Fertilizer Prescription Equation Demonstration for Targeted Yield of Rice in Farmer Fields of Telangana State

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Abstract

Field level demonstrations were conducted in rice crop at twenty six different locations to assess the validity of soil test based fertilizer application with a target yield of 60 q ha^{-1} in Telangana State. The mean initial soil fertility status of different fields was 198 kg N, 60 kg P and 337 kg K ha^{-1}. To achieve a target yield 60 q ha^{-1} as per fertilizer prescription equation based on soil test indicated that an amount of N, P$_2$O$_5$ and K$_2$O to be applied was in the range of 43 to 191, 23 to 147 and 22 to 172 kg ha^{-1}. The yield realized by farmers was in the range of 40 to 60 in these twenty six locations with a mean 52 q ha^{-1} and 49 to 63 with mean of 56 q ha^{-1} due to soil test based fertilizer usage. The mean economic gain variation due to change in fertilizer use and yield between use of STCR equation and farmers own method worked out to be Rs 8065 ha^{-1}.

Introduction

Rice is the staple food for more than the sixty percent of world population. In India, it contributes about 41.5% of total food grain production. Paddy is one of the major crops in the state and it is grown both *kharif* and *rabi* seasons. In Telangana, paddy occupies an area of 10.46 lakh ha. with production of 30.47 lakh tones [1]. Food security on long term basis can only obtained by a balance between crop production and soil health along with environment sustainability. Fertilizer plays a key role in ensuring self sufficiency in food grain production. Fertilizer consumption has increased to 26.29 mt of nutrients (N+P+K) in 2017-18 from a level of 0.070 mt in1951-52.The role of chemical fertilizers for increasing agricultural production, particular in developing countries is well established. Some argue that fertilizer was as important as seed in Green Revolution [2].

Among the different agricultural inputs fertilizer is the most important input for increasing the crop production and it has become one of the costliest inputs in agriculture. The use of right amount of fertilizer is necessary for farm profitability and environment protection. Because of increasing input costs and decreasing commodity prices the farmers are currently looking for new ways to increase efficiency and cut costs. In this regard targeted yield approach has been found to be beneficial which recommends balanced fertilization considering available nutrient status in the soil and the crop needs. Targeted yield approach was first developed by [3, 4] established theoretical basis and experimental technique suit to Indian conditions. Excessive and indiscriminate use of inorganic fertilizers creates imbalance of nutrition causing decline in productivity and simultaneously increased cost of production. The present investigation was under taken in farmer's fields to assess the feasibility of fertilizer prescription equations of yield target approach in Rice. The specific yield equation based on soil health besides ensuring sustainable crop production also steers the farmers towards economic use of costly fertilizer inputs depending on their financial status and market price of the crop under consideration [5].

Material and Methods

A field experiment was conducted in farmer's fields at twenty six different locations of Telangana state during *rabi* 2016-17 and 2017-18. The objective of present investigation was to study the influence of different nutrient management approaches on productivity of rice. Treatments comprised of 2 nutrient management approaches *viz.,* Farmers Fertilizer practice (FFP) and STCR. In STCR approach initial soil available nutrients N, P and K are required

to compute the target yield equations at a particular field level. A target yield 60 qha^{-1} was taken for a test variety of KNR-118. The required quantity of fertilizers to attain the target yield was calculated based on initial soil fertility status and equation given below, where FN, FP and FK are fertilizer N, P_2O and K_2O in kg ha^{-1} respectively. T is the target yield in q ha^{-1}; SN, SP and SK are soil available N, P and K in kg ha^{-1} respectively,

FN = 3.58 T - 0.57 SN
FP = 1.71 T - 2.46 SP
FK = 1.48 T - 0.16 SK

Initial soil sample are collected at each location and analyzed for pH of the soil in 1:2.5 soil water suspensions [6] and electrical conductivity of the soil in 1:2.5 soil water extract. Available nitrogen in the soil was determined by alkaline permanganate method [7], available phosphorus by Olsen's extractant [8] and available potassium in soil was extracted with neutral normal ammonium acetate [6]. Initial nutrient status across the twenty six locations has revealed that the soils are neutral to moderately alkaline in reaction, non-saline and low organic carbon in nature. Available nitrogen was low to medium in the range of 102 – 301 kg ha^{-1}, available phosphorus was low to high with range 10 – 174 kg P_2O_5 ha^{-1} and available potassium was medium to high ranging from 110 – 550 kg K_2O ha^{-1} (**Table 1**). The required nitrogen was applied through three splits 25 per cent at basal, 25 per cent at tillering, 25 per cent at active tillering and last dose at panicle initiation stage while phosphorus and potassium are applied as basal.

An interaction meeting was held with farmers to know the different fertilizer application practices among them. Majority of the farmers following the fertilizer practices was considered as Farmers Fertilizer Practice. It was observed that farmers are mostly concentrating in the application of nitrogen and phosphorus fertilizers but they are applying less dose of potassium. Plant protection measures were adopted as and when required. The grain yield was recorded at harvest. It was noticed that in all the locations farmers practice has applied more fertilizers compared over STCR recommendations.

Table 1 Physico-chemical properties of selected farmer's fields

S. No.	Farmers Name	pH	EC (dS m^{-1})	OC (%)	Avail. N (kg ha^{-1})	Avail.P_2O_5 (kg ha^{-1})	Avail.K_2O (kg ha^{-1})
1	V. Hariya	7.87	0.381	0.31	201	60	305
2	V. Mangya	7.45	0.225	0.29	188	45	504
3	M. Padmi	7.66	0.122	0.40	226	50	500
4	M. Chandu	7.33	0.364	0.38	301	74	374
5	M. Ambri	7.41	0.739	0.35	201	19	328
6	M. RoopSingh	7.92	0.789	0.42	263	49	317
7	S. Neeliya	7.49	0.425	0.25	213	41	344
8	M. Janaki	7.21	0.14	0.44	238	69	345
9	S. Mohan	7.69	0.217	0.27	213	39	398
10	R. Naveen	7.52	0.205	0.32	276	32	348
11	Ketavath Shiva	8.12	0.428	0.43	283	88	394
12	Jarpla Ambar Singh	7.82	0.518	0.33	209	134	366
13	Daravath Sangya	7.92	0.486	0.24	173	117	326
14	Maloth Santhosh	8.06	0.329	0.31	186	174	303
15	Daravath Peershi	8.26	0.308	0.47	213	92	454
16	Banoth Dariya	7.98	0.446	0.19	148	55	250
17	K. Srinivas Rao	7.85	0.261	0.23	176	98	110
18	A. Srinivas	7.44	0.259	0.19	151	92	128
19	K. Lakshman Rao	7.83	0.258	0.32	176	49	136
20	A. Mysaiah	7.81	0.452	0.30	213	13	466
21	A. Jangaiah	7.78	0.553	0.22	188	15	325
22	S. Pandu	7.62	0.508	0.17	151	10	550
23	A. Gopalam	7.79	0.245	0.26	213	34	413
24	D. Pandu goud	7.87	0.381	0.31	112	41	278
25	T. Lakshmaiah	7.45	0.225	0.29	102	44	192
26	P. Mahender goud	7.41	0.739	0.35	132	36	304
	Mean			0.31	198	60	337

Table 2 Fertilizer application rates among different treatments

Sl. No.	Farmers Name	Farmer Fertilizer Practice (kg ha⁻¹)			STCR Recommendations (kg ha⁻¹)		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	V. Hariya	125	125	125	100	38	48
2	V. Mangya	200	80	0	108	54	22
3	M. Padmi	200	250	0	86	49	22
4	M. Chandu	125	250	0	43	23	39
5	M. Ambri	125	125	63	100	83	45
6	M. RoopSingh	188	75	0	65	50	47
7	S. Neeliya	188	125	50	93	59	43
8	M. Janaki	100	250	0	79	29	43
9	S. Mohan	150	188	0	93	61	36
10	R. Naveen	120	250	50	57	69	42
11	Ketavath Shiva	136	96	78	124	102	50
12	Jarpla Ambar Singh	153	115	75	161	38	54
13	Daravath Sangya	186	80	78	179	61	60
14	Maloth Santhosh	162	75	75	172	60	64
15	Daravath Peershi	172	115	75	159	30	40
16	Banoth Dariya	180	105	40	191	147	72
17	K. Srinivas Rao	135	70	40	134	32	68
18	A. Srinivas	130	65	50	148	34	62
19	K. Lakshman Rao	100	60	50	134	58	56
20	A. Mysaiah	115	50	45	114	66	40
21	A. Jangaiah	120	50	50	128	64	52
22	S. Pandu	132	60	50	148	65	32
23	A. Gopalam	130	50	40	114	60	48
24	D. Pandu goud	138	68	54	100	28	48
25	T. Lakshmaiah	126	72	60	108	54	22
26	P. Mahender goud	130	62	52	100	83	45
	Mean	145	112	46	117	58	46

Results and Discussion

The fertilizer usage was more in farmer fertilizer practice treatment compared to soil test based fertilizer application (**Table 2**). It was observed that 19 percent of more nitrogen was applied and nearly double the dose of phosphorus application was noticed which may be due to application of more complex fertilizers than straight fertilizers at different stages of crop. Yield data recorded was in the range of 40.13 to 60.15 q ha⁻¹ with a mean yield of 52 q ha⁻¹ in different locations under farmers practice while in case of STCR treatment was 49.05 to 63.41 q ha⁻¹ with a mean yield of 56 q ha⁻¹ (**Table 3**). In STCR technology has recorded an additional mean yield of 5qha⁻¹ over farmer fertilizer practice. The higher grain yield in STCR recommendation may be due to application of fertilizers based on needs of crop. Fertilizers in target yield approach, takes into account the crop needs and nutrients present in the soil. It may be due to coincidence of fertilizers application with critical stages of crop. It might have resulted in better assimilation of photosynthetates to grain. Similar results were obtained by [9-12]. It was noticed that on an average farmers are investing an excess amount of Rs. 2472 per hectare over soil test based fertilizer application. It may due to indiscriminate application of complex fertilizers than straight fertilizers.

The total fertilizer cost incurred by farmer fertilizer management was higher than STCR approach. It was observed that the total cost of the fertilizer was more by Rs.2419/- in Farmer fertilizer practice over STCR treatment (**Table 4**). Relative income gain due to fertilizer use and additional yield obtained due adoption soil test based fertilizer application was found to be in the range of Rs 707 to 16,113/- with a mean of Rs 8065 ha⁻¹. This may be due to higher productivity and gross returns in the STCR treatment over the farmer fertilizer practice treatment. It might be also due to nutrient balance in soil due to soil test based fertilizer application and nutrient reserves in the soil. Similar results are reported by [11]. It was observed in certain locations they have recorded negative income it may be due to application of lower dose of fertilizers than required by plant.

Table 3 Grain yield and change in grain yield among different treatments in Rice

Sl. No	Farmers Name	Grain Yield (q ha⁻¹)		Change in grain yield over FFP	Total cost of fertilizers (Rs. ha⁻¹)		Excess amount invested in FFP over STCR
		FFP	STCR		FFP	STCR	
1	V. Hariya	53.75	58.95	+ 5.2	9778	4277	5501
2	V. Mangya	52.00	56.55	+ 4.55	12070	4723	7347
3	M. Padmi	46.25	51.50	+ 5.25	12070	4168	7902
4	M. Chandu	45.50	51.75	+ 6.25	7383	2548	4835
5	M. Ambri	43.38	54.68	+ 11.3	8581	6608	1973
6.	M. Roop Singh	41.40	49.05	+ 7.65	11074	4408	6666
7	S. Neeliya	40.63	49.90	+ 9.27	12032	5198	6834
8	M. Janaki	50.80	54.98	+ 4.18	5906	3375	2531
9	S. Mohan	52.05	59.13	+ 7.08	8859	5159	3700
10	R. Naveen	44.08	49.55	+ 5.47	8046	5251	2795
11	Ketavath Shiva	48.60	52.45	+ 3.85	8999	8309	690
12	Jarpla Ambar Singh	47.45	56.10	+ 8.65	10098	5645	4453
13	Daravath Sangya	45.62	56.37	+ 10.75	8831	7231	1600
14	Maloth Santhosh	49.85	52.26	+ 2.41	8175	7209	966
15	Daravath Peershi	49.35	56.15	+ 6.80	10344	4791	5553
16	Banoth Dariya	48.97	50.39	+ 1.42	8888	12132	-3244
17	K. Srinivas Rao	60.10	62.34	+ 2.24	7062	5731	1331
18	A. Srinivas	60.13	63.14	+ 3.01	7025	5837	1188
19	K. Lakshman Rao	59.33	63.41	+ 4.08	6349	6860	-511
20	A. Mysaiah	57.25	61.64	+ 4.39	5803	6560	-757
21	A. Jangaiah	58.55	62.14	+ 3.59	6026	7004	-978
22	S. Pandu	59.25	62.17	+ 2.92	6760	6686	74
23	A. Gopalam	60.15	62.85	+ 2.70	5838	6466	-628
24	D. Pandu goud	57.00	58.00	+1.0	5264	3560	1704
25	T. Lakshmaiah	55.00	56.00	+1.0	5605	3544	2061
26	P. Mahender goud	54.00	55.00	+1.0	4895	5588	693
	Mean	52	56	5	8145	5726	2472

FLDs on Rice in different farmers fields at Telangana State

Table 4 Comparative study of grain yield, gross return and net profit among different treatments

Sl. No	Farmers Name	Seed yield (q ha⁻¹)		Total cost of fertilizers (Rs. ha⁻¹)		Gross Returns (Rs. ha⁻¹)		Gross Returns over Fertilizer cost (Rs. ha⁻¹)		Relative income (Rs. Over FP)
		FFP	STCR	FFP	STCR	FFP	STCR	FFP	STCR	
1	V.Hariya	53.75	58.95	9778	4277	64500	70740	54722	66463	11741
2	V.Mangya	52.00	56.55	12070	4723	62400	67860	50330	63137	12807
3	M.Padmi	46.25	51.5	12070	4168	55500	61000	43430	56832	13402
4	M.Chandu	45.50	51.75	7383	2548	54600	60940	47217	58392	11175
5	M.Ambri	43.38	54.68	8581	6608	52056	65616	43475	59008	15533
6	M.RoopSingh	41.40	49.05	11074	4408	49680	57860	38606	53452	14846
7	S.Neeliya	40.63	49.90	12032	5198	48756	56880	36724	51682	14958
8	M.Janaki	50.80	54.98	5906	3375	60960	64800	55054	61425	6371
9	S.Mohan	52.05	59.13	8859	5159	62460	70956	53601	65797	12196
10	R.Naveen	44.08	49.55	8046	5251	52896	58660	44850	53409	8559
11	Ketavath Shiva	48.60	52.45	8999	8309	66331	71439	57332	63130	5798
12	Jarpla Ambar Singh	47.45	56.10	10098	5645	63450	75110	53352	69465	16113
13	Daravath Sangya	45.62	56.37	8831	7231	61880	70843	53049	63612	10563
14	Maloth Santhosh	49.85	52.26	8175	7209	69093	70694	60918	63485	2567
15	Daravath Peershi	49.35	56.15	10344	4791	66149	74492	55805	69701	13896
16	Banoth Dariya	48.97	50.39	8888	12132	67016	65973	58128	53841	-4287
17	K.Srinivas Rao	60.10	62.34	7062	5731	95559	99121	88497	93389	4892
18	A.Srinivas	60.13	63.14	7025	5837	95607	100393	88582	94555	5973
19	K.Lakshman Rao	59.33	63.41	6349	6860	94335	100822	87986	93962	5976
20	A.Mysaiah	57.25	61.64	5803	6560	91028	98008	85224	91447	6223
21	A.Jangaiah	58.55	62.14	6026	7004	93095	98803	87069	91798	4729
22	S.Pandu	59.25	62.17	6760	6686	94208	98850	87447	92164	4717
23	A.Gopalam	60.15	62.85	5838	6466	95639	99932	89801	93466	3665
24	D.Pandu goud	57.00	58.00	5264	3560	104800	106200	99536	102640	3104
25	T.Lakshmaiah	55.00	56.00	5605	3544	102000	103400	96395	99856	3461
26	P.Mahender goud	54.00	55.00	4895	5588	100600	102000	95705	96412	707
	Mean	52	56	8145	5726	74023	79669	65878	73943	8065

Conclusion

Twenty six field level demonstrations were conducted on rice at different locations of Telangana state to popularize the fertilizer targeted yield equations developed earlier on this crop. It was recorded that in STCR approach additional mean yield 5qha⁻¹ and income of Rs. 8065 ha⁻¹ was obtained.

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