Impact Factor(SJIF) : 7.207 Volume : 7 | February - January| 2019-2020 Print ISSN : 2321 - 7847

EPRA International Journal of Agriculture and Rural Economic Research

Peer Reviewed Journal

FERTILIZER PRESCRIPTIONS UNDER STCR -IPNS FOR RICE-RICE CROPPING SEQUENCE IN INCEPTISOL (*TYPIC USTROPEPT*)

U.Bagavathi Ammal

Department of Soil Science and Agricultural Chemistry, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal-609603.

Pradipdey

Project Coordinator, IISS,Bhopal

ABSTRACT

To develop the fertilizer prescription equations based on Soil test crop response approach for Rice-Rice, field experiments were conducted at farmer's field in Karikalampakkam village, U.T of Puducherry, during 2015-2016. Soil test data, yield and NPK uptake by rice-rice were used for obtaining four important basic parameters viz., nutrient required to produce one quintal of rice, contribution of nutrients from fertilizers, contribution of nutrients from soil and contribution of nutrients from FYM (% CFYM) for both rice crops . The per cent contribution of nutrients from soil (CS), fertilizer (CF), and FYM (CFYM) were found to be 19.15, 45.90 and 23.27 for N, 12.13, 40.16 and 26.98 for P_2O_5 and 13.76, 79.64 and 41.07 for K_2O, respectively for rice (cv.white ponni) .The same for the rice (cv.ADT 45) was 13.48, 40.46 and 34.26 for N, 15.81, 44.64 and 19.89 for P_2O_5 and 10.48, 58.60 and 41.51 for K_2O, respectively. Fertilizer prescription equations were developed and nomograms were formulated based on the equations for a range of soil test values and desired yield target for rice. Under NPK + FYM @12.5 t ha^{-1} , 47, 29, 34 and 41 , 22 and 27 kg ha^{-1} of fertilizer N, P_2O_5 and K_2O, respectively could be saved for attaining target yield of 70 q ha^{-1} for rice cv. white ponni and cv.ADT 45 as compared to NPK fertilizers alone.

KEY WORDS: ***Basic parameters, Fertilizer prescription equations, Rice-rice cropping sequence***

INTRODUCTION

The conservative estimates show that the demand for food grains would increase from 257 million tones (Mt) in 2012-13 to 355 Mt by 2030 (Dey, 2016). This increase in demand has to be met from the fixed arable land available (H"141 million ha), with less scope for further horizontal expansion. Out of which, 120 million hectare is estimated to be suffering from different forms of land degradation (ICAR and NAAS, 2010). Contrary to increasing food demand, the factor productivity and rate of response of crops to applied fertilizers under intensive cropping system are declining year after year. Although food grain production has increased many fold, the irony is that it has been achieved at the cost of deterioration of natural resources (Prasad, 2004), In India, the nutrient use has increased by 173 %, but average increase in total food grain was only 125 % during the past five decades and at many places productivity got plateaued or showing decreasing trend.

Rice (*Oryza sativa* L.) is central to the lives of billions of people around the world. At the global level, rice is the most widely grown crop which occupies an area of about 161.8 million hectares, of which Asia covers about 143.2 million hectares. Similarly, Out of the total world rice production of 701 million tons, Asia contributes approximately 633.7 million tons (FAO Statistical year book, 2013). The slogan 'Rice is life' is most appropriate for India; as this crop plays a vital role in our India's food security and is a mean of livelihood for millions of rural households (Ajaykumar *et al.*, 2016). In India, more than 44 million hectares area is occupied by rice under three major ecosystems, rainfed uplands (16% area), irrigated medium lands (45%) and rainfed lowland (39%), with a productivity of 0.87, 2.24 and 1.55 tons per hectare, respectively (Tiwari *et al.*, 2013). Although the largest area under rice crop in the world (44 m ha) is in India, average productivity is lesser than China and Japan.

The annual consumption of fertilizers, in nutrient forms (N, P and K) has increased from 0.07 million tons in 1951-52 to more than 28 million tons in 2010-11 and per hectare consumption has increased from less than 1 kg in 1951-52 to the level of 135 kg in 2010-11 (Karsangla and Gohain, 2015), the nutrient use efficiency has gone down from 16 kg food grain produced per kg NPK applied during 1970's to 8 kg food grain produced per kg NPK applied during 1990's and around 6 kg now due to increasing deficiency of secondary and micronutrient (Tiwari *et al*., 2013).

The current fertilization practices do not put back in equal measure the nutrient to the soil as have been removed by crops, resulting in continuous depletion of soil fertility status. This can be offset only by adopting soil testing and applying integrated plant nutrient supply as has been enunciated as " The Law of Optimum", which has been demonstrated and validated in numerous farmer's field for obtaining targeted yield of crops under the All India Co-ordinated Research Project on Soil Test Crop Response (AICRP-STCR) project annual reports (Ramamoorthy and Velayutham, 2011, Tandan 2014 and Velayutham *et al*., 2016).The targeted yield approach wherein Ramamoorthy *et al.* (1967) established the theoretical basis and experimental proof for the fact that Liebig's law of minimum operates equally well for N, P and K. In Union territory of Puducherry, this type of work has not yet been initiated. Hence, it is pertinent to develop soil test crop response relationship for giving fertilizer recommendations under IPNS for desired yield targets for rice-rice cropping sequence in Inceptisol of Puducherry.

MATERIALS AND METHODS

The experiments were conducted at farmer's holding of Karikalampakkam village in Nettapakkam commune of Pondicherry district, U.T. of Puducherry. The study area comes under coastal alluvial plain (PC1) classified as fine, mixed isohyperthermic, *Typic Ustropept* with an area of 12.72 per cent. According to agro climatic zonal classification, Puducherry is located at 11^0 56' North latitude and 79^0. 66' East longitude to develop targeted yield equations (Ramamoorthy et al. 1967). The soils of experimental field was slightly alkaline (pH 8.40) and non-saline in reaction and sandy clay loam in texture. The P and K fixing capacities of the soil 150 and 100 kg ha^{-1}, respectively. The fertility statuswas low, high and medium with respect to available N (170.8 kg ha^{-1}), P (65.4 kg ha^{-1}) and K (236 kg ha^{-1}). Following the inductive methodology of Ramamoorthy *et al* (1967), the experiment was conducted in two phases. In the first phase, fertility gradient experiment was conducted by raising rice (cv. kulla ponni) as an exhaust crop during 2015. For this, the field was divided into three equal strips which were fertilized with $N_0P_0K_0$ (strip-I), $N_1P_1K_1$ (strip-II) and $N_2P_2K_2$ (strip-III) levels to create fertility gradient . Subsequently, in the second phase, after the harvest of the exhaust crop, test crop experiment with rice (cv. White ponni) was transplanted on 9.11.15 and harvested on 11.3.16. And after the harvest of rice (cv. White ponni) , the rice (cv.ADT 45) was transplanted on 1.4.16 and harvested on 22.6.16 . Each of the fertility strips was subdivided into 24 sub-plots resulting in 72 plots. There were 24 treatments consists of 4 levels of N (0,50, 100 and 150 kg ha^{-1}), P_2O_5 (0 , 25, 50 and 75 kg ha^{-1}), K_2O (0 , 25, 50 and 75 kg ha^{-1}) and Farmyard manure (FYM) (0 , 6.25 and 12.5 t ha^{-1}).The moisture and N , P_2O_5 and K_2O contents of FYM were 28, 0.52,0.32 and 0.38 per cent respectively . Pre-sowing soil samples were collected from each plot for each crop and were analyzed for available N (Alkaline potassium permanganate method), available P (Olsen's method) and available K (Ammonium acetate method). Grain and straw yields of both rice crops were recorded and these samples were analysed for N, P and K contents and uptake values were computed. Using the data on crop yield, nutrient uptake , pre-sowing soil available nutrients and fertilizer doses applied , the basic parameters viz., nutrient requirement (NR) , contribution of nutrients from soil (CS), fertilizer (CF) and contribution of nutrients from FYM (% CFYM) were calculated as per procedure described by Ramamoorthy *et al.* (1967) and Santhi *et al* .(2002) . These parameters were used for formulation of fertilizer prescription equations for deriving fertilizer doses and the soil test based fertilizer recommendations were prescribed in the form of a ready reckoner for desired yield target of ice-rice under NPK alone s well as NPK + FYM.

RESULTS AND DISCUSSION

Soil Available Nutrients

Strip –wise range and mean soil test values of pre-sowing stage for available nutrients are furnished in table 1. The average content of available nutrients was found to increase with increasing fertility strips and the highest content was recorded in strip III. The average available N content increased from 150.6 to 228.7 kg ha^{-1} and 151.6 to 211.2 kg ha^{-1} for rice cv.white ponni and cv ADT 45, respectively. The increase in N could be due to the addition of double dose of NPK fertilizers than single dose and control. The increased availability of P and K may be due to the application of graded levels of phosphatic and potassic fertilizers either on par with or over and above the P and K fixing capacity of the experimental field. Similar buildup of P and K was noticed by Coumaravel (2012) and Bagavathi Ammal *et al* .(2013).

Table 1 .Pre-sowing soil available NPK (kg ha^{-1}) in various strips

Strip	Available N		Available P_2O_5		Available K_2O	
	Range	Mean	Range	Mean	Range	Mean
Rice (cv.white ponni)						
Strip-I	142.8 – 156.8	150.6	42.2-49.8	46.2	200-212	208
Strip-II	198.8-220.2	205.8	50.4-59.6	54.7	216-242	229
Strip-III	218.6-235.2	228.7	51.6-61.9	56.2	260-283	270
Rice (cv.ADT 45)						
Strip-I	120.4-170.8	151.6	37.3-55.8	45.4	182-210	203.4
Strip-II	165.2-221.2	205.3	42.9-59.2	51.3	205-240	226.9
Strip-III	170.8-243.8	211.2	47.4-61.3	53.6	232-286	263.8

Grain yield and Nutrient Uptake

Range and mean values of grain yield and nutrient uptake under different strips are given in table 2. Maximum yield both rice was obtained in strip III followed by strip II and I. A crop which is grown under favourable environment is bound to produce better yields, provided the nutrient supply is matching with nutrient accumulation that occurs in the crop. The strip –wise average nutrient uptake was in the order of strip III >II > I for both the crops. The result indicated that a wide variability existed in the soil test values, grain yield and nutrient uptake which is a pre-requisite for calculating the basic parameters and fertilizer prescription equations for calibrating the fertilizer doses for specific yield targets (Santhi *et al.*, 2002)

Table 2 .Grain Yield and Nutrient uptake by rice (kg ha^{-1}) in various strips

Parameters	Strip I		Strip II		Strip III	
	Range	Mean	Range	Mean	Range	Mean
Rice (cv.white ponni)						
Grain yield	2860-7210	5383	3015-7735	5580	3360-8100	5693
N uptake	36.1-89.6	73.1	38.0- 104.2	80.5	42.5-115.2	86.2
P_2O_5 uptake	6.0-17.9	12.6	6.6-20.6	15.2	7.7 -21.6	15.2
K_2O uptake	28.9 -75.2	58.7	31.1 -79.1	63.9	36.2-85.1	66.8
Rice (cv.ADT 45)						
Grain yield	2640 -6400	4954	2710-6580	5177	2810-7110	5405
N uptake	19.4 -82.6	54.9	22.4 -83.6	65.2	24.8 -101.2	72.7
P_2O_5 uptake	6.5 -18.9	14.6	6.9 -24.8	16.8	7.3 – 24.7	17.7
K_2O uptake	21.3 -47.0	40.4	22.2-57.6	44.0	25.1-60.6	47.5

Basic Parameters

In targeted yield model, making use of the data on yield of crop, uptake of NPK, initial soil test values and doses of N, P_2O_5 and K_2O applied, the basic parameter for rice was computed and presented in table 3. The basic parameters for developing fertilizer prescription equation for rice are i) nutrient requirement in kg q^{-1} of rice (NR), ii) per cent contribution from soil available nutrient (Cs), iii) per cent contribution from fertilizer (Cf) and iv) per cent contribution from FYM (Cfym).

The nutrient requirement for the production of one quintal of rice cv white ponni and cv ADT 45 were computed as 1.44, 0.58 and 1.37 and 1.25, 0.73 and 1.01 kg of N, P_2O_5 and K_2O, respectively. The per cent contribution from soil for rice cv white ponni and cv ADT 45 was found to be 19.15 and 13.48 for N , 12.13 and 15.81 for P_2O_5 and 13.76 and 10.48 for K_2O , respectively. The per cent contribution of nutrients from the fertilizer sources revealed that among the three nutrients contribution was more in the case of K than N and P. The high value of K could be due to interaction effect of higher doses of N and P coupled with priming effect of K doses , which might have caused the release of soil K , resulting in the higher uptake in the native soil sources by crop (Ray *et al.*, 2000).

The per cent contribution of N, P_2O_5 and K_2O from FYM was 23.27, 26.98 and 41.07, respectively for rice cv.white ponni and 34.26, 19.89 and 41.51 for rice cv.ADT 45.In both the cases higher contribution was recorded in the case of K , which might be due to the supply of carbon which act as the source of energy for the buildup of bacterial population which inturn would have enhanced the release of K from organic sources and native sources . The findings is in close conformity with Natesan *et al.* (2007)

Table 3.Basic parameters for Rice

Parameters	Rice cv.white ponni			Rice cv. ADT 45		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Nutrient requirement (kg q^{-1})	1.44	0.58	1.37	1.25	0.73	1.01
Per cent contribution from soil	19.15	12.13	13.76	13.48	15.81	10.48
Per cent contribution from fertilizer	45.90	40.16	79.74	40.46	44.64	58.60
Per cent contribution from FYM	23.27	26.98	41.07	34.26	19.89	41.51

Fertilizer Prescription Equations for Desired Yield Targets

Based on the basic parameters, fertilizer prescription equations for targeted yield of both rice varieties under NPK alone as well as NPK + FYM were formulated and are furnished in table 4. On the basis of these equations , a ready reckoner as prepared for making fertilizer recommendations for different soil test values to meet specified yield targets of rice under NPK alone and NPK + FYM (Table 5).

Table 4 .Soil test based fertilizer prescription equations for targeted yield of rice

Particulars	Rice cv.white ponni	Rice cv. ADT 45
	Fertilizer alone	**Fertilizer alone**
FN (Fertilizer N-kg ha^{-1})	3.13 T -0.42 SN	3.13 T -0.42 SN-0.51 ON
F P_2O_5 (Fertilizer P_2O_5 - kg ha^{-1})	1.45 T -0.69 SP	1.45 T -0.69 SP -1.54 OP
F K_2O (Fertilizer K_2O- kg ha^{-1})	1.72 T -0.21 SK	1.72 T -0.21 SK –0.62 OK
	Fertilizer with FYM	**Fertilizer with FYM**
FN (Fertilizer N-kg ha^{-1})	3.06 T – 0.33 SN	3.06 T – 0.33 SN – 0.85 ON
F P_2O_5 (Fertilizer P_2O_5 - kg ha^{-1})	1.63 T – 0.81 SP	1.63 T – 0.81 SP – 1.02 OP
F K_2O (Fertilizer K_2O- kg ha^{-1})	1.70 T -0.22 SK	1.70 T -0.22 SK - 0.85 OK

T-yield target in q ha^{-1} .SN,SP and SK-soil available N,P and K. ON,OP and OK-N,P and K applied through organics

Table 5 Fertilizer recommendation (kg ha^{-1}) for yield targets of rice under NPK and NPK+FYM

Soil test values N: P_2O_5 : K_2O- kg ha^{-1}	NPK alone		NPK + FYM (12.5 t ha^{-1}))	
	Rice cv. white ponni			
	60 q ha^{-1}	70 q ha^{-1}	60 q ha^{-1}	70 q ha^{-1}
200: 12: 120	104:79:78	136: 93: 95	58: 50: 44	89: 64: 61
240: 16: 160	88: 76:70	119: 91:87	41: 47: 36	72: 62: 53
280: 20: 200	71: 73: 62	102: 88: 79	38: 44: 27	56: 59: 45
	Rice cv. ADT 45			
	60 q ha^{-1}	70 q ha^{-1}	60 q ha^{-1}	70 q ha^{-1}
200: 12: 120	118: 88:76	149: 104: 93	75: 59: 30	99: 75: 47
240: 16: 160	105: 84: 68	136: 101:85	75: 56:25	85: 72:39
280: 20: 200	92: 81: 59	122: 97: 76	75: 52: 25	75: 69: 30

Based on the fertilizer prescription equations for rice cv white ponni for NPK alone, fertilizer N recommendation was found in the range from 102 to 136, fertilizer P_2O_5 from 88 to 93 and fertilizer K_2O from 79 to 95 kg ha^{-1} for attaining a yield target of 70 q ha^{-1} (Table 5)) .When FYM was applied along with NPK fertilizers , fertilizer requirement of N, P_2O_5 and K_2O was found in the range of 56 to 89, 59 to 64 and 45 kg ha^{-1} , respectively at the same level of soil test values. Similar trend also observed in rice cv.ADT 45. Under NPK + FYM @12.5 t ha^{-1} , 47, 29, 34 and 41 , 22 and 27 kg ha^{-1} of fertilizer N, P_2O_5 and K_2O, respectively could be saved for attaining target yield of 70 q ha^{-1} for rice cv. white ponni and cv.ADT 45 as compared to NPK fertilizers alone. Similar results were also reported by Anjali Basumatary *et al.* (2015)

Use of FYM resulted in saving of fertilizer nutrients in rice-rice cropping sequence. Target yield equations generated from soil test crop correlation approach technology ensures not only sustainable crop production but also economies of use of costly fertilizer inputs. Practice of fertilizing rice crop using fertilizer prescription equations developed would help in achieving higher productivity, nutrient use efficiency and profitability.

Acknowledgment

The financial assistance of AICRIP-STCR , Bhopal to carry out the research is gratefully acknowledged.

REFERENCES

1. *Ajaykumar. R., R. Venkitaswamy and A. Rajeshkumar. (2016). Sustainable nutrient management practices to increase the productivity of transplanted low land rice. Cleanup India, 13-15 Dec. 2016, TNAU, Coimbatore.*
2. *Anjali Basumatary., S.Ahmed and K.N.Das. (2015) Soil test based fertilizer prescriptions under integrated plant nutrient supply for rice-rice cropping sequence in Inceptisol of Assam. Journal of Indian Society of soil science* ***63****, 186-190*
3. *Bagavathi Ammal, U., R. Sankar., K. Coumaravel. and A. Baskar. (2013). Studies on minimizing N fertilizer through STCR-IPNS.* ***In: Proc.*** *International conference on "Conventional or Non-conventional organic inputs in agriculture" Pondicherry, 209-210.*
4. *Coumaravel, K. (2012). Soil Test Crop Response correlation Studies through integrated plant nutrition system for Maize-Tomato sequence.* ***Ph.D. (Ag.) Thesis,*** *TNAU, Coimbatore.*
5. *Dey, P. (2016). Soil health management Bull. Indian Soc. Soil Sci.,* ***13:*** *79-97.*
6. *ICAR and NAAS. (2010). Degraded and wastelands of India, Status and Spatial distribution, Indian Counil of Agricultural research and National Academy of Agricultural Sciences, New Delhi. 158.*
7. *Karsangla, A.O. and T. Gohain. (2015). Effect of different doses of NPK fertilizers on local rice (Oryza sativa L.) under direct-seeded upland condtion. J. Soils and Crops,* ***25(1):*** *54-61.*
8. *Natesan, R., P. Murugesa Boopathi, R. Santhi, S. Thiyageswari, N. Chandra Sekaran, C. Paulraj, S. Natarajan, A. Subba Rao and Y. Muralidharudu. (2007).* ***Bull.*** *Soil Test Crop Response based fertilizer prescription for different soils and crops in Tamil Nadu.*
9. *Prasad, J. (2004). Environmental implications of soil degradation in India-A review. Agricultrual reviews,* ***25:*** *57-63.*
10. *Ramamoorthy, B., R.K. Narasimham and R.S. Dinesh. (1967). Fertilizer application for specific yield taregts on Sonora 64 (wheat). Indian fmg.,* ***17:*** *43-45.*
11. *Ramamoorthy, B and M. Velayutham. (2011). The Law of Optimum and soil test base fertilizer use for targeted yield of crops and soil fertility management for sustainable agriculture. Madras Agric. J.,* ***98(10-12):*** *295-307.*
12. *Ray, P., .K. Jana, A.K. Maitra, D.N. Saha, M.N. Chaudhury, J.S. Saha and A.R. Saha. (2000). Fertilizer prescription on soil test basis for jute, rice and wheat in a Typic Ustochrept. Journal of Indian Society of soil science* ***48****: 79-84.*
13. *Santhi, R., R. Natesan and G. Selvakumari. (2002). Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisol of TamilNadu. Agropedology,* ***12:*** *141-147.*
14. *Tandon, HLS. (2014). Soil testing for balanced fertilization. FDCO, New Delhi.p.170.*
15. *Tiwari, R.K., A. Jha, S.K. Tripathi, I.M. Khan and S.K. Rao. (2013). Rice based cropping system and climate change. JNKVV. Res. J.,* ***47:*** *239–247.*
16. *Velayutham, M. M., Santhi,R., Subba Rao, A., Muralidharudu, Y. and Dey,P.(2016). The Law of Optimum and its application for realizing Targeted yields in India- A mini- review (Thaninayagam Adigal), March 2016. P.12-20.*