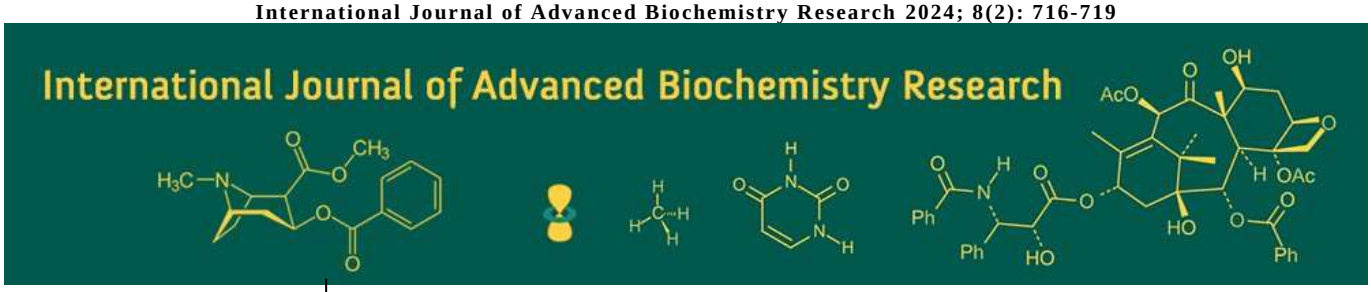

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Growth and yield attainment of foxtail millet (*Setaria italica*) under organic nutrient management practices

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Abstract
A field experiment was conducted during *rabi*, 2021-22 on sandy loam soils of dryland farm at S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh in foxtail millet to study the effect of organic nutrient management practices. The experiment was laid out in split-plot design with three main plots and five sub plot treatments replicated thrice. Main plot treatments consisted of three sources of manure *viz.,* Recommended dose of N through farmyard manure (M_1), Recommended dose of N through vermicompost (M_2) and Recommended dose of N through poultry manure (M_3) and sub plot treatments consisted of five foliar applications *viz.,* Water spray (S_1), Vermiwash @ 5% spray (S_2), Panchagavya @ 3% spray (S_3), Humic acid @ 0.5% spray (S_4) and Seaweed extract @ 0.3% spray (S_5) allotted to sub-plots. The experimental results indicated that application of recommended dose of nitrogen through poultry manure or vermicompost along with foliar spraying of 3% panchagavya or 0.3% seaweed extract twice at 30 and 45 DAS significantly influenced the growth and yield attributes.

Keywords: Foxtail millet, manures and foliar application

Introduction
Millets are nutrient rich seeded grasses that serve as a significant source of food and fodder for millions of resource strapped farmers and are essential to the ecological and economic stability of an area. Millets hold significant social importance by fostering nutritional diversity, empowering marginalised communities, preserving cultural heritage, enhancing food security in challenging environments and supporting sustainable agricultural practices. Foxtail millet (*Setaria italica* L.), one of the eight millets, is a dry land crop of the graminaceae family. It is nutritionally superior to conventional food grains in terms of higher protein, dietary fiber which plays an important role in the energy requirement and nutrient intake of human and exhibits hypoglycemic effect due to the presence of higher proportion of unavailable complex carbohydrate (Vanithasri *et al.*, 2012) [10].
In the recent energy crisis, synthetic fertilizers are becoming exorbitantly expensive and declining soil fertility insist the use of organic manures in crop production (Upendranaik *et al.*, 2018) [9]. Mainly in recent days, organic farming is in high demand because of the perceived benefits to the environment as well as human health. A vital component of organic farming is providing organic sources of nutrients to promote growth as well as to sustain soil quality. Plants should be fed with foliar nutrition as a practical alternative to increase yield. Hence, use of properly designed organic foliar sprays like humic acid extract, seaweed extract, vermiwash and panchagavya are the best ways to correct the micronutrient deficiencies encountered in organic cultivation.

Material and Methods
The experiment was conducted during *rabi*, 2021-22 at dryland farm, S. V. Agricultural College, Tirupati campus of Acharya N. G. Ranga Agricultural University which is geographically situated at 13.5° N latitude and 79.5° E longitude at an altitude of 182.9 m above mean sea level in the Southern Agro-climatic Zone of Andhra Pradesh. The present experiment was laid out in a split-plot design and replicated thrice. The treatments included three organic manure levels *viz.,* Recommended dose of N through farmyard manure (M_1), Recommended dose of N through vermicompost (M_2) and Recommended dose of N through

poultry manure (M_3) and five foliar applications *viz*., Water spray (S_1), Vermiwash @ 5% spray (S_2), Panchagavya @ 3% spray (S_3), Humic acid @ 0.5% spray (S_4) and Seaweed extract @ 0.3% spray (S_5) at 30 and 45 DAS allotted to the sub-plots. The soil of the experimental field was sandy loam, neutral in soil reaction, low in organic carbon (0.35%) and available nitrogen (176.0 kg ha^{-1}), medium in available phosphorus (27 kg ha^{-1}) and available potassium (219 kg ha^{-1}). The crop was sown at 22.5 cm x 10.0 cm spacing with a seed rate of 8 kg ha^{-1}. The variety SiA 3156 of foxtail millet was sown on 22nd of October and recommended dose of the fertilizer 40:20 kg N P_2O_5 ha^{-1}. All the other recommended practices were also adopted as per the crop requirement.

Results and Discussion

Growth attributes

Growth parameters *viz*., plant height, leaf area index and dry matter production were significantly influenced by different organic manures and foliar applications at all the stages of observations except at 25 DAS.

The taller plants with higher leaf area index and higher dry matter production were recorded with the application of RDN through poultry manure (M_3) and it was comparable with application of RDN through vermicompost (M_2). Significantly lower growth attributes of plants were observed with the application of RDN through farmyard manure (M_1). Among the foliar sprays, higher growth attributes were noticed with the application of panchagavya @ 3% (S_3) followed by application of seaweed extract @ 0.3% (S_5) and both were at par. The next best treatments were vermiwash @ 5% (S_2) and humic acid @ 0.5% (S_4). Significantly lower growth attributes were observed under water spray (S_1). This is in agreement with the findings of Govindappa *et al.* (2009) [3], Abdullahi *et al*. (2014) [1] and Aravind *et al*. (2020) [2].

At all the stages of crop growth except at 25 DAS, higher number of tillers m^{-2} were observed with the application of RDN through poultry manure (M_3) closely followed by application of RDN through vermicompost (M_2) and significantly lower number of tillers were noted with application of RDN through farmyard manure (M_1). Among the foliar sprays, higher number of tillers m^{-2} were seen with application of panchagavya @ 3% (S_3) followed by seaweed extract @ 0.3% (S_5) and both were at par with each other. The later best treatments in recording higher tiller number were vermiwash @ 5% (S_2) and humic acid @ 0.5% (S_4) and both were on par with each other. Significantly lower number of tillers were observed with water spray (S_1). Enhanced number of tillers m^{-2} with these organic sources, as evidenced in the investigation corroborate with the findings of Upendranaik *et al*. (2018) [9], Khadadiya *et al*. (2019) [4] and Suruthi *et al*. (2019) [8].

Influence of different organic manures and foliar applications and their interaction was found to be non-significant on days to 50% flowering and days to maturity.

Yield attributes and Yield

Among the different manures, higher values of yield attributes *viz*., number of panicles m^{-2}, panicle length, panicle weight and grain weight $panicle^{-1}$ were observed with the application of RDN through poultry manure (M_3) and it was on par with application of RDN through vermicompost (M_2). The lowest yield attributes were observed with the application of RDN through farmyard manure (M_1). Among the foliar sprays, application of 3% panchagavya (S_3) recorded higher yield attributes and it was on par with 0.3% seaweed extract (S_5) except for panicle length. The next best treatments were 5% vermiwash (S_2) and 0.5% humic acid (S_4). Significantly lower yield attributes were recorded with water spray (S_1). The panicle length was significantly higher with the application of panchagavya @ 3% (S_3) and it was on par with rest of the treatments except water spray (S_1), which recorded significantly lower panicle length. The test weight was not significantly influenced by the different organic manures and foliar applications.

The grain and straw yield were very much influenced by different organic sources. Among the organic manures, higher yield of foxtail millet was recorded with the application of poultry manure (M_3), followed by vermicompost (M_2), which were at par with each other. The above two treatments were significantly superior to the farmyard manure (M_1). Among the foliar applications, higher yield was seen with the application of panchagavya @ 3% (S_3) followed by seaweed extract @ 0.3% (S_5) which were on par with each other and in turn significantly superior to rest of the treatments. This was followed by vermiwash @ 5% (S_2) and humic acid @ 0.5% (S_4) and were at par with each other and significantly superior to water spray (S_1) which recorded lower yield (Table 1).

During this study, organic manures might have acted as nutrient sources facilitating higher removal by plants. This might have helped in improvement of growth and yield attributes due to higher concentration of macro and micro nutrients in conjunction with steady nutrient release throughout the crop period in poultry manure and also due to the rich source of NPK. Presence of plant growth regulators like auxins, gibberellins and cytokinins in vermicompost might have enhanced the plant growth and overall yield when compared to farmyard manure. The better yield with panchagavya was ascribed due to the higher production of plant growth regulators which have helped in enhancing the biological efficiency of the crop compared to other foliar sprays. Since poultry manure and panchagavya contain high nitrogen and high macro & micro nutrients and growth promoting substances which might have helped in increased yield attributes and yield (Table. 1). These results are in conformity with Sangeetha *et al*. (2013) [7], Priya and Satyamoorthi (2019) [5] and Raviraja *et al*. (2020) [6].

Table 1: Growth components of foxtail millet as influenced by organic manures and foliar sprays

Treatments	Plant height(cm)				Leaf area index			
	25	50	75	At harvest	25	50	75	At harvest
Organic manures (M)								
M_1: 100% N through Farmyard manure	23.7	59.5	78.3	81.3	0.23	1.18	1.68	1.38
M_2: 100% N through Vermicompost	24.5	65.2	87.8	91.8	0.24	1.39	1.94	1.64
M_3: 100% N through Poultry manure	24.6	68.2	91.2	96.6	0.24	1.47	1.98	1.78
SEm±	0.40	1.43	1.41	1.45	0.011	0.022	0.032	0.035
CD (P=0.05)	NS	5.6	5.6	5.7	NS	0.09	0.13	0.14
Foliar sprays (S)								
S_1: Water spray	24.1	55.7	76.1	80.1	0.24	1.15	1.67	1.42
S_2: Vermiwash @ 5%	24.1	62.3	84.1	88.1	0.23	1.31	1.83	1.57
S_3: Panchagavya @ 3%	24.8	73.7	93.7	97.7	0.24	1.51	2.01	1.75
S_4: Humic acid @ 0.5%	24.0	61.4	83.3	87.9	0.23	1.30	1.81	1.55
S_5: Seaweed extract @ 0.3%	24.2	69.0	91.7	95.7	0.24	1.44	1.97	1.70
SEm±	0.53	1.93	2.26	2.31	0.010	0.041	0.032	0.041
CD (P=0.05)	NS	5.6	6.6	6.8	NS	0.12	0.13	0.12
M at S								
SEm±	0.91	3.32	3.77	3.87	0.021	0.065	0.075	0.078
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
S at M								
SEm±	0.90	3.20	3.16	3.24	0.018	0.047	0.072	0.075
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Treatments	**Dry matter production (kg ha^{-1})**				**No. of tillers**			
	25	**50**	**75**	**At harvest**	**25**	**50**	**75**	**At harvest**
Organic manures (M)								
M_1: 100% N through Farmyard manure	305	963	2161	2571	31.9	50.1	49.1	48.1
M_2: 100% N through Vermicompost	344	1228	2480	2853	34.6	63.5	62.3	60.1
M_3: 100% N through Poultry manure	347	1386	2653	2996	34.9	67.3	66.1	65.1
SEm±	11.0	43.1	57.3	57.4	0.98	1.14	1.26	1.11
CD (P=0.05)	NS	169	225	227	NS	4.5	4.95	4.35
Foliar sprays (S)								
S_1: Water spray	317	933	2133	2477	32.4	51.2	49.9	48.8
S_2: Vermiwash @ 5%	331	1172	2372	2752	34.0	59.3	58.1	56.9
S_3: Panchagavya @ 3%	352	1423	2702	3116	35.4	68.9	67.6	66.5
S_4: Humic acid @ 0.5%	324	1062	2338	2698	32.6	57.6	56.3	55.2
S_5: Seaweed extract @ 0.3%	337	1372	2612	2991	34.5	65.2	63.9	62.8
SEm±	12.8	41.0	69.1	75.3	1.08	1.99	1.96	1.94
CD (P=0.05)	NS	119	202	220	NS	5.8	5.71	5.65
M at S								
SEm±	22.6	77.2	121.4	130.3	1.93	3.29	3.278	3.18
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
S at M								
SEm±	24.5	97.0	128.2	128.1	2.19	2.55	2.82	2.45
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Yield components of foxtail millet as influenced by organic manures and foliar sprays

Treatments	No. of panicles m^{-2}	Panicle length (cm)	Weight of the panicle (g)	Grain weight panicle^{-1} (g)	Test weight (g)
Organic manures (M)					
M_1: 100% N through Farmyard manure	43.2	9.51	3.50	2.31	2.65
M_2: 100% N through Vermicompost	54.7	11.0	4.39	2.68	2.85
M_3: 100% N through Poultry manure	58.2	11.9	4.59	2.95	2.93
SEm±	1.38	0.23	0.095	0.070	0.090
CD (P=0.05)	5.4	0.9	0.38	0.28	NS
Foliar sprays (S)					
S_1: Water spray	43.8	9.43	3.66	2.34	2.75
S_2: Vermiwash @ 5%	50.6	10.6	4.05	2.58	2.77
S_3: Panchagavya @ 3%	58.9	12.3	4.55	2.92	2.89
S_4: Humic acid @ 0.5%	49.8	10.3	4.03	2.57	2.76
S_5: Seaweed extract @ 0.3%	56.9	11.1	4.50	2.82	2.88
SEm±	1.94	0.31	0.120	0.070	0.080
CD (P=0.05)	5.7	0.9	0.36	0.21	NS
Organic manures (M) X Foliar sprays (S)					
M at S					
SEm±	3.37	0.57	0.216	0.132	0.145
CD (P=0.05)	NS	NS	NS	NS	NS
S at M					
SEm±	2.90	0.55	0.217	0.160	0.193
CD (P=0.05)	NS	NS	NS	NS	NS

Table 3: Grain and straw yield (kg ha^{-1}) and harvest index (%) of foxtail millet as influenced by organic manures and foliar sprays

Treatments	Grain yield	Straw yield	Harvest index
Organic manures (M)			
M_1: 100% N through Farmyard manure	828	1575	34.6
M_2: 100% N through Vermicompost	999	1754	36.5
M_3: 100% N through Poultry manure	1026	1845	36.2
SEm±	23.5	37.4	0.92
CD (P=0.05)	92	147	NS
Foliar sprays (S)			
S_1: Water spray	846	1460	36.7
S_2: Vermiwash @ 5%	930	1678	35.7
S_3: Panchagavya @ 3%	1045	1956	34.8
S_4: Humic acid @ 0.5%	926	1635	36.1
S_5: Seaweed extract @ 0.3%	1010	1896	34.8
SEm±	25.6	48.6	0.84
CD (P=0.05)	75	142	NS
Organic manures (M) X Foliar sprays (S)			
M at S			
SEm±	46.1	84.1	1.60
CD (P=0.05)	NS	NS	NS
S at M			
SEm ±	52.6	92.1	2.10
CD (P=0.05)	NS	NS	NS

Conclusion

Application of recommended dose of nitrogen *i.e.* 40 kg N ha^{-1} through poultry manure and foliar spraying of 3% panchagavya or 0.3% seaweed extract twice at 30 and 45 DAS is viable and remunerative organic nutrient management practice for foxtail millet under Southern Agro-climatic Zone of Andhra Pradesh.

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