum input level. Organic liquid formulations like panchagavya, vermiwash and pink pigmented facultative methylotrophs can be used as foliar spray to supply nutrients, plant growth hormones to achieve higher yield and protection from pest and diseases. Nowadays, consumers are more conscious of health which puts high demand for organically grown food products. Hence there is a wide scope for organic food.

Based on the above facts, a field experiment on “Effect of organic manures and organic foliar sprays on yield attributes and yield of barnyard millet” was formulated to study the effect of organic manures and organic foliar sprays on growth attributes, yield attributes and yield of barnyard millet.

2. MATERIALS AND METHODS

2.1 Experimental Location

The field experiments were carried out during summer season (February-May) of 2022 in Field No. 37F at Eastern Block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore which is located in Tamil Nadu's western agro-climatic zone at 11º02' N latitude, 76º94' E longitude and 427 m above mean sea level.

2.2 Experimental Design

The experiment was laid out in factorial randomized block design (FRBD) with three replications comprising 2 factors. Factor I – organic manure consists of 3 levels *viz.,* Enriched farmyard manure (M_1), enriched vermicompost (M_2) and control (M_3). Factor II – organic foliar spray consists of 4 levels *viz.,* 3% Panchagavya (F_1), 2 % pink pigmented facultative methylotrophs (PPFM) (F_2), 3% vermiwash (F_3) and water spray (F_4). Enriched farmyard manure and enriched vermicompost were applied as basal at the rate of 1 t ha^{-1}.

Organic foliar sprays were sprayed at 40 and 70 DAS of barnyard millet. High yielding barnyard millet variety MDU 1 was raised with a spacing of 25 × 10 cm. All management practices were carried out as per the recommendations of the crop.

2.3 Experimental Material

Enriched farm yard manure was prepared by using 10 kg of rock phosphate, 10 kg each of biofertilizers *viz*., *Azospirillum, Azotobacter* and *Phosphobacteria* and 2 kg of bio-mineralizer thoroughly mixed with one ton of well decomposed and powdered FYM on dry weight basis and made into a heap like structure. Bio-mineralizer was used to accelerate the decomposition rate. Watering was done periodically once in two days and turning was carried out on 15th day of composting. The heap was kept for 30 days for composting under the shade with 60 per cent moisture. Enriched vermicompost was prepared in similar way.

2.4 Biometric Observation

The growth parameters of crop plants were recorded from tagged plants in each plot at different growth stages *viz*., 40 DAS, 60 DAS, 80 DAS and harvesting stage of the crop. Growth parameters such as plant height, leaf area index, number of tillers m^{-2}, dry matter production and yield parameters such as number of productive tillers m^{-2}, 1000 grain weight, grain and straw yield were recorded by following standard procedure.

2.5 Statistical Analysis

The data on various characters studied during the course of examination were statistically analysed for factorial randomized block design. Wherever the treatment difference was significant, critical difference were worked out at five per cent probability level. Treatment differences that were not significant were denoted as “NS”.

3. RESULTS AND DISCUSSION

3.1 Influence of Organic Manure and Organic Foliar Spray on Growth Attributes of Barnyard Millet

3.1.1 Plant height (cm)

Plant height differed significantly among the organic manures and organic foliar sprays whereas their interaction remained non-significant (Table 1). The influence of organic manures on plant height was in the order of enriched vermicompost > enriched farmyard manure > control. Influence of organic foliar sprays was in the order of panchagavya > vermiwash > PPFM > water spray. Significantly higher plant height (152.2 cm) was recorded in plots where enriched vermicompost was applied @ 1 t ha^{-1} (M_2). It was followed by the application of enriched farmyard manure @ 1 t ha^{-1} (M_1). Significantly lower plant height was observed in control plots (137.5). Foliar application of 3% panchagavya (F_1) gave significantly higher plant height (154.5). It was followed by application of 3% vermiwash (F_3). It was observed that application of organic manures and organic foliar sprays enhanced the plant height. Plant height in grain crops depicts that plant metabolism was influenced by various nutrients. The enhanced plant growth in response to application of enriched vermicompost might be due to the presence of various macro and micro nutrients that are readily available to the plants. Higher plant height achieved by panchagavya applied plots might be due to plant hormones and beneficial microbes supplied by panchagavya.
Similar findings were recorded by Jothi et al., [5] who found that application of vermicompost and 3% panchagavya produced significantly superior growth and yield in rice. According to Muthuvel [6], foliar spray of 3% panchagavya obtained higher plant height and number of branches per plant in bhendi.

3.1.2 Leaf Area Index (LAI)

Organic manures and organic foliar sprays significantly influenced the leaf area index of barnyard millet while their interaction has no significant effect (Table1). Significantly greater leaf area index (8.25) was observed in plots that received enriched vermicompost @ 1 t ha^{-1} (M_2) followed by enriched farmyard manure @ 1 t ha^{-1} (M_1). With respect to organic foliar spray significantly superior leaf area index (8.42) was observed in the plots that were applied with 3% panchagavya (F_1). The higher leaf area index achieved from application of enriched vermicompost and panchagavya might be due to that enriched vermicompost supplies abundant macro and micro nutrients and soil enzymes and panchagavya providing plant growth hormones to the plants. Aravind *et al.* (2020) [7] recorded similar result with foliar spray of 3% panchagavya along with application of poultry manure achieved higher leaf area index in finger millet.

Table 1. Effect of organic manures and organic foliar sprays on plant height at harvest stage and leaf area index at 80 DAS

Treatment	Plant height (cm) @ harvest				Leaf Area Index (LAI) @ 80 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
F1	159.5	162.5	141.5	154.5	8.77	9.26	7.23	8.42
F2	148.2	146.3	137.5	144.0	8.01	7.83	6.85	7.56
F3	150.0	153.2	138.6	147.3	8.32	8.48	6.90	7.90
F4	143.8	146.8	132.4	141.0	6.97	7.45	6.09	6.83
Mean	150.4	152.2	137.5	146.7	8.02	8.25	6.77	7.68
Factor	M	F	M×F		M	F	M×F	
SEd	4.02	4.64	8.04		0.20	0.24	0.41	
CD (P=0.05)	8.34	9.63	NS		0.42	0.49	NS	

M_1 - Enriched farmyard manure, M_2- Enriched vermicompost, M_3 – Control; F_1 – 3% Panchagavya, F_2 – 2% Pink pigmented facultative methylotrophs, F_3 – 3 % vermiwash, F_4 – water apray

3.2 Influence of Organic Manures and Organic Foliar Sprays on Yield Attributes and Yield of Barnyard Millet

3.2.1 Yield attributes

Different yield components such as number of productive tillers m^{-2}, number of filled grains/panicle, 1000 grain weight attributes the yield. The yield attributes, grain yield and straw yield were significantly increased with the application of different organic manures and organic foliar sprays.

3.2.2 Productive tillers

Number of productive tillers m^{-2} produced is an important component that influences the yield. Number of productive tillers m^{-2} was significantly influenced by the application of organic manures and foliar sprays while their interaction remained non-significant (Table 2). The treatment that received enriched farmyard manure @ 1 t ha^{-1} produced significantly more number of productive tillers (224) which was followed by enriched vermicompost @ 1 t ha^{-1} (M_2). Significantly lower number of productive tillers (178) was produced by control (M_3). With respect to organic foliar sprays, application of 3% panchagavya (F_1) produced significantly more number of tillers (227) than vermiwash, PPFM and water spray.

3.2.3 Ear head length

The data regarding ear head length revealed that significantly longer ear head (20.5) was produced by the treatments that received enriched vermicompost @ 1 t ha^{-1} (Table 2) which was followed by enriched farmyard manure @ 1 t ha^{-1} (M_2) whereas significantly lower length (17.5) was produced by control (M_3). Foliar application of 3% panchagavya (F_1) produced significantly lengthier ear head (20.7) followed by 3% vermiwash (F_3).

Table 2. Effect of organic manures and organic foliar sprays on number of productive tillers m^{-2} and ear head length

Treatment	Number of productive tillers m^{-2}				Ear head length (cm)			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
F_1	247	242	193	227	21.4	22.3	18.4	20.7
F_2	217	214	174	202	19.9	19.6	17.3	18.9
F_3	221	228	187	212	20.2	20.8	17.5	19.5
F_4	206	211	157	191	18.8	19.4	16.8	18.3
Mean	223	224	178	208	20.1	20.5	17.5	19.4
Factor	M	F	M×F		M	F	M×F	
SEd	5.66	6.54	11.32		0.55	0.63	1.10	
CD (P=0.05)	11.74	13.55	NS		1.14	1.32	NS	

M_1 - Enriched farmyard manure, M_2- Enriched vermicompost, M_3 – Control ; F_1 – 3% Panchagavya, F_2 – 2% Pink pigmented facultative methylotrophs, F_3 – 3 % vermiwash, F_4 – water spray

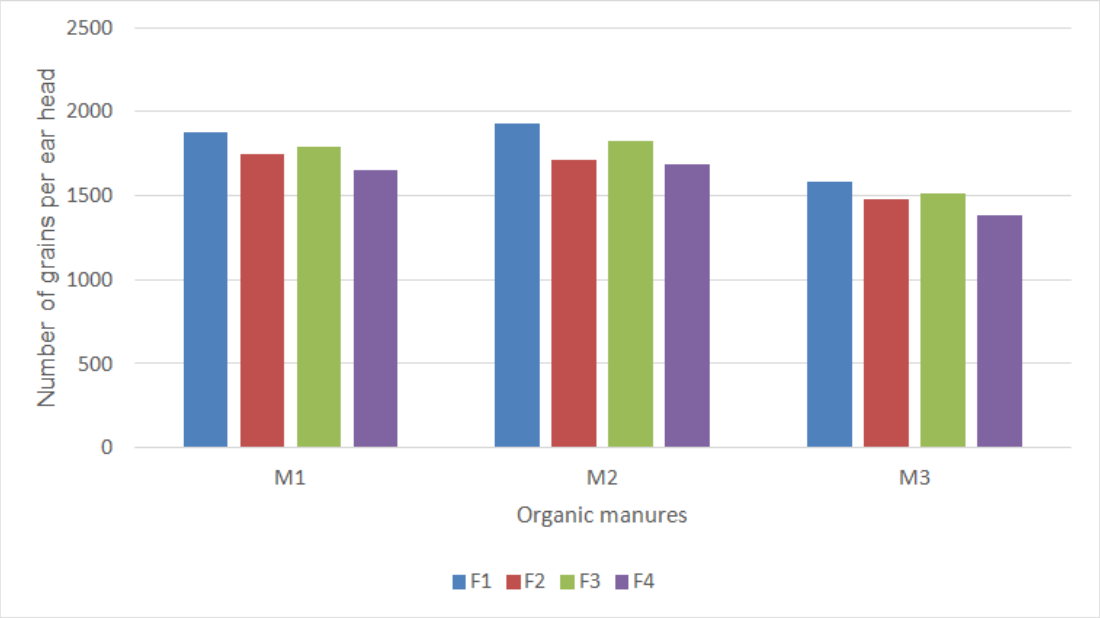

Fig. 1. Effect of organic manures and organic foliar sprays on number of grains per year head

Table 3. Effect of organic manures and organic foliar sprays on grain yield and straw yield

Treatment	Grain yield (kg/ha)				Straw yield (kg/ha)			
	M_1	M_2	M_3	Mean	M1	M2	M3	Mean
F_1	2405	2544	1887	2279	7450	7580	6753	7261
F_2	2062	2044	1659	1922	7105	7060	6379	6848
F_3	2169	2210	1747	2042	7021	7254	6694	6990
F_4	1907	1989	1576	1824	6894	6921	6124	6646
Mean	2136	2197	1717	2017	7118	7204	6487	6936
Factor	M	F	M×F		M	F	M×F	
SEd	53.44	61.71	106.88		223.58	258.16	447.15	
CD (P=0.05)	110.83	127.97	NS		463.67	NS	NS	

M_1 - Enriched farmyard manure, M_2- Enriched vermicompost, M_3 – Control; F_1 – 3% Panchagavya, F_2 – 2% Pink pigmented facultative methylotrophs, F_3 – 3 % vermiwash, F_4 – water spray

3.2.4 Number of grains per ear head

Organic manures and organic foliar sprays were significantly influenced the number of grains per ear head while their interaction remained non-significant (Fig 1). Significantly greater number of grains per ear head (1768) was produced by the treatment with application of enriched vermicompost @ 1 t ha^{-1} (M_2) followed by the enriched farmyard manure @ 1 t ha^{-1} (M_1). Application of 3% panchagavya (F_1) significantly increased the number of grains per ear head (1798) followed by 3% vermiwash (F_3).

3.2.5 Grain yield

Organic manures and organic foliar sprays influenced the grain yield of barnyard millet significantly while their interaction remained non – significant (Table 3). The grain yield was in the order of enriched vermicompost > enriched farmyard manure > control while in regard to foliar sprays it is in the order of panchagavya > vermiwash > PPFM > water spray. The plots in which enriched vermicompost @ 1 ha^{-1} (M_2) applied yielded significantly higher grain yield (2136 kg/ha) and it was followed by enriched farmyard manure (M_1). Significantly lower grain yield (1717 kg/ha) was recorded in control. Regarding organic foliar sprays significantly higher grain yield (2279 kg/ha) was produced by application of 3% panchagavya (F_1) against other foliar sprays. The greater yield by enriched vermicompost might be due to the fact that it contains assimilable macro and micro nutrients, plant growth harmones and soil enzymes that enhances soil microbes and retains soil nutrients

for a longer period. Manivannan et al. [8] supported this by stating that application of vermicompost significantly improved the soil available N, P, K and other micro nutrients. It also enhanced the soil microbes and soil enzyme activity. Panchagavya contains plant growth hormones and beneficial microorganisms naturally in it that can promote the growth and development of the plants [9].

The results are in line with Somasundaram et al., [10] who found that application of enriched vermicompost along with 5% egg amino acid gave significantly greater yield in finger millet. Application of vermicompost along with recommended dose of fertilizer and foliar application of 0.5% $ZnSO_4$ + 1% urea has recorded significantly higher growth and yield in barnyard millet [11]. Selvaraj [12] also observed that french bean yield was increased 36 per cent with application of vermicompost along with panchagavya. These findings were also supported by Shardha and Sujathamma [13] who concluded that NPK 50% + vermicompost + panchagavya 3% + jeevamrutha 5% gave the significantly higher grain yield in rice. Application of 100% N equivalent vermicompost (4 t ha^{-1}) along with FYM @ 7.5 t ha^{-1} gave superior yield in finger millet. Application of vermicompost @ 6 t ha^{-1} along with 3% panchagavya produced greater seed yield in green gram [14].

3.2.6 Straw yield

Straw yield was significantly influenced by organic manure while influence of organic foliar spray remains non – significant (Table 3). Significantly higher straw yield (7204 kg/ha) was obtained with the application of enriched vermicompost @ 1 t ha^{-1} (M_2) which was followed by enriched farmyard manure (M_1). Significantly lower straw yield (6487 kg/ha) was obtained in control. Shardha and Sujathamma revealed significantly higher straw yield was obtained with the application of 50% NPK + vermicompost + 3% panchagavya + 5% jeevamrutha. It was also supported by Somasundaram et al. [10] who reported significantly higher grain yield by application of enriched vermicompost @ 1 t ha^{-1} along with foliar spray of effective microorganism. Foliar spray of 3% panchagavya along with application of poultry manure resulted in superior grain and straw yield in finger millet [7].

4. CONCLUSION

It can be concluded from the above study that application of enriched vermicompost @ 1 t ha^{-1} recorded higher yield attributes *viz.,* number of productive tillers m^{-2}, number of grains per ear head and grain yield of barnyard millet. Among organic foliar sprays, application of 3% panchagavya resulted in maximum grain yield. Therefore, enriched vermicompost and panchagavya can be recommended to get the maximum yield in barnyard millet. Future line of work can be carried out to assess the performance of other sources of organic manures and foliar sprays on the yield of barnyard millet

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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