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STUDIES ON FEASIBILITY AND RESPONSE OF N P K APPLICATION THROUGH DIFFERENT APPROACHES IN RAGI UNDER RAINFED CONDITION

Saraswathi *et al.*,

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SARASWATHI[1], Y. VISHAWANATH SHETTY[1], M. ASHWINI[2], B. NETHRAVATHI[1] AND S. VANDANA[1]
[1]Department of Soil Science and Agricultural Chemistry, UAHS, Shimoga - 577 204
[2]Departments of Agronomy, UAHS, Shimoga - 577 204
e-mail: sarukushi1@gmail.com

ABSTRACT

An experiment to study the feasibility and response of NPK application through different approaches in ragi under rainfed condition.A field experiment was conducted on alfisols during 2013 of Zonal Agricultural and Horticultural Research station, college of Agricultural, Navile, shimoga. The results revealed that the application of organic manure with NPK nutrients on soil test crop response (STCR) basis recorded higher grain yield (3238.00 kg ha^{-1}) and straw yield (8926.00 kg ha^{-1}) of ragi. The targeted yield in ragi was achieved with integrated nutrient supply through organic and inorganic sources using STCR approach, however, $\pm$5% deviation was observed through STCR technology. It was inferred from the study that the STCR technology may be the appropriate approach for optimum nutrient supply which improves the soil properties especially the soil health and productivity in a long run in comparison to other nutrient management technologies.

***Corresponding author**

INTRODUCTION

Fertilizer is one of the costliest inputs in agriculture and the use of right amount of fertilizer is fundamental for farm profitability and environmental protection (Kimetu *et al.*, 2004). To enhance farm profitability under different soil-climate conditions, it is necessary to have information on optimum doses of fertilizers for crops. Traditionally, to determine the optimum doses of fertilizer are most appropriate method to apply fertilizers on the basis of soil test and crop response studies.

During 1956-57 the semi-quantitative soil test calibrations were evolved and advocated for the use. Subsequently in India the quantitative refinements in the fertilizer recommendations based on the soil and plant analysis were made (1967-68) through the All India CoordinatedResearch Project for Investigation on Soil test crop response correlation (STCRC). The ICAR project on soil test crop response correlation used the targeted yield approach to develop relationship between crop yields on the one hand and soil test values and fertilizer inputs on the other.

Finger millet is an important cereal that belongs to the grass Poaceae family (Dida *et al.*, 2008). It has outstanding attributes as a subsistence food crop. It is grown globally on more than 4 million hectares and is the primary food source for millions of people in tropical dryland regions.The most striking feature, which made 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. Finger millet also has superior nutritional qualities compared to rice and wheat.Finger millet is the third most important millet in India (locally called as Ragi), next to sorghum and pearl millet, covering an area of 2 million hectares with annual production of 2.15 million tonnes. In Karnataka, it is grown in an area of 0.8 m ha with an annual production of 1.34 milliontonnes. Finger millet is high in dietary fiber and calcium. It also has medicinal attributes and is used by diverse communities for making specialty foods for diabetics, gluten-free food for people suffering from celiac disease and weaning foods for infants (National Research Council, 1996; Tylor *et al.,* 2006).

The soil test crop response (STCR) approach for targeted yield is unique in indicating both soil test based fertilizer dose, the fertilizerrecommendation for pre-set yield target is a refined technique for most efficient use fertilizer and soil nutrient and the level of yield that can be achieved with good management practices and climatic conditions on the response of crops to applied and native nutrients. In order to sustain the yield and reduce the cost of fertilizers and in turn cost of cultivation, the STCR approach is very important (Saxena *et al.,* 2008 and Chatterjee *et al.,* 2010). Targeted yield approach stricken a balance between fertilizing the crop and fertilizing the soil (Sonar *et al.,* 1982).The present investigations are aimed at prescription based fertilizer application on soil test basis for specific yield targets of ragi to recommend to the farmer for judicious use of fertilizer for sustainable crop production. A study on refining the integrated plant nutrient supply on STCR basis was conducted to study the feasibility of NPK application through different approache and the response of ragi to NPK under rainfed condition.

MATERIALS AND METHODS

STCR approach was adopted to conduct the field experiments on "Optimizing fertilizer doses for high yield, quality and economics of Ragi during, 2013 at Zonal Agricultural and Horticultural Research station, college of Agricultural, Navile, shimoga. Composite soil sample was drawn from the experimental site at 0-15 cm depth prior to laying out of experiment for initial soil properties (Table 1). Calculated quantities of FYM were applied @ 10 t ha^{-1}as per the treatment details 15 days before the transplanting of finger millet. Fifty per cent of nitrogen through CO (NH2)2 (Urea) and entire quantity of phosphorus through SSP (Single Super Phosphate) and potassium through MOP (Murate of Potash) were supplied at the time of transplanting as a basal dose to each plot and remaining 50 per cent of nitrogen was applied at 30 days after transplanting as indicated in the treatment details.

The soil samples were analyzed by adopting standard procedures (Nitrogen - Subbaiah and Assija method (1956), Phosphorus - Olsen *et al.* (1954), Potassium - Jackson (1973)). The soil was sandy loam in texture, neutral in reaction, low in organic carbon, low in available N, P and medium in available K. The experiment was laid out in randomized block design with the following nine treatments and 3 replications.

Treatment details

The experiment comprised of nine treatments and the details of which are given below.

T_1: RDF + compost @ 10 t ha^{-1}

T_2: Recommended NPK + 50 % NK + compost @ 10 t ha^{-1}

T_3: STCR based NPK + compost @ 10 t ha^{-1}

T_4: STL based NPK + compost @ 10 t ha^{-1}

T_5: Recommended NPK through enriched compost

T_6: Recommended NPK + 50% NK through enriched compost

T_7: STCR based through enriched compost

T_8: STL based through enriched compost

T_9: Control

The fertilizer adjustment equation developed by AICRP on STCR, UAS, Bangalore Centre for Zone – 7 and used.

F-N = 3.29 T – 28.47 SN (O.C %) – 0.00281 OM (in kg).

F-P2O5 = 1.798 T – 0.189 SP2O5 (Bray s P2O5) – 0.00173 OM (in kg).

F-K2O = 1.775 T – 0.15 SK2O (Amm.Acetate - K2O) – 0.0015 OM (in kg)

Using the above fertilizer adjustment equations the quantity of fertilizer nutrients required for achieving 40 q ha^{-1} grain yield of finger millet was worked out. The fertilizer N, P_2O_5 and K_2O applied and nutrient N, P_2O_5 and K_2O supplied by 10 tons of compost was deducted from the total quantity required for 40 q ha^{-1}yield and the remaining was supplied with fertilizers.

RESULTS AND DISCUSSION

The plant height was significantly influenced by various treatment combinations both at 40 DAT (Days after transplanting) and at harvest stage. Significantly the highest plant height was 70.37 cm at 40 DAT and 125 cm at harvest stage were recorded due to application of fertilizers and organic manures on STCR basis (T3) compared to all other treatments. The number of leaves significantly differed at 40 DAT. Minimum of 21 leaves per plant was recorded in control and which significantly increased to 42 leaves per plant due to application of fertilizer and compost on STCR basis (Table 2). Similar findings were reported by Prakash *et al.* (2014).

The highest grain yield (3238.00 kg ha^{-1}) was recorded with the application of fertilizers and compost on STCR basis (T3), which differed significantly over control (2385 kg ha^{-1}), the application of fertilizers based on RDF + compost @ 10 t ha^{-1} (2892.30 kg ha^{-1}),and STCR based through enriched compost (3012.70 kg ha^{-1}). Among the treatments remarkable difference was also noticed in above parameters (Table 3).

It was observed from the (Table 3) that use NPK fertilizers and compost applied based on STCR equation (T_3), and RDF + 50 % NK + 10 t compost @ 10 t ha^{-1} (T_2) treatment resulted in greater values for all the parameters under observation followed by T_7 (STCR based through enriched compost) which is also mirrored by the per cent increase in grain and straw yields of ragi in which the extent of increase was remarkably higher in the above said treatments. Application of fertilizers based on STCR equation in conjunction with organic manure (T_3) treatment might have facilitated the applied nutrients efficiently according to the need of crop and enriched nutrient reserve in soil which lead to better uptake of the nutrients by the crop and as outcome of that it ensued (3238.00 kg ha^{-1}) grain yield which was slightly higher (-19.05 %) than the targeted yield, its indicate that higher yield target may be achieved through integrated supply of nutrients from different sources.

The lower deviation might be due to better response to the applied nutrients on STCR basis in presence of organic manure indicating the importance of balanced nutrition of crops. . However, the highest per cent increase in grain yield over control was recorded due to application of fertilizers and FYM on STCR basis T3 (35.72 %) followed by RDF + 50 % NK + @ 10 t compost (28.34 %a respectively). The results indicate that higher grain yield may be achieved through integrated supply of nutrients from different sources. Similar findings were

Table 1: Initial soil properties of the soil of experimental site

Parameters	Values
Physical properties	
Soil order	*TypicHaplustalf*
Sand (%)	78.00
Silt (%)	8.00
Clay (%)	14.00
Textural of soil	Sandy Loam
Bulk density (Mg m^{-3})	1.52
Chemical properties	
pH (1:2.5)	6.00
EC (dS m^{-1}) at 25^0 C	0.04
Organic Carbon (g kg^{-1})	4.20
CEC [cmol (p$^+$)Kg^{-1}]	6.53
Available N (kg ha^{-1})	190
Available P_2O_5 (kg ha^{-1})	180
Available K_2O (kg ha^{-1})	223
Available S (ppm)	9.50

Table 2: Effect of organic and different levels of inorganic nutrients on plant height number ofleaves per hill in different stages of ragi

Treatment	Plant height (cm)		Number of leaves/plant	Number of tillers / hill	
	40 DAT	At harvest		40 DAT	At harvest
T_1	61.55	101.00	24.17	3.53	3.80
T_2	68.00	115.66	39.83	4.93	5.50
T_3	70.37	125.00	42.50	5.33	5.50
T_4	66.51	102.66	35.20	4.00	4.26
T_5	62.43	99.00	27.00	3.76	3.76
T_6	68.55	98.33	39.66	4.60	5.13
T_7	67.78	117.33	39.26	4.73	5.20
T_8	67.42	109.33	35.00	3.50	3.80
T_9	57.00	95.00	21.67	3.20	3.46
SEm±	1.92	3.87	3.98	0.24	0.27
C.D @5%	5.77	11.60	11.90	0.74	0.81

Table 3: Effect of organic and different levels of inorganic nutrients of Grain and stra yieldof ragi.

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

Table 4: Soil physic-chemical properties and fertility status as influenced by different approaches of nutrient management

Treat.No	physicochemical properties			Fertility status kg ha^{-1}		
	pHat harvest	EC (dSm^{-1})At harvest	OC g Kg^{-1}	NAt harvest	P_2O_5At harvest	K_2OAt harvest
T_1	6.16	0.03	5.20	189.36	92.93	123.80
T_2	6.13	0.02	5.23	235.20	99.70	132.60
T_3	6.44	0.05	5.35	253.16	125.26	141.10
T_4	6.15	0.01	5.30	191.30	94.46	123.80
T_5	6.04	0.03	5.25	182.06	86.03	103.83
T_6	6.37	0.03	5.27	183.50	87.70	113.33
T_7	6.10	0.01	5.36	187.50	89.56	119.20
T_8	6.20	0.06	5.31	183.50	86.46	110.26
T_9	6.00	0.03	4.93	155.76	74.40	97.33
SEm±	0.67	0.04	0.16	6.50	4.08	4.19
C.D @5%	NS	NS	0.48	19.50	12.22	12.56

reported by Apoorva *et al.* (2010) and Meena *et al.* (2013).

The highest straw yield of 8926.00 kg ha^{-1} was recorded with the application of fertilizers and compost on STCR basis (T3), which differed significantly over application of RDF + compost (7572.00kg ha^{-1}), RDF +50% NK+ compost (8500 kg ha^{-1}) and STCR based through enriched compost (8329 kg ha^{-1}) in Table 3. The increase in straw yield was due to application of fertilizer and compost on STCR basis was ascribed to better plant growth due to improved nutrient supply and uptake of nutrients by crop with improvement in soil properties. Increase in straw yield was due to the increased nutrient availability with conjunctive use of organic and inorganic were responsible for better growth and dry matter accumulation in finger millet and this could be also due to the decomposition of succulent green manure crop and FYM. Similar findings were reported by Apoorva *et al.* (2010).

Soil characteristics

The average value of the soil physicochemical properties and fertility parameters (after crop harvest) given (Table 4) indicates that initially the soils were neutral in reaction with average pH 6.0 and low in soluble salts (0.04 dSm^{-1}) (Table 4).

The organic carbon content which was earlier measured low (4.20 g kg^{-1}) in the experimental fields before transplanting, increased in all the treatments in 2013. The organic carbon content was noticed to be remarkably high in STCR treatments especially (T_3). The soils were very low in N (190 kg ha^{-1}), high in P (180.0 kgha^{-1}) and medium in K (223 kg ha^{-1}) before transplanting of ragi crop (Table1). The available N increased in all the treatments except control in 2013, however, the remarkable rise was observed in STCR treatments (T_3). This is because, the amount of N fertilizers applied differed between different approaches which could be the reason for variation in soil available nitrogen status among the treatments (Table 4). The favorable soil condition under organic manure application might have facilitated the mineralization of soil N leading to build up of higher available N (Chesti*et al*., 2013).

The available phosphorus status of soil in control was (74.40 kg ha^{-1}) which increased significantly to (125.26 kg ha^{-1}) at harvest stages, respectively due to application of STCR based NPK and compost @ 10 t ha^{-1} increase the phosphorus contents of soil (Table 4). Higher availability Phosphorus might be due to coating of sesquioxides by organic material thus reduced the phosphorus fixing by soil and release of carbon dioxide and organic acids solubilising the native soil phosphorus (Sujatha *et al*., 2014). Significantly highest available potassium (123.80 kg ha^{-1}) at harvest stages, respectively in the treatments (T_3) where application of STCR based NPK and compost @ 10 t ha^{-1}. The significantly lowest value (97.33 kg ha^{-1} at harvest stages, respectively in control plots where no fertilizers were applied (Table 4). similarly when the acid or acid farming compound are added in the form of compost to the soil, will lead to availability of potassium. The effect is positive resulting in more availability of potassium to the plants the hydrogen ions released from organic materials are exchanged with potassium on exchange site or set free from the fixed site of the clay micelle (Sarwar*et al.,* 2008).

These results suggest that the specific yield based on STCR equation not only optimizes the crop yield to the desired level but maintains the better soil health which is a prime factor for sustainable crop production. The above findings suggest that STCR technology may be the appropriate approach for optimum nutrient supply which improves the soil properties especially the soil health and productivity in a long run in comparison to other nutrient management technologies. The results indicated that the integrated nutrient supply with inorganic fertilizers through STCR approach is necessary for both productivity and sustainability.

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