



## Evaluation of Soil Test and Yield Target Based Fertilizer Prescription Model for Radish on an Alfisol

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Field experiments were conducted in Southern and Western Zones of Tamil Nadu to evaluate the Soil Test Crop Response based fertilizer prescription model under Integrated Plant Nutrition System (STCR-IPNS) for desired yield targets of radish on red calcareous soils (Palathurai series-Typic Rhodustalf). The treatments include control, blanket recommendation, soil test crop response (STCR) based fertilizer dose for an yield target of 40 t ha<sup>-1</sup> and 50 t ha<sup>-1</sup>, STCR-IPNS based fertilizer dose for an yield target of 40 t ha<sup>-1</sup> and 50 t ha<sup>-1</sup> and farmer's practice. The results of the experiments indicated that, in all the six trials, the per cent achievement of the targeted yield was within  $\pm 10$  per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for radish. The highest mean per cent achievement was recorded with STCR - IPNS - 50 t ha<sup>-1</sup> (101.3) followed by STCR-NPK alone 50 t ha<sup>-1</sup>. The highest mean yield was recorded in STCR-IPNS - 50 t ha<sup>-1</sup> (50.6 t ha<sup>-1</sup>) recording an increase of 56.7 per cent over blanket recommendation and 69.0 per cent over farmer's practice. Among the treatments, STCR-IPNS-50 t ha<sup>-1</sup> recorded relatively higher RR (81.3 kg kg<sup>-1</sup>) and BCR (2.24) than other treatments. Post-harvest soil available NPK indicated the build up and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS.

**Key words:** Alfisol, Fertilizer prescription, radish, STCR-IPNS

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At present, an annual net negative balance of about 8-10 million tons of nutrients is reported in India (Singh, 2008 and Subba Rao and Sammi Reddy, 2010) which is due to the indiscriminate and imbalanced use of fertilizers. It can be corrected only with proper organic manure and inorganic fertilizer schedule based on soil fertility evaluation. In vegetable production, India is next to China with an annual production of 87.53 million tones from 5.86 million hectares having a share of 14.4 per cent to the world production (<http://agricoop.nic.in/hort/hortrevo5.htm>). Radish (*Raphanus sativus*, Brassicaceae) is an important root vegetable grown in India and specifically in Tamil Nadu. Radishes and their greens provide an excellent source of vitamin C. Increasing, production of radish become inevitable since it is one of the prominent vegetables.

A blanket recommendation of NPK 50:100:50 kg ha<sup>-1</sup> is followed for radish. Soil test based fertilizer prescription eliminates over or under usage of fertilizer inputs thereby increase fertilizer use efficiency and yield of crops. Soil testing becomes one of the vital tools in increasing the yield of crops by optimum prescription of fertilizers to crops and maintenance of soil fertility. The relationship between soil available nutrients and yield was outlined by Truog (1960). Ramamoorthy *et al.* (1967) established the fact that there exists a linear

relationship between the nutrient absorbed by the plant and the grain yield or economic produce. A unique field experimental approach (Inductive methodology) on Soil Test Crop Response Correlation studies was evolved through creating a macrocosm of soil fertility variability within a microcosm of an experimental field (Ramamoorthy *et al.*, 1967) by applying graded doses of fertilizers. This provides a scientific basis for balanced fertilization not only between fertilizer nutrients but also with the soil available nutrients. Umadevi (2005) and Vijayalakshmi (2008) established better correlation on soil test crop response correlation studies on carrot and radish respectively. Soil-test-based fertilizer prescription for beetroot was developed on Typic Haplustalf of Tamil Nadu and found to be useful in increasing the yield of beetroot (Santhi *et al.*, 2011).

Hence, the present study has been carried out for radish on Palathurai soil series which is red calcareous in nature. Adoption of the results emanated from the study is possible if it is test verified in farmer's holdings.

#### **Materials and Methods**

Field experiments were carried out during 2009-11 to validate the fertilizer prescription equations developed for radish under IPNS on Palathurai soil series (Typic Haplustalf) in the Southern and Western Zone of Tamil Nadu. The field trials were

conducted in six locations viz., Peedampalli (Rabi-2009) and Kuppepalayam (Coimbatore District) with Pusa Chetki short (Kharif- 2009), Kalipalayam (Coimbatore District) with var Pusa chetki short (Rabi-2010), Perumalkoilpatti (Dindigul District) with var. Super Shakthi (Kharif-2010), Keeranoor (Dindigul district) with var. Poughja 501(Rabi-2011) and Kuppanur (Coimbatore District) with var.Pusa chetki short (Kharif-2011).

Initial soil samples were collected from each plot and analyzed for pH, EC, alkaline KMnO<sub>4</sub>-N (Subbiah and Asija, 1956), Olsen-P (Olsen *et al.*, 1954), NH<sub>4</sub>OAc-K (Standford and English, 1949) and DTPA extractable micronutrients (Lindsay and Norwell, 1978). The initial soil fertility status for different locations are shown in Table 1. Fertilizer prescription equations for radish under IPNS on Palathurai soil series are furnished below:

$$FN = 0.69 T - 0.74 SN - 1.03 ON$$

$$FP_2O_5 = 0.28 T - 1.35 SP - 1.15 OP$$

$$FK_2O = 0.43 T - 0.21 SK - 0.64 OK$$

where, FN, FP<sub>2</sub>O<sub>5</sub> and FK<sub>2</sub>O are fertilizer N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in kg ha<sup>-1</sup> respectively; T = Root yield target in q ha<sup>-1</sup>; SN, SP and SK are available N, P and K in kg ha<sup>-1</sup> respectively; ON, OP and OK are N, P and K supplied through vermicompost in kg ha<sup>-1</sup>

The treatments imposed are as follows: i) Control, ii) Blanket fertilizer dose, iii) STCR based fertilizer dose for an yield target of 40 t ha<sup>-1</sup>, iv) STCR-IPNS based fertilizer dose for an yield target of 40 t

ha<sup>-1</sup>, v) STCR based fertilizer dose for an yield target of 50 t ha<sup>-1</sup>, vi) STCR-IPNS based fertilizer dose for an yield target of 50 t ha<sup>-1</sup> and vii) Farmer's practice. Based on the initial soil test values of available N, P and K and the quantities of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O supplied through vermicompost, fertilizer doses were calculated and applied for STCR treatments for various yield targets (Table 2). Treatments (iii) and (v) received only inorganic fertilizers based on STCR equations developed, while treatment (iv) and (vi) received vermicompost @ 5 t ha<sup>-1</sup> and NPK fertilisers were applied after adjusting the nutrients supplied through vermicompost based on STCR-IPNS equations. Fifty per cent of N and full dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were applied basally and the remaining 50 per cent N was applied on 20 days after sowing and all other packages of practices were carried out periodically. Using the data on root yield and fertilizer doses applied, the parameters viz., per cent achievement {(yield obtained / yield target aimed) x 100} and response ratio (RR) were worked out (Response Ratio = Response in kg ha<sup>-1</sup> / Quantities of fertilizer N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O applied in kg ha<sup>-1</sup>). Post-harvest soil samples were collected and analyzed for available N, P and K status.

## Results and Discussion

### Root yield of radish

The mean root yield of six locations revealed that the highest root yield was recorded in the treatment STCR-IPNS-50 t ha<sup>-1</sup> (50.63 t ha<sup>-1</sup>) followed by STCR-NPK alone -50 t ha<sup>-1</sup> (48.84 t ha<sup>-1</sup>), STCR-

**Table 1. Initial soil fertility status of six locations**

Location	pH	E.C (dSm <sup>-1</sup> )	KMnO <sub>4</sub> -N (Kg ha <sup>-1</sup> )	Olsen -P (Kg ha <sup>-1</sup> )	NH <sub>4</sub> OAc-K (Kg ha <sup>-1</sup> )	DTPA -Zn (mg kg <sup>-1</sup> )	DTPA -Fe (mg kg <sup>-1</sup> )	DTPA -Mn (mg kg <sup>-1</sup> )	DTPA-Cu (mg kg <sup>-1</sup> )
Peedampalli, Coimbatore District	7.65	0.21	266	44.0	440	2.32	5.68	2.54	1.62
Kuppepalayam, Coimbatore District	7.52	0.15	164	56.0	372	1.26	3.46	2.86	1.48
Kalipalayam, Coimbatore District	8.69	0.03	245	52.8	682	0.85	2.74	13.9	1.41
Perumalkoilpatti, Dindigul District	7.80	0.21	254	50	479	1.31	13.0	2.32	6.97
Keeranoor, Dindigul District	7.82	0.20	224	36	225	1.29	11.4	4.23	7.09
Kuppanur, Coimbatore District	8.06	0.03	176	40	693	1.11	12.7	2.56	5.69

IPNS -40 t ha<sup>-1</sup> (38.30 t ha<sup>-1</sup>) and STCR-NPK alone - 40 t ha<sup>-1</sup> (37.21 t ha<sup>-1</sup>) indicating that the STCR -IPNS treatments recorded relatively higher yield over STCR -NPK alone (Table 3) treatments. Blanket recorded

relatively lower yield (32.32 t ha<sup>-1</sup>) as compared to STCR treatments. STCR - IPNS-50 t ha<sup>-1</sup> recorded an yield increase of 56.7 per cent over blanket recommendation and 69.0 per cent over farmer's

**Table 2. Fertilizer doses (kg ha<sup>-1</sup>) imposed in six locations based on fertilizer prescription equation**

Treatment	Peedampalli 2009			Kuppepalayam 2009			Kalipalayam 2010			Perumalkoilpatti 2010			Keeranur 2011			Kuppanur 2011		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blanket	50	100	50	50	100	50	50	100	50	50	100	50	50	100	50	50	100	50
STCR - NPK alone -40 t ha <sup>-1</sup>	79	53	80	155	37	94	95	41	29	88	45	71	110	63	125	146	58	26
STCR - IPNS - 40 t ha <sup>-1</sup>	39	33	55	115	17	69	55	21	25*	48	25	41	55	27	98	91	22	25*
STCR - NPK alone -50 t ha <sup>-1</sup>	148	81	123	224	65	137	164	69	72	157	73	114	179	91	168	215	86	69
STCR - IPNS - 50 t ha <sup>-1</sup>	108	61	98	184	45	112	124	49	47	117	53	84	124	55	141	160	50	42
Farmer's practice	50	65	45	50	75	45	40	75	40	50	70	50	50	60	50	50	75	50

practice (Table 3). Statistical scrutiny of yield data from the six locations revealed that STCR -IPNS-50 t ha<sup>-1</sup> found to record significantly higher root yield over all other treatments. STCR -IPNS-40 t ha<sup>-1</sup> and

STCR-NPK alone-40 t ha<sup>-1</sup> were on par in their effect on root yield whereas blanket recorded significantly lower yield over STCR treatments.

**Table 3. Root yield of radish as influenced by soil testing and yield targeting in six locations**

Treatment	Peedampalli 2009	Kuppepalayam 2009	Kalipalayam 2010	Perumalkoil Patti 2010	Keeranur 2011	Kuppanur 2011	Mean Yield	Mean % increase over blanket	Mean % increase over Farmers practice
	t ha <sup>-1</sup>								
Control	22.50	19.25	21.90	20.90	20.00	19.60	20.69	-	-
Blanket	32.80	30.40	35.50	35.00	30.70	29.50	32.32	-	7.9
STCR-NPK alone - 40 t ha <sup>-1</sup>	37.40	36.85	37.00	36.80	37.80	37.40	37.21	15.1	24.2
STCR - IPNS - 40 t ha <sup>-1</sup>	38.50	38.85	38.20	38.50	38.50	38.00	38.43	18.9	28.3
STCR - NPK alone -50 t ha <sup>-1</sup>	49.70	47.44	49.00	49.40	48.70	48.80	48.84	51.1	63.0
STCR - IPNS -50 t ha <sup>-1</sup>	51.00	50.38	50.20	51.20	50.80	50.20	50.63	56.7	69.0
Farmer's practice	30.60	29.65	30.10	34.00	28.10	27.30	29.96	-	-
Mean	37.50	36.12	37.41	37.97	36.37	35.83			
SEd							0.72		
CD(.05)							1.47		

**Per cent achievement**

The highest per cent achievement of the yield targets was recorded with STCR-IPNS-50 t ha<sup>-1</sup> (101.3) followed by STCR-NPK alone-50 t ha<sup>-1</sup> (97.7), STCR-IPNS-40 t ha<sup>-1</sup> (96.1) and STCR-NPK alone-40 t ha<sup>-1</sup> (93.0) (Table 4). Yield targeting with IPNS

recorded relatively higher per cent achievement than that aimed under their respective NPK alone treatments. In all the six trials, per cent achievement of the targeted yield was within  $\pm 10$  per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for radish.

**Table 4. Per cent achievement of radish yield targets in six locations**

Treatment	Peedampalli 2009	Kuppepalayam 2009	Kalipalayam 2010	Perumalkoil patti 2010	Keeranur 2011	Kuppanur 2011	Mean
Control	-	-	-	-	-	-	-
Blanket	-	-	-	-	-	-	-
STCR-NPK alone - 40 t ha <sup>-1</sup>	93.5	92.1	92.5	92.0	94.5	93.5	93.0
STCR - IPNS - 40 t ha <sup>-1</sup>	96.3	97.1	95.6	96.3	96.3	95.1	96.1
STCR - NPK alone -50 t ha <sup>-1</sup>	99.4	94.9	98.1	98.8	97.4	97.6	97.7
STCR - IPNS -50 t ha <sup>-1</sup>	102.0	100.8	100.3	102.4	101.6	100.4	101.3
Farmer's practice	-	-	-	-	-	-	-

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

The mean RR recorded for various treatments ranged from 55.8 kg kg<sup>-1</sup> in farmer's practice to 81.3 kg kg<sup>-1</sup> in STCR-IPNS-50 t ha<sup>-1</sup> (Table 5). Among the STCR treatments, IPNS recorded relatively higher RR than NPK alone. This might be due to the better use efficiency of applied NPK fertilizers under IPNS.

Blanket recorded 58.1 kg kg<sup>-1</sup>, which was relatively lower than STCR treatments. 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, efficient utilization of applied fertilizer nutrients in the presence of organic sources and the synergistic

**Table 5. Response ratio of radish as influenced by various treatments in six locations**

Treatment	Peedampalli 2009	Kuppepalayam 2009	Kalipalayam 2010	Perumalkoil patti 2010	Keeranur 2011	Kuppanur 2011	Mean
	kg kg <sup>-1</sup>						
Control	-	-	-	-	-	-	-
Blanket	51.5	55.8	68.0	70.5	53.5	49.5	58.1
STCR-NPK alone - 40 t ha <sup>-1</sup>	70.3	61.5	91.5	77.9	59.7	77.4	73.1
STCR - IPNS - 40 t ha <sup>-1</sup>	75.5	68.5	98.8	86.3	62.1	80.0	78.5
STCR - NPK alone -50 t ha <sup>-1</sup>	77.3	66.2	88.9	82.8	65.6	78.9	76.6
STCR - IPNS -50 t ha <sup>-1</sup>	81.0	73.1	92.8	88.1	70.3	82.7	81.3
Farmer's practice	50.6	59.4	52.8	77.1	50.6	44.0	55.8

effect of the conjoint addition of various sources of nutrients. Similar findings were recorded by Muralidharudu *et al.*, (2011) using targeted yield concept in various crops. STCR-IPNS-50 t ha<sup>-1</sup> was found to record the highest B:C ratio of 2.24 followed by STCR-NPK alone-50 t ha<sup>-1</sup> (2.16), STCR-IPNS-

40 t ha<sup>-1</sup> (1.77) and STCR-NPK alone-40 t ha<sup>-1</sup> (1.72) (Table 6). Higher root yield and response ratio were recorded with STCR-IPNS followed by STCR-NPK alone in a red calcareous soil for beetroot and radish as compared to blanket and farmer's practice (Santhi *et al.*, 2011a; Poongothai *et al.*, 2011).

**Table 6. Benefit cost ratio of radish yield in six locations**

Treatment	Peedampalli 2009	Kuppepalayam 2009	Kalipalayam 2010	Perumalkoil patti 2010	Keeranur 2011	Kuppanur 2011	Mean
Control	1.13	1.09	1.10	0.92	0.83	1.11	1.03
Blanket	1.51	1.58	1.64	1.41	1.17	1.53	1.47
STCR-NPK alone - 40 t ha <sup>-1</sup>	1.75	1.91	1.75	1.51	1.43	1.94	1.72
STCR - IPNS - 40 t ha <sup>-1</sup>	1.80	2.02	1.81	1.58	1.45	1.98	1.77
STCR - NPK alone - 50 t ha <sup>-1</sup>	2.23	2.36	2.22	1.94	1.76	2.43	2.16
STCR - IPNS -50 t ha <sup>-1</sup>	2.29	2.51	2.28	2.02	1.84	2.50	2.24
Farmer's practice	1.44	1.56	1.42	1.40	1.10	1.44	1.39

**Post-harvest soil fertility**

The data on KMnO<sub>4</sub>-N, Olsen-P and NH<sub>4</sub>OAc-K indicated the built up and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS. Despite higher removal of nutrients,

the fertility status was maintained in STCR-IPNS as compared to STCR-NPK alone (Table 7). This might be attributed to the prevention of losses of nutrients under IPNS, even after meeting the crop needs. Greater profit consistent with maintenance of soil fertility status is realised when fertiliser is applied

**Table 7. Post- harvest soil fertility as influenced by various treatments in six locations**

Treatment	Peedampalli 2009			Kuppepalayam 2009			Kalipalayam 2010			Perumalkoilpatti 2010			Keeranur 2011			Kuppanur 2011		
	SN	SP	SK	SN	SP	SK	SN	SP	SK	SN	SP	SK	SN	SP	SK	SN	SP	SK
	Kg ha <sup>-1</sup>																	
Control	242	36.2	402	152	48.0	368	230	47.2	653	237	45.3	453	208	30.0	210	160	36.0	675
Blanket	256	38.6	441	165	56.2	376	251	54.6	685	260	52.9	483	238	34.5	236	191	39.0	690
STCR - NPK alone -40 t ha <sup>-1</sup>	275	45.5	452	172	59.0	395	257	56.5	690	265	53.0	486	243	36.1	247	196	41.6	711
STCR - IPNS - 40 t ha <sup>-1</sup>	278	46.8	458	179	61.5	418	259	59.3	694	269	55.9	491	247	37.9	252	201	43.9	716
STCR - NPK alone -50 t ha <sup>-1</sup>	283	48.2	462	184	63.0	422	261	58.7	699	271	58.2	495	252	39.5	259	204	45.1	723
STCR - IPNS -50 t ha <sup>-1</sup>	289	50.8	469	189	64.6	429	265	61.7	702	276	60.4	503	256	44.1	264	207	47.5	727
Farmer's practice	248	39.6	438	166	66.2	370	250	49.5	684	257	48.3	481	235	32.2	228	188	33.2	688
Initial values	266	44	440	164	56	372	245	52.8	682	254	50	479	224	36	225	176	40	693

for appropriate yield targets in succession over years using STCR-IPNS concept (Ramamoorthy and Velayutham, 2011). Gupta and Jagannath (1998) reported that the application of FYM in conjunction with chemical fertilizers will not only increase the productivity of all the cropping sequences but also improve the soil fertility.

**Conclusion**

The per cent achievement of the targeted yield was within  $\pm 10$  per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for radish on red calcareous soils. The highest mean yield, RR, per cent achievement and BCR were recorded with STCR – IPNS- 50 t ha<sup>-1</sup> followed by STCR- NPK alone- 50 t ha<sup>-1</sup>. The post-harvest soil available N, P, and K status indicated the build up and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS. Therefore fertilizer prescription equations developed for radish under IPNS can be recommended for red calcareous soils of Tamil Nadu for achieving yield target of 50 t ha<sup>-1</sup> with sustained soil health.

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