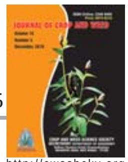
Journal of Crop and Weed, 16(1): 142-150 (2020)

ISSN- O : 2349 9400 ; P : 0974 6315



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Targeted yield approach and a framework of fertilizer recommendation in rice

D. MOUNIKA, M. MARTIN LUTHER, K. CHANDRA SEKHAR, [1]G. KISHORE BABU AND [2]K. JAYA LALITHA

Department of Agronomy, [1]Department of Soil Science and Agricultural Chemistry, [2.]Department of Crop Physiology, ANGRAU, Guntur, A.P.

Received : 21.04.2020 ; Revised : 18.06.2020 ; Accepted : 23.06.2020

DOI : 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 andgrain 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 (T_5 and T_{10}) and RDF with FYM (T_6).

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 Asiaof 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 (T_1), Soil test based fertilizer recommendation(T_2);Targeted yield fertilizer recommendations for 5.5 t ha^{-1} (T_3), 6.5 t ha^{-1} (T_4) and 7.5 t ha^{-1} (T_5) ; Treatment T_1 + FYM @ 10 t ha^{-1} (T_6); Treatment T_2 + FYM @ 10 t ha^{-1} (T_7); Treatment T_3 + FYM @ 10 t ha^{-1} (T_8); Treatment T_4 + FYM @ 10 t ha^{-1} (T_9); and Treatment T_5 + FYM @ 10 t ha^{-1} (T_{10}). 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, 15^0 54′ North Latitude, 80^0 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^{0}C to 37.9^{0}C and 26.6^{0}C to 37.6^{0}C during 2017 and 2018, respectively. The corresponding mean minimum

Email : dmounika358@yahoo.in

temperatures were 16.5^{0}C to 26.4^{0}C in 2017 and 17.7^{0}C to 26.8^{0}C, in 2018. While the average weekly maximum and minimum temperatures during the same period were 31.4^{0}C and 23.1^{0}C during 2017 and 32.5^{0}C and 23.3^{0}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 25^0 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_2O_5 (kg ha^{-1})	76.0	78.0	Olsen's method(Olsen *et al.*, 1954)
	Available K_2O (kg ha^{-1})	352.0	358.0	Neutral normal ammonium acetate method (Muhr*et al.*, 1965)

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

*FN= 2.30 x T 0.32 x SN	SN= Soil Nitrogen
*FP_2O_5=1.91 x T - 1.90 x SP	SP= Soil Phosphorous
*FK=2.27 x T - 0.27 x 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 (T_7) treatment which was at par with the application of STFR alone (T_2) 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 (T_{10}) followed by 7.5 t ha^{-1} alone (T_5) and RDF with FYM (T_6) 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 (T_7), STFR fertilizer recommendation alone (T_2) 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 T_3, T_4, T_9 and T_8 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 (T_7) treatment which was at par with the application of STFR alone (T_2) 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} (T_3) treatment which was at par with the application of STFR alone, with and without application of FYM (T_9,T_4 and T_8) 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 (T_7), STFR fertilizer recommendation alone (T_2) 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 T_3, T_4, T_9 and T_8 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 (T_7) along with high initial soil P status might have caused coating ofsesquioxides 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 (T_7) treatment which was at par with the application of STFR alone (T_2) and T_{10} 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} (T_3) treatment which was at par with the application of STFR alone with and without application FYM treatments (T_9, T_4,T_8, T_6 and T_1) and the treatmentsT_7, T_2 and T_{10} 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 (T_7), STFR fertilizer recommendation alone (T_2) 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 T_3, T_4, T_9 and T_8 respectively at maturity in pooled data.The beneficial effect of STFR with combination of 10 t ha^{-1} FYM (T_7) 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) (T_2) 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 (T_2). It is further observed that the differences in the returns obtained from rupee invested between treatments T_2 and T_5 were not significant. The lower net returns obtained in the treatments with organic manure (FYM) T_{10}, T_7, T_8 and T_9 were significantly inferior to T_2 and T_5 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_2O_5 (kg ha^{-1})			Available K_2O (kg ha^{-1})		
		1st year	2nd year	Pooled	1st year	2nd year	Pooled data	1st year	2nd 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 bysite - specific nutrient management in rice-blackgram sequence during *kharif* 2017-18, 2018-19

Treatments	**Economics**											
	Cost of cultivation			**Gross returns**			**Net returns**			**Returns $rupee^{-1}$ investment**		
	1st year	**2nd year**	**Pooled**	**1st year**	**2nd year**	**Pooled**	**1st year**	**2nd year**	**Pooled**	**1st year**	**2nd 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 toharness the synergistic effects of balanced fertilization". This was clearly evident in case of the treatment T_2 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 (T_7), followed by T_2 produced significantly higher grain yield compared to rest of the treatments. However, they were on par with that of T_{10} in the year 2018 and T_{10} and T_5 in 2017. The higher yields recorded with STFR+FYM (T_7) were5117, 6023 and 5570 kg ha^{-1} which were statistically on par with STFR application alone (T_2) *i.e*, 5099, 5805 and 5452 kg ha^{-1} during 1stand 2ndyears 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 theexact 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 (T_3) followed by other targeted yield fertilizer recommendation treatments (T_4, T_8 and T_9) were significantly inferior compared with other treatments. However, differences among the treatments based on targeted yield fertilizer recommendation treatments T_4, T_3,$T_8$and T_9 and RDF (T_1) were not statistically significant.

Grain yield recorded with 7.5 t ha^{-1} targeted yield fertilizer recommendation with FYM (T_{10}) found significantly superior over the targeted yield fertilizer recommendation treatments (T_3,T_4,$T_8$and T_9) at harvest during the year 2017 and in pooled data.The differences were not significant among the treatments T_{10}, $T_9$and T_4.

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 (T_7), STFR fertilizer recommendation alone (T_2) 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 (T_3, T_4, T_9 and T_8) 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)		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd 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) based156-42-28 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 (T_7) followed by STFR without FYM (T_2), 7.5 t ha^{-1} targeted yield with FYM (T_{10}) and without FYM (T_5) compared to rest of the treatments at harvest. Targeted yield fertilizer recommendations except for 7.5 t ha^{-1} without FYM ($T_{3,}$ $T_{4,}$ T_8 andT_9) recorded the significantly lower number of panicles m^{-2} compared to other treatments ($T_{7,}$ $T_{2,}$ $T_{10,}$ $T_{5,}$ and T_6) 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 (T_{10}) with FYM found significantly superior to other targeted yield fertilizer recommendation treatments (T_3, T_4,T_9 andT_8) 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 (T_7), STFR fertilizer recommendation alone (T_2) was 21.37 %, 21.72 %, 16.20 % & 18.62 % and 20.0 %, 20.35 %, 14.73 % &17.19 %, over the targeted yield fertilizer recommendation T_3, T_4, T_9 and T_8 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 Thavaprakaash (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 (T_7) and STFR alone (T_2) recorded significantly maximum number of filled grains $panicle^{-1}$ compared to all other treatments. However the differences in filled grains between the treatments T_2 and T_{10} were not significant during year 2017 and 2018. Though 5.5 t ha^{-1} targeted yield fertilizer recommendation(T_3) recorded lower number of filled grains $panicle^{-1}$, the differences among the rest of the treatments except T_7, T_2 and T_{10}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 *kharif* rice during 2017-18 and 2018-19

Standard meteorological Week	Date and month	2017 Mean temp (^{0}C) Max.	2017 Mean temp (^{0}C) Min.	2017 Mean RH (%)	2017 Rainfall (mm)	2017 Rainy days	2018 Mean temp (^{0}C) Max.	2018 Mean temp (^{0}C) Min.	2018 Mean RH (%)	2018 Rainfall (mm)	2018 Rainy days
30	23rd July -29th July	37.9	26.4	58.5	7.8	2	37.0	26.7	60.0	5.3	1
31	30th July-05th Aug	37.6	26.1	63.1	9.3	1	37.6	26.8	56.5	4.1	1
32	6th Aug-12th Aug	34.2	24.5	79.8	105.1	4	34.2	24.9	73.4	102.2	2
33	13th Aug-19th Aug	33.1	23.9	73.5	18.4	1	30.0	24.0	78.1	71.5	5
34	20th Aug-26th Aug	31.8	24.3	78.3	111	3	32.9	25.4	73.2	11.1	1
35	27th Aug -02nd Sep	33.3	25.2	75.8	54.7	1	34.4	25.2	75.4	7.0	1
36	03rd Sep-09th Sep	33.6	25.3	81.0	113.7	3	35.5	25.7	68.9	11.1	2
37	10th Sep-16th Sep	32.8	26.0	78.0	53.9	2	34.7	26.6	78.5	30.0	1
38	17th Sep-23rd Sep	33.9	25.9	70.6	1.4	0	32.7	24.0	84.0	50.9	4
39	24th Sep-30th Sep	33.1	24.8	83.8	70.7	5	33.3	25.3	82.6	2.4	0
40	01st Oct-07th Oct	32.1	24.9	86.2	87.8	3	34.1	25.0	80.2	11.6	1
41	08th Oct-14th Oct	32.7	25.5	80.6	11.0	1	34.8	24.8	73.0	0.0	0
42	15th Oct-21st Oct	33.6	24.5	76.0	22.2	1	32.0	24.2	83.4	23.1	2
43	22nd Oct-28th Oct	33.7	23.9	75.3	0.0	0	32.8	22.5	77.8	0.0	0
44	29th Oct-04th Nov	31.8	24.8	77.0	0.0	0	31.7	22.5	82.3	38.2	2
45	05th Nov-11th Nov	31.3	21.7	76.1	1.7	0	32.2	22.8	83.9	0.0	0
46	12th Nov-18th Nov	31.7	22.6	75.6	0.0	0	31.5	21.7	76.6	16.9	2
47	19th Nov-25th Nov	31.9	22.9	81.1	30.8	1	30.6	22.0	81.4	2.0	0
48	26th Nov-02nd Dec	30.2	19.1	72.5	0.0	0	30.8	18.8	73.2	0.0	0
49	03rd Dec-09th Dec	30.3	18.0	70.7	0.0	0	30.0	21.6	82.0	1.0	0
50	10th Dec-16th Dec	31.7	18.9	72.9	0	0	30.6	19.5	75.3	0	0
51	17th Dec-23rd Dec	30.7	17.2	72.3	0	0	26.6	18.3	82.6	47	1
52	24th Dec-31st 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 (T_7), STFR fertilizer recommendation alone (T_2) 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 (T_3, T_4, T_9 and T_8) 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 (T_5 and T_{10}), and RDF with FYM (T_6). Whereas targeted yield recommendation 5.5 and 6.5 t ha^{-1} (T_3 and T_4) 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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