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Validation of Soil Test Based Fertilizer Prescription Equations under Integrated Plant Nutrition System for Desired Yield Target of Wheat

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Soil test based fertilizer prescriptions for desired yield target of wheat were developed under Integrated Plant Nutrition System (IPNS) for Ooty soil series (*Typic Haplohumult*) of Tamil Nadu. To validate the equations, experiments were conducted in Salem and Namakkal districts at farmers holding on similar soil series. The results revealed that the per cent 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) and BCR over blanket while STCR - IPNS treatments recorded relatively higher yield, RR and BCR over STCR-NPK alone treatments. The highest mean yield of 41.63 q ha^{-1} was recorded with STCR-IPNS 40 q ha^{-1} with an increase of 55.8 per cent over blanket. Post - harvest soil fertility with respect to available N, P and K revealed that there was sustainability of soil fertility in STCR treatments. Therefore soil test based fertilizer prescription can be recommended to hilly and foothill areas of Tamil Nadu for achieving 40 q ha^{-1} of wheat.

Key words: Wheat, soil test, fertilizer prescription, IPNS, targeted yield, per cent achievement, response ratio
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Wheat is the second most important staple food crop of India and the major states that are involved in the cultivation of wheat are those located in the plains of Uttar Pradesh, Punjab and Haryana. In Southern hill zone, the area under wheat is 0.1 m ha in which Tamil Nadu contributes 99 per cent of the area. In Tamil Nadu, suitable climatic condition is prevailing in the hilly and adjoining areas of hilly region for the cultivation of wheat during rabi season.

In Indian Agriculture, nutrient mining is a great threat as wide gap exists between the annual plant nutrient removal from the soil and addition of nutrients through external sources (Singh, 2008). Balanced fertilization can be the only option to mitigate this anomaly. 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. Hence, emphasis has to be given for adoption of soil test crop response based balanced fertilization. In this context, fertilizer prescription equations for Hill Wheat were developed following the STCR- IPNS concept by adopting inductive cum targeted yield approach (Ramamoorthy *et al*., 1967) for Ooty soil series (*Typic Haplohumult*).

For wide scale adoption, these equations are to be test verified on farmer's holding. Hence, the present investigation was undertaken in six farmer's holdings of hilly regions *viz*., Karumandurai, Keelakadu, Malayalapatti and Tumbal villages (Kalrayan Hills)

of Salem district and Karkudalpatti and Kappaluthu villages (Kolli Hills) of Namakkal district.

Materials and Methods

Fertilizer prescription equations for hill wheat under IPNS on Ooty soil series are furnished below:

$$FN = 7.60\ T - 0.55\ SN - 0.92\ ON$$
$$FP_2O_5 = 3.59\ T - 0.26\ SP - 0.54\ OP$$
$$FK_2O = 3.88\ T - 0.45\ SK - 0.51\ OK$$

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}.

These equations were test verified by conducting verification trials in six locations during 2007-10. There were six treatments *viz*., i) control, ii) blanket, iii) STCR-NPK alone for 35 q ha^{-1}, iv) STCR-NPK alone for 40 q ha^{-1}, v) STCR-IPNS for 35 q ha^{-1}, vi) STCR-IPNS for 40 q ha^{-1}. Based on the initial soil test values of available N, P and K, the fertilizer doses were calculated for yield targets of 35 and 40 q ha^{-1} and the range values of fertilizer doses applied in six trials is given in Table 1. 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* @ 2 kg ha^{-1} were applied. The quantity of nutrients supplied through organic sources were taken into account and the remaining quantity was applied through inorganic fertilizers based on STCR-IPNS

equations. Fifty percent of N and full dose of P_2O_5 and K_2O were applied basally and the remaining 50 % N was applied at crown root initiation stage (15 – 20 DAS) 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} and response ratio (response in kg ha^{-1} / quantities of fertiliser N, P_2O_5 and K_2O applied in kg ha^{-1}) were worked out. In addition, benefit cost ratio was also worked out. Post-harvest soil samples were also collected and analyzed for available N (Subbiah and Asija, 1956), available P (Olsen *et al*., 1954 ; Bray and Kurtz, 1948) and K (Hanway and Heidal, 1952) status.

Results and Discussion

Grain yield

The grain yield recorded in various treatments at different locations is given in Table 1. Among the treatments STCR-IPNS 40 q ha^{-1} registered highest grain yield and it ranged from 39.8 to 43.80 q ha^{-1} at Malayalapatti and Tumbal respectively. With respect to mean grain yield, the highest yield of 41.63 q $ha^{-1}$was recorded in IPNS – 40 q ha^{-1} treatment followed by NPK alone - 40 q ha^{-1} (40.65 q ha^{-1}), IPNS treatment -35 q ha^{-1} (36.24 q ha^{-1}) and NPK alone – 35 q ha^{-1} (35.48 q ha^{-1}) indicating that the STCR - IPNS treatments recorded relatively higher yield over STCR - NPK alone treatments. Blanket recorded relatively lower yield (26.65 q ha^{-1}) as compared to STCR treatments. The per cent increase in yield due to the adoption of IPNS technology (STCR - IPNS for 40 q ha^{-1}) was 56.2 per cent over blanket and 115 per cent over control. The result is in accordance with the findings of Konde *et al*. (2008) who observed a higher response of wheat for the conjoint use of FYM and inorganic fertilizer. This might be due to the synergistic effect and balanced supply of nutrients from soil, fertiliser, organic and biological sources and efficient utilization of applied nutrients under IPNS (Virendra Kumar and Yashbir Singh Shivay, 2010).

Table 1. Range values of nutrients applied and influence of treatments on grain yield (q ha^{-1}) at different locations

Treatment	Range values of nutrients added (kg ha^{-1})			Karuman-durai	Keela-kadu	Malayala-patti	Tumbal	Karkudal-patti	Kappa-luthu	Mean yield
	N	P_2O_5	K_2O							
Control	0	0	0	21.20	19.90	17.00	18.70	20.25	19.00	19.34
Blanket	100	60	30	30.70	29.70	23.50	25.00	26.00	25.00	26.65
STCR -NPK alone -35 q ha^{-1}	149-166	102-120	15*-86	36.70	36.00	34.20	34.90	36.50	34.60	35.48
STCR- NPK alone - 40 q ha^{-1}	187-204	120-138	27-106	40.80	38.70	39.50	43.90	41.50	39.50	40.65
STCR -IPNS - 35q ha^{-1}	98-114	91-108	15*-64	37.00	36.80	34.10	37.50	36.80	35.25	36.24
STCR -IPNS -40 q ha^{-1}	136-152	109-126	15*-84	41.60	41.00	39.80	43.80	42.75	40.80	41.63

* Maintenance dose @ 50 % of blanket

Table 2. Influence of treatments on per cent achievement at different locations

Treatment	Karumandurai	Keelakadu	Malayalpatti	Tumbal	Karkudalpatti	Kappaluthu	Mean percent achivement
Control	-	-	-	-	-	-	-
Blanket	-	-	-	-	-	-	-
STCR -NPK alone -35 q ha^{-1}	105	103	97.7	99.7	104.2	98.9	101.4
STCR- NPK alone - 40 q ha^{-1}	102	97	98.8	109.8	103.8	98.75	101.7
STCR -IPNS- 35 q ha^{-1}	106	105	97.4	107.1	105.1	100.7	103.6
STCR -IPNS -40 q ha^{-1}	104	103	99.5	109.5	106.9	102.0	104.2

Per cent Achievement

The highest per cent achievement of the yield targets was recorded with 40 q ha^{-1} (104.2) under IPNS followed by 35 q ha^{-1} - IPNS, 40 q ha^{-1} NPK alone and 35 q ha^{-1}- NPK alone (Table 2) Yield targeting with IPNS recorded relatively higher percent achievement than that aimed under their respective NPK alone treatments. In all the six trials, the per cent achievement of the targeted yield was with in $\pm$ 10 per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for wheat. The balanced nutrition of crops based on soil test and crop response would have resulted in such higher per cent achievement. (Selvakumari *et al*., 2001)

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

In different locations, the response ratio ranged from 3.0 in blanket to 6.8 in STCR - IPNS - 40 q ha^{-1}. With respect to the mean RR, it ranged from 3.8 kg kg^{-1} in blanket to 5.9 kg kg^{-1} in STCR - IPNS 40 q ha^{-1}. Among the treatments, IPNS recorded relatively higher RR than NPK alone treatments. Blanket recorded 3.8 kg kg^{-1}, which is significantly lower than STCR treatments (Table 3). The relatively higher RR recorded under STCR and STCR-IPNS treatments when compared to blanket might be due to balanced supply of nutrients from fertiliser, efficient utilization of applied fertiliser nutrients in the presence of organic sources and the synergistic effect of the

Table 3. Influence of treatments on response ratio (kg kg^{-1}) and BCR at different locations

Treatment	Karuman-durai	Keela-kadu	Malayala-patti	Tumbal	Karkudal-patti	Kappa-luthu	Mean RR	Mean BCR
Control	-	-	-	-	-	-	-	1.22
Blanket	5.00	5.16	3.4	3.3	3.0	3.2	3.8	1.44
STCR -NPK alone -35 q ha^{-1}	5.60	5.42	6.0	5.5	4.9	4.4	5.3	1.75
STCR- NPK alone - 40 q ha^{-1}	5.60	5.05	6.4	6.8	5.3	4.7	5.6	1.79
STCR -IPNS- 35 q ha^{-1}	5.70	5.60	6.0	6.4	5.0	4.5	5.5	1.92
STCR -IPNS -40 q ha^{-1}	5.80	5.67	6.5	6.8	5.5	5.0	5.9	1.96

conjoint addition of various sources of nutrients. This was already highlighted by Subba Rao and Sanjay Srivastava (2000). With regard to BCR, higher values of 1.92 and 1.96 were recorded in STCR -IPNS - 35 q ha^{-1} and STCR - IPNS - 40 q ha^{-1} followed by STCR-NPK alone treatments, blanket and control.

Post-harvest soil fertility status

The data pertaining to the initial and post harvest sol fertility was given in Tables 4 & 5. The result indicated the built up and maintenance of available N, P and K status due to soil test based fertiliser

Table 4. Available nitrogen, phosphorus and potassium (kgha^{-1}) status as influenced by treatments

Treatment	Karumandurai			Keelakadu			Malayalapatti		
	SN	SP	SK	SN	SP	SK	SN	SP	SK
Control	184	85.0	255	186	48.5	225	167	76.0	270
Blanket	194	89.3	268	199	51.2	237	178	79.8	287
STCR -NPK alone -35 q ha^{-1}	201	93.5	270	206	59.0	238	185	86.6	288
STCR- NPK alone - 40 q ha^{-1}	211	96.4	273	214	63.6	240	193	90.5	291
STCR -IPNS- 35 q ha^{-1}	205	94.8	271	210	62.3	240	188	88.9	290
STCR -IPNS -40 q ha^{-1}	213	98.5	274	219	64.8	241	197	91.5	294
Initial status	196	91.0	264	204	54.0	234	182	82	285

recommendation under IPNS while depletion was noticed in control and blanket. Despite higher removal of nutrients, the fertility status was maintained in STCR-IPNS treatments as compared to STCR-NPK alone treatments. This might be attributed to the prevention of losses of nutrients under IPNS, even after meeting the crop needs. Subba Rao *et al.,* (2009) emphasised the need for choosing the appropriate yield target and fertilizer use practices for achieving the higher yield and maintenance of soil fertility. The findings of Pachauri and Vinay Singh (2001) and Smitha John et al. (2010) are in

Table 5. Available nitrogen, phosphorus and potassium (kgha^{-1}) status as influenced by treatments

Treatment	Tumbal			Karkudalpatti			Kappaluthu		
	SN	SP	SK	SN	SP	SK	SN	SP	SK
Control	189	42.5	232	194	39.2	140	191	18.5	101
Blanket	201	46.2	249	213	45.2	155	208	21.2	112
STCR -NPK alone -35 q ha^{-1}	210	52.0	250	219	47.0	157	214	25.5	115
STCR- NPK alone - 40 q ha^{-1}	222	55.2	254	228	53.2	164	222	29.6	120
STCR -IPNS- 35 q ha^{-1}	215	54.2	251	223	51.2	160	218	27.9	118
STCR -IPNS -40 q ha^{-1}	226	59.8	257	230	54.8	168	227	31.4	124
Initial status	206	48	242	212	44.6	153	205	20.7	110

accordance with the present study. They observed the build up of soil fertility while adopting STCR-IPNS technology.

The study revealed that per cent achievement of the aimed yield target was within $\pm$ 10 per cent variation in all the six trials confirming the validity of the equations. The STCR-IPNS - 40 q ha^{-1} treatment recorded higher percent achievement of 104.2. The same treatment recorded the highest mean grain yield of 41.63 q ha^{-1} over blanket along with the highest RR (5.9 kg kg^{-1}) and BCR (1.96). The yield increase due to the adoption of STCR-IPNS technology was 55.8 per cent over blanket. Hence, the fertilizer prescription equations developed for Hill Wheat under Integrated Plant Nutrition System can be recommended for the hilly and adjoining hilly regions for achieving higher yield with sustained soil health. Thus, the STCR-IPNS technology is one of the tools for achieving the twin objectives of getting higher yield along with sustained soil productivity.

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