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Effect of Integrated Nutrient Management on Growth and Yield of Rice (*Oryza sativa* L.)

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Keywords

Rice, INM, Growth, Yield

A B S T R A C T

The present investigation entitled “Effect of integrated nutrient management on growth and yield of rice (*Oryza sativa* L.) was conducted at Research Farm, Bihar Agricultural College, Bihar Agricultural University, Sabour during *Kharif* season 2014 to evaluate the impact of continuous use of inorganic fertilizers and organic nutrients on productivity, economics and soil fertility status. Growth attributes such as plant height (96.8 cm), number of tiller m^{-2} (332), LAI(4.22) and dry matter accumulation (1285.7 gm^{-2}) were found highest with the treatment T_5 (50 % RDF + 50 % N through FYM) but remained at par with all the treatment where either 25 or 50 % N was substituted through organic sources (T_6 toT_{10}). The differences in growth attributes were statistically alike between 100 % RDF and treatments supplicated either 25 or 50 % N through organic sources (T_6 toT_{10}). Maximum number of days taken to 50 % flowering (98.7 days) and maturity (136.5 days) were recorded with T_5 (50 % RDF+50 % N as FYM) but remained at par with all the treatment where either 25 or 50 % N was substituted through organic sources (T_6 to$T_{10)}$ and also with 100 % inorganic source only.

Introduction

Rice (*Oryza sativa* L.) is a staple food crop in South, South-East and East Asia. Rice supplies 20% and 31% of the total calories required by world and Indian population, respectively. It is estimated that rice requirement of India by 2020 will be 118.93 MT (Sahane *et al.,* 2013). Imbalanced nutrient management under intensive cropping system and decreased soil organic matter are the key factors responsible for decline in soil quality parameters (Kang *et al.,* 2005) such as deterioration of the physical, chemical and biological health of soils, and declined factor productivity, due to much higher annual removal of nutrients by crops and cropping systems than the amount added through fertilizers and resulted negative nutrient balance. In recent past, Indian farmers showed tendency to apply more nitrogenous fertilizers to maximize rice yield. High nitrogen application without appropriate balance with phosphorus, potassium and other nutrients resulted negative effect on soil (Kumar *et al.,* 2011). The improved genotypes of cereals require large quantities of nitrogen for the expression of their production potential especially under low soil nitrogen. Fertilizer N and bio-sources are the major sources of nitrogen supply for crops. Inorganic fertilizer is not a complete substitute for organic matter and vice–versa and their role is complementary to each other. Either organic manures or chemical fertilizers alone can achieve the sustainability of production system under intensive farming. The increasing cost of chemical input, pollution, soil health and sustainability of the production system had generated interest in the integrated nutrient management.

The integrated nutrient supply system is the most logical concept for managing long-term soil fertility and productivity (Ramesh *et al.,* 2009). Use of chemical fertilizers and organic manures has been found promising in arresting the decline trend in soil-health and productivity through the correction of marginal deficiencies of some secondary and micro-nutrients, micro-flora and fauna and their beneficial influence on physical and biological properties of soil. Integrated nutrient management system can bring about equilibrium between degenerative and restorative activities in the soil eco-system (Upadhyay *et al.,* 2011).

Green manuring has twin benefits of soil quality and fertility enhancement while meeting a part of nutrient needs of crop. Organic manures provide regulate supply of N by releasing it slowly resulting in increased yield of rice and nutrient use efficiency (Sharma 2002). Crop residues have potential for improving the soil and water conservation, sustaining soil productivity and enhancing crop yields (Das *et al.,* 2003). Integrated use of inorganic fertilizers, organic manures, green manures and crop residue are the only alternatives which may help in improving soil health and sustained productivity. Use of organic manures, green manures, crop residues along with inorganic fertilizers not only reduces the demand of inorganic fertilizers but also increases the efficiency of applied nutrients due to their favorable effect on physical, chemical and biological properties of soil (Pandey *et al.,* 2007), as organic manure provide a good substrates for the growth of microorganism and maintain a favorable nutrient supply to crop and achieve sustainable crop production.

However, due to above point the main purpose of this research is to study the effect of INM on growth and yield parameters of rice.

Materials and Methods

The present investigation entitled “Effect of integrated nutrient management on growth and yield of rice (*Oryza sativa* L.)’’ was under taken during *kharif* season 2014 from the ongoing long-term field experiment “Integrated Nutrient Management in rice-wheat cropping system” initiated since 1984 at Research Farm, Bihar Agriculture College, Bihar Agriculture University, Sabour. The experiment was laid out in a randomized block design with 10 treatment combinations, comprised of inorganic and organic sources of nutrients *i.e*. T_1(Control), T_2 (50 % RDF), T_3(75 % RDF), T_4(100 % RDF), T_5(50 % RDF + 50 % N through FYM), T_6 (75% RDF + 25 % N through FYM),T_7(50 % RDF + 50 % N through wheat straw), T_8 (75 % RDF + 25 % N through wheat straw), T_9(50 % RDF + 50 % N through sesbania green manuring), T_{10} (75 % RDF + 25% N through sesbania green manuring).

Experiment site is situated at latitude of 25°15'4" N and a longitude of 78°2'4" E with altitude of 37.19 m above the mean sea level in Bhagalpur district of Bihar state under Gangetic plains of India. Sabour has a sub-tropical climate characterized with hot desiccating summer, cold winter and moderate annual rainfall. The experimental plot was sandy loam in texture, neutral pH (7.4), low in organic carbon (0.46%) and available nitrogen (246 kg ha^{-1}), medium in available phosphorus (23.6 kg ha^{-1}) and potassium (155 kg ha^{-1}). Rice variety "Sita" was used as test variety in this experiment. Rice variety 'Sita' 20 days aged, 2-3 seedlings were transplanted per hill at 15x15 cm spacing on 09th July, 2014. The crop was harvested on 3rd November, 2014.

The data recorded in respect to different observation in the study were analyzed statistically with the help of computer following the MSTAT procedure for randomize block design (RBD) as suggested by Cochran and Cox 1977. The standard error of means was calculated in each case and critical difference (CD) at 5% level of probability was worked out for comparing the treatment means, wherever 'F' test was found significant. The data on plant growth recorded at 30, 60, 90 and at harvest.

Results and Discussion

Effect of Integrated nutrient management on growth parameters

Plant height

The plant height increased rapidly due to integrated nutrient supply up to 90 DAT. Subsequent elongations was slower particularly between 90 DAT and at harvest mainly because of higher demand of photosynthetic to meet the reproductive requirement after reduction division stage. In the present study the plant height increased with increasing fertility level from T_1 (control) to T_4 (100% RDF). Significantly taller plants (97.63 cm) (Table-1) was recorded with T_5 (50% RDF+50 % N as FYM) which was comparable to almost plots substituted either25 or 50 % N by organic source along with 75 or 50 % N as inorganic source (T_6 to T_{10}) and also with T_4 (100% RDF), but superior over control/under fertilized (T_1- $T_{3)}$ plotsat all the growth stages and at harvest stage. This might be attributed due to the fact that higher doses of nutrients resulted in higher availability of nutrients in the soil for plant nourishment and further, organic source which slow release and continuous availability of nutrients enhanced cell division, elongation as well as various metabolic processes which ultimately increased the plant height. The results have got close conformity with the findings of Krishna *et al.*, (2008), Dutt and Chauhan (2010) and Murthy (2012).Integration of 25 or 50 % Organic nutrients as (FYM/GM) with 50 or 75% inorganic release slow and continuous nutrients to the plant, and improved soil environment for better root penetration leading to better absorption of moisture and nutrients and produced better plant height and growth. These findings are in close agreement with those of Aruna and Mohhamad (2005) and Barik *et al.*, (2006). Bellakki *et al.*, (1998) reported the superior performance of organic N as FYM /GM might be owing to reduced loss of N by fixation of NH_4^+ ion with humus present in FYM and increased availability of N to crop which ultimately increased the plant height.

Number of tillers m^{-2}

The data on tillers m^{-2} recorded at regular interval (Table-2) indicated that the tillers m^{-2} steady increase in the number of tillers m^{-2} up to the stage of 60 DAT, thereafter declined with the advancement in age. The reduction in the number of tillers after 60 days resulted due to the ageing and senescence which was responsible for dying of the secondary and tertiary tillers. The present study observed that increasing fertility level from 0-100% RDF (T_1 to T_4) and maximum tillers m^{-2} was recorded under integrated nutrient management T_5 (50% RDF+50 % N as FYM) which was at par with either 25 or 50 % N substituted by organic source (T_6 to $T_{10)}$ at all the growth stages and at harvest stage. This might be attributed due to the fact that higher doses of nutrients resulted in higher availability of nutrients in the soil for plant nourishment and further, organic source, release slow and continuous availability of nutrients which enhanced cell division, elongation as well as various metabolic processes which ultimately increased the tillers and source capacity of the plant. The results have got close conformity with the findings of Krishna *et al.,* (2008), Dutt and Chauhan (2010) and Murthy (2012). Tillering is the product of the expansion of auxiliary buds which is closely associated with the nutritional conditions of the culm because a tiller receives carbohydrate and nutrient from the culm during its early growth period which improved by the application of nitrogen (Tisdale and Nelson, 1975). Similarly, Bellakki *et al.,* (1998) reported the superior performance of organic N as FYM /GM might be owing to reduced loss of N by fixation of NH_4^+ ion with humus present in FYM and increased availability of N to crop which ultimately increased the tillers.

LAI (Leaf area Index) and chlorophyll content

LAI (Leaf area Index) and chlorophyll content were higher at flowering stage after that got declined till harvest, this was due to adequate supply of nutrient to the plant and potential of plant for its absorption (Masoni *et al.*, 1993). Present investigation noticed that increasing fertility level from 0-100% RDF (T_1 toT_4) increased LAI and SPAD value and maximum LAI (4.22) and SPAD (38.78) value were recorded with T_5 (50% RDF+50 % N as FYM) (Table- 3. and 4. respectively), which was at par with 25–50 % N substituted by organic source as in T_{6} – T_{10}almost growth stages which ultimately increased the source capacity. Bellakki *et al.,* (1998) reported the superior performance of organic N as FYM /GM might be owing to reduced loss of N by fixation of NH_4^+ ion with humus present in FYM and increased availability of N to crop which ultimately increased the tillers. The results have got close conformity with the findings of Krishna *et al.*, (2008), Dutt and Chauhan (2010) and Murthy (2012).

Dry matter accumulation and Crop growth rate

Dry matter production progressively increased up to harvest and the increase was remarkable from flowering to harvest because after heading and flowering, the increase in the weight of the ear become very marked (Ishizuka,1971).Application of 50 % RDF + 50% N through FYM (T_5) in rice recorded significantly highest dry matter accumulation (1285.75) (Table-5) and Crop growth rate (CGR) (Table-6), which was at par to all the treatment where either 25 or 50 % N was substituted through organic sources (T_6, T_7, T_8, $T_9$and T_{10})as compared to unfertilized plots (T_1-T_3) at all the growth stages. This might be attributed due to the fact that higher doses of nutrients resulted in higher availability of nutrients in the soil for plant nourishment and further, organic source release slow and continuous availability of nutrients enhanced cell division, elongation as well as various metabolic processes which increased plant growth attributes which ultimately attained the highest source capacity and dry matter accumulation. The results have got close conformity with the findings of Krishna *et al.*, (2008), Dutt and Chauhan (2010) and Murthy (2012). This clearly indicated superiority of organic sources over the inorganic were more pronounced. This is due to slow release and continuous availability of nutrients to the plant, and improved soil environment for better root penetration leading to better absorption of moisture and nutrients.

Thus, plants supplied with adequate amount of major nutrients produced more leaves and brought about greater accumulation of photosynthates, produced taller plant, more no. of tillers hill^{-1} and finally dry matter accumulation.

These findings are in close agreement with those of Aruna and Mohhamad (2005) and Barik *et al.*, (2006). The increase in crop growth characters may be attributed to mineralization of FYM or through soubilization of nutrients from native source during the process of decomposition.

The better crop growth with combined use of nutrients in desired quantity may be attributed to improvement in physico-chemical and biological properties of soil which maintained continuous supply of nutrient to crop.

Days taken to 50% flowering and Days taken to maturity

Days taken to 50 % flowering and maturity of rice were affected significantly with increasing doses of nutrients (NPK) from 0 to 100% RDF applied either through fertilizers alone or in combination with organic manure. However, 2-5 days and 2-10 days delay in flowering and maturity was recorded with 50-100% RDF applied either chemical source only or in combination of INM. Maximum number of days taken to 50% flowering and maturity were recorded with T_5 (50 % RDF+50 % N as FYM) which remained at par to all the treatment where 25-50 % N applied as organic source T_6,T_7,T_8,T_9 and T_{10}) and with T_4 (100 % RDF) but lowest was recorded with T_1 (control). This might be due to better availability of nutrients applied either through fertilizers or in combination with organic sources increased vegetative phase of the crop vis-a-vis delayed flowering and maturity as compared to sub-optimal supply of nutrients to rice crop.

Effect of integrated nutrient management on yield attributes and yield

Yield Attributes

In the present investigation yield and yield attributing characters *viz*. number of panicle, panicle length, grains panicle^{-1} and test weight (Table 4.8) were discussed. Distinct positive effect of INM was noticed on these yield attributes. All these parameters attained higher values with increasing NPK level from unfertilized to 100 % RDF and further when 25 or 50 % nutrients substituted through organic sources viz FYM, GM or wheat straw brought about appreciable increase in yield attributing characters and finally grain as well as straw yield.

Significantly higher yield attributes (number of panicle, panicle length, grains panicle^{-1} and test weight) were recorded with T_5 (50%RDF+50%N as FYM) which remained at par to all the treatment where 25-50 % N applied as organic source (T_6, T_7, T_8, T_9 and T_{10}) and also in T_4 (100 % RDF) but lowest was recorded with T_1 (control).

Table.1 Effect of INM on plant height (cm) at different growth stages of rice

Treatment	**Plant height (cm)**			
	30 DAT	**60 DAT**	**90 DAT**	**At harvest**
T_1:Control	42.78	55.33	62.30	60.33
T_2: 50%RDF	46.89	58.78	71.49	70.77
T_3: 75%RDF	51.33	62.00	79.98	79.18
T_4: 100%RDF	54.56	65.00	89.19	88.30
T_5: 50%RDF+50%FYM	59.33	75.00	97.63	96.82
T_6: 75%RDF+25%FYM	57.11	68.33	92.22	91.30
T_7: 50%RDF +50%WS	58.11	70.78	94.68	93.81
T_8: 75%RDF+25%WS	55.11	66.00	86.48	85.62
T_9: 50%RDF+50%GM	59.00	72.22	97.24	96.24
T_{10}:75%RDF+25%GM	56.33	67.33	89.17	88.28
SEm±	2.33	2.43	5.10	5.18
CD (P=0.05)	6.93	7.21	15.15	15.40

Table.2 Effect of INM on tiller m-2 at different growth stages of rice

Treatment	**Tiller m^{-2}**			
	30 DAT	**60 DAT**	**90 DAT**	**Maturity**
T_1:Control	95.33	105.31	91.57	90.67
T_2: 50%RDF	214.37	248.71	231.32	221.31
T_3: 75%RDF	221.47	298.01	283.15	270.90
T_4: 100%RDF	230.97	338.75	325.70	311.61
T_5: 50%RDF+50%FYM	300.33	347.80	343.08	332.01
T_6: 75%RDF+25%FYM	264.93	343.30	335.59	321.07
T_7: 50%RDF +50%WS	278.85	332.65	331.09	316.77
T_8: 75%RDF+25%WS	248.47	334.62	330.50	316.19
T_9: 50%RDF+50%GM	287.30	344.33	343.08	328.23
T_{10}:75%RDF+25%GM	257.73	340.65	336.49	321.93
SEm±	9.25	10.59	10.24	9.82
CD (P=0.05)	27.49	31.45	30.43	29.16

Table.3 Effect of INM on leaf area index (LAI) at different growth stages of rice

Treatment	Leaf Area Index		
	30 DAT	60 DAT	90 DAT
T_1:Control	1.11	1.79	2.90
T_2: 50%RDF	1.43	2.19	3.24
T_3: 75%RDF	1.47	2.25	3.45
T_4: 100%RDF	1.49	2.50	3.67
T_5: 50%RDF+50%FYM	1.67	2.86	4.22
T_6: 75%RDF+25%FYM	1.60	2.71	4.13
T_7: 50%RDF +50%WS	1.62	2.81	4.17
T_8: 75%RDF+25%WS	1.54	2.64	4.01
T_9: 50%RDF+50%GM	1.64	2.82	4.20
T_{10}:75%RDF+25%GM	1.58	2.67	4.09
SEm±	0.05	0.09	0.13
CD (P=0.05)	0.16	0.26	0.38

Table.4 Effect of INM on Chlorophyll content SPAD value at different growth stages of rice

Treatment	SPAD value			
	30 DAT	60 DAT	90 DAT	At harvest
T_1:Control	34.67	32.20	29.67	27.16
T_2: 50%RDF	39.40	39.67	39.10	32.84
T_3: 75%RDF	42.37	42.00	40.83	34.30
T_4: 100%RDF	47.07	43.90	43.87	36.85
T_5: 50%RDF+50%FYM	48.33	44.53	46.17	38.78
T_6: 75%RDF+25%FYM	49.47	43.63	45.77	38.44
T_7: 50%RDF +50%WS	45.27	42.67	45.27	38.02
T_8: 75%RDF+25%WS	46.97	41.33	45.53	38.25
T_9: 50%RDF+50%GM	48.80	47.97	46.80	39.31
T_{10}:75%RDF+25%GM	50.07	45.03	46.13	38.19
SEm±	1.13	1.27	0.90	0.82
CD (P=0.05)	3.36	3.77	2.68	2.43

Table.5 Effect of INM on dry matter accumulation (gm-2) at different growth stages of rice

Treatment	Dry matter accumulation (gm^{-2})			
	30 DAT	60 DAT	90 DAT	Maturity
T_1:Control	75.00	175.00	338.00	410.67
T_2: 50%RDF	98.67	204.00	427.67	740.32
T_3: 75%RDF	126.67	247.67	551.33	833.28
T_4: 100%RDF	147.33	387.67	778.00	1199.89
T_5: 50%RDF+50%FYM	161.00	436.67	866.67	1285.75
T_6: 75%RDF+25%FYM	155.67	404.67	817.33	1254.77
T_7: 50%RDF +50%WS	157.33	419.00	864.67	1270.45
T_8: 75%RDF+25%WS	149.67	394.00	792.67	1243.95
T_9: 50%RDF+50%GM	159.33	429.00	861.67	1274.35
T_{10}:75%RDF+25%GM	155.00	399.33	800.67	1236.85
SEm±	**5.13**	**10.95**	**21.29**	**37.77**
CD (P=0.05)	15.23	32.52	63.24	112.21

Table.6 Effect of INM on crop growth rate (CGR) at different growth stages of rice

Treatment	0-30 DAT	30-60 DAT	60-90 DAT	90 DAT-Harvest
T_1:Control	2.50	3.33	5.43	2.42
T_2: 50%RDF	3.29	3.51	7.46	10.42
T_3: 75%RDF	4.22	4.03	10.12	9.40
T_4: 100%RDF	4.91	8.01	13.01	14.06
T_5: 50%RDF+50%FYM	5.37	9.19	14.86	15.04
T_6: 75%RDF+25%FYM	5.19	8.30	13.76	14.58
T_7: 50%RDF +50%WS	5.24	8.72	14.33	13.53
T_8: 75%RDF+25%WS	4.99	8.14	13.29	13.97
T_9: 50%RDF+50%GM	5.31	8.99	14.42	13.76
T_{10}:75%RDF+25%GM	5.17	8.14	13.38	14.54
SEm±	0.17	0.46	0.77	1.50
CD (P=0.05)	0.51	1.37	2.28	4.44

Table.7 Effect of INM on days taken to 50% flowering and maturity

Treatment	50%flowering	Days taken to maturity
T_1:Control	90.8	126.2
T_2: 50%RDF	91.6	126.7
T_3: 75%RDF	92.3	130.5
T_4: 100%RDF	94.4	135.0
T_5: 50%RDF+50%FYM	98.7	136.5
T_6: 75%RDF+25%FYM	97.5	135.9
T_7: 50%RDF +50%WS	96.8	135.9
T_8: 75%RDF+25%WS	92.8	135.1
T_9: 50%RDF+50%GM	95.3	135.9
T_{10}:75%RDF+25%GM	95.5	135.1
SEm±	1.6	2.4
CD (P=0.05)	4.7	7.1

Table.8 Effect of INM on yield attributes of rice

Treatments	No of Panicles (m^{-2})	Panicle length (cm)	Total grains/ panicle	Filled grains/ panicle	Sterile grain/ panicle	Grain filling %	Test weight (g)
T_1:Control	89.67	16.37	83.40	62.00	21.40	74.36	20.07
T_2: 50%RDF	218.17	17.30	101.03	89.00	12.03	88.08	20.53
T_3: 75%RDF	266.62	19.97	110.23	97.33	12.90	88.31	21.70
T_4: 100%RDF	306.57	22.30	121.83	110.33	11.50	90.55	22.17
T_5: 50%RDF+50%FYM	323.85	26.90	126.43	118.33	8.10	93.53	22.77
T_6: 75%RDF+25%FYM	315.07	25.43	121.13	110.67	10.47	91.36	22.07
T_7: 50%RDF +50%WS	311.38	25.77	127.23	117.33	9.90	92.20	22.33
T_8: 75%RDF+25%WS	311.10	23.47	124.50	112.67	11.83	90.51	22.37
T_9: 50%RDF+50%GM	320.17	26.77	124.53	115.67	8.87	92.92	22.47
T_{10}:75%RDF+25%GM	316.20	24.50	123.73	112.33	11.40	90.83	22.13
SEm±	10.58	0.88	4.95	4.73	1.20	1.01	0.43
CD (P=0.05)	31.44	2.62	14.70	14.06	3.56	3.00	1.27

Table.9 Effect of INM on Grain yield, Straw yield and Harvest index

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
T_1:Control	9.35	12.63	42.53
T_2: 50%RDF	27.59	35.31	43.87
T_3: 75%RDF	36.01	45.02	44.44
T_4: 100%RDF	49.12	60.41	44.85
T_5: 50%RDF+50%FYM	55.10	66.94	45.26
T_6: 75%RDF+25%FYM	50.46	61.05	45.18
T_7: 50%RDF +50%WS	52.80	64.39	45.06
T_8: 75%RDF+25%WS	49.65	60.57	45.04
T_9: 50%RDF+50%GM	54.79	66.29	45.25
T_{10}:75%RDF+25%GM	50.27	60.82	45.25
SEm±	1.44	1.68	0.52
CD (P=0.05)	4.28	4.98	1.54

All the yield attributes were higher with the substitution of FYM/green manure or wheat straw in combination with 50-75% RDF due slow release and continuous supply of nutrients in balance quantity throughout the various growth stages enables the rice plants to assimilate sufficient photosynthetic products and thus, increased the dry matter and source capacity, resulted in the production of increased panicles with more number of fertile grains and higher test weight, grain and straw yield. Similarly, Pandey *et al.,* (2007) observed that substitution of 25 or 50 organic in combination with 50-75% RDF improved physic-chemical and biological properties of soil which improved the efficiency in utilization of native as well as applied nutrients at faster rate, which favored better plant growth and improved the yield components of rice. The result corroborates the findings of Parihar (2004), Virdia *et al.,* (2010), Kumar *et al.,* (2012), Das *et al.,* (2014) reported similar effect of FYM on rice. Farmyard manure might have supplied the essential minerals and affect for efficient use of applied nutrients for increasing the yield attributes (Ramkrishna *et al.,* 2007).

Grain Yield, Straw Yield and Harvest Index

Grain yield, straw yield and harvest index of rice increased up to 100 % RDF and more increased when 25 or 50 % nutrients substituted through organic sources viz FYM, GM or wheat straw along with 50-75 % RDF. The maximum rice grain yield of (55.10 q ha^{-1}), straw yield (66.94 q ha^{-1}) and harvest index (45.26%) was obtained with T_5 (50 % RDF+50 % N as FYM) which remained at par with treatments T_7(50%RDF+50% N as wheat straw) and T_9 (50%RDF+50%N as GM) (Table-.). The higher yield was achieved through integrated nutrient management because the grain and straw yield is the final product which depends upon the development of yield components such as effective tillers, panicle length, test weight, total and filled grain $panicle^{-1}$. All the yield attributes and yield were higher with the substitution either 25 or 50 % N as FYM or green manure or wheat straw in combination with 50 or 75% RDF due slow release and continuous supply of nutrients in balance quantity throughout the various growth stages enables the rice plants to assimilate sufficient photosynthetic products and thus, increased the dry matter and source capacity resulted in increased of yield attributes and finally yield of grain and straw. Furthermore, substitution of 25 or 50 organic in combination with 50-75% RDF improved physicochemical and biological properties of soil which improved the efficiency in utilization of native as well as applied nutrients at faster rate, which favored better plant growth and improved the yield components of rice (Pandey *et al.,* 2007). The result corroborate the findings of Virdia *et al.,* (2010),Prakash *et al.,* (2010), Kumar *et al.,* (2012), Sepehya *et al.,* (2012),Das *et al.,* (2014). Farmyard manure might have supplied the essential minerals and worked as catalyst for efficient use of applied nutrients for increasing the yield attributes (Ramkrishna *et al.,* 2007). Similar results was suggested by Parihar (2004) also FYM being store-house of both macro and micro nutrients which might have enhanced the metabolic process vis-à-vis enlarged source and sink capacity, which ultimately enhanced the grain and straw yields. The results are in agreement with finding of Sowmya *et al.,* (2011), Singh *et al.,* (2011), Majumdar *et al.,* (2007) have also reported that sustained production in a rice-wheat cropping system, integrated nutrient management involving both organic manures/residue and chemical fertilizer is essential.

Substitution of 50 % recommended dose of N through FYM along with 50% RDF resulted significantly highest growth and yield of grain (55.10 qha^{-1}) and straw (66.94 qha^{-1}) which were at par with application 50 % N either through green manure or wheat straw along with 50% RDF.

Thus, the application of 50 % RDF along with 50 % N either through FYM or green manure or wheat straw may be recommended for getting higher grain yield of rice.

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