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Effect of Paddy Straw Based Integrated Nutrient Management Practices for Sustainable Production of Rice

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Abstract: *The field experiments on Integrated Nutrient Management in rice were carried out (Kharif 2010,2011 and 2012 and summer 2011 and 2012) in red loamy soil at Agricultural and Horticultural Research Station, Kathalagere, Channagiri taluk, Davanagere district of Karnataka, India to develop suitable integrated nutrient management practices for rice using organic and inorganic sources of nutrients through integration of paddy straw treated with combination of cow dung slurry @ 5% + Trichoderma harizianum @5 kg ha^{-1} + Pleurotus sajor caju @ 5 kg ha^{-1}.The organic sources of nutrients used in the present study were FYM (Farm yard manure), paddy straw and Gliricidia sipium. The results of the present investigation clearly indicated that the supply of recommended dose of NPK with FYM or paddy straw treated with cow dung slurry @ 5% + T. harizianum @5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1} or Gliricidia yielded significantly positive response in increasing yield attributes like grain and straw yield in rice. The pooled experimental data of five season experimentation confirmed the results for sustainability of rice productivity.*

Keywords: *Rice Straw, Integrated Nutrient Management, Sustainable. Trichoderma harizianum, Pleurotus sajor caju, cow dung slurry*

I. Introduction

Rice (Oryza sativa L.) is one of the most important cereal food crops of India in term of area, production and consumer preference. India is also the second largest producer and consumer of rice in the world. In command areas, rice-rice cropping system is the most common practice. The continued use of inorganic fertilizers over years in paddy field without the application of organic amendments resulted in the change of soil structure and increase in salinity or alkalinity apart from decreasing the soil fertility. The availability of Farm Yard manure (FYM), the main source of organic fertilizers, is also one of the limiting factors for application to the soil. Apart from the FYM, the paddy straw is also an important organic source of plant nutrients which can be incorporated into the soil to supplement the nutrient requirement of the plant. Since the paddy straw is available in bulk after each harvest, it could be utilized effectively after proper microbial decomposition and could be used along with inorganic fertilizers for sustainable production of rice.

Rice straw contains nitrogen (0.5- 0.8%), P2O5 (0.16-0.27%), K2O (1.4-2.0%), S (0.05-0.10%) and Si (4-7%) per ton on dry matter basis [1]. The composted rice straw is reported to contain 33 per cent carbon and 1.9 per cent N and, the carbon: nitrogen ratio was 18[2] in addition digestible organic matter (51.5%), cellulose (47.2%), lignin (3.0%) and soluble phenolic compounds (4.3%) [3]. More than 70 per cent of nitrogen released from the rice straw could be used by the rice crop in soil which receives continuous application of rice straw for a period of 10 years [4].

The integrated use of both inorganic and organic sources of substrates enhances the efficiency of both the substances to maintain soil productivity. However, the lack of proper knowledge of the use of organic sources and their inability to meet the total nutrient requirement of crop to achieve sustained yield levels resulted in the poor maintenance of soil health. Hence, the integrated application of organic substances with inorganic fertilizers is not only essential for managing soil health but also to increase crop productivity. A perusal of literature indicated that there is meager information on rice straw utilization in rice fields either in combination with inorganic or organic substances.

In view of the above, it was aimed to study the effect of rice straw integration with inorganic fertilizer and FYM on soil nutrient management for sustainable production of rice in different seasons of the year.

II. Materials And Methods

The field experiments were carried out during 2010-2012 in Kharif and summer seasons (Kharif 2010, 2011 and 2012 and summer 2011 and 2012) in moderately shallow and dark reddish brown clay soils with the initial soil fertility status of p^H-6.40, 0.68 % organic carbon, 288 kgha^{-1} available nitrogen, 12.3 kg ha^{-1} available phosphorus and 211.4 kgha^{-1} available potash at Agricultural and Horticultural Research Station, Kathalagere, Channagiritaluk, Davanagere district that comes under Bhadra (river) command of Karnataka, India situated between 13^0 2' to 13^0 05' North latitude and 76^0 15' East longitude and an altitude of 561.6 meters above mean sea level under Southern Transitional Zone (Zone-7) of Karnataka which receives average annual rainfall of 654.0 mm.

The paddy straw was collected from the freshly harvested rice crop, dried in the field and cut into 12 inch segments then the paddy straw was treated with combination of freshly prepared cow dung slurry @ 5%(volume/weight basis) + Trichoderma harizianum @5 kg ha^{-1} + Pleurotus sajor caju @ 5 kg ha^{-1}.The treatment regimes used in the present study were combination of NPK with FYM treated paddy straw or Gliricidia sepium

The field experiments were laid out in Randomized Complete Block Design (RCBD) with 12 treatments replicated thrice in a treatment plot size of 8.4 x 6.9 m. The rice seedling nursery and the main crop were raised as per the package of practices and the nutrient management practices were adopted as per the experimental treatments [6]. The rice variety JGL-1798 healthy seedlings of 25 days old were planted with the spacing of 20 cm x 10 cm. The treatment details include-T_1:Control (without application of fertilizers), T_2:50% NPK, T_3:75% NPK, T_4:100% NPK, T_5:50% NPK + 50% NPK through FYM, T_6:75% NPK + 25% NPK through FYM, T_7:50% NPK + 50% NPK supplied through Paddy Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1}, T_8: 75% NPK + 25% NPK supplied through Paddy Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1},T_9:50% NPK + 50% NPK supplied through Gliricidia sipium, T_{10}:75% NPK + 25% NPK supplied through Gliricidia, T_{11}:Farmers Practice(85:50:30 kg NPK ha^{-1}& 5t ha^{-1} FYM) and T_{12}:Recommended dose NPK (100: 50: 50 kg NPK) + 10 t ha^{-1} FYM.

The observation on yield attributes (productive tillers/hill and panicle weight), grain and straw yield of rice were recorded at harvest and the data were subject for statistical ANOVA at P= 0.05 [5].

III. Results And Discussion

The pooled data of five seasons (Kharif 2010,2011 and 2012 and summer 2011 and 2012) on yield attributing factors revealed that the application of 75% NPK + 25% NPK supplied through Paddy Straw treated with cow dung slurry @ 5% + T. harizianum @ 5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1} treated plots had significantly enhanced the number of productive tillers (19.42 per hill) and panicle weight (4.76 g per plant) as compared to application of 100% NPK alone supplied through inorganic fertilizers (17.86/hill and 4.13 g, respectively) [T_8] followed by the application of 50% NPK + 50% NPK through paddy straw with cow dung slurry @ 5% + T. harizianum @ 5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1} [T_7] (TABLE 1 & 2). The enhanced yield attributing factors were related to the release of plant nutrients by the process of microbial degradation of rice straw according to the plant demand.

Similarly, the pooled data of five seasons on grain and straw yield revealed that application of 75% NPK + 25% NPK supplied through paddy straw treated with cow dung slurry @ 5% + T. harizianum@5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1} treated plots recorded significantly highest yield of grain (7201 kg ha^{-1}) and straw yield (9000 kg ha^{-1}) compared to application of 100% NPK alone supplied through inorganic fertilizers (6896 kg ha^{-1} and 8609 kg ha^{-1}, respectively) and on par with the application of recommended dose of NPK + 10 tons FYM (7050 kg ha^{-1} and 8829 kg ha^{-1}, respectively).

The results of the present investigation clearly indicated that supply of recommended dose of NPK either through inorganic and organic sources showed that nutrients supplied in combination with FYM or paddy straw treated with cow dung slurry @ 5% + T. harizianum @5 kg ha^{-1} + P. sajor caju@ 5 kg ha^{-1}(T_8) or Gliricidia (T_{10}) had significantly positive response in increasing yield attributes, grain and straw yield in rice.

The increased rice yield could be due to return of available nutrients in the form of NPK, C and other minerals from decomposed rice straw treated with T. viridae to soil [6] as suggested by Man et al. In another experiment Man et al showed that application of rice straw decomposed with Trichoderma spp and combined with 50% NPK fertilizers increased rice yield over application of chemical fertilizers alone[7]. It has been shown that the integrated use of fertilizers and manure or crop residue could be an efficient practice for getting high crop yields in rice without degradation of soil fertility [8]. Studies conducted have also shown that use of 12 t ha^{-1} FYM and 60 kg/ha N [9] and application of 12 t ha^{-1} FYM in combination with 80 kg ha^{-1} N [10] produced rice yields equivalent to that obtained with 120 kg ha^{-1} N. Also, application of 75% NPK through fertilizers + 25% through Glyricidia or rice straw [11], 25% recommended N through FYM and 50%

recommended NPK through fertilizers plus 50% NPK through compost and FYM recorded similar rice grain yields as that of 100% NPK applied through fertilizers[12].

The results of present investigation suggested that the application of 75% NPK through chemical fertilizers in combination with 25% NPK supplied through Paddy Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg ha^{-1} + P. sajor caju @ 5 kg ha^{-1} was the best integrated nutrient management practices in rice, since there was a balanced combination of organic and inorganic source of nutrients.

IV. Conclusion

The results of the present study showed that the application of the combination treatments of 75% NPK + 25% NPK supplied through Paddy Straw treated with cow dung slurry @ 5% + T. harizianum @5 $kgha^{-1}$ + P. sajor caju @ 5 kg ha^{-1}helped in the balance maintaining the organic and inorganic nutrients in soil and hence the increased rice productivity. The present study also showed that rice straw could be efficiently exploited for conservation of soil nutrients under rice ecosystem through proper decomposing techniques, simultaneously enhancing soil microorganisms beneficial for plant growth and productivity.

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Table 1. Effect of inorganic and organic source of nutrients on productive tillers of rice plants per hill in different seasons

Sl. No.	Treatments	Productive tillers/hill					Pooled
		Kharif 2010	Summer 2011	Kharif 2011	Summer 2012	Kharif 2012	
T_1	Control	12.63	12.06	12.70	13.29	12.68	**12.67**
T_2	50% NPK	14.62	14.61	15.30	15.89	15.52	**15.18**
T_3	75% NPK	16.25	16.59	16.90	17.13	17.05	**16.78**
T_4	100% NPK	17.32	17.59	17.97	18.27	18.17	**17.86**
T_5	50% NPK + 50% NPK through FYM	17.05	17.23	17.62	18.04	18.41	**17.67**
T_6	75% NPK + 25% NPK through FYM	17.72	17.72	17.96	18.33	18.87	**18.12**
T_7	50% NPK + 50% NPK through Paddy Straw*	18.52	18.70	19.08	19.66	19.81	**19.15**
T_8	75% NPK + 25% NPK through Paddy Straw*	18.94	19.06	19.32	19.75	20.04	**19.42**
T_9	50% NPK + 50% NPK through Glyricidia	16.75	17.31	17.68	18.08	18.36	**17.63**
T_{10}	75% NPK + 25% NPK through Glyricidia	18.09	18.30	18.41	18.66	19.05	**18.50**
T_{11}	Farmers Practice(85:50:30 kg $NPKha^{-1}$& FYM 5 tha^{-1})	16.80	17.10	17.48	18.17	18.64	**17.63**
T_{12}	Rec.NPK (100: 50: 50 kg NPK) + 10 tons FYM	18.94	19.35	19.43	19.70	20.08	**19.50**
	S.Em±	**0.24**	**0.17**	**0.16**	**0.11**	**0.13**	**0.10**
	CD at 5%	**0.71**	**0.50**	**0.47**	**0.31**	**0.37**	**0.27**

* Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg/ha + P. sajor caju@ 5 kg ha^{-1}

Table 2. Effect of inorganic and organic source of nutrients on panicle weight of rice in different seasons

Sl. No.	Treatments	Panicle weight (g)					Pooled
		Kharif 2010	Summer 2011	Kharif 2011	Summer 2012	Kharif 2012	
T_1	Control	2.92	2.90	3.02	3.10	2.74	**2.93**
T_2	50% NPK	3.37	3.41	3.58	3.52	3.49	**3.47**
T_3	75% NPK	3.66	3.73	3.92	3.79	3.79	**3.77**
T_4	100% NPK	4.01	4.12	4.20	4.21	4.11	**4.13**
T_5	50% NPK + 50% NPK through FYM	3.93	3.95	4.13	4.13	4.13	**4.05**
T_6	75% NPK + 25% NPK through FYM	4.07	4.13	4.23	4.20	4.26	**4.17**
T_7	50% NPK + 50% NPK through Paddy Straw*	4.42	4.57	4.62	4.68	4.52	**4.56**
T_8	75% NPK + 25% NPK through Paddy Straw*	4.63	4.73	4.86	4.84	4.78	**4.76**
T_9	50% NPK + 50% NPK through Glyricidia	3.99	4.08	4.17	4.17	4.12	**4.10**
T_{10}	75% NPK + 25% NPK through Glyricidia	4.03	4.15	4.37	4.21	4.18	**4.18**
T_{11}	Farmers Practice(85:50:30 kg NPKha^{-1}& FYM 5 t/ha)	4.23	4.35	4.48	4.46	4.34	**4.37**
T_{12}	Rec.NPK (100: 50: 50 kg NPK) + 10 tons FYM	4.56	4.53	4.63	4.68	4.61	**4.60**
	S.Em+	**0.05**	**0.05**	**0.03**	**0.03**	**0.06**	**0.02**
	CD at 5%	**0.14**	**0.15**	**0.08**	**0.10**	**0.17**	**0.07**

* Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg/ha + P. sajor caju@ 5 $kgha^{-1}$

Table 3. Effect of inorganic and organic source of nutrients on grain yield of rice in different seasons

Sl. No.	Treatments	Grain yield($kgha^{-1}$)					Pooled grain yield
		Kharif 2010	Summer 2011	Kharif 2011	Summer 2012	Kharif 2012	
T_1	Control	4144	4295	4110	4044	3959	**4110**
T_2	50% NPK	6247	6303	6173	6186	6207	**6223**
T_3	75% NPK	6486	6540	6488	6531	6389	**6486**
T_4	100% NPK	6804	6889	6949	6951	6891	**6896**
T_5	50% NPK + 50% NPK through FYM	6551	6567	6651	6709	6604	**6616**
T_6	75% NPK + 25% NPK through FYM	6643	6736	6832	6822	6735	**6753**
T_7	50% NPK + 50% NPK through Paddy Straw*	6901	6959	7046	7102	6947	**6991**
T_8	75% NPK + 25% NPK through Paddy Straw*	7149	7242	7191	7252	7175	**7201**
T_9	50% NPK + 50% NPK through Glyricidia	6553	6632	6644	6718	6409	**6591**
T_{10}	75% NPK + 25% NPK through Glyricidia	6662	6757	6818	6859	6688	**6756**
T_{11}	Farmers Practice(85:50:30 kg NPKha^{-1}& FYM 5 tha^{-1})	6763	6831	6807	6770	6606	**6755**
T_{12}	Rec.NPK (100: 50: 50 kg NPK) + 10 tons FYM	7027	7112	7068	7094	6950	**7050**
	S.Em+	**19.30**	**22.83**	**34.94**	**44.93**	**43.96**	**27.57**
	CD at 5%	**56.61**	**66.94**	**102.45**	**131.75**	**128.91**	**78.56**

* Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg/ha + P. sajor caju@ 5 $kgha^{-1}$

Table 4. Effect of inorganic and organic source of nutrients on Straw yield of rice in different seasons

Sl. No.	Treatments	Straw yield(kg ha^{-1})					Pooled straw yield
		Kharif 2010	Summer 2011	Kharif 2011	Summer 2012	Kharif 2012	
T_1	Control	5013	5547	5087	5303	4733	**5136**
T_2	50% NPK	7534	8123	7603	8134	7374	**7754**
T_3	75% NPK	7827	8449	8090	8567	7638	**8114**
T_4	100% NPK	8239	8912	8587	9095	8212	**8609**
T_5	50% NPK + 50% NPK through FYM	7947	8533	8233	8830	7915	**8291**
T_6	75% NPK + 25% NPK through FYM	8059	8707	8424	8937	8064	**8438**
T_7	50% NPK + 50% NPK through Paddy Straw*	8353	9036	8766	9331	8344	**8766**
T_8	75% NPK + 25% NPK through Paddy Straw*	8652	9408	8845	9521	8577	**9000**
T_9	50% NPK + 50% NPK through Glyricidia	7924	8590	8337	8826	7678	**8271**
T_{10}	75% NPK + 25% NPK through Glyricidia	8070	8742	8457	8994	7944	**8441**
T_{11}	Farmers Practice(85:50:30 kg NPK/ha & FYM 5 t/ha)	8225	8824	8436	8905	7875	**8453**
T_{12}	Rec.NPK (100: 50: 50 kg NPK) + 10 tons FYM	8511	9190	8798	9263	8384	**8829**
	S.Em+	**39.86**	**29.61**	**46.40**	**57.27**	**60.79**	**39.88**
	CD at 5%	**116.89**	**86.83**	**136.08**	**167.95**	**178.25**	**113.64**

* Straw treated with cow dung slurry @ 5% + T. harizianum @5 kg/ha + P. sajor caju@ 5 $kgha^{-1}$