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Effect of Establishment Methods and Sources of Organic Nutrients on Productivity and Nutrient Uptake of Finger Millet, (*Eleusine coracana* L.)

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ABSTRACT

Field experiment was conducted during 2006 and 2007 to "study the effect establishment methods and different organic nutrient sources on yield and nutrient uptake of finger millet". Soil of the experimental site was red sandy loam in texture, low in organic carbon (0.43%) and available nitrogen (270.60 kg ha^{-1}), medium in available P_2O_5 (32.25 kg ha^{-1}) and K_2O (149.80 kg ha^{-1}). Treatment consisted of 12 treatment combinations two main plot treatments of establishment methods and six nutrient sources in sub plot and was laid out in split plot design with three replications. The results indicated that aerobic method of cultivation recorded significantly higher grain yield (3358 kg ha^{-1}), straw yield (6337 kg ha^{-1}) and total N, P_2O_5 and K_2O (140.63, 18.97 and 95.21 kg ha^{-1}, respectively) of finger millet as compared to puddled rice soil condition. Among the different organic nutrient sources, application of poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing recorded significantly higher grain yield (3484 kg ha^{-1}), straw yield (6574 kg ha^{-1}) and total N, P_2O_5 and K_2O uptake (146.93, 19.50 and 99.66 kg ha^{-1}, respectively) in both puddled and aerobic condition and which was on par with application of sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure at top dressing.

Key words: *FYM; Finger millet; N equivalent; Poultry manure; Grain; Straw*

INTRODUCTION

Finger millet is an important crop of Karnataka with >60% area of the country followed by Uttarakhand (10%), Maharashtra (9.6%), Tamilnadu (6.5%), Odisha (4.8%) and Andhra Pradesh (3.6%). It is mainly a *Kharif* season crop, but also grown during Rabi/summer in Karnataka and Odisha over a smaller area. In Karnataka, it is grown in an area of 0.70 m ha producing 1.20 m t with a yield of 1845 kg ha^{-1} (Anon., 2015). It is an important nutritive crop of the semi-arid zones of the world and it is the staple food crops for millions of people in Africa and Asia.

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Sustainable production for a long period of time from different crop based cropping system is possible by making complementary interaction between the crop in cropping system like including legumes in cereal-based cropping system, deep-rooted crop with shallow rooted crop, optimum population of both the crops, combined use of agronomical/ cultural, mechanical, chemical and biological approaches to weeds and pest management. To achieve more sustainable production from finger millet based cropping systems, application of judicious and balanced fertilization through organic and inorganic fertilizers proved better and recorded more system yield per unit area than sole cropping.

Organic method is self-sufficient and self-dependent as compared to modern chemical farming with principle of nutrients capturing and relying more on organic inputs that is need of the hour. Organic farming minimizes the use of external inputs and aims at optimization of crop productivity rather than its maximization through renewal and strengthening of ecological processes and functions of farm ecosystem[7]. Therefore the use of locally available agro-inputs in agriculture by avoiding or minimizing the use of synthetic agrochemicals appears to be one of the probable options to sustain the agricultural productivity. Various organic nutrient sources are available which contain good amount of major plant nutrients to produce comparable yields[2]. The practices of organic cultivation vary with the availability of local resources of manures and their nutrient content and as such it is necessary to identify both the source and its quantity to meet the nutrient requirement of finger millet. At the same time the food habits of the consumers are changing rapidly. Developed countries people have become more health conscious. Hence the demand for organic food products is on the rise. The crop yields have declined under irrigated condition which could be ascribed for not using organic manures or low doses. Most of the soils are low in organic carbon and deficit in many essential nutrients. Mostly, research on organic production of finger millet was mainly concentrated on the use of FYM, compost, green manure, oil cakes *etc*. Therefore, an investigation was under taken to study the effect of organic nutrient sources on yield and nutrient uptake of finger millet under different establishment methods.

MATERIAL AND METHODS

Field experiment was conducted during *kharif* 2006 and 2007 at Zonal Agricultural Research Station, Mandya, University of Agricultural Sciences, Bengaluru to "Study the effect of different establishment methods and organic nutrient sources on yield and economics of finger millet". Soil of the experimental site was red sandy loam in texture, low in organic carbon (0.43%) and available nitrogen (270.60 kg ha^{-1}), medium in available P_2O_5 (32.25 kg ha^{-1}) and K_2O (149.80 kg ha^{-1}). Treatments consisted of 12 combinations of two main plot treatments (methods of cultivation) and six nutrient sources in sub plot (T_1: Recommended fertilizer dose (FYM 10 t + 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1}), T_2: FYM @ 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing, T_3: Pressmud 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing, T_4: Poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing, T_5: Sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing, T_6: Urban compost 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing) were laid out in split plot design with three replications. The variety used was Indaf 9 it was developed at Zonal Agricultural Research Station, Visweshwaraiah Canal Farm, Mandya, University of Agricultural Sciences, Bengaluru. This is a short duration variety and comes to harvest in 105 days and suitable for both irrigated and rainfed condition.

The relevant yield was recorded at harvest and subjected to statistical analysis; results were then analyzed statistically for drawing conclusion using analysis of variance

(ANOVA) procedure[3]. The plant samples used for recording dry matter production at harvest were used for analyzing nutrients present in the plant. After recording the dry weight from each treatment the samples were powdered in a micro Willey mill. The samples were analyzed for concentration (%) of different macronutrients (N, P_2O_5 & K_2O) present in finger millet plant parts. Nitrogen content of grain and straw was estimated by modified micro-kjeldhal's method as outlined by Jackson and expressed in percentage. Nutrient uptake (kg ha^{-1}) by crop was calculated for each treatment separately using the following formula

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}}{100} \times \text{Dry weight (kg ha}^{-1}\text{)}$$

The sum of uptake of nutrients in grain and straw was considered as the total uptake by the crop. The phosphorus content of grain and straw was determined by Vanadomolybodo phosphoric acid yellow colour method and absorbance of the solution was recorded at 430 nm using spectrophotometer and then computed to total uptake by crop as same as that of N uptake. Potassium content in plant sample (grain and straw separately) was determined by Flame photometer method and expressed in kg ha^{-1} as explained in nitrogen estimation.

RESULTS AND DISCUSSION

Grain and straw yield: Significantly, higher grain and straw yield (3358 and 6337 kg ha^{-1}, respectively) of finger millet was registered in aerobic method of establishment as compared to puddled method of establishment (3029 and 5715 kg ha^{-1}, respectively). This might be due to continuous supply of oxygen to root zone leading to higher uptake of nutrients which resulted in higher leaf area, higher dry matter and better translocation of source to sink ration. The results are in the line those of Richa Khanna[6]. Among the nutrient sources application of recommended dose of fertilizer recorded significantly higher grain and straw yield (3884 and 7328 kg ha^{-1}, respectively) as compared to organic source of nutrients. Among different organic sources of nutrients application of poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing recorded significantly higher grain and straw yield (3484 and 6574 kg ha^{-1}, respectively) and was on par with application of sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing (3373 and 6363 kg ha^{-1}, respectively) as compared to all other sources of nutrients. The increase in grain yield is a result of better growth and growth components application of poultry manure could have released the nutrients slowly into the soil solution to match the required absorption pattern of finger millet. Probably, the adequate supply of nutrients could have resulted in higher uptake of nutrients like nitrogen, phosphorous and potassium and resulted in higher grain yield of finger millet[5].

Nutrients uptake by finger millet: finger millet grown under aerobic situation recorded significantly higher nitrogen (69.97, 70.66 and 140.63 kg ha^{-1}, respectively), phosphorous (8.75, 10.22 and 18.97 kg ha^{-1}, respectively) and potassium (27.99, 67.22 and 95.21 kg ha^{-1}, respectively) uptake in grain, straw and total uptake as compared to puddled condition. Puddled situation resulted in considerable wastage of water and plant nutrients due to deep percolation below root zone and set a chain of undesirable hazards such as poor soil aeration, water logging and imbalanced soil water nutrient environment leading to reduction in mineralization and uptake of nutrient.

Among different nutrient sources, application of recommended dose of fertilizer recorded significantly higher nitrogen (80.92, 76.73 and 157.65 kg ha^{-1}, respectively),

phosphorous (10.11, 12.64 and 22.75 kg ha^{-1}, respectively) and potassium (32.37, 73.90 and 106.27 kg ha^{-1}, respectively) uptake in grain, straw and total uptake as compared to organic source of nutrients. Among different organic source of nutrients, application of poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing recorded significantly higher nitrogen (72.57, 74.34 and 146.93kg ha^{-1}, respectively), phosphorous (9.07, 10.43 and 19.50 kg ha^{-1}, respectively) and potassium (29.04, 70.62 and 99.66 kg ha^{-1}, respectively) uptake in grain, straw and total uptake which was on par with application of sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing as compared to all other source of nutrients. Application of poultry manure help in release of more nutrients and also produce more humic acid and humic substances, which form chelates with phosphorus. The chelated phosphorus has been reported to be more soluble in water, which might have favoured in more release of phosphorus and easily available to the crop[4].

Table 1: Grain yield and straw yield of finger millet as influenced by methods of establishment and organic sources of nutrients

Treatments	Grain yield (kg ha-1)			Straw yield (kg ha-1)		
	Pooled					
	M1	M2	Mean	M1	M2	Mean
T1: Recommended fertilizer dose	3781	3987	3884	7134	7523	7328
T2: FYM @ 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	2748	3152	2950	5184	5946	5565
T3: Pressmud 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	2512	2729	2621	4740	5149	4944
T4: Poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	3283	3686	3484	6194	6954	6574
T5: Sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	3142	3604	3373	5927	6799	6363
T6: Urban compost 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	2709	2994	2851	5110	5649	5380
Mean	3029	3358	3194	5715	6337	6026
	M	T	MxT	M	T	MxT
S.Em+	82.55	88.59	498.54	151.21	111.96	933.65
CD@5%	247.65	265.78	NS	453.65	335.90	NS

Note: M_1: Puddled rice cultivation
M_2: Aerobic rice cultivation
RDF: Recommended Dose of Fertilizer (100:50:50 kg N:P_2O_5:K_2O ha^{-1}+ FYM 4t ha^{-1})
NS: Statistically not-significant

Table 2: Nutrients uptake by grain of finger millet as influenced by methods of establishment and organic source of nutrients

Treatments	Nutrients uptake by grain (kg ha^{-1}) (Pooled)								
	N			P_2O_5			K_2O		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
T_1: Recommended fertilizer dose	78.77	83.06	80.92	9.85	10.38	10.11	31.51	33.23	32.37
T_2: FYM @ 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	57.24	65.66	61.45	7.15	8.21	7.68	22.90	26.26	24.58
T_3: Pressmud 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	52.33	56.85	54.59	6.54	7.11	6.82	20.93	22.74	21.84
T_4: Poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	68.40	76.78	72.59	8.55	9.60	9.07	27.36	30.71	29.04
T_5: Sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	65.45	75.07	70.26	8.18	9.38	8.78	26.18	30.03	28.10
T_6: Urban compost 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	56.43	62.38	59.40	7.05	7.80	7.43	22.57	24.95	23.76
Mean	63.10	69.97	66.53	7.89	8.75	8.32	25.24	27.99	26.61
	M	T	MxT	M	T	MxT	M	T	MxT
S.Em+	1.68	1.55	10.29	0.27	0.20	1.39	0.84	0.59	4.19
CD@5%	5.05	4.65	NS	0.81	0.60	NS	2.52	1.79	NS

Note: M_1: Puddled rice cultivation
M_2: Aerobic rice cultivation
RDF: Recommended Dose of Fertilizer (100:50:50 kg N:P_2O_5:K_2O ha^{-1}+ FYM 4t ha^{-1})
NS: Statistically not-significant

Table 3: Nutrients uptake by straw of finger millet as influenced by methods of establishment and organic source of nutrients

Treatments	Nutrients uptake by straw (kg ha^{-1}) (Pooled)								
	N			P_2O_5			K_2O		
	M_1	M_2	Pooled	M_1	M_2	Pooled	M_1	M_2	Pooled
T_1: Recommended fertilizer dose	75.70	77.76	76.73	12.52	12.76	12.64	73.42	74.39	73.90
T_2: FYM @ 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	63.53	65.54	64.54	8.91	9.19	9.05	60.35	62.26	61.31
T_3: Pressmud 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	61.52	63.22	62.37	8.63	8.87	8.75	58.44	60.06	59.25
T_4: Poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	73.60	75.07	74.34	10.32	10.53	10.43	69.91	71.32	70.62
T_5: Sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	70.79	73.59	72.19	9.93	10.32	10.12	67.25	69.90	68.58
T_6: Urban compost 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	66.40	68.80	67.61	9.32	9.65	9.48	63.09	65.36	64.22
Mean	68.59	70.66	69.63	9.94	10.22	10.08	65.41	67.22	66.31
	M	T	MxT	M	T	MxT	M	T	MxT
S.Em±	0.54	0.82	4.60	0.07	0.13	0.93	0.55	1.06	6.18
CD@5%	1.63	2.47	NS	0.22	0.40	NS	1.66	3.20	NS

Note: M_1: Puddled rice cultivation
M_2: Aerobic rice cultivation
RDF: Recommended Dose of Fertilizer (100:50:50 kg N:P_2O_5:K_2O ha^{-1}+ FYM 4t ha^{-1})
NS: Statistically not-significant

Table 4: Total nutrients uptake by finger millet as influenced by methods of establishment and organic source of nutrients

Treatments	Total nutrients uptake by finger millet (kg ha^{-1}) (Pooled)								
	N			P_2O_5			K_2O		
	M_1	M_2	Pooled	M_1	M_2	Pooled	M_1	M_2	Pooled
T_1: Recommended fertilizer dose	154.47	160.82	157.65	22.37	23.14	22.75	104.93	107.62	106.27
T_2: FYM @ 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	120.77	131.20	125.99	16.06	17.40	16.73	83.25	88.52	85.89
T_3: Pressmud 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing	113.85	120.07	116.96	15.17	15.98	15.57	79.37	82.80	81.09
T_4: Poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	142.00	151.85	146.93	18.87	20.13	19.50	97.27	102.03	99.66
T_5: Sewage sludge 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	136.24	148.66	142.45	18.11	19.70	18.90	93.43	99.93	96.68
T_6: Urban compost 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing.	122.83	131.18	127.01	16.37	17.45	16.91	85.66	90.31	87.98
Mean	131.69	140.63	136.16	17.83	18.97	18.40	90.65	95.21	92.92
	M	T	MxT	M	T	MxT	M	T	MxT
S.Em±	1.61	2.15	15.87	0.32	0.40	2.72	0.86	1.08	9.48
CD@5%	4.82	6.45	NS	0.95	1.20	NS	2.59	3.26	NS

Note: M_1: Puddled rice cultivation
M_2: Aerobic rice cultivation
RDF: Recommended Dose of Fertilizer (100:50:50 kg N:P_2O_5:K_2O ha^{-1}+ FYM 4t ha^{-1})
NS: Statistically not-significant

CONCLUSION

Among different organic nutrient management practices application of poultry manure 125 kg N equivalent + 25% of recommended N equivalent poultry manure as top dressing has been found superior with respect to yield and

nutrients uptake by the finger millet under both puddled rice soil condition and aerobic rice soil condition.

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