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Impact of rice straw incorporation and nutrient management on economic returns and yield of summer rice in Chhattisgarh plains

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Abstract
The field experiment was conducted during summer season of 2013-14 and 2014-15 at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG) to impact of rice straw incorporation and nutrient management on economic returns and yield of summer rice in Chhattisgarh plains. The result on rice straw incorporation revealed that significantly grain and straw yield, gross return, net return and B/C ratio was registered under rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT+10 kg N ha^{-1} (S_3), in case of grain and straw yield were found at par to treatment rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2) and *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) during both the years and on mean basis. In case of gross return and net return were at par to treatment *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) at 2014-15 and mean data. Along with that at par to treatment *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) at year 2013-14 and rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2). Among the nutrient management revealed that significantly highest grain and straw yield, gross return, net return and B/C ratio were recorded higher under 150% RDF (180:90:60 kg N, P_2O_5 and K_2O ha^{-1}) (F_4), which were found to statistically similar to treatment 100% RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}) (F_3) during both the years and on mean basis.

Keywords: Rice straw incorporation, nutrient management, gross return, net return, b/c ratio and yield

Introduction
In India, total rice crop area is 45.5 m ha, production is 105.31 mt and average productivity is 2393 kg ha^{-1}. Chhattisgarh state is popularly known as "Rice bowl of India", which constitutes over 85% of the total food grain production in state. In *khaif*, rice is cultivated over an area of 3.68 m ha with productivity of 20.20 q ha^{-1}. In summer season, it is cultivated in 1.97 lakh ha area with productivity of 38.47 q ha^{-1} (Anonymous, 2015) [1]. In rice-rice cropping system, after harvesting, particularly rice straw was burned in the cultivated area and some was left as rice straw and stuff before incorporated into soil. Rice straw compost incorporation plays an importance role on soil nutrients fertility by adding soil nutrient. The composition of fresh rice straw included nitrogen (14.26 kg ha^{-1}), phosphorus (1.86 kg ha^{-1}) and potassium (35.34 kg ha^{-1}). These components are retained and accumulated in the soil. The nutrients and soil abundance has increased when rice straw was incorporated into soil for several years (Pomnamperuma, 1984) [5]. Application of inorganic fertilizer alone in large quantities over a long period of time results in imbalance in supply of other nutrients. Cassman and Pingali (1995) [3] reported that the intensified rice mono cropping for several years has begun to show a declining trend in rice yield. Imbalanced nutrient management and decreased soil organic matter are the key responsible factors for the observed declining trend in rice-based cropping systems (Nambiar, 1995, Reddy and Krishnaiah, 1999) [4, 6]. In this context residue incorporation holds a great promise in maintaining yield stability through correction of marginal deficiencies of secondary and micronutrients, enhancing efficiency of applied nutrients and providing favorable soil physical condition (Banerjee and Pal, 2009) [2].
In few pockets of Chhattisgarh, rice-rice cropping system is quite popular. Presently farmers are in habit of burning the rice straw and using more quantity inorganic fertilizers for rice crop. Very little work on rice straw incorporation and nutrient management has been done specially in summer rice; therefore attempt is needed to study its impact on economic returns as well as yield of summer rice under the agro-climatic condition of Chhattisgarh plains.

Materials and Methods

In order to study the impact of rice straw incorporation and nutrient management on economic returns and yield of summer rice in Chhattisgarh plains. The soil of the experimental area was '*Vertisols*' which is locally known as *'Kanhar'*. The soil was neutral in reaction and medium in fertility levels having low in N, medium in P and high in K. The climate of the region is dry moist, sub-humid with an average annual rainfall of 1200-1400 mm. The summer rice crop received 115.4 and 105.1 mm rainfall during summer season of 2013-14, 2014-15, respectively. The treatment consisted of 4 rice straw incorporation *i.e.* normal transplanting (S_1), rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2), rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT + 10 kg N ha^{-1} (S_3) and *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) and 4 nutrient management *i.e.* control (F_1), 50% RDF (60:30:20 kg N, P_2O_5 and K_2O ha^{-1}) (F_2), 100% RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}) (F_3) and 150% RDF (180:90:60 kg N, P_2O_5 and K_2O ha^{-1}) (F_4) were tested on medium duration rice cv. MTU 1010 during summer season of 2013-14 and 2014-15 in strip plot design with 3 replications. Rice cultivar – MTU 1010 was transplanted on 30th January 2014 and 31st January 2015 and harvest in 1st week of May in 2014 and 2015. The observation regarding grain yield, straw yield, cost of cultivation and economic returns.

Effect of cost of cultivation and economic returns

As regards to economics of summer rice (Table 1), treatment rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT +10 kg N ha^{-1} (S_3) registered significantly highest gross returns, net returns and benefit cost ratio during both the years and on mean basis. In returns and net returns was at par to treatment *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) during both the years and on mean basis. As well as treatment rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2) was at par during 2013-14.

Among nutrient management, treatment 150% RDF (180:90:60 kg N, P_2O_5 and K_2O ha^{-1}) (F_4) recorded significantly highest gross and net returns and B:C ratio which was at par to treatment 100% RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}) (F_3) during both the years and on mean basis. Further treatment 50 % RDF (60:30:20 kg N, P_2O_5 and K_2O ha^{-1}) (F_2) also recorded comparable values of net return during 2013-14 and B:C ratio during both the years and on mean basis.

Effect on grain and straw yield (qha^{-1})

Among rice straw incorporation (table 2), significantly highest grain and straw yield of summer rice was recorded under treatment rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT + 10 kg N ha^{-1} (S_3), which was at par to treatments rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_2) and Trichoderma treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) during both the year and on mean basis. As regards to nutrient management, significantly highest grain and straw yield was noted under treatment 150% RDF (180:90:60 kg N, P2O5 and K2O ha-1) (F4), which was at par to treatment 100% RDF (120:60:40 kg N, P2O5 and K2O ha-1) (F3) during both the years and on mean basis.

Tuyen and Tan (2001) [7] recorded that management of rice straw is an important agronomic practice for rice cultivation. It is more important in the area with very highly intensive cultivation and found that removal of rice straw is reducing soil chemical properties. Burning rice straw is not good as compared to incorporation into the soil. However, it is no time for soil fallow in the wet season, burning and no tillage gave better than rice straw left over without incorporation into the soil or removal. In long run, rice straw incorporation into the soil give better yield and better physical and chemical property of the soil. Tillage offered very small, benefit in improving grain yield of rice in case of very intensive rice monoculture, but it is the main way to incorporate rice straw into the soil. Otherwise, rice straw left over which gave negative effect on grain yield of rice.

Table 1: Cost of cultivation (Rs. ha^{-1}) and economic returns of summer rice as influenced by rice straw incorporation and nutrient management

`Treatment	Cost of cultivation (Rs. ha^{-1})			Gross return (Rs. ha^{-1})			Net return (Rs. ha^{-1})			B/C ratio		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Rice straw incorporation												
S_1	25922.50	25922.50	25922.50	56351.00	56179.04	56265.02	30428.50	30256.54	30342.52	1.16	1.15	1.15
S_2	27622.50	27622.50	27622.50	62300.26	60787.51	61543.88	34677.76	33165.01	33921.38	1.23	1.17	1.20
S_3	27442.00	27442.00	27442.00	66465.38	67961.78	67213.58	39023.38	40519.78	39771.58	1.43	1.49	1.46
S_4	31230.00	31230.00	31230.00	65472.85	66223.10	65847.98	34242.85	34993.10	34617.98	1.08	1.09	1.08
S.Em±				1452.62	1874.36	1485.73	1452.62	1874.36	1485.73	0.05	0.06	0.05
CD (P=0.05)				5026.73	6486.14	5141.30	5026.73	6486.14	5141.30	0.17	0.22	0.17
Nutrient management												
F_1	23891.50	23891.50	23891.50	40761.55	39823.29	40292.42	16870.05	15931.79	16400.92	0.71	0.67	0.69
F_2	27619.25	27619.25	27619.25	63928.48	61353.11	62640.79	36309.23	33733.86	35021.54	1.32	1.23	1.27
F_3	30369.50	30369.50	30369.50	71719.91	73512.40	72616.15	41350.41	43142.90	42246.65	1.36	1.42	1.39
F_4	30336.75	30336.75	30336.75	74179.57	76462.62	75321.09	43842.82	46125.87	44984.34	1.50	1.59	1.54
S.Em±				2655.91	3422.89	2616.45	2655.91	3422.89	2616.45	0.09	0.12	0.09
CD (P=0.05)				9190.67	11844.76	9054.12	9190.67	11844.76	9054.12	0.32	0.43	0.32

S_1- Normal transplanting	F_1- Control
S_2- Rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT)	F_2- 50% RDF (60:30:20 kg N, P_2O_5 and K_2O ha^{-1})
S_3- Rice straw incorporation @ 5 t ha^{-1} disc harrowing twice fb irrigation at 30	F_3- 100% RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1})

DBT + 10 kg N ha^{-1}	
S_4- Trichoderma treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT	F_4- 150% RDF (180:90:60 kg N, P_2O_5 and K_2O ha^{-1})

Table 2: Grain and straw yield of summer rice as influenced by rice straw incorporation and nutrient management

Treatment	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Rice straw in corporation						
S_1	38.53	37.15	37.84	48.27	46.30	47.29
S_2	42.61	40.21	41.41	52.81	49.59	51.20
S_3	45.48	44.98	45.23	55.82	54.89	55.35
S_4	44.81	43.83	43.86	54.89	53.30	54.09
S.Em±	0.99	1.38	1.15	1.54	1.60	1.41
CD (P=0.05)	3.41	4.78	3.97	5.33	5.55	4.86
Nutrient management						
F_1	27.77	26.28	27.03	37.62	34.27	35.95
F_2	43.74	40.60	42.17	53.97	49.73	51.85
F_3	49.10	48.65	48.42	59.48	59.47	59.48
F_4	50.82	50.64	50.73	60.72	60.60	60.66
S.Em±	1.82	2.28	1.39	2.09	2.42	1.82
CD (P=0.0 5)	6.31	7.88	4.82	7.25	8.39	6.31
Interaction (RSI X NM)	S	S	S	S	S	S

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