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Effect of Different Sources of Organic Manures on Growth and Yield of Foxtail Millet (*Setaria italica* L.) under Integrated Organic Farming System

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Authors' contributions

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

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ABSTRACT

Aims: To increase the area of millets under cultivation and also to create awareness about the use of different organic manures in agriculture.
Study Design: Randomized complete block design.
Place and Duration of Study: Department of Agronomy, MARS, University of Agricultural Sciences, Raichur, 2016 (kharif).
Methodology: As a part of the experiment, the solid wastes like cow dung, bullocks dung, feed waste, cattle shed wastes and all the goat droppings produced by livestock components in IFS were stored, composted and available quantity of nutrients in various organic manures was worked out on a dry weight basis. This available quantity of organic manure obtained from livestock components of IFS was calculated and utilized as per different treatment schedule.
Results: Results of study revealed that higher plant height (183.11 cm), Leaf area (22.60 cm^2 $plant^{-1}$), dry matter production (22.08 g $plant^{-1}$), total number of tillers at harvest (2.73), grain yield

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(1841 kg ha^{-1}), stover yield (7066 kg ha^{-1}) and harvest index (0.21) increased significantly due to application of jeevamrutha + mulching + IFS compost + vermicompost + panchagavya over control. The highest gross return (Rs. 56,996) and net return (Rs. 39,846) was obtained with jeevamrutha + mulching + IFS compost + vermicompost + panchagavya and minimum with control. This treatment is followed by jeevamrutha + mulching + IFS compost + panchagavya and IFS compost + panchagavya.

Conclusion: A long-term field investigation is needed to ascertain the benefits of organic manures and/ or liquid manures on yield and quality of millets and their effect on soil physical, chemical and biological properties.

Keywords: Foxtail millet; jeevamrutha; mulching; IFS compost; vermicompost; panchagavya.

1. INTRODUCTION

Integrated Farming System (IFS) is a multidisciplinary farm approach and is very effective in solving the problems of small and marginal farmers. In IFS system, an inter-related set of enterprises is used so that the "waste" from one component becomes an input for another part of the system, which in terms reduces the cost and also improves the production as well as increases income. The location specific farming system under different agro eco-systems needs to be developed based on available resources which will result in sustainable development [1]. In a recent energy crisis, hike in the prices of the inorganic fertilizers and declining soil health and productivity necessitate the use of organic manures compulsorily in agricultural crop production. The continuous use of inorganic fertilizers under intensive cropping system has caused widespread deficiency of secondary and micronutrients in soil [2]. Nowadays organic farming practices are gaining huge importance as farmers have realized the benefits of organic farming in terms of soil fertility, soil health and sustainable productivity. Farmers are well aware of the use of organic manure *viz*., compost, vermicompost and FYM and organic liquid manures such as panchagavya and jeevamrutha in organic farming. These organic liquid manures play a key role in promoting growth and providing immunity to plant system.

Foxtail millet is essentially a dry land crop belonging to the family of graminaceae and can be grown annually. The crop is cultivated in a variety of soils. It is grown in both red and black soils under rainfed condition with an annual rainfall of 500 mm to 700 mm rainfall areas with a prolonged summer. Foxtail millet requires less rainfall than sorghum, maize and wheat but success depends on strategic falls of rain. This crop has interesting properties i.e., fairly tolerant to drought, and can escape terminal drought because of early maturity. There is no need of much fertilizer and the seed viability is up to 3-4 years. The grain contains approximately 11.7% protein, 3.9% fat, 3% ash, 7% crude fiber and 60.9% carbohydrates [3]. Millets are amazing in their nutrient content. In India, small millets are cultivated over an area of 589.6 thousand ha with an annual production of 385.9 thousand tonnes and productivity of 654 kg ha^{-1}. In Karnataka, small millets occupy an area of 23.0 thousand ha, producing 12.0 thousand tonnes with an average productivity of 522 kg ha^{-1} [4]. The adoption of IFS can increase the area of millets under cultivation.

2. MATERIALS AND METHODS

A field experiment was conducted during the *Kharif* 2016 at IOFS unit of organic block of Main Agricultural Research Station (MARS), Raichur situated on the latitude of 16°12^{1} N latitude, 77°20^{1} E longitude with an elevation of 389 meters above mean sea level and is located in North Eastern Dry Zone of Karnataka. The experiment was laid out in RCBD with 10 treatments replicated thrice. The studies included ten treatments *i.e*., T_1- Control (No manure, no jeevamrutha and no mulching application), T_2-Jeevamrutha and mulching, T_3-Integrated farming system (IFS) compost equivalent to 100 per cent RDN, T_4-IFS compost equivalent to 50 per cent RDN + vermicompost equivalent to 50 per cent RDN, T_5-Jeevamrutha and mulching + IFS compost equivalent to 100 per cent RDN, T_6-Jeevamrutha and mulching + IFS compost equivalent to 50 per cent RDN + vermicompost equivalent to 50 per cent RDN, T_7-IFS compost equivalent to 100 per cent RDN + Foliar spray of 3 per cent panchagavya, T_8-IFS compost equivalent to 50 per cent RDN + vermicompost equivalent to 50 per cent RDN+ Foliar spray of 3 per cent panchagavya, T_9-Jeevamrutha and mulching + IFS compost equivalent to 100 per cent RDN + Foliar spray of 3 per cent panchagavya and T_{10}-Jeevamrutha and mulching

+ IFS compost equivalent to 50 per cent RDN + vermicompost equivalent to 50 per cent RDN+ Foliar spray of 3 per cent panchagavya. Foxtail millet variety SIA-2644 was selected for study.

Jeevamrutha was prepared in a drum by mixing 10 kg desi cow dung with 10 litres cow urine, 2 kg local jaggery, 2 kg pulse (Gram) flour and handful of rhizosphere soil and the volume was made with water upto 200 litres. This solution was kept in shade covering with wet gunny bag and was stirred the mixture clockwise twice a day for 8 days. Prepared Jeevamrutha was applied to the required plot at the time of sowing (500 litres ha^{-1}). Rice straw used for mulching at 30 DAS. IFS compost prepared by using crop residues as well as the solid wastes like cow dung, feed waste, cattle shed waste, and the goat droppings produced by livestock components of IFS unit were filled in pits of 2 m wide, 5 m length and 1 m depth to a thickness of about 15 cm. Cow dung slurry was spread over this layer to increase its biodegradation. These materials applied in alternate layers till the height reached 0.3 m above ground level as per the composting procedure. The IFS compost was ready within 4 to 4 $^{1}/_{2}$ months. Panchagavya was prepared by using the ingredients *viz*., cow dung (7 kg), cow urine (3*l*), cows milk (2*l*), curd made from cow milk (2*l*), ghee made from cow milk (2*l*), tender coconut water (3*l*) and ripened banana (12 Nos) as per the procedure given by [5]. The soil of the experimental site was deep black and clay in texture with the available nitrogen (134.26 kg ha^{-1}), phosphorus (57.32 kg ha^{-1}), potassium (471.55 kg ha^{-1}), organic carbon content (0.61%).

3. RESULTS AND DISCUSSION

Results obtained in the present field trial showed that treatment supplemented with jeevamrutha + mulching + IFS compost + vermicompost + panchagavya recorded significantly higher growth parametes *viz*., plant height (183.11 cm), leaf area (22.60 cm^2 $plant^{-1}$), dry matter production (22.08 g $plant^{-1}$) and total number of tillers at harvest (2.73) and was on par with jeevamrutha + mulching + IFS compost + panchagavya (Table 1). However, significantly lower growth parmeters were recorded with control treatment. This might be due to adequate supply of nutrients at different growth stages of the crop as well as presence of growth regulators in Panchagavya contributing to higher grain yield [6] and [7]. The yield of any crop plants depends on the assimilatory surface of the plant system. A sound source interms of plant height, leaf area, Stem girth to support and hold the leaves are logically able to increase the dry matter and its distribution in different parts is important for determination of total yield of the crop [8].

Grain and stover yield of foxtail millet was significantly influenced by the nutrient management practices through IOFS. The data revealed that maximum grain and stover yield of was obtained with the application of jeevamrutha + mulching + IFS compost + vermicompost + panchagavya (1841 kg ha^{-1} and 7066 kg ha^{-1}) which was significantly superior over all other treatments except the treatments receiving jeevamrutha + mulching + IFS compost + panchagavya (1717 kg ha^{-1} and 7066 kg ha^{-1}) and IFS compost + panchagavya (1660 kg ha^{-1} and 6263 kg ha^{-1}) (Table 2). The lower grain and stover yield of foxtail millet (736 kg ha^{-1} and 5225 kg ha^{-1}) was obtained with control treatment (no manure no jeevamrutha and no mulching). [9] and [10]. Further, in the treatments which received mulching practice along with combined application of organics (jeevamrutha + mulching + IFS compost + vermicompost + panchagavya and jeevamrutha + mulching + IFS compost + panchagavya) might have resulted in higher soil moisture content and better ecological environment and thus resulting in higher grain yield and stover yield of foxtail millet. [11] also noticed better soil environment and higher crop productivity.

Economic analysis indicated that treatments receiving jeevamrutha + mulching + IFS compost + vermicompost + panchagavya recorded significantly higher net returns (Rs. 39,846 ha^{-1}) and was found on par with jeevamrutha + mulching + IFS compost + panchagavya (Rs. 36,863 ha^{-1}), IFS compost + panchagavya, (Rs. 36,374 ha^{-1}) and IFS compost + vermicompost + panchagavya (Rs. 34,046 ha^{-1}) (Table 3). This could be attributed to higher grain yield of foxtail millet in these organic manurial treatments. The lower net returns were obtained in control plot (Rs. 14,442 ha^{-1}) which might be because of lower grain yield in the treatment. Treatment receiving jeevamrutha + mulching recorded significantly higher BC ratio (3.48) which inturn was statistically on par with all organic treatments except control and jeevamrutha + mulching + IFS compost + vermicompost because of lower production cost apart from higher grain yield (Table 2). These results are in conformity with the findings of [12,13,14,15] and [16].

Table 1. Plant height (cm), Leaf area (cm^2 $plant^{-1}$), Dry matter production (g $plant^{-1}$) and Number tillers $plant^{-1}$ at harvest at different growth stages of foxtail millet as influenced by nutrient management practices through Integrated Organic Farming System

Treatments	Plant height (cm)	Leaf area (cm^2 $plant^{-1}$)	Dry matter production (g $plant^{-1}$)	Number tillers $plant^{-1}$ at harvest
T_1: Control (No manure, no jeevamrutha and no mulching application)	170.28	14.73	13.05	1.40
T_2: Jeevamrutha + mulching	172.79	17.47	16.68	1.80
T_3: IFS compost*	178.49	18.17	16.99	2.20
T_4: IFS compost + vermicompost**	177.03	17.23	17.55	2.00
T_5:Jeevamrutha + mulching + IFS compost*	181.26	19.73	17.83	2.40
T_6: Jeevamrutha+mulching + IFS compost + vermicompost**	179.79	18.00	18.01	1.93
T_7: IFS compost* + panchagavya	181.27	19.18	18.61	2.47
T_8: IFS compost + vermicompost** + panchagavya	173.63	20.80	17.98	2.07
T_9: Jeevamrutha + mulching + IFS compost* + panchagavya	182.21	21.53	20.85	2.53
T_{10}:Jeevamrutha + mulching + IFS compost + vermicompost** + panchagavya	183.11	22.60	22.08	2.73
S. Em±	1.87	0.48	0.49	0.13
C. D. at 5%	5.56	1.42	1.45	0.38

** Integrated Farming System compost equivalent to 100 % RDN (30 kg ha^{-1}) in T_3, T_5, T_7, and T_9*
*** IFS compost (50%) + vermicompost (50%) equivalent to 100 % RDN (30 kg ha^{-1}) in T_4, T_6, T_8, and T_{10}*
Foliar spray of panchagavya (3%) at 30 DAS and 45 DAS

Table 2. Grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index of foxtail millet as influenced by nutrient management practices through Integrated Organic Farming System

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (HI)
T_1: Control (No manure, no jeevamrutha and no mulching application)	736	5225	0.12
T_2: Jeevamrutha + mulching	1376	5589	0.20
T_3: IFS compost*	1362	5743	0.19
T_4: IFS compost + vermicompost**	1395	6010	0.19
T_5: Jeevamrutha + mulching + IFS compost*	1523	5963	0.20
T_6:Jeevamrutha + mulching + IFS compost + vermicompost**	1360	6096	0.18
T_7: IFS compost* + panchagavya	1660	6263	0.21
T_8:IFS compost + vermicompost** + panchagavya	1594	6272	0.20
T_9: Jeevamrutha + mulching + IFS compost* + panchagavya	1717	6856	0.20
T_{10}: Jeevamrutha + mulching + IFS compost + vermicompost** + panchagavya	1841	7066	0.21
S. Em±	77	148	0.01
C. D. at 5%	231	442	NS

** Integrated Farming System compost equivalent to 100 % RDN (30 kg ha^{-1}) in T_3, T_5, T_7, and T_9*
*** IFS compost (50%) + vermicompost (50%) equivalent to 100 % RDN (30 kg ha^{-1}) in T_4, T_6, T_8, and T_{10} Foliar spray of panchagavya (3%) at 30 DAS and 45 DAS*

Table 3. Cost of cultivation, gross returns, net returns and BC ratio of foxtail millet as influenced by nutrient management practices through Integrated Organic Farming System

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net Returns (Rs. ha^{-1})	BC ratio
T_1: Control (No manure, no jeevamrutha and no mulching application)	8954	23396	14442	2.61
T_2: Jeevamrutha + mulching	12249	42657	30408	3.48
T_3: IFS compost*	12819	42306	29487	3.30
T_4: IFS compost + vermicompost**	13393	43362	29969	3.24
T_5:Jeevamrutha + mulching + IFS compost*	15033	47191	32158	3.14
T_6:Jeevamrutha + mulching + IFS compost + vermicompost**	15164	42324	27160	2.79
T_7: IFS compost* + panchagavya	14992	51366	36374	3.43
T_8:IFS compost + vermicompost** + panchagavya	15342	49388	34046	3.22
T_9: Jeevamrutha + mulching + IFS compost* + panchagavya	16371	53234	36863	3.25
T_{10}: Jeevamrutha + mulching + IFS compost + vermicompost** + panchagavya	17150	56996	39846	3.32
S. Em±			2344	0.18
C. D. at 5%			6966	0.53

** Integrated Farming System compost equivalent to 100 % RDN (30 kg ha^{-1}) in T_3, T_5, T_7, and T_9*

*** IFS compost (50%) + vermicompost (50%) equivalent to 100 % RDN (30 kg ha^{-1}) in T_4, T_6, T_8, and T_{10} Foliar spray of panchagavya (3%) at 30 DAS and 45 DAS*

4. CONCLUSION

In rainfed integrated organic farming production system, higher grain yield and net returns from foxtail millet cultivation could be obtained with application either jeevamrutha + mulching + ifs compost (equivalent to 50% RDN) + vermicompost (equivalent to 50% RDN) + 3% foliar spray of panchagavya at 30 and 45 DAS or jeevamrutha + mulching + ifs compost (equivalent to 100% RDN) + 3% foliar spray of panchagavya at 30 and 45 DAS or ifs compost (equivalent to 100% RDN) + 3% foliar spray of panchagavya at 30 and 45 DAS or ifs compost (equivalent to 50% RDN) + vermicompost (equivalent to 50% RDN) + 3% foliar spray of panchagavya at 30 and 45 DAS.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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