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Research Article

RESPONSE OF INORGANIC FERTILIZER AND CROP RESIDUE ON NUTRITIONAL CONTENT AND ECONOMICS OF BASMATI RICE (*Oryza sativa* L.)

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Abstract- A field experiment was conducted during *Kharif* season of July 2013 & 2014 at crop research farm SHIATS Allahabad to study the effect of inorganic fertilizer and wheat residue on nutritional content and economics in basmati rice. Treatments were arranged using factorial R.B.D with three replications. The result revealed that increasing level of NPK fertilizer and crop residue significantly increases nitrogen, phosphorus, potassium and protein content in grain. Besides these, treatment also found more remunerative in terms of net return and benefit cost ratio.

Keywords- Rice, NPK fertilizer, Wheat residue, Protein and Economics.

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Introduction

Rice being the third largest cereal crop it's the staple food for nearly half of the world population. The area, production & productivity of the crop in India is approximately 43.95 M ha, 106.54 MT & 24.24 kg ha^{-1} (Agricultural statistics at a glance 2014). Basmati rice is renowned as queen of rice amongst all rice crops. The area under aromatic rice, have been increasing day by day & with the opening world market as well as domestic consumption [1]. Basmati rice is renowned as queen of rice amongst all rice crops. The area under aromatic rice, have been increasing day by day & with the opening world market as well as domestic consumption [1]. The traditionally grown long-grain Basmati rice is basically raised in Punjab, Haryana and areas of western UP. The Basmati rice production In MY 2014/15, was estimated at 8.8 MMT from (2.0 M ha.), which was 1.2. MMT up from last year, yet according to (USDA 2014-15) MY 2015/16 is forecast to increase further to 9.5 MMT. Rice contributes 43 & 46 percent total food grain production & total cereal production consecutively. Continuing to play a vital role in the national food grain supply, it's also the staple food for nearly half the world population. Globally in terms of production it ranks after wheat-maize, of which Asia alone accounts for 90 & 92% of area and production respectively thus concentrating production, consumption & trade in Asia. Overall rice grown in Asia is consumed 1/3rd in China & 1/5th in India. UP accounting 14416 thousand tones of total rice produced in India during 2015.

In India over 500 million ton of agricultural residue are produced every year. With increase production of rice and wheat, residue production has also increased substantially. There is a large variability in production of CRs, and their use depends on the crops grown, cropping intensity and productivity in different regions of India. One ton of wheat residue contains 4-5 kg N, 0.7- 0.9 kg P, & 9-11 kg K. Besides NPK, one ton of rice and wheat residue contain about 9-11 kg S, 100 g Zn, 777g Fe & 745g Mn [2]. It appears that the application of nitrogen increased the protein percentage, which in turn increased the grain weight. Kausar *et al.* [3] also reported similar result. Grain weight is a genetically controlled trait, which is greatly influenced by environment during the process of grain filling. The higher N content of nitrogen treated plants could be connected with the positive effect of nitrogen in some important physiological processes. These differences were statistically significant as reported by Chaturvedi [4].

Materials & Methods

Experimental details

The trial with three replications and twelve treatments was laid out in Factorial (4x3) R.B.D to assess the performance of different organic and inorganic fertilizer on growth and yield of paddy crop (*Vr.* Pusa basmati -1121) during *Kharif* season to assess the response of inorganic fertilizer and crop residue on nutritional content and economics of basmati rice at crop research farm SHIATS Naini, Allahabad (UP) INDIA. The Crop Research Farm is situated at 25^0 57' N latitude, 87^0 19' E longitude and 98 m altitude from the sea level. This area is situated on the right side of the river *Yamuna* and by the opposite side of Allahabad City. The area received about 800.45mm rainfall during the *Kharif* season of both the Years. The rainfall during the cropping season varied in both the years (1061.90 mm in 2013 and 539.00 mm in 2014). The deficiency in rainfall was 50.75% in 2014 (Figure 1).Temperature ranging from maximum 16.60 to 36.09^{0}C, relative humidity ranging from 66.49 to 91.74% and total bright sunshine of 111.07 hours and 113. prevailed during the crop periods of 2013 and 2014 respectively. The soil of the experimental plot was sandy loam in texture (59.16.0% sand, 25.23% silt and 15.61% clay), slightly acidic (pH 7.81) low in soil organic carbon (0.38%), available nitrogen (191.43 kg ha^{-1}) low in available phosphorus (17.16 kg ha^{-1}) and medium in potassium (143.62kg ha^{-1}). The experiment comprised twelve treatments with 3 replications having 4 different Inorganic fertilizer levels and 3 different residue incorporation levels. Required quantity of fertilizer as per treatment was applied uniformly in the plots through broadcast method of application. A uniform dose of

120 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} were applied in the form of Urea (46 % N), Single Super Phosphate (16% P_2O_5) and Mureate of Potash (60% K_2O). All plots received ½ dose of N, full dose of P and K and 1/4th N fertilizer at two equal splits - at tillering & panicle initiation as per treatments.

Factor levels: 4		
I_0	Control	0:0:0 NPK
I_1	25% NPK	30:15:15 NPK
I_2	50% NPK	60:30:30 NPK
I_3	100% NPK	120:60:60 NPK
Factor levels: 3		
W_0	Control	
W_1	50% Wheat residue	2.5 tone/ha.
W_2	100%Wheat residue	5.0 tone/ha.

The crop irrigated as and when required. The weeds were removed manually at 30 and 60 days after transplanting (DAT). The residue incorporation was at 5 tons wheat straw. Harvesting was done on November 15, 2013 and November 17, 2014. The data were statistically analyzed applying the techniques of analysis of variance and the significance of different sources of variations was tested under Factorial RBD design at probability level 0.05%.

Results and Discussion

Plant height

The crop at 100% NPK fertilizer application has been found to accelerate, the plant height was found to be highest in treatment I_3 which was (39.36, 40.11 cm) at 60DAT in 1st and 2nd year respectively although the least growth was found to be with the control treatments. However the incorporation of 5 $tone^{-ha}$ wheat residue, then highest plant height was found in treatment W_2 (39.36, 40.11 cm) at 60 DAT in 1st and 2nd year respectively although the least growth was found to be with the control treatments. The interaction of the treatments depicts a clear idea that when crop residue up-to $5tha^{-1}$ is substantially supported by 100% NPK fertilizer it responds positively where plant ht. was found to be significant at 60DAT in the year 2013 but non-significant in the year 2014, the maximum height attained 60DAT in response of inorganic fertilizer and wheat residue was (40.56 and 42.00) in treatment T_{11} (100 % RDF and 5 t ha^{-1} wheat residue) in both the year of experiment respectively. Similarly, height attained due to combination of inorganic fertilizer and wheat residue in treatment T_{10} was found to be at par to treatment T_{11} in the year 2013-2014 at 30 and 60 DAT. As similar findings was reported by Arshadullah *et al.* [5].

Effect of different treatment on plant height at 60 DAS

	I[st] Year (2013)				II[nd] Year (2014)			
Treatment	W_0	W_1	W_2	Mean	W_0	W_1	W_2	Mean
I_0	32.57	33.93	34.51	33.67	29.33	32.67	34.67	32.22
I_1	36.71	38.37	38.63	37.90	35.00	35.33	36.00	35.44
I_2	36.97	38.98	39.67	38.54	36.67	38.67	39.33	38.22
I_3	37.39	40.13	40.56	39.36	38.00	40.33	42.00	40.11
Mean	35.91	37.85	38.34		34.75	36.75	38.00	
	F test	S.Ed	C.D		F test	S.Ed	C.D	
Inorganic(I)	S	0.18	0.38		S	0.51	1.06	
Residue(W)	S	0.16	0.33		S	0.59	1.22	
Interaction (I x W)	S	0.31	0.65		NS			

Nutrient content and nutritional content percent in rice grain

Nitrogen content percent in grain

Effect of increasing level of inorganic fertilizer on nitrogen content percent in grain was found significantly influenced in the year 2013 and 2014 maximum was found in treatment I_3 which was (1.237 and 1.282), while minimum in I_0 (control). In the same way, effect of increasing level of wheat residue on nitrogen content percent in grain was found significantly increased in both the year of experiment respectively. Maximum was found in treatment W_2 which was (1.229 and 1.197), whereas minimum in treatment W_0 (control). Among the interaction, effect of inorganic fertilizer and wheat residue on nitrogen content percent in grain was found to be significant in year 2013 but non-significant in the year 2014. However, the maximum nitrogen content percent in grain was found in the treatment T_{11} (100 % RDF and 5 t ha^{-1} wheat residue) in both the year of experiment respectively While minimum in treatment W_0 (control). Similar finding was showed that the total nitrogen uptake followed a significant quadratic response with the increasing of N rate (chemical and biological fertilization) in the range of 0 to 200 kg /ha reported by Fageria *et al.* [6].

Effect of different levels of Inorganic fertilizer and wheat residue on Nitrogen content (%) in grains of Rice (Oryza sativa L.)

	I[st] Year (2013)				II[nd] Year (2014)			
Treatment	W_0	W_1	W_2	Mean	W_0	W_1	W_2	Mean
I_0	1.189	1.192	1.197	1.193	0.980	1.103	1.107	1.063
I_1	1.203	1.221	1.229	1.218	1.117	1.120	1.103	1.113
I_2	1.208	1.234	1.240	1.227	1.153	1.147	1.247	1.182
I_3	1.216	1.244	1.251	1.237	1.240	1.277	1.330	1.282
Mean	1.204	1.223	1.229		1.123	1.162	1.197	
	F test	S. Ed	C.D		F test	S. Ed	C.D	
Inorganic(I)	S	0.001	0.002		S	0.011	0.023	
Residue(W)	S	0.001	0.002		S	0.013	0.027	
Interaction(I x W)	S	0.002	0.003		NS	0.022	0.046	

Phosphorus content percent in grain:

Effect of increasing level of inorganic fertilizer on Phosphorus content percent in grain in the year 2013 and 2014 was found to be significantly influenced, maximum in treatment I_3 which was (0.278 and 0.302), while minimum in I_0 (control). As regards the significant effect of increasing level of wheat residue fertilizer on phosphorus content percent in grain in the year 2013 and 2014 was found to be maximum in treatment W_2 which was (0.271 and 0.292) but minimum was found in treatment W_0 (control). The interaction effect of inorganic fertilizer and wheat residue on Phosphorus content percent in grain was found non-significant. However, the maximum phosphorus content in grain was reported in the treatment T_{11} (100 % RDF and 5 t ha^{-1} wheat residue) in both the year of experiment respectively While minimum in treatment W_0 (control). It is in agreement with the findings of Sharma *et al.* [7].

Potassium content percent in grain:

Effect of increasing level of inorganic fertilizer on potassium content in grain was found significant in both the year of experiment respectively. The maximum potassium content in grain was found in treatment I_3 which was (0.170 and 0.237), while minimum in treatment I_0 (control). Further, the effect of different levels of wheat residue on potassium content in grain was found to be significantly influenced in the year of experiment 2013 and 2014 respectively. The maximum potassium content in grain was found in treatment W_2 which was (0.161 and 0.246), while minimum in treatment W_0 (control). In case of interaction, the interaction effect of inorganic fertilizer and wheat residue on Potassium content in grain was found to be significant in year of experiment 2013 but non-significant was found in the year 2014. However, the maximum Potassium content in grain was found in the treatment T_{11} (100 % RDF and 5 t ha^{-1} wheat residue) in both the year of experiment respectively. While, minimum was found in W_0 (control). As similar finding was reported by Saha *et. al.* [8].

Protein content percent in grain

The significant effect was found increasing level of inorganic fertilizer on protein

content percent in grain in the year 2013 and 2014 respectively. Protein content in grain was found maximum in treatment I_3 which was (7.64 and 7.92), while minimum in I_0 (control). Further the significant effect was found increasing level of inorganic fertilizer on Protein content in grain (%) in both the year of experiment 2013 and 2014 respectively. Maximum Protein content in grain was found in treatment W_2 which was (7.49 and 7.52), while minimum in W_0(control). Similarly, attained due to wheat residue in treatment W_1 was found to be at par to treatment W_2 in the year 2014. The data further revealed that the significant interaction effect was found increasing level of inorganic fertilizer and wheat residue on Protein content in grain (%) in the year 2013 but non-significant in the year of experiment 2014. However, the maximum Protein content in grain was reported in the treatment T_{11} (100 % RDF and 5 t ha^{-1} wheat residue) in both the year of experiment respectively, while minimum in W_0(control). Finding obtained that integrated nitrogen management practices significantly influenced the quality characters by Aruna *et al.* [9]

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Effect of different levels of Inorganic fertilizer and wheat residue on Phosphorus content (%) in grains of Rice (Oryza sativa L.)

	Ist Year (2013)				IInd Year (2014)			
Treatment	W_0	W_1	W_2	Mean	W_0	W_1	W_2	Mean
I_0	0.252	0.256	0.254	0.254	0.232	0.256	0.269	0.252
I_1	0.266	0.261	0.268	0.265	0.257	0.269	0.285	0.270
I_2	0.279	0.280	0.273	0.277	0.282	0.275	0.286	0.281
I_3	0.266	0.277	0.289	0.278	0.270	0.307	0.330	0.302
Mean	0.266	0.268	0.271		0.260	0.277	0.292	
	F test	S. Ed	C.D		F test	S. Ed	C.D	
Inorganic (I)	S	0.005	0.010		S	0.006	0.012	
Residue (W)	NS	-	-		S	0.007	0.014	
Interaction (I x W)	NS	-	-		NS	-	-	

Effect of different levels of inorganic fertilizer and wheat residue on potassium content (%) in grains of rice.

	Ist Year (2013)				IInd Year (2014)			
Treatment	W_0	W_1	W_2	Mean	W_0	W_1	W_2	Mean
I_0	0.127	0.131	0.136	0.131	0.134	0.179	0.216	0.176
I_1	0.141	0.156	0.16	0.153	0.151	0.183	0.241	0.192
I_2	0.149	0.163	0.166	0.159	0.203	0.231	0.254	0.229
I_3	0.153	0.173	0.183	0.17	0.202	0.237	0.272	0.237
Mean	0.143	0.156	0.161		0.173	0.207	0.246	
	F test	S. Ed	C.D		F test	S. Ed	C.D	
Inorganic(I)	S	0.001	0.002		S	0.006	0.013	
Residue(W)	S	0.001	0.002		S	0.007	0.015	
Interaction (I x W)	S	0.002	0.004		NS			

Effect of different levels of inorganic fertilizer and wheat residue on protein content (%) in grains of rice.

	Ist Year (2013)				IInd Year (2014)			
Treatment	W_0	W_1	W_2	Mean	W_0	W_1	W_2	Mean
I_0	6.84	6.87	7	6.9	6.63	6.8	6.9	6.78
I_1	7.17	7.47	7.47	7.37	7.1	7.37	7.43	7.3
I_2	7.3	7.63	7.65	7.53	7.03	7.5	7.6	7.38
I_3	7.37	7.72	7.83	7.64	7.7	7.93	8.13	7.92
Mean	7.17	7.42	7.49		7.12	7.4	7.52	
	F test	S. Ed	C.D		F test	S. Ed	C.D	
Inorganic(I)	S	0.02	0.05		S	0.07	0.14	
Residue(W)	S	0.02	0.04		S	0.08	0.16	
Interaction(I x W)	S	0.04	0.09		NS	-	-	

Economics of different treatment combinations and benefit cost ratio of Rice (2013)

Treatment combination	Inorganic Fertilizer (I)	Crop Residue (C)	Yield		Selling Rate		Gross return	Cost of cultivation	Net return	Benefit Cost Ratio
			Grain	Straw	Grain	Straw				
	N: P: K (kg ha^{-1})	t ha^{-1}	q ha^{-1}	q ha^{-1}	R q^{-1}	R q^{-1}	R ha^{-1}	R ha^{-1}	R ha^{-1}	
I_0 W0	-	-	21.93	60.46	2,200	150	57,323	43,400	13,923	1.32
I_0 C_1	-	2.5 t ha^{-1}	22.50	62.01	2,200	150	58,802	49,900	8,902	1.18
I_0 C_2	-	5.0 t ha^{-1}	22.73	62.68	2,200	150	59,415	48,400	11,015	1.23
I_1 W0	30: 15: 15 kg ha^{-1}	-	25.57	68.50	2,200	150	66,522	45,110	21,412	1.47
I_1 C_1	30: 15: 15 kg ha^{-1}	2.5 t ha^{-1}	32.97	81.82	2,200	150	84,800	47,610	37,190	1.78
I_1 C_2	30: 15: 15 kg ha^{-1}	5.0 t ha^{-1}	33.70	86.81	2,200	150	87,162	50,110	37,052	1.74
I_2 W0	60: 30: 30 kg ha^{-1}	-	26.10	71.96	2,200	150	68,215	46,820	21,385	1.46
I_2 C_1	60: 30: 30 kg ha^{-1}	2.5 t ha^{-1}	35.20	88.98	2,200	150	90,788	49,320	41,468	1.84
I_2 C_2	60: 30: 30 kg ha^{-1}	5.0 t ha^{-1}	39.07	90.89	2,200	150	99,580	51,820	47,760	1.92
I_3 W0	120: 60: 60 kg ha^{-1}	-	35.00	75.33	2,200	150	88,307	50,238	38,069	1.76
I_3 C_1	120: 60: 60 kg ha^{-1}	2.5 t ha^{-1}	40.12	91.11	2,200	150	101,923	52,738	49,185	1.93
I_3 C_2	120: 60: 60 kg ha^{-1}	5.0 t ha^{-1}	43.50	95.92	2,200	150	110,089	55,238	54,861	1.99

Table- 4.5 *Economics of different treatment combinations and benefit cost ratio of Rice (2014)*

Treatment combination	Inorganic Fertilizer (I)	Crop Residue (C)	Yield		Selling Rate		Gross return	Cost of cultivation	Net return	Benefit Cost Ratio
			Grain	Straw	Grain	Straw				
	N: P: K (kg ha^{-1})	t ha^{-1}	q ha^{-1}	q ha^{-1}	R q^{-1}	R q^{-1}	R ha^{-1}	R ha^{-1}	R ha^{-1}	
I_0W0	-	-	21.60	59.76	2,200	150	54,984	44,800	10,184	1.23
I_0C_1	-	2.5 t ha^{-1}	23.59	64.59	2,200	150	61,587	47,300	14,287	1.30
I_0C_2	-	5.0 t ha^{-1}	26.20	64.81	2,200	150	67,342	49,800	17,542	1.35
I_1W0	30: 15: 15 kg ha^{-1}	-	25.98	67.78	2,200	150	67,323	46,510	20,813	1.45
I_1C_1	30: 15: 15 kg ha^{-1}	2.5 t ha^{-1}	31.86	69.45	2,200	150	80,510	47,300	33,210	1.70
I_1C_2	30: 15: 15 kg ha^{-1}	5.0 t ha^{-1}	35.20	72.40	2,200	150	88,300	49,800	38,500	1.77
I_2W0	60: 30: 30 kg ha^{-1}	-	28.55	76.20	2,200	150	74,240	48,220	26,020	1.54
I_2C_1	60: 30: 30 kg ha^{-1}	2.5 t ha^{-1}	35.30	82.30	2,200	150	90,005	50,720	39,285	1.77
I_2C_2	60: 30: 30 kg ha^{-1}	5.0 t ha^{-1}	38.87	84.90	2,200	150	98,249	53,220	45,029	1.85
I_3W0	120: 60: 60 kg ha^{-1}	-	37.03	87.18	2,200	150	94,543	51,638	42,905	1.83
I_3C_1	120: 60: 60 kg ha^{-1}	2.5 t ha^{-1}	42.93	91.57	2,200	150	108,182	54,138	54,044	1.99
I_3C_2	120: 60: 60 kg ha^{-1}	5.0 t ha^{-1}	45.39	94.94	2,200	150	114,099	56,638	56,524	2.02

Economic of treatments

Maximum cost of cultivation (R55,238 ha^{-1} and R56,638 ha^{-1}) was recorded in treatments T_{11} (NPK 100% RDF and 5 tonne ha^{-1}) in the consecutive years 2013 and 2014 respectively due to the highest labour cost and more expenditure on cost of inorganic fertilizer and cost of wheat residue. The minimum cost of cultivation (R 43,400ha^{-1} and R 44,800 ha^{-1}) was observed in treatments T_0 (Control) and T_1 (2.5 tonne wheat residue) respectively due to less labour charge and less cost due to no fertilizer application in the consecutive years of experiment.

Maximum gross return (R110,089 ha^{-1} and R114,099 ha^{-1}) was obtained from treatment T_{11} (NPK 100% RDF and 5 tone ha^{-1}) due to the highest grain and straw yield. Among the other remaining treatments minimum gross return (R57,323 ha^{-1} and R54,984 ha^{-1}) was obtained from the treatment T_0 (Control) was found in the both the consecutive years of experiment 2013 and 2014. In spite of the fact that treatment T_{11} (NPK 100% RDF and 5 tonne ha^{-1}) recorded the highest net return (R54,861 ha^{-1} and 56,524 Rha^{-1}) and the minimum net return (R8,902 ha^{-1} and R10,184 ha^{-1}) in both the years of experiment was recorded varying within the years in treatment T_1 and T_0 (2.5 tonne ha^{-1}) because of high cost of cultivation. Maximum benefit cost ratio (1.99 and 2.02) was recorded in the treatment T_{11} (NPK 100% RDF and 5 tone ha^{-1}) because of higher gross return (R110,089 ha^{-1}) with lesser cost of cultivation (R55,238 ha^{-1}) The cost of cultivation was higher with inorganic fertilizer (NPK 100% RDF) and wheat residue incorporation (5 tone ha^{-1}). The results were confirmed by the findings of Borkar *et al*. [10].

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Conflict of Interest: None declared

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