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Effects of targeted yield based fertilizer application on soil properties, growth and quality of rice under rice-wheat cropping system in vertisol

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Abstract
The present investigation was carried out at the research farm of JNKVV under AICRP on STCR, Department of Soil Science and Agricultural Chemistry, College of Agriculture, JNKVV, Jabalpur (MP). The experiment was taken under the ongoing project of AICRP on STCR with six different treatments based on targeted yield of rice and wheat cropping sequence. with The six treatments were consisted as RT_1 (Control), RT_2 (GRD @ 80:50:30 NPK kgha^{-1}), RT_3 (Targeted Yield 5 t ha^{-1}), RT_4 (Targeted Yield , 6 t ha^{-1}), RT_5 (Targeted Yield ,5 t ha^{-1} with 5 t FYM ha^{-1}) and RT_6 (Targeted Yield 6 t ha^{-1} with 5 t FYM ha^{-1}) in rice crop during *kharif* season. Whereas, six treatments also consisted *i.e.*WT_1 (Control), WT_2 (GRD @ 120:80:60 NPK kgha^{-1}),WT_3 (Targeted Yield 4.5 t ha^{-1}), WT_4 (Targeted Yield , 6 t ha^{-1}), WT_5 (Targeted Yield ,4.5 t ha^{-1} with 5 t FYM ha^{-1}) and WT_6 (Targeted Yield 6 t ha^{-1} with 5 t FYM ha^{-1}) in wheat crops during *Rabi* season were tested under Randomized Block Design with four replications. The different treatments was slightly decreased than the initial soil pH value of 7.78 when pH value recorded at 0-20 cm soil depth in rice crop at 30, 60, 90 DAS and at harvesting stage. However, the different treatments of wheat crop was not significantly influence on pH of surface (0-20 cm) soils at different time interval. The EC values at 0-20 cm depth showed increasing trend over passage of time of growth as compared to initial value in rice. The EC value was increased at 30 and 60 DAS and deceased after later stage in wheat crop. An application of integrated nutrient increased organic carbon at 0-20 cm at different time intervals in both rice and wheat crop. The R T_6 treatment exhibited maximum plant height, tillers/hills and panicle length in crops. The highest yield of grain and straw was recorded in treatment RT_6 having higher target yield 5.57 t ha^{-1} and 8.53 t ha^{-1}respectively. The maximum protein content was also recorded under RT_6 in rice and wheat crops.

Keywords: Targeted yield, soil properties, rice growth, yield attributes, yield and quality

Introduction

Rice (*Oryza sativa* L.) is one of the most staple food crops, which supplies major source of calories for about 45% of world population particularly to the people of Asian countries. Rice stands second in the world after wheat in area and consumes 90% of world rice (Anonymous, 2006) [1]. An intensive agriculture for higher yields using synthetic fertilizer especially nitrogen and phosphorus enhances the production, but on the other hand addition of these fertilizers adversely effects the environment due to emission of greenhouse gases. The quantity of fertilizer depends on uptake of nutrients by crops. The dumping of fertilizers by the farmers in fields without information on soil fertility status and nutrient requirements by crops might cause adverse effects on soils and crops both regarding nutrient toxicity and deficiency either by over use or inadequate use of fertilizers. Integrated Nutrient Management approach is flexible and minimizes use of chemicals but maximize use efficiency and improve the soil health Ramamoorthy *et al.* (1967) [14]. The balanced NPK fertilization has received considerable attention in India. It provides the balanced nutrition to the crop according to the actual requirement of the crop and soil fertility conditions. The soil test crop response (STCR) approach for targeted yield is unique in indicating both soil test based fertilizer dose and the level of yield that can be achieved with good agricultural practices (Gosh *et al.*, 2004; Hegde *et al.*, 2004 and Prasad *et al.*, 2004) [6, 8, 13].

The degradation of soil health has also been reported due to long-term imbalanced use of fertilizer nutrients. Although, overall nutrient use (N: P_2O_5:K_2O) of 4:2:1 is considered ideal for Indian soils and the present use ratio of 6.8:2.8:1 is far off the mark. These imbalance nutrient use has resulted in wide gap between crop removal and fertilizer application. The partial factor productivity of fertilizers during the last three and half decades showed a declining trend from 48 kg food grains/kg NPK fertilizer in 1970-71 to 10 kg food grains/ kg NPK fertilizer in 2007-08 (Aulakh and Benbi, 2008, Subba Rao and Reddy, 2009) [3, 17]. The soil test based fertilizer application is on the basis of nutrient required by the crop to produce substantial yield. Change in cropping sequence with respect to availability of resources the integrated approach of nutrient supply through inorganic and organic (FYM) has become very much promising in building soil health and quality of produce.

Materials and Methods

The field experiment was conducted on rice crops during *Kharif* 2013 at Research Farm of Department of Soil Science & Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experimental soil was medium black belonging to fine montmorillonitic hyperthermic family of Typic Haplustert and had pH of 7.8, electrical conductivity 0.25 dSm^{-1} (1: 2.5 soil: water ratio) and organic carbon content 0.55%. The six treatments consisted of RT_1- Control, RT_2-General Recommended Dose (GRD), RT_3 - Targeted Yield 5.0 t $ha^{-1}$$RT_4$- Targeted Yield 6.0 t ha^{-1} RT_5-Targeted Yield 5.0 t ha^{-1} + 5 t FYM $ha^{-1}$and RT_6- Targeted Yield 6.0 t ha^{-1} + FYM 5 t ha^{-1} in rice during *kharif* season and six treatments as WT_1 (Control), WT_2 (GRD @ 120:80:60 NPK $kgha^{-1}$),WT_3 (Targeted Yield 4.5 t ha^{-1}), WT_4 (Targeted Yield , 6 t ha^{-1}), WT_5 (Targeted Yield ,4.5 t ha^{-1} with 5 t FYM ha^{-1}) and WT_6 (Targeted Yield 6 t ha^{-1} with 5 t FYM ha^{-1}) in wheat during *Rabi* season. The six treatments were replicated four times in a Randomized Block design for both the crops. The treated seeds of rice (Kranti) were sown in rows at proper spacing in the first week of July 2013, after basal application of fertilizers as per treatments. The soil samples were collected before sowing and after the harvest of rice crop during 2013 with the help of a tube auger (stainless steel) from each plot at 0-20 cm soil depth. The basic soil parameters were estimated by using standard laboratory procedures (Jackson, 1973) [9].

The fertilizer doses for any yield target based on soil test value fertilizer adjustment equations were computed as per procedure of Ramamoorty *et al.* 1967 [14] (Table.1 and Table. 2). The targeted yield for rice was 5.0 and 6.0 tones ha^{-1} and fixed as 80:50:30 kg ha^{-1} with NPK dose. The fertilizer materials used FYM, Urea, Single Super Phosphate and Murat of potash. The full dose of P and K and half dose of N were applied and mixed thoroughly with soil at the time of sowing. The remaining half dose of N was top-dressed in two splits at tillering stage and booting stage. The cultivation of rice was done adopting proper package of practices. The rice crop was grown under irrigated soil condition. The grain yields of rice were recorded at the harvest of crop on maturity for each treatment. The soil and plant samples were analyzed by standard laboratory procedure and analysis of variance was carried out using the Randomized Block Design as described by Gomez and Gomez, (1984) [7].

Table 1: Soil test value for rice-wheat cropping sequence

S.N.	Nutrients	Soil test value (kg ha^{-1})			
		Rice	Wheat	Rice	Wheat
		2013	2013-14	2014	2014-15
1.	Available soil N(kg ha^{-1})	230.04	196.55	223.25	195.02
2.	Available soil P(kg ha^{-1})	17.06	18.35	17.59	16.43
3.	Available soil K(kg ha^{-1})	250.74	226.34	250.58	230.46

Table 2: Fertilizer adjustment equation used for rice and wheat

a. Rice					b. Wheat				
F N	=	4.25 T	-	0.45 SN	F N	=	4.40 T	-	0.45 SN
F P_2O_5	=	3.55 T	-	4.89 SP	F P_2O_5	=	4.00 T	-	5.73 SP
F K_2O	=	2.10 T	-	0.18 SK	F K_2O	=	2.53 T	-	0.16 SK

Where,

F N= Fertilizer nitrogen (kg ha^{-1})

F P_2O_5=Fertilizer phosphorus (kg ha^{-1})

F K_2O=Fertilizer potassium (kg ha^{-1})

T= Desired yield target (q ha^{-1})

SN= Available soil nitrogen (kg ha^{-1})

SP= Available soil phosphorus (kg ha^{-1}

SK= Available soil potassium (kg ha^{-1})

Table 3: Fertilizer requirements for rice-wheat cropping sequence (2013-14)

Treatment code	Treatment details	Nutrient supplied (kg ha^{-1})			FYM (t ha^{-1})
		N	P_2O_5	K_2O	
(a) *Kharif* (Rice)					
R T_1	Control	0	0	0	0
R T_2	General recommended dose	80	50	30	0
R T_3	Targeted Yield 5 t ha^{-1}	119.12	100.73	68.85	0
R T_4	Targeted Yield 6 t ha^{-1}	161.62	136.23	89.85	0
R T_5	Targeted yield 5 t ha^{-1} + 5 t FYM ha^{-1}	69.12	50.73	18.85	5
R T_6	Targeted Yield 6 t ha^{-1} + 5 t FYM ha^{-1}	111.62	86.13	32.85	5
(b) *Rabi* (Wheat)					
W T_1	Control	0	0	0	0
W T_2	General recommended dose	120	80	60	0
W T_3	Targeted Yield 4.5 t ha^{-1}	117.72	82.99	78.90	0
W T_4	Targeted Yield 6 t ha^{-1}	178.61	145.57	119.54	0
W T_5	Targeted Yield 4.5 t ha^{-1} + 5 t FYM ha^{-1}	107.68	89.69	79.08	5
W T_6	Targeted Yield 6 t ha^{-1} + 5 t FYM ha^{-1}	183.72	145.05	115.60	5

Table 4: Fertilizer requirement for rice-wheat cropping sequence (2014-15)

Treatment code	Treatment details	Nutrient supplied (kg ha^{-1})			FYM (t ha^{-1})
		N	P_2O_5	K_2O	
(a) *Kharif* (Rice)					
R T_1	Control	0	0	0	0
R T_2	General recommended dose (GRD)	80	50	30	0
R T_3	Targeted Yield 5 t ha^{-1}	82.67	99.156	81.07	0
R T_4	Targeted Yield 6 t ha^{-1}	111.05	141.753	96.54	0
R T_5	Targeted yield 5 t ha^{-1} + FYM 5 t ha^{-1}	88.31	92.463	73.16	5
R T_6	Targeted Yield 6 t ha^{-1} + FYM 5 t ha^{-1}	122.34	153.244	90.09	5
(b) *Rabi* (Wheat)					
W T_1	Control	0	0	0	0
W T_2	General recommended dose (GRD)	120	80	60	0
W T_3	Targeted Yield 4.5 t ha^{-1}	130.26	100.76	91.99	0
W T_4	Targeted Yield 6 t ha^{-1}	193.75	142.76	131.01	0
W T_5	Targeted Yield 4.5 t ha^{-1} + FYM 5 t ha^{-1}	122.73	55.03	91.63	5
W T_6	Targeted Yield 6 t ha^{-1} + FYM 5 t ha^{-1}	206.30	149.69	130.83	5

Results and Discussion

Write conclusion in 100-120 following

Soil properties

Soil pH

Soil pH is an intrinsic property which is decided by the exchangeable cations on clay surface and taken larger time to get change. The data on pH of surface (0-20 cm) soil recorded at 30, 60, 90 DAS at harvest of rice and wheat are presented in (Table 5). In general, the pH value recorded at 0-20 cm soil in rice crop at 30, 60, 90 DAS and at harvest under different treatments was slightly decreased than the initial soil pH value of 7.78 on the mean basis during both the years. The data recorded on pH at 0-20 cm soil of rice crop revealed that different treatments did not significantly influence at different interval on the mean basis during both the years. However, maximum pH was observed under control (RT_1) followed by GRD @ 80:50:30 NPK kgha^{-1} (RT_2) on the mean basis during both the years. Whereas, other treatments were almost similar values of pH at 0-20 cm (pH 7.65 to 7.69) at different interval on the basis of mean during both the years.

The different treatments significantly influence on pH in surface (0-20 cm) soils at different time interval on the mean basis during both the years in wheat crop. However, maximum pH was found in control (WT_1) at different interval during on the basis of mean during both the years. The treatments T. Y. 4.5 t + 5 t FYM ha^{-1} (WT_5)and T. Y. 6.0 t + 5 t FYM ha^{-1} (WT_6) recorded relatively lower pH as compared to others during both the years at 90 DAS and harvest stage. The different treatments significantly decreased than the initial pH value of 7.77 at 0-20 cm soil in wheat at 30, 60, 90 DAS and harvest stage on the basis of mean during both the years (Table 6).

Electrical conductivity (dSm^{-1})

The data on EC of surface (0-20 cm depth) soils recorded at 30, 60, 90 DAS and at harvest of rice and wheat are presented in (Table 7). In general, the EC at 0-20 cm soil depth in rice at 30, 60, 90 DAS and at harvest under different treatments was increased as compared to the initial soil EC value of 0.22 (dSm^{-1}) during on the basis of mean during both the years. Further, EC values in soil at 0-20 cm revealed slightly increasing trend from 30 DAS to harvest. The data on EC at 0-20 cm soil depth in rice crop revealed that different treatments did not exert significant influence on this parameter at different stages of rice during on the basis of mean both the years. However, numerically maximum EC value was observed under T.Y. 5.0 t ha^{-1} + 5 t FYM ha^{-1} (RT_5) and T.Y.6.0 t ha^{-1} (RT_4) at 0-20 cm depth of soil at harvest stage.

The different treatments failed to have significant impact on EC values at 0-20 cm of soil during on the basis of mean both the years in wheat crops. The EC values increased from 30 DAS to 60 DAS, thereafter it declined at 90 DAS and again it increased slightly at harvest during both the years on the mean basisat 0-20 cm soil. The maximum EC values at 0-20 cm soil depth were noted at 60 DAS in all the treatments during both the years. Numerically maximum EC value was recorded in T. Y. 6.0 t ha^{-1} (WT_4) followed by T. Y. 4.5 t ha^{-1} + 5 t FYM ha^{-1} (WT_5), T. Y. 4.5 t ha^{-1} (WT_3) and T. Y. 6.0 t ha^{-1} + 5 t

FYM ha^{-1} (WT_6) at harvest stageon the mean basis at 0-20 cm soil depth (Table 8).

Soil organic carbon (g kg^{-1})

Soil organic carbon is key soil property for evaluating the soil health. The data on soils organic carbon of surface (0-20 cm) soil at 30, 60, 90 DAS and at harvest of rice and wheat are presented in (Table 9 and Table 10).

The data on organic carbon in soil at 0-20 cm revealed that different treatmentswere significant effect on this parameter at different time interval of rice on the basismean during both the years. Treatment T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1} (RT_6) havesignificantly higher organic carbon at 0-20 cm depth at different time interval as compared to others during both the years. However, treatment T.Y.5.0 t ha^{-1}+ 5 t FYM ha^{-1} (RT_5) was at par at 60 DAS on the basis of mean during 2014. Treatment T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1} (RT_6) showed significantly higher organic carbon as compared to others at 20-40 cm soil at various time interval of riceduring both the years. However, it was comparable to treatment T.Y.5.0 t ha^{-1}+ 5 t FYM ha^{-1} (RT_5)at harvest during 2013.

As regards to wheat crop, the organic carbon was significantly higher in treatment T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1} (WT_6) at 0-20 cm depth of soil as compared to others at different time interval on the basis of mean during both the years. However, it was at par to treatment T.Y.4.5 t ha^{-1}+5 t FYM ha^{-1} (WT_5) at 30 DAS on the basis of mean during 2013 and at 60 DAS during 2014. Further, treatments T.Y.6.0 t ha^{-1}(WT_4) and T.Y.4.5 t ha^{-1}(WT_3) also recorded at par values of organic carbon on the basis of mean at 30 DAS.

Growth parameters

The effect of soil test based fertilizer application ongrowth parameters data were presented in (Table 11)

Themaximumplant height was recorded in treatment RT6 and minimum was recorded in RT_1 (44.85 cm)followed by RT2 (63.95 cm). However, RT_3, RT_4 and RT_5 were at par with RT_6 in both year of cropping sequence (2013 and 2014). Similar resultswere also reported by Sahu *et al.*, (2015) [16].

The data recorded on number of tillers hill^{-1} showed significant variation and it was found maximum (9.29) under RT_6 which was at par with RT_3, RT_4 and RT_5 whereas, the minimum number of tillers hill^{-1} (4.35) was recorded in RT_1 followed by RT_2 in both year of cropping sequence. Similar result was also reported by Tabar *et al.*, (2012) [20].

The number of tillers and panicle hill^{-1}were significantly recorded higher in treatment RT_6(9.23) over all the treatments except RT_3, RT_4 andRT5 which was being at par in both years of cropping sequence. However, the minimum number of tillers and panicle hill^{-1} (4.15) associated with RT_1 (control) followed by (RT_2) in both year of cropping sequence. Similar results were also reported by Sahu *et al.* (2015) [16] and Chaubey *et al.*, (2015) [4]. The higher number of tillers and panicle hill^{-1} (9.23) significantly higher in treatment RT_6in over all the treatments except RT_3, RT_4andRT_5 which was being at par in both years of cropping sequence. However, the minimum number of tillers and panicle hill^{-1} (4.15) associated with RT_1 (control) followed by (RT_2), respectively in both year of cropping sequence. Similar results were also reported by Tan *et al.*, (2000) [12].

Grain and straw yields

A perusal of data of grain and straw yieldof paddy given in Table 12 indicated significant variation due to different treatments and were found significantly higher over control. The higher target of 6 t ha^{-1} (T.Y.6 t ha^{-1} + 5 t ha^{-1} FYM) could not be achieved and deviated by ± 6.17% negatively, whereas, the target of 5 t ha^{-1} (T.Y.5 t ha^{-1} + 5 t ha^{-1} FYM) was obtained comfortably. The grain yield target was achieved only in treatment RT5 (T.Y.5 t ha^{-1} + 5 t ha^{-1} FYM) which was significantly increased over control having increased by 60.32 percent. The treatment RT_6 target (T.Y.6 t ha^{-1} + 5 t ha^{-1} FYM) could not be achieved however; it was significantly superior over rest of the treatments, except RT4 and RT5 in both years of cropping sequence. The yield increased over GRD due to 6 t ha^{-1} target (T.Y.6 t ha^{-1} + 5 t ha^{-1}FYM) was 25.04 percent. This result confirms with the result reported by Roy *et al.*, (1997) [15], Mishra and Vyas (1992) [10]. Pandya *et al.* (2005) [11], Dwivedi *et al.* (2011) [5], Mishra *et al.* (2015) [11] and Sahu *et al.* (2015) [16] were reported that the overall increase in yield due to treatments either GRD or soil test based fertilizer fix application for fix target with and without FYM have markedly augmented yield of paddy.

Protein content (%)

The effect of soil test based fertilizer application on grain and straw protein content of rice shown on **(**Table 12). It was observed that the protein content gradually increased ranging from 5.97 to 7.70 percent differing significantly with control. The highest protein content was recorded in RT_6 (TY 6 t ha^{-1} + 5 t ha^{-1}FYM) in both year of cropping sequence. Similar finding have been also reported by Tayefe *et al.* (2012) [18].

Table 5: pH of rice- growing soil (0-20cm) at different time interval as influenced by targeted yield- based nutrient application

Treatment	pH at 0-20 cm of rice- growing soil											
	30 DAS			60 DAS			90 DAS			At harvest		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
RT_1- Control	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.68	7.69	7.69	7.68	7.69
RT_2- GRD@ 80:50:30 NPK kgha^{-1}	7.68	7.68	7.68	7.69	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.67
RT_3 - T.Y.5.0 t ha^{-1}	7.67	7.67	7.67	7.68	7.68	7.68	7.68	7.67	7.68	7.68	7.67	7.67
RT_4- T.Y.6.0 t ha^{-1}	7.67	7.67	7.67	7.68	7.68	7.68	7.68	7.67	7.68	7.68	7.67	7.67
RT_5- T.Y.5.0 t ha^{-1}+5 t FYM ha^{-1}	7.67	7.66	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.66
RT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	7.67	7.65	7.66	7.67	7.67	7.67	7.66	7.66	7.66	7.66	7.66	7.66
S Em ±	0.01	0.01	0.01	0.008	0.006	0.006	0.008	0.01	0.007	0.008	0.013	0.007
CD (p = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 6: pH of wheat- growing soil (0-20 cm) at different time interval as influenced by targeted yield-based nutrient application

Treatment	pH at 0-20 cm of wheat - growing soil											
	30 DAS			60 DAS			90 DAS			At harvest		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
WT_1- Control	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69
WT_2- GRD@ 120:80:60 NPK kg ha^{-1}	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68
WT_3 - T.Y.4.5 t ha^{-1}	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68
WT_4- T.Y.6.0 t ha^{-1}	7.68	7.68	7.68	7.68	7.68	7.68	7.67	7.68	7.68	7.67	7.67	7.67
WT_5- T.Y.4.5 t ha^{-1}+ 5 t FYM ha^{-1}	7.68	7.68	7.68	7.68	7.67	7.67	7.66	7.66	7.66	7.67	7.66	7.66
WT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	7.68	7.67	7.68	7.67	7.67	7.67	7.66	7.66	7.66	7.67	7.66	7.66
S Em ±	0.007	0.008	0.005	0.008	0.01	0.01	0.010	0.007	0.005	0.005	0.005	0.003
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 7: EC (dSm^{-1}) of rice- growing soil (0-20cm) at different time interval as influenced by targeted yield- based nutrient application

Treatment	EC (dSm^{-1}) at 0-20 cm of rice - growing soil											
	30 DAS			60 DAS			90 DAS			At harvest		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
RT_1- Control	0.203	0.195	0.199	0.205	0.196	0.200	0.202	0.222	0.212	0.250	0.253	0.251
RT_2- GRD@ 80:50:30 NPK $kgha^{-1}$	0.230	0.218	0.224	0.231	0.220	0.225	0.206	0.230	0.218	0.243	0.240	0.241
RT_3 - T.Y.5.0 t ha^{-1}	0.218	0.205	0.211	0.222	0.208	0.215	0.207	0.233	0.220	0.245	0.258	0.251
RT_4- T.Y.6.0 t ha^{-1}	0.233	0.218	0.225	0.233	0.220	0.226	0.220	0.225	0.223	0.248	0.258	0.253
RT_5- T.Y.5.0 t ha^{-1}+5 t FYM ha^{-1}	0.218	0.198	0.208	0.223	0.203	0.213	0.207	0.222	0.214	0.235	0.270	0.253
RT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	0.228	0.203	0.215	0.226	0.211	0.218	0.214	0.223	0.218	0.235	0.258	0.246
S Em ±	0.008	0.006	0.005	0.006	0.006	0.004	0.006	0.010	0.007	0.006	0.005	0.004
CD (p = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 8: EC (dSm^{-1}) of wheat - growing soil (0-20cm) at different time interval as influenced by targeted yield - based nutrient application

Treatment	EC (dSm^{-1}) at 0-20 cm of wheat - growing soil											
	30 DAS			60 DAS			90 DAS			At harvest		
	2013-14	2014-14	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
WT_1- Control	0.190	0.193	0.191	0.249	0.249	0.249	0.211	0.215	0.213	0.228	0.234	0.231
WT_2- GRD@ 120:80:60 NPK kg ha^{-1}	0.200	0.205	0.203	0.253	0.253	0.253	0.205	0.210	0.207	0.233	0.238	0.235
WT_3 - T.Y.4.5 t ha^{-1}	0.198	0.208	0.203	0.259	0.258	0.259	0.210	0.217	0.213	0.233	0.240	0.236
WT_4- T.Y.6.0 t ha^{-1}	0.195	0.210	0.203	0.261	0.261	0.261	0.211	0.216	0.213	0.238	0.242	0.240
WT_5- T.Y.4.5 t ha^{-1}+ 5 t FYM ha^{-1}	0.218	0.210	0.214	0.262	0.264	0.263	0.204	0.212	0.208	0.230	0.243	0.237
WT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	0.210	0.208	0.209	0.263	0.265	0.264	0.210	0.216	0.213	0.235	0.238	0.236
S Em ±	0.006	0.006	0.004	0.002	0.002	0.001	0.012	0.008	0.009	0.004	0.004	0.003
CD (p = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 9: Organic carbon (g kg^{-1}) of rice - growing soil (0-20 cm) at different time interval as influenced by targeted yield- based nutrient application

Treatment	Organic carbon (g kg^{-1}) at 0-20 cm of rice - growing soil											
	30 DAS			60 DAS			90 DAS			At harvest		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
RT_1- Control	4.90	4.90	4.90	4.80	4.80	4.80	4.80	5.00	4.30	4.50	4.70	4.20
RT_2- GRD@ 80:50:30 NPK $kgha^{-1}$	5.30	5.30	5.30	5.50	5.50	5.50	5.50	5.70	5.10	6.10	5.50	5.00
RT_3 - T.Y.5.0 t ha^{-1}	5.90	5.80	5.90	6.20	6.20	6.20	5.80	5.60	5.40	6.30	5.60	5.20
RT_4- T.Y.6.0 t ha^{-1}	6.10	6.10	6.10	6.30	6.40	6.40	5.90	6.10	5.90	6.30	5.70	5.40
RT_5- T.Y.5.0 t ha^{-1}+5 t FYM ha^{-1}	6.20	6.40	6.30	6.40	6.60	6.50	6.20	5.80	5.90	6.30	5.90	6.10
RT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	6.30	6.50	6.40	6.50	6.60	6.50	6.30	6.40	6.20	6.50	6.40	6.45
S Em ±	0.02	0.01	0.01	0.017	0.008	0.01	0.008	0.020	0.006	0.014	0.011	0.004
CD (p = 0.05)	0.06	0.03	0.04	0.052	0.025	0.03	0.025	0.061	0.020	0.045	0.033	0.014

Table 10: Organic carbon (g kg^{-1}) of wheat - growing soil (0-20 cm) at different time interval as influenced by targeted yield- based nutrient application

Treatment	Organic carbon (g kg^{-1}) at 0-20 cm of wheat- growing soil											
	30 DAS			60 DAS			90 DAS			At harvest		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
WT_1- Control	4.33	4.23	4.28	4.35	4.45	4.40	4.73	4.75	4.74	4.68	4.75	4.71
WT_2- GRD@ 120:80:60 NPK kg ha^{-1}	5.20	5.13	5.16	4.80	4.85	4.83	5.25	5.40	5.33	5.28	5.35	5.31
WT_3 - T.Y.4.5 t ha^{-1}	5.33	5.43	5.38	4.95	5.13	5.04	5.38	5.60	5.49	5.35	5.53	5.44
WT_4- T.Y.6.0 t ha^{-1}	5.50	5.58	5.54	5.05	5.33	5.19	5.63	5.70	5.66	5.53	5.63	5.58
WT_5- T.Y.4.5 t ha^{-1}+ 5 t FYM ha^{-1}	5.53	5.63	5.58	5.25	5.50	5.38	5.65	5.73	5.69	5.65	5.75	5.70
WT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	5.55	5.70	5.63	5.35	5.50	5.43	5.90	5.98	5.94	5.85	5.98	5.91
S Em ±	0.009	0.006	0.006	0.006	0.006	0.004	0.006	0.006	0.003	0.010	0.019	0.010
CD (p = 0.05)	0.030	0.018	0.018	0.018	0.018	0.012	0.018	0.018	0.012	0.032	0.058	0.031

Table 11: Effect of soil test based fertilizer application on growth and yield attributes of rice crop (2013-2014)

Treatments	Plant height (cm)		Tillers hill^{-1}		Panicleshill^{-1}		Panicle length (cm)	
	2013	2014	2013	2014	2013	2014	2013	2014
RT_1- Control	44.85	43.06	4.88	4.35	4.15	4.15	17.45	17.34
RT_2- GRD@ 80:50:30 NPK kgha^{-1}	63.95	59.91	7.75	7.61	7.47	7.47	20.28	20.79
RT_3 - T.Y.5.0 t ha^{-1}	72.80	69.06	8.50	8.43	8.31	8.31	20.95	21.07
RT_4- T.Y.6.0 t ha^{-1}	73.70	70.93	8.98	8.63	8.55	8.55	22.47	23.02
RT_5- T.Y.5.0 t ha^{-1}+5 t FYM ha^{-1}	77.70	70.92	9.20	8.97	8.87	8.87	22.02	23.19
RT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	78.50	73.92	9.78	9.29	9.23	9.23	22.40	23.25
SEm ±	2.93	1.62	0.22	0.29	0.32	0.32	0.48	0.36
CD(p=0.05)	8.82	4.90	0.68	0.89	0.97	0.97	1.44	1.08

Table 12: Effect of soil test based fertilizer application on grain, straw yield and protein content (%) of rice.

Treatment	Grain (t ha^{-1})		Straw (t ha^{-1})		Protein content (%)	
	2013	2014	2013	2014	2013	2014
RT_1- Control	3.11	2.21	4.32	3.47	5.80	5.97
RT_2- GRD@ 80:50:30 NPK kgha^{-1}	4.16	4.26	5.95	6.38	6.63	6.37
RT_3 - T.Y.5.0 t ha^{-1}	4.57	4.78	6.53	7.25	6.74	6.61
RT_4- T.Y.6.0 t ha^{-1}	5.94	5.22	8.50	7.97	7.29	7.00
RT_5- T.Y.5.0 t ha^{-1}+5 t FYM ha^{-1}	4.79	5.57	6.84	8.53	7.73	7.16
RT_6- T.Y.6.0 t ha^{-1}+ 5 t FYM ha^{-1}	6.62	5.63	9.47	8.68	8.12	7.70
SEm ±	0.23	0.17	0.33	0.28	0.49	0.185
CD(p=0.05)	0.69	0.52	0.99	0.85	1.46	0.556

Conclusion

In conclusion, the study reveals significant insights into the dynamic nature of soil properties, particularly pH, electrical conductivity (EC), and organic carbon content, influenced by different treatments in rice and wheat crops. While soil pH exhibited slight variations under different treatments, it remained relatively stable over time. Conversely, EC showed an increasing trend with time, influenced by various treatments. Organic carbon content, crucial for soil health, exhibited significant variations across treatments and time intervals, particularly favoring treatments with higher organic inputs. Growth parameters such as plant height, tillers per hill, and panicle per hill were significantly influenced by treatments, with notable variations observed. Grain and straw yields were significantly impacted by treatments, with certain treatments surpassing yield targets, particularly those incorporating organic inputs. Additionally, protein content in grains showed significant improvement under specific treatments, emphasizing the role of soil management practices in enhancing crop quality. Overall, the findings underscore the importance of tailored soil management strategies in optimizing soil health and crop productivity.

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