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Influence of Soil Test-Based Nutrient Refinement on Uptake and Soil Fertility of Rice

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***Abstract* – A survey of paddy growing soils (50 surface soils) of northern transition zone was undertaken to study their fertility status which indicated that soils were acidic to slightly alkaline (pH-4.5-7.1), non-saline (EC 0.06-0.48 dS m^{-1}) with diverse available N (112-560 kg ha^{-1}), P_2O_5 (8.40-59.80 kg ha^{-1}) K_2O (144-480 kg ha^{1}) status. Majority of soils were low-medium-high (LMH) status of N, P_2O_5 and K_2O, respectively. A field experiment was also carried out in predominant category of NPK status at Kalkeri village of Dharwad district to refine the existing fertilizer dose to paddy there were six treatments *viz*., T_1 (RDF 100 : 50 : 50), T_2 (STCR 157 : 108 : 79), T_3 (125 : 50 : 43.75), T_4 modified RDF_1 (125 : 50 : 37.5), T_5 modified RDF_2 (150 : 50 : 25) and T_6 modified STL (125 : 37.5 : 43.75). Among the treatments, T_2 (STCR) recorded significantly higher grain yield (53.00q ha^{-1}), higher total uptake by paddy *viz*., N (204.77 Kg ha^{-1}), P_2O_5 (38.48 Kg ha^{-1}), K_2O (266.35 Kg ha^{-1}) and also higher residual soil available major nutrients status after harvest of crop.**

***Keywords* – Residual Soil, STCR, Survey, Uptake.**

I. INTRODUCTION

Rice (*Oryza sativa* L.) is not only a grain, but also life for more than 50 per cent of the global population. India contributed 46 per cent to total world rice production in 2011 (Anon., 2011). The gross domestic product (GDP) of the country touches to 8 per cent because of the increased production of rice. India exports rice worth $160 billion. Rice accounts for 92.24 million tones grown in an area of 43.7 million hectares and it continues to hold the key to sustain food production by contributing 20-25 per cent of agriculture and assures food security in India the importance and demand for rice will increase in Coming years. According to FAO, the global rice requirement in 2025 will be of the order of 800 million tones. India is the leading producer of rice next to China. But, its productivity in India is lower than China, the soil test based fertilizer application for economic yield production for specific yield targets was more beneficial and helps in maintaining soil fertility. However, it was revealed that fertilizer adjustment equations should be used within the experimental range of soil test values and achievable yield levels obtained (Dhillon *et al*., 1999).

Balanced use of fertilizers is one of the most important means to obtain higher yields. Such balanced fertilization is ensured through soil testing . Hence there is a need to refine the existing soil test based fertilizer recommendations for attaining higher yields in paddy. (Berra *et al*., 2006).

II. MATERIALS AND METHODS

1. *Survey*

Fifty surface (0-15 cm) samples from paddy growing soils were collected to characterize them with respect to their fertility (NPK) status. A field experiment was conducted in the predominant category of low – medium - high (LMH) status of N, P_2O_5 and K_2O, respectively.

2. *Geographical Location and Climate of Field Experiment*

The field experiment was conducted at the Kalkeri village (Dharwad district) during may 2011 of Northern transition zone (Zone-VIII) of Karnataka which lies between latitude 15^{0}41’688” N and 74^{0}88’561” E longitude at an altitude of 680 m above mean sea level. Total rainfall received during cropping season was 927mm

3. *Soil Characteristics of Experimental Site*

A composite soil sample was collected from the experimental site from a depth of 0 –to 15 cm before sowing and was analyzed for physico-chemical properties. The results of soil analysis along with the methods are furnished in Table 1.

4. *Experiment Details*

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The Experiment comprised of six treatments and the details of Which are given below

T_1 : RDF
(100:50:50 N, P_2O_5 and K_2O Kg ha^{-1})
T_2 : STCR
(157:108:79 N, P_2O_5 and K_2O Kg ha^{-1})
T_3 : STL (+ 25 % RD N Kg ha^{-1} and -12.5% RD K_2O Kg ha^{-1})
(125: 50: 43.75 N, P_2O_5 and K_2O Kg ha^{-1})
T_4 : Modified RDF_1 (+25 % RD N Kg ha^{-1} and -25% RD K_2O Kg ha^{-1})
(125:50:37.5 N, P_2O_5 and K_2O Kg ha^{-1})
T_5 : Modified RDF_2 (+50% RDF N Kg ha^{1} and -50% RDF K_2O Kg ha^{-1})
(150:50:25 N, P_2O_5 and K_2O Kg ha^{-1})
T_6 : Modified STL (T_3 +75 % of RD P2O5 Kg ha^{-1} +RD of PSB)
(125:37.5:43.75 N, P_2O_5 and K_2O Kg ha^{-1})

Note: Recommended rate of FYM (10 t ha^{-1}) and $ZnSO_4$ (25 Kg ha^{-1}) were applied to all treatments.

5. *Fertilizer Calculation*

5.1 *STL Approach:*

In soil test laboratory dose (STL, T3), amount of fertilizer was calculated based on soil test rating. As the soil was low in nitrogen, 25 % more nitrogenous fertilizer than recommended was applied. Like that, the status of P in soil is medium so the recommended dose of phosphorous to be applied and as there is high potassium status in soils, 12.5% less potash fertilizers than recommended were applied. Hence, the calculated fertilizer dose was 125: 50:43.75 N, P_2O_5 and K_2O Kg ha^{-1}.

5.2 *STCR Approach :*

The following STCR equation developed for rainfed paddy was used for achieving targeted yield

$$FN = 3.45\,T - 0.29\,SN,\ FP_2O_5 = 2.82\,T - 1.70\,SP_2O_5 \text{ and } FK_2O = 2.00\,T - 0.09\,SK_2O$$

Where, T = Targeted yield, SN = Available soil nitrogen, SP_2O_5 = Available soil phosphorous and SK_2O = Available soil potassium. FN, FP_2O_5 and FK_2O were nitrogen, phosphatic and potassic fertilizers to be applied, respectively.

The investigation was undertaken to elicit information on rice growth parameters, yield attributes, concentration and uptake of nutrients, post-harvest soil nutrient status and economics as influenced by different fertilizer doses.

III. Results and Discussion

Influence of different Levels of N,P and k Fertilizers based on Soil Test Values on Grain Yield

The grain yield was significantly influenced by the application of different levels of N, P and K fertilizers shown in Table II. The maximum grain yield (53 q ha^{-1}) was recorded with the application of fertilizers based on STCR. In general, treatments receiving higher doses of fertilizers recorded higher yield and yield attributes. The increased yield in these treatments could be due to greater availability of nutrients from the soil due to application of higher dose of fertilizers resulted in greater uptake by the paddy crop and increased yield in paddy. The results were accordance with Subramoney and Padmanabhan Nambiar (1969). The more number of productive tillers, better panicle length, mean panicle weight, number of grains per panicle and 1000 grain weight are because of the application of higher dose of fertilizers, similar results were also reported by the Mahajan *et al.* (1995), secondly, paddy crop responds much to the applied fertilizer. Higher grain yield of hybrid rice with application of nitrogen @ 200 kg ha^1 was also noticed due to increased availability of macro nutrients as reported by Chandrasekarappa (1985).

Influence of different Levels of N, P and K Fertilizers based on Soil Test Values on Nutrient Uptake

A significant higher uptake (both straw and grain) of nitrogen, phosphorus and potassium was observed at all stages under STCR treatment (T_2) in all stages (Table. III) The nitrogen uptake was highest in the STCR treatment which could be attributed to higher available N, P and K status of soil leading to balanced fertilization and greater uptake of N in presence of adequate supply of P and K, the present results are in agreement with the findings of many earlier workers. Prasad and Prasad (1994) indicated that application of K releases the fixed NH_4^+ ion from soil and helps to take up more nitrogen.

Devasenamma *et al*. (1999) noticed that increase in rate of application of nitrogen up to 180 kg N ha^{-1} increased the uptake of nitrogen at all the stages of crop growth.

Mohod *et al*. (1991) also reported that PSB culture alone or in combination with phosphatic fertilizers increased the phosphorus uptake by rice.

Potassium uptake by paddy followed the same trend as nitrogen due to synergistic effect between Nitrogen and soil due to higher level fertilizer application and high dry matter production (Table. V) The results were in accordance with the findings of Singh *et al.* (2000) and Mollah (2008).

Influence of different Levels of N, P and K Fertilizers based on Soil Test Values on Soil Available Nutrients after Harvest

The nitrogen content at harvest was more than the initial status in all treatments. Treatment, T_2 recorded the highest available N of 139 kg ha^{-1} and treatment RDF (T_1) recorded the lowest available N of 128.7 kg ha^{-1}. The higher residual available nitrogen could be due to the application of higher dose of nitrogen. The results were in conformity with Arun kumar *et al.* (2007) and Apoorva *et al.* (2010) an shown in Table VI

The available phosphorus content in soil increased from its initial status in all the treatments. The highest (39.20) available phosphorus content was recorded in T_2 because of application of higher dose of phosphatic fertilizers followed by T_6 which received PSB besides fertilizer which enhanced the available P status. PSB inoculation might have resulted in greater mobilization of insoluble native inorganic phosphate and mineralization of organic phosphorus. These findings were in accordance with Alam *et al.* (2009) and Mohod *et al*. (1991).

At harvest stage, the available potassium content in soil decreased from its initial status in all the treatments because of greater uptake K by paddy which resulted in lower K status. Among all treatments, STCR treatment T_2 resulted in the higher potassium status. This is because of application of higher potassic fertilizers to the soil. Milapchand *et al*. (2004).

IV. Conclusion

In STCR technology, the fertilizer doses are tailored to obtain specific yield levels of crop taking into account the soil contribution and the contribution from other components of integrated plant nutrient supply system. So, there is a balanced supply of required quantities of plant nutrients to the crop there by wastages can be avoided. This prevents pollution and paves higher returns. Looking into the economic condition of the farmer the fertilizer requirement can be lowered or increased by lowering or increasing the yield target within the genetic potential of the crop or varieties. Crop needs are satisfied to produce the higher economic yields, ensure quality of the produce and avoid excessive levels of nutrients. Among the treatments, STCR (T_2) treatment, proved superior with respect to growth parameters. Yield and nutrient uptake. The treatment T_5 also recorded higher values which were on par with STCR (T_2). Hence, along with STCR (T_2) treatment, T_5 is also equally better treatment which achieved more yield than RDF .STCR equations need to be developed for different soils and crops of this region for both major and micro nutrients.

REFERENCES

[1] Alam M M and Ali M H 2009 yield attributes yield and harvesting index of three irrigated rice varieties under different levels of phosphorous advances of biological research 3(4):13-15

[2] Anonymous 2011 Annual report all India coordinated research project on paddy Bangalore centre pp: 116-125.

[3] Apoorva K B Prakash SS Rajesh N L and Nandini B 2010 STCR approach for optimizing integrated plant nutrient supply on growth yield and economics of finger millet (*Eleusine coracana* L.) European journal of biological science, 4 (1): 19-27.

[4] Arun Kumar M A Gali S K and Hebsur N S 2007 Effect of different levels of NPK on growth and yield parameters of sweet corn Karnataka Journal of Agricultural Sciences 20: 41- 43.

[5] Berra R. Seal A Bhattacharyya P Das T H Sarkar D and Kangjoo K 2006 Targeted yield concept and framework of fertilizer recommendation in irrigated rice domains of subtropical Indian. *Journal of Zhejiang University Science,* **7:**12-13

[6] Chandrashekarappa K N 1985 Efficiency of Nitrogen phosphorous and potassium applications of rice (*Oryza sativa* L.) *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences Bangalore.

[7] Devasenamma V Reddy M R and Rajan M S 1999 Effect of varying levels of Nitrogen on growth yield and nitrogen uptake of rice hybrids. *The Andhra Agricultural Journal.* 46 : 124-125.

[8] Dhillon N S Brar J S Benipal D S. and Mavi M S 1997 Effect of soil test based fertilization approaches for different crops Crop Research32:377-381.

[9] Kumari M B G S Subbaiah G Veeraraghavaiah and Rao C V H 2000 Effect of plant density and nitrogen levels on growth yield of rice the Andhra Agricultural Journal 47:188-190.

[10] Mahajan, JP Singh R P and Dwivedi A K.1995 Phosphorus utilization by different Rice varieties in Vertisol Journal of Nuclear Agriculture Biology 24: 154-157.

[11] Milapchand DK Bendi and Azaad AS 2004 Modifying the soil test based fertilizer recommendation for targeted yield of rice on a Typic Haplustaif. Journal of Indian Society of soil Science. 52: 258-261.

[12] Mohod SP Guptha D N. and Chavan A S1991 Effect of P solubilizing organisms on yield and N uptake by rice Journal of Maharashtra Agricultural University 16 : 229-231.

[13] Mollah M R A Khalequzzaman K M. Hossain MM and Rahman S M L 2008 the Cropping pattern based fertilizers recommendation for mustard-BoroTAman Rice cropping pattern under AEZ-25 Nandigram, Bogra. *Journal Soil Nature*, **2**:31-34.

[14] Prasad B and Prasad J 1994 Integrated nutrient management for specific yield of rice (*Oryza sativa* L.) based on targeted yield concept and soil test values Indian Journal Agricultural Science 67: 13-17.

[15] Singh G Ganeshamurthy A N Nair A K Dinesh R and Ravisankar N 2000 Response of rice to applied phosphorus in acid saline soils of Andaman and Nicobar islands. Journal of Indian Society of Coastal Agricultural Research 18: 139-143.

[16] Subramoney N and Padmanabhan Nambiar E 1969 Soil test crop response correlation studies in Kerala. *Journal of Indian Society of Soil Sci*ence 17: 179-182.

AUTHOR'S PROFILE

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Table 1. Physico-chemical characteristics of the soil of experimental site.

Sl No.	Particulars	Values	Method employed
A.	**Physical properties**		
1.	Particle size analysis Sand (%)	31.10	Hydrometer method (Piper, 2002)
	Silt (%)	39.20	
	Clay (%)	29.70 Sandy	
	Textural class	Clay loam	
2.	Bulk density (Mg m^{-3})	1.31	Core method (Black, 1967)
B.	**Chemical properties**		
1.	Soil reaction (1:2.5)	6.55	Potentiometric method (Sparks, 1996)
2.	Electrical conductivity (1:2.5, dS m^{-1})	0.18	Conductometric method (Sparks, 1996)
3.	Organic carbon (g kg^{-1})	6.90	Walkley and Black's wet oxidation method (Sparks, 1996)
4.	Available nitrogen (kg ha^{-1})	128.0	Alkaline permanganate method (Subbiah and Asija, 1956)
5.	Available phosphorus (kg ha^{-1})	29.60	Bray's method of extraction and estimation by colorimetry (Sparks, 1996)
6.	Available potassium (kg ha^{-1})	367.0	Ammonium acetate extraction and estimation by flame photometer (Sparks, 1996)
7.	Available sulphur (kg ha^{-1})	31.40	$CaCl_2.2H_2O$ (0.15%) extraction and estimation by turbidimetry (Sparks, 1996)
8.	Available Iron (mg kg^{-1})	3.70	DTPA extraction and estimated by atomic absorption spectrophotometer (Lindsay and Norvell, 1978)
9.	Available Zinc(mg kg^{-1})	0.70	
10.	Available Copper (mg kg^{-1})	2.68	
11.	Available Manganese(mg kg^{-1})	9.85	

Table II: Effect of different fertilizer levels on grain and straw yield of paddy.

Treatments	Grain yield (q ha^{-1})	Straw yield (qha^{-1})
T_1 - RDF (100:50:50 N, P_2O_5 and K_2O kg ha^{-1})	41.25	47.02
T_2 - STCR (157:108:79 N, P_2O_5 and K_2O kg ha^{-1})	53.00	60.42
T_3 – STL (125:50:43.75 N, P_2O_5 and K_2O kg ha^{-1})	43.15	46.95
T_4 - Modified RDF_1 (125:50:37.5 N, P_2O_5 and K_2O kg ha^{-1})	42.23	48.14
T_5 - Modified RDF_2 (150:50:25 N, P_2O_5 and K_2O kg ha^{-1})	48.13	55.36
T_6 - Modified STL (125:37.5:43.75 N, P_2O_5 and K_2O kg ha^{-1}) + PSB	46.95	53.52
SEm±	2.08	2.38
CD (0.05)	6.26	7.17

Table III. Effect of different fertilizer levels on plant nitrogen concentration and uptake by paddy.

Treatments	Nitrogen concentration (%) and uptake (kg ha^{-1}) at different stages					
	30 DAS	60 DAS	90 DAS	Harvest		Total uptake
				Straw	grain	
T_1 - RDF (100:50:50 N, P_2O_5 and K_2O kg ha^{-1})	42.60 (1.69)	72.54 (1.15)	82.89 (1.00)	57.63 (0.70)	65.25 (1.01)	122.88
T_2 - STCR (157:108:79 N, P_2O_5 and K_2O kg ha^{-1})	96.79 (2.65)	122.91 (1.60)	134.57 (1.40)	99.04 (0.99)	105.73 (1.40)	204.77
T_3 – STL (125:50:43.75 N, P_2O_5 and K_2O kg ha^{-1})	50.70 (1.82)	87.74 (1.31)	91.93 (1.04)	65.97 (0.80)	80.27 (1.21)	146.24
T_4 - Modified RDF_1 (125:50:37.5 N, P_2O_5 and K_2O kg ha^{-1})	47.20 (1.79)	83.25 (1.25)	86.10 (1.03)	62.71 (0.75)	77.65 (1.19)	140.36
T_5 - Modified RDF_2 (150:50:25 N, P_2O_5 and K_2O kg ha^{-1})	81.00 (2.36)	116.73 (1.53)	119.88 (1.25)	92.04 (0.96)	98.87 (1.33)	190.91
T_6 - Modified STL (125:37.5:43.75 N, P_2O_5 and K_2O kg ha^{-1}) + PSB	70.05 (2.21)	99.48 (1.39)	103.41 (1.14)	89.97 (0.95)	89.50 (1.27)	179.47
SEm±	5.65 (0.18)	5.69 (0.08)	5.52 (0.05)	5.60 (0.06)	5.98 (0.06)	6.64
CD (0.05)	17.02 (0.54)	17.14 (0.25)	16.63 (0.16)	16.88 (0.18)	17.9 (0.19)	20.03

Note: The values in parentheses indicate N (%) concentration.

Table IV. Effect of different fertilizer levels on plant phosphorous concentration and uptake by paddy

Treatments	Phosphorous concentration (%) and uptake (kg ha^{-1}) at different stages					
	30 DAS	60 DAS	90 DAS	Harvest		Total uptake
				Straw	grain	
T_1 - RDF (100:50:50 N, P_2O_5 and K_2O kg ha^{-1})	9.54 (0.36)	21.36 (0.33)	21.93 (0.27)	7.14 (0.09)	17.11 (0.26)	24.25
T_2 - STCR (157:108:79 N, P_2O_5 and K_2O kg ha^{-1})	15.69 (0.43)	29.65 (0.39)	33.13 (0.34)	15.17 (0.15)	23.31 (0.31)	38.48
T_3 – STL (125:50:43.75 N, P_2O_5 and K_2O kg ha^{-1})	11.31 (0.40)	23.67 (0.35)	25.41 (0.29)	9.04 (0..11)	18.40 (0.28)	27.44
T_4 - Modified RDF_1 (125:50:37.5 N, P_2O_5 and K_2O kg ha^{-1})	9.63 (0.36)	22.37 (0.34)	23.04 (0.28)	7.24 (0.09)	17.68 (0.27)	24.92
T_5 - Modified RDF_2 (150:50:25 N, P_2O_5 and K_2O kg ha^{-1})	14.06 (0.41)	27.19 (0.36)	29.48 (0.31)	11.40 (0.12)	21.41 (0.29)	32.81
T_6 - Modified STL (125:37.5:43.75 N, P_2O_5 and K_2O kg ha^{-1}) + PSB	13.19 (0.42)	27.29 (0.38)	29.78 (0.32)	12.07 (0.13)	21.15 (0.30)	33.22
SEm±	0.81 (0.01)	1.09 (0.01)	1.48 (0.01)	0.91 (0.01)	2.11 (0.01)	2.31
CD (0.05)	2.43 (0.04)	3.27 (0.03)	4.46 (0.04)	2.74 (0.03)	6.35 (0.03)	6.97

Note: The values in parentheses indicate P (%) concentration.

Table V. Effect of different fertilizer levels on plant potassium concentration and uptake by paddy.

Treatments	Potassium concentration (%) and uptake (kg ha^{-1}) at different stages					
	30 DAS	60 DAS	90 DAS	Harvest		Total uptake
				Straw	Grain	
T_1 - RDF (100:50:50 N, P_2O_5 and K_2O kg ha^{-1})	31.02 (1.22)	70.08 (1.08)	77.28 (0.93)	88.59 (1.06)	69.37 (0.40)	157.96
T_2 - STCR (157:108:79 N, P_2O_5 and K_2O kg ha^{-1})	62.32 (1.71)	126.70 (1.65)	136.03 (1.42)	142.65 (1.40)	123.70 (0.50)	266.35
T_3 – STL (125:50:43.75 N, P_2O_5 and K_2O kg ha^{-1})	40.47 (1.46)	88.80 (1.33)	97.61 (1.10)	103.43 (1.21)	87.62 (0.41)	191.05
T_4 - Modified RDF_1 (125:50:37.5 N, P_2O_5 and K_2O kg ha^{-1})	35.15 (1.33)	77.01 (1.15)	82.05 (0.99)	99.57 (1.19)	75.57 (0.40)	175.14
T_5 - Modified RDF_2 (150:50:25 N, P_2O_5 and K_2O kg ha^{-1})	56.03 (1.61)	103.39 (1.37)	129.26 (1.35)	129.85 (1.33)	101.91 (0.48)	231.76
Iodified STL (125:37.5:43.75 N, P_2O_5 and K_2O kg ha^{-1}) + PSB	47.66 (1.51)	97.15 (1.36)	115.49 (1.27)	117.10 (1.24)	95.51 (0.47)	212.61
SEm±	2.71 (0.08)	5.98 (0.08)	6.99 (0.07)	5.03 (0.04)	4.96 (0.02)	13.45
CD (0.05)	8.18 (0.24)	18.01 (0.24)	21.07 (0.21)	15.17 (0.12)	14.96 (0.06)	13.07

Note: The values in parentheses indicate K (%) concentration

Table VI. Effect of different fertilizer levels on available nitrogen, phosphorous, potassium and sulphur status after harvest of crop.

Treatments	Nitrogen	Phosphorus	Potassium	Sulphur
	kg ha^{-1}			
T_1 - RDF (100:50:50 N, P_2O_5 and K_2O kg ha^{-1})	128.70	29.48	320.90	25.20
T_2 - STCR (157:108:79 N, P_2O_5 and K_2O kg ha^{-1})	139.03	39.20	362.60	29.40
T_3 - STL (125:50:43.75 N, P_2O_5 and K_2O kg ha^{-1})	131.64	31.67	336.10	26.40
T_4 - Modified RDF_1 (125:50:37.5 N, P_2O_5 and K_2O kg ha^{-1})	129.93	30.79	327.40	25.80
T_5 - Modified RDF_2 (150:50:25 N, P_2O_5 and K_2O kg ha^{-1})	136.29	33.55	347.00	28.60
T_6 - Modified STL (125:37.5:43.75 N, P_2O_5 and K_2O kg ha^{-1})+PSB	134.54	32.75	343.70	27.70
SEm±	1.82	1.28	8.68	1.68
CD (0.05)	5.48	3.87	26.16	NS

NS- Non significant