RESEARCH ARTICLE

COMPARATIVE PERFORMANCE OF DIFFERENT ORGANIC SOURCES OF NUTRIENTS AND PLANTING SYSTEMS ON GROWTH AND YIELD OF SCENTED RICE (*ORYZA SATIVA* L.)

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Abstract: A field experiment was conducted at crop research farm, Department of Agronomy, Allahabad School of Agriculture, Sam Higginbottom Institute of Agricultural, Technology & Sciences, Allahabad (U. P). It is on the near of the river Yamuna to study the effect of different planting systems and organic sources of nutrients on growth and yield of scented rice (*Oryza sativa* L.)" during *kharif* season at 2010.

The field experiment was laid out in split plot design with three replications. The results showed that treatment (M_2)green manuring with *Crotalaria spp.* (M_2) gave 4.08 and 30.87% more seed yield compared than othergreen manuring with *sesbania spp***.**(M_1) and basal application of FYM 12 t ha^{-1} (M_3) respectively and significantly maximum growth and yield attributes plant height (70.24 cm, 98.71 cm, at 60, 100 DAS respectively), plant dry weight (14.67, 42.13, 81.71, and 145.47 g at 20, 40, 60, 80, and 100 DAS), CGR (g m^{-2} day^{-1}) (00.136, 0.483, 1.442, 1.897 and 2.768 g at 0-20, 20-40, 40-60, 60-80 and 80-100 DAS), , number of effective tillers $hill^{-1}$ (9.36), grain yield (7.85 t ha^{-1}), straw yield (7.85 t ha^{-1}), harvest index (38.05 %) and test weight(22.61 g) than other application of green manuring treatments.

The treatment (S_3) *i.e.* system of rice intensification (SRI), (S_3) gave 15.00 and 38.89 % significantly the highest seed yield (5.27 ha^{-1}) compared than other system of planting S_1 transplanted rice and direct seeded rice (DSR) also recorded non significantly the highest straw yield (8.25 t ha^{-1}), but significantly higher harvest index (38.52 %) and test weight (23.00 g) than other two planting system.

Keyword: System of Rice Intensification (SRI), Organic sources, Green manuring, Scented rice and Pusa Basmati -1

INTRODUCTION

Rice is one of the most important cereal crops in India. Rice is grown in an area of 42.40 million ha produces about 104.39 million tones with the productivity 2462 kg ha^{-1}(*GOI*, 2012-13). Meeting the targeted demands of rice is a challenging task. Decreasing in the soil fertility and increasing in water scarcity is becoming threat for rice cultivation.

Rice (*Oryza sativa* L.) is the staple food for nearly half of the world population and most of them are living in developing countries. The crop occupies one third of the world's total area and provides 35 to 60 % of the calories consumed by 2.7 billion people. The excessive use of chemicals in agriculture causes water pollution and human health hazards.(Thawait *et al.*, 2014) Organic farming is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, genetically modified organisms. The crop plants growing depends largely on temperature, root volume, moisture and soil fertility for their growth and nutritional requirements (Singh and Singh, 2005). FYM or well decomposed compost at the 5 to 10 t ha^{-1} every year is helpful in maintaining soil health, increases the availability of nutrient and reduces toxic effects of chemicals and fertilizers. Green manure using dhaincha (*Sesbania aculeata* L), or sunnhemp (*Crotalaria juncea.* L) will promote sustainability in the rice based cropping system (Abraham *et al.*,2002).

Most of the growth in rice production during this period is attributed to release of high yielding varieties and use of higher doses of fertilizers, but the use of higher doses of high analysis fertilizers (containing only N, P and K) and insufficient use of organics has created deficiencies of secondary and micronutrients particularly of Zn and Fe (Takkar, 1996). Proper selection of a variety and appropriate nutrient management are important in organic rice production (Manjunath *et al.*,2009). A number of organic waste materials are available, which can supply a good amount of plant nutrients, NPK to produce comparable yield (Ghosh, 2005). Organic manures as a source of humus and plant nutrients need to improve the soil fertility and soil health of tropical soils.

Rice being a crop having high water requirement, there is a need to search for alternative method to reduce water requirement of rice without reduction in yield. In recent years, water table is running down at a very rapid rate throughout the globe, thus, poses alarming threats and limiting the scope for cultivation of high water requiring crops very seriously. Rice being water requirement crop, there is a need to search for alternate methods to reduce water requirement without reduction in the yield (Krishna *et al.*,2008). System of Rice Intensification (SRI) is another emerging water saving technology,

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with many fold increase in crop yield (Laulanie,1993). SRI is emerging water saving technology, with many fold increase in crop yield. This method was developed in Madagascar (West Africa) in the early 1980s, where it has been shown that yield can be enhanced by suitably modifying certain management practices such as controlled supply of water, planting of younger seedlings and providing wider spacing (Hugar *et al.*,2009).The sustainability of DSR, however, is endangered by heavy weed infestations (Chauhan, 2012; Mahajan *et al.*, 2013).

By adopting this SRI system of cultivation we could save water, protect soil productivity and could environment by checking methane gas from water submerged rice cultivation practices, bring down the input cost besides improving the production for providing food to the burgeoning population. Careful water management needs to be pursuit. The field should be kept moist and water should not be allowed stagnated and should be kept shallow (up to 2.5 cm) and intermittent irrigation i.e. alternatively drying and wetting shaved about 30-40 percent water under SRI as compared to conventional rice cultivation. This system of cultivation not only helps to minimize loss of nutrients specially nitrogen but also helps to increase applied nutrient and enhance the tillering of rice plants. Increased soil aeration and organic matter help in improving soil biology leading to better nutrient availability. (Chowdhury *et al.*, 2014)

This paper deals with the objective to determine suitable organic sources and system of planting for scented rice variety practices cultivation to maximize their growth attributes, yield and yield attributes.

MATERIAL AND METHOD

Experimental site and soil characteristics

A field experiment was conducted during *kharif* season of the year 2010 at Allahabad located at 25^0 North latitude, 81^0 $50^{"}$ East longitude and 98 m above the mean sea level. Rice variety Pusa Basmati -1 was taken as test variety to study the effect of different planting systems and organic sources of nutrients on growth and yield of scented rice (*Oryza sativa* L.)". The soil of the experimental plot was sandy loam in texture, alkaline in reaction (pH 7.93) and available nitrogen 0.028 kg ha^{-1}, available phosphorous 19.85 kg ha^{-1} and available potassium 163.2 kg ha^{-1}content. The soil is experimental plot was sandy loam in texture having pH of 7.93 with low level of organic carbon 0.33 %, available N (0.028 kg ha^{-1}) but medium level of P (7.00 kg ha^{-1}) and K (50.66 kg ha^{-1}).

Experimental design and treatments There were nine treatment combinations, consisting of three organic manuring, M_1 - Green manuring with dhaincha (*Sesbaniaaculeata* L), M_2 -Green manuring with sunnhemp (*Crotalaria juncea.* L) and M_3 - Basal application of FYM (12 t ha^{-1} as a main plot treatment and three S_1 -system of planting transplanted rice, S_2 -Direct seeded rice and S_3 - System of Rice Intensification as a sub plot treatments
were tested under split plot design with three replications.

Green manuring, FYM and application of organic manure

Green manure crops dhaincha (*Sesbania aculeata* L.) and sunnhemp (*Crotalaria juncea.* L.) were grown in the up to 60 days and buried in the field with tractor drawn disc plough at 16 June 2010. FYM was applied at the rate of 12 t ha^{-1} 15 days before transplanting.

Transplanting and sowing

In the experiment for the transplanting SRI treatment of 12 days old rice seedling was done with spacing (25 cm x 25 cm), in conventional transplanted rice, the transplanting of 21 days old rice seedling with spacing (20 cm x 15 cm) and other crop establishment method direct seeded rice drum seedling of sprouted seed of rice with spacing (15 cm x 5 cm) under puddle conditions.

Crop growth rate (CGR) (g m^{-2} day^{-1})

It represents dry weight gained by unit area of a crop in a unit time, expressed as g $m^{-2}day^{-1}$. The crop growth rate was computed with the help of dry matter production recorded for each treatment at 0-15, 15-30, 30-45, and 45-60 DAS intervals. It was calculated with the help of following formula.

$$\text{Crop growth rate (CGR)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

W_1 = dry weight production per unit area at time t_1

W_2 = dry weight production per unit area at time t_2

Statistical analysis

The value of table 'F at 5% level significance, where the treatment difference between were found significant the value of CD and CV % were also worked out to compare the treatment mean (Snedecor and Cochran 1967). At initial stage select random five plants from net plot area for further recording observations.

RESULT AND DISCUSSION

Effect of organic manure

Data presented in (Table-1) indicated that different organic sources of nutrients green manuring with *Sesbaniaspp.* (M_1) recorded non-significant, the highest plant height at 20 DAT/DAS. In treatment green manuring with *Crotalaria spp.* (M_2) was found non- significant the highest plant height at 60 DAS and 100 DAS. Application of organic manure source green manuring with *crotalaria spp.* recorded non - significantly the highest plant dry weight (1.66 g, 14.67 g, and 42.13g at 20, 40, 60DAS and also significantly higher81.71 g and 145.47 g at 80 and 100 DAS respectively).The treatment also recorded significantly crop growth rate (g m^{-2} day^{-1}) the highest at 0.136 g, 0.483 g, 1.442 g and 1.897 g at 0-20, 20-40, 40-60, 60-80 DAS respectively, as compared to rest of all organic sources of nutrients. However significantly higher CGR (2.768 g m^{-2} day^{-1}) at 60-100 DAS/DAT. Among organic sources, supplication of green manuring with *crotalaria spp.* increased the RGR (g g^{-1} day^{-1}) significantly as against the application of rest of the organic green manuring sources. The treatment also recorded significantly higher number of effective tillers $hill^{-1}$ (9.36) but was at par with rest of the treatments. The variation in plant growth due to organic manures was considered to be due to variation in the availability of major nutrients. All the parameters were significantly lower with the control. The increase in the plant height might be due to green manuring of *sesbania* spp. and *Crotalaria spp*. may have resulted in the priming effect and made the fixed soil nutrients in available from and thus showed perceptible increase of plant height (Suzuki, 1997).The probable reason for that the maximum CGR (g m^{-2} day^{-1}) in green manuring of *Crotalaria spp* poetically throw might be due to the addition of nitrogen in to the soil and also organic matter, which may have had its impact on physio-chemical and biological properties of soil (Singh and Singh, 2008)

Further data presented in (Table-2) indicated that significantly higher grain yield (4.89 t ha^{-1}) and non-significantly the highest straw yield (7.85 t ha^{-1}) were obtained under treatment M_2 (Green manuring with *crotalaria spp*). Whereas, significantly lower grain yield (3.38 t ha^{-1}) and non- significantly the lowest straw yield (7.38 t ha^{-1}) were observed under organic sources of nutrients M_1 (Basal application of FYM 12 t ha^{-1}). Treatment M_2 (Green manuring with *crotalaria spp*) recorded higher grain yield, that increase at the extent of 4.08, and 30.87 % over the treatments M_1, and M_3 respectively. While treatment grain yield (4.69 t ha^{-1}) M_1 (Green manuring with *Sesbania spp*.) at par with treatment M_2 (Green manuring with *Crotalaria spp*).However, the lowest grain and straw yields were associated with basal application of FYM (12 t ha^{-1} (M_3). This might be because decomposition of the manures releases nutrients slowly throughout the growth period that leads to better nutrient supply for chlorophyll synthesis, (Srivastava 2014).The increased dry matter production might have resulted in which turn produced higher number of panicles leading to higher yield. This increased panicle length may be attributed to steady supply of nutrients which enhanced the dry matter production due to more availability of photosynthates. (Singh *et al.*,2013)

The higher nutrient uptake with organic manure might be attributed to solubilization of native nutrients, chelation of compex intermediate organic molecules produced during decomposition of added organic manures, their mobilization and accumulation of different nutrients in different plant parts healthy root growth as translocation of photosynthates.The increase in seed yield this may be due ascribed to the micro and macro nutrient availability as well as physical condition of the soil (Parihar, 2004).

Application of green manuring through *Crotalaria spp* (M_2) brought about significantly higher harvest index (38.05 %) and test weight (22.33 g) rest of the treatments.However, treatment M_1 (Green manuring with *Sesbania spp*.) was at par with M_2 (Green manuring with *Crotalaria spp*) in case of harvest index and test weight.

Effect of system of planting

Data The results indicated that treatment (Table-1) system of planting S_1 (Transplanted rice) recorded significantly higher plant height at 20 DAT/DAS. However, treatment S_3(System of rice intensification) was statistically significantly higher plant height at 60, 100 DAT/DAS. . The treatment S_1 (Transplanted rice) recorded significantly the higher plant dry weight 1.55 g at 20 DAS and significantly higher (15.01 g, 52.33 g, 150.48 g at 40, 60, 100 DAS and significantly the highest 88.52 g at 80 DAS respectively. The treatment also recorded significantly the highest crop growth rate (g m^{-2} day^{-1})0.505 g, 1.713 g and 2.208 g at 20-40, 40-60, 60-80 DAS respectively as compared to rest of all system of planting. However significantly the highest CGR (3.221 g m^{-2} day^{-1}) at 80-100 DAS/DAT. Among system of planting application of S_3System of rice intensification increased the RGR (g g^{-1} day^{-1}) 0.030 and 0.026 g at60-80 and 80-100 DAS/DAT significantly as against the application of rest of the system of planting. The treatment also recorded significantly the highest number of effective tillers $hill^{-1}$ (10.85).

System of planting had significantly the highest effect on grain yield (5.27 t ha^{-1}) of scented rice and non-significantly the highest straw yield (8.25 t ha^{-1}) were recorded under treatment S_3(System of rice intensification) (Table-2). Whereas, significantly lower grain yield (3.22 t ha^{-1}) and non significantly lower straw yield (6.88 t ha^{-1}) were observed under system of planting treatment S_2 (Direct seeded rice).

Application of S_3 (System of rice intensification) brought about significantly higher harvest index (38.52 %) and test weight (23.00 g) rest of the treatments. However, treatment S_3(System of rice intensification) was at par with S_1 (Transplanted rice) in case of harvest index and test weight.

The probable reason might be attributed to the large volume, profuse and strong tillers and well filled spikelets with higher grain weight Satyanarayana and Babu (2004). Second reason higher grain yield realized with SRI method might be due to large root volume, strong tillers with big panicles as well as higher fertility of spikelet. The present findings are similar to those recorded by Jayadeva *et al.*, (2008).

Table 1. Effect of organic sources of nutrients and system of planting on growth, yield and yield attributes of rice

Treatments	Plant height (cm)			Plant dry weight (g)					CGR (g m^{-2} day^{-1})					RGR (g g^{-1} day^{-1})				No. of effective tillers $hill^{-1}$
	20 DAS	60 DAS	100 DAS	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	0-20 DAS	20-40 DAS	40-60 DAS	60-80 DAS	80-100 DAS	20-40 DAS	40-60 DAS	60-80 DAS	60-100 DAS	
Organic sources																		
M_1 : Green Manuring with Sesbania spp.	**33.49**	67.15	95.97	1.33	12.61	39.34	**71.88**	**125.00**	0.116	0.458	1.355	1.876	**2.661**	**0.118**	0.057	0.028	**0.023**	**9.16**
M_2 : Green Manuring with Crotalaria spp	32.52	**70.24**	**98.71**	**1.66**	**14.67**	**42.13**	**81.71**	**145.47**	**0.136**	**0.483**	**1.442**	**1.897**	**2.768**	**0.128**	**0.061**	**0.029**	**0.028**	**9.36**
M_3:Basal application of FYM 12 t ha^{-1}	33.32	64.38	85.35	0.86	11.14	41.98	62.62	98.73	0.11	0.417	1.185	1.284	1.633	0.087	0.050	0.024	0.019	7.33
F test	NS	NS	NS	NS	NS	NS	S	S	NS	NS	NS	S	S	S	NS	NS	S	S
SEd(_+)	0.73	2.87	4.62	0.43	1.5	3.65	2.50	1.60	0.06	0.135	0.110	0.183	0.215	0.007	0.008	0.004	0.002	0.32
CD (P=0.05)	-	-	-	-	-	-	5.45	3.49	-	-	-	0.400	0.596	0.016	-	-	0.005	0.71
System of planting																		
S_1: Transplanted rice	**35.49**	**67.41**	**93.02**	**1.55**	**14.97**	**47.48**	75.11	138.32	**0.157**	**0.496**	**1.577**	**1.793**	2.584	**0.113**	0.058	**0.027**	0.023	9.46
S_2: Direct seeded rice (DSR)	29.98	60.43	86.34	0.97	8.38	23.61	52.57	83.98	0.105	0.357	0.690	1.056	1.257	0.107	0.046	0.024	0.020	5.54
S_3 :System of Rice Intensification (SRI)	**33.42**	**73.92**	**100.67**	**1.33**	**15.01**	**52.33**	**88.52**	**150.48**	0.106	**0.505**	**1.713**	**2.208**	**3.221**	0.106	**0.063**	**0.030**	**0.026**	**10.85**
F test	S	S	S	S	S	S	S	S	NS	NS	S	S	S	NS	NS	S	S	S
SEd(_+)	1.51	3.83	4.49	0.17	1.33	2.79	6.03	13.04	0.061	0.084	0.177	0.146	0.184	0.003	0.006	0.001	0.001	0.50
CD (P=0.05)	3.29	8.34	9.79	0.37	2.90	6.07	13.14	28.42	-		0.386	0.319	0.402	-	-	0.003	0.002	1.10

Table 2. Effect of between organic manuring practices and system of planting on yield attributes, and (seed yield t ha $^{-1}$)of scented rice

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Test weight(g)
Organic manure				
M_1 : GM with Sesbania spp.	**4.69**	7.58	**37.53**	**22.33**
M_2 : GM with Crotalaria spp	**4.89**	**7.85**	**38.05**	**22.61**
M_3 : Basal application of FYM 12 t ha^{-1}	3.38	7.38	31.20	22.00
F test	S	NS	S	NS
SEd(_+)	0.35	0.87	0.86	1.03
CD (P=0.05)	0.76	-	1.75	-
System of planting				
S_1 : Transplanted rice	4.47	7.68	**36.81**	**22.16**
S_2: Direct seeded rice (DSR)	3.22	6.88	31.45	21.77
S_3 :System of Rice Intensification (SRI)	**5.27**	**8.25**	**38.52**	**23.00**
F test	S	NS	S	S
SEd(_+)	0.26	0.54	1.16	0.43
CD (P=0.05)	0.58	-	2.54	0.95

Table 3. Interaction effect between organic manuring practices and system of planting on seed yield (t ha^{-1})

Organic manure sources	System of planting		
	S_1 : Transplanted rice	S_2: Direct seeded rice (DSR)	S_3 :System of Rice Intensification (SRI)
M_1 : GM with Sesbania spp.	5.00	3.33	5.05
M_2 : GM with Crotalaria spp	4.76	3.66	6.25
M_3 : Basal application of FYM 12 t ha^{-1}	3.66	2.66	3.83
S.Em. ±	NS		
CD at 5%	-		

Significantly higher harvest index (38.52 **%)** was observed in treatment S_3(System of rice intensification). However, treatment S_1 (Transplanted rice) was statistically at par with S_3(System of rice intensification).

Interaction effect between organic manure and planting systems

The appraisal of data presented in (Table 3) revealed that there was non-significant interaction effect between organic manure and planting systems. Significantly the highest seed yield (6.25t ha-1) was recorded under treatment combination M_2S_3 (Green Manuring with Crotalaria *spp* (M_2) and System of Rice Intensification (SRI) (S_3). The probable reason might be the highest seed yield was recorded under treatment combination M_2S_3(Green Manuring with Crotalaria *spp* (M_2) and System of Rice Intensification (SRI) (S_3) increase in yield attributes, grain and straw yields might be due to large root volume, strong tillers with big panicles as well as higher fertility of spikelet. The present findings similar to those recorded by (Jayadeva *et al.*, 2008).

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