https://doi.org/10.29321/MAJ.10.A02184

Madras Agric. J. 74 (6-7) : 312-319 June-July 1987

RATIONALISED FERTILISER PRESCRIPTION FOR RICE-ALFISOL ALLUVIUM BASED ON SOIL TEST-CROP RESPONSE STUDIES

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Test verification trials with rice-IR. 20, IR. 50, Bhavani, Co. 43, Ponni and Palyur-1 were conducted in sixteen sites on Noyyal alluvium (Typic Haplustalf) in TNAU Farm/ farmer's holdings in Coimbatore by adopting fertiliser prescription based on the new concept of "Fertilizer Prescription Procedure for specific yield targets". The results indicated that the fertiliser prescription based on the new concept fitted well with the yield targets up to 50 q/ha, while the fertiliser prescription for 45 q/ha of yield target recorded the highest value cost ratios, (VCR). The post-harvest soil analysis from these plots also showed that there was no appreciable decline in the fertility status by following this approach.

Rice is the staple food in Tamil Nadu. It is cultivated an area of 19.18 lakh hectares. While the area remains some from 1966 onwards, the yield has been increased from 37.91 lakhs tonnes in 1966-67 to 79.99 lakh tonnes in 1986-87. The per hectare production of rice has been stepped up from 1410 kg/ha to 2780 kg/ha, during this period an increase in 63.5 per cent was only due to the concerted efforts of use of fertilisers and management. Among the major plant nutrients, N is the most deficient in the soils, followed by P. Rice crop depends well to N-application followed by P. The results of numerous experiments on rice concluded that less than 30-40 per cent of the applied fertiliser - N is generally utilised by the rice crop (De Datta, 1981). More over rice is the major consumer of fertiliser - N and accounts for about one third of the total - N consumed in India.

The potential for N, for rice in India towards stabilising the mean grain yield at 2.4 t/ha is estimated to be around 65 kg N/ha, as against the current level of N-consumption for rice in India which is 25 kg N/ha (Strangal, 1979). Proper fertiliser management plays a key role in improving the yield of rice. The fertiliser is not only a costly input but also short in supply. The world's energy crisis has further aggravated the situation. A rationalised fertiliser prescription should be attempted which will take into consideration of the soil supplying power of the nutrients as well as the nutrient requirement, of the crop. With the above views, this study has been attempted to extend a rationalised fertiliser prescription for rice crop based on soil fertility status for alfisol-alluvium of Tamil Nadu.

MATERIALS AND METHODS

Soil test-crop response field trials were conducted on Noyyal alluvium at TNAU Farm, Coimbatore over four fertility gradients artificially created and biologically stabilised by growing

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Table-1. Physico-Chemical characteristics of soil (Range Values of 16 sites)

Mechanical Composition		
	Clay	18.6 to 25.20%
	Silt	11.8 to 14.20%
	Fine sand	18.9 to 22.30%
	Coarse sand	42.5 to 50.20%
Chemical Properties		
	pH	7.6 to 7.9
	EC	0.21 to 0.36 m. mos/cm
	CEC	12.6 to 15.0 me/100 g
	Water holding capacity	26.40 to 34.06%
	Organic Carbon	0.66 to 0.79%
	Available nitrogen	194—226 kg/ha
	Availeble Phosphorus	17.8—25.5 kg/ha
	Available potassium	482—788 kg/ha

Table-2 Basic data and fertiliser prescription equations

Basic Formation / Nutrient	N	P_2O_5	K_2O
Nutrient requirement kg/q	1.76	0.35	1.39
Soil Efficiency (%)	26.96	75.58	30.11
Fertiliser efficiency (%)	40.12	12.37	91.52

FN = 4.39 T — 0.68 SN

F P_2O_5 = 2.83 T — 6.11 SP

F K_2O = 1.41 T — 0.329 SK

Where F, S represents fertiliser and soil nutrients in kg/ha

T-targetted yield in q/ha.

gradient crops of rice. Test crop trials with rice Bhavani were conducted by superimposing the twenty seven treatments combinations, consisting of five levels of N, four levels of P_2O_5 and three levels K_2O at 50 kg interval and six absolute control ($N_0P_0K_0$), over the four gradients stripes in a fractional factorial design. From the mean grain yield the total N, P and K uptake, basic data for developing the fertiliser prescription equations were derived. The basic data viz., the nutrient requirement in kilogram to produce one quintal of grain yield, per cent efficiencies of soil and fertiliser and fertiliser prescription equations are given in Table 2.

The prescription equations were test verified over 16 sites at Tamil Nadu Agricultural University farm/farmer's holdings at Coimbatore on Noyyal alluvium (Typic Haplustalf). Noyyal series is brown to dark brown in colour, very deep, non-calcareous, friable, alluvial soils found along the banks of the river - Noyyal. Soil is well drained in nature with textural classes varying from sandy loam to sandy-clay loam. The physico-chemical properties of the soil is presented in Table 1. The soil reaction ranges from 7.6 to 7.9, conductivity varies from 0.21 to 0.36 m.mhos/cm and the water holding capacity falls between 26.40 and 34 06 per cent. Cation exchange capacity varies from 12.6 to 15.0 m.e./100 g with organic carbon ranging from 0.66 to 0.79 per cent.

The treatments consisted of fertiliser recommendation for 45, 50, 55 q/ha of yield targets based on the soil available nutrients, soil test based fertiliser recommendation-Mitscherlich-Bray's approach, a blanket recommendation of fertiliser not based on soil nutrient status and an absolute control. The rice varieties IR 20, IR 50, Bhavani, CO 43, Ponni and Paiyur-1 were grown during rabi 1982-'83. The rice grain yields were recorded. The initial and post-harvest soil samples were analysed for $KMnO_4$—N, Olsen-P and NH_4OAc—K. The validity of the fertiliser prescription based on this new concept was examined by 't' test.

RESULTS AND DISCUSSION

Yield and per cent achievement

Rice grain-yield, value cost ratio (VCR) are given in Table 3. Rice grain yields ranged from 19.55 q/ha to 58.54 q/ha. The lowest grain yield was recorded by the control - $N_0P_0K_0$. The fertiliser prescription for 45 q/ha-yield target ranged from 44.0 to 66 0 kg of N/ha, without P and K while for 50 q/ha yield-target, the macronutrients prescription varied from 89 to 110 kg of N/ha, from 0 to 36 kg P_2O_5/ha. without K. The treatment - 45 q/ha yield target registered yields which ranged from 37.40 q/ha at a farmer's holding to 49.82 q/ha at TNAU farm with a mean yield of 43 77 q/ha. The per cent achievement for 45 q/ha yield target varied from 83.4 to 109 7. In the case of 50 q/ha yield target the achieved yield ranged from 39.10 q/ha to 52.82q/ha with per cent achievement varying from 78.2 to 107.2. The highest yield target 55 q/ha treatment showed a higher variation in yield (39.87-54.37 q/ha) with achievement ranging from 72.6 to 98.86 per cent (Table 5).

The values of mean grain yield of rice showed that the mean grain yield of 43.77 q/ha was registered by 45 q/ha yield target with an average per cent achievement of 98 27 (Table 5) The treatment 50 q/ha yield target recorded a mean grain yield of 47 19 q/ha with 94 38 mean per cent achievement. Velautham *et al*, (1985) have have reported that lower yield targets are achieved within ±10% error and the possible reason might be that according to law of minimum, the actual yield obtained is one given by limiting nutrient. The grain yield showed a decreasing trend at 55 q/ha yield target. (Mean grain - 46 45 q/ha ; Per cent achievement 84 46). The statistical examination of the pooled values revealed that 't' values for 45 q/ha and 50 q/ha treatments were not significant, indicating the targetted and observed yields were being homogenous in nature. However at 55 q/ha treatment, the test was significant - indicating a large variation between the yield aimed and the yiled achieved. The reason may be due to the response behaviour of rice varieties for high fertiliser levels by following a quadratic trend and also due to the limited yield potential of the locality which could seldom exceeds 50 q/ha yield except in TNAU farms. In general it was observed the yield as well as per cent achievement were higher in TNAU farm than in farmers' holdings in Coimbatore.

Rice varieties and per cent achievement

Among the varieties, rice Ponni and Paiyur-1 recorded over cent per cent achievement in both the yield targets of 45 and 50 q/ha while rice IR 20, Bhavani and CO. 43 could record only over ninety per cent yield achievements. Thus it was obvious that 45 q/ha yield in farmers' holdings and 50 q/ha yield in University farm could easily achieved (Table 4).

Trealments and value cost ratio

Irrespective of the sites, the highest rice grain yield was observed in the blanket prescription of fertilisers except in rice Paiyur-1 and IR 20 where 55 q/ha yield target registered the highest yield and in rice Ponni, soil test recommendation recorded the highest yield. Eventhough, the blanket prescription of fertiliser gave the highest yield, VCR from the farmers point of view was the lowest for blanket recommendation (2.90 to 5.35 Rs/Re investment on fertilisers). Among the yield targets, 45 q/ha yield-target recorded the highest VCR(3 80 to 15.53) irrespective of the varieties/locations. The VCR tended to decrease with increase in yield targets (Table 3). Verma *et al*. (1987) reported similar results in rice.

The Noyyal soil series in all the locations is considerably high in available K (NH_4OAc-k ; 412-788 kg/ha), so the soil available K-was found to be sufficient to meet the K nutrient requirement of the crop it warrents no fertiliser potash application, while the nitrogen status of the soils is comparatively lower, so the N-requirement or the crop is quite high-it goes up to 110 kg/ha. The available P status of the soil is observed to be medium to high and also due to influence of submergence, P requirement of the rice varieties seldom exceeded over 35 kg/ha (Table 2).

Table 3: Fertiliser status, fertiliser dose, rice grain yield and VCR (Mean of three replications)

Locations and Variety	Fertility status (kg/ha) N*	P*	K*	Treatment	Fertiliser dose (kg/ha) N	P_2O_5	K_2O	Grain yield (q/ha)	VCR	Percent achievement
Tamil Nadu	195	25.5	788	Control	0	0	0	25.96	—	—
Agricultural University				Blanket recomm	100	50	50	52.61	5.69	
Farm IR. 50				45 q/ha	65	0	0	44.20	10.99	98.23
				50 q/ha	87	0	0	49.61	10.64	99.22
				55 q/ha	109	0	0	51.69	9.24	93.99
IR. 20	195	25.5	788	Control	0	0	0	26.95	—	—
				Blanket recomm.	120	60	60	54.00	4.92	
				45 q/ha	65	0	0	44.17	10.37	99.00
				50 q/ha	87	0	0	50.18	10.53	100.36
				55 q/ha	109	0	0	54.37	9.85	98.86
Paiyur-1	195	25.5	788	Control	0	0	0	33.17	—	
				Blanket recomm	120	60	60	52.70	3.59	
				45 q/ha	65	0	0	47.53	8.65	105.63
				50 q/ha	87	0	0	50.33	7.78	100.66
				55 q/ha	109	0	0	59.33	7.24	96.97
Ponni	195	17.8	672	Control	0	0	0	39.89	—	—
				Blanket recomm	120	60	60	55.80	2.90	—
				S.T.L. Rec.	132	62	0	58.54	3.57	—
				45 q/he	65	18	0	48.26	3.81	105 6
				50 q/ha	87	33	0	52.81	4.03	107.2
CO 43	195	17.8	672	Control	0	0	0	31.01	—	—
				Blanket recomm	120	60	60	54.02	4.19	—
				STL Rec.	132	62	0	52.95	4.20	—
				45 q/ha	65	18	0	49.35	8.34	109.7
				50 q/ha	87	33	0	52.42	6.67	104 9
IR 20	195	17.8	672	Control	0	0	0	25.01	—	—
				Blanket recomm	120	60	60	52.89	5.36	—
				STL Rec	132	62	0	53.09	5.37	—
				45 q/ha	65	18	0	47.30	9 41	100.0
				50 q/ha	87	33	0	49.82	7.73	99.6
K. Murugesan	207	20.72	605	Control	0	0	0	23.58	—	—
Vettaikaran Kovil				Blanket Recomm	120	60	60	46.23	4.23	—
Thondamuthur				45/qha	60	0	0	44.34	13.84	98.5
Block var.				50/qha	80	15	0	45.28	8 86	90.6
IR. 20				55/qha	105	30	0	47.18	6.70	85.8
Nanjappan	220	22.48	560	Control	0	0	0	21.49	—	—
Gounder				Blanket Recomm	120	60	60	41.81	3.83	—
Kaliannan Puduru				45/qha	55	0	0	38.45	12.41	85 5
IR 20				50 q/ha	80	5	0	41.25	9.29	82.6
				55 q/ha	100	10	0	40.35	6.78	73.6

1	2	3	4	5	6	7	8	9	10	12
Palanisamy	219	20.72	605	Control	0	0	0	23.48	—	—
Palayampalayam				Blanket Recomm	120	60	60	43.69	2.96	—
R. 20				45/qha	50	0	0	38.42	6.90	85.4
				50/qha	75	15	0	43.16	6.64	86.3
				55/qha	95	30	0	41.06	4.06	74.7
Muppanda Gounder	212	19.50	616	Control	0	0	0	25.22	—	—
Palayam-Palayam				Blanket Recomm	120	60	60	43.92	3.92	—
R. 20				45 q/ha	55	5	0	40.00	9.07	88.9
				50 q·ha	80	20	0	43.48	7.52	86.9
				55 q/ha	100	35	0	44.78	6.20	81.4
N. Ponnusamy	223	20.72	482	Control	0	0	0	28.56	—	—
Kaliannan Pudur				Blanket Recomm	100	50	50	46.64	4.06	—
Bhavani				45 q/ha	50	0	0	43 79	12.70	97.3
				50 q/ha	70	15	0	45.22	8,13	90.4
				55 q/ha	90	30	0	45.70	5.41	83.1
R. Chinnasamy	194	19.56	672	Control	0	0	0	21.99	—	—
Kaliannan Pudur				Blanket Recomm	100	50	50	43.98	4.93	—
Bhavani				45 q/ha	70	5	0	42.12	10.54	94.0
				50 q/ha	90	20	0	41.74	6.79	83.5
				55 q/ha	110	35	0	43.23	5.47	78.6
R. Palanisamy	225	21.90	412	Control	0	0	0	19.55	—	—
Kaliannan pudur				Blanket Recomm	100	50	50	40 80	4.76	—
IR. 50				45 q/ha	50	0	0	37.80	14.28	83.4
				50 q/ha	70	5	0	38.25	9.84	76.5
				55 q/ha	95	10	0	39.95	7.48	72.6
B. Palanisamy	226	22.10	432	Control	0	0	0	21.68	—	—
Thondamuthur				Blanket Recomm	100	50	50	41.65	4.48	—
IR 50				45/qha	50	0	0	37.40	12.58	83.1
				50 q/ha	70	5	0	39.10	9.17	78.2
				55 q/ha	95	10	0	35.10	6.71	72.6
N. Ponnusamy,	224	23.60	426	Control	0	0	0	21.68	—	—
Kaliannan Pudur				Blanket Reeomm	100	50	50	41.65	4.09	—
IR 50				45 q/ha	50	0	0	37.40	12.58	88.8
				50 q/ha	70	5	0	39.40	9.17	78.2
				55 q/ha	95	10	0	39.98	6.68	72.6
S. Kanthasamy,	225	22.40	434	Control	0	0	0	23.80	—	—
Kaliannan Pudur				Blanket Recom	100	50	50	41.65	4.00	—
IR. 50				45 q/ha	50	0	0	39.10	12.24	86.9
				50 q/ha	70	5	0	39.90	8.47	79.9
				55 q/ha	95	10	0	40.80	6.36	74.2

*N, P & K — $KMuO_4$, 01 sen. P and NH_4 OAC-K
N @ 5.11/kg
P_2O_5 @ 6.00/kg
K_2O @ 2.11/kg

Grain @ 2.00/kg

Table-4 Rice Grain yield (q/ha) and Initial Soil Nubients (kg/ha).

	IR 20	IR 50	Ponni	Bhavani	CO 43	Paiyur-1
Control	25.28	22.53	39.89	25.28	31.01	33.17
Blanket Recomn	47.83	43.33	55.80	45.31	54.02	52.90
45 q/ha	41.45	39.10	48.26	42.95	43.30	47.53
50 q/ha	45.52	41.19	52.81	43.48	49.82	50.33
55 q/ha	45.54	42.46	–	44.47	–	53.33
$KMnO_4$-N(PS)	208	219	195	208	195	196
Olsen-P (PS)	21.12	23.10	17.8	20.14	17.8	25 5
NH_4OAc-K (PS)	641	498	672	577	672	788

PS=Mean values of Pre-sowing soil analysis in kg/ha

Table-5 Mean values of yield of Rice Grain q/ha (Polled 16 sites)

Treatment	Range	Mean	Percent Achievement	't' Value
45 q/ha	37.40 – 49.82	43.77 (16)	98.07	0.19 NS
50 q/ha	39.10 – 52.82	47.19 (16)	94.38	1.12 NS
55 q/ha	39.87 – 54.37	46.45 (13)	84.46	7.61*

Number in paranthesis indicates the number of sites

Table-6 Available nutrient status in post-harvest soil (kg/ha)

variety	Treatment	$KMnO_4$-N		Olsen-P		NH_4O AC-K	
		Range	Mean	Range	Mean	Range	Mean
IR 50	Control	187-207	194	10.64-16.50	12.04	381-505	422
	B. Recomm	219-231	225	15.12-18.72	16.90	426-585	460
	45 q/ha	201-208	206	11.20-11.52	12 99	396-582	437
	50 q/ha	211-216	214	12.32-15.12	14.34	381-525	423
	55 q/ha	216-225	219	12.32-15.12	14.56	381-517	446
IR 20	Control	187-210	199	15.12-19.60	17.12	511-627	532
	B. Recomm	204-228	215	16.88-21.40	19.93	515-538	582
	45 q/hs	188-210	201	15.12-20 72	18 08	537-627	585
	50 q/ha	191-219	208	17.36-20.72	20.16	515-638	608
	55 q/ha	201-225	213	19.60-21.84	20.70	526-650	583
Bhavani	Control	187-189	188	15.12-16.88	16.00	437-627	538
	B. Recomm	204-228	216	22.40-23.60	23.00	470-683	578
	45 q/ha	194-220	207	17.36-18 50	17.93	448-638	543
	50 q/ha	197-223	210	17.36-19 60	18.48	458-650	549
	55 q/ha	201-229	215	18.60-19.60	19.30	459-605	532
Ponni	Control	172-180	176	13.20-14 00	13.60	573-597	585
	B. Recomm	200-204	202	19.40-20.00	19.70	630-640	635
	45 q/ha	197-213	205	16.50-20.50	18.50	580-650	615
	50 q/ha	180-204	192	14.12-17.12	15.62	560-670	615
	55 q/ha	190-202	196	15.85-18.15	17.00	590-640	615
Paiyur-1	Control	170-194	182	14.60-16.60	15.60	590-600	595
	B. Recomm	198-208	203	19.20-25.60	22.40	624-640	632
	45 q/ha	192-204	196	15.30-17.70	16.50	614-640	627
	50 q/ha	190-202	196	16.70-17.70	17.20	604-630	617
	55 q/ha	192-208	200	16.00-18.40	17.20	600-654	627
CO 43	Control	179-191	185	10.52-15.80	13.00	585-625	605
	B. Recomm	196-212	204	16.30-20.30	18.30	605-665	635
	45 q/ha	187-203	195	16.50-19.15	18.00	595-615	605
	50 q/ha	190-212	201	14.00-16.60	15.39	605-645	625
	55 q/ha	194-208	201	15.20-17.60	16.40	603-631	617

Table 7. Yield-Targetted & Acheived with percent ochievemets and NPK status before & after harvest Rice

Location	Fertility Status			Nutrient applied (Kg/ha)			Grain Yield q/ha		Per cent achievement	Post-harvest soil analysis (kg/ha)		
	N*	P*	K*	N	P_2O_5	K_2O	Targetted	Achieved		N*	P*	K*
M Block TNAU Farms, Coimbatore-3 (Typic Haplustalf) Area 1.2 ac.	210	22.8	727	56	0	0	45.0	45.79	>100	203	19.6	685
K. Block Area 1.2 ac.	208	22.8	818	56	0	0	45.00	45.19	>100	198	18.9	768

*N $KMnO_4$-N

*P Olsen-P

*K NH_4OAc-K

The post-harvest soil fertility status of these sixteen locations indicated that the lowest availability of nutrients N was recorded by the control plots (Table 6). The variation in available nutrient status was not appreciable among the treatments, eventhough blanket recommendation of fertiliser registered slightly higher values. The results revealed that the fertility status was not altered considerably by following the prescription concept of fertiliser application.

From the observations, it is clear that the fertiliser application based on prescription procedure is not only helpful in getting the desired yield targets, to get more profit and also takes care off the maintenance of soil ferrility to support sustained rice production.

Encouraged by the results, obtained from the test verification trials and also to test the valadity of this new concept over a larger area, the most profitable yield target - 45 q/ha was chosen and tried over a larger area of 1.2 area (0.49 ha) in two blocks of TNAU farm, Coimbatore, with rice Bhavani as test crop. Thc details of soil nutrient status fertiliser dose, yield and post-harvest soil analysis are given in Table 7. The fertiliser dose of 56 kg N/ha alone without P and K was applied to achieve 45 q/ha of yield, as the Noyyal elluvium contained sufficient available P and K. The post-harvest soil analysis showed that there was no appreciable change in $KMNO_4$—N, Olsen-P and a mild reduction in NH_4OAc-K was noticed.

Thus, it can be concluded that new concept of fertiliser prescription for specific yield targets of rice in Tamil Nadu - Alfisol alluvium based on the soil available nutrients resulted not only in the maintenance of soil macronutrients status.

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