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EFFECT OF ORGANIC SOURCES AND FERTILIZER LEVELS ON QUALITY AND GRAIN YIELD OF HYBRID RICE

C. SUBHA LAKSHMI*, A. PRATAP KUMAR REDDY AND G. JAYASREE

Department of Agronomy, College of Agriculture, Rajendranagar, Acharya N.G. Ranga Agricultural University, Hyderabad -500 030

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ABSTRACT

A field experiment was conducted for two consecutive years at College Farm, College of Agriculture, Rajendranagar, Hyderabad during kharif 2009 and 2010 to study the effect of organic sources and fertilizer levels on quality parameters and grain yield of hybrid rice. The experiment was laid out in split plot design with three replications. The treatments included organic sources (control – no organic manuring, 5 t subabul ha^{-1}, 2.5 t rice straw ha^{-1}) in main plot and fertilizer levels comprising of N:K_2O kg ha^{-1} (150:75, 175:50, 175:25, 200:50, 200:25, 225:0) in sub plots. The results revealed that among the organic sources, 5t subabul ha^{-1} recorded the highest milling percentage, head rice recovery and grain yield in both the years. Application of 200 kg N + 56 kg K_2O ha^{-1} was the best fertilizer level in recording highest values of milling percentage, head rice recovery and grain yield. Interaction effect was significant on milling percentage, head rice recovery and grain yield. Addition of 5 t subabul ha^{-1} + 200:50 N:K_2O kg ha^{-1} recorded the highest mean milling (76.18), head rice recovery (55.03) % and grain yield (6370 kg ha^{-1}) and was at par with 5t subabul ha^{-1} + 200:25 N:K_2O kg ha^{-1}. Length/Breadth ratio of grain was neither influenced by organic sources nor fertilizer levels. Mean protein content (9.04%) of rice grain was the highest with 5 t subabul ha^{-1}. Fertilizer level comprising of 225:0 and 150:75 N: K_2O kg ha^{-1} recorded the highest and lowest protein content respectively. The increase in mean protein content with 225:0 over 150:75 N: K_2O kg ha^{-1} was 3.72 percent.

Key words*:* Organic sources, fertilizer levels, grain quality, hulling, head rice recovery, milling, protein, rice

INTRODUCTION

Rice is one of the major staple cereal foods. Initially, the mandate of rice researchers was to maximize the yield for which methods and procedures have been established. In recent past it has been shifted to quality rice production. This is because high yielding varieties or hybrids take off smoothly if they are nutritive and possess consumer acceptability. Demand for quality rice has always been a major factor in rice marketing and becomes more important in developing countries as the economic status of the people increases. Although, rice quality has many components and is related to preference in different cultures, its major elements include milling properties, grain size, shape and appearance and cooking and eating characteristics. Among these protein content, milled rice recovery (especially head rice recovery) and grain colour are primary concerns. Rice is the major protein source in most of the rice eating areas and protein can also influence the physicochemical properties of cooked rice. Head rice yield which affects market value, is directly related to brown rice yield and milled rice yield which together form the milling quality. Owing to high grain yield, hybrid rice removes a substantial amount of major nutrients from the soil and deficiency of these nutrients reduces its grain yield. Organic manures not only act as the source of nutrients, but also modify the soil physical behavior as well as increase the efficiency of applied nutrients, yield and quality of produce. It is imperative to use technologies in integrated manner so that the potential yield of hybrid rice could be realized on sustained basis (Pandey *et al*., 2007). Hence the present investigation was conducted to find out the suitable nutrient management strategy to improve the quality and grain yield of hybrid rice.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, College of Agriculture, Rajendranagar, Hyderabad during *kharif* 2009 and 2010. The farm is geographically situated at an altitude of 542.6 m above the mean sea level on 17º 19' N latitude and 78º 23' E longitudes. The soil of the experimental site was sandy clay loam in texture, alkaline in reaction (pH-7.9), low in organic carbon (2.6 g kg^{-1}), low in available nitrogen (242 kg ha^{-1}), medium in available P_2O_5 (39.4 kg ha^{-1}) and high in available K_2O (368 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The treatments consisted of organic sources (M_1- control, M_2- 5t subabul ha^{-1}, M_3- 2.5t rice straw ha^{-1}) in main plots, and fertilizer levels comprising of N:K_2O kg ha^{-1} (F_1-150:75, F_2-175:50, F_3-175:25, F_4-200:50,

Corresponding author Email: subhanairdr@gmail.com

F_5-200:25, F_6-225:0) in sub-plots. A common dose of 75 kg P_2O_5 ha^{-1} in the form of DAP was applied to all the plots. Measured quantities of subabul twigs and rice straw were incorporated in the respective treatment plots twelve days before transplanting. The N, P and K content in subabul twigs was 3.90, 0.39 and 2.2% while in rice straw, N, P and K was 0.54, 0.16 and 1.6. The entire dose of P_2O_5 and half dose of K_2O were applied as basal dose while N was applied in three equal splits i.e. at transplanting, maximum tillering and at panicle initiation stage. The remaining K_2O was applied at flowering stage of the crop. Twenty five days old seedlings of KRH-2 @ one seedling/hill were transplanted 20x15 cm spacing. Standard cultural practices were carried out from transplanting to maturity. Grain yield was recorded at moisture of 14%. Grain length and breadth of brown rice (dehulled) was measured by 'Mitutoyo Micrometer" and expressed in mm. Grain length was divided by grain breadth and L/B ratio was obtained. Milling and head rice recovery (HRR) % were calculated by following formulas.

$$\text{Milling (\%)} = \frac{\text{Weight of polished}}{\text{Weight of paddy}} \text{ X } 100$$

$$\text{HRR (\%)} = \frac{\text{Weight of head rice recovered}}{\text{Weight of sample used}} \text{X } 100$$

Protein content of grain was estimated by Lowry's method (Lowry *et al*., 1951). The data were subjected to statistical analysis by applying analysis of variance for split plot design and significance was tested by F-test (Snedecor and Cochran, 1967) at 5% level of probability.

RESULTS AND DISCUSSION

Quality parameters

Among the organic sources, 5t subabul ha^{-1} recorded the highest milling and head rice recovery % in both the years and was found significantly superior to 2.5t rice straw ha^{-1} and no organic manuring. Sangeetha *et al*. (2013) also recorded higher values of milling and head rice recovery % with the application of organic sources when compared to no organic manuring. Fertilizer level comprising of 200:50 N: K_2O kg ha^{-1} recorded significantly higher values of milling percentage and head rice recovery compared to other fertilizer levels (Table 1). Balanced fertilization of N and K might be the probable reason. Interaction effect was found significant on milling percentage (Tables 2). Application of 5 t subabul ha^{-1} + 200:50 N : K_2O kg ha^{-1} recorded the highest valu of milling percentage and was comparable to 5t subabul ha^{-1} + 200:25 N:K_2O kg ha^{-1}. On the other hand, lowest value of milling percentage was recorded under no manure + 175 kg N and 50 kg K_2O ha^{-1}. There was no significant influence of organic sources and fertilizer levels on L/B ratio of rice grain.

Table 1: Quality parameters and grain yield of hybrid rice as influenced by organic sources and fertilizer levels

Treatment	Milling (%)		Head rice recovery (%)		L/B ratio		Protein content (%)		Grain yield (kg ha^{-1})	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Organic sources										
Control	67.32	68.90	48.63	49.77	2.97	2.98	8.76	8.78	5623	5753
Subabul @ 5t ha^{-1}	71.98	73.68	52.00	53.22	2.99	3.00	9.03	9.04	6012	6155
Rice straw @ 2.5t ha^{-1}	69.10	70.73	49.92	51.09	2.97	2.98	8.81	8.82	5772	5908
S.Em±	0.60	0.61	0.43	0.44	0.03	0.03	0.05	0.04	44	51
CD (P=0.05)	1.66	1.70	1.20	1.23	NS	NS	0.14	0.11	123	142
Fertilizer levels (N:K_2O kg ha^{-1})										
F_1 - 150:75	67.02	68.59	48.41	49.55	2.97	2.98	8.72	8.73	5597	5730
F_2 - 175:50	69.15	70.78	49.95	51.12	2.98	2.99	8.75	8.77	5776	5907
F_3 - 175:25	67.51	69.10	48.77	49.92	2.98	2.98	8.75	8.76	5639	5760
F_4 - 200:50	72.33	74.03	52.25	53.48	2.99	3.00	8.92	8.93	6041	6190
F_5 - 200:25	71.09	72.76	51.35	52.56	2.98	2.99	8.92	8.93	5937	6083
F_6 - 225:0	69.72	71.36	50.36	51.55	2.99	3.00	9.04	9.06	5823	5963
S.Em±	0.46	0.47	0.33	0.35	0.02	0.02	0.04	0.05	42	39
CD (P=0.05)	0.95	0.97	0.68	0.70	NS	NS	0.11	0.14	85	81

Interaction (Manures X fertilizers) had a significantly beneficial effect on rice recovery in both the years (Table 3) and maximum recovery percentage was recorded under 5 t subabul ha^{-1} + 200 kg N and 50 kg K_2O ha^{-1} and lowest in no manure and 175 kg N + 50 kg K_2O ha^{-1} treatment.

Protein content

Protein content of rice grain was the highest with 5t subabul ha^{-1} and was significantly superior to 2.5t rice straw ha^{-1} and no organic manuring (control). High protein content associated with incorporation of subabul might be due to the ensured supply of nitrogen. Increase in protein content with organic manuring was also reported by Saritha Hegde *et al*. (2013). Among the fertilizer levels tested, 225:0 N:K_2O kg ha^{-1} registered the highest protein content of grain (Table 1). Increased protein content with increased level of nitrogen may be due to the fact that nitrogen forms the principal constituent of protein and indisputably protein content would always be in direct proportion with the dose of applied nitrogen (Ganga Devi *et al*., 2012).

Table 2: Effect of interaction between organic sources and fertilizer levels on milling % of hybrid rice

Organic sources	Fertilizer levels (N:K_2O kg ha^{-1})					
	150:75	**68.05175:50**	**175:25**	**200:50**	**200:25**	**225:0**
		2009				
Control	66.09	68.34	64.23	70.02	68.01	67.22
Subabul @ 5 t ha^{-1}	68.05	70.72	70.56	75.29	74.55	72.72
Rice straw @ 2.5 t ha^{-1}	66.91	68.38	67.75	71.67	70.70	69.21
		S.Em±			CD (P=0.05)	
F at same level of M		0.80			1.87	
M at same or different level of F		0.95			2.21	
		2010				
Control	67.64	69.95	65.74	71.66	69.61	68.81
Subabul @ 5 t ha^{-1}	69.65	72.39	72.22	77.06	76.31	74.43
Rice straw @ 2.5 t ha^{-1}	68.48	69.99	69.34	73.36	72.36	70.84
		S.Em±		CD (P=0.05)		
F at same level of M		0.82		1.91		
M at same or different level of F		0.97		2.26		

Grain yield

The grain yield of hybrid rice was significantly influenced by organic sources and fertilizer levels. Among the organic sources tested, 5 t subabul ha^{-1} recorded the highest grain yield in both the years. Both the organic sources were found to be superior to control. The per cent increase in grain yield with 5 t subabul ha^{-1} and 2.5 t rice straw ha^{-1} was 6.92 and 2.65, respectively over control in 2009 and these were 7.0 and 2.7% in 2010. Organic sources due to stable and slow mineralization might have resulted in gradual release of nutrients besides improving soil health and reflected in higher grain yields over control. Moola Ram *et al*. (2011), Rana Inayat Ali *et al*. (2012) and Singh *et al*. (2013) also reported significantly higher grain yield in rice with the incorporation of green manures when compared to control. Fertilizer level 200:50 N:K_2O kg ha^{-1} recorded the highest grain yield among the fertilizer levels tested (Table 1). Santhosh Kumar (2009) also reported similar results. The results clearly indicated that the advantage of higher level of N (200 kg N ha^{-1}) was found effective only when an optimum dose of K_2O (50 kg K_2O ha^{-1}) was applied along with nitrogen. This might be due to balanced fertilization of nitrogen and potassium at higher levels. Even at high N level, with elimination of K application the advantage of high N level was not realized. The interaction effect indicated that incorporation of subabul @ 5 t ha^{-1} significantly improved the grain yield at all fertilizer levels except F_1. The additional grain yield obtained with subabul incorporation under F_1 was 96, 164 kg ha^{-1} and 100, 170 kg ha^{-1} compared to rice straw incorporation and no organic manuring during 2009 and 2010 respectively but the differences were found non-significant. Rice straw incorporation @ 2.5t ha^{-1} augmented the rice grain yields only at fertilizer levels F_3 and F_5 as compared under control. Fertilizer levels F_2 and F_3 (nitrogen constant at 175 kg ha^{-1} and potassium at 50 and 25 kg ha^{-1} respectively) gave on par grain yields under manurial treatments M_2 and M_3. Similarly, fertilizer levels F_4 and F_5 (nitrogen constant at 200 kg ha^{-1} and potassium at 50 and 25 kg ha^{-1} respectively) gave on par yields indicating that ncorporation of organic sources coupled with higher i levels of nitrogen could help in reducing the level of potassium application.

Table 3: Effect of interaction between organic sources and fertilizer levels on head rice recovery % of hybrid rice

Organic sources	Fertilizer levels (N:K_2O kg ha^{-1})					
	150:75	**68.05175:50**	**175:25**	**200:50**	**200:25**	**225:0**
		2009				
Control	47.74	49.37	46.40	50.58	49.13	48.56
Subabul @ 5 t ha^{-1}	49.16	51.09	50.97	54.39	53.85	52.53
Rice straw @ 2.5 t ha^{-1}	48.33	49.40	48.94	51.77	51.07	50.00
		S.Em±			CD (P=0.05)	
F at same level of M		0.58			1.35	
M at same or different level of F		0.68			1.60	
			2010			
Control	48.86	50.53	47.49	51.77	50.28	49.70
Subabul @ 5 t ha^{-1}	50.32	52.29	52.17	55.67	55.12	53.77
Rice straw @ 2.5 t ha^{-1}	49.47	50.56	50.09	52.99	52.27	51.17
		S.Em±		CD (P=0.05)		
F at same level of M		0.56		1.38		
M at same or different level of F		0.70		1.63		

Perusal of the data revealed that maximum yield advantage by both subabul and rice straw incorporation was seen with F_4 (200:50 N:K_2O kg ha^{-1}) and was comparable to F_5 (200:25 N:K_2O kg ha^{-1}) thus saving 25 kg K_2O ha^{-1}. The highest grain yield was obtained with M_2F_4 and remained on par with M_2F_5. The grain yield reduction due to either skipping of K fertilizers or application of low doses of K could be compensated when conjunctive use of K rich organic sources like subabul and rice straw are applied along with high levels of nitrogen (Table 4). Singh *et al.* (2013) reported similar results.

Table 4: Effect of interaction between organic sources and fertilizer levels on grain yield (kg ha^{-1}) of hybrid rice

Organic sources	Fertilizer levels (N:K_2O kg ha^{-1})					
	150:75	**175:50**	**175:25**	**200:50**	**200:25**	**225:0**
		2009				
Control	5520	5708	5365	5848	5680	5615
Subabul @ 5 t ha^{-1}	5684	5907	5893	6289	6227	6074
Rice straw @ 2.5 t ha^{-1}	5588	5712	5659	5987	5905	5781
		S.Em±			CD (P=0.05)	
F at same level of M		72			163	
M at same or different level of F		79			180	
		2010				
Control	5650	5840	5480	5980	5820	5750
Subabul @ 5 t ha^{-1}	5820	6040	6020	6450	6380	6220
Rice straw @ 2.5 t ha^{-1}	5720	5840	5780	6140	6050	5920
		S.Em±			CD (P=0.05)	
F at same level of M		68			159	
M at same or different level of F		80			188	

On the basis of the results, it is inferred that incorporation of subabul @ 5t ha^{-1} along with 200:25 N: K_2O kg ha^{-1} could help in improving the quality parameters (milling and head rice recovery %) and grain yield of hybrid rice.

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