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Impact of different sources of organic nutrients on uptake, availability of nutrients, growth and yield of Finger Millet under rainfed condition

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Abstract
Field experiment was conducted at university of Agricultural Sciences, Bangalore during *Kharif* seasons of 2006 and 2007 under rain fed condition with different organic manures viz., FYM, sewage sludge, poultry manure compost, urban garbage compost, enriched urban garbage compost and vermicompost at the rate equivalent to recommended nitrogen and comparison with inorganic fertilizers to study the effect of different organic manures on nutrient uptake, availability and grain yield of finger millet under rain fed condition. The results indicated that application of sewage sludge recorded higher nutrient uptake (40.5, 8.8 and 31.5 kg of N, P and K/ha, respectively) and its availability after harvesting (258.7 63.7 and 269.2 kg of N, P and K/ha, respectively) and was on par with poultry manure compost. Highest grain yield (1870 kg ha^{-1}) and straw yield (3105 kg ha^{-1}) of finger millet was recorded with application of sewage sludge followed by poultry manure compost (1833 and 3052 kg ha^{-1}, respectively) over all other treatments. The study clearly indicated that use of sewage sludge and poultry manure compost application at equivalent recommended nitrogen dose could be successfully used for Finger millet to substitute the chemical fertilizers are found to be sustainable.

Keywords: finger millet, nutrient uptake, availability, grain yield and straw yield

Introduction

Agricultural scenario after green revolution is dismal and coupled with many problems. Fast expansion in cultivated area, reduction in the use of organic manures and continuous cropping with only fertilizers have all created hungry and thirsty soils. In this context, judicious use of plant nutrients is one of the most important aspects for sustaining the crop production. The nutrient (NPK) consumption crossed 20.70 million tonnes mark in 2005-06 (Anon., 2006) as against the estimated crop removal of about 30 million tonnes leaving a nutrient gap of nearly 9.3 million tones. Although the current gap is partly bridged by sources other than fertilizers like organic sources of nutrients. Organic Farming aims at production of quality and safe agricultural Products, which contain no chemical residues following eco-friendly production methods and farming systems that restore and maintain soil fertility. The soil is loosing its productivity over year making the farming more miserable. In order to bring back the productivity of soil, it needs to improve physical, chemical and biological properties of soil. Organic farming is being advocated as an alternate farming system for sustainable agriculture. A stage has reached that supplementary and complementary role of organic materials is being felt once again for sustainable agriculture and to keep the soil health. In the past, research on fertilizer use in our country was mainly confirmed to the nutritional requirement of individual crops through chemical farming. But recently, there has been a shift in research priority from individual crops to cropping system and organic farming. Among the millets Finger millet (*Eleusine coracara* (L.) Gaertn.) is one of the major staple food crop of Karnataka grown in an area of 10.5 lakh ha, with an annual production of 15.7 lakh tonnes and productivity of 1889 kg ha $^{-1}$. In India it accounting for 54 per cent area and 44.9 per cent production (Krishne Gowda, *et al.*, 2007). The information on sustainable productivity of finger millet with use of organic manures viz., FYM, urban garbage compost, sewage sludge, poultry manure compost and vermicompost in finger millet is essential.

Materials and Methods

Field experiment was conducted during the *Kharif* season of 2006 and 2007 at Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore.

The soil of the experimental site was red sandy loam in texture classified under the order *Alfisols*, Vijapura series, isohyperthermic family of *oxihaplustaf*. pH was slightly acidic (6.44) having low cation exchange capacity (7.50 C mol kg^{-1}) with an electrical conductivity of 0.23 dSm^{-1}. The organic carbon content was 0.47 per cent. The soil was low in available nitrogen (202.8 kg ha^{-1}), high in available phosphorus (26.2 kg ha^{-1}) and medium in available potassium (217.10 kg ha^{-1}). The average annual rainfall was 927 mm distributed in 62 rainy days (> 2.5 mm). An amount of 595 mm and 690 mm of rainfall was received during cropping period in 2006 and 2007 respectively. It was slightly lower than the normal rainfall (24.3 and 5 per cent respectively).

The experiment was conducted in a Randomized Complete Block Design with four replications to study the response of fingermillet under rain fed condition as influenced by different organic sources. The experiment comprised of seven treatments with different organic sources such as FYM, sewage sludge, poultry manure compost, urban garbage compost, vermin compost and enriched urban garbage compost were applied on at the rate equivalent to recommended nitrogen basis and compared with recommended inorganic fertilizers(50:40:25 kg NPK/ha). Soil analysis for available nitrogen, phosphorous and potassium was carried out using alkaline permanganate method (Subbaiah and Asija, 1956) [12], Olsen's method (Jackson, 1973) [6] and neutral normal NH_4OAC (Jackson, 1973) [6]. Similarly uptake studies were carried out for nitrogen, phosphorus and potassium. Nitrogen was determined by Microkjeldhal method (Jackson, 1973) [6]. The phosphorus content was determined by Vanadomolybdate phosphoric yellow colour method and absorbance was recorded at 430nm using spectrophotometer (Jackson, 1973) [6]. The potassium content was determined from same diacid digested sample using digital flame photometer. The information on nitrogen content and quantity of organic manure used in the experiment is presented in Table 1. Fingermillet variety GPU-28 were selected for the study. Plant biometric observations were recorded at 30, 60, 90 DAS and at harvest. The experimental data were analysed statistically by following Fischer's method of analysis of variance wherever 'F' test was significant at P=0.05. The results have been compared among treatments based on critical difference at same level of significance.

Table 1: Composition of organic manures used in the experiment

Organic manure	2006		2007	
	N (%)	Quantity used(t/ha)	N (%)	Quantity used (t/ha)
Farm yard manure	0.55	9.1	0.47	10.6
Urban Garbage Compost	0.75	6.7	0.63	8.0
Sewage Sludge	1.43	3.5	1.24	4.0
Poultry Manure Compost	1.93	2.6	1.71	3.0
Enriched Urban Garbage compost	1.26	4	1.02	5.0
Vermicompost	1.4	3.6	1.33	3.5

Table 1.1: Effect of different organic sources of nutrients on growth attributes of finger millet at harvest (Data pooled over two years)

Reatment	Plant height (cm)	Number of tillers $plant^{-1}$	TDMA $plant^{-1}$ (g) at harvest	Leaf area index @ 90 DAS	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Recommended NPK	79.0	4.75	22.7	2.01	1583	2598
Farm yard manure	75.4	4.58	20.5	1.88	1520	2538
Urban garbage compost	78.2	4.73	21.5	1.98	1558	2609
Sewage sludge	100.8	6.03	29.4	2.68	1870	3105
Poultry manure compost	98.1	5.85	28.4	2.58	1833	3052
Enriched urban garbage compost	91.9	5.53	26.7	2.42	1759	2889
Vermicompost	87.7	5.33	25.7	2.32	1726	2841
S.Em ±	2.35	0.15	0.65	0.06	34.55	55.82
CD at 5 %	7.06	0.44	1.95	0.18	103.6	167.4

Note: Organic manures used were equivalent to recommended dose of 50 kg nitrogen ha^{-1}TDMA- Total dry matter accumulation

Results and Discussion

Nutrient uptake and availability

Among different organic nutrient sources, application of sewage sludge resulted in higher nutrient uptake (40.5, 8.8 and 31.5 kg of N P_2O_5 and K_2O per ha, respectively). This was followed by poultry manure compost (39.5, 8.6 and 30.6 kg ha^{-1} N, P_2O_5 and K_2O, respectively). The magnitude of increase in uptake of N, P_2O_5 and K_2O with application of sewage sludge recorded 32.3, 28.6 and 29.1 per cent higher over FYM and 5.9, 5.0 and 4.6 per cent over recommended dose of fertilizer (Table 2). This could be attributed to higher availability of nutrients in available form. Further, this is also attributed to higher dry matter production and higher NPK concentration that was found during proximate analysis of different organic sources as uptake is a positive function of dry matter yield. In turn, the form of nutrients and amount of moisture in the soil influence the total uptake of nutrients by the crop. Higher NPK concentration in poultry manure compost and sewage sludge coupled with higher availability of nutrients in simple form over the entire cropping season could have resulted in higher yields and nutrient uptake than FYM, vermicompost and inorganic fertilizers. Poultry manure contains all the essential plant nutrients such as N, P, K, Ca, Mg, S, B, Zn etc which increased the yield of crop (Dosani *et al*., 1999) [4]. Similar findings are also reported by Devegowda (1997) [2] and he opined that poultry manure contain higher concentration of macro and micronutrients that contributed for higher availability and uptake of nutrients than FYM or urban garbage compost.

Application of organic nutrient sources increased the available N, P_2O_5 and K_2O of soil at harvest (Table.2) as compared to initial soil status. The soil available nitrogen followed the order as follows-farm yard manure > urban garbage compost> poultry manure compost> sewage sludge > vermi compost > enriched urban garbage compost (265.9, 262.7, 260.4, 258.7, 258.3 and 256.8 kg N ha^{-1}, respectively)

(Table 2). Similarly, soil available P_2O_5 was in the order of poultry manure compost > sewage sludge> enriched urban garbage compost > urban garbage compost> farm yard manure > vermi compost (70.1, 63.7, 59.7, 54.0, 51.9 and 50.6 kg P_2O_5 ha^{-1}, respectively). While available K_2O in soil was in the order of farm yard manure > poultry manure compost > urban garbage compost > sewage sludge > enriched urban garbage compost > vermi compost (285.6, 279.5, 269.5, 269.2, 264.9, and 254.4 kg K_2O ha^{-1}, respectively). Significantly, lowest available N, P_2O_5 and K_2O in soil were noticed in the plot with recommended dose of fertilizer (178.8 N ha^{-1}, 26.4 kg P_2O_5 ha^{-1} and 176.4 kg K_2O ha^{-1}, respectively). Improvement in soil nitrogen status as compared to its initial status was observed due to organic manures owing to their slow mineralization in soil releasing low amount of N to crop growth could have resulted in accumulation of more available N in soil after the harvest of crop. Similar results were obtained by Hortenstine and Rothwell (1973) [5], Yogananda (2001) [13], Zaman *et al*. (2002) [14] and Poornesh *et al*. (2004) [9]. There is clear evidence in the results that where ever uptake of nutrients increased there was decrease in the status of available nutrients in soil after harvest of the crop.

Table 2: Nutrient uptake by finger millet and nutrient availability in soil as influenced by different organic sources of nutrients

Treatment	Nutrient uptake (kg/ha)			Availability of nutrients (kg/ha)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Recommended NPK	31.3	6.9	24.7	172.8	26.4	176.4
Farm yard manure	27.8	6.4	22.5	265.9	51.9	285.6
Urban garbage compost	30.0	6.6	23.6	262.7	54.0	269.5
Sewage sludge	40.5	8.8	31.5	258.7	63.7	269.2
Poultry manure compost	39.5	8.6	30.6	260.4	70.1	279.5
Enriched urban garbage compost	37.7	8.1	29.2	256.8	59.7	264.9
Vermicompost	36.4	7.8	28.4	258.3	50.6	254.4
S.Em $\pm$	1.15	0.26	1.24	3.96	0.95	3.44
CD at 5 %	3.45	0.77	3.72	11.88	2.86	10.32

Note: Organic manures used were equivalent to recommended dose of 50 kg nitrogen

Growth attributing characters and yield of finger millet

Application of sewage sludge on 50 kg N equivalent basis produced significantly higher growth components viz., plant height (100.8 cm), number of tillers per plant (6.03), total dry matter production (29.4 g/ plant) and LAI (2.68) followed by poultry manure compost Perhaps, the supply of macro and micro nutrients owing to narrow C: N ratio and nutrients release during crop growth period which might have influenced the growth and yield (Table 1). Though all the treatments received equal quantity of N, faster release of macro and micro nutrients from sewage sludge and composted poultry manure might have increased the grain yield of finger millet. Maximum grain and straw yield (1870 and 3105 kg ha^{-1}, respectively) was recorded in sewage sludge application which was followed by poultry manure compost (1833 and 3052 kg ha^{-1}, respectively) and they were significantly superior over other treatments (Table 1). This was perhaps due to higher yield attributing parameters like number of productive tillers per plant, number of fingers per ear, grain yield per plant, length of ear and 1000 grain weight**,** which might be responsible for higher grain yield per hectare and also higher growth components. Similar results were reported by Dinesh Kumar (2006) [3] and Poornesh *et al*. (2004) [9] in finger millet under rain-fed condition. Favourable effect of sewage sludge application on water holding capacity, bulk density, organic carbon, available nutrients, soil pH, EC, CEC and microbial population of the rhizosphere was well documented by Subbaiah and Sreeramulu (1979) [13]. Sewage sludge is not only a source of organic matter but also source of primary nutrients such as nitrogen and phosphorous besides being an excellent source of micronutrients. The economic yield is a fraction of the total biological yield of the crop and dry matter production is an important determinant of the grain yield. Total dry matter production may reflect on the economic yield in view of the fact that, vegetative part of the plant serves as the source, whereas the grains are the sink. During the vegetative growth stage, accumulation of dry matter and its distribution into yield attributes in the reproductive stage through a process of translocation from source to sink finally determines the yield. This was attributed to higher concentration of nutrients in sewage sludge and poultry manure and faster mineralization (Jha *et al*., 2001) [7]. Many earlier reports have indicated that the soil physico-chemical and biological properties were improved with the application of poultry manure (Devegowda, 1997) [2]. Therefore use of either sewage sludge or poultry manure compost could be successfully used to replace the fertilizers at recommended doses for profitable and sustainable yield under rainfed condition.

Conclusion

The study results clearly revealed that application of either sewage sludge or poultry manure compost could be successfully used for profitable and sustainable productivity of finger millet under rainfed condition. Further, these manures are also cost effective and a potential substitute for FYM and fertilizers for replenishing nutrient requirement of crops.

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