Indian J. Dryland Agric. Res. & Dev. 2016 31(1) : 72-76 DOI 10.5958/2231-6701.2016.00012.9

Production Potential and Economics of Fingermillet based Intercropping under Organic production System in *Alfisols* of Karnataka

N. Jagadeesha[1], V.C. Reddy[2], M.R. Umesh[3] and Siddaram[4]

[1] *Division of Agronomy, College of Horticulture, Munirabad, University of Horticultural Sciences, Bagalkot-583 234, Karnataka*
[2] *Division of Agronomy, University of Agricultural Sciences, Bangalore-560 065, Karnataka*
[3] *Division of Agronomy, University of Agricultural Sciences, Raichur-584 104, Karnataka*
[4] *Department of Agronomy, College of Agriculture, Kalaburagi, UAS, Raichur-585 101, Karnataka*

Email: jaggudr@gmail.com

ABSTRACT: Field experiment was conducted at University of Agricultural Sciences, Bangalore with an objective to enhance productivity of fingermillet intercropping in organic systems of production during *Kharif* 2006 and 2007. Different organic manures at 50 kg N equivalent used in the experiment is farm yard manure (FYM), sewage sludge, poultry manure compost (PMC), urban garbage composts, enriched urban garbage compost and vermi compost (VC) compared to fertilizers alone. Irrigation water was provided during dry spells throughout the crop growth period. Application of sewage sludge (2498 kg/ha) or PMC (2475 kg/ha) produced significantly higher fingermillet grain yield and intercrop pigeonpea yield. Higher benefit cost ratio was recorded with the application of sewage sludge (2.27) and poultry manure compost (2.19) over the rest of the organic sources. The results inferred that application of a cheaper source organic manures like sewage sludge or poultry manure are substitutes for huge quantity of fertilizers applied with the fingermillet production system.

Key words: Fingermillet, pigeonpea, poultry manure, sewage sludge

Introduction

Green revolution brought about a great change in Indian agriculture, which was rightly termed as "from begging bowl to bread basket". This was mainly achieved with high yielding, fertilizer responsive crop cultivars and increased fertilizer use led to deterioration of land and soil health there by slowly reduced the productivity (Mukesh Kumar Pandey *et al.,* 2008). This herculean task has to be achieved through steep increase in the productivity of different crops using improved technology and increased cropping intensity. In this context, judicious use of plant nutrients is one of the options for enhancing the productivity of crops. In recent energy crisis, hike in the prices of the inorganic fertilizers and declining soil health and productivity necessitate the use of organic manures in agricultural crop production. In the past, research on fertilizer use in our country was mainly confirmed to the nutritional requirement of individual crops through chemical farming. There has been a shift in research priority from individual crops to a cropping system considering the residual effect of N, P_2O_5 and K_2O, which are promoted by organic farming practices (Savant and Dutta, 1982). The continuous use of inorganic fertilizers under intensive cropping system has caused a widespread deficiency of secondary and micronutrients in soil. Legumes as an additive intercrop in fingermillet would increase the productivity of soil and cropping system. Besides helping supply of protein to the farmers by practicing fingermillet with pigeonpea (8:2) based intercropping system. The research evidences conspicuously indicated that both fingermillet (Umesh, 2012) and pigeonpea productivity (Umesh and Shankar, 2013) enhances in rain-fed *Alfisols* under integrated nutrient management. Further, yield improvement is also possible through protective irrigation. It is necessary to manage the soil moisture through protective irrigation. Although the millet crops are reported to be most tolerant to moisture stress but even for short period of moisture stress during critical stages of growth, markedly reduces the yield (Udayakumar *et al.*, 1986). The information on sustainable productivity of fingermillet and pigeonpea to use of organic manures in fingermillet based intercropping system is very meager. The present study was undertaken to evaluate the fingermillet and pigeonpea intercropping system under different organic manures in *Alfisols* under protective irrigation.

Materials and Methods

A field experiment was conducted during the *Kharif* 2006 and 2007 at the Agronomy field unit, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore (77^0 35^1 E, 12^0 58^1 N, 930 m above mean sea level). The soil of the experimental site was red sandy loam in texture classified under the order *Alfisols*, Vijapura series, *Isohyperthermic* family *Oxihaplustaf*. It has pH 6.44 having low CEC (7.50 C mol/kg) with an EC of 0.23 dSm^{-1} and organic carbon content was 0.47%. 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 the cropping period in 2006 and 2007 respectively (Figure 1). It was slightly lower than the normal rainfall (24.3 and 5%, respectively).

The soil was lower, higher and medium available NPK respectively. The experiment was laid out in RCBD with four replications. The treatments comprised of different organic sources of nutrients such as FYM, sewage sludge, poultry manure compost (PMC), urban garbage compost, vermicompost (VC) and enriched urban garbage, compost were applied equivalent to

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

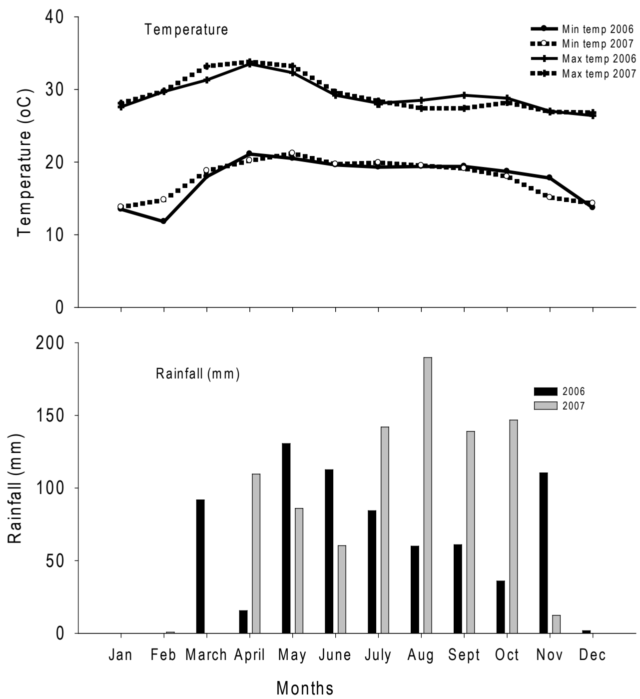

Fig. 1 : Rainfall, maximum and minimum temperature prevailed during 2006 and 2007 at experimental site, GKVK, Bangalore

recommended nitrogen basis and compared with recommended inorganic fertilizers (50:40:25 kg NPK/ha). The information on nitrogen content and quantity of organic manure used in the experiment is presented in Table 1. Fingermillet variety GPU-28 and pigeonpea variety TTB-7 were selected for the study. Plant biometric observations were recorded at 30, 60, 90 DAS and at harvest in both the component crops. The weather conditions were favorable for raising crops and two protective irrigations were provided during dry spells. Both the component crops were free from pest and diseases by timely prophylactic measures.

Economic returns of the trial was worked out based on the prevailing market prices of input and outputs. Net return (₹/ha) was calculated by deducting the cost of cultivation from gross returns in both the years. B:C ratio was worked out by cost of cultivation and net returns. The experimental data were analyzed 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 in the same level of significance.

Results and Discussion

Grain and straw yield of fingermillet

Among organic manures, application of either sewage sludge (equivalent to 50 kg N) or poultry manure compost produced higher grain and straw yield (Table 2) lowest by application of FYM. This could be ascribed to the higher nutrient composition (Table 1) coupled with a pattern of nutrient release into soil solution to match the required absorption pattern (Anand, 1995). The production of photosynthates and their translocation to sink depends upon the availability of mineral nutrients besides soil moisture in fingermillet. Masthan Reddy *et al*. (2005) and Poornesh *et al.* (2004) reported application of different organic manures profound impact on fingermillet productivity. Many of the earlier reports have also indicated that the soil physico-chemical and biological properties were improved with the favourable application of either sewage sludge or poultry manure *viz*., water storage, bulk density, organic carbon, available nutrients, soil pH, EC, CEC and microbial population of the rhizosphere (Jha *et al*., 2001). Further, slow and steady rate of nutrient release into soil solution was also responsible for better absorption of nutrients by fingermillet (Devagowda, 1997 and Dosani *et al*., 1999).

Sewage sludge contains about 60% of its nitrogen as uric acid, 30% as a more stable organic form of N and less than 10% as mineral N. The uric acid rapidly converts N to ammonical form subsequently into available NO_3 and also contain growth promoting hormones and produce better root growth than fertilizers application. Similar results of higher yield were reported by Dinesh Kumar (2006) in fingermillet. Favourable effects of sewage sludge and poultry manure compost on soil pH, EC, redox potential, CEC and microbial population of the rhizosphere is well documented by Reddy and Reddy (1998) and Yogananda and Reddy (2004). Therefore, it could be concluded that sewage sludge and poultry manure compost serves as a good amendment as well as a store house of nutrients for plant growth.

Grain and stalk yield of Pigeonpea

Application of sewage sludge produced significantly higher pigeonpea grain yield (370 kg/ha) followed by poultry manure compost (355 kg/ha) and lower in FYM application (263 kg/ha) (Table 2). Stalk yield of pigeonpea was also significantly higher with the application of sewage sludge (1407 kg/ha) and poultry manure compost over FYM (1021 kg/ha). The synchrony of improved plant nutrient release and its availability had a profound

Table 2 : Productivity of fingermillet and pigeonpea as influenced by application of different organic sources of nutrients

Treatment	Fingermillet				Intercrop pigeonpea			
	Grain yield (kg/ha)		Straw yield (kg/ha)		Grain yield (kg/ha)		Stalk yield (kg/ha)	
	2006	2007	2006	2007	2006	2007	2006	2007
Recommended NPK (50 :40 :25 kg NPK/ha)	2048	2041	3307	3278	298	292	1148	1125
Farm yard Manure*	1858	2010	3164	3451	252	273	983	1059
Urban Garbage Compost	1941	2097	3246	3544	270	293	1054	1136
Sewage Sludge	2364	2632	3768	4362	345	394	1318	1496
Poultry Manure Compost	2342	2607	3731	4286	336	373	1284	1416
Enriched urban Garbage Compost	2251	2423	3590	3948	320	349	1233	1340
Vermicompost	2207	2403	3542	3862	309	335	1191	1286
S.Em. +	87	91	125	133	11	12	42	44
C.D. (p=0.05)	260	272	374	400	34	36	125	131

*Organic manures applied equivalent to 50 kg nitrogen
Ragi seeds- ₹ 720/q, Straw-1400/t, Pigeonpea seeds- ₹ 2000/q, Pigeonpea stalk- ₹ 300/t

influence on crop yield. Similar results of higher yield were also reported by Umesh (2002) in fingermillet with pigeonpea intercrop; Dinesh Kumar (2006) in soybean and Dosani *et al.* (1999) in groundnut. Not only the amount of nutrients present in the soil, but also their availability in rhythm with the pattern of crop growth is important, which in turn could influence on plant growth (Sheshadri Reddy *et al*., 2004; Malligowda *et al*., 2000).

Nutrient Uptake

Application of different organic manure significantly increased total uptake (grain and straw) of N, P and K by fingermillet. Among all manures, application of sewage sludge on N-basis influences N, P_2O_5 and K_2O uptake to the extent of 40.5, 8.8 and 31.5 kg ha^{-1}, respectively over FYM (Table 3). 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% over FYM and 5.9, 5.0 and 4.6% over the recommended dose of fertilizer. In general, the uptake of nutrients by the crop depends on the amount and duration of availability of nutrients in soil. In turn, amount of moisture in the soil and the source of nutrients and influence the total uptake of nutrients by the crop. Higher NPK concentration in poultry manure composts and sewage sludge (Table 1) coupled with higher availability of nutrients could have resulted in better nutrient uptake than FYM, vermicompost. 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. Since solid and the liquid portion of the poultry excreta is excreted together, poultry manure is a concentrated source of N and P (Dosani *et al*., 1999). Devegowda (1997) opined that poultry manure contained higher concentrations of macro and micronutrients that contributed for higher availability and uptake of nutrients than FYM or urban garbage compost. On mineralization of organic manures, several nutrients are released in available form over long period of time depending on the range of C: N ratio (Ryan *et al*., 1973; Banerjee and Srinivasan, 1983 and Zaman *et al*., 2002).

Economics returns

The different organic manure application showed considerable variation in economics (Table 4). Application of organic manures alone resulted in lowest cost of cultivation, highest net return and B: C ratio. This is because of the lower cost of cultivation due to relatively cheaper organic manures containing most of the plant nutrients as compared to inorganic fertilizers alone. Higher B: C ratio (2.27) was obtained with the application of sewage sludge followed by poultry manure compost (2.19). It could be due to the low cost of cultivation and higher net return with the application of sewage sludge followed by poultry manure compost (Table 3). While, application of vermicompost recorded lowest B: C ratio (1.10) despite medium returns due to relatively higher cost of cultivation (₹ 13625/ha). Higher economic returns in intercropping under different nutrient management were also reported by Nanjundappa *et al.* (2003), Poornesh (2003), Sheshadri Reddy *et al.* (2005), Umesh and Shankar, (2013) and Rukmangada Reddy *et al*. (2007). Further, Prajwal Gungal (2007) found that application of N through organic manure not only reduced the cost of cultivation, but also resulted in higher grain yield thereby increasing the net returns.

Table 3 : Nutrient uptake by fingermillet and soil residual nutrient in organic production system

Treatment	Nutrient uptake by fingermillet (kg/ha)						Residual nutrient status after two years (kg/ha)		
	N		P_2O_5		K_2O		N	P	K
	Grain	Straw	Grain	Straw	Grain	Straw			
Recommended NPK (50 :40 :25 kg NPK/ha)	20.3	10.9	4.2	2.7	6.9	17.8	172.8	26.4	176.4
Farm Yard Manure*	18.0	9.8	4.0	2.4	6.5	16.0	265.9	51.9	285.6
Urban Garbage Compost	19.5	10.5	4.1	2.5	6.7	16.9	262.7	54.0	269.5
Sewage Sludge	25.6	15.0	5.3	3.5	8.6	22.8	258.7	63.7	269.2
Poultry Manure Compost	25.0	14.5	5.2	3.4	8.5	22.2	260.4	70.1	279.5
Enriched Urban Garbage Compost	23.8	13.9	4.9	3.2	8.1	21.1	256.8	59.7	264.9
Vermicompost	23.0	13.4	4.8	3.1	7.9	20.5	258.3	50.6	254.4
S.Em.±	0.6	0.6	0.1	0.2	0.2	1.1	4.0	1.0	3.4
C.D. (p=0.05)	1.9	1.7	0.4	0.4	0.6	3.2	11.9	2.9	10.3

*Organic manures applied equivalent to 50 kg nitrogen

Table 4 : Economic returns of fingermillet + pigeonpea intercropping under organic production system

Treatment	Cost of cultivation (₹/ha)		Net returns (₹/ha)		B:C ratio	
	2006	2007	2006	2007	2006	2007
Recommended NPK (50:40:25 kg NPK/ha)	9894	10192	16843	16600	1.70	1.63
Farmyard manure*	10120	10420	13022	14661	1.29	1.41
Urban garbage compost	9975	10300	14261	15961	1.43	1.55
Sewage sludge	9525	9700	20066	23685	2.11	2.44
Poultry manure compost	9600	9800	19591	22856	2.04	2.33
Enriched urban garbage compost	10100	10550	17903	19805	1.77	1.88
Vermicompost	13700	13550	13686	16244	1.00	1.20

*Organic manures applied equivalent to 50 kg nitrogen
Ragi seeds- ₹ 720/q, Straw- ₹ 1400/t, Pigeonpea seeds- ₹ 2000/q, Pigeonpea stalk- ₹ 300/t

Conclusion

Application of sewage sludge and poultry manure compost was found to be effective as organic manure in enhancing productivity of fingermillet and pigeonpea intercropping in *Alfisols* under protective irrigation. Further, these manures are also cost effective and a potential substitute for FYM and fertilizers for the replenishing nutrient requirement of crops.

References

Anand AS. 1995. Characterization and utilization of sewage and industrial sludge for crop production. *M.Sc (Agri.) Thesis,* UAS, Bangalore.

Devegowda G. 1997. Poultry manure excreta and other wastes as a source organic manures. *In*: Training course on organic farming, UAS, GKVK, Bangalore, pp: 7-11.

Dinesh Kumar. 2006. Integrated nutrient management for fingermillet-soybean and soybean-fingermillet cropping system. *Ph.D., Thesis*, UAS, Bangalore, Karnataka.

Dosani AAK, Talashikar S and Mehta VB, 1999. Effect of poultry manure applied in combination with fertilizers on the yield, quality and nutrient uptake of groundnut. Journal of Indian Society of Soil Science, 47(1): 166-169.

Jha SK, Sharma A and Singh RP. 2001. Characterization of farm and city waste manures of diverse origin. Journal of Research, 13 (2): 117-123.

Khandey BA, Thakur RC and Khushu MK. 1990. Effect of nitrogen, FYM and zinc application on yield, yield attributes and nutrient uptake of maize. Haryana Journal of Agronomy, 6: 113-117.

Masthan Reddy BG, Patter PS and Kuchanur PH. 2005. Response of rice to poultry manure and graded levels of NPK under irrigated conditions. Oryza, 42 (2):109-111.

Mukesh Kumar Pandey, Vishalgupta CS, Kalha and Dolly Gupta. 2008. Organic farming – principles and practices for progressive agriculture. Green Farming, 1 (6): 16-19.

Nanjundappa G, Reddy VC and Yogananda, SB. 2003. Forage yield of Napier grass as influenced by water hyacinth and poultry waste. Mysore Journal of Agricultural Sciences, 37(2): 122-125.

Poornesh AS, Reddy, VC and Kalyana Murthy KN. 2004. Effect of urban garbage compost and sewage sludge on yield of ragi (*Eleusine coracana* (L.) Gaertn) and soil properties. Environment and Ecology, 22 (3): 720-723.

Prajwal Gungal. 2007. Evaluation of enriched organic manures on the performance of hybrid cotton. *M.Sc (Agri.) Thesis,* UAS., Bangalore.

Reddy, BG and Reddy MS. 1998. Effect of organic manures and nitrogen levels on soil available nutrients status in maize-soybean cropping system. Journal of Indian Society of Soil Science, 46: 474-476.

Rukmangada Reddy S, Reddy VC, Ramakrishna Parama VR. and Pampa Samanta. 2007. Effect of FYM, sewage sludge and urban compost on growth and yield of sweet sorghum (*Sorghum bicolor* L. Moench). Journal of Soils and Crops, 17(2): 211-216.

Savant MK and Dutta SK. 1982. Nitrogen transformation in wetland, rice soils. Advances in Agronomy 35: 241-302.

Sheshadri Reddy S. 2005. Effect of poultry manure, sewage sludge and urban compost on yield and economics of groundnut. Journal of Oilseed Research, 22 (2):245-248.

Sheshadri Reddy S, Shivaraj B and Reddy VC. 2004. Nutrient uptake and agronomic efficiency of groundnut as influenced by different organic manures. Karnataka Journal of Agricultural Sciences, 17(4): 670-674.

Udayakumar M, Sashidhar VR and Prasad TG. 1986. Physiological approaches for improving productivity of fingermillet under rainfed conditions. In :Paper presented at the International Workshop on Small Millets. Oct. 26th Nov. 2, 1986, UAS., Bangalore.

Umesh MR. 2002. Assessment of inter cropping, advantage of fingermillet with castor and pigeonpea under integrated nutrient supply levels. *M.Sc (Agri.) Thesis,* UAS., Bangalore.

Umesh MR, Sharanappa and Jagadeesha N. 2006. Growth, yield and nutrient uptake of fingermillet as influenced different cropping systems and fertility levels. *In:* National seminar on resource management for sustainable agriculture. Conducted by Annamalai University, Annamalai Nagar. Pp-345.

Umesh MR and Shankar MA. 2013. Yield Performance and Profitability of Pigeonpea (*Cajanus cajana* L.) Varieties under Different Nutrient Supply Levels in Dryland *Alfisols* of Karnataka. Indian Journal of Dryland Agriculture Research and Development, 28(1): 63-69.

Umesh MR. 2008. Investigations on balanced fertilization for maize-pigeonpea cropping sequence in *Alfisols* of Karnataka. *Ph.D. Thesis*, UAS, Bangalore.

Yogananda and Reddy. 2004. Growth and sustainability of rice varieties as influenced by urban compost and inorganic fertilizers. Journal of Ecology and Biology, 16 (4): 279-285.

Received: October 2015; Accepted: May 2016