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Nutrient Expert and Soil Test Crop Response Assisted Site Specific Nutrient Management: An Alternative Precision Fertilization Technology for Direct Seeded Rice under Tungabhadra Irrigation Command

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ABSTRACT

A field experiment was conducted to study the Nutrient Expert (NW) and Soil Test Crop Response (STCR) assisted site specific nutrient management for precision fertilization in direct seeded rice (DSR) under Tunga Bhadra Irrigation command at Agricultural Research Station, Dhadesugur, University of agricultural Sciences, Raichur, Karnataka, India, during 2016 summer season. Nutrient Expert has been developed to provide simpler and faster crop advisory to use SSNM using existing site information. Soil testing helps the farmers to use fertilizers according to requirement of crop. Fertilizer use for targeted yield is an approach, which takes into account the crop needs and nutrients present in the soil. The experiment was laid out in a 2 x 3 x 2 factorial + 1control (RDF-150:75:75) Randomized complete block design with three replications. The first factor was nutritional approaches involving NE and STCR, second factor was yield target (6 t, 7 t and 8 t ha^{-1}) and the third factor was micronutrients and organics ($ZnSO_4$ + $FeSO_4$ + FYM 10 t ha^{-1}) and control (no micronutrients or organics). Significantly higher rice grain yield was recorded with STCR (7385 kg ha^{-1}) approach followed by NE (6737 kg ha^{-1}) both having yield target of 8 t ha^{-1} and application of micronutrients + organics. Similarly, net returns were significantly higher with STCR approach (` 97786/- ) at 8 t ha$^{-1}$ yield target with the application of micronutrients and organics followed by Nutrient Expert approach at 8 t ha$^{-1}$ yield target without application of micronutrients/organics (`96510/- and B:C - 3.74). Thus, NE being comparable with STCR and user friendly makes it an ideal choice for nutrient management in DSR.

Key words: *Direct Seeded Rice, STCR, Nutrient expert, Grain yield, Net returns, BC ratio*

INTRODUCTION

Today, the world needs more grain for food. This has to be achieved even with diminishing arable lands, water scarcity, and rising costs of cultivation. In addition, climate change is adding further complexity. Rice is one of the most important staple food crops of the world and India. Rice accounts for 55% of total cereal production in the country.

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The per capita food intake in India is 2234 kcal $person^{-1} day^{-1}$ of which 30% comes from rice. With an estimated population of 1.4 billion by 2020, the country will require 300 m t of grain compared with the approximately 272 m t at present. In India, rice is grown in an area of 43.95 m ha with an annual production of about 106.54 m t and the productivity is about 2.37 t ha^{-1} [3]. In Karnataka, rice is cultivated in command areas of Cauvery, Tunga Bhadra and Upper Krishna, where conventional puddling and transplanting (PuTPR) is the major system of cultivation. Farm-based approaches, which used to be at the center of agricultural practices for centuries to improve productivity, need to be explored once again. Direct seeded rice (DSR) is one such farm-based approach which is relatively easy and the results are visible in a short period of time. There is clearly an urgent need to find ways to grow more food with less water and fewer inputs. Already, under ICAR-STCR scheme yield equations are developed but these have not been tested for DSR situation [2]. Recently, International Plant Nutrition Research has come out with Site Specific Nutrient Management (SSNM) with software (Nutrient Expert) for transplanted rice nutrition (IPNI. 2011). This also needs to be evaluated for DSR conditions. The most comprehensive approach of fertilizer application by incorporating soil test values, nutrient requirement of the crop, contribution of nutrients from soil, manures, fertilizers and fixing yield-targets is possible only through Soil Test Crop Response (STCR) and Nutrient Expert approaches. Keeping this in view, the present investigation was carried out to Nutrient Expert and Soil Test Crop Response Assisted Site Specific Nutrient Management: An Alternative Precision Fertilization Technology for Direct Seeded Rice under Irrigation Command.

MATERIAL AND METHOD

The experiment was conducted in agricultural research station, Dhadesugur, University of agriculture sciences, Raichur during year Rainy 2015 and 2016. Soil samples (0-20 cm in depth) were collected, dried and passed through 2 mm sieve and analyzed for physico chemical properties as described by Jachson[5]. Available nitrogen, by the alkaline permanganate method[7]; available potassium, by the ammonium acetate method[5] as described by Jackson[5]. The soil was neutral in reaction (pH 7.30) and again high in soluble salts (1.08 dS m^{-1}). The soil was medium to high in organic carbon (0.75 %), medium in available nitrogen (286.2 kg ha^{-1}) and available P_2O_5 (25.4 kg ha^{-1}), while it was high in K_2O (440.1 kg ha^{-1}) during summer season. The 2 x 3 x 2 factorial + 1 control (RDF-150:75:75) trial was arranged in a randomized completely block design with three replications. The first factor was nutritional approaches involving nutrient expert and soil test crop response, second factor was yield target (6 t, 7 t and 8 t) and third factor was micronutrients and organics *viz.* no micronutrients or organics and $ZnSO_4$ + $FeSO_4$ + Organic manure and one control. The targeted yield of crop was decided as per yield potential of varieties. Pre sowing soil samples were analyzed according to the standard procedures. Quantities of nitrogen, phosphorus and potassium were calculated with the help of fertilizer adjustment equations and as follow.

$FN = 3.45\,T - 0.029\,SN\ (KMnO_4 - N)$

$FP_2O_5 = 2.82\,T – 1.90\,SP_2O_5\ (Olsen's - P_2O_5)$

$FK_2O = 2.00\,T - 0.09\,SK_2O\ (NH_4OAC - K_2O)$

Where,

T = Targeted yield (q ha^{-1})

FN = Nitrogen supplied through fertilizer (kg ha^{-1})

FP_2O_5 = Phosphorus supplied through fertilizer (kg ha^{-1})

FK_2O= Potassium supplied through fertilizer (kg ha^{-1})

SN, SP_2O_5 and SK_2O are initial soil test value for available N, P_2O_5 and K_2O, kg ha^{-1} respectively.

Fertilizer applied as per the Nutrient Expert is a decision support tool for nutrient management in rice. The guidelines provided by this software are in consistent with the scientific principles of SSNM[1].

RESULTS AND DISCUSSION

Grain yield varied due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects nutritional approaches and micronutrient + organics levels did not induce significant changes (5766 – 6410 with N_1 and N_2, and 5721 and 6455 with M_1 and M_2 respectively) (Table 1) while the effects due to varied fertilization and micronutrient + organic supply resulted in significant variations. In the yield targets, 8 t ha^{-1} yield target (T_3) recorded the maximum grain yield (6547).Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher yield (6709) (Table 1 and fig 1). The study highlights the importance of factor/s other than NPK with higher target of 8 t ha^{-1} set during summer. Bera *et al*.[4] suggested that for efficient utilization of applied fertilizer some other parameters like soil pH, organic carbon status, soil texture, bulk density, water holding capacity, soil drainage, etc. are important, since these are the major determining factors of soil nutrient retention. It is also presumed that irrigation water ECe is important which was rather high during summer in the present investigation. These need consideration for the development of an effective fertilizer schedule as well as nutrient supply source in view of the better nutrient absorption and assimilation by the plants particularly for summer crop. Among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded higher grain yield (6878) (Table 1 and fig 1). Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher yield (7385) followed by STCR + 7 t ha^{-1} yield target + micronutrient supply ($N_2T_2M_2$ - 7444) (Table 1 and fig 1) which was on par. Similarly, Bera *et al.* [4] also reported better performance of 8 t ha^{-1} yield target through STCR over farmers practice and general recommendation. Supplementation of organics and micronutrient 6455 kg ha^{-1}recorded 7.01 per cent increased yield over no supplementation 6032 kg ha^{-1}. All the N-T-M combinations except $N_1T_1M_{1-2}$, $N_2T_1M_1$ and $N_1T_2M_1$ were significantly superior to the recommended control (5288) (Table 1) with regard to grain yield. Similar to the present study, Bera *et al*.[4] too observed relatively higher response ratio with lower target of 7 t ha^{-1} than with 8 t ha^{-1} though it had also recorded higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels[6]. Two points emerge out of this; one is that it is possible to achieve higher yield target with supportive nutrition (micronutrients and organics in this instance) either through NE or through STCR approach. Another important point that could be made out is among the two approaches it is NE which makes use of lesser nutrients to achieve the target than STCR approach and when the N P K ratio is 2:1:1 in blanket recommendation it is almost 2:1:1.8 highlighting the need for more K.

Another thing observed in the study was that to achieve almost same yield targets STCR approach used more nutrients than NE. This fact is reflected in returns wherein in spite of numerically higher grain yield. net returns were significantly higher with STCR approach (`97786/- ) at 8 t $ha^{-1}$ yield target with the application of micronutrients and organics followed by Nutrient Expert approach at 8 t $ha^{-1}$ yield target without application of micronutrients/organics (`96510/- and B:C - 3.74) (Table 1 and fig 2). Thus, NE being comparable with STCR and user friendly makes it an ideal choice for nutrient management in DSR and with NE approach Since economics is the robust tool that helps to arrive at pragmatic decisions with regard to recommendations of productions technologies and in the present instance either of the approaches could be used, and preferably Nutrient Expert for its simplicity, farmer friendly nature besides monetary advantage.

Table 1: Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain yield, net returns (` ha^{-1}) and B: C under direct seeded condition during summer season

N x T x M		Grain yield (kg ha^{-1})				Net returns (` ha^{-1})				B : C			
		T_1	T_2	T_3	N x M	T_1	T_2	T_3	N x M	T_1	T_2	T_3	N x M
N_1	M_1	4988^{e}	5484^{d}	6032^{c}	5501^{c}	75095^{e}	86248^{b-d}	96510^{a}	85951^{b}	3.24^{c}	3.53^{b}	3.74^{a}	3.50^{a}
	M_2	5338^{d}	6016^{c}	6737^{b}	6030^{b}	65831^{f}	80240^{de}	93706^{a}	79926^{c}	2.32^{g}	2.59^{f}	2.82^{e}	2.58^{c}
N_2	M_1	5624^{d}	6168^{c}	6033^{c}	5942^{b}	82516^{cd}	91349^{ab}	87162^{bc}	87009^{b}	3.13^{cd}	3.22^{c}	3.00^{d}	3.11^{b}
	M_2	6603^{b}	6648^{b}	7385^{a}	6879^{a}	86099^{b-d}	86118^{b-d}	97786^{a}	90001^{a}	2.56^{f}	2.49^{f}	2.63^{f}	2.56^{c}
Target		5638^{c}	6079^{b}	6547^{a}		**77385^{c}**	**85989^{b}**	**93791^{a}**		**2.81^{c}**	**2.96^{b}**	**3.05^{a}**	
Control		5288				79605				3.26			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N_1		5163^{e}	5750^{d}	6384^{b}	5766^{a}	70463^{d}	83244^{c}	95108^{a}	82938^{a}	2.78^{c}	3.06^{b}	3.28^{a}	3.04^{a}
N_2		6113^{c}	6408^{b}	6709^{a}	6410^{a}	84308^{c}	88734^{b}	92474^{ab}	88505^{a}	2.85^{c}	2.86^{c}	2.81^{c}	2.84^{b}
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M_1		5306^{e}	5826^{d}	6032^{cd}	5721^{a}	78805^{d}	88799^{b}	91836^{a}	86480^{a}	3.18^{b}	3.37^{a}	3.37^{a}	3.31^{a}
M_2		5971^{c}	6332^{b}	7061^{a}	6455^{a}	75965^{d}	83179^{c}	95746^{a}	84963^{a}	2.44^{d}	2.54^{d}	2.72^{c}	2.57^{b}

Comparison	Grain yield S.Em±	Grain yield LSD 0.05	Net returns S.Em±	Net returns LSD 0.05	B : C S.Em±	B : C LSD 0.05
N	202.2		3958		0.09	
T	247.6		4847		0.11	
M	202.2		3958		0.09	
N x T	350.2		6855		0.16	
M x T	350.2		6855		0.16	
N x M	285.9		5597		0.13	
N x T x M	495.2		9694		0.23	
Control Vs Rest	107.5	313.8	2070	6049	0.05	0.14

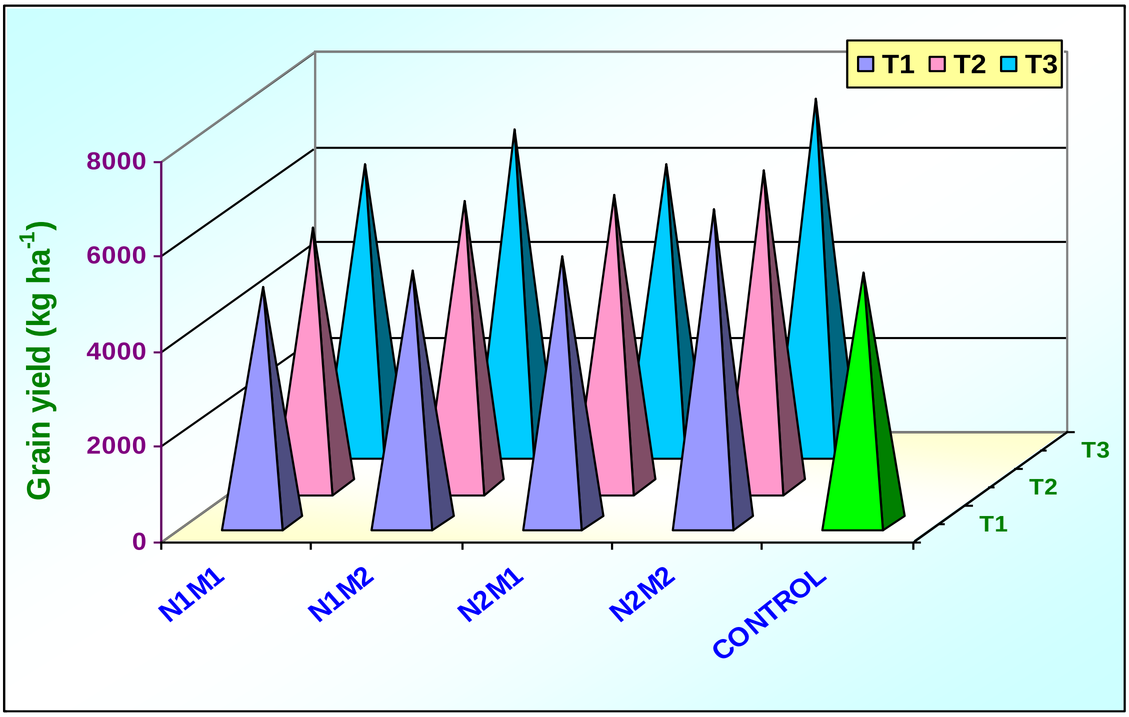
NS – Not significant

Nutrient approach (**N**) : **N_1**- Nutrient Expert, **N_2**- Soil Test Crop Response approach

Yield Targets (**T**) : **T_1**- 6 t ha^{-1}, **T_2**- 7 t ha^{-1}, **T_3**- 8 t ha^{-1}

Micronutrient & Organics (**M**) : **M_1** - Without $FeSO_4$+$ZnSO_4$ + Organics,
M_2 - With $FeSO_4$+$ZnSO_4$ + Organics

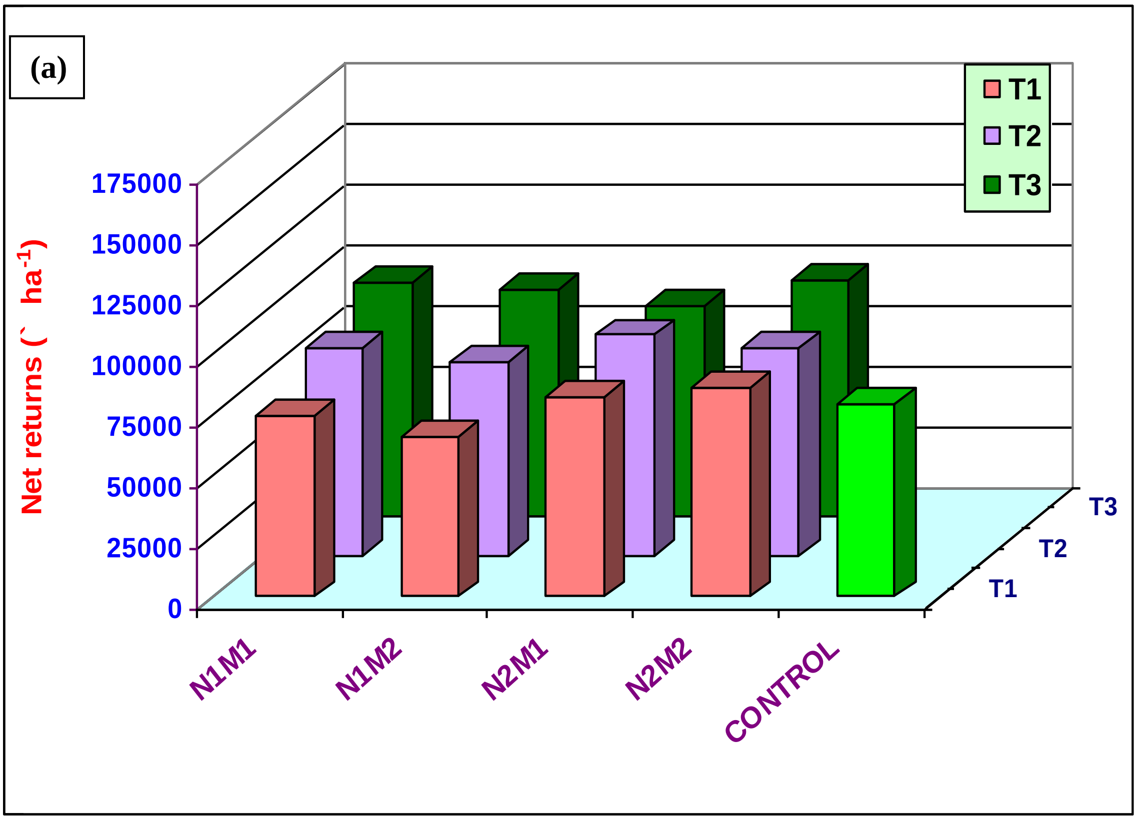
Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT.

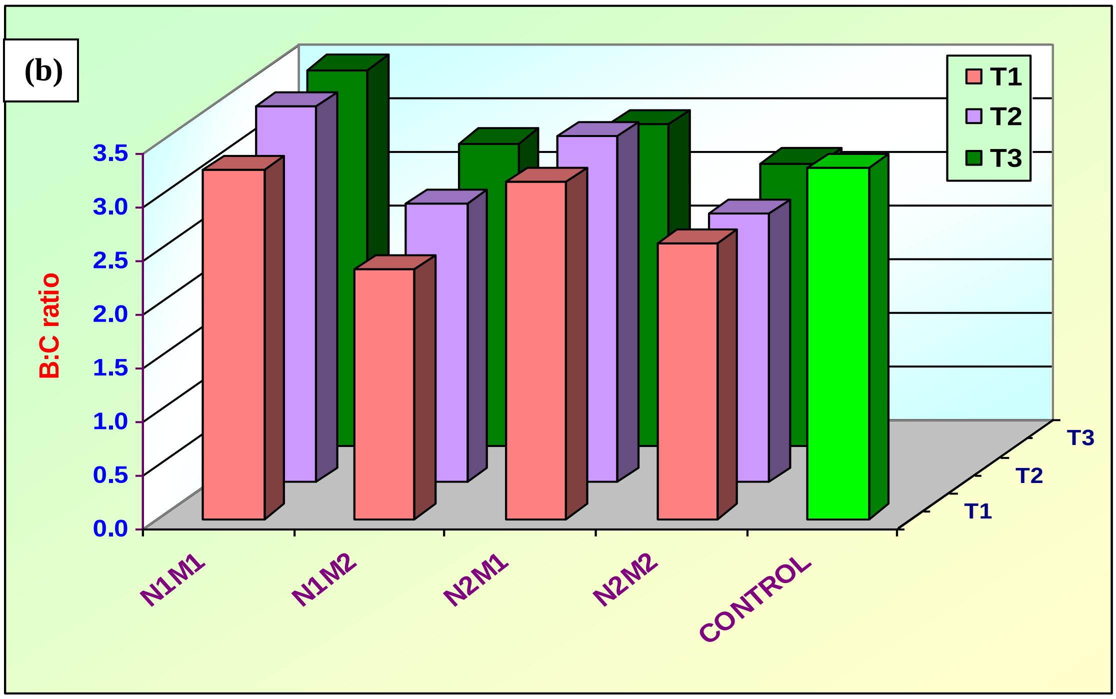


LEGEND

Nutritional approaches **(N)**: **N_1**- Nutrient Expert, **N_2**- Soil Test Crop Response approach
Yield Targets **(T)**: **T_1**- 6 t ha^{-1}, **T_2**- 7 t ha^{-1}, **T_3**- 8 t ha^{-1}
Micronutrient & Organics **(M)**: **M_1** - Without $FeSO_4$+$ZnSO_4$ + Organics, **M_2** - With $FeSO_4$+$ZnSO_4$ + Organics

Fig. 1: Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) sterility percentage and (b) grain yield (kg ha^{-1}) under direct seeded condition during summer season





LEGEND

Nutritional approaches **(N)**: **N_1**- Nutrient Expert, **N_2**- Soil Test Crop Response approach
Yield Targets **(T)**: **T_1**- 6 t ha^{-1}, **T_2**- 7 t ha^{-1}, **T_3**- 8 t ha^{-1}
Micronutrient & Organics **(M)**: **M_1** - Without $FeSO_4$+$ZnSO_4$ + Organics, **M_2** - With $FeSO_4$+$ZnSO_4$ + Organics

Fig. 2: Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) net returns (` ha^{-1}) and (b) B:C ratio under direct seeded condition during summer season

CONCLUSION

Significantly higher rice grain yield was recorded with STCR (7385 kg ha^{-1}) approach followed by NE (6737 kg ha^{-1}) both having yield target of 8 t ha^{-1} and application of micronutrients + organics. Similarly, net returns were significantly higher with STCR approach (` 97786/- ) at 8 t ha$^{-1}$ yield target with the application of micronutrients and organics followed by Nutrient Expert approach at 8 t ha$^{-1}$ yield target without application of micronutrients/organics (`96510/- and B:C - 3.74).

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