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Effect of NPK Application through Different Approaches on Yield and Secondary Nutrient Uptake by Finger Millet (*Eleusine coracona* L.) under Rainfed Conditions

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ABSTRACT

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 secondary 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}). The percent deviation for targated yield of 40 q ha^{-1} (19.05 %) . Similarly higher uptake was recorded in STCR based NPK + compost 10 t ha^{-1} both in grain and straw. Total calcium and magnesium uptake by ragi crop was significantly higher in treatment receiving STCR based NPK and compost @ 10 t ha^{-1} T_3 (67.55 and 44.43 kg ha^{-1}) and lowest was in control (38.46 and 22.98 kg ha^{-1}). Total S uptake (18.32 kg S ha^{-1}), was recorded with the application of STCR based NPK and compost @ 10 t ha^{-1}. The highest calcium and magnesium content (4.80 and 4.16 cmol (p^{+}) kg^{-1}) in soil was found in STCR approach (T_3). The highest available sulpher (12.42 ppm), content was found where application of STCR based NPK and compost @ 10 t ha^{-1} (T_3) and lowest sulphur content was found in control plot (2.12 ppm).

Key words: *STRC, Target yield and STL.*

INTRODUCTION

Finger millet (*Eleusine coracona* (L.) *Garten*.), ranks third in importance among millets in the country in area (2 million ha) and production (2.8 million tonnes) after sorghum and pearl millet. One of the striking features which make finger millet an important dry land crop is its resilience and ability to withstand adverse weather conditions when grown in soils having poor water holding capacity.

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Finger millet is a staple food of millions of people in India and Africa especially for working class and also an ideal food for patients suffering from diabetes. The grains are high in calcium and iron besides being rich in carbohydrates and proteins.

Most soils are able to supply only a fraction of the nutrients needed to achieve high yields of arable crops. These levels are not in balanced condition to meet crop requirement. Therefore, fertilizer recommendation aim at providing balanced nutrition to crops in order to produce maximum yield. Hence, the addition of fertilizer should consider the nutrient availability in soil. They provide the nutrient in adequate quantity and in ratios found in plants for achieving a desired yield target. Such balanced fertilization is ensured through soil testing and it increases the efficiency and economy in fertilizer use. Continuous use of inorganic nutrients source will adversely affect soil physico-chemical properties and thereby decline crop yields. In order to sustain the yield and reduce the dependence on inorganic fertilizer use, conjunctive use of organic manures and fertilizer is very much essential.

In this regard the different centers of AICRP on STCR have developed equations to include organic manures to prescribe the nutrients for specific yield target of the crop. However, the research information on use of fertilizer adjustment equations for prescribing nutrients from different sources is very sparse. In view of the above facts a study on optimizing the integrated nutrient supply on STCR basis is taken with the following objectives.

MATERIAL 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, I have take 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 calcium and magnesium by Versenate titration method[3] and Ca and Mg uptake was calculated by multiplying dry matter with content (%) of plant. Sulphur k in plant sample were analyzed after digestion with diacid (HNO_3: $HClO_4$) digest was estimated by Turbidometric method[3] using spectrophotometer 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*[6]. 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.

$$\text{Nutrient uptake [Kg ha}^{-1} = \frac{\textit{Nutrient concentration}\ (\%)\ \text{x Yield of grain /straw [Kgha}^{-1}]}{100}$$

RESULTS AND DISCUSSION

Application of fertilizer by different approaches in combination with organic manures increased grain and straw yield significantly over control (Table 1). Application of fertilizer based on STCR (T_3) produced maximum ragi grain (3238.00 kg ha^{-1}) and, which was35.72 per cent higher over control (2385.70 Kg ha^{-1}). The highest ragi grain yield in T_3 was statistically on par with T_2 (3062.00 Kg ha^{-1}) and T_7 (3012.70 Kg ha^{-1}) treatments. The increase in yield might be due to improvement in yield and 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. The deviation was further reduced when fertilizer and compost were applied on STCR basis, thus minimum deviation was observed (19.05%) from targated yield 40 q ha^{-1}. The lower deviation might be due to better response to applied nutrients on STCR basis in presence of organic manures indicating the importance of balanced nutrition of crops. These results are conformity with findings of Apoorva *et al*[1].

The lowest straw yield was recorded (6616.00 Kg ha^{-1}) in control plot (Table 1) where as the highest straw yield (8926.00 Kg ha^{-1}) was recorded with application of STCR based NPK and compost 10 t ha^{-1}. The increase in straw yield was due to application of higher dose of major nutrients supply and subsequently uptake of nutrients by crop which was responsible for better growth and dry matter accumulation. Similar results were reported by Ramesh *et al*[7].

Effect of organic and different levels of inorganic nutrients on secondary nutrients content in grain at harvest stages of finger millet.

Calcium and Magnesium concentration in grain, straw and their uptake.

Calcium concentration of ragi grain revealed significant differences among the different treatments studied (Table 2). Calcium content of grain was (0.42 %) in control which was on par with T_1. Significantly higher Ca content was observed in treatment in T_3, T_2 and T_7 (0.57, 0.53, and 0.52 per cent respectively).While the remaining treatments were statistically on par with each other. The calcium concentration in (Table 2) in control plot was 0.43 per cent in straw whereas, maximum Ca content of straw was recorded due to application of STCR based NPK and compost @ 10 t ha^{-1} in T_3 (0.55%). Further, it was statistically on par with treatments T_2 and T_7. The magnesium concentration in ragi grain differed significantly due to application of fertilizers and compost 10 t ha^{-1} (Table 2). The magnesium concentration in control plot was 0.27 per cent followed by 0.29 and 0.3 per cent in RDF + compost @ 10 t ha^{-1} and RDF through enriched compost respectively. The magnesium concentration 0.38 per cent recorded with application of STCR based NPK and compost @ 10 t ha^{-1} (T_3) was significantly superior over the other treatments expect T_2 (0.36 %) which was on par with each T_3. Data pertaining to Mg content in straw is presented in Table 9. The lowest Mg content in straw (0.25 %) was recorded in control. Significantly higher Mg concentration was recorded in T_3 (0.36%) due to application of STCR based NPK and compost @ 10 t ha^{-1}. It may be due to higher concentration of calcium and magnesium in grain and straw of ragi increased under different treatments. Where both organic and inorganic nutrients were supplied. The application of organic materials significantly changed the status of secondary elements in the soil. The water soluble forms of Ca and Mg in the soil significantly increased which resulted in higher uptake of these two nutrients by the plants. There is always a direct relation between the soil concentration of nutrients and its quantity taken by the plants[8].

Total calcium uptake by ragi crop was significantly higher in treatment receiving STCR based NPK and compost @ 10 t ha^{-1}

(T_3) 67.55 kg ha^{-1} and lowest was in control (38.46 kg ha^{-1}) where as T2, T7 (59.50 and 56.47 kg ha^{-1} respectively) were statistically on par with each other (Table3). The total magnesium uptake by ragi grain and straw differed significantly due to various treatments imposed. A significantly highest magnesium uptake 44.43 kg ha^{-1} was recorded due to application of STCR based NPK and compost @ 10 t ha^{-1} for target yield of 40 q ha^{-1} compared to RDF + compost @ 10 t ha^{-1} 39.91 kg ha^{-1} and lowest magnesium uptake was recorded in control plot (22.98 kg ha^{-1}) were no fertilizer applied. Increase in uptake of calcium and magnesium might be due to higher biomass production in the same treatment. This higher uptake could be due to the application of higher nitrogen fertilizer in this treatment which resulted in increased calcium uptake. Similar results of higher uptake of Ca and Mg was attributed to higher content of their nutrient elements and also mineralization of native Ca and Mg[9].The increased uptake of the nutrients was due to added supply of nutrient and well decomposed root system resulting in better absorption of water and nutrient[4].

Sulphur concentration in grain, straw and their uptake.

The highest concentration of S in ragi grain and straw was observed in the T_3 (STCR based NPK and compost @ 10 t ha^{-1}). The lowest was estimated for control (T_9). Similar results were reported by Anil Kumar *et al.,*[2] and they observed higher nutrient uptake due to IPNS treatment in ragi. Highest S uptake by ragi grains (5.82 kg S ha^{-1}), straw (12.05 kg S ha^{-1}) and total S uptake (18.32 kg S ha^{-1}), was recorded with the application of STCR based NPK and compost @ 10 t ha^{-1} as compared to other treatments which were on par with each other. The higher total uptake of sulphur was due to significantly higher biomass production. Similar results of increased S uptake have been reported by Nasreen *et al*[10]. The maximum sulphur content in rice grain by incorporation of FYM along with inorganic fertilizer increased the S uptake[11].

Nutrient concentration and higher uptake observed with integrated nutrient supply treatment may be due to application of nutrients as per the plant requirement in the form of both organic and inorganic sources which might have added nutrients to the available pool besides improving the root environment, availability of nutrients and loss of nutrients in soil, which intern increased the uptake of nutrients by crop.

Effect of organic and different levels of inorganic nutrients on exchangeable calcium, magnesium and available sulphur status of soil at harvest of finger millet.

The highest calcium content (4.80cmol (p^+) kg^{-1}) in soil was found in STCR approach (T_3). The lowest calcium content (3.33 coml (p^+) kg^{-1}) was found in control where no fertilizers were applied (Table 4). The increase in Ca content in STCR approach plot might be due to application of STCR based NPK and compost @ 10 t ha^{-1} which increase the some secondary nutrients and some amount of secondary nutrients from the straight fertilizers particularly SSP which contain18% which might have resulted in increase in calcium content. Prasad *et al.,*[5] also reported that FYM being good sources of calcium and magnesium increase calcium and magnesium content in the soil. The significant highest value of exchangeable magnesium (4.16 cmol (p^+) kg^{-1}) was found in STCR approach (T_3). Therefore the behavior of magnesium was very much similar to calcium. Plots applied with NPK along with compost @ 10 t ha^{-1} recorded significantly higher magnesium contents than the control (T_9). The highest available sulpher (12.42 ppm), content was found where application of STCR based NPK and compost @ 10 t ha^{-1} (T_3) and lowest sulphur content was found in control plot (2.12 ppm). The S content is generally highest where application of NPK fertilizers with compost @ 10 t ha^{-1} resulted in significantly higher sulphur content other than control plot.

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

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	% Deviation in grain yield from the target	% increase in grain yield over control
T_1 - RDF + Compost @ 10 t ha^{-1}	2892.30	7572.00	-27.69	21.23
T_2 - RDF+ 50 % NK + Compost @ 10 t ha^{-1}	3062.00	8500.00	-23.45	28.34
T_3 -STCR Based NPK + Compost @ 10 t ha^{-1}	3238.00	8926.00	-19.05	35.72
T_4 -STL Based NPK + Compost @ 10 t ha^{-1}	2938.70	8210.00	-26.53	23.17
T_5 -RDF through Enriched Compost	2735.30	7211.00	-31.61	14.65
T_6 -RDF + 50% NK through Enriched Compost	2940.30	8201.00	-26.49	23.24
T_7 -STCR Based through Enriched compost	3012.70	8329.00	-24.68	26.28
T_8 -STL Based through Enriched Compost	2848.30	7720.00	-28.79	19.39
T_9 -Control	2385.70	6616.00	_	_
SEm±	134.71	249.12		
C.D @5%	**403.89**	**746.90**		

Table 2: Effect of organic and different levels of inorganic nutrients on secondary nutrient content in grains and straw of finger millet

Treat. No	Treatments	Concentration (%)					
		Grain			Straw		
		Ca	**Mg**	**S**	Ca	Mg	S
T_1	RDF + Compost @ 10 t ha^{-1}	0.47	0.29	0.13	0.44	0.28	0.10
T_2	RDF + 50 % NK + Compost @ 10 t ha^{-1}	0.53	0.36	0.16	0.51	0.34	0.13
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	0.57	0.38	0.18	0.55	0.36	0.14
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	0.51	0.32	0.15	0.48	0.31	0.11
T_5	RDF through Enriched Compost	0.45	0.30	0.12	0.44	0.29	0.10
T_6	RDF + 50% NK through Enriched Compost	0.50	0.31	0.15	0.46	0.33	0.12
T_7	STCR Based through Enriched compost	0.52	0.33	0.16	0.49	0.33	0.13
T_8	STL Based through Enriched Compost	0.49	0.31	0.12	0.48	0.29	0.10
T_9	Control	0.42	0.27	0.10	0.43	0.25	0.09
	SEm±	0.01	0.01	0.01	0.02	0.01	0.009
	C.D @5%	**0.05**	**0.04**	**0.04**	**0.06**	**0.05**	**0.02**

Table 3: Effect of organic and different levels of inorganic nutrients on total nutrient uptake by grain and straw in finger millet

Treat. No	Treatments	Uptake (kg ha^{-1})		
		Ca	Mg	S
T_1	RDF + Compost @ 10 t ha^{-1}	46.91	29.59	11.33
T_2	RDF + 50 % NK + Compost @ 10 t ha^{-1}	59.50	39.91	15.95
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	67.55	44.43	18.32
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	54.44	34.88	13.45
T_5	RDF through Enriched Compost	44.03	29.13	10.49
T_6	RDF + 50% NK through Enriched Compost	52.42	36.17	13.58
T_7	STCR Based through Enriched compost	56.47	37.34	15.64
T_8	STL Based through Enriched Compost	51.01	31.21	11.13
T_9	Control	38.46	22.98	8.34
	SEm±	2.39	1.35	0.97
	C.D @5%	**6.96**	**4.07**	**2.92**

Table 4: Effect of organic and different levels of inorganic nutrients on exchangeable calcium, magnesium and available sulphur status of soil at harvest in finger millet

Treat. No	Treatments	At harvest		
		Ca [coml (p^+) Kg^{-1}]	Mg [coml (p^+) Kg^{-1}]	S (mg kg^{-1})
T_1	RDF + Compost @ 10 t ha^{-1}	4.00	2.60	11.62
T_2	RDF + 50 % NK + Compost @ 10 t ha^{-1}	4.30	3.83	12.39
T_3	STCR Based NPK + Compost @ 10 t ha^{-1}	4.80	4.16	12.42
T_4	STL Based NPK + Compost @ 10 t ha^{-1}	4.03	2.70	12.29
T_5	RDF through Enriched Compost	3.80	2.60	8.62
T_6	RDF + 50% NK through Enriched Compost	4.00	2.40	10.90
T_7	STCR Based through Enriched Compost	3.90	3.50	10.38
T_8	STL Based through Enriched Compost	3.90	2.40	10.88
T_9	Control	3.50	1.91	8.12
	SEm±	0.18	0.34	0.40
	C.D @5%	**0.55**	**1.04**	**1.22**

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