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Influence of rice straw incorporation and nutrient management on energetic 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 influence of rice straw incorporation and nutrient management on energetic and yield of summer rice in Chhattisgarh plains. The result on energy output, energy output-input ratio and energy use efficiency where adjudged to be the best under treatment *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) and both were statistically similar to treatments rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2) and rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT + 10 kg N ha^{-1} (S_3) during both the years and mean basis. 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 years and on mean basis. Among the nutrient management revealed that significantly highest energy output, energy output-input ratio, energy use efficiency energy intensiveness, grain and straw yields were registered with treatment 150% RDF (180:90:60 kg N, P_2O_5 and K_2O ha^{-1}) (F_4) which was found to be 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.

Keywords: Rice straw incorporation, nutrient management, energy, output-input ratio, energy use efficiency, yield and energetic

Introduction
Rice provides 21% of global human per capita energy and 15% of per capital protein. Calories from rice are particularly important in Asia, especially among the poor, where it accounts for 50-80% of daily caloric intake. As expected, Asia accounts for over 90% of the world's production of rice, with China, India and Indonesia producing the most. Only 6-7% of the world's rice crop is traded in the world market. Thailand, Vietnam, China and the United States are the world's largest exporters. The United States produces 1.5% of the world's rice crop with Arkansas, California and Louisiana producing 80% of the U.S. rice crop. 85% of the rice that is produced in the world is used for direct human consumption. Rice can also be found in cereals, snack foods, brewed beverages, flour, oil, syrup and religious ceremonies to name a few other uses. 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 energetic of production as well as yield of summer rice under the agro-climatic condition of Chhattisgarh plains.

Materials and Methods

In order to study the influence of rice straw incorporation and nutrient management on energetic 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 and energetic.

Results and discussion

Energetic of production

Findings on energy parameters like energy output, energy output-input ratio, energy use efficiency and energy intensiveness have been presented in table 1.

Table 1: Energetics of summer rice as influenced by rice straw incorporation and nutrient management

Treatment	Energy output (MJ x10^{-3} ha^{-1})			Energy output- Input ratio			Energy use efficiency (kg x10^{-3} ha^{-1})			Energy intensiveness (MJ Re^{-1})		
	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	323.30	311.73	317.52	9.82	9.44	9.63	7.28	7.00	7.14	4.49	4.31	4.40
S_2	354.41	334.44	344.43	10.70	10.07	10.39	7.94	7.47	7.70	4.62	4.34	4.48
S_3	349.46	345.59	347.53	10.50	10.35	10.43	7.78	7.67	7.73	5.00	4.93	4.97
S_4	376.49	368.32	372.40	11.30	11.01	11.16	8.38	8.16	8.27	4.27	4.15	4.21
SEm±	8.12	10.26	8.22	0.27	0.32	0.26	0.20	0.23	0.20	0.11	0.13	0.11
CD (P=0.05)	28.11	35.52	28.44	0.94	1.09	0.92	0.70	0.81	0.68	0.40	0.45	0.38
Nutrient management												
F_1	227.51	215.41	221.46	7.20	6.68	6.94	5.36	4.97	5.16	3.69	3.42	3.56
F_2	358.27	332.66	345.47	10.79	9.98	10.39	8.00	7.40	7.70	4.78	4.43	4.60
F_3	401.95	397.95	399.95	12.00	11.93	11.96	8.89	8.84	8.87	4.82	4.79	4.81
F_4	415.94	414.06	415.00	12.33	12.28	12.30	9.13	9.09	9.11	5.07	5.08	5.08
SEm±	15.05	18.47	14.52	0.43	0.51	0.40	0.32	0.38	0.29	0.18	0.23	0.17
CD (P=0.0 5)	52.07	63.93	50.26	1.50	1.78	1.38	1.11	1.31	1.02	0.63	0.79	0.60

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 DBT + 10 kg N ha^{-1}	F_3- 100% RDF (120:60:40 kg N, P_2O_5 and K_2O 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})

Among rice straw incorporation, the energy output and energy use efficiency where adjudged to be the best under treatment *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) and both were statistically similar to treatments rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2) and rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT + 10 kg N ha^{-1} (S_3) during both the years and mean basis. The energy output-input ratio was recorded highest with *Trichoderma* treated rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT (S_4) which was at par to treatments rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 days before transplanting (DBT) (S_2) and rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT +10 kg N ha^{-1} (S_3) only during 2013-14 and on mean basis. The energy intensiveness was noted to be significantly highest with treatments rice straw incorporation @ 5 t ha^{-1} by disc harrowing twice fb irrigation at 30 DBT +10 kg N ha^{-1} (S_3) during both the years and on mean basis but it was 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) only during 2013-14.

As regards to nutrient management significantly highest energy output, energy output-input ratio, energy use efficiency and energy intensiveness were registered with treatment 150% RDF (180:90:60 kg N, P_2O_5 and K_2O ha^{-1}) (F_4) which was found to be 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 in case of energy intensiveness, comparable values were also recorded under treatment 50% RDF (60:30:20 kg N, P_2O_5 and K_2O ha^{-1}) (F_2) 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.

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

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
SEm±	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
SEm±	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

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.

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