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Effect of solid and liquid organic sources on content and uptake of micro-nutrients by finger millet [*Eleusine coracana* L.] grown under organic farming system

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Abstract
A field trial was conducted at Rajendrapur Farm, Navsari Agricultural University, Waghai to study the "Effect of organics on soil properties, yield and quality of finger millet [*Eleusine coracana* (L.) Gaertn.]" during *kharif* season of 2018 and 2019. Among the different treatments significantly higher nutrient content Fe in grain and straw were recorded under the treatment of application of 100% RDN through biocompost (S_1) in pooled results. However all the liquid organics showed non significant effect on nutrient content (Fe, Mn, Zn and Cu) of grain and straw. While, in case of nutrient uptake by grain and straw, application of 100% and 75% RDN through biocompost as well as enriched banana pseudostem sap @ 1% and *Jeevamrut* @ 1% recorded best nutrient (Fe, Mn, Zn und Cu) uptake among different treatments under study.

Keywords: Foliar nutrition, micro nutrient, *Eleusine coracana*, finger millet

Introduction
In India, finger millet [*Eleusine coracana* (L.) Gaertn.] is cultivated on area of 890.9 thousands ha with production of 1238.7 thousands tones with a productivity of 1390 kg/ha. In Gujarat, finger millet occupies an area about 2.7 Thousands ha with production of 3.96 thousands tones with a productivity of 1344 kg/ha (Anon., 2020). The major finger millet growing states are Karnataka, Uttarakhand, Maharashtra, Tamil Nadu and Odisha. Where is in Gujarat finger millet cultivated mainly in dry land and tribal area of Dang, Valsad and some parts of Navsari, Surat and Panchmahal districts.

Organic agriculture is a holistic crop production and management system which can be practiced in any situation from lowest rainfall areas to highest rainfall areas to achieve sustainable productivity without the use of external inputs such as chemical fertilizers and pesticides and has many environmental advantages like encouraging conservation and development of on-farm natural resources and their optimum utilization in maintaining the soil fertility status for a long time with enhanced microbial activity. The organically produced food grains, fruits, vegetables, spices, condiments, medicinal and aromatic plant products have showed good keeping quality than products grown with chemical fertilizers. Organic agriculture is adopted with a blend of ecologically safe modern technologies which are acceptable to the farmers (Pathak and Ram, 2007 and Sreenivasa *et al.*, 2009) [6, 9].

Finger millet also known as ragi in India is one of the important cereals occupies highest area under cultivation among the small millets. In Gujarat, finger millet is the staple food of the tribals in Agroclimatic Zone – I, II and III. It is grown under *kharif* rainfed crop in the least fertile soil of South Gujarat.

Materials and Methods
The field experiment titled "Effect of organics on soil properties, yield and quality of finger millet [*Eleusine coracana* (L.) Gaertn.]". was carried out by laying out a field experiment on finger millet with combined application of solid organic with foliar application of liquid organics in *kharif* season during 2018 and 2019.

The soil analysis data indicated that the soil of the experimental field was medium in organic carbon (0.60% and 0.58%), neutral in reaction (pH 6.85 and 6.95) with normal electrical

conductivity (0.15 and 0.20 dSm^{-1}) during the year 2018 and 2019, respectively.

Treatments were laid out in a randomized block design (factorial concept) with three replications. Treatments were compared with control recommended practice consisting of 40-20-0 NPK kg/ha. In *kharif* season, treatments were allotted to different experimental units of finger millet through solid organics (Factor - S *viz.*, S_1: 100% RDN through biocompost, S_2: 75% RDN through biocompost and S_3: 50% RDN through biocompost) and foliar application of liquid organics (Factor - L *viz.*, L_1: Enriched Banana pseudostem sap @ 1%, L_2: *Jeevamrut* @ 1%, L_3: *Vermiwash* @ 1% and L_4: Cow Urine @ 1%).

Well decomposed solid organic manures (biocompost) is applied based on gross plot size and calculated quantities of these organic manures were applied well mixed with soil homogenously in the respective plots one day prior to sowing that particular bed. Before application of organic manures, it was analyzed for Fe, Mn, Zn and Cu content and is represented in Table 1 while, different liquid organics *viz.* enriched banana pseudostem sap, Jeevamrut, vermiwash and cow urine were applied through foliar application at 15, 30 and 45 DAT of finger millet. Before application of liquid organic, it was analyzed for Fe, Mn, Zn and Cu content is represented in Table 2. The finger millet variety GNN 6 was sown in june 2018 and 2019. Standard agronomic practices were adopted for raising healthy crop.

Results and Discussion

Effect of solid organics

The data revealed that the iron content in finger millet grain and straw were significantly influenced due to application of solid organics. Significantly higher value of iron in grain and straw (4.48 ppm and 3.98 ppm) were recorded under the treatment of application of 100% RDN through biocompost (S_1) in pooled data respectively, which was found statistically at par with the application of 75% RDN through biocompost (S_2) (i.e. 4.33 ppm and 3.93 ppm). Significantly the lowest Fe content by grain and straw (4.15 ppm and 3.84 ppm) were noted with the treatment S_3: the application of 50% RDN through biocompost in pooled results respectively. The data revealed that the manganese, zinc and copper content in finger millet grain and straw were observed to be non significant effect as influenced by different application of solid organics except zinc content in grain.

The data furnished in Table 3 & 4 unveiled that a significantly maximum Fe, Mn, Zn and Cu uptake by grain (10.15, 333.30, 4.48 & 6.15 g/ha), straw (19.44, 502.41, 9.99 & 23.76 g/ha) and total uptake (29.59, 835.71, 14.47 and 37.69 g/ha) during pooled data respectively, was recorded on the application of 100% RDN through biocompost (S_1), which remained statistically in line with the application of 75% RDN through biocompost (S_2) in pooled data analysis except pooled data in straw as well as total uptake. However, significantly the lowest Fe, Mn, Zn & Cu uptake by grain, straw and total uptake were noted with the treatment S_3: the application of 50% RDN through biocompost in pooled results respectively.

As evident from tables (Table 3 & 4) of nutrient content and uptake by finger millet showed discernible influence of different treatments of solid fertilizer on the nutrient content and uptake by finger millet. The organic manures improve soil physico-chemical properties which increase availability of micro nutrients to the crop and therefore increases its uptake. Also increased crop yield contributed in total uptake of nutrients. The similar findings had been reported on growth parameters obtained under the application using solid organics by Umesh *et al.* (2006) [11], Jagathjothi *et al.* (2010) [4], Aariff khan and Krishna (2016) [1] and Saraswathi *et al.* (2018) [8] in finger millet.

Effect of liquid organics

The data revealed that the iron, manganese, zinc and copper content in finger millet grain and straw were observed to be non significant effect as influenced by different application of liquid organics.

Application of enriched banana pseudostem sap @ 1% (L_1) recorded maximum Fe, Mn, Zn and Cu uptake by grain (10.09, 333.87, 4.50 and 13.96 g/ha), straw (18.86, 484.22, 9.70 and 23.13 g/ha) and total uptake (28.96, 818.09, 14.19 and 37.09 g/ha) of finger millet in pooled results respectively, which remained statistically at par with treatment L_2: Application of *Jeevamrut* @ 1% during Fe, Mn, Zn and Cu uptake by grain (9.67, 320.89, 4.30 and 13.42 g/ha), straw (18.14, 467.25, 9.35 and 21.94 g/ha) and total uptake (27.81, 788.14, 13.65 and 35.36 g/ha) in pooled analysis. While lowest Fe, Mn, Zn and Cu uptake by grain, straw as well as total uptake of finger millet pooled data analysis under treatment L_4: application of cow urine @ 1%.

Different type of liquid organics influenced significantly on micro nutrient content and uptake of nutrients by finger millet. Application of enriched banana pseudostem sap and *Jeevamrut* effect observed superior as compared with other liquid fertilizer. The possible reasons for increase in nutrient content and uptake by finger millet may be due to ready assimilation of plant nutrients by crop, these plant liquid organics also contents different plant growth promoting substances which results in good crop growth. These findings are in close agreement with those reported by Laharia *et al.* (2013) [5], Teja and Murthy (2015) [10], Sandhya Rani *et al.* (2017) [7] and Ananda *et al.* (2018) [2] in finger millet.

Interaction Effect

A perusal of data revealed that the interaction effects between solid and liquid organics on iron, manganese, zinc and copper content and uptake of grain, straw as well as total uptake as influenced by different treatments did not show significant effect in pooled data analysis among the different treatments.

Control V/s Rest

As evident from tables 3 and 4 iron, manganese, zinc and copper content and uptake of grain, straw as well as total uptake of finger millet showed that they remained unaffected on the rest of the treatments compare with respectively over the control.

Table 1: Nutrient Content of Biocompost

SN	Manures	Nutrient content (mg/kg)			
		Fe	Mn	Zn	Cu
1	Biocompost	1270	130	58	25

Table 2: Chemical composition of liquid organics

Liquid organic	Content of Nutrient (mg/l)			
	Fe	Mn	Zn	Cu
Enriched banana pseudostem sap	41	13.5	3.61	0.7
Jeevamrut	73	3.70	2.50	1.20
Vermiwash	3.99	1.38	0.45	0.15
Cow Urine	3.0	3.0	1.5	7.0

Table 3: Effect of solid and liquid organics on Iron & Manganese content and their uptake by finger millet (Pooled of 2 Year)

Treatment	Fe content (ppm)		Fe uptake (g/ha)			Mn content (%)		Mn uptake (g/ha)		
	Grain	Straw	Grain	Straw	Total	Grain	Straw	Grain	Straw	Total
S_1	4.48	3.98	10.15	19.44	29.59	147.42	102.59	333.30	502.41	835.71
S_2	4.33	3.93	9.51	18.24	27.75	144.60	100.37	317.73	464.72	782.45
S_3	4.15	3.84	7.67	14.15	21.82	140.67	97.37	259.86	359.39	619.26
S.Em. (±)	0.06	0.03	0.22	0.39	0.44	3.14	2.01	8.88	12.22	14.46
CD at 5%	0.16	0.09	0.63	1.10	1.26	NS	NS	25.24	34.74	41.13
L_1	4.42	3.97	10.09	18.86	28.96	146.43	102.11	333.87	484.22	818.09
L_2	4.38	3.93	9.67	18.14	27.81	145.57	101.12	320.89	467.25	788.14
L_3	4.27	3.90	8.56	16.59	25.16	143.08	99.19	287.05	423.29	710.34
L_4	4.22	3.86	8.11	15.51	23.63	141.85	98.03	272.72	393.94	666.66
S.Em. (±)	0.07	0.03	0.25	0.45	0.51	3.62	2.32	10.25	14.11	16.70
CD at 5%	NS	NS	0.72	1.28	1.46	NS	NS	29.14	40.12	47.49
Interaction(SxL)										
S.Em. (±)	0.11	0.06	0.44	0.78	0.89	6.27	4.02	17.75	24.44	28.93
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Treat Mean	4.32	3.91	9.11	17.28	26.39	144.23	100.11	303.63	442.18	745.81
Control	4.26	3.84	8.97	17.97	26.94	143.58	95.31	304.00	447.56	751.56
Control v/s Rest										
S.Em. (±)	0.08	0.04	0.32	0.57	0.65	4.62	2.96	13.07	17.98	21.29
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	6.49	3.75	11.87	10.98	8.24	10.66	9.86	14.32	13.52	9.50

Table 4: Effect of solid and liquid organics on Zinc & Copper content and their uptake by finger millet (Pooled of 2 Year)

Treatment	Zn content (ppm)		Zn uptake (g/ha)			Cu content (ppm)		Cu uptake (g/ha)		
	Grain	Straw	Grain	Straw	Total	Grain	Straw	Grain	Straw	Total
S_1	1.97	2.05	4.48	9.99	14.47	6.15	4.86	13.93	23.76	37.69
S_2	1.94	2.03	4.25	9.43	13.67	6.04	4.78	13.27	22.17	35.43
S_3	1.88	1.97	3.48	7.25	10.73	5.87	4.63	10.86	17.12	27.98
S.Em. (±)	0.02	0.03	0.11	0.19	0.23	0.10	0.07	0.35	0.53	0.69
CD at 5%	0.06	NS	0.31	0.54	0.66	NS	NS	1.00	1.50	1.96
L_1	1.97	2.04	4.50	9.70	14.19	6.11	4.86	13.96	23.13	37.09
L_2	1.95	2.03	4.30	9.35	13.65	6.07	4.76	13.42	21.94	35.36
L_3	1.91	2.01	3.83	8.53	12.36	5.98	4.72	12.00	20.17	32.16
L_4	1.90	1.99	3.65	7.98	11.63	5.92	4.68	11.38	18.82	30.19
S.Em. (±)	0.03	0.03	0.13	0.22	0.27	0.11	0.09	0.41	0.61	0.79
CD at 5%	NS	NS	0.36	0.63	0.76	NS	NS	1.15	1.73	2.26
Interaction(SxL)										
S.Em. (±)	0.04	0.054	0.22	0.38	0.46	0.20	0.15	0.70	1.05	1.38
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Treat Mean	1.93	2.02	4.07	8.89	12.96	6.02	4.76	12.69	21.01	33.70
Control	1.86	2.06	3.95	9.61	13.56	5.91	4.57	12.55	21.29	33.84
Control v/s Rest										
S.Em. (±)	0.032	0.04	0.16	0.28	0.34	0.14	0.11	0.52	0.78	1.01
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.546	6.52	13.25	10.45	8.74	8.01	7.72	13.57	12.27	10.00

Conclusion

From the results of field experimentation, it can be concluded that application of 100% RDN through biocompost and foliar application of banana pseudostem sap or Jeevamrut @ 1% at 15, 30 and 45 DAT of finger millet resulted in higher content and uptake of micro nutrients under organic farming system.

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