



Targeted yield approach and a framework of fertilizer recommendation in rice

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Received : 21.04.2020 ; Revised : 18.06.2020 ; Accepted : 23.06.2020

DOI: <https://doi.org/10.22271/09746315.2020.v16.i1.1285>

ABSTRACT

A field experiment was conducted at the Agricultural College farm, Bapatla, during kharif and rabi 2017-18 and 2018-19. The experiment was conducted with variety of rice BPT-5204 in a Randomized Block Design with ten treatments and three replications. The soil NPK status at post harvest of rice, gross returns, net returns, returns rupee⁻¹ investment and grain yield, yield attributes were recorded with soil test based fertilizer recommendation with 10 t ha⁻¹ FYM application which was at par with soil test based fertilizer recommendation alone and 7.5 t ha⁻¹ targeted yield recommendation along with FYM (T₅ and T₁₀) and RDF with FYM (T₆).

Keywords: Economics, physic-chemical properties, rice, TYFR, weather and yield –yield attributes.

Rice is a staple food crop not only in India but also in entire South East Asia of the total rice (*Oryza sativa* L.) production in the world; more than 90 per cent is in Asia. Rice is cultivated in 111 countries of all continents, except Antarctica. India and China are the leading producers as well as consumers of rice. In India, it is grown in an area of 43.9 m ha with a production of 99.24 m t and productivity of 2494 kg ha⁻¹. In Andhra Pradesh, it is grown in an area of 2.152 m ha with a production of 8.05 m t and productivity of 3741 kg ha⁻¹ (Anon., 2018). Integrated nutrient management, which entails the maintenance / adjustment of soil fertility to an optimum level for crop productivity to obtain the maximum benefit from all possible sources of plant nutrients. To get more and more yield, farmers inclined to the excess use of chemical fertilizer, but the decision on fertilizer use requires knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrient needs, supply of nutrients from indigenous sources, and the short and long term fate of fertilizer applied. Application of fertilizers by the farmers in the fields without information on soil fertility status and nutrient requirement by the crop causes adverse effects in soil and crop regarding both nutrient toxicity and deficiency either by over use or inadequate use.

MATERIALS AND METHODS

A field experiment was conducted at the Agricultural College farm, Bapatla, during kharif and rabi 2017-18 and 2018-19. The experiment was conducted with variety of rice BPT- 5204 in a Randomized Block Design with ten treatments and three replications. The treatments

comprised of Recommended Dose of Fertilizer (T₁), Soil test based fertilizer recommendation (T₂); Targeted yield fertilizer recommendations for 5.5 t ha⁻¹ (T₃), 6.5 t ha⁻¹ (T₄) and 7.5 t ha⁻¹ (T₅); Treatment T₁ + FYM @ 10 t ha⁻¹ (T₆); Treatment T₂ + FYM @ 10 t ha⁻¹ (T₇); Treatment T₃ + FYM @ 10 t ha⁻¹ (T₈); Treatment T₄ + FYM @ 10 t ha⁻¹ (T₉); and Treatment T₅ + FYM @ 10 t ha⁻¹ (T₁₀). The experimental soil was clay loam in texture, slightly alkaline in reaction, non saline, low in available nitrogen, low in organic carbon, high available phosphorus and potassium. The application of nutrients was done following the soil test based fertilizer recommendations as per the treatment. Target yield fertilizer recommendations were based on using the target yield equations developed for Krishna Godavari agro ecological region.

Land pattern details

The Agricultural College Farm, Bapatla, is situated at an altitude of 5.49 m above mean sea level, 15° 54' North Latitude, 80° 25' East Longitude and about 7 km away from the Bay of Bengal.

Crop situation weather data

Weather data recorded during kharif and rabi seasons of 2017-18 and 2018-19 were summarized and presented in table.

Weather during kharif rice

The weekly mean maximum temperature during rice growing period (kharif season) ranged from 30.1°C to 37.9°C and 26.6°C to 37.6°C during 2017 and 2018, respectively. The corresponding mean minimum

temperatures were 16.5°C to 26.4°C in 2017 and 17.7°C to 26.8°C, in 2018. While the average weekly maximum and minimum temperatures during the same period were 31.4°C and 23.1°C during 2017 and 32.5°C and 23.3°C during 2018, respectively. The weekly mean relative humidity ranged from 58.5 to 86.2 per cent during 2017 and 56.5 to 84.0 per cent during 2018, while the average weekly relative humidity was 75.2 and 76.6 per cent during 2017 and 2018, respectively. A total rainfall of 727.7mm and 428.5mm was received during crop growing period in 2017 and 2018 with 28 and 26 rainy days, respectively.

RESULTS AND DISCUSSION

Nutrient availability (n, p and k) in soil after harvest of rice crop

Data pertaining to the soil available N at harvest presented in the table 1 revealed that available N in the soil did differ significantly by the treatments based on fertilizer recommendations with and without application of FYM during both the years of study and in pooled data.

Mechanical soil analysis and physical and physico-chemical properties of the experimental soil.

S. No.	Properties	2017-18	2018-19	Method of analysis
I	Physical properties			
	Sand (%)	42.0	40.0	Bouyoucos hydrometer method (Piper, 1960)
	Silt (%)	20.0	21.0	
	Clay (%)	38.0	39.0	
	Textural class	Clay loam	Clay loam	
II	Physico-chemical properties			
	pH (1:2.5)	7.60	7.40	Glass electrode method (Jackson, 1973)
	EC (dS m ⁻¹ at 25°C)	0.26	0.30	Digital conductivity meter (Jackson, 1973)
III	Chemical properties			
	Organic carbon(%)	0.41	0.43	Modified walky and black method (Walky and Black, 1934)
	Available N (kg ha ⁻¹)	146.0	163.0	Alkaline permanganate method (Subbiah and Asija, 1956)
	Available P ₂ O ₅ (kg ha ⁻¹)	76.0	78.0	Olsen's method(Olsen <i>et al.</i> , 1954)
	Available K ₂ O (kg ha ⁻¹)	352.0	358.0	Neutral normal ammonium acetate method (Muhret <i>et al.</i> , 1965)

By using formulae Targeted yield (q ha⁻¹) equation for *kharif*-rice (Anon., 2007).

$$*FN= 2.30 \times T - 0.32 \times SN$$

SN= Soil Nitrogen

$$*FP_2O_5=1.91 \times T - 1.90 \times SP$$

SP= Soil Phosphorous

$$*FK=2.27 \times T - 0.27 \times SK$$

SK= Soil Potassium

Fertilizer schedule during *kharif* rice- during 2017and 2018 (As per initial soil analysis data).

Treatments	2017-18N-P-K (kg ha ⁻¹)	2018-19N-P-K (kg ha ⁻¹)
T ₁	120-60-40	120-60-40
T ₂	156-42-28	156-42-28
T ₃	80-30-30	70-30-28
T ₄	102-30-52	98-30-50
T ₅	125-30-75	123-30-73
T ₆	T ₁ +FYM@ 10 t ha ⁻¹	T ₁ +FYM@ 10 t ha ⁻¹
T ₇	T ₂ +FYM@ 10 t ha ⁻¹	T ₂ +FYM@ 10 t ha ⁻¹
T ₈	T ₃ +FYM@ 10 t ha ⁻¹	T ₃ +FYM@ 10 t ha ⁻¹
T ₉	T ₄ +FYM@ 10 t ha ⁻¹	T ₄ +FYM@ 10 t ha ⁻¹
T ₁₀	T ₅ +FYM@ 10 t ha ⁻¹	T ₅ +FYM@ 10 t ha ⁻¹

Soil available N at harvest (kg ha⁻¹)

Among the treatments, the higher soil available N was observed with the STFR with combination of 10 t ha⁻¹ FYM (T₇) treatment which was at par with the application of STFR alone (T₂) and found significantly superior to rest of the treatments. Nitrogen availability in soil after rice crop was significantly influenced by targeted yield fertilizer recommendations also. Application of fertilizers along with organic manures might have created suitable soil conditions that helped the mineralization of soil N and multiplication of soil microbes, which could have converted organically bound nitrogen into readily available forms leading to building up of higher available N in soil. Similar results were observed in the findings of Swarup and Yaduvanshi (2000), Chettri *et al.* (2017) and Roy *et al.* (2017). The maximum soil N was observed with the application of 7.5 t ha⁻¹ with FYM (T₁₀) followed by 7.5 t ha⁻¹ alone (T₅) and RDF with FYM (T₆) in both the years of study and in pooled data.

The percentage increase in available soil N at final harvest of rice with STFR fertilizer recommendation with 10 t ha⁻¹ FYM (T₇), STFR fertilizer recommendation alone (T₂) are 24.9% ,19.1% , 15.1 % and 21.1% ; 24.1% , 18.3% , 14.4% and 20.3% over the targeted yield fertilizer recommendation T₃, T₄, T₉ and T₈ respectively at maturity in pooled data. Data pertaining to the soil available P at harvest presented in the table 1 revealed that available P in the soil did differ significantly due to soil test based fertilizer recommendation with application of FYM during both the years of study and in pooled data.

Soil available phosphorous (kg ha⁻¹)

Among the treatments, the higher soil available P was observed with the STFR with combination of 10 t ha⁻¹ FYM (T₇) treatment which was at par with the application of STFR alone (T₂) and found significantly superior to rest of the treatments. The lowest soil available P was observed with the targeted yield fertilizer recommendation of 5.5 t ha⁻¹ (T₃) treatment which was at par with the application of STFR alone, with and without application of FYM (T₉, T₄ and T₈) treatments and found significantly superior to rest of the treatments.

The percentage increase in available soil P at final harvest of rice with STFR fertilizer recommendation with 10 t ha⁻¹ FYM (T₇), STFR fertilizer recommendation alone (T₂) are 31.5%, 22.9 % , 20.9 % and 28.8 % ; 27.4 % , 18.3 % , 16.2 % and 24.0 % over the targeted yield fertilizer recommendation T₃, T₄, T₉ and T₈ respectively at maturity in pooled data.

Since, phosphorus fertilizers are not subjected to leaching losses in soil unlike nitrogen, higher levels of phosphorus might have left higher residual phosphorus in soil. The addition of 10 t ha⁻¹ FYM in the treatment

STFR (T₇) along with high initial soil P status might have caused coating of sesquioxides by these organic materials and thus reduced the phosphorus fixation by soil. Also release of carbon dioxide and organic acids during decomposition of organic material might have solubilising effect on native phosphorus in soil. Earlier Bharadwaj and Omanwar, 1994 and Singh *et al.*, (2008) also expressed similar views.

Available soil potassium (kg ha⁻¹)

The available potassium status of the soil (Table 1) increased with increasing rates of potassium application. Among the treatments, the higher soil available K was observed with the STFR with combination of 10 t ha⁻¹ FYM (T₇) treatment which was at par with the application of STFR alone (T₂) and T₁₀ and found significantly superior to rest of the treatments. The lowest soil available K was observed with the targeted yield fertilizer recommendation of 5.5 t ha⁻¹ (T₃) treatment which was at par with the application of STFR alone with and without application FYM treatments (T₉, T₄, T₈, T₆ and T₁) and the treatments T₇, T₂ and T₁₀ significantly inferior to rest of the treatments.

Percentage increase in available soil K at final harvest of rice with STFR fertilizer recommendation with 10 t ha⁻¹ FYM (T₇), STFR fertilizer recommendation alone (T₂) are 30.3% , 10.3 % , 20.8 % and 26.4 % ; 25.6 % , 4.2 % , 15.4 % and 21.4 % , over the targeted yield fertilizer recommendation T₃, T₄, T₉ and T₈ respectively at maturity in pooled data. The beneficial effect of STFR with combination of 10 t ha⁻¹ FYM (T₇) treatment on available potassium might be due to the reduced potassium fixation and release of potassium due to the interaction of organic matter with clay besides the direct addition of potassium to the potassium pool in soil. Similar results were also observed by Sarkar *et al.* (2014) and Chettri *et al.* (2017).

Economics

Data presented in table 2 revealed that soil test based fertilizer (STFR) (T₂) recorded the highest returns per rupee investment and found significantly superior to the rest of the treatments due to higher net returns realized in the same treatment significantly compared to rest of the treatments. The reason is clearly visible from lower cost of cultivation in the treatment (T₂). It is further observed that the differences in the returns obtained from rupee invested between treatments T₂ and T₅ were not significant. The lower net returns obtained in the treatments with organic manure (FYM) T₁₀, T₇, T₈ and T₉ were significantly inferior to T₂ and T₅ due to higher cost of cultivation which is reflected in realizing significantly lower net returns during the year 2017, 2018 and in pooled data.

Rao and Srivastava (2000) opined that “Soil test based application of plant nutrient helps to realize higher response ratio and returns per rupee investment the

Table 1: NPK availability (kg ha⁻¹) in soil after harvest of rice as influenced by site - specific nutrient management in rice during *kharif* 2017-18, 2018-19

Treatments	Available N (kg ha ⁻¹)			Available P ₂ O ₅ (kg ha ⁻¹)			Available K ₂ O (kg ha ⁻¹)		
	1 st year	2 nd year	Pooled	1 st year	2 nd year	Pooled data	1 st year	2 nd year	Pooled
T ₁ - Recommended dose of fertilizer (RDF) 120-60-40 kg ha ⁻¹	244.0	266.7	255.3	40.1	42.1	41.1	322.1	327.5	324.8
T ₂ - Soil test based fertilizer recommendation (STFR)	275.0	282.6	278.8	47.6	48.7	48.2	379.3	387.7	383.5
T ₃ - Targeted yield fertilizer recommendation for 5.5 t ha ⁻¹	206.7	216.3	211.5	34.8	35.2	35.0	283.3	288.3	285.8
T ₄ - Targeted yield fertilizer recommendation for 6.5 t ha ⁻¹	221.7	234.0	227.8	38.6	40.2	39.4	302.9	311.3	307.1
T ₅ - Targeted yield fertilizer recommendation for 7.5 t ha ⁻¹	266.7	275.0	270.8	43.6	45.5	44.5	346.7	354.3	350.5
T ₆ - T ₁ +FYM @ 10t ha ⁻¹	257.7	269.4	263.5	41.7	43.5	42.6	332.0	338.0	335.0
T ₇ - T ₂ +FYM @ 10 t ha ⁻¹	280.0	283.3	281.7	50.6	51.6	51.1	405.0	413.3	409.2
T ₈ - T ₃ +FYM @ 10 t ha ⁻¹	215.0	229.3	222.2	36.3	37.1	36.7	299.3	304.3	301.8
T ₉ - T ₄ +FYM @ 10 t ha ⁻¹	232.7	244.0	238.3	39.7	41.1	40.4	320.9	327.5	324.2
T ₁₀ - T ₅ +FYM @ 10t ha ⁻¹	269.4	280.0	274.7	45.6	46.8	46.2	360.7	368.3	364.5
SEm(±)	15.91	15.51	8.10	1.46	1.90	1.52	19.47	18.64	18.88
LSD(0.05)	47.27	46.09	24.08	4.35	5.63	4.51	57.85	55.34	56.09
CV (%)	11.1	10.41	5.5	6.0	7.6	6.18	10.0	9.44	9.6

Table 2: Cost of cultivation (Rs. ha⁻¹), gross returns (Rs. ha⁻¹), net returns (Rs. ha⁻¹) and return rupee⁻¹ invested of rice as influenced by site - specific nutrient management in rice-blackgram sequence during *khariif* 2017-18, 2018-19

Treatments	Economics														
	Cost of cultivation				Gross returns				Net returns				Returns rupee ⁻¹ investment		
	1 st year	2 nd year	Pooled		1 st year	2 nd year	Pooled		1 st year	2 nd year	Pooled		1 st year	2 nd year	Pooled
T ₁ -Recommended dose of fertilizer (RDF) 120-60-40 kg ha ⁻¹	48264	48464	48364		78620	101570	90095		30355	53106	41731		0.63	1.10	0.86
T ₂ -Soil test based fertilizer recommendation (STFR)	47934	48134	48034		89586	112216	100901		41652	64082	52867		0.87	1.33	1.10
T ₃ -Targeted yield fertilizer recommendation for 5.5 t ha ⁻¹	47598	47698	47648		74066	92442	83254		26468	44744	35606		0.56	0.94	0.75
T ₄ - Targeted yield fertilizer recommendation for 6.5 t ha ⁻¹	48146	48346	48246		77265	100094	88680		29119	51748	40434		0.60	1.07	0.84
T ₅ - Targeted yield fertilizer recommendation for 7.5 t ha ⁻¹	48720	48920	48820		85067	107244	96156		36347	58324	47336		0.75	1.19	0.97
T ₆ -T ₁ +FYM @ 10 t ha ⁻¹	56264	58264	57264		82083	103656	92870		25819	45392	35605		0.46	0.78	0.62
T ₇ -T ₂ +FYM @ 10 t ha ⁻¹	55934	57934	56934		89747	116423	103085		33813	58489	46151		0.60	1.01	0.81
T ₈ -T ₃ +FYM @ 10 t ha ⁻¹	55598	57598	56598		76110	93804	84957		20512	36206	28359		0.37	0.63	0.50
T ₉ -T ₄ +FYM @ 10 t ha ⁻¹	56146	58146	57146		77693	101225	89459		21547	43079	32313		0.38	0.74	0.56
T ₁₀ -T ₅ +FYM @ 10 t ha ⁻¹	56720	58720	57720		85861	108726	97294		29141	50006	39574		0.51	0.85	0.68
SEM(±)	-	-	-		2223.0	2583.8	1761.3		2223.0	2583.8	1761.3		0.04	0.05	0.03
LSD(0.05)	-	-	-		6605.0	7676.9	5233.1		6605.0	7676.9	5233.1		0.13	0.14	0.10
CV (%)	-	-	-		4.72	4.31	3.29		13.06	8.86	7.63		12.85	8.68	7.23

Table 3: Grain yield (kg ha⁻¹), of kharif rice as influenced by targeted yield equation based fertilizer doses under integrated nutrient management during 2017, 2018 and pooled data.

Treatments	2017	2018	Pooled
T ₁ - Recommended dose of fertilizer (RDF) 120-60-40 kg ha ⁻¹	4450	5236	4843
T ₂ - Soil test based fertilizer recommendation (STFR)	5099	5805	5452
T ₃ - Targeted yield fertilizer recommendation for 5.5 t ha ⁻¹ (TYFR)	4234	4800	4517
T ₄ - Targeted yield fertilizer recommendation for 6.5 t ha ⁻¹ (TYFR)	4370	5163	4766
T ₅ - Targeted yield fertilizer recommendation for 7.5 t ha ⁻¹ (TYFR)	4831	5540	5186
T ₆ - T ₁ +FYM @ 10 t ha ⁻¹	4667	5346	5007
T ₇ - T ₂ +FYM @ 10 t ha ⁻¹	5117	6023	5570
T ₈ - T ₃ +FYM @ 10 t ha ⁻¹	4358	4870	4614
T ₉ - T ₄ +FYM @ 10 t ha ⁻¹	4396	5226	4811
T ₁₀ - T ₅ +FYM @ 10 t ha ⁻¹	4876	5614	5245
SEm(±)	141.2	157.1	108.9
LSD(0.05)	419.2	466.9	323.6
CV (%)	5.2	5.0	3.77

nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization". This was clearly evident in case of the treatment T₂ where soil test based fertilizers were applied without incurring extra cost on FYM. Bera *et al.* (2006) and Das *et al.* (2016) also reported that the targeted yield fertilizer recommendations were more precise to achieve higher yields, which led to higher profits.

Effect of site specific nutrient management on yield and yield attributes of rice

Grain yield

Data pertaining to grain yield (Table 3) indicated that STFR with 10 t ha⁻¹ FYM (T₇), followed by T₂ produced significantly higher grain yield compared to rest of the treatments. However, they were on par with that of T₁₀ in the year 2018 and T₁₀ and T₅ in 2017. The higher yields recorded with STFR+FYM (T₇) were 5117, 6023 and 5570 kg ha⁻¹ which were statistically on par with STFR application alone (T₂) *i.e.*, 5099, 5805 and 5452 kg ha⁻¹ during 1st and 2nd years and in pooled data respectively.

Increased use of fertilizers in the fields without information on soil fertility status and nutrient requirement by crop causes undesirable effects on soil and crop. Management of site specific variability in nutrient supply is a key strategy to overcome the imbalances in fertilizer applications. Soil test based application of plant nutrients facilitate the exact application of nutrients in proportion to the extent of the deficiency of a particular nutrient.

The lowest yields observed with the targeted yield fertilizer recommendation @ 5.5 t ha⁻¹ alone (T₃) followed by other targeted yield fertilizer recommendation treatments (T₄, T₈ and T₉) were

significantly inferior compared with other treatments. However, differences among the treatments based on targeted yield fertilizer recommendation treatments T₄, T₃, T₈ and T₉ and RDF (T₁) were not statistically significant.

Grain yield recorded with 7.5 t ha⁻¹ targeted yield fertilizer recommendation with FYM (T₁₀) found significantly superior over the targeted yield fertilizer recommendation treatments (T₃, T₄, T₈ and T₉) at harvest during the year 2017 and in pooled data. The differences were not significant among the treatments T₁₀, T₉ and T₄.

Soil test based fertilizer recommendation regulate on the reason that nutrient requirement of the crop minus nutrient supplied by soil should be the amount of fertilizer needed. It requires estimating the amount of nutrient removed by a crop for a certain yield level and the contribution of nutrient from the soil source, then finally the amount of fertilizer to be added to meet the requirement of crop is calculated considering the efficiency of fertilizer. This approach provides the foundation for optimum resources utilization and balanced nutrient management.

The percentage increase in grain yield with STFR recommendation with 10 t ha⁻¹ FYM (T₇), STFR fertilizer recommendation alone (T₂) was 18.9%, 14.4 %, 13.6 % and 17.2 % ; 17.1 %, 12.6 %, 11.8 % and 15.4 % over the targeted yield fertilizer recommendation (T₃, T₄, T₉ and T₈) at harvest during both the years 2017, 2018 and in pooled data, respectively.

Soil testing provides sound information about the fertility and productivity of soils. The effectiveness of soil test must be judged from actual field performance. This facilitates the farmers to make the most profitable use of the costly inputs in farming. These findings are in corroboration with that of Bera *et al.* (2006).

Table 4: Yield attributes of rice as influenced by site specific nutrient management during kharif 2017-18 and 2018-19.

Treatments	Number of panicles m ⁻²			Number of filled grains panicle ⁻¹			Test Weight (1000 grain weight g)		
	1 st year	2 nd year	Pooled	1 st year	2 nd year	Pooled	1 st year	2 nd year	Pooled
T ₁ ⁻ (RDF) 120-60-40 kg ha ⁻¹	249.1	266.7	257.9	143.0	157.3	150.2	15.9	16.6	16.2
T ₂ ⁻ (STCR) based 156-42-28 kg ha ⁻¹	271.8	299.3	285.6	164.2	169.0	166.6	16.3	17.0	16.7
T ₃ ⁻ (80-30-30 NPK TYFR @ 5.5 t ha ⁻¹)	227.6	228.7	228.1	132.6	151.7	142.1	15.6	16.3	15.9
T ₄ ⁻ (102-30-52 NPK TYFR @ 6.5 t ha ⁻¹)	238.0	216.3	227.2	141.3	153.0	147.1	15.7	16.4	16.0
T ₅ ⁻ (125-30-75 NPK TYFR @ 7.5 t ha ⁻¹)	254.9	280.0	267.5	147.3	162.9	155.1	16.2	16.9	16.5
T ₆ ⁻ (T1+FYM) @ 10 t ha ⁻¹	250.7	275.0	262.9	146.0	161.2	153.6	16.1	16.8	16.5
T ₇ ⁻ (T2+FYM)	277.2	302.9	290.1	169.0	179.8	174.4	17.0	17.7	17.4
T ₈ ⁻ (T3+FYM)	236.4	237.4	236.9	135.2	152.5	143.9	15.6	16.3	16.0
T ₉ ⁻ (T4+FYM)	242.6	244.4	243.5	142.1	154.3	148.2	15.8	16.5	16.2
T ₁₀ ⁻ (T5+FYM)	263.6	283.3	273.5	149.9	166.8	158.4	16.3	17.0	16.6
SEm(±)	4.86	14.71	8.29	5.40	4.95	3.62	0.53	0.45	0.49
LSD(0.05)	14.43	43.70	24.63	16.04	14.71	10.78	NS	NS	NS
CV (%)	3.3	9.6	5.5	6.36	5.33	4.08	5.7	4.6	5.1

Number of panicles m⁻²

A perusal of the data on number of panicles m⁻² (Table 4.) indicated that it was significantly influenced by the various treatments during two consecutive years and in pooled data.

The highest number of panicles m⁻² were observed with STFR with FYM (T₇) followed by STFR without FYM (T₂), 7.5 t ha⁻¹ targeted yield with FYM (T₁₀) and without FYM (T₅) compared to rest of the treatments at harvest. Targeted yield fertilizer recommendations except for 7.5 t ha⁻¹ without FYM (T₃, T₄, T₈ and T₉) recorded the significantly lower number of panicles m⁻² compared to other treatments (T₇, T₂, T₁₀, T₅ and T₆) at harvest. However, differences between these treatments and applications of RDF were not significant during both the years and pooled data. Number of panicles m⁻² recorded with 7.5 t ha⁻¹ targeted yield fertilizer recommendation (T₁₀) with FYM found significantly superior to other targeted yield fertilizer recommendation treatments (T₃, T₄, T₉ and T₈) at harvest during 2017 and 2018.

The percentage increase in number of panicles m⁻² with STFR fertilizer recommendation with 10 t ha⁻¹ FYM (T₇), STFR fertilizer recommendation alone (T₂) was 21.37 %, 21.72 %, 16.20 % & 18.62 % and 20.0 %, 20.35 %, 14.73 % & 17.19 %, over the targeted yield fertilizer recommendation T₃, T₄, T₉ and T₈ respectively at maturity in pooled data.

Organic manures improve the physical, chemical and biological properties of the soil. These are the sources of all the nutrients required by plants in limited quantities so as to maintain C:N ratio in the soil. When these are added to soil along with inorganic fertilizer it increases fertility and productivity of soil.

Similar findings are supported by Kandeshwari and Thavaprakash (2016) who reported that extra yields were most probably secured by the addition of organic manure, particularly at the rate of 10 t ha⁻¹ of FYM, along with optimum plant stand.

Number of filled grains panicle⁻¹

Data on total filled grains panicle⁻¹ are presented (Table 4) at harvest of rice which was significantly affected by soil test and targeted yield based fertilizer recommendation during both the years of experimentation.

At harvest, STFR with 10 t ha⁻¹ FYM (T₇) and STFR alone (T₂) recorded significantly maximum number of filled grains panicle⁻¹ compared to all other treatments. However the differences in filled grains between the treatments T₂ and T₁₀ were not significant during year 2017 and 2018. Though 5.5 t ha⁻¹ targeted yield fertilizer recommendation (T₃) recorded lower number of filled grains panicle⁻¹, the differences among the rest of the treatments except T₇, T₂ and T₁₀ were not statistically significant during the years 2017 and 2018.

Average weekly weather data recorded at Agricultural College Farm, Bapatla during crop growth period (23rd July to 31st December 2017 and 2018) of *khari* rice during 2017-18 and 2018-19

Standard meteorological Week	Date and month	2017					2018				
		Mean temp (°C)		Mean RH (%)	Rainfall (mm)	Rainy days	Mean temp (°C)		Mean RH (%)	Rainfall (mm)	Rainy days
		Max.	Min.				Max.	Min.			
30	23 rd July -29 th July	37.9	26.4	58.5	7.8	2	37.0	26.7	60.0	5.3	1
31	30 th July-05 th Aug	37.6	26.1	63.1	9.3	1	37.6	26.8	56.5	4.1	1
32	6 th Aug-12 th Aug	34.2	24.5	79.8	105.1	4	34.2	24.9	73.4	102.2	2
33	13 th Aug-19 th Aug	33.1	23.9	73.5	18.4	1	30.0	24.0	78.1	71.5	5
34	20 th Aug-26 th Aug	31.8	24.3	78.3	111	3	32.9	25.4	73.2	11.1	1
35	27 th Aug -02 nd Sep	33.3	25.2	75.8	54.7	1	34.4	25.2	75.4	7.0	1
36	03 rd Sep-09 th Sep	33.6	25.3	81.0	113.7	3	35.5	25.7	68.9	11.1	2
37	10 th Sep-16 th Sep	32.8	26.0	78.0	53.9	2	34.7	26.6	78.5	30.0	1
38	17 th Sep-23 rd Sep	33.9	25.9	70.6	1.4	0	32.7	24.0	84.0	50.9	4
39	24 th Sep-30 th Sep	33.1	24.8	83.8	70.7	5	33.3	25.3	82.6	2.4	0
40	01 st Oct-07 th Oct	32.1	24.9	86.2	87.8	3	34.1	25.0	80.2	11.6	1
41	08 th Oct-14 th Oct	32.7	25.5	80.6	11.0	1	34.8	24.8	73.0	0.0	0
42	15 th Oct-21 st Oct	33.6	24.5	76.0	22.2	1	32.0	24.2	83.4	23.1	2
43	22 nd Oct-28 th Oct	33.7	23.9	75.3	0.0	0	32.8	22.5	77.8	0.0	0
44	29 th Oct-04 th Nov	31.8	24.8	77.0	0.0	0	31.7	22.5	82.3	38.2	2
45	05 th Nov-11 th Nov	31.3	21.7	76.1	1.7	0	32.2	22.8	83.9	0.0	0
46	12 th Nov-18 th Nov	31.7	22.6	75.6	0.0	0	31.5	21.7	76.6	16.9	2
47	19 th Nov-25 th Nov	31.9	22.9	81.1	30.8	1	30.6	22.0	81.4	2.0	0
48	26 th Nov-02 nd Dec	30.2	19.1	72.5	0.0	0	30.8	18.8	73.2	0.0	0
49	03 rd Dec-09 th Dec	30.3	18.0	70.7	0.0	0	30.0	21.6	82.0	1.0	0
50	10 th Dec-16 th Dec	31.7	18.9	72.9	0	0	30.6	19.5	75.3	0	0
51	17 th Dec-23 rd Dec	30.7	17.2	72.3	0	0	26.6	18.3	82.6	47	1
52	24 th Dec-31 st Dec	30.1	16.5	71.2	0	0	29.1	17.7	78.3	0	0
Total		722.9	531.9	1729	727.7	28.0	749.4	536.4	1761.3	428.5	26
Mean		31.4	23.1	75.2			32.5	23.3	76.6		

Test weight (1000 grain weight) (g)

The data (Table 4) pertaining to test weight revealed that test weight was not significantly affected by different nutrient management practices with application of FYM during both the years of experimentation and in pooled data .

However, among the treatments, soil test based fertilizer scheduling with application of 10 t ha⁻¹ FYM recorded higher test weight numerically followed by STFR alone when compared to other treatments during both years. Adequate supply of all nutrients might have contributed to proper development of grain after flowering, which in turn might have favored the higher weight of the grain.

The percentage increase in test weight with STFR fertilizer recommendation with 10 t ha⁻¹ FYM (T₇), STFR fertilizer recommendation alone (T₂) was 8.62%, 8.04 %, 6.89 % and 8.04% ; 4.79, 4.17, 2.99 and 2.39%, over the targeted yield fertilizer recommendation (T₃, T₄, T₉ and T₈) at harvest during both the years 2017, 2018 and in pooled data .

Thus based on the grain yield, yield attributes, NPK soil status and economics it can be recommended to go for up to soil test based fertilizer recommendation with 10 t ha⁻¹ FYM application (156-42-28 kg NPK ha⁻¹), applied. Among the treatments with soil test based fertilizer recommendation with 10 t ha⁻¹ FYM application which was at par with soil test based fertilizer recommendation alone and 7.5 t ha⁻¹ targeted yield recommendation along with FYM (T₅ and T₁₀), and RDF with FYM (T₆). Whereas targeted yield recommendation 5.5 and 6.5 t ha⁻¹ (T₃ and T₄) found with significantly lower grain yield, availability of soil nitrogen, phosphorous, potassium, economics and yield attributes compared to the rest of treatments during both the years of study.

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