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RESEARCH ARTICLE :

Effect of NPK application through different approaches on yield and major nutrient uptake by finger millet (*Eleusine coracona* L.) under rainfed conditions

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SUMMARY : A field experiment was conducted on alfisols during 2013 of Zonal Agricultural and Horticultural Research Station, College of Agriculture, Navile, Shivamogga. To study the effect of NPK application through different approaches on yield and major nutrient uptake by finger millet (*Eleusine coracona* L.) under rainfed conditions. A total of nine treatments were tried in a Randomized Complete Block Design (RCBD) with three replications. The treatments comprise of RDF + compost 10 t ha^{-1}, RDF + 50 % NK + compost 10 t ha^{-1}, STCR based NPK + compost 10 t ha^{-1}, STL based NPK + compost 10 t ha^{-1}, RDF through enriched compost, RDF + 50% NK through enriched compost, STCR based through enriched compost, STL based through enriched compost, with a control. The results revealed that application of STCR based NPK and compost 10 t ha^{-1} for targeted yield 40 q ha^{-1} recorded a highest grain yield (3238.00 kg ha^{-1}) and straw yield (8926.00 kg ha^{-1}). Similarly higher uptake was recorded in STCR based NPK + compost 10 t ha^{-1} both in grain and straw. The highest partial factor productivity was recorded in T_2 which receive NPK + 50 % NK + compost 10 t ha^{-1}.

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BACKGROUND AND OBJECTIVES

Finger millet [*Eleusine coracana* (L.) *Garten*.], ranks third in importance among millets in area (2 million ha) and production (1.98 million tonnes) after sorghum and pearl millet in the country (Anonymous, 2014). Finger millet is poor man's crop mostly grown in poor or marginal lands. Most of the fertile land is reserved for rich crops like paddy, maize, jowar, groundnut, pigeonpea etc. The crop is also not that cared in terms of fertility management and other aspects. Usually farmers mix the Di-Ammonium Phosphate or other chemical fertilizers at the time of sowing and forget the crop without any other management. Many farmers apply only

available organic manures with them and do minimum management.Under rainfed farming situations, the only available organic manure source is FYM. Along with that, farmers can efficiently make use of the resources with them for the preparation of compost. In that concern, on their houses they can prepare nutritious vermicompost by adopting vat technology. Otherwise, they can also utilize the farm waste and coconut fronds for compost preparation. This enable them cheap production cost, employment generation and supply of nutritious fresh organic manure to the crops. In order to achieve the yield potentiality of transplanted finger millet, there is need to supply balanced nutrition apart from good care. This study pertains to Effect of NPK application through different approaches on yield and major nutrient uptake by finger millet (*Eleusine coracona* L.) to see its effect on soil health and yield of finger millet crop with the following objectives: To study feasibility NPK through different approaches on yield and nutrient uptake.

RESOURCES AND METHODS

A field experiment was conducted on alfisols during 2013 of Zonal Agricultural and Horticultural Research Station, College of Agriculture, Navile, Shivamogga, which is located at a latitude of 13^0 58' 30.4 north, a Longitude of 75^0 34', the climate of the study area in general is tropical wet and dry summer type. The mean maximum temperature was (33.70^0 C) in the month of April and minimum temperature occurs in December with value being 14^0 C. The mean annual rainfall of the region is 842.33 mm. During this season, ragi has been taken as rainfed crop. The ragi crop cv. GPU28 was sown in june 2013 keeping the plants to plants distance of 22.5 cm and row spacing of 30 cm, following standard package of practices. A total of nine treatments were tried in a Randomized Complete Block Design (RCBD) with three replication. The treatments comprise of RDF + compost 10 t ha^{-1}, RDF + 50 % NK + compost 10 t ha^{-1}, STCR based NPK + compost 10 t ha^{-1}, STL based NPK + compost 10 t ha^{-1}, RDF through enriched compost, RDF + 50% NK through enriched compost, STCR based through enriched compost, STL based through enriched compost, with a control.

The compost was applied 4-5 weeks before sowing of the ragi crop. NPK were applied in the form of urea, single superphosphate and muriate of potash. Full dose of P, K and half dose of N was applied at the time of sowing and half dose of N was top-dressed at 21 days after sowing of ragi crop. Representative soil samples (0-15 cm) were collected from each of the 27 plots before application of fertilizer and compost for sowing of ragi crop. At the time of harvesting from each plot five plants were selected for grain and straw sampling. The plants were analyzed for N by micro-Kjeldahal method (Jackson, 1973) and N uptake was calculated by multiplying dry matter with content (%) of plant. The P and k in plant sample were analyzed after digestion with diacid (HNO_3: $HClO_4$) digest was estimated by vanadomolybdate phosphoric acid yellow color method (Jackson, 1973) using spectrophotometer. Potassium content in the acid digest was measured using flame photometer and total uptake was calculated. With the help of nutrient uptake data and soil test values, the basic data (nutrient requirement in kg t^{-1} of grain, per cent contribution from soil and applied fertilizer) were computed by Ramamoorthy *et al*. (1967). The basic data, in turn, was transformed into simple workable fertilizer adjustment equations for calculating fertilizers N, P and K doses for yield targets based on initial soil test values.

Nutrient uptake :

Nutrient uptake for different elements like N, P, K, and S was calculated using the formula as given below.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient concentration (\%) x Yield of grain/Straw (kg ha}^{-1}\text{)}}{100}$$

Partial factor productivity (PEP) :

$$\text{PEP} = \frac{\text{Grain yield treated plots}}{\text{Fertilizer applied}}$$

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Effect of organic and different levels of inorganic nutrients on yield attributes at different stages of finger millet :

Achieving consistent high yields depends on better management of soil and water resources along with applied inputs in a given situation of environment. Optimizing the fertilizer requirements for crop production is influenced by soil, crop, climate and mangemental factors. This calls for site specific knowledge of crop

nutrient requirement, indigenous nutrient supply and recovery efficiency of applied fertilizers. In the present investigation, the grain yield differed significantly due to application of inorganic fertilizers and compost through different approaches. Quantity and quality of growth attributes observed by plant largely depends on presence of ideal soil conditions, its genetic potentiality and the environment acting through its internal physiological and bio-chemical process. The consequence of higher and lower growth parameters achieved due to treatment effect is reflecting back for getting difference in yield parameters (Table 1)

The maximum number of ear heads per plant (3.56) were obtained in T_3(STCR based NPK + compost 10 t ha^{-1}) and followed by T_2 (RDF + 50 % NK +compost 10 t ha^{-1}) are presented in (Table 1). It may be due to ready availability of nutrients from mineral fertilizer and mineralization of organic manure throughout the growing period did not put the plants in nutrients stress at any stage and resulted in maximum grain production (Azam shah *et al.,* 2010). On the similar line the finger length was found 3.80 cm in control, which further increased significantly to 6.30 cm. This is mainly due to higher application of nitrogen and potassium which also helped to increase in cob weight and number of grains per cob. These results are in accordance with that of Khan *et al.* (2011). There was significant difference in the test weight of seeds. This varied from 2.80 g in control to 4.40 g in treatment receiving fertilizers and compost @ 10 t ha^{-1} on STCR approach, which was superior over all the other treatments. The significant increase in test weight may be attributed to better grain filling ability of the crop due to ease availability of nitrogen and other nutrients from Soil and fertilizers. Similar finding was also reported by Apoorva *et al*. (2010).

Table 1: Effect of organic and different levels of inorganic nutrients on yield attributes of finger millet

Treatment No	Treatments	Number of Ear heads $plant^{-1}$	Finger length (cm)	Test weight of 1000 seed (g)
T_1	RDF + Compost @ 10 t ha^{-1}	3.73	4.66	3.10
T_2	RDF+ 50 % NK + Compost @ 10 t ha^{-1}	4.90	5.43	3.76
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	5.73	6.30	4.40
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	4.26	4.90	3.56
T_5	RDF through enriched compost	3.80	4.60	3.26
T_6	RDF + 50% NK through enriched compost	4.40	5.10	3.60
T_7	STCR Based through enriched compost	4.90	5.31	3.20
T_8	STL Based through enriched compost	4.40	4.40	3.03
T_9	Control	3.56	3.80	2.80
	S.E.±	0.25	0.19	0.15
	C.D. (P=0.05)	0.74	0.58	0.45

Table 2 : Effect of organic and different levels of inorganic nutrients ongrain and straw yield of finger millet

Treatment No.	Treatments	Grain yield	Straw yield
		($kg\ ha^{-1}$)	
T_1	RDF + Compost @ 10 t ha^{-1}	2892.30	7572.00
T_2	RDF+ 50 % NK + Compost @ 10 t ha^{-1}	3062.00	8500.00
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	3238.00	8926.00
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	2938.70	8210.00
T_5	RDF through Enriched Compost	2735.30	7211.00
T_6	RDF + 50% NK through enriched compost	2940.30	8201.00
T_7	STCR Based through enriched compost	3012.70	8329.00
T_8	STL Based through enriched compost	2848.30	7720.00
T_9	Control	2385.70	6616.00
	S.E.±	134.71	249.12
	C.D. (P=0.05)	403.89	746.90

Effect of organic and different levels of inorganic nutrients of grain and straw yield of finger millet :

The data regarding the grain and straw yield are presented in Table 2. The performance of ragi crop varied significantly due to application of nutrient based on different approach. The highest grain yield in T_3 (3238.00 kg ha^{-1}) was recorded with the application of STCR based NPK and compost @ 10 t ha^{-1} which differed significantly over control (2385.70 kg ha^{-1}), Followed, by T_2 (3062.00 kg ha^{-1}). The increase in yield might be due to improvement in yield and yield components for better partitioning of carbohydrates from leaf to reproductive parts and efficiency of applied nutrient in the soil resulting in increased yield in finger millet.

Variation in the straw yield was observed due to treatment effect. It followed the similar trend that of yield variation. Statistically superior straw yield was recorded in application STCR based NPK and compost10 t ha^{-1} (8926.00 kg ha^{-1}). The lowest straw yield was observed (6616.00 kg ha^{-1}) in control plot (Table 2). The increase in straw yield was due to application of higher dose of major nutrients ascribed to better plant growth and higher biomass due to improved nutrient supply and subsequently uptake of nutrients by crop which was responsible for better growth and dry matter accumulation. Similar results are reported byApoorva *et al*. (2010). These variations are mainly attributed to variation in the drymatter accumulation by different plant parts. Similar observations were also recorded in the studies of Radha Krishna (1979). Similar results were reported by Ramesh *et al.* (2007); Anil Kumar *et al.* (2003); Singh *et al.* (2006) and Singh and Pathak (2003) observed similar increase in straw yield of ragi, rice and wheat, crop. They attributed that the increase in straw yield could be due to decomposition of succulent green manure crop and FYM. Increased yield due to the application of organic manures might be attributed to the availability of essential nutrients in soil throughout the crop growth period by achieving synchrony between nutrient release and crop demand during crop growth period. The results are in conformity with findings of Godhawale and Dahipale (2007).The harvest index is a measure of productive efficiency that how efficiently a crop can use its physiological inheritance. It was one of the most stable physiological traits for grain yield. Significantly higher harvest index (0.28) was recorded in recommended NPK + compost at 10 t ha^{-1} might be due to quantitative increase in grain and straw yield.

Effect of organic and different level of inorganic nutrients on primary nutrients uptake by finger millet :

The nitrogen uptake increased with advancement in age and the maximum was recorded at harvest stage. Highest total uptake (99.14 kg N ha^{-1}) of nitrogen was realized (Table 4) due to application of STCR based NPK and compost 10 t ha^{-1}. This might be due to increase in uptake of N could also be due to higher biomass of grain and straw along with higher concentration and may be due to easy transformation of urea into available N with addition of zinc. Increased uptake of nutrient in plant system is a consequence of availability of nutrients synergistic relationship between organic manure and chemical fertilizer. Similar pattern of nutrient uptake due

Table 3 : Effect of organic and different levels of inorganic nutrients on major nutrient content in grains and straw of finger millet

Treatments No.	Treatments	Concentration (%)					
		Grain			Straw		
		N	P	K	N	P	K
T_1	RDF + Compost @ 10 t ha^{-1}	0.82	0.60	0.44	0.70	0.50	0.84
T_2	RDF + 50 % NK + Compost @ 10 t ha^{-1}	0.87	0.67	0.49	0.77	0.63	0.87
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	0.92	0.68	0.50	0.78	0.65	0.88
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	0.85	0.62	0.47	0.75	0.55	0.86
T_5	RDF through enriched compost	0.82	0.59	0.44	0.74	0.54	0.83
T_6	RDF + 50% NK through enriched compost	0.83	0.66	0.47	0.75	0.55	0.85
T_7	STCR Based through enriched compost	0.86	0.65	0.48	0.77	0.59	0.86
T_8	STL Based through enriched compost	0.85	0.63	0.45	0.74	0.58	0.80
T_9	Control	0.76	0.55	0.44	0.69	0.52	0.70
	S.E.±	0.02	0.02	0.02	0.02	0.02	0.02
	C.D. (P=0.05)	0.08	0.07	0.07	0.06	0.07	0.08

to synergistic effect between organic and inorganic sources was reported by Subramanian (1989) and Apoorva *et al.* (2010). It is also in agreement with the findings of Raniperumal *et al.* (1988).

The P uptake increased with aging of finger millet crop (Table 4) and maximum was recorded at harvest stage. Higher total uptake (80.02 kg ha^{-1}) was seen in combined application of STCR based NPK and compost 10 t ha^{-1} compared to others The increased P uptake may be ascribed to more availability of nutrients from the added fertilizer and their solubility action of organic acids produced during the decomposition of organic materials, thus resulting in more release of both of native and applied P nutrients. The higher grain and straw yield in (T_3) has resulted in higher uptake of phosphorus among these treatments. In addition, higher phosphorus uptake by the crop is attributed to higher solubility, even distribution of nutrients throughout root zone and higher efficiency of applied fertilizers Ashok and Jayadeva (2013) found that significantly higher nutrient uptake (504.8, 103.1and 212.3 N, P and K kg ha^{-1}) was recorded in SSNM through fertilizers for targeted yield of 10 t ha^{-1} over 100% RDF (219.4, 32.2 and 73, N, P and K kg ha^{-1}).

Significantly higher K uptake by ragi grains in T_3 (16.19 kg ha^{-1}), straw (78.54 kg ha^{-1}) and higher total uptake of potassium in the T_3 (94.73 kg ha^{-1}) was recorded with application of STCR based NPK and compost @ 10 t ha^{-1} for a targeted yield of 40 q ha^{-1} due to addition of compost resulted in the extraction of more K by millet crop when compared to control. The increase in potassium uptake with organic sources of FYM was due to the priming effect that organic on decomposition release organic acids which solubilise native *i.e.*, fixed and non-exchangeable form of K and change the soil solution with potassium ions at later stage of crop growth

Table 4 : Effect of organic and different levels of inorganic nutrients on total uptake primary nutrient by finger millet

Treatment No.	Treatments	Uptake (kg ha^{-1})		
		N	P	K
T_1	RDF + Compost @ 10 t ha^{-1}	76.71	55.21	76.32
T_2	RDF + 50 % NK + Compost @ 10 t ha^{-1}	91.99	74.05	88.95
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	99.14	80.02	94.73
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	86.26	63.42	84.50
T_5	RDF through Enriched Compost	75.59	55.06	71.85
T_6	RDF + 50% NK through enriched compost	86.46	64.50	83.51
T_7	STCR Based through enriched compost	89.60	68.71	86.10
T_8	STL Based through enriched compost	81.76	62.71	74.50
T_9	Control	64.66	47.52	56.80
	S.E.±	4.66	1.88	2.83
	C.D. (P=0.05)	13.99	5.63	8.49

Table 5 : Effect of organic and different levels inorganic nutrient on partial factor productivity of major nutrients in finger millet

Treatment No.	Treatments	Partial factor productivity Kg Kg^{-1}			
		N	P	K	Total
T_1	RDF + Compost @ 10 t ha^{-1} (111:80:86)	26.06	36.15	33.63	30.18
T_2	RDF+ 50 % NK + Compost @ 10 t ha^{-1} (136:80:98)	22.51	38.28	31.24	33.27
T_3	STCR Based NPK + Compost @ 10 t ha^{-1} (158:48:94)	20.49	67.46	34.45	26.45
T_4	STL Based NPK + Compost @ 10 t ha^{-1} (111:67:86)	26.47	43.21	34.16	28.29
T_5	RDF through Enriched Compost (111:80:86)	24.64	34.19	31.80	30.18
T_6	RDF + 50% NK through enriched compost (136:80:98)	21.62	36.75	30.00	33.27
T_7	STCR Based through enriched compost (158:48:94))	19.06	62.75	32.04	26.46
T_8	STL Based through enriched compost (111:67:86)	25.66	41.88	33.12	28.29
T_9	Control	00	00	00	0.00
	S.E.±	2.10	2.59	0.87	0.96
	C.D. (P=0.05)	6.37	7.85	2.64	2.92

(Sri Ranjitha *et al.*, 2013). Significantly increase in plant potassium content in compost it is easily assimilated form and higher dose of potassium (55 kg K_2O ha^{-1}) application in STCR approach (Table 4) which has caused the higher uptake. Additive effect of higher doses of nitrogen and phosphorus and priming effect of starter doses of potassium, caused the release of potassium form non labile pool to labile pool. This resulted in increased uptake form the nature soil sources by the potato crop (Reddy *et al.*, 1972). The results of the present study were supported with study of Singh and Sarkar (2001) their studies indicated that application of 210:90:150 kg NPK ha^{-1} recorded significantly higher NPK uptake of 158:13:160.7 kg ha^{-1} as compared to state recommended dose of 100:60:40 kg NPK ha^{-1}.

Effect of organic and different levels inorganic nutrient on partial factor productivity of major nutrients in ragi :

Partial factor productivity is the ratio of grain yield obtained in the treatment to that of nutrient applied. Here total partial productivity of major nutrients is computed (Table 5). The higher total partial productivity (33.27 kg kg^{-1}) was registered withapplication of recommended NPK + 50 % NK+ compost @ 10 t ha^{-1} (T_2), whereas intreatment T_3 *i.e*. STCR based NPK + Compost @ 10 t ha^{-1} registered lowertotal partial productivity (26.45kg kg^{-1}). It might be due to lesser availability of nutrients and uptake pattern of major NPK nutrients in the soil. These computed parameters are mainly based on the contents and yield response. In one way, they truly indicate the system efficiency for the given treatments.

Conclusion :

It is concluded that application of STCR based NPK + 10 t ha^{-1} compost has enhanced the uptake of nutrients by crop there by achieved the higher yields. However, combined application of different inorganic fertilizers and organic manures in conjunction with effective will influence the higher growth and yield of finger millet crop interns it improves soil health and soil quality.

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