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Zinc and Iron fortification through enriched organics and foliar nutrition on growth, yield and economics of foxtail millet (*Setaria italica*

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ABSTRACT

An experiment was conducted to study the impacts of zinc and iron enriched organic manures on growth and yield of foxtail millet in an Organic block. Results revealed that significantly higher grain and stover yield, net returns and Benefit cost ratio (1262 kg/ha, 4210 kg/ha, ₹ 27185 /ha and 2.83 respectively) were recorded with application of Zn and Fe enriched compost along with foliar spray of panchagavya and was found on par with the treatment receiving Zn and Fe enriched vermicompost along with foliar spray of $ZnSO_4$ and $FeSO_4$ (0.5 %) at 30 DAS (1232 kg /ha, 4195 kg /ha,₹ 25522 /ha and 2.62 respectively) and Zn and Fe enriched vermicompost along with foliar spray of panchagavya (3%) at 30 and 45 DAS (1137 kg /ha, 4092 kg /ha, ₹ 21897 /ha and 2.31 respectively). These treatments also showed similar effects with respect to growth and yield parameters contributing for the higher yield and monetary benefits.

Introduction

Malnutrition is a prime fitness problem specifically in less evolved international locations. Millet, called nutrient-dense cereals, attracts greater awareness on research in the areas of bio-fortification and to be able to feed the developing population international with high quality meals, multiplied yields are wished. The adoption of recent technology without thinking about the soil heath condition, a good way to increase crop manufacturing has brought about a fast depletion of vitamins and soil fertility. Among micronutrients, Zn and Fe are highly depleted nutrients that cause terrible crop yields. negative agricultural zinc with terrible zinc (much less than 30%) is considered to be ubiquitous inside the international. because of the ongoing erosion of soil fertility, zinc deficiency in Indian soil is expected to upward push from 42 per cent in 1970 to 63 percent by 2025 (Singh, 2011). Decreased growth, abnormal brain growth, accelerated hazard of infectious diseases which includes pneumonia and diarrhea, and unfavorable beginning consequences in pregnant ladies are all related to zinc deficiency (Black *et al.,* 2008). Abnormal iron metabolism is one of the most common human sicknesses, accompanying with medical symptoms which includes anemia, iron overdose and neurodegenerative diseases (Nazanin *et al.*, 2014). Consistent with iron (Fe) deficiency data in India, 79 percent of preschool youngsters and fifty six percent of women have anemia (Krishnaswamy, 2009) because 1970, India's iron supplementation program has did not deal with iron

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deficiency (Anand *et al*., 2014).Foxtail millet is fairly drought tolerant. It can be planted as a short-term catch crop as a solitary crop or as an intercrop due to its rapid growth. It is a very rich source of various micro and macro nutrients, vitamins as well as minerals. studies display that one hundred grams of foxtail millet grains comprise 12.3 percent protein, 60.9 gram of carbohydrate, 4.3 gram of fat, 3.5 gram of ash, 8 gram of crude fiber, 31 milli gram of calcium, 4.9 milligram of iron, 0.31 milligram of phosphorus, 9.2 milligram of copper, 21.4 milligram of zinc, 0.27 milligram of potassium, 0.01 milligram of sodium, 0.13 milligram of magnesium, 21.9 milligram of manganese, 31 milligram of vitamin E, 0.99 milligram of thiamin, 0.099 milligram of riboflavin, 3.70 milligram of niacin, and 351 kilocalories of energy (Anonymous, 2017). Due to its growth in barren soils with little enter, the yield price of this plant does now not change below rain-fed situations, and the potential yield is yet to be decided. The loss of product is in particular due to low soil fertility, which may be stored inside the organic device for a long time. The plant responds nicely to natural rely due to its low nutrient requirement. Enrichment the use of natural manure, which acts as natural chelates, found economically viable technique. Addition of micronutrients to natural manures, notably zinc and iron, along with increasing decomposition rate, it improves the quality of grain.The process of boosting the natural content of bioavailable nutrients in agricultural plants is referred to as biofortification. Fundamental bio-enriched meals might not offer excessive degrees of minerals and nutrients as nutritional dietary supplements or fortified ingredients, however they can boom micronutrient consumption in terrible dietary supplements on a day by day basis, and therefore complement present remedies. (Prasenjit *et al*., 2016). within the case of biodiversity, gronomic bio-fortification is achieved through the use of natural matter and / or by means of making use of micronutrient fertilizer to the soil and / or by spraying directly on leaves. Biologically enriching with micronutrients along with improving the quality of organics it also enhances quality of grain (developing quantity of micronutrients, minerals, and vitamins), as well as yields and economic returns. (Savithri *et al.,* 1999, Anil kumar and Kubsad, 2017, Patil *et al.,* 2016, Nikhil and Salakinkop, 2017).

Material and Methods

During the 2018 Kharif, field research was carried out at the Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka, India, located between 16° 12 ' North latitude and 77° 20' East longitude at an altitude of 389 meters above sea level and falls within Karnataka's North Eastern Dry Zone. The study used a randomized block design with ten treatments replicated thrice. Zn and Fe rich compost and vermicompost application with $ZnSO_4$ @ 15 kg/ha and $FeSO_4$ @ 10 kg/ha alone and 3.0% panchagavya spray at 30 and 45 DAS and 0.5 percent $ZnSO_4$ and $FeSO_4$ each in 30 DAS, and compost alone was a treatment option. Enriched manures are applied in comparable to 100% recommended dose. Variety, SiA-2644 high in Fe and medium in Zn content was chosen for study. Natural manure (compost and vermicompost) is enriched with micronutrients such as $ZnSO_4$ and $FeSO_4$ in a recommended dose of $ZnSO_4$ @ 15 kg/ha and $FeSO_4$ @ 10 kg/ha and the manure is allowed to ferment for a month by spraying water regularly and mixing content 2 to 3 times a day. Fermented manure is applied during sowing as per treatment Nutrient composition of compost, enriched compost, vermicompost and enriched vermicompost were 0.77 % N, 0.68 % P_2O_5, 1.01 % K_2O, 75.4 ppm Zn and 1465 ppm Fe ; 1.12 % N, 0.72 % P_2O_5, 1.05 % K_2O, 77.6 ppm Zn and 1500 ppm Fe; 1.57 % N, 0.79 % P_2O_5, 1.22 % K_2O, 84 ppm Zn and 1247.3 ppm Fe and 1.68 % N, 0.82 % P_2O_5, 1.25 % K_2O, 90 ppm Zn and 1290 ppm Fe respectively. Test site was consist of deep black soil with slightly alkaline (pH 7.71), Electrical conductivity (Ec) of 0.22 dSm^{-1} , medium organic carbon content (0.6 percent), low N (137.2 kilogram per hectare), high phosphorus and high potassium (74.70 and 752.5 kilogram per hectare), low Zn (0.58 parts per million), and high Fe (13.91). On August 4, 2018, brushing at a distance of 4 cm in shallow furrows was used for sowing.

Results and Discussion

Growth conditions: The plant's vegetative and reproductive growth are vital in realizing the crop's potential output. Height of the plant and tillers plant^{-1} at harvest (Table 1) was significantly higher with application Zn and Fe enriched compost, comparable to 100 % recommended dose of nitrogen + foliar sprays of 3.0 % panchagavya (122.73 and 2.27 at harvest, respectively) and followed by Zn and Fe enriched vermicompost, comparable to 100 % recommended dose of nitrogen + foliar spray of 0.5 % $ZnSO_4$ and $FeSO_4$ each and Zinc and iron enriched vermicompost along with foliar spray of 3.0 percent panchagavya over other treatments. Plant height improvements owing to Zn and Fe enhanced organics and foliar sprays might be linked to good crop nutrition, which resulted in optimal growth and these results were in line with Shilpa (2011) reported that growth parameters like plant height (53.33 cm at tillering stage, 64.67 cm at panicle initiation stage and 89.00 cm at harvest stage), number of panicles (288 per m^2) were significantly increased in the treatment of 100 % NPK + FYM + 1 % FYM fortified $ZnSO_4$ + 1 % FYM fortified $FeS0_4$ in rice, Manjunatha *et al.* (2013), observed that among the different enriched compost treatments, application of enriched compost @ 6 t/ha + 100 per cent recommended NPK in sunflower produced significantly higher plant height and number of leaves (158.6 cm and 16.9) as compared to 100 per cent recommended NPK + FYM @ 6 t/ha and compost alone, Mahantesh (2016) and Meena and Fathima (2017).

At harvest, Zinc and iron enriched compost + panchagavya application had a comparatively greater leaf area index (0.91) ,and was on par with, Zn and Fe enriched vermicompost along with foliar spray of $ZnSO_4$ and $FeSO_4$ (0.87) and Zn and Fe enriched vermicompost comparable to 100 percent recommended dose of nitrogen + foliar spray of $ZnSO_4$ and $FeSO_4$ (0.87) and Zn and Fe enriched vermicompost (0.87). The compost application equivalent to 100 percent RDN resulted in a much lower leaf area index (0.82), which was comparable to the other manurial treatments. The improvement in leaf area index was attributed to a significant increase in assimilatory surface area, which resulted in higher photosynthetic accumulation. This could possibly be credited to pile up the nutritional accessibility for plants to uptake, that could have resulted surge in the cell growth and a greater assimilatory surface. These findings were in accord with Shilpa (2011) and Anilkumar and Kubsad (2017), revealed that soil application of RDF + enriched FYM (*i.e.* 50 kg FYM /ha + 3.75 kg $ZnSO_4$ and $FeSO_4$ /ha) to sorghum recorded significantly higher gross returns (Rs. 211924 /ha), net returns (Rs. 85702 /ha) and BC ratio (3.50) over control.

Zn and Fe enriched compost along with foliar spray of panchagavya appliction resulted in more dry matter accumulation in different plant parts at different growth stages (leaves, stem, and reproductive parts), but it was on par with the application of Zn and Fe enriched vermicompost + foliar spray of $ZnSO_4$ and $FeSO_4$ and Zn and Fe enriched vermicompost. When compared to the other treatments, compost application equivalent to 100 percent recommended dose of nitrogen resulted in much lower dry matter buildup in leaves, stems, and reproductive regions. (Fig 2)

At different growth stages (Table 2), significantly higher total dry matter production was noticed with application of Zn and Fe enriched compost along with foliar spray of panchagavya and on par results with application of Zn and Fe enriched vermicompost along with foliar spray of $ZnSO_4$ and $FeSO_4$ and Zn and Fe enriched vermicompost + foliar spray of panchagavya which were superior over compost application alone and remaining treatments at different growth stages. Individual plant elements such as leaves, stems, and reproductive parts accumulate more dry matter in various treatments, results in higher overall dry matter output. These results were conforming to Senthil *et al*. (2004), opined from his experimental results that zinc and iron enriched coir pith (1 t/ha) in curcumin recorded significantly higher leaf dry matter, stem dry matter and rhizome yield of turmeric (770 kg/ha, 543 kg/ha and 28 t/ha) over control and other treatments, however the same treatment was found on par with zinc and iron enriched with FYM (1 t/ha). Mahantesh (2016), and Patil *et al*. (2017), opined that significantly higher maize grain (60.9 q/ha) and straw yield (62.57 q/ ha) was recorded with application of 7.5 t of maize residue compost enriched with 15 kg $ZnSO_4$ on account of significantly higher test weight (31.51 g), grain yield plant^{-1} (134.7 g/ plant) and total dry matter production (326.38 g/plant).

Table 1 : Growth parameters of foxtail millet as influenced by agronomic fortification through organic nutrient management practices

Treatments	Plant height (cm)			Number of tillers per plant at harvest	LAI		
	30 DAS	60 DAS	At harvest		30 DAS	60 DAS	At harvest
T1: Compost*	18.15	101.00	106.00	2.00	0.47	1.30	0.82
T2: Enriched compost** with Zn and Fe	19.97	106.33	112.93	2.07	0.52	1.37	0.84
T3: Enriched vermicompost*** with Zn and Fe	21.37	113.33	115.53	2.13	0.54	1.39	0.86
T4: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$	20.78	111.13	114.40	2.07	0.52	1.38	0.86
T5: Enriched compost** with Zn and Fe +Foliar spray of Panchagavya	22.44	120.60	122.73	2.27	0.63	1.49	0.91
T6: Enriched vermicompost*** with Zn and Fe +Foliar spray of Panchagavya	21.88	114.53	120.13	2.23	0.56	1.40	0.87
T7: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of Panchagavya	18.29	102.47	106.20	2.07	0.50	1.35	0.83
T8: Enriched compost** + Foliar spray of $ZnSO_4$ and $FeSO_4$	21.67	114.07	115.60	2.20	0.54	1.39	0.86
T9: Enriched vermicompost*** + Foliar spray of $ZnSO_4$ and $FeSO_4$	22.42	118.27	122.33	2.27	0.57	1.41	0.87
T10: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of $ZnSO_4$ and $FeSO_4$	21.10	111.60	115.20	2.10	0.52	1.38	0.86
S. Em±	0.94	2.38	2.97	0.06	0.02	0.03	0.01
C. D. at 5%	2.79	7.06	8.84	0.17	0.06	0.09	0.04

Table 2 : Growth parameters of foxtail millet as influenced by agronomic fortification through organic nutrient management practices

Treatments	DMP (g/plant)			Rate of DMP (g/plant/day)	
	30 DAS	60 DAS	At harvest	31 DAS to 60 DAS	61 DAS to harvest
T1: Compost*	0.28	3.59	6.19	0.11	0.08
T2: Enriched compost** with Zn and Fe	0.38	4.07	7.52	0.12	0.11
T3: Enriched vermicompost*** with Zn and Fe	0.45	4.49	8.21	0.13	0.12
T4: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$	0.41	4.22	7.64	0.13	0.11
T5: Enriched compost** with Zn and Fe +Foliar spray of Panchagavya	0.49	5.32	9.57	0.16	0.13
T6: Enriched vermicompost*** with Zn and Fe +Foliar spray of Panchagavya	0.45	4.73	8.43	0.14	0.12
T7: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of Panchagavya	0.36	3.74	7.31	0.11	0.11
T8: Enriched compost** +Foliar spray of $ZnSO_4$ and $FeSO_4$	0.45	4.54	8.29	0.14	0.12
T9: Enriched vermicompost*** + Foliar spray of $ZnSO_4$ and $FeSO_4$	0.48	4.89	8.93	0.15	0.13
T10: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of $ZnSO_4$ and $FeSO_4$	0.43	4.41	7.93	0.13	0.11
S. Em±	0.03	0.21	0.33	0.01	0.01
C. D. at 5%	0.08	0.62	0.98	0.02	0.03

Table 3 : Yield and yield parameters of foxtail millet as influenced by agronomic fortification through organic nutrient management practices

Treatments	Ear head length (cm)	Ear head weight (g)	Grain yield plant^{-1} (g)	1000 seed weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index
T_1: Compost*	14.53	3.57	3.28	2.83	695	3080	0.18
T_2: Enriched compost** with Zn and Fe	15.47	4.29	3.57	3.03	837	3704	0.18
T_3: Enriched vermicompost*** with Zn and Fe	16.07	4.49	4.21	3.21	917	3918	0.19
T_4: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$	15.87	4.37	3.90	3.04	869	3794	0.19
T_5: Enriched compost** with Zn and Fe +Foliar spray of Panchagavya	16.53	5.36	4.88	3.47	1262	4210	0.23
T_6: Enriched vermicompost*** with Zn and Fe +Foliar spray of Panchagavya	16.27	5.12	4.47	3.24	1137	4092	0.22
T_7: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of Panchagavya	15.87	4.22	3.38	3.01	795	3523	0.18
T_8: Enriched compost** + Foliar spray of $ZnSO_4$ and $FeSO_4$	16.13	4.96	4.35	3.21	951	4065	0.19
T_9: Enriched vermicompost*** + Foliar spray of $ZnSO_4$ and $FeSO_4$	16.33	5.18	4.70	3.32	1232	4195	0.23
T_{10}: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of $ZnSO_4$ and $FeSO_4$	15.93	4.38	3.92	3.19	889	3898	0.19
S. Em±	0.37	0.30	0.32	0.15	83	175	0.01
C. D. at 5%	NS	0.89	0.95	NS	246	521	NS

Table 4: Economics of foxtail millet as influenced by agronomic fortification through organic nutrient management practices

Treatments	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit Cost ratio
T_1: Compost*	12578	25070	12492	1.99
T_2: Enriched compost** with Zn and Fe	13578	30177	16599	2.22
T_3: Enriched vermicompost*** with Zn and Fe	15450	32716	17266	2.12
T_4: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$	13578	31210	17632	2.30
T_5: Enriched compost** with Zn and Fe +Foliar spray of Panchagavya	14878	42063	27185	2.83
T_6: Enriched vermicompost*** with Zn and Fe +Foliar spray of Panchagavya	16750	38647	21897	2.31
T_7: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ +Foliar spray of Panchagavya	14878	28679	13801	1.93
T_8: Enriched compost** + Foliar spray of $ZnSO_4$ and $FeSO_4$	13903	33943	20040	2.44
T_9: Enriched vermicompost*** + Foliar spray of $ZnSO_4$ and $FeSO_4$	15775	41297	25522	2.62
T_{10}: Compost* + Soil application of $ZnSO_4$ and $FeSO_4$ + Foliar spray of $ZnSO_4$ and $FeSO_4$	15775	31974	16199	2.03
S. Em±	-	2224	2224	0.15
C. D. at 5%	-	6608	6608	0.45

***Compost equivalent to 100 % RDN in T_1, T_4, T_7 and T_{10}**　　**DAS: Days after sowing**

****Enriched compost equivalent to 100 % RDN in T_2, T_5 and T_8**

*****Enriched vermicompost equivalent to 100 % RDN in T_3, T_6 and T_9**

$ZnSO_4$ @ 15 kg/ha and $FeSO_4$ @ 10 kg ha^{-1} application to soil

0.5 % $ZnSO_4$ and 0.5 % $FeSO_4$@ 30 DAS and 3.0 % of Panchagavya at 30 and 45 DAS foliar application

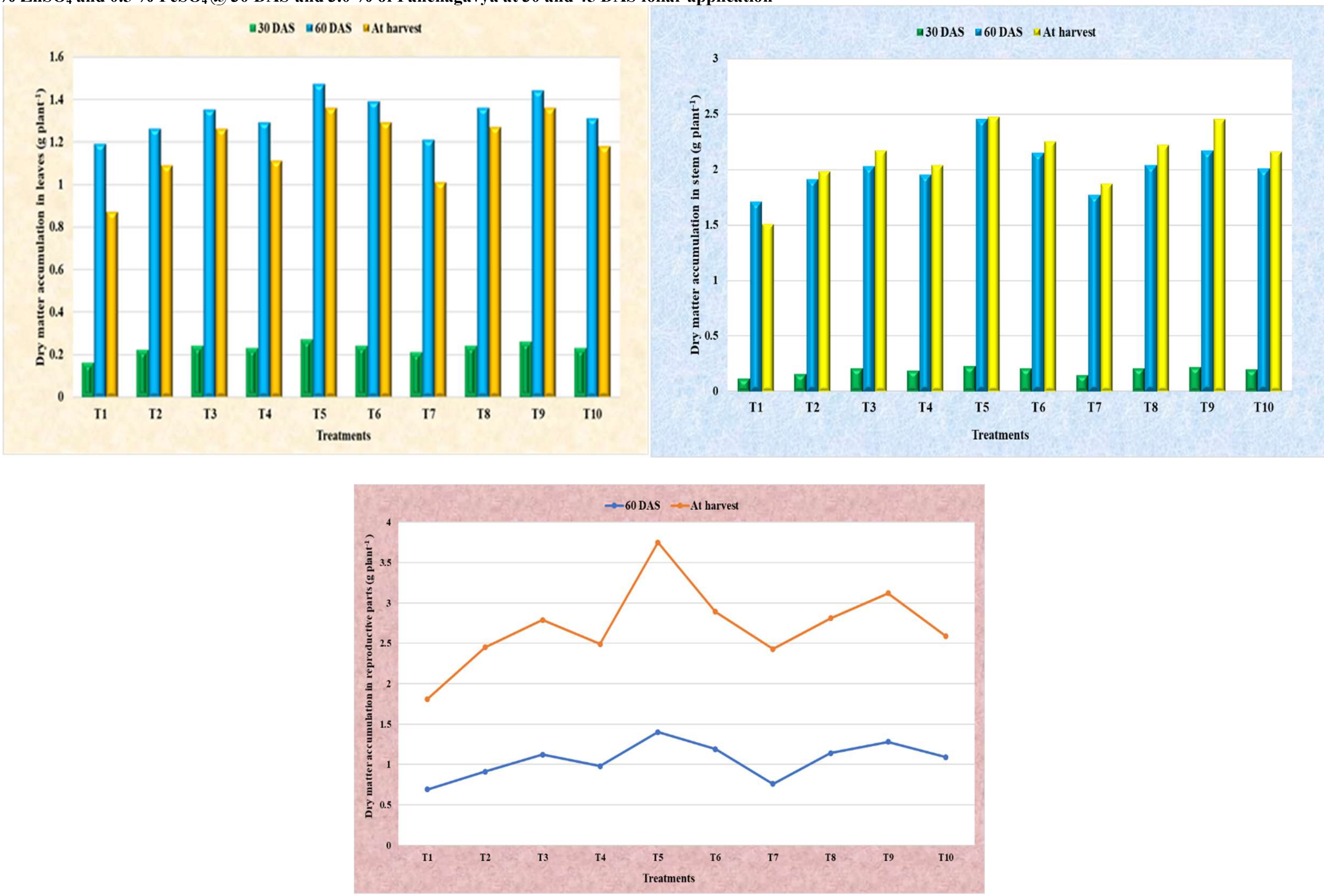

Fig. 1: Dry matter accumulation in leaves, stem and reproductive parts (g/plant) at different growth stages of foxtail millet as influenced by agronomic fortification through organic nutrient management practices

Rate of dry matter production is higher with Zn and Fe enriched compost, along with foliar spray of three percent panchagavya application, this is due to increase in balanced and continuous supply nutrients resulted in higher photosynthesis and translocation of photosynthates to the different parts of the plant. These findings were in agreement with Latha and Sharanappa (2014) opined that application of enriched biodigested liquid organic manure (EBDLM) at 25 kg N equivalent ha^{-1} + 3 sprays of panchagavya at 3% resulted in significantly higher pod yield and kernel yields (2.34 and 1.78 t/ha respectively) and the yield attributes like number of pods/plant and shelling outturn (47.2 and 76.0% respectively) of groundnut and also resulted in higher onion bulb yield (37.78 t/ha) and yield parameters like bulb diameter (6.10 cm), bulb length (5.52 cm) and bulb size index (33.7) in the groundnut-onion cropping system. and Pradeep and Sharanappa (2014) revealed that application of enriched bio digested liquid manure at 125 kg N equivalent/ha + 3 sprays of panchagavya (3 %) to chilli crop resulted in significantly higher plant height, branches per plant, leaf area index, leaf area duration, total dry matter production and dry fruit yield as compared to control.

Yield parameters: Different agronomic fortification procedures had a considerable impact on foxtail millet grain output (Table 3). Application of Zn and Fe enriched compost with foliar spray of panchagavya (3 %) @ 30 and 45 DAS resulted in significantly higher grain yield (1262 kg/ha) and on par with the treatment receiving Zn and Fe enriched vermicompost comparable to 100 percent recommended dose of nitrogen + foliar spray of $ZnSO_4$ and $FeSO_4$ (0.5 % each) (1232 kg/ha) and Zn and Fe enriched vermicompost + foliar spray of panchagavya @ 30 and 45 DAS (1137 kg/ha). These treatments outperformed compost equivalent to 100 percent RDN, which produced lower grain yields (695 kg/ha). With Zinc and iron enriched compost along panchagavya spray, Zinc and iron enriched vermicompost with foliar spray of $ZnSO_4$ and $FeSO_4$ and Zinc and iron enriched vermicompost + 0.5 percent panchagavya spray, yield increases were 45.0, 43.6, and 38.9%, respectively, over compost alone.The high grain production of these treatments *i.e.,* the use of zinc and iron rich in organics in the soil, may be due to improved availability of zinc and iron in the soil by limiting their fixation and precipitation, which can improve their efficiency. Foliar spray of panchagavya as a growth promoter increases the efficiency of plant by creating a grater source to immerse the energy in the plant and increase nutrient absorption. In addition, the yield is increased by these treatments, namely, the combined use of compost and vermicompost as well as foliar nutrition such as panchagavya or zinc and iron nutrition compared to application of compost or vermicompost alone, without enrichment and foliar nutrition may be due to better metabolism and photosynthates production by the plant as well as enlargement of and cell division. Furthermore, the rise in yield attributes in both treatments could be attributed to the continued provision of organically chelated iron and zinc, in addition to accessible NPK nutrients to the crop. Assimilation of photosynthates and translocation from the source (leaves) to the sink (ear) all require iron and zinc. Therefore, the use of Zinc and iron through the use of enriched organics with foliar spray of panchagavya or $ZnSO_4$ and $FeSO_4$ may be the best way to manage micronutrient pressure to increase crop yields. Latha *et al.* (2001), Tolessa *et al*. (2001), Elnaz *et al.* (2016), Anilkumar and Kubsad (2017), Ananda and Kalyanamurthy (2017), Nikhil and Salakinkop (2017), and Vipen *et al.* (2017) have shown that spraying with foliar fertilizers or liquid organics increases the yield.

Increased yield characteristics such as ear head weight (5.36 g) and yield of grain per plant (4.88 g) may also be linked to the treatment of Zinc and irone enriched manures (compost) with spray for panchagavya. These results are compared with those obtained with enriched vermicompost + $ZnSO_4$ and $FeSO_4$ sprays, as well as improved vermicompost + panchagavya sprays (Table 3). The data on the ear head length of the foxtail millet did not differ significantly from the use of Zn and Fe enriched manures. However the use of Zinc and iron enriched manure (compost) + panchagavya spray (16.53 cm) recorded a much higher earhead length compared to other treatments. While composting alone indicates the length of the small earhead of the foxtail millet (14.53 cm). Increased ear length with organic manures + panchagavya spray may be due to the abundant availability of appropriate growth resources. Data on test weight

(weight of 1000 seeds) not differ significantly between treatments.
Enriched compost with Zinc and iron application + foliar spray of panchagavya (4210 kg/ha) application had a significance in increased stover yield, which was on par with Zinc and iron enriched vermicompost along with foliar spray of $ZnSO_4$ and $FeSO_4$ (4195 kg/ha), Zinc and iron enriched vermicompost with foliar spray of panchagavya (4092 kg/ha) and Zn and Fe enriched compost with foliar (4065 kg/ha). While significantly lower stover yield was noticed with compost alone (3080 kg/ha). Differences in growth factors such as total dry matter production and accumulation in different plant parts such as leaves and stem were blamed for differences in stover output. These reports were in consonance with Yadav *et al*. (2011), Hamaad *et al.* (2012) concluded that increase in plant growth and Zn concentration was higher when plants were grown with Zn enriched FYM compared to $ZnSO_4$ or Zn-EDTA application alone, indicating the positive role of organic matter in increasing grain yield and grain Zn concentration The maximum Zn concentration in rice grains (13.9 mg/kg) and straw (19.1 mg/kg) was seen and Choudhary *et al.* (2013) concluded that foliar application of panchagavya + leaf extract of neem recorded significantly higher number of nodules, number of pods per plant, pod weight per plant, pod yield, haulm yield and harvest index in ground nut as compared to other treatments. Panchagavya + leaf extracts of neem recorded significantly higher 100 kernels weight, shelling percent, nutrient uptake of N and P, oil content over other sources.Economics: Application of zinc and iron enriched compost along with foliar spray of panchagavya (Rs. 27185 /ha and 2.83 respectively) surpassed all other treatments except Zn and Fe enriched vermicompost with foliar spray of $ZnSO_4$ and $FeSO_4$ (Rs. 25522 /ha and 2.62 respectively) and Zn and Fe enriched vermicompost with foliar spray of panchagavya (Rs. 21897 /ha and 2.62 respectively) and lowest is with compost equivalent to 100% RDN (Rs. 12492 /ha and 1.99 respectively) (Table 4). This could be due to higher yield of grain and stover in comparison to the rest of the treatments. Naveen (2009), Patil *et al.* (2012) and Bandiwaddar and Patil (2015) found that the use of enriched organic manures with foliar sprays of nutrients or liquid organic manures resulted in greater net monetary returns and BC ratio.

Conclusion
Micronutrient fertilizer in the form of enriched organic manures not only enriches plants with the trace elements, but also preserves the health of the soil to produce healthy and quality grain because the quality of food, which is the basis of human health, ultimately determined by the soil quality which is raised upon it so, under the organic production system by application of zinc and iron enriched manure (compost) + 3 percent foliar spray of panchagavya @ 30 and 45 DAS, or Zn and Fe enriched vermicompost + foliar spray of 0.5 percent $ZnSO_4$ and $FeSO_4$ each @ 30 DAS, or zinc and iron enriched vermicompost + foliar spray of 3% panchagavya @ 30 and 45 DAS is best recommendation for sustainable growth and yield.

Conflict of interest
The authors declare that they have no conflict of interest.

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