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RESEARCH ARTICLE :

Evaluation of soil test and yield target based fertilizer prescription model for brinjal on an alfisol

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SUMMARY : Field experiments were conducted in Western Zone (Thondamuthur block, Coimbatore Dt.) 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 brinjal on red non calcareous soils (Palaviduthi series-TypicRhodustalf). The treatments include control, blanket recommendation, soil test crop response (STCR) based fertilizer dose for a yield target of 30 t ha^{-1}, 35 t ha^{-1} and 40 t ha^{-1}, STCR-IPNS based fertilizer dose for a yield target of 30 t ha^{-1}, 35 t ha^{-1} and 40 t ha^{-1}and farmer's practice. The results of the experiments indicated that, in the evaluation experiment, the per cent achievement of the targeted yield was within ± 10 per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for brinjal. The highest mean per cent achievement was recorded with STCR - IPNS - 350 t ha^{-1} (105.0) followed by STCR-INS30 t ha^{-1} (102.9). Among the treatments, STCR-IPNS-35 t ha^{-1} of brinjal has proved its superiority and recorded a yield increase of 23.7 and 45.3 per cent, respectively over blanket and farmer's practice. The increase in response ratio due to STCR-IPNS-35 t ha^{-1} over blanket and farmer's practice was 4.71 and 19.57 kg kg^{-1}, respectively and that of BCR was 0.62 and 0.90, respectively. Among the treatments, STCR-IPNS-30 t ha^{-1} recorded relatively higher Response Ratio (97.37 kg kg^{-1}) and STCR-IPNS-35 t ha^{-1}BCR in (3.01) than other treatments. Post-harvest soil available NPK indicated the buildup and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS.

KEY WORDS :
Alfisol, Fertilizer prescription, Brinjal, STCR-IPNS

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BACKGROUND AND OBJECTIVES

There is an increasing concern about the sustainability of Indian agriculture because of deterioration in soil fertility. Importance of soil in supplying plant nutrients is known since the beginning of agriculture. The concept was more convincingly advocated since Liebig's time around 1840, when many methods have been tried to get precise basis for estimating soil nutrient supplying capacity and predicting the fertilizer requirements of crops. It is therefore essential that nutrient supplying capacity of soil be continuously monitored to ensure and improve sustainability of agriculture (Dhinesh and Santhi, 2015).Though, India has become second largest consumer of fertilisers in the world, the per hectare fertiliser use in India is relatively low as compared to many other countries and the NPK use ratio is highly imbalanced (8.0:2.7:1 in 2013-14 *vs* an optimum ratio of 4:2:1). These issues have led to widespread negative nutrient balance in most Indian soils (Srivastava, 2015).At present, there are signs of fatigue ness in crop productivity, decline in response ratio, loss of nutrients during crop production cycle, escalating cost of fertilisers and wide diversity in fertiliser use in different parts of our country which are to be relooked so as to achieve higher crop productivity with sustained soil health. Owing to these reasons, ensuring higher fertiliser use efficiency by farmers at large is still to be realized. In this context, soil fertility evaluation plays a major role for mitigating the above issues and provides valuable guidance to various stakeholders for judicious fertiliser use. 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-testbased fertilizer prescription for beetroot was developed on Typic Haplustalf of Tamil Nadu and found to be useful in increasing the yield of brinjal (Dhinesh and Santhi, 2015). Hence, the present study has been carried out for brinjal, to validate the fertilizer prescription equation on farmers' holdings (Palaviduthi soil series).

RESOURCES AND METHODS

Field experiments were carried out during 2015 to validate the fertilizer prescription equations developed for brinjal under IPNS on Palaviduthi soil series (TypicHaplustalf) in the Western Zone of Tamil Nadu. The field trial was conducted in Kuppanur village of Coimbatore District with var. CO (B) 2.Initial soil samples were collected from each plot and analyzed for pH, EC, alkaline KMnO4-N (Subbiah and Asija, 1956), Olsen-P (Olsen *et al*., 1954), NH4OAc-K (Standford and English, 1949) and DTPA extractable micronutrients (Lindsay and Norwell, 1978). The initial soil fertility status for experimental field and fertilizer prescription equations for brinjal under IPNS on Palaviduthi soil series are shown in Table A.

Where, FN, $FP_2O_5$and FK_2O are fertilizer N, $P_2O_5$and K_2O in kg ha^{-1}, respectively; T = fruit 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 FYM in kg ha^{-1}.

The experiment was laid out in Randomized Block Design with three replications, comprising nine treatments *viz*., blanket recommendation, STCR-NPK alone for 30, 35 and 40 t ha^{-1} yield targets, STCR-IPNS for 30, 35 and 40 t ha^{-1} yield targets, farmer's practice and absolute control. The fertiliser doses were computed using the fertiliser prescription equations developed under NPK alone and under IPNS. For STCR-IPNS treatments, FYM was applied @ 12.5 t ha^{-1} basally and the quantity of NPK contributed through FYM (with 26 % moisture, 0.68 %, 0.33 % and 0.62 % NPK, respectively) was adjusted from the inorganic fertiliser doses. The fertiliser doses applied for various treatments are furnished in Table A. Using the data on fruit 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^{-1} / Quantities of fertilizer N, P_2O_5 and K_2O applied in kg ha^{-1}). Post harvest soil samples were collected and analyzed for available N, P and K status. The test crop brinjal (*var*. CO 2) was planted with a spacing of 60 cm x 60 cm in plots of area 36 m^2 (6 m x 6 m). All the agronomic practices were carried out periodically and

Table A : Fertilizer prescription equation and initial soil test value for red non calcareous for Typic Haplustalf

Fertilizer Prescription equations	Major nutrients (kg ha^{-1})			Micronutrients (mg kg^{-1})		
FN = 0.69 T – 0.72 SN – 0.64 ONss	$KMnO_4$-N	:	190	DTPA-Zn	:	0.87
FP_2O_5 = 0.41 T – 3.57 SP – 0.72 OP	Olsen-P	:	16.5	DTPA-Fe	:	3.90
FK_2O = 0.65 T – 0.34 SK – 0.52 OK	NH_4OAc-K	:	478	DTPA-Mn	:	4.20
				DTPA-Cu	:	0.82

the crop was grown to maturity. At maturity, fruit samples were collected on five randomly selected plants of each replication to analyze for nutrient content and uptake of N, P and K were computed. At each harvest, the fruit yield was recorded plot wise.

OBSERVATIONS AND ANALYSIS

The STCR treatments showed a remarkable influence on the fruit yield of brinjal as compared to other treatments. The yield ranged from 14.60 t ha^{-1} in absolute control to 37.30 t ha^{-1} in STCR-IPNS-40 t ha^{-1}. The yield recorded under STCR-NPK alone treatments for the targets of 30, 35 and 40 t ha^{-1} were 29.80, 35.85 and 36.74 t ha^{-1}, respectively. The corresponding yields obtained under STCR-IPNS treatments were 30.86, 36.75 and 37.30 t ha^{-1}, respectively. Though STCR-IPNS-40 t ha^{-1} had registered numerically higher yield (37.30 t ha^{-1}), it was statistically on par with STCR-IPNS-35 t ha^{-1} (36.75 t ha^{-1}) and also with STCR-NPK alone - 40 t ha^{-1} and STCR-NPK alone-35 t ha^{-1}. In all the yield targets, STCR-IPNS recorded numerically higher yield over their respective STCR-NPK alone treatments. Increased vegetative growth and balanced C: N ratio due to organic manure might have increased the synthesis of carbohydrates which ultimately promoted the yield of vegetable fruits. These findings were supported by Yadav *et al*. (2004), Mohammad *et al.* (2010) and Shilpi*et al.* (2014) wherein the integrated use of inorganic fertilisers and organic manures could able to support the plant growth and yield of brinjal. In the present investigation also, these factors might have contributed for the yield enhancement in brinjal when NPK fertilisers were coupled with FYM. The per cent achievement recorded under the present investigation ranged from 91.9 in STCR-NPK alone - 40 t ha^{-1} to 105.0 in STCR-IPNS - 35 t ha^{-1} and proved the validity of the fertiliser prescription equations for brinjal at all the three yield target levels under both STCR-NPK alone and IPNS. The highest achievement of the yield targets was recorded with STCR-IPNS - 35 t ha^{-1} (105.0 %) followed by STCR-IPNS - 30 t ha^{-1} (102.9 %) and STCR-NPK alone - 35 t ha^{-1} (102.4 %). This might be due to the better use efficiency of applied NPK fertilisers at low yield target levels (Milap Chand *et al.*, 2006, Bera *et al.*, 2006 and Dhillon *et al.*, 2006).The response ratio (RR) recorded for various treatments ranged from 69.03 kg kg^{-1} in farmer's practice to 97.37 kg kg^{-1} in STCR-IPNS-30 t ha^{-1} followed by STCR-NPK alone-30 t ha^{-1} (89.22 kg kg^{-1}) and STCR-IPNS-35 t ha^{-1}(88.60 kg kg^{-1}). While blanket recommendation recorded 83.89 kg kg^{-1}, which is relatively lower as compared to the STCR-NPK alone treatments whose RR were 89.22 and85.00 kg kg^{-1},respectively for 30 and 35 t ha^{-1} yield targets. The increase in RR due to STCR-IPNS-35 t ha^{-1} over blanket was 4.71 kg kg^{-1} and over farmer's practice was 19.57 kg kg^{-1}. It was evident from the data that lower yield targets (30 and 35 t ha^{-1}) were better achieved than the higher yield target (40 t ha^{-1}) under both NPK alone and IPNS. The benefit cost ratio (BCR) indicated that the highest value was obtained in STCR- IPNS-35 t ha^{-1} (3.01) followed by STCR-IPNS - 40 t ha^{-1} (2.99). The BCR of blanket recommendation and farmer's practice was 2.39 and 2.11, respectively, which is lower than all the STCR treatments. The increase in benefit cost ratio (BCR) due to STCR-IPNS-35 t ha^{-1} over blanket and farmer's practice was 0.62 and 0.90, respectively. Similar

Table 1 : Results of validation experiment on Brinjal

Sr. No.	Treatments	FYM (t ha^{-1})	Fertiliser doses (kg ha^{-1}) N	P_2O_5	K_2O	Yield (t ha^{-1})	Per cent achievement	RR (kg kg^{-1})	BCR
T_1	Blanket	25.0	100	50	30	29.70	-	83.89	2.39
T_2	STCR-NPK alone-30 t ha^{-1}	-	70	64	33	29.50	98.3	89.22	2.49
T_3	STCR-NPK alone-35 t ha^{-1}	-	105	85	60**	35.85	102.4	85.00	2.95
T_4	STCR-NPK alone-40 t ha^{-1}	-	139	100**	60**	36.74	91.9	74.05	2.97
T_5	STCR -IPNS- 30 t ha^{-1}	12.5	50*	42	15*	30.86	102.9	97.37	2.56
T_6	STCR -IPNS- 35 t ha^{-1}	12.5	65	63	35	36.75	105.0	88.60	3.01
T_7	STCR -IPNS- 40 t ha^{-1}	12.5	99	83	60**	37.30	93.3	75.92	2.99
T_8	Farmer's Practice	5.0	85	45	25	25.30	-	69.03	2.11
T_9	Absolute control	0	0	0	0	14.60	-	-	1.27
	S.E. ±					0.69			
	C.D. (P=0.05)					1.48			

trend of superiority of STCR-IPNS over farmer's practice in terms of BCR was reported by Malawadi *et al.* (2004), Meena *et al.* (2012) and Pandey and Chandra, (2013) in tomato and Shilpi *et al.* (2014) in brinjal. Among STCR treatments, the RR and BCR of STCR-IPNS was higher than their respective STCR-NPK alone treatments. Chatterjee *et al.* (2010), Khosa *et al.* (2012) and Sellamuthu *et al.* (2013) also reported the superiority of the target yield concept over other practices for various crops as it gave higher yields and optimal economic returns. Regarding the uptake of N, P and K the range was from 20.2, 6.2 and 42.5 kg ha^{-1},respectively in absolute control to 160.0, 36.0 and 151.5 kg ha^{-1} in STCR-IPNS-40 t ha^{-1}. However, the N, P and K uptake values of STCR-IPNS - 40 t ha^{-1} was on par with STCR-IPNS-35 t ha^{-1} (158.8, 35.8 and 151.0 kg ha^{-1}, respectively). At higher yield targets, STCR-IPNS recorded numerically higher N, P and K uptake over respective STCR-NPK alone treatments (Table 2). The results have clearly brought out the fact that the STCR treatments except STCR-NPK alone-30 t ha^{-1} recorded significantly higher nutrient uptake over blanket recommendation (92.0, 20.0 and 119.5 kg N, P and K ha^{-1}, respectively). Both blanket and STCR treatments excelled farmer's practice (54.3, 10.5 and 95.8 kg N, P and K ha^{-1}, respectively).Though STCR-IPNS-40 t ha^{-1} recorded higher nutrient uptake, it was comparable to STCR-IPNS-35 t ha^{-1}. All the STCR-IPNS treatments recorded higher uptake as compared to their corresponding STCR-NPK alone treatments. All the STCR treatments (except STCR-NPK alone - 30 t ha^{-1}) proved to be superior to blanket recommendation and farmer's practice. This might be due to balanced supply of nutrients, efficient utilization of applied fertiliser nutrients in the presence of organic sources and the synergistic effect of the conjoint addition of various sources of nutrients (Bharamappa *et al.* (2009), Mohan Kumar and Naresh Gowda (2010) and Ugade *et al.* (2014).

According to Velayutham *et al.* (1984), if the targeted yield was achieved within ± 10 per cent variation, then the equations are found to be valid. The results of the validation experiment on brinjal clearly indicated that the per cent achievement was within ± 10 per cent (90 - 110 %) variation at all yield target levels proving the validity of the fertiliser prescription equations for brinjal.

Conclusion:

The per cent achievement of the targeted yield was within ±10 per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for brinjal on red non calcareous soils. The highest mean yield was obtained with STCR – IPNS- 40 t ha^{-1}. However, per cent achievement and BCR were recorded with STCR – IPNS- 35 t ha^{-1}followed by STCR- IPNS-30 t ha^{-1} in STCR-IPNS- 40 t ha^{-1} in per cent achievement and BCR, respectively. The post harvest soil available N, P, and K status indicated the buildup and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS. Therefore, fertilizer prescription equations developed for brinjal under IPNS can be recommended for red non calcareous soils of Tamil Nadu for achieving yield target of 30 t ha^{-1} with sustained soil health.

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Table 2 : Effect of various treatments on total N, P and K uptake by brinjal

Sr. No.	Treatments	Nutrient uptake (kg ha^{-1})		
		N	P	K
T_1	Blanket	92.0	20.0	119.5
T_2	STCR-NPK alone-30 tha^{-1}	86.5	18.3	111.0
T_3	STCR-NPK alone-35 t ha^{-1}	156.2	34.8	149.0
T_4	STCR-NPK alne-40 t ha^{-1}	158.5	35.2	150.3
T_5	STCR -IPNS- 30 t ha^{-1}	103.6	26.4	126.2
T_6	STCR -IPNS- 35 t ha^{-1}	158.8	35.8	151.0
T_7	STCR -IPNS- 40 t ha^{-1}	160.0	36.0	151.5
T_8	Farmer's Practice	54.3	10.5	95.8
T_9	Absolute control	20.2	6.2	42.5
	S.E.	1.43	0.91	2.04
	C.D. (P=0.05)	3.0	1.9	4.3

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