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Nutrient uptake and quality parameters of finger millet as influenced by crop residue composting

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Abstract
A field experiment was conducted during *rabi,* 2018-19 at Students Farm, College of Agriculture. Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The experimental soil was sandy clay loam texture with pH 7.46, EC 0.36 dS m^{-1} and OC (0.67%). The soil was low in available nitrogen (260.0 kg ha^{-1}), medium in available phosphorus (45.1 kg ha^{-1}) and high in available potassium (521.0 kg ha^{-1}). The experiment was laid out in a randomized block design with eight treatments and replicated thrice. The results revealed that, conjunctive use of inorganics and organics through crop residue composting significantly influenced the nutrient uptake and quality parameters of finger millet. Application of 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate recorded significantly higher grain (3540 kg ha^{-1}) and straw yield (5899 kg ha^{-1}). The lowest grain (1453 kg ha^{-1}) and straw yield (3737 kg ha^{-1}) were recorded with control plot that consisted of no nitrogen application. Similarly, significantly higher NPK uptake (51.0, 5.5 and 21.9 kg ha^{-1}) by grain and straw (56.0, 25.1 and 102.6 kg ha^{-1}) was recorded with application of 75% RDN+ 25% N through cotton stubbles vermicompost + 2% rockphosphate followed by T_5 treatment - 75% RDN + 25% N through cotton stubbles vermicompost. Quality parameters *viz*., calcium (0.44%), iron (85.2 ppm), zinc (32.0 ppm) and crude protein content (9.0%) in grain were also higher with the application of 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate over rest of the treatments and the treatment was comparable with 75% RDN +25% N through cotton stubbles vermicompost.

Keywords: Finger millet, integrated nutrient management, crop residue composting, redgram and cotton stubbles vermicompost, FYM and vermicompost. Nutrient uptake and quality parameters of finger millet.

Introduction
Finger millet (*Eleusine coracana* L. Gaertn) commonly known as "nutritious millet" is the fourth important small millet crop grown globally after sorghum, pearl millet and foxtail millet. Finger millet was domesticated in western Uganda and the Ethiopian highlands atleast 5000 years ago before introduction to India approximately 3000 years ago. It is called finger millet, because the inflorescence resembles the fingers of a human hand.

Finger millet, E. coracana L. is also known as ragi and mandua (India); kaddo (Nepal); fingerhirse (Germany); petit mil, eleusine cultivee, coracan, koracan (France); bulo (Uganda); kambale, lupoko, mawele, amale, bule (Zambia); poho, rapoko, zviyo, njera, mazhovole (Zimbabwe); finger millet, African millet, koracan (England); dagussa, tokuso, barankiya (Ethopia); wimbi, mugimbi (Kenya). It is an important staple food in parts of eastern and central Africa and India. The word ragi originated from a Sanskrit word "raga" meaning red. In Telangana, it is cultivated in an area of 1000 hectares, with a production of 1000 tonnes and productivity of 1000 kg ha^{-1} respectively. (Indiastat.com, 2016). Among different states of India, Karnataka ranked first both in area and production, while, Tamilnadu recorded highest productivity followed by Karnataka during 2016-17 (Sakamma *et al*., 2018) [9].

In Telangana state, cotton, redgram and castor are the major *kharif* crops cultivated under rainfed situations. The stubbles of these crops are generally very strong and pose serious problem for removal and hence, burnt for ease and to facilitate towards timely land preparation for the *rabi* crops. Burning of crop residues/stubbles leads to loss of nutrients and organic matter apart from damaging microflora present in the topsoil. Crop residues form the alternate potent organic source for nutrient substitution through composting and it reduces the pollution generated through burning them.

Keeping, the above points in view the present experiment was initiated to evaluate the effect of compost prepared from cotton and redgram stubbles in combination with inorganic fertilizers on nutrient uptake and quality parameters of finger millet.

Material and Methods

A field experiment was conducted during *rabi*, 2018-19 at Student Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad under irrigated conditions. The soil of the experimental site was sandy clay loam with soil pH (7.46), EC (0.36dS m^{-1}) and OC (0.67%). The soil was low in available nitrogen (260.0 kg ha^{-1}), medium in available phosphorus (45.1 kg ha^{-1}) and high in available potassium (521.0 kg ha^{-1}). This experiment was laid out in a Randomized block design with three replications and eight treatments. The size of gross and net plots were 4.5 m x 4.0 m and 3.3 m x 3.6 m respectively. There were eight treatments that comprised of comprised of T_1- 100% RDF (60:30:30 - N: P_2O_5: K_2O kg ha^{-1}), T_2- control without nitrogen T_3- 75% RDN + 25% N through FYM, T_4-75% RDN + 25% N through redgram stubbles vermicompost, T_5- 75% RDN + 25% N through cotton stubbles vermicompost, T_6- 75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate, T_7 - 75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate, T_8- 75% RDN +25% N through farmers practice vermicompost. The ragi variety GPU-28 was used in the present experiment.

GPU-28 variety seeds were directly sown on 29th September during 2018 adopting a spacing 30 cm x 10 cm. The RDF for finger millet was 60:30:30 NP and K kg ha^{-1}. Entire P (SSP) and K (MOP) fertilizer were applied as basal and N (Urea) was applied in two equal splits, 50% as basal and remaining 50% at 30 DAS. In integrated nutrient management treatments (T_3, T_4, T_5, T_6, T_7 & T_8), 25 per cent nitrogen was applied through organic manures as basal and remaining as that of recommended dose of fertilizers (100% RDF).

The organics were applied as per the treatments (Table. 1) and incorporated before sowing of the crop. Sowing was done adopting spacing of 30 × 10 cm. A total rainfall of 96.8 mm was received in 7 rainy days during *rabi*, 2018-19. The crop was harvested at physiological maturity when all the ear heads turned to brown and seeds were easily detachable.

Table 1: Details of the nutrient content and amount of material added in nutrient management treatments.

S. N	Organic source	Nutrient content (%)			Quantity of organics added (t ha^{-1})
		N (%)	P (%)	K (%)	
1.	Vermicompost prepared from redgram stubbles	2.20	2.15	0.98	0.68
2.	Vermicompost prepared from redgram stubbles+2% rockphosphate	2.35	2.60	1.08	0.63
3.	Vermicompost prepared from cotton stubbles	2.0	1.08	0.99	0.75
4.	Vermicompost prepared from cotton stubbles+2% rockphosphate	2.10	1.32	0.98	0.71
5.	Farmers practice of vermicompost	1.68	0.44	0.40	0.88
6.	FYM	0.50	0.22	0.41	3.0

Results and Discussion

Yield and yield components

The yield attributes viz., of number of panicles $hill^{-1}$, number of fingers ear $head^{-1}$, 1000- seed weight, grain yield, straw yield and harvest index differed significantly due to nutrient management practices through crop residue composting. Higher number of panicles m^{-2} (158), fingers ear $head^{-1}$ (8.5), and test weight (3.29 g) compared to all other treatment combinations and control. In the treatments consisting of 25% N substitute through organics might be due to prolonged and adequate supply of nutrients coinciding with the critical crop growth stages reflecting in improved growth and yield attributes. These findings are in line with those of Basavaraj Naik *et al*. (2017) [3] and Ananda *et al*. (2017) [1]. (Table 2)

Significantly higher grain (3540 kg ha^{-1}), straw yield (5899 kg ha^{-1}) and harvest index (37.5%) were registered with T_7- 75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate and it was on par with T_5- 75% RDN +25% N through cotton stubbles vermicompost, T_6- 75% RDN +25% N through redgram stubbles vermicompost + 2% rockphosphate and T_5- 75% RDN +25% N through redgram stubbles vermicompost. Improved yield in the present study with treatments consisting of conjunctive application of inorganics + 25% N through organics was probably due to higher uptake of nutrients that led to better translocation of photosynthates from source to sink. These results are in line with those of Narayan Hebbal *et al*. (2018) [6] and Prakasha *et al*. (2018) [8] (Table 2).

Table 2: Yield attributes of finger millet as influenced by crop residue composting.

Treatments	Panicles m^{-2}	No. of fingers ear $head^{-1}$	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1- 100% RDF	138	7.3	2.90	2551	4868	34.5
T_2- control without nitrogen	103	6.2	2.45	1453	3737	27.9
T_3- 75% RDN + 25% N through FYM	140	7.8	3.13	2895	5254	35.5
T_4- 75% RDN + 25% N through redgram stubbles vermicompost	149	8.1	3.15	3114	5542	36.1
T_5- 75% RDN + 25% N through cotton stubbles vermicompost	154	8.4	3.22	3402	5753	37.2
T_6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	151	8.2	3.16	3231	5595	36.6
T_7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	158	8.5	3.29	3540	5899	37.5
T_8- 75% RDN + 25% N through farmers practice vermicompost	144	7.8	3.04	2917	5252	35.6
S. Em ±	3.6	0.2	0.1	201	312	1.2
CD (P=0.05)	9.2	0.5	0.3	522	811	3.1

*RDF: 60:30:30 - N: P_2O_5: K_2O kg ha^{-1}

Nitrogen uptake

The data pertaining to the uptake of nitrogen (kg ha^{-1}) at harvest of finger millet was presented in the Table 3. The crop residue composting had significantly influenced the nitrogen uptake at all stages of crop growth.

At harvest, T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate maintained its superiorty by rendering highest N uptake (107.0 kg ha^{-1}) of which 51.0 kg ha^{-1} was accumulated in grain and remaining 56.0 kg ha^{-1} was stored in straw and it was significantly superior to the remaining nutrient management treatments. It was followed by T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (100.8 kg ha^{-1}) and T_6 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost + 2% rockphosphate. (94.7 kg ha^{-1}) and T_4 with (89.9 kg ha^{-1}) and T8 with application of 75% RDN + 25% nitrogen through farmers practice vermicompost (82.7 kg ha^{-1}) and T_3 - 75% RDN + 25% nitrogen through FYM (78.5 kg ha^{-1}). The 100% RDF recorded total uptake of nitrogen (64.6 kg ha^{-1}). The control recorded least uptake of nitrogen at harvest (30.8 kg ha^{-1}). (Table 3)

Nutrient uptake is the resultant of nutrient content and dry matter accumulation. Significantly higher dry matter accumulation at different crop growth stages coupled with the higher seed yield under treatments T_7 and T_5 resulted in significantly higher nitrogen uptake by crop. Further, increased nitrogen uptake of nitrogen might be attributed to greater availability of nutrients to plant in presence of organic manures due to their solubilizing effect on different forms of nutrients present in the soil and their contribution to growth coupled with improved cell permeability and better absorption. These findings are in agreement with Aariff khan and Krishna (2016) [2] and Pallavi *et al*. (2014) [7].

Table 3: Nitrogen, Phosphorus, Potassium uptake (kg ha^{-1}) at harvest by finger millet as influenced by crop residue composting.

Treatments	Nitrogen uptake			Phosphorus uptake			Potassium uptake		
	Grain	straw	Total	Grain	straw	Total	Grain	straw	Total
T1- 100% RDF	31.2	33.4	64.6	3.20	10.40	13.60	11.98	77.88	89.86
T2- control without nitrogen	13.7	17.1	30.8	1.35	6.46	7.81	6.30	53.81	60.11
T3- 75% RDN + 25% N through FYM	37.9	40.6	78.5	3.97	18.38	22.35	14.40	85.64	100.04
T4- 75% RDN + 25% N through redgram stubbles vermicompost	42.6	47.3	89.9	4.56	20.50	25.06	16.81	91.44	108.25
T5- 75% RDN + 25% N through cotton stubbles vermicompost	48.4	52.4	100.8	5.26	23.99	28.50	20.75	98.37	119.12
T6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	44.9	49.8	94.7	4.87	22.65	27.21	18.73	95.11	113.84
T7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	51.0	56.0	107.0	5.57	25.18	30.75	21.94	102.64	124.58
T8- 75% RDN + 25% N through farmer's practice vermicompost	39.4	43.3	82.7	3.99	18.48	22.47	15.75	86.13	101.88
S.Em.±	4.11	4.7	5.75	0.3	1.05	1.13	1.38	5.48	0.05
CD (P=0.05)	10.75	11.8	12.3	0.7	2.25	2.41	3.9	13.7	0.12

*RDF: 60:30:30 - N: P_2O_5: K_2O kg ha^{-}

Phosphorus uptake

Results from the experiment reveal that at harvest T_7 maintained its superiority in terms of P uptake over other treatments. Treatment T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate (30.75 kg ha^{-1}) of which 5.57 kg ha^{-1} was accumulated in grain and remaining 25.18 kg ha^{-1} was stored in straw. It was followed by T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (28.50 kg ha^{-1}), T_6 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost + 2% rockphosphate. (27.21 kg ha^{-1}) and T_4 (25.06 kg ha^{-1}), T_8 - 75% RDN + 25% nitrogen through farmers practice vermicompost (22.47 kg ha^{-1}) and T_3 with application of 75% RDN + 25% nitrogen through FYM (22.35 kg ha^{-1}). The 100% RDF recorded total uptake of nitrogen (13.60 kg ha^{-1}). The control recorded least uptake of phosphorus at harvest (7.81 kg ha^{-1}). (Table 3)

Improved P uptake under combined application of inorganic fertilizer and crop stubble vermicompost at all the growth stages may be ascribed to greater availability of nutrients from added fertiliser and due to the solubility of organic acids produced during degradation of organics resulting in release of both native and applied P. Further, products of organic decay such as organic acids and humus are thought to be effective in forming complexes. Similar results were earlier reported by Varalakshmi *et al*. (2005) [12] and Shankar *et al*. (2015) [11].

Potassium uptake

At harvest T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate (recorded highest K uptake (124.58 kg ha^{-1}) of which 21.94 kg ha^{-1} was accumulated in grain and remaining 102.64 kg ha^{-1}. It was followed by T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (119.12 kg ha^{-1}) and T_6 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost + 2% rockphosphate. (113.84 kg ha^{-1}) and T_4 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost (108.25 kg ha^{-1}) and T_8 - 75% RDN + 25% nitrogen through farmers practice vermicompost (101. 88kg ha^{-1}) and T_3 - 75% RDN + 25% nitrogen through FYM (100.04 kg ha^{-1}) followed by 100% RDF recorded total uptake of nitrogen (89.86 kg ha^{-1}). While, the control plot recorded least uptake of phosphorus at harvest (60.11 kg ha^{-1}). (Table 3)

Improved K uptake at all the crop growth stages under treatments T_7 and T_6 could be attributed to the improved dry matter accumulation and K content as evident from the respective data Further, conjugative use of organics and inorganics through crop residue vermicomposting in the present study helped towards more solubilization of K bearing minerals and from insoluble forms, thus reducing K fixation and facilitating higher availability of K in soils and for crop uptake. Similar results were reported by Varalakshmi *et al*. (2005) [12] and Shankar *et al*. (2015) [11].

Quality parameters

Crude protein content (%)

The data on crude protein content (%), calcium content (%), iron content (ppm), zinc content (ppm) in grain of finger millet was significantly influenced by nutrient management through crop residue composting was presented in Table 3.

It is clearly evident from the data that different treatments exerted significant effect on protein content. Among the treatments T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate recorded significantly higher protein content (9.0%). However, treatment T_7 was on par with and T_5 -75% RDN + 25% nitrogen through cotton stubbles vermicompost (8.9%). While, significantly lowest protein content (28.0%) was registered with control with no nitrogen application.

Improved crude protein content in treatments with 25% N substitution through crop residues composting improved N content in grain (Appendix III). Similar results pertaining to higher crude protein content in finger millet was reported by Pallavi *et al*. (2014) [7] (Table 4)

Table 4: Quality parameters in grain of finger millet as influenced by crop residue composting

Treatments	Protein (%)	Calcium (%)	Iron (ppm)	Zinc (ppm)
T_1- 100% RDF	7.6	0.35	72.5	23.7
T_2- control without nitrogen	5.9	0.31	52.7	19.3
T_3- 75% RDN + 25% N through FYM	8.2	0.42	73.6	24.5
T_4- 75% RDN + 25% N through redgram stubbles vermicompost	8.5	0.39	77.2	28.9
T_5- 75% RDN + 25% N through cotton stubbles vermicompost	8.9	0.40	83.1	31.5
T_6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	8.7	0.42	82.1	31.4
T_7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	9.0	0.44	85.2	32.0
T_8- 75% RDN + 25% N through farmers practice vermicompost	8.4	0.37	76.3	25.8
S.Em ±	0.25	0.03	3.2	1.28
CD (P=0.05)	0.72	0.06	8.2	3.2

*RDF: 60:30:30 - N: P_2O_5: K_2O kg ha^{-1}

4.3.2 Calcium content (%)

It is clearly evident from the data that different treatments exerted significant effect on calcium content. Among the treatments T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate recorded significantly higher calcium content (0.44%). However, treatment T_7 was on par with and T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (0.40%). While, significantly lowest protein content (0.31%) was registered with control with no nitrogen application. (Table 4)

Conjunctive use of organics and inorganics might have improved calcium content in treatments with 25% N substitution through crop residues composting. These results are in line with those of Giribabu *et al*. (2010) [5].

4.3.4 Iron content (ppm)

The data on iron content (%) in grain of finger millet was significantly influenced by nutrient management through crop residue composting was presented in Table 3.

It is clearly evident from the data that different treatments exerted significant effect on calcium content. Among the treatments T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate recorded significantly higher calcium content (85.2 ppm). However, treatment T_7 was on par with and T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (83.1 ppm). (Table 4)

Integrated use of organics and inorganics might have improved iron content in treatments with 25% N substitution through crop residues composting. These results are in line with those of Ananda *et al*. (2017) [1].

4.3.5 Zinc content (ppm)

It is clearly evident from the data that different treatments exerted significant effect on calcium content. Among the treatments T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate recorded significantly higher calcium content (32.0 ppm). However, treatment T_7 was on par with and T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (31.5 ppm). While, significantly lowest zinc content (19.3 ppm) was registered with control plot with no nitrogen application.

Application of organics to Finger millet crop improved the crop uptake, that reflected in quality parameters like zinc content. These results are in line with those of Sandhya Rani *et al*. (2017) [10]. (Table 4).

Table 5: Post- harvest soil available N, P_2O_5 and K_2O (kg ha^{-1}) as influenced by crop residue composting.

Treatments	Nitrogen (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
T1- 100% RDF	163.3	33.9	450.2
T_2- control without nitrogen	139.9	28.2	391.5
T_3- 75% RDN + 25% N through FYM	173.9	35.9	509.8
T_4- 75% RDN + 25% N through redgram stubbles vermicompost	200.2	37.6	523.2
T_5- 75% RDN + 25% N through cotton stubbles vermicompost	267.5	40.2	545.6
T_6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	221.6	38.4	532.2
T_7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	271.7	43.4	551.4
T_8- 75% RDN + 25% N through farmers practice vermicompost	182.9	36.8	512.3
S.Em.±	15.0	1.56	19.0
CD (P=0.05)	40.6	3.94	40.6
Initial available nutrients (kg ha^{-1})	260	45.17	521

*RDF: 60:30:30 - N: P_2O_5: K_2O kg ha^{-1}

Conclusions

From the above results it could be concluded that on red soils of Southern Telanagana regions application of 75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate to finger millet results in higher nutrient uptake leading to higher yield, quality parameters and economics of finger millet.

References

1. Ananda MR, Sharanappa, Kalyana Murthy KN. Growth, yield and quality of groundnut as influenced by organic nutrient management in groundnut (*Arachis hypogaea* L.) finger millet (*Eleusine coracana* L.) cropping system. Mysore Journal of Agricultural Sciences. 2017; 51(2):385-391.
2. Aariff Khan MA, Krishna A. Response of minor millet crops by nutrient management practices in marginal lands of *Melia azedarach* based Agri-silvi system. International Journal of Tropical Agriculture. 2016; 34(2):451-457.
3. Basavaraj Naik T, Kumar Naik AH, Suresh Naik KP. Nutrient management practices for organic cultivation of finger millet (*Eleusine coracana* L.) under southern transitional zone of Karnataka, India. International Journal of Current Microbiological Applied Sciences. 2017; 6(11):3371-3376.
4. Dieda MM, Wanyera N, Harrison Dunn ML, Bennetzen, JL, Devos KM. Population structure and diversity in finger millet (*Eleusine coracana*) germplasm. Tropical Plant Biology. 2008; 1:131-141.
5. Giribabu B, Luther MM, Chandra Sekhar K, Sankara Rao V. Effect of nutrient management system on productivity of finger millet (*Eleusine coracana* L. Gaertn) cultivars under sandy soils. The Andhra Agricultural Journal. 2010; 57(1):4-6.
6. Narayan Hebbal, Ramachandrappa BK, Mudalairiyappa, Thimmegouda MN. Yield and economics of finger millet with establishment methods under different Planting geometry and nutrient Source. Indian Journal of Dryland Research and Development. 2018; 33(1):54-58.
7. Pallavi CH. Nutrient management in finger millet (*Eleusine coracana* L.) under *Melia azedarach* based agri- silvi system. *M.Sc. (Ag) Thesis*. Acharya N.G Ranga Agricultural University, Hyderabad, India, 2014.
8. Prakasha G, Kalyana murthy KN, Rohani N, Prathima AS, Meti. Effect of spacing and nutrient levels on growth and attributes and yield of finger millet (*Eleusine coracana* (L.) Gaertn] under guni method of planting in red sandy loamy soil of Karnataka, India. International Journal of Current Microbiology and Applied Sciences. 2018; 7(5):1337-1343.
9. Sakamma, S., Umesh, K.B., Girish, M.R., Ravi, S.C and Satish kumar, M. 2018. Finger millet (*Eleusine coracana* (L.) Gaertn) production system: status, potential constrains and implications for improving small farmer's welfare. *Journal of Agricultural science.*10(1): 149-155
10. Sandhya Rani Y, Triveni U, Patro TSSK, Anuradha N. Effect of nutrient management on yield and quality of finger millet (*Eleusine coracana* (L.) Gaertn). International Journal of Chemical studies. 2017; 5(6):1211-1216.
11. Shankar MA, Thimmegowda MN, Bhavitha NC, Manjunatha. Integrated nutrient management for enhancing the productivity of finger millet under dry land condition. Mysore Journal of Agricultural Sciences. 2015; 49(3):502-509.
12. Varalakshmi LR, Srinivasamurthy CA, Bhaskar S. Effect of integrated use of organic manures and inorganic fertilizers on organic carbon, available N, P and K in sustaining productivity of groundnut-finger millet cropping system. Journal of Indian Society of Soil Science. 2005; 53(3):315-318.