Int.J.Curr.Microbiol.App.Sci (2018) *7*(9): 2131-2139

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 09 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.709.261

Validation of Soil Test and Yield Target Based Fertiliser Prescription Model for Hybrid Maize on Vertisol

R. Suresh* and R. Santhi

Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India

**Corresponding author*

Keywords

Vertisol, Maize, STCR-IPNS, Validation and Yield

Article Info

Accepted:
16 August 2018
Available Online:
10 September 2018

A B S T R A C T

Field experiments were conducted at three different locations in southern zone of Tamil Nadu to validate the fertiliser prescription developed from Soil test Crop Response correlation under Integrated Plant Nutrition System (STCR-IPNS) for maize on vertisol based on Inductive cum Targeted yield model. The treatments include control, blanket recommendation (100% RDF), blanket recommendation (NPK+FYM @ 12.5t ha^{-1}), soil test crop response (STCR) based fertilizer dose for an yield target of 9.0, 10.0 and 11.0 t ha^{-1}, STCR-IPNS based fertilizer dose for an yield target of 9.0, 10.0 and 11.0 t $ha^{-1}$and farmer's practice. The N, P and K fertilizer for different targets was calculated based on the initial soil test values of the respective locations. The cultivation practices were carried out periodically and the grain yield was recorded at harvest. Using the data on grain yield and fertilizer doses applied, parameters *viz.*, per cent achievement, response ratio (RR) and benefit: cost ratio (BCR) were computed. The results revealed that the targeted yield has been achieved within +/-10 per cent variation proving the validity of the equations. The range and mean values of the three validation experiments indicated that the highest mean grain yield of maize was recorded with STCR-IPNS-11t ha^{-1} (11.08 t ha^{-1}) followed by STCR-IPNS-10 t ha^{-1} (10.15 t ha^{-1}). Though the highest response ratio of 14.44 kg kg^{-1} was recorded in STCR-IPNS-9 t ha^{-1}, the highest BCR was recorded in STCR-IPNS-11 t ha^{-1} (2.26). The mean increase in yield due to STCR-IPNS-11 t ha^{-1} was 39.7 per cent over blanket (100% RDF), 17.6 per cent over blanket + FYM@ 12.5t ha^{-1} and 59.6 per cent over farmer's practice. Farmer's practice recorded relatively lower yield and response ratio as compared to blanket and STCR treatments while the STCR-IPNS treatments recorded the highest per cent achievement and response ratio over farmer's practice. Therefore the fertilizer prescription equations developed for hybrid maize on Pilamedu soil series (Typic Haplustert) for achieving 11t ha^{-1} can be adapted to similar and allied series in other agro-climatic zones of Tamil Nadu.

Introduction

Fertilizer is one of the key inputs for achieving the estimated food grain production of our country. The indiscriminate use of fertilizers by the farmer without knowing the crop requirement and fertility status of the soil leads to the adverse effect on soil health and crop productivity. The escalating cost coupled with increasing demand on inorganic

fertilizers and depletion of soil health necessitates the safe and efficient method of fertilizer application. Maize (*Zea mays* L.), one of the important millet crops grown in India is an exhaustive crop and the nutritional requirement cannot be met with the native nutrient reserves. Therefore, additional nutritional requirement can be met by external fertilizer application. Soil testing is one of the most efficient tool for optimum as well as balanced fertilization (Kumar *et al.,* 2013). To determine the optimum fertilizer doses, the most appropriate method is to apply fertilizer doses based on soil test crop response under Integrated Plant Nutrition System studies (Singh *et al.,* 2012). Soil testing becomes one of the vital tool for providing optimum dose of fertilizers to crops, thus maintaining the soil fertility. Soil test based fertilizer prescription eliminates over or under usage of fertilizers thereby increasing the fertilizer use efficiency and yield of crops. The Inductive cum Targeted yield concept developed by Ramamoorthy *et al.,* (1967) established the theoretical basis and experimental technique to suit the Indian soil and climatic conditions. The fertilizer prescription developed from soil test crop response under Integrated Plant Nutrition System is to be validated at farmer's holdings on similar soil series. With this background, the present investigation was undertaken to validate the fertiliser prescription equations developed for maize on Pilamedu series (Typic Haplustert) at north-western and southern zones of Tamil Nadu.

Materials and Methods

Field experiments were conducted during *Kharif* 2017 to validate the fertilizer prescription equation developed for hybrid maize (TNAU maize hybrid CO 6) at three locations, *viz*. Kottur Avarampatti village of Dindigul district (Southern zone), Devaiyur of Perambalur district (North western zone) and Bathrakalipuram of Theni district (Southern zone). The fertilizer prescription equations developed for desired yield target of maize for Pilamedu soil series are furnished below.

STCR-NPK alone

FN=3.78T-0.78 SN
F P_2O_5=1.47 T- 2.02 SP
F K_2O = 1.79 T-0.14 SK

STCR-IPNS (NPK+FYM)

FN =3.78 T-0.78 SN-0.89 ON
FP_2O_5 =1.47 T- 2.02 SP -0.91 OP
FK_2O = 1.79 T-0.14 SK -0.62 OK

Where, FN, FP_2O_5 and FK_2O are fertilizer N, P_2O and K_2O in kg ha^{-1} respectively. T is the yield targeted in q ha^{-1}; SN, SP and SK are soil available N, P and K in kgha^{-1} respectively; ON, OP and OK are N, P and K supplied through FYM in kg ha^{-1}.

The validation experiments were laid out in Randomised block design with three replications. The treatments imposed were as follows (i).Blanket fertilizer dose (100% RDF (250:75:75 kg N, P_2O_5 and K_2O)), (ii) Blanket + FYM @12.5tha^{-1}, (iii) STCR based fertilizer dose for an yield target of - 9t ha^{-1} (iv) STCR based fertilizer dose for an yield target of-10t ha^{-1} (v) STCR based fertilizer dose for an yield target of-11tha^{-1}, (vi) STCR-IPNS based fertilizer dose for an yield target of 9t ha^{-1}, (vii) STCR-IPNS based fertilizer dose for an yield target of10t ha^{-1}, (viii) STCR-IPNS based fertilizer dose for an yield target of 11t ha^{-1}, (ix) farmer's practice and (x) Absolute control. Initial soil samples were collected in each location and analysed for alkaline $KMnO_4$-N (Subbiah and Asija, 1956), Olsen-P (Olsen *et al.,* 1954) and NH_4OAc-K (Hanway and Heidal, 1952).The fertility status of the soil indicated that the $KMnO_4$-N ranged from 175 to 198 kg ha^{-1}, Olsen-P from 12-13 kg ha^{-1} and NH_4OAc-K from 380-584 kg ha^{-1} (Table

1). Based on the initial soil test values, the fertilizer doses were calculated and applied (Table 1, 2 and 3). The test crop TNAU maize hybrid CO 6 was raised during *Kharif* 2017 and the grain yield was recorded at harvest. Using the data on grain yield and fertilizer dose applied, the parameters, *viz*., percent achievement {(yield obtained/yield targeted) × 100} and response ratio (RR) were worked out (Response ratio=response in kg ha^{-1}/quantities of fertilizer N, P_2O and K_2O applied in kg ha^{-1}). BCR (B: C ratio) was worked out based on the standard procedure (Gittinger, 1982). The details of fertiliser doses applied, grain yield, percent achievement, response ratio and BCR are furnished in tables 1, 2 and 3.

Results and Discussion

At Devaiyur, the highest grain yield of maize was recorded with STCR-IPNS-11 t ha^{-1} (11.19 t ha^{-1}) followed by STCR-IPNS-10 t ha^{-1} (10.24 t ha^{-1}).The highest response ratio was recorded inSTCR-IPNS-9 t ha^{-1} (14.49 kg kg^{-1}) followed by STCR-IPNS-10 t ha^{-1} (14.15 kg kg^{-1}) and STCR-IPNS-11 t ha^{-1} (14.07 kg kg^{-1}) while the highest BCR was recorded in STCR-IPNS-11 t ha^{-1} (2.26). The increase in yield due to STCR-IPNS-11 t $ha^{-1}$was 39.4 per cent over blanket (100% RDF), 17.9 per cent over blanket+FYM@12.5tha^{-1} and 60.3 per cent over farmer's practice (Table 1).

At Kottur Avarampatti, the highest grain yield of maize was recorded with STCR-IPNS-11 t ha^{-1} (11.06 t ha^{-1}) followed by STCR-IPNS-10 t ha^{-1} (10.13 t ha^{-1}). The highest response ratio was recorded in STCR-IPNS-9 t ha^{-1} (14.07 kg kg^{-1}) followed by STCR-IPNS-10 t ha^{-1} (13.75 kg kg^{-1}) and STCR-IPNS-11 t ha^{-1} (13.72kg kg^{-1}). Similar trend of superiority was reported by Coumaravel *et al.*, (2013) in maize, Debarathi Bhaduri and Poonam Gautam (2013) in wheat. The highest BCR was recorded in STCR-IPNS-11 t ha^{-1} (2.28). Similar results were also reported by Manish Singh *et al.*, (2017). The increase in yield due to STCR-IPNS-11 t ha^{-1} was 39.8 per cent over blanket (100% RDF), 18 per cent over blanket+ FYM @12.5tha^{-1} and 59.0 per cent over farmer's practice (Table 2).

At Bathrakalipuram, the highest grain yield of maize was recorded with STCR-IPNS-11 t ha^{-1} (11 t ha^{-1}) followed by STCR-IPNS-10 t ha^{-1} (10.1 t ha^{-1}). The highest response ratio was recorded in STCR-IPNS-9 t ha^{-1} (14.79 kg kg^{-1}) followed by STCR-IPNS-10 t ha^{-1} (14.26 kg kg^{-1}) and STCR-IPNS-11 t ha^{-1} (14.07 kg kg^{-1}) while the highest BCR was recorded in STCR-IPNS-11 t ha^{-1} (2.27). The increase in yield due to STCR-IPNS-11 t ha^{-1} was 39.9 per cent over blanket (100% RDF), 16.9 per cent over blanket+FYM@12.5tha^{-1} and 59.6 per cent over farmer's practice (Table 3).

The results emanated from all the locations revealed that the targeted yield has been achieved within +/- 10 per cent variation proving the validity of the equations (Table 4). Similar results were reported by Santhi *et al.*, (2011) in beetroot and Sharma *et al.*, (2015) for pearl millet. The range and mean values of the three validation experiments indicated that the highest mean grain yield of maize was recorded with STCR-IPNS-11 t ha^{-1} (11.08 t ha^{-1}) followed by with STCR-IPNS-10 t ha^{-1} (10.15 t ha^{-1}). However, the yields recorded in STCR-IPNS were on par with their respective STCR-NPK alone treatments.

Though the highest response ratio of 14.44 kg kg^{-1} was recorded in STCR-IPNS-9 t ha^{-1}, the highest BCR was in recorded in STCR-IPNS-11tha^{-1} (2.26). This might be due to the better use efficiency of applied NPK fertilizers under IPNS. Similar findings were recorded by Sellamuthu *et al.*, (2015). The mean increase in yield due to STCR-IPNS-11 t ha^{-1} was 39.7 per cent over blanket (100% RDF), 17.6 per cent over blanket + FYM@12.5tha^{-1} and 59.6 per cent over farmer's practice.

Table.1 Results of validation experiment on maize

Location					
Village	:	Devaiyur	Hybrid	:	**TNAU Maize Hybrid CO 6**
Block	:	Perambalur	Soil	:	**Pilamedu series (Typic Haplustert)**
Taluk	:	Perambalur	D/P:	:	**31.08.2017**
District	:	**Perambalur**	**D/H:**	:	**18.12.2017**

Sl. No.	Treatments	FYM (t ha^{-1})	Fertiliser doses (kg ha^{-1})			Grain Yield (kg ha^{-1})	Per cent achieve-ment	RR (kg kg^{-1})	BCR
			FN	FP_2O_5	FK_2O				
T_1	Blanket (100 % RDF)	-	250	75	75	8025	-	11.20	**1.88**
T_2	Blanket + FYM @ 12.5 t ha^{-1}	12.5	296	101	108	9490	-	11.77	**2.05**
T_3	STCR-NPK alone-9.0 t ha^{-1}	-	186	108	108	9110	101.2	13.84	**2.04**
T_4	STCR-NPK alone-10.0 t ha^{-1}	-	224	123	126	9885	98.9	13.40	**2.12**
T_5	STCR-NPK alone-11.0 t ha^{-1}	-	261	138	144	10750	97.7	13.27	**2.22**
T_6	STCR-IPNS-9.0 t ha^{-1}	12.5	140	82	75	9370	104.1	14.49	**2.08**
T_7	STCR-IPNS-10.0 t ha^{-1}	12.5	178	97	93	10240	102.4	14.15	**2.18**
T_8	STCR-IPNS-11.0 t ha^{-1}	12.5	215	112	111	11188	101.7	14.07	**2.26**
T_9	Farmer's Practice	0	240	75	0	6980	-	10.90	**1.60**
T_{10}	Absolute control	0	0	0	0	3546	-	-	**1.08**
				SEd		268			
				CD (P = 0.05)		**563**			

*maintenance dose

Fertilizer Prescription equations	Major Nutrients (kg ha^{-1})		
FN = 3.78T-0.78SN-0.89ON	$KMnO_4$-N	:	**198**
FP_2O_5 = 1.47T-2.02SP-0.91OP	Olsen-P	:	**12**
FK_2O = 1.79T-0.14SK-0.62OK	**NH_4OAc-K**	**:**	**380**

Table.2 Results of validation experiment on Maize

Location					
Village	:	KotturAvarampatti	Hybrid	:	**TNAU Maize Hybrid CO 6**
Block	:	Dindigul	Soil	:	**Pilamedu series (TypicHaplustert)**
Taluk	:	Dindigul	D/P:	:	**05.09.2017**
District	:	**Dindigul**	**D/H:**	:	**22.12.2017**

Sl. No.	Treatments	FYM (t ha^{-1})	Fertiliser doses (kg ha^{-1})			Grain Yield (kg ha^{-1})	Per cent achieve-ment	RR (kg kg^{-1})	BCR
			FN	FP_2O_5	FK_2O				
T_1	Blanket (100 % RDF)	-	250	75	75	7910	-	10.82	**1.86**
T_2	Blanket + FYM @ 12.5 t ha^{-1}	12.5	298	99	107	9375	-	11.49	**2.03**
T_3	STCR-NPK alone-9.0 t ha^{-1}	-	218	108	79	9015	100.2	13.41	**2.04**
T_4	STCR-NPK alone-10.0 t ha^{-1}	-	256	123	97	9780	97.8	13.02	**2.13**
T_5	STCR-NPK alone-11.0 t ha^{-1}	-	293	137	115	10640	96.7	12.95	**2.22**
T_6	STCR-IPNS-9.0 t ha^{-1}	12.5	170	84	47	9280	103.1	14.07	**2.08**
T_7	STCR-IPNS-10.0 t ha^{-1}	12.5	208	99	65	10125	101.3	13.75	**2.17**
T_8	STCR-IPNS-11.0 t ha^{-1}	12.5	245	113	83	11060	100.5	13.72	**2.28**
T_9	Farmer's Practice	0	225	95	0	6955	-	10.54	**1.56**
T_{10}	Absolute control	0	0	0	0	3582	-	-	**1.09**
				SEd		264			
				CD (P = 0.05)		**555**			

*maintenance dose

Fertilizer Prescription equations	Major Nutrients (kg ha^{-1})		
FN = 3.78T-0.78SN-0.89ON	$KMnO_4$-N	:	**185**
FP_2O_5 = 1.47T-2.02SP-0.91OP	Olsen-P	:	**13**
FK_2O = 1.79T-0.14SK-0.62OK	**NH_4OAc-K**	**:**	**550**

Table.3 Results of validation experiment on Maize

Location					
Village	:	Bathrakalipuram	Hybrid	:	**TNAU Maize Hybrid CO 6**
Block	:	Bodi	Soil	:	**Pilamedu series (Typic Haplustert)**
Taluk	:	Bodi	D/P:	:	**16.09.2017**
District	:	**Theni**	**D/H:**	:	**04.01.2018**

Sl. No.	Treatments	FYM (t ha^{-1})	Fertiliser doses (kg ha^{-1})			Grain Yield (kg ha^{-1})	Per cent achieve-ment	RR (kg kg^{-1})	BCR
			FN	FP_2O_5	FK_2O				
T_1	Blanket (100 % RDF)	-	250	75	75	7845	-	10.88	**1.84**
T_2	Blanket + FYM @ 12.5 t ha^{-1}	12.5	298	98	106	9392	-	11.75	**2.03**
T_3	STCR-NPK alone-9.0 t ha^{-1}	-	203	108	79	8982	99.8	14.07	**2.05**
T_4	STCR-NPK alone-10.0 t ha^{-1}	-	241	123	97	9755	97.6	13.58	**2.13**
T_5	STCR-NPK alone-11.0 t ha^{-1}	-	279	138	115	10560	96.0	13.28	**2.21**
T_6	STCR-IPNS-9.0 t ha^{-1}	12.5	155	85	48	9262	102.9	14.79	**2.08**
T_7	STCR-IPNS-10.0 t ha^{-1}	12.5	193	100	66	10070	100.7	14.26	**2.17**
T_8	STCR-IPNS-11.0 t ha^{-1}	12.5	231	115	84	10978	99.8	14.07	**2.27**
T_9	Farmer's Practice	0	230	100	0	6880	-	10.26	**1.53**
T_{10}	Absolute control	0	0	0	0	3495	-	-	**1.07**
				SEd		243			
				CD (P = 0.05)		**511**			

*maintenance dose

Fertilizer Prescription equations	Major Nutrients (kg ha^{-1})		
FN = 3.78T-0.78SN-0.89ON	$KMnO_4$-N	:	**175**
FP_2O_5 = 1.47T-2.02SP-0.91OP	Olsen-P	:	**12**
FK_2O = 1.79T-0.14SK-0.62OK	**NH_4OAc-K**	**:**	**584**

Table.4 Range and mean values of validation experiments on maize

Sl. No	Treatments	Fertiliser doses(kg ha^{-1})			Mean Grain yield (kg ha^{-1})	Per cent achievement	RR (kg kg^{-1})	BCR
		FN	FP_2O_5	FK_2O				
T_1	Blanket (100 % RDF)	250	75	75	7927	-	10.96	1.84
T_2	Blanket + FYM @ 12.5 t ha^{-1}	250	75	75	9419	-	11.67	2.03
T_3	STCR-NPK alone-9.0 t ha^{-1}	186-218	108	79-108	9036	100.4	13.77	1.88
T_4	STCR-NPK alone-10.0 t ha^{-1}	224-256	123	97-126	9807	98.1	13.33	2.11
T_5	STCR-NPK alone-11.0 t ha^{-1}	261-293	137-138	115-144	10650	96.8	13.16	2.20
T_6	STCR-IPNS-9.0 t ha^{-1}	140-170	82-85	47-75	9304	103.4	14.44	2.07
T_7	STCR-IPNS-10.0 t ha^{-1}	178-208	97-100	65-93	10145	101.5	14.05	2.16
T_8	STCR-IPNS-11.0 t ha^{-1}	215-245	112-115	83-111	11075	100.7	13.95	2.26
T_9	Farmer's Practice	225-240	75-100	0	6938	-	10.56	1.69
T_{10}	Absolute control	0	0	0	3541	-	-	1.07

Major Nutrients (kg ha^{-1})		
$KMnO_4$-N	:	175 - 198
Olsen-P	:	12 - 13
NH_4OAc-K	:	380 - 584

Target yield equations generated from STCR-IPNS technology ensured not only sustainable crop production but also economized use of costly fertilizer inputs (Mahajan *et al.,* 2013). Farmer's practice recorded relatively lower yield and response ratio as compared to blanket and STCR treatments while the STCR-IPNS treatments recorded the highest per cent achievement, response ratio and BCR over farmer's practice (Table 4).

To conclude, the per cent achievement of the targeted yield of all the three validation experiments was within +/- 10% variation proving the validity of the fertiliser prescription equations for prescribing fertilizer doses for hybrid maize on Vertisol. The mean grain yield of hybrid maize from three validation experiments indicated that STCR-IPNS- 11 t ha^{-1} was found to record higher grain yield over all other treatments. All STCR-IPNS treatments recorded relatively higher response ratio and BCR over STCR treatments. The highest BCR was recorded in STCR-IPNS-11t ha^{-1}andthereforethe fertilizer prescription equations developed for hybrid maize under IPNS can be recommended for black calcareous soils (Typic Haplustert) of Tamil Nadu for achieving yield target of 11t ha^{-1} with sustained soil fertility.

References

Coumaravel, K., R. Santhi and S. Maragatham. 2013. Soil test crop response correlation studies under integrated plant nutrition system for hybrid maize on an Alfisol. Madras Agric. J., 100(7-9):660-664.

Debarati Bhaduri and Poonam Gautam., 2013. Optimization and validation of targeted yield equation based fertilizer doses under INM for wheat in TARAI region of Uttarakhand, India. Indian J. Agric. Res. 47(1): 16-25.

Gittinger, J. Price. 1982. Economic analysis of agricultural projects. Economic Development Institute of the World Bank. Johns Hopkins University Press. Baltimore, London.

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

Kumar, R., K. Srinivas and N. Sivaramane (2013), Assessment of the maize situation, outlook and investment opportunities in India. Country Report – Regional Assessment Asia (MAIZE-CRP). 1-2.

Mahajan, G.R., R.N. Pandey., S.C. Datta. And S.C. Dinesh (2013).Soil test based fertilizer recommendation of nitrogen, phosphorous and sulphur in wheat (*Triticum aestivum L.)* in an alluvial soils. Intl.J.Agric.Env.Biotech, 6:271-281.

Manish Singh, Y.V. Singh, S.K. Singh, Pradip Dey, L.K. Jat and Ram, R.L. 2017. Validation of Soil Test and Yield Target based Fertilizer Prescription Model for Rice on Inceptisol of Eastern Zone of Uttar Pradesh. Int.J.Curr.Microbiol. App.Sci. 6(2): 406-415.

Olsen, S.R, Cole, C.V and Watanabe. F.S. (1954). Estimation of Available Phosphorous in Soils by Extraction with Sodium Bicarbonate. Pp. 939. Circular US Dept. of Agriculture, 1400 Independence Ave. S.W., Washington DC.

Ramamoorthy. B, RL Narasimham, RS Dinesh. 1967. Fertilizer recommendations based on fertilizer applications for specific yield targets of Sonara-64., *Indian farming:* 17(5): 43-45.

Santhi. R., A. Bhaskaran and R. Natesan. 2011. Integrated fertilizer prescriptions for beetroot through Inductive cum targeted yield model on an Alfisol.

Commun. Soil. Sci. Pl. Analysis, 42: 1905-1912.

Sellamuthu, K.M, R. Santhi, S. Maragatham and P. Dey (2015). Validation of soil test and yield target based fertilizer prescription model for wheat on Vertisol. Research on crops, 16 (1):53-58.

Sharma, V.K., R.N. Pandey and B.M.Sharma.2015.studies on long term impact of STCR based. Integrated fertilizer use on pearl millet (*Pennisetum glaucum*)-wheat (*Triticum aestivum*) cropping system in semi-arid condition of India. J. Environ. Bio, 36(1): 241-247.

Singh. M., B.S. Dwivedi and S.P. Datta. 2012. Integrated nutrient management for enhancing productivity, nutrient use efficiency and environmental quality. In: Soil Science in the service of nation, Pp. 55-57. ISSS, New Delhi.

Subbiah, B.V. and G.L. Asija. (1956). A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci*., 25: 259-260.

How to cite this article:

Suresh, R. and Santhi, R. 2018. Validation of Soil Test and Yield Target Based Fertiliser Prescription Model for Hybrid Maize on Vertisol. *Int.J.Curr.Microbiol.App.Sci.* 7(09): 2131-2139. doi: https://doi.org/10.20546/ijcmas.2018.709.261