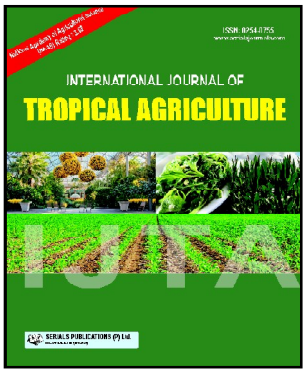

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Validation of Inductive cum Targeted Yield Model based Fertilizer Prescription for Rice under SRI on an Alfisol in Western Zone of Tamil Nadu

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Abstract: Soil test based fertilizer prescriptions for desired yield target of rice under System of Rice Intensification (SRI) were developed under Integrated Plant Nutrition System (IPNS) for Noyyal soil series (*Typic Haplustalf*) of Tamil Nadu. To validate the equations, experiments were conducted in farmers holding of Coimbatore district on Noyyal soil series. The treatments consisted of control, blanket recommendation, soil test crop response (STCR) based fertilizer dose for an yield target of 6, 7 and 8 t ha^{-1}, STCR-IPNS based fertilizer dose for an yield target of 6, 7 and 8 t ha^{-1} and farmer's practice. The results revealed that the percent achievement of the aimed yield target was within ± 10 per cent variation confirming the validity of the equations. STCR treatments recorded significantly higher yield, Response Ratio RR, BCR and post harvest soil fertility over blanket while STCR - IPNS treatments recorded relatively higher yield, RR and BCR over STCR-NPK alone treatments. The highest grain yield of 6510 and 7600 kg ha^{-1} were recorded with STCR-IPNS -7 t ha^{-1} and 8 t ha^{-1} respectively in location I and location II with an yield increase of 37 and 39.4 per cent over blanket. Post - harvest soil fertility with respect to available N, P and K revealed that there was build up and sustainability of soil fertility in STCR treatments.

Key words: Rice, SRI, STCR-IPNS, Fertilizer prescription, targeted yield

Rice is a global foodgrain and staple food for more than half of the world population. System of Rice Intensification (SRI) is such holistic agro ecological crop management technique seeking alternatives to

the conventional high input oriented agriculture, through effective integration of crop, soil, water and nutrient and it is gaining momentum in India since 2003. This methodology increases the productivity of irrigated rice by changing the management of plants, soil, water and nutrients resulting in both healthy soil and plants, supported by greater root growth and the soil microbial abundance and diversity

Indian population continues to increase and the provision of adequate supply of food remains a challenge. Nutrient mining is also a great threat in Indian Agriculture, as wide gap exists between the annual plant nutrient removal from the soil and addition of nutrients through external sources which is set to reach around 15 million tonnes by 2025. Though the increased use of fertilizer has resulted in higher productivity of food grains until last decade, now there are signs of stagnation in agricultural productivity particularly of food grains, decline in response ratio and wide diversity in fertilizer use in different parts of the country.

Instead of blanket recommendation, soil test based nutrient management practices should be adopted for better productivity, profitability, sustainability and environmental safety which eliminates over or under usage of fertilizer inputs thereby increases fertilizer use efficiency and yield of crops. Nowadays many computer software based fertilizer recommendation models are available but their usage is limited only to rich farmers and researchers and remains beyond reach of poor farmers. In this context, Inductive cum Targeted yield model approach (Ramamoorthy *et al.* (1967)[1] based fertilization is simple and easy-to-use. Addition of Integrated Plant Nutrition System (IPNS) to this concept paves the way for balanced fertilization of crops for specific yield target. This provides a scientific basis for balanced fertilization not only between fertilizer nutrients but also with the soil available nutrients. Subba Rao *et al.* (2009)[2] emphasised the need for choosing the appropriate yield target and fertilizer use practices for achieving the higher yield and maintenance of soil fertility.

Keeping the above points in view, Fertilizer Prescription Equations (FPEs) were developed for rice under SRI on Noyyal series following the STCR-IPNS concept and inductive cum targeted yield approach. For wide scale adoption of these fertilizer prescription model in farmer's holdings, the validation study was undertaken.

MATERIALS AND METHODS

Validation experiments were conducted in two farmer's holdings of Ikkarai Boluvampatti (Location I) and Pachanvayalpathi (Location II) villages, Coimbatore district in Western Zone of Tamil Nadu with rice variety White ponni and Bhavani on Noyyal series (Typic Haplustalf).

Chemical properties of experimental soil

The soil of the experimental site was clay loam in texture with predominance of illitic type of clay minerals, which taxonomically categorized under the great group (Typic Haplustalf). In location I, Soil of experimental field was medium in available N (282 kg ha^{-1}) and high in available P (24 kg ha^{-1}) and K (610 kg ha^{-1}). The soils in location II had low available N (240 kg ha^{-1}) and high available P (26 kg ha^{-1}) and K (410 kg ha^{-1}). The soils were found to be neutral in reaction and non-saline. DTPA extractable Fe, Mn, and Cu were present in sufficiency range and Zn in deficient range.

Validation experiment

Fertilizer prescription equations for rice under SRI, on Noyyal soil series are furnished below:

$FN = 4.33\ T - 0.53\ SN - 0.68\ ON$

$FP_2O_5 = 2.08\ T - 3.18\ SP - 0.70\ OP$

$FK_2O = 2.78\ T - 0.30\ SK - 0.63\ OK$

where, FN, FP_2O_5 and FK_2O are fertiliser N, P_2O_5 and K_2O in kg ha^{-1} respectively; T - Grain yield target in q ha^{-1}; SN, SP and SK are available N, P and K in kg ha^{-1} respectively; ON, OP and OK are N, P and K supplied through organic manure in kg ha^{-1}.

The trial consisted of nine treatments *viz*., Control, Blanket fertilizer dose, STCR based fertilizer dose for an yield target of 6, 7 and 8 t ha^{-1}, STCR-IPNS based fertilizer dose for an yield target of 6, 7 and 8 t ha^{-1} and farmer's practice. Based on the initial soil test values of available N, P and K, the fertilizer doses were calculated for yield targets of 6,7 and 8 t ha^{-1} and the fertilizer doses applied in two trials are given in Table 1 and 2. In STCR treatments, only inorganic fertilizers were applied based on STCR equations developed, while in STCR-IPNS treatments FYM @ 12.5 t ha^{-1} and *Azospirillum* and Phosphobacteria each @2 kg ha^{-1} were applied. The quantity of nutrients supplied through organic sources was taken into account and the remaining quantity was applied through inorganic fertilizers based on STCR-IPNS equations. Twenty five per cent of N and K_2O and full dose of P_2O_5 were applied basally before transplantation and biofertilisers were applied a week after transplantation. Remaining N and K_2O were applied in three equal splits *viz.,* tillering, panicle initiation and heading stages and routine agronomic practices were carried out periodically. Using the data on grain yield and fertiliser doses applied, the parameters *viz*.,per cent achievement {(yield obtained / aimed yield target) x 100}, response ratio (response in kg ha^{-1}/ quantities of fertiliser N, P_2O_5 and K_2O applied in kg ha^{-1}) , benefit cost ratio were worked out. Based on these parameters, Fertilizer prescription equations were validated. Post-harvest soil samples were collected and analyzed for available N (Subbiah and Asija, 1956) {3}, available P (Olsen *et al*., 1954) {4} and K (Hanway and Heidal, 1952) {5} status.

RESULTS AND DISCUSSION

Grain yield and Per cent Achievement

The grain yield recorded in various treatments at two locations were given in Table 1 and 2. Among the treatments, the grain yield ranged from 2420 to 6510 kg ha^{-1} in location I with variety White Ponni and the highest yield was registered in STCR-IPNS 7 t ha^{-1} which was found to be on par with STCR- IPNS - 8 t ha^{-1}, followed by STCR -NPK alone- 8 t ha^{-1}, STCR- NPK alone- 7 t ha^{-1}, STCR- IPNS - 6 t ha^{-1}, STCR- NPK alone- 6 t ha^{-1} indicating that the STCR – IPNS treatments recorded relatively higher yield over STCR- NPK alone treatments. The respective yield increase in STCR-IPNS 7 t ha^{-1}, was 37.1 and 41.2 per cent when compared to blanket (4750 kg ha^{-1}) and farmer's practice (4610 kg ha^{-1}). In location II, with variety Bhavani, the yield ranged from 2340 to 7600 kg ha^{-1} and the highest grain yield was recorded with 8 t ha^{-1}- IPNS treatment while relatively lower yield was recorded in farmers practice (5350 kg ha^{-1}) and blanket (5650 kg ha^{-1}). In STCR-IPNS -8 t ha^{-1}, the per cent increase in yield over blanket and farmers practice was 34.5 and 42.1, respectively. Among STCR treatments, relatively higher yield was recorded with STCR-IPNS treatments. The result is in accordance with the findings of Maragatham *et al.* (2013) {6} who observed a positive and synergistic influence of conjoint use of FYM and inorganic fertilizer on wheat yield. Application of organic manures prolonged the availability of nutrients to the crop, that promoted growth and development of plants and ultimately resulted in increased yield attributes and yield. The second reason might be due to enhancement of root growth due to various growth regulating substances by inoculation of biofertilizers (Kanzaria *et al*., 2010) {7}.

Yield targeting with IPNS recorded relatively higher percent achievement than that aimed under their respective NPK alone treatments (Table 1 &2). The per cent achievement of the targeted yield was

within +/- 10 per cent variation in all the yield targets in location II and up to 7 t ha^{-1} yield target in location I proving the validity of the equations for prescribing integrated fertilizer doses for rice during kharif season. The balanced nutrition of crops based on soil test and crop response would have resulted in such higher percent achievement (Praveena Katharine *et al.,* 2014) [8]

Response Ratio (RR) and Benefit Cost Ratio (BCR)

The response ratio ranged from 12.9 to 18.4 Kg Kg^{-1} and 12.4 to 17.5 Kg Kg^{-1} in location I and II respectively. Among the treatments, IPNS recorded relatively higher RR than NPK alone treatments. Blanket has recorded relatively lower response ratio as compared to STCR treatments. In general, the response ratio decreased with increasing level of nutrient doses and yield target (Table 1 & 2). The mean (2 locations) increase in RR due to the adoption of STCR and STCR-IPNS technology was 2.4 & 3.0 kg kg^{-1} over blanket and farmer's practice respectively. The relatively higher RR recorded under STCR and STCR-IPNS treatments when compared to blanket might be due to balanced supply of nutrients from fertilizer and organic sources. This was already highlighted by. With regard to BCR, higher values of 1.76 and 1.94 were recorded in STCR -IPNS – 8 t ha^{-1} and lower values were recorded in blanket, farmers practice and control. STCR-IPNS technology ensures sustainable crop production with economical use of fertilizer inputs (Mahajan *et al.*, 2013) [9].

Post-harvest soil fertility status

The data pertaining to the initial and post harvest sol fertility was given in Figure 1 & 2. The result indicated the build up of available nitrogen (N), phosphorus (P) and potassium (K) status due to soil test based fertilizer recommendation under IPNS (STCR-IPNS) while depletion was noticed in blanket, Farmer's practice and control. Despite higher removal of nutrients, there was build up in fertility status of STCR-IPNS treatments as compared to STCR-NPK alone treatments. This might be due to the release of several organic acid during decomposition of organic manure which in turn

Table 1
Results of validation trial at Ikkarai Boluvampatti (Location I)

S. No.	*Treatments*	*Nutrients added (kg ha^{-1})*			*Grain yield (kg ha^{-1})*	*Achiev-ement (%)*	*RR (kg kg^{-1})*	*BCR*
		N	*P_2O_5*	*K_2O*				
1.	Blanket	75	50	50	4750	-	13.3	1.32
2.	STCR- NPK alone- 6 t ha^{-1}	110	48	25*	5580	93.0	17.2	1.58
3.	STCR- NPK alone- 7 t ha^{-1}	150**	69	25*	6350	90.7	16.1	1.74
4.	STCR -NPK alone- 8 t ha^{-1}	150**	90	33	6380	79.8	14.2	1.75
5.	STCR- IPNS - 6 t ha^{-1}	65	28	25*	5800	96.7	18.4	1.59
6.	STCR- IPNS - 7 t ha^{-1}	109	49	25*	6510	93.0	16.8	1.76
7.	STCR- IPNS - 8 t ha^{-1}	150**	70	25*	6480	81.0	14.5	1.76
8.	Farmer's practice	90	40	40	4610	-	12.9	1.29
9.	Absolute Control	0	0	0	2420	-	-	0.73

*: maintenance dose (50 % of blanket) ; ** maximum dose (200 % of blanket)

Table 2
Results of validation trial at Pachanvayalpathi (Location II)

S.No.	*Treatments*	*Nutrients added(kg ha^{-1})*			*Grain yield (kg ha^{-1})*	*Achiev-ement (%)*	*RR (kg kg^{-1})*	*BCR*
		N	*P_2O_5*	*K_2O*				
1.	Blanket	150	50	50	5450	-	12.4	1.52
2.	STCR- NPK alone- 6 t ha^{-1}	133	42	44	5810	96.8	15.8	1.60
3.	STCR- NPK alone- 7 t ha^{-1}	176	63	72	7150	102.1	15.5	1.87
4.	STCR -NPK alone- 8 t ha^{-1}	219	84	99	7340	91.8	12.4	1.88
5.	STCR- IPNS - 6 t ha^{-1}	91	25*	25*	6180	103.0	17.5	1.75
6.	STCR- IPNS - 7 t ha^{-1}	134	39	38	7415	105.9	16.3	1.93
7.	STCR- IPNS - 8 t ha^{-1}	177	60	65	7600	95.0	13.1	1.94
8.	Farmer's practice	170	40	30	5350	-	12.5	1.47
9.	Absolute Control	0	0	0	2340	-	-	0.57

*maintenance dose (50 % of blanket)

reduced the fixation of nutrients and prevent the losses of nutrients under IPNS ultimately increased the nutrient use efficiency (Anil Kumar *et al.*, 2009) {10}. The findings of Santhi *et al.* (2011) {11} are in accordance with the present study. They observed maintenance of soil fertility and yield increase in beetroot while adopting STCR-IPNS technology. Ramamoorthy and Velayutham (2011) {12} indicated that higher profit with maintenance of soil fertility status was realized when fertilizers were applied for appropriate yield targets in succession over years using STCRIPNS concept.

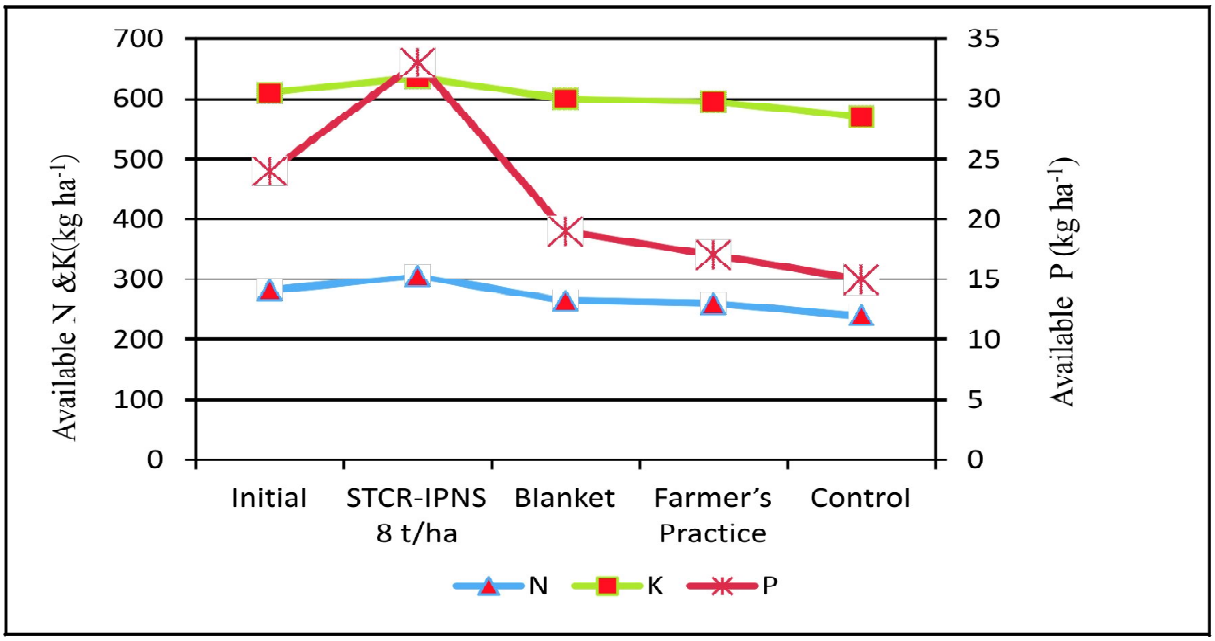

Figure 1: Post harvest soil fertility (kg ha^{-1}) as influenced by treatments (location I)

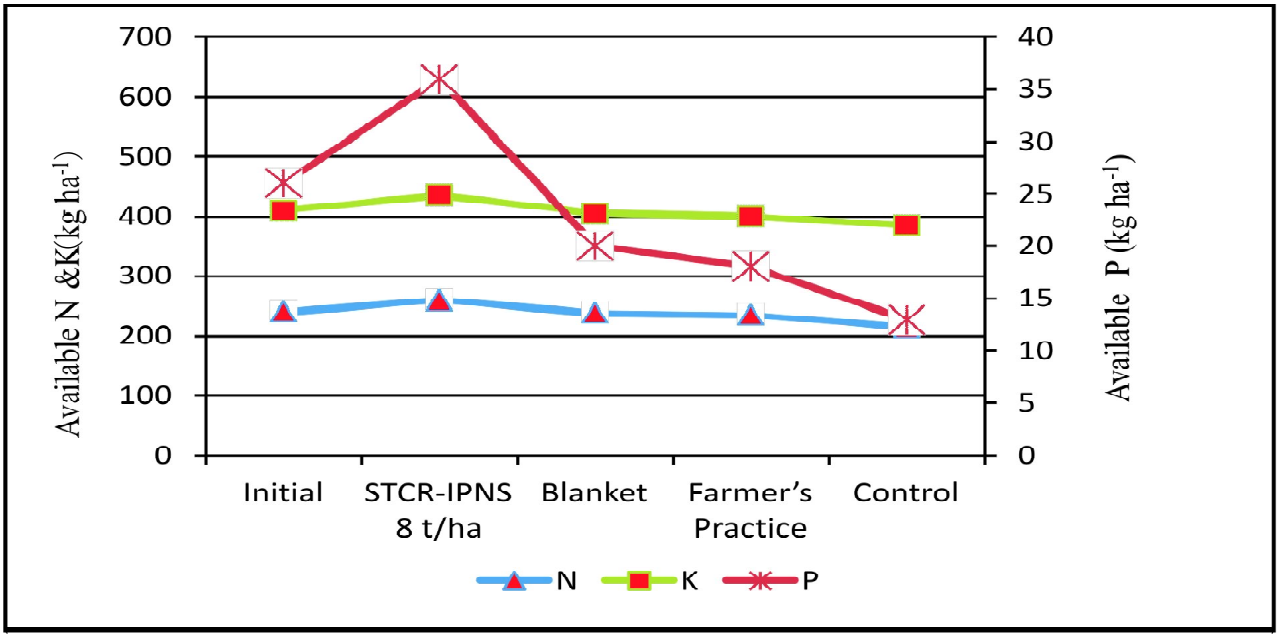

Figure 2: Post harvest soil fertility (kg ha^{-1}) as influenced by treatments (location II)

CONCLUSION

The study revealed that percent achievement of the aimed yield target was within + 10 per cent variation in the trials confirming the validity of the equations. The mean (2 locations) increase in yield and RR due to the adoption of STCR and STCR-IPNS technology was 26.3 & 31.5 per cent and 2.4 & 3.0 kg kg^{-1} over blanket and farmer's practice respectively. Yield targeting up to 7 t ha^{-1} for White Ponni and 8 t ha^{-1} for Bhavani was found to be ideal. Therefore, based on the results of the two trials, it could be inferred that for targeting up to 7 t ha^{-1} for White Ponni and 8 t ha^{-1} for Bhavani under SRI would be ideal for rice-rice sequence on Noyyal series (Clay loamy, mixed isohyperthermic, *Typic Haplustalf*). Target yield equations generated from STCR-IPNS technology ensures not only sustainable crop production and maintenance of soil fertility but also economise use of costly fertilizer inputs. Hence, practice of fertilizing crops using ready reckoner worked out from fertilizer prescription equations developed for rice crop under SRI on Noyyal soil series needs to be popularized among the farmers to achieve higher productivity, nutrient use efficiencies and profitability.

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REFERENCES

Ramamoorthy, B., Narasimham, R.L. and Dinesh, R.S. (1967), Fertiliser application for specific yield targets on Sonora 64 (wheat). *Indian Farming*, **17:** 43-45.

Subba Rao, A., Muralidharudu, Y., Brij Li Lakaria and Singh, K. N. (2009), Soil testing and nutrient recommendation. *J. Indian Soc. Soil Sci.,* **57:** 559-71.

Subbiah, B.V. and Asija, G.I. (1956), A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci.,* **25:** 259-60.

Olsen, S.R, Cole, C.V., Watnabe, F.S. and Dean, I. (1954), Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circ 939, US Govt. Printing Office, Washington DC

Hanway, J.J. and Heidal, H. (1952), Soil analysis methods as used in Lowa State College. *Agric Bulletin*., **57:** 1-13.

Maragatham, S, A.Bhaskaran, R.Santhi and R. Natesan. (2013), Validation of Soil Test Based Fertiliser Prescription Equations under Integrated Plant Nutrition System for desired yield target of Wheat. Madras Agric. J. 100 (4-6) : 473-476.

Kanzaria, K. K., Sutaria, G. S., Akbari, K. N., Vora,V. D. and Padmani, D. R. (2010), Effect ofintegrated nutrient management on productivity of pearl millet and soil fertility of sandy loam soils under rainfed conditions. *An Asian J. Soil Sci.* **5** : 154-56.

Praveena Katharine, S, R. Santhi, C.N.Chandrasekhar, S.Maragatham and K. M. Sellamuthu (2014), Evaluation of STCR-IPNS recommendation for transgenic cotton on Inceptisol. Research on Crops. 15(1): 226 – 231.

Mahajan, G. R., Pandey, R. N., Datta, S. C., Dinesh Kumar, Sahoo, R. N. and Rajender Prasad (2013), Soil test based fertilizer recommendation of nitrogen, phosphorus and sulphur in wheat (*Triticum aestivum* L.) in an alluvial soil. *Int. J. Agric. and Environ. Biotechnol.* **6** : 271-81.

Anil Kumar, Manoj Kumar, Gera, Rajesh, HoodaR. S. and Yadav, H. P. (2009), Compensating nutrient requirnment in pearl millet-wheat cropping system through manures and biofertilizer in semi-arid region of Haryana. *Indian J. agric. Sci.* **79** : 767-71.

Santhi, R., Bhaskaran, A. and Natesan, R. (2011), Integrated Fertilizer Prescriptions for Beetroot through Inductive cum Targeted Yield Model on an Alfisol. *Commun. Soil Sci. Plant Anal.* **42**: 1905-1912.

Ramamoorthy, B. and Velayutham, M. (2011), The Law of optimum and soil test based fertilizer use for targeted yield of crops and soil fertility management for sustainable agriculture. *Madras Agric. J.* **98** : 295-307.