

Original Research Article

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Residue Management and Nutrient Dynamics in Combine Harvester Operated Rice Field

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ABSTRACT

Keywords

Rice residue, Combine harvester, Nutrient dynamics, Yield, Yield attributes.

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Rice residues are important natural resources, and recycling of these residues improves the soil physical, chemical and biological properties. Management of rice straw is a major challenge as it is considered to be a poor feed for the animals due to high silica content. A field experiment was conducted at Agricultural Research Station, Bhavanisagar during 2014-2015 and 2015-2016 to review the suitable rice residue management practices and nutrient dynamics by using combine harvester operated rice field after cultivating rice. In both the years, the results revealed that incorporation of straw as such with tractor mounted with half cage wheel and rotovator with addition of biomineralizer (TNAU microbial consortia) for decomposition of straw and incorporation later followed by 100 percent recommended dose of fertilizers (T_3) recorded the highest DMP (8358 and 8609 kg ha⁻¹), no. of tillers M⁻² (572 and 589), no. of productive tillers M⁻² (400 and 412), filled grains per panicle (168 and 173), 1000 grain weight (20.24 and 20.85g), grain yield (7706 and 7937 kg ha⁻¹) and straw yield (9982 and 10281 kg ha⁻¹). This was followed by incorporation of straw as such with tractor mounted with half cage wheel and rotovator with 25 kg additional dose of N ha⁻¹ as basal.

Introduction

Rice (*Oryza sativa* L.) is a “Global Grain” (Reddy *et al.*, 2013) cultivated widely across the world feeding millions of mankind. As the primary dietary source of carbohydrates, rice plays an important role in meeting energy requirements and nutrient intake. In India, during 2014-15, the area under cultivation of rice was about 44.1 m. ha with the production and productivity of 105.5 m.t and 2.42 kg ha⁻¹ respectively. In Tamil Nadu, during the year 2014-15 the area under rice cultivation was about 17.95 lakh ha and the production and productivity recorded were 57.28 lakh tonnes and 3191 kg ha⁻¹ respectively (Ministry of

Agriculture, 2014-2015). Long term experiments conducted in India since 1885 intelligibly indicated that balanced application of chemical fertilizer alone, under intensive cropping does not sustain crop productivity but resulted in substantial loss of soil health leading to depletion of organic carbon and availability of micronutrients in soil over years (Vats *et al.*, 2001). The recycling of crop residues has the advantage of converting the surplus farm waste into useful product for meeting nutrient requirement of crops. It also maintains the soil properties and improves the overall ecological balance of the crop

production system (Mandal *et al.*, 2004). Use of crop residues as soil organic amendment in the system of agriculture is a viable and valuable option (Pathak, 2012). It is the primary substrate for replacement of organic matter and upon mineralization, crop residues supplies essential plant nutrients, additionally residue incorporation can improve physical and biological conditions of the soil and prevent soil degradation. A large amount of rice residue is annually produced in the rice growing countries. The estimate shows that 120×10^6 kg yr⁻¹ rice residue, out of 180×10^6 kg yr⁻¹ (assuming that 1/3rd of the residue is used as feed for animals and other purposes) can be returned to the soil to enhance soil quality; it will contribute to soil 2.604 million tonnes of N + P₂O₅ + K₂O, considering the nutrient contents in rice straw as 0.61% N, 0.18% P₂O₅ and 1.38% K₂O₄ (Tandon, 1996 and Mandal *et al.*, 2004). In India every year, it's about 106 m.t of rice straw is produced annually and its adds about 0.61, 0.27 and 1.71 m.t of N, P and K, respectively (Vaiyapuri *et al.*, 2016). The application of organic amendments like rice straw had increased soil aggregate stability and decreased soil bulk density (Karami *et al.*, 2012). The latter soil property is strongly correlated to soil organic C, since the addition of organic amendments normally increases soil organic C and conversely decrease soil bulk density (Bauer and Black, 1994).

Rice-rice-groundnut are the most dominant cropping system under irrigated condition in Lower Bhavani Project command area. The harvest of *Kharif* rice coincides with planting of *rabi* rice due to the onset of north east monsoon resulting in labour scarcity. With the introduction of combine harvesters, has advantage for timely harvest of the crop. But, it leaves behind a swath of loose rice residues, which interfere with field operations. However, management of the rice straw is a major challenge as it is considered to be a

poor feed for the animals owing to high silica content. To avoid this problem farmers resort to burning of crop residue, which not only lead to loss of huge biomass but also cause environmental pollution.

Hence an alternate way for effective utilization of this valuable resource is essential. Keeping these points in view, the present study was taken up as residue management and nutrient dynamics in combine harvester operated rice field after rice cultivation.

Materials and Methods

The field experiment was conducted at Agricultural Research Station, Bhavanisagar during 2014- 15 to 2015 - 16 to find out suitable rice residue management practices and nutrient dynamics by using combine harvester operated rice field after cultivating rice. The experiment was laid-out in Randomized Block Design (RBD) with five replications. The treatments were T₁: Incorporation of straw as such with tractor mounted with half cage wheel and rotovator, T₂: T₁ + 25 kg additional dose of N/ha as basal, T₃: T₁ + addition of biomineralizer for decomposition of straw and incorporation later and T₄: Control (no residues). Recommended dose of chemical fertilizer for rice 150:50:50 NPK kg ha⁻¹ were applied for all the treatments. The rice variety CO 51 was used as test variety. Growth parameters *viz.*, plant height (cm), DMP (kg/ha) and number of tillers/m² were recorded during 60 DAS, yield and yield parameters like no. of productive tillers/m², filled grains/panicle, 1000 grain weight (g), grain and straw yield (kg/ha) were also recorded in rice. Soil samples were collected at flowering stage and after harvest of rice and analyzed for available NPK by following standard procedures. Twenty five days old seedlings were transplanted with a spacing of 20 x 20 cm.

Table.1 Influence of residue management practice on plant height and dry matter production (DMP) of rice at 60 DAS

| Treatment | | 2014-15 | | 2015-16 | |
|----------------|--|-----------------------------|-------------|-------------------|-------------|
| | | Growth parameters at 60 DAS | | | |
| | | Plant height (cm) | DMP (kg/ha) | Plant height (cm) | DMP (kg/ha) |
| T ₁ | Incorporation of straw as such with tractor mounted with half cage wheel and rotovator | 89.70 | 6852 | 92.39 | 7058 |
| T ₂ | T ₁ + 25 kg additional dose of N/ha as basal | 93.65 | 7571 | 96.46 | 7798 |
| T ₃ | T ₁ + addition of biomineralizer for decomposition of straw and incorporation later | 99.37 | 8358 | 102.35 | 8609 |
| T ₄ | Control (no residues) | 80.00 | 5642 | 82.40 | 5811 |
| | SEd | 7.63 | 423 | 7.31 | 455.0 |
| | CD _{p=0.05} | 14.53 | 869 | 15.30 | 912.0 |

Table.2 Influence of residue management practice on yield and yield parameters of rice

| Treatment | 2014-15 | | | | | |
|----------------|----------------------------------|--|-----------------------|-----------------------|---------------------|---------------------|
| | Yield and yield attributes | | | | | |
| | Number of tillers/m ² | No. of productive tillers/m ² | Filled grains/panicle | 1000 grain weight (g) | Grain yield (kg/ha) | Straw yield (kg/ha) |
| T ₁ | 462 | 323 | 109 | 16.47 | 6842 | 8542 |
| T ₂ | 528 | 369 | 142 | 19.32 | 7382 | 9038 |
| T ₃ | 572 | 400 | 168 | 20.24 | 7706 | 9982 |
| T ₄ | 396 | 277 | 98 | 14.03 | 5238 | 7642 |
| SEd | 45.0 | 24 | 12 | 1.48 | 356 | 722 |
| CD (p=0.05) | 93.0 | 52 | 24 | 3.60 | 726 | 1455 |
| Treatment | 2015-16 | | | | | |
| T ₁ | 476 | 333 | 112 | 16.96 | 7047 | 8798 |
| T ₂ | 544 | 380 | 146 | 19.90 | 7603 | 9309 |
| T ₃ | 589 | 412 | 173 | 20.85 | 7937 | 10281 |
| T ₄ | 408 | 285 | 101 | 14.45 | 5395 | 7871 |
| SEd | 46.0 | 26 | 13 | 1.62 | 374 | 758 |
| CD (p=0.05) | 94.0 | 54 | 27 | 3.96 | 765 | 1536 |

Table.3 Influence of residue management practice on soil available nutrient status of rice (kg/ha)

| Treatment | 2014-15 | | | | | |
|----------------|-------------------------|-------------------------------|------------------|----------------------|-------------------------------|------------------|
| | Nutrient dynamics | | | | | |
| | Flowering stage (kg/ha) | | | Post harvest (kg/ha) | | |
| | N | P ₂ O ₅ | K ₂ O | N | P ₂ O ₅ | K ₂ O |
| T ₁ | 247 | 10.82 | 438 | 248 | 12.43 | 459 |
| T ₂ | 226 | 10.47 | 415 | 229 | 11.82 | 432 |
| T ₃ | 186 | 10.05 | 427 | 187 | 11.76 | 425 |
| T ₄ | 264 | 14.67 | 442 | 267 | 14.95 | 426 |
| SEd | 20.63 | 1.28 | 22.43 | 21.53 | 1.46 | 20.42 |
| CDp=0.05 | 43.20 | 2.64 | NS | 44.32 | 3.02 | NS |
| Treatment | 2015-16 | | | | | |
| T ₁ | 254 | 11.14 | 451 | 255 | 12.80 | 473 |
| T ₂ | 233 | 10.78 | 427 | 236 | 12.17 | 445 |
| T ₃ | 192 | 10.35 | 440 | 193 | 12.11 | 438 |
| T ₄ | 272 | 15.11 | 455 | 275 | 15.40 | 439 |
| SEd | 21.10 | 1.48 | 23.42 | 22.85 | 1.45 | 21.60 |
| CDp=0.05 | 44.16 | 3.06 | NS | 46.20 | 2.96 | NS |

Fig.1 Effect of residue management practice on yield and yield attributes of rice

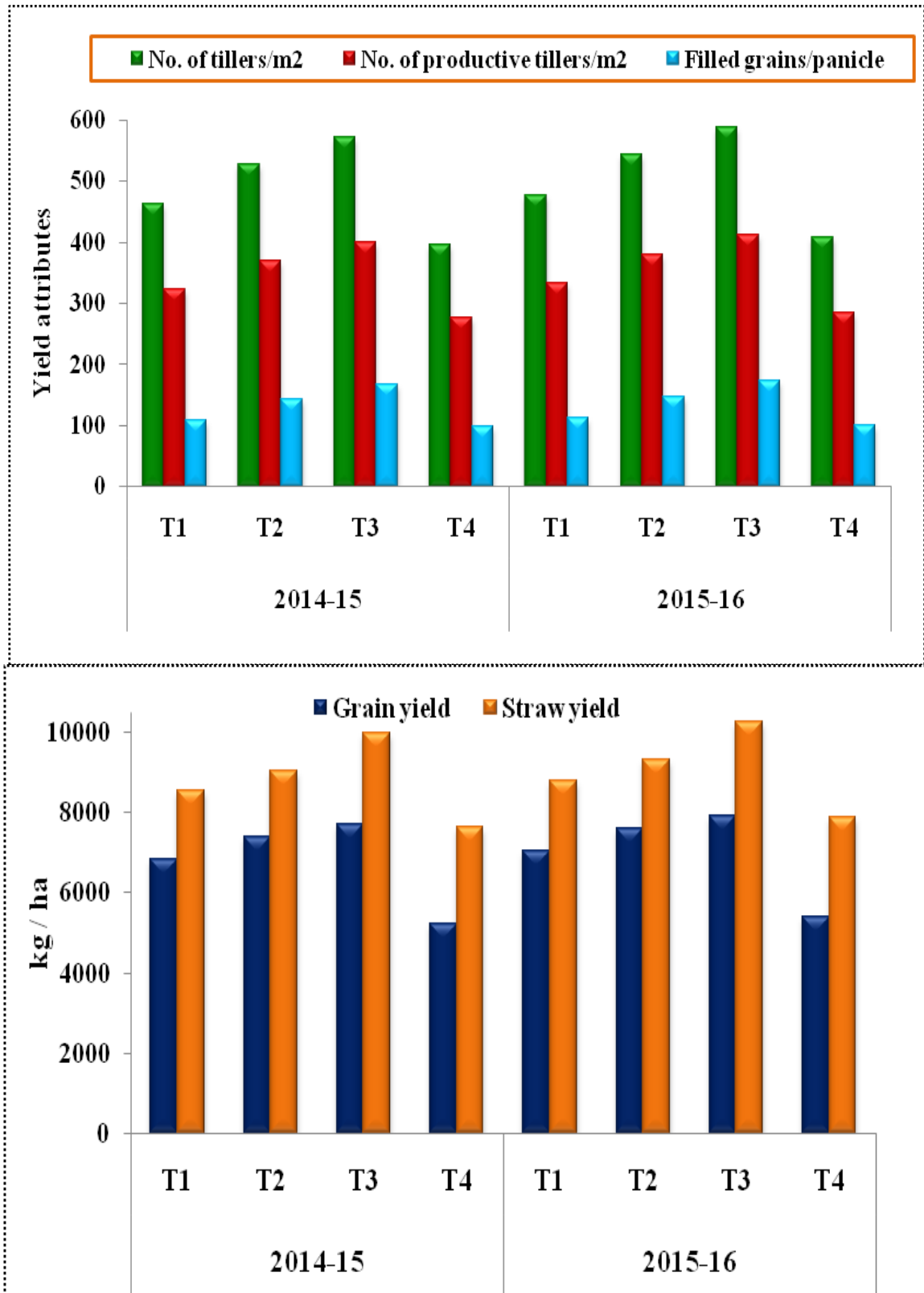
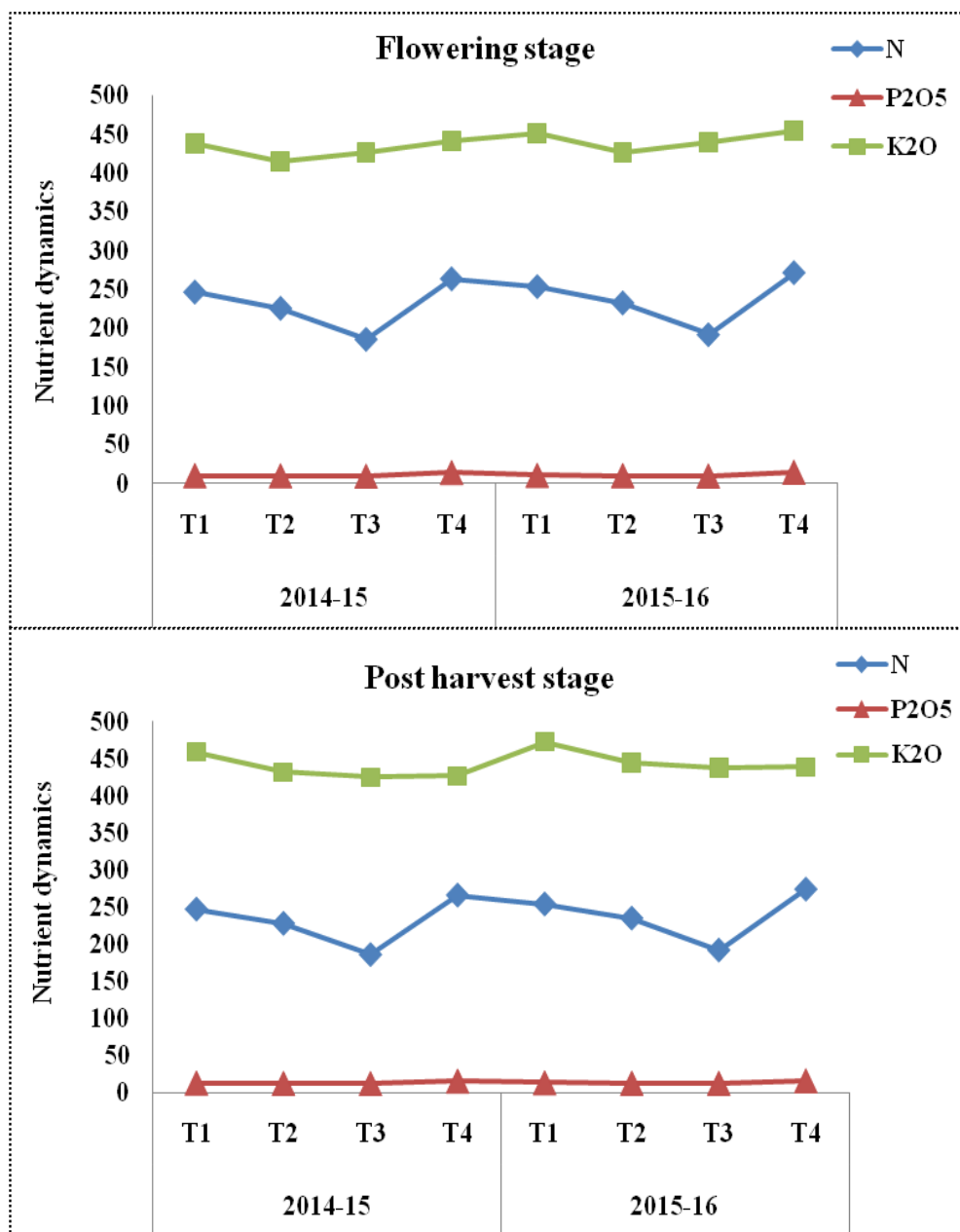


Fig.2 Effect of residue management practice on soil available nutrient status of rice (kg/ha)



Results and Discussion

The growth parameters recorded on 60 DAS during I and II year are presented in the Table 1. The higher plant height (99.37 and 102.35 cm) was recorded with incorporation of straw as such with tractor mounted with half cage wheel and rotovator with addition of biomineralizers for decomposition of straw and incorporation

later at 60 DAT. This was on par with all the treatments except control (80.00 and 82.40 cm) at all stages of crop growth. Incorporation of straw as such with tractor mounted with half cage wheel and rotovator with addition of biomineralizers for decomposition of straw and incorporation later recorded higher plant height due to inclusion of microbial consortia for fastening the decomposition of organic waste

and reduce the C : N ratio for continuous availability nutrients along with 100% recommended dose of chemical fertilizer. Positive effect of incorporation of rice straw with nutrients on plant height as earlier reported by Machado *et al.*, (1992) and Vaiyapuri *et al.*, (2016).

Dry matter production was significantly influenced by T₃ (8358 and 8609 kg ha⁻¹), which was on par with T₂ except T₁ and control. The increase in dry matter production might be due to the increased availability of nutrients in rice as a result of higher nutrient release from composted paddy straw and steady nutrient availability from paddy straw incorporation with microbial inoculants due to rapid break down than the paddy straw applied plots. The results are akin to the findings of Radhakrishna *et al.*, 1995 and Vaiyapuri *et al.*, (2016). The yield and yield contributing traits of I and II year are presented in the Table 2 (Fig. 1). The yield contributing traits *viz.*, no. of tillers M⁻² (572 and 589), no. of productive tillers M⁻² (400 and 412), filled grains per panicle (168 and 173) and 1000 grain weight (20.24 and 20.85g) were significantly influenced by incorporation of straw as such with tractor mounted with half cage wheel and rotovator with addition of biomineralizers for decomposition of straw and incorporation later, which was on par with T₂ except T₁ and control. Higher uptake of nutrient through straw incorporation with added microbes at higher nutrient levels might be improved the yield attributes. Similar results have been reported by Sivakami (2000).

Grain yield and straw yield were significantly influenced by incorporation of straw as such with tractor mounted with half cage wheel and rotovator with addition of biomineralizers for decomposition of straw and incorporation later along with 100 per cent recommended dose of fertilizer (7706 kg ha⁻¹; 7937 kg ha⁻¹ for grain yield and 9982 kg ha⁻¹; 10281 kg ha⁻¹ for straw yield). This was on par with T₂ except T₁ and control. The increase in grain and straw yield might be due to the increased availability of nutrients in rice as a result of

higher nutrient release from composted paddy straw and steady nutrient availability from paddy straw incorporation with microbial inoculants due to rapid degradation of lignin, cellulose and silica content of straw and recommended dose of fertilizer, and increasing the availability nutrients particularly N and silica. Similar findings were also reported by Malek *et al.*, (1998) and Vaiyapuri *et al.*, (2016).

Influence of residue management practice on soil available nutrient status of rice (kg/ha) at flowering and post-harvest stages are presented in Table 3 (Fig. 2). Incorporation of composted paddy straw and paddy straw incorporation with microbial inoculants with 100 percent inorganic fertilizer (RDF) influenced the soil available nutrients in flowering stage and also post-harvest available nutrients. Availability of higher nutrient from the compost and unutilized portion of nutrient supplied by the rice residue and re-mobilization of native soil nutrients through organic acids produced during decomposition and rapid decomposition rate by microbial could be the reason for more available soil nutrients. The results are similar to the findings of Son (1995).

The intelligent management and utilization of crop residues is essential for the improvement of soil quality and crop productivity under rice-based cropping systems of the semi-arid. Crop residues, usually considered a problem, when managed correctly can improve soil organic matter dynamics and nutrient cycling, thereby creating a rather favourable environment for plant growth. Crop residues contain large quantities of nutrients, and thus the return of crop residues to the soil can save a considerable quantity of fertilizers. The most viable option is to retain residue in the field; burning should be avoided. Current study revealed that, rice straw incorporation coupled with biomineralizer increases the crop growth, yield attributes, grain and straw yield due to higher utilization of nutrients in flowering and post-harvest soil nutrient status of rice.

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