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Response of Hybrid Rice (*Oryza sativa L.*) to Organic Sources and Fertilizer Levels in Southern Telangana Region of Andhra Pradesh

KEYWORDS: Dry matter production, Grain yield, Hybrid rice, Phosphorus uptake, rice straw, subabul.

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ABSTRACT *An experiment was conducted for two consecutive years at College Farm, College of Agriculture, Rajendranagar, Hyderabad during kharif 2009 and 2010 to study the response of hybrid rice to organic sources and fertilizer levels. The experiment was laid out in split plot design with three replications. The treatments included organic sources (No organic manuring - control, subabul incorporation @ 5 t ha^{-1}, rice straw incorporation @ 2.5 t ha^{-1}) as main plot treatments and fertilizer levels comprising of N:K_2O kg ha^{-1} (150:75, 175:50, 175:25, 200:50, 200:25, 225:0) as sub plot treatments. Among the organic sources, incorporation of subabul @ 5 t ha^{-1} recorded the highest dry matter production, grain yield and phosphorus uptake. Among the fertilizer levels tested, 200:50 N:K_2O kg ha^{-1} was found the best fertilizer level in recording the highest dry matter production, grain yield and phosphorus uptake and was found significantly superior to remaining fertilizer levels. Interaction effect between organic sources and fertilizer levels was found significant on dry matter production, grain yield, phosphorus uptake at tillering, 50% flowering, panicle initiation stage and phosphorus uptake by grain. Subabul incorporation @ 5 t ha^{-1} + 200:50 N:K_2O kg ha^{-1} recorded the highest dry matter production, grain yield, phosphorus uptake at tillering, 50% flowering, panicle initiation stage and phosphorus uptake by grain and remained on par with subabul incorporation @ 5 t ha^{-1} + 200:25 N:K_2O kg ha^{-1}.*

Introduction:
Rice (*Oryza sativa*) the prince among cereals is the premier food crop not only in India but world too (Chhabra, 2002). The demand for rice continues to increase owing to continued growth of population. It is predicted that a 50% to 60% increase in rice production will be required to meet demand from population growth by 2025. Rice yield increases are likely to occur through fine-tuning of crop management (Qi-chun Zhang and Guang-huo Wang, 2005). Nutrient management is one of the main factors that affects grain yield. Hence the present investigation was carried out to study the response of hybrid rice to organic sources and fertilizer levels.

Material and Methods
Site and Soil
An experiment was conducted for two consecutive years at College 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 17° 19′ N latitude and 78° 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 (0.26), low in available nitrogen (242 kg ha^{-1}), medium in available phosphorus (39.4 kg ha^{-1}) and high in available potassium (368 kg ha^{-1}).

Design and Treatments
The experiment was laid out in split plot design with three replications. The treatments consisted of organic sources (control – no organic manuring, subabul incorporation @ 5 t ha^{-1}, rice straw incorporation @ 2.5 t ha^{-1}) as main plots, and fertilizer levels comprising of N:K_2O kg ha^{-1} (150:75, 175:50, 175:25, 200:50, 200:25, 225:0) as sub-plots. A common dose of 75 kg P_2O_5 ha^{-1} was applied to all the plots. Measured quantities of subabul twigs and rice straw were incorporated in the respective treatmental plot twelve days before transplanting. The % of N:P:K in subabul twigs was 3.90:0.39:2.2 and 3.84:0.40:2.3 in 2009 and 2010 respectively while in rice straw N:P:K was 0.54:0.16:1.6 and 0.51: 0.14:1.5 in 2009 and 2010 respectively. The entire dose of P_2O_5 and half dose of K_2O were applied basally 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. The hybrid used was KRH-2. Twenty five and twenty one days old seedlings were transplanted during 2009 and 2010 respectively. Five plants at random from the border were sampled at 30, 60 and 90 days after transplanting for determining the dry matter production. The selected plants were cut close to the ground, cleaned, transferred to labeled brown paper bags, air dried and then oven dried at 60°C to a constant weight. These weights were recorded and expressed in g plant^{-1} and converted to q ha^{-1}. Plant samples were analyzed for phosphorus content at tillering, panicle initiation, 50 per cent flowering and at harvest. The contents were multiplied with dry matter and uptake obtained. The P uptake by grain was obtained by multiplying the P content in grain with the grain yield. Molybdo phosphoric yellow colour method was adopted for phosphorus analysis. The data was subjected to statistical analysis as outlined by Snedecor and Cochran, 1967.

Results and Discussion
Dry matter production
The data presented in Table 1 revealed that dry matter production by hybrid rice was significantly influenced by organic sources and fertilizer levels. Among the organic sources, incorporation of subabul @ 5 t ha^{-1} recorded the highest dry matter production at 30, 60 and 90 DAT. Both the organic sources were found significantly superior to control (no organic manuring). The incorporation of organic sources might have improved the physical conditions of the soil and enhanced its nutrient supplying capacity which resulted in higher dry matter production. A significant improvement in dry matter production with green manuring was also reported by Balaji Naik (2002). Among the fertilizer levels tested, application of 200:50 N:K_2O kg ha^{-1} resulted in the highest dry matter production followed by 200:25 N:K_2O kg ha^{-1}. Optimum availability of nutrients might be the possible reason for the production of highest dry matter in 200:50 N:K_2O kg ha^{-1} treatment. Similar results were reported by Santhosh Ku-

mar (2009). Interaction effect was significant on dry matter production. Subabul incorporation @ 5 t ha^{-1} coupled with 200:50 N: K_2O kg ha^{-1} recorded the highest dry matter and remained on par with subabul incorporation @ 5 t ha^{-1} + 200:25 N: K_2O kg ha^{-1} at 30, 60 and 90 DAT during both the years of study (Tables 2, 3 and 4).

Grain yield

The grain yield of hybrid rice was significantly influenced by organic sources and fertilizer levels (Table 1). Subabul incorporation @ 5 t ha^{-1} recorded the highest grain yield during both the years of study. The next best treatment was rice straw incorporation @ 2.5 t ha^{-1}. Both the organic sources were found significantly superior to control. Rana Inayat Ali et al., (2012) also reported significantly higher grain yield in rice with the incorporation of green manures when compared to control. Among the fertilizer levels, 200:50 and 150:75 N: K_2O kg ha^{-1} recorded the highest and lowest grain yield respectively during both the years. The data related to interaction effect of organic sources and fertilizer levels on grain yield is presented in Table 5. Subabul incorporation @ 5 t ha^{-1} + 200:50 N: K_2O recorded the highest grain yield and remained on par with subabul incorporation @ 5 t ha^{-1} + 200:25 N: K_2O kg ha^{-1}.

Phosphorus uptake

Perusal of the data presented in Table 6 revealed that phosphorus uptake by hybrid rice was significantly influenced by organic sources and fertilizer levels. The highest phosphorus uptake was recorded by subabul incorporation @ 5 t ha^{-1} followed by rice straw incorporation @ 2.5 t ha^{-1}. Both the organic sources were found significantly superior to control. Higher phosphorus uptake associated with subabul incorporation @ 5 t ha^{-1} might be due to organic acids produced during decomposition of organic matter which are capable of releasing the phosphorus associated with clay minerals. Besides this, organic manures form complexes with iron, aluminium ions and hydrous oxide thus preventing its fixation as inorganic complexes. This was also substantiated by Sri Ranjitha (2011). Fertilizer level comprising of 200:50 N:K_2O kg ha^{-1} resulted in maximum phosphorus uptake followed by 200:25 N:K_2O kg ha^{-1}. Higher biomass production associated with 200:50 N:K_2O kg ha^{-1} led to higher P uptake. Interaction effect was found significant on phosphorus uptake (Tables 7, 8, 9 and 10). Subabul incorporation @ 5 t ha^{-1} coupled with 200: 50 N: K_2O kg ha^{-1} recorded the highest phosphorus uptake and remained on par with subabul incorporation @ 5 t ha^{-1} coupled with 200:25 N: K_2O kg ha^{-1}.

Table 1: Dry matter production and grain yield of hybrid rice as influenced by organic sources and fertilizer levels

Treatment	Dry matter production (q ha^{-1})						Grain yield (kg ha^{-1})	
	30 DAT		60 DAT		90 DAT			
Organic sources	2009	2010	2009	2010	2009	2010	2009	2010
M1 - No organic manuring (control)	17.24	17.66	54.88	56.21	102.23	104.75	5623	5753
M2 - Subabul incorporation @ 5 t ha^{-1}	18.57	19.01	59.10	60.52	110.09	112.78	6012	6155
M3 - Rice straw incorporation @ 2.5 t ha^{-1}	17.73	18.18	56.44	57.87	105.13	107.84	5772	5908
S.Em±	0.15	0.16	0.49	0.49	0.91	0.92	44	51
CD (P=0.05)	0.42	0.43	1.34	1.36	2.50	2.54	123	142
Fertilizer levels (N:K_2O kg ha^{-1})								
F1 - 150:75	17.18	17.58	54.69	55.96	101.90	104.29	5597	5730
F2 - 175:50	17.75	18.17	56.48	57.83	105.22	107.76	5776	5907
F3 - 175:25	17.27	17.69	54.99	56.30	102.45	104.92	5639	5760
F4 - 200:50	18.65	19.13	59.37	60.89	110.59	113.46	6041	6190
F5 - 200:25	18.29	18.76	58.20	59.70	108.43	111.25	5937	6083
F6 - 225:0	17.93	18.39	57.08	58.52	106.34	109.05	5823	5963
S.Em±	0.12	0.12	0.37	0.38	0.70	0.71	42	39
CD (P=0.05)	0.24	0.25	0.76	0.78	1.42	1.46	85	81

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Table 2: Effect of interaction between organic sources and fertilizer levels on dry matter production by hybrid rice at 30 DAT

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	16.90	17.50	16.39	18.02	17.39	17.24
M2- Subabul incorporation @ 5 t ha^{-1}	17.55	18.22	18.18	19.45	19.24	18.75
M3- Rice straw incorporation @ 2.5 t ha^{-1}	17.10	17.51	17.26	18.48	18.22	17.80
	S.Em±		CD (P=0.05)			
F at same level of M	0.20		0.47			
M at same or different level of F	0.24		0.56			
	2010					
M1- No manuring (Control)	17.32	17.92	16.76	18.45	17.84	17.68
M2- Subabul incorporation @ 5 t ha^{-1}	17.91	18.66	18.59	19.97	19.74	19.23
M3- Rice straw incorporation @ 2.5 t ha^{-1}	17.53	1.792	17.72	18.98	18.69	18.26
	S.Em±		CD (P=0.05)			
F at same level of M	0.21		0.49			
M at same or different level of F	0.22		0.52			

Table 3: Effect of interaction between organic sources and fertilizer levels on dry matter production by hybrid rice at 60 DAT

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	53.79	55.70	52.17	57.36	55.36	54.88
M2- Subabul incorporation @ 5 t ha^{-1}	55.86	58.01	57.86	61.92	61.25	59.69
M3- Rice straw incorporation @ 2.5 t ha^{-1}	54.44	55.73	54.94	58.83	58.00	56.67
	S.Em±		CD (P=0.05)			
F at same level of M	0.65		1.51			
M at same or different level of F	0.77		1.79			
	2010					
M1- No manuring (Control)	55.12	57.05	53.35	58.71	56.78	56.27
M2- Subabul incorporation @ 5 t ha^{-1}	56.99	59.38	59.17	63.55	62.83	61.20
M3- Rice straw incorporation @ 2.5 t ha^{-1}	55.78	57.05	56.39	60.40	59.49	58.10
	S.Em±		CD (P=0.05)			
F at same level of M	0.66		1.54			
M at same or different level of F	0.78		1.82			

Table 4: Effect of interaction between organic sources and fertilizer levels on dry matter production by hybrid rice at 90 DAT

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	100.21	103.76	97.19	106.85	103.13	102.24
M2- Subabul incorporation @ 5 t ha^{-1}	104.06	108.06	107.79	115.34	114.10	111.20
M3- Rice straw incorporation @ 2.5 t ha^{-1}	101.42	103.83	102.35	109.58	108.05	105.58
	S.Em±		CD (P=0.05)			
F at same level of M	1.21		2.81			
M at same or different level of F	1.43		3.32			
	2010					
M1- No manuring (Control)	102.72	106.31	99.41	109.41	105.81	104.85
M2- Subabul incorporation @ 5 t ha^{-1}	106.20	110.65	110.26	118.42	117.07	114.04
M3- Rice straw incorporation @ 2.5 t ha^{-1}	103.95	106.31	105.08	112.55	110.85	108.27
	S.Em±		CD (P=0.05)			
F at same level of M	1.24		2.88			
M at same or different level of F	1.46		3.39			

Table 5: Effect of interaction between organic sources and fertilizer levels on grain yield (kg ha-1) of hybrid rice

Treatment	Fertilizer levels (N:K_2O kg ha-1)					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	5520	5708	5365	5848	5680	5615
M2- Subabul incorporation @ 5 t ha-1	5684	5907	5893	6289	6227	6074
M3- Rice straw incorporation @ 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					
M1- No manuring (Control)	5650	5840	5480	5980	5820	5750
M2- Subabul incorporation @ 5 t ha-1	5820	6040	6020	6450	6380	6220
M3- Rice straw incorporation @ 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			

Table 6: Phosphorus uptake (kg ha-1) by hybrid rice at different stages of crop growth as influenced by organic sources and fertilizer levels

Treatment	Tillering		Panicle initiation		50 % flowering		Grain	
Organic sources	2009	2010	2009	2010	2009	2010	2009	2010
M1 - No organic manuring (control)	4.74	4.97	17.15	17.99	25.18	26.41	24.44	25.61
M2 - Subabul incorporation @ 5 t ha-1	5.46	5.72	19.77	20.73	29.02	30.43	28.11	29.33
M3 - Rice straw incorporation @ 2.5 t ha-1	5.00	5.25	18.12	19.01	26.59	27.91	25.94	27.00
S.Em±	0.04	0.04	0.15	0.16	0.23	0.23	0.22	0.31
CD (P=0.05)	0.12	0.12	0.42	0.44	0.62	0.64	0.63	0.85
Fertilizer levels (N:K_2O kg ha-1)								
F1 - 150:75	4.69	4.92	17.02	17.83	24.98	26.17	24.33	25.33
F2 - 175:50	5.00	5.24	18.12	18.99	26.59	27.87	25.89	26.89
F3 - 175:25	4.76	4.98	17.22	18.05	25.28	26.50	24.78	25.67
F4 - 200:50	5.51	5.79	19.97	20.96	29.31	30.78	28.33	29.67
F5 - 200:25	5.32	5.58	19.25	20.21	28.26	29.67	27.44	28.67
F6 - 225:0	5.11	5.36	18.50	19.41	27.15	28.50	26.22	27.66
S.Em±	0.03	0.04	0.12	0.13	0.18	0.19	0.38	0.43
CD (P=0.05)	0.07	0.07	0.25	0.27	0.37	0.39	0.79	0.87

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Table 7: Effect of interaction between organic sources and fertilizer levels on phosphorus uptake (kg ha^{-1}) by hybrid rice at tillering stage

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	4.56	4.86	4.29	5.14	4.83	4.73
M2- Subabul incorporation @ 5 t ha^{-1}	4.87	5.25	5.22	5.99	5.86	5.57
M3- Rice straw incorporation @ 2.5 t ha^{-1}	4.67	4.88	4.76	5.41	5.26	5.03
	S.Em±		CD (P=0.05)			
F at same level of M	0.06		0.14			
M at same or different level of F	0.07		0.16			
	2010					
M1- No manuring (Control)	4.78	5.11	4.49	5.39	5.07	4.96
M2- Subabul incorporation @ 5 t ha^{-1}	5.09	5.50	5.46	6.29	6.15	5.84
M3- Rice straw incorporation @ 2.5 t ha^{-1}	4.90	5.11	5.00	5.69	5.52	5.28
	S.Em±		CD (P=0.05)			
F at same level of M	0.06		0.15			
M at same or different level of F	0.07		0.17			

Table 8: Effect of interaction between organic sources and fertilizer levels on phosphorus uptake (kg ha^{-1}) by hybrid rice at panicle initiation stage

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	16.50	17.67	15.52	18.62	17.49	17.13
M2- Subabul incorporation @ 5 t ha^{-1}	17.65	19.02	18.91	21.68	21.21	20.16
M3- Rice straw incorporation @ 2.5 t ha^{-1}	16.91	17.67	17.24	19.61	19.05	18.21
	S.Em±		CD (P=0.05)			
F at same level of M	0.22		0.50			
M at same or different level of F	0.25		0.58			
	2010					
M1- No manuring (Control)	17.31	18.51	16.24	19.51	18.36	17.98
M2- Subabul incorporation @ 5 t ha^{-1}	18.43	19.93	19.79	22.78	22.27	21.15
M3- Rice straw incorporation @ 2.5 t ha^{-1}	17.73	18.51	18.11	20.61	20.00	19.11
	S.Em±		CD (P=0.05)			
F at same level of M	0.23		0.52			
M at same or different level of F	0.26		0.60			

Table 9: Effect of interaction between organic sources and fertilizer levels on phosphorus uptake (kg ha^{-1}) by hybrid rice at 50 per cent flowering stage

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	24.22	25.92	22.78	27.33	25.67	25.14
M2- Subabul incorporation @ 5 t ha^{-1}	25.91	27.92	27.76	31.82	31.14	29.59
M3- Rice straw incorporation @ 2.5 t ha^{-1}	24.81	25.94	25.30	28.78	27.96	26.73
	S.Em±		CD (P=0.05)			
F at same level of M	0.32		0.73			
M at same or different level of F	0.37		0.85			
	2010					
M1- No manuring (Control)	25.41	27.18	23.85	28.64	26.96	26.39
M2- Subabul incorporation @ 5 t ha^{-1}	27.06	29.26	29.06	33.44	32.70	31.05
M3- Rice straw incorporation @ 2.5 t ha^{-1}	26.03	27.18	26.59	30.25	29.36	28.06
	S.Em±		CD (P=0.05)			
F at same level of M	0.33		0.77			
M at same or different level of F	0.38		0.88			

Table 10: Effect of interaction between organic sources and fertilizer levels on phosphorus uptake (kg ha^{-1}) by rice grain

Treatment	Fertilizer levels (N:K_2O kg ha^{-1})					
Organic sources	F1 150:75	F2 175:50	F3 175:25	F4 200:50	F5 200:25	F6 225:0
	2009					
M1- No manuring (Control)	23.67	25.33	22.33	26.33	25.00	24.00
M2- Subabul incorporation @ 5 t ha^{-1}	25.00	27.02	27.00	30.67	30.33	28.67
M3- Rice straw incorporation @ 2.5 t ha^{-1}	24.33	25.33	25.00	28.00	27.01	26.01
	S.Em±		CD (P=0.05)			
F at same level of M	0.66		1.42			
M at same or different level of F	0.65		1.38			
	2010					
M1- No manuring (Control)	24.69	26.33	23.33	27.67	26.00	25.67
M2- Subabul incorporation @ 5 t ha^{-1}	26.00	28.01	28.00	32.33	31.67	30.00
M3- Rice straw incorporation @ 2.5 t ha^{-1}	25.32	26.33	25.67	29.00	28.33	27.33
	S.Em±		CD (P=0.05)			
F at same level of M	0.74		1.60			
M at same or different level of F	0.74		1.61			

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