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Full Research Article

Productivity and Profitability of Basmati Rice Varieties under SRI

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Abstract

The results of a field experiment conducted during the *kharif* season of 2007 and 2008 at OUAT, Bhubaneswar on basmati rice varieties under system of rice intensification (SRI) showed that application of organic manure (FYM 15.0 t ha^{-1}) improved growth attributes like plant height, tillering, LAI and CGR of basmati rice varieties, increased panicle production and filled grains $panicle^{-1}$, produced high grain (4.42 t ha^{-1}) and straw (6.57 t ha^{-1}) yields and fetched the high gross return comparable to those of INM (50% RDF+7.5 t FYM ha^{-1}), but significantly greater than those of inorganic fertilization (RDF). However, use of RDF (60-30-30 kg N-P_2O_5-K_2O ha^{-1}) was more remunerative in terms of net returns and returns per rupee invested than organic manuring or INM practice due to higher cost of organic manures. The basmati rice variety Pusa Basmati-1 performed better than Geetanjali. Similarly, crop planted at close spacing (20×20 cm^2) showed improved growth and increased yield and profit over those of wide spacing (25×25 cm^2); but growth, yield and economics of basmati rice did not vary much between the crops planted with 10 and 15-day old seedlings. The results suggest to grow Pusa Basmati-1 at 20×20 cm^2 spacing with 10 or 15-day old single seedlings under organic manuring or INM practice for better growth, higher yield and greater profit.

1. Introduction

Rice being the predominant food crop of the world plays a pivotal role towards ensuring both food and nutrition security to the global population in general and the South-East Asia, including India, in particular. It is estimated that about 180 million tonnes (mt) rough rice (120 mt milled rice) needs to be produced in India by 2020 with an average productivity of 4.03 t ha^{-1} to maintain the present level of food self-sufficiency. This means the productivity needs to be doubled from the current level (Mishra et al., 2006) under declining land and water resources. In the mean time, a unique package of rice production named 'System of Rice Intensification' (SRI) has come up as a ray of hope. The key practices in SRI are raising of seedlings in a non-flooded garden like nursery, transplanting of very young seedlings of 8-12 days old at 2-3 leaf stage singly in a square pattern with wider spacing than usual, avoiding continuous flooding of rice to maintain mostly aerobic soil condition, controlling weeds mechanically and applying compost as much as possible (Makarin et al., 2002). This method not only boosts production but also saves water, induces greater resistance to disease and insect pest, reduces vulnerability to drought, lodging, storm damage, improves soil health and reduces environmental threats. Sato and Uphoff (2007) reported 78% increase in average rice yield with 40% reduction in water use, 50% in fertiliser use and 20% in cost of production in SRI method as compared to conventional method in Indonesia.

Basmati rice is an important agricultural export commodity of India. Moreover, emergence of a sizeable middle income group and a perceptible change in their food habit has increased the demand of quality rice like basmati in India. Basmati rice is expected to respond to SRI techniques to overcome the low productivity constraint. Literature indicates very vital role of seedling age, spacing and nutrient management practices on growth and productivity of rice in SRI method. The above factors of productivity need to be optimised with different rice varieties especially basmati rice under different agro-climatic zones for achieving high grain yield. Keeping this in view an investigation was carried out in the East and South-Eastern Coastal plain of Odisha to assess the response of basmati rice varieties to SRI method under different spacing, age of seedling and nutrient management practices.

2. Materials and Methods

The field experiment was conducted during the *kharif* season of 2007 and 2008 at the Central Farm, Orissa University of Agriculture and Technology, Bhubaneswar ($20^0$15′ N Latitude, $85^0$52′ E Longitude and an altitude of 25.9 m MSL) in split-plot design with three nutrient management practices (F_1=60-30-30 kg N-P_2O_5-K_2O ha^{-1} (RDF), F_2=50% RDF+7.5 t FYM ha^{-1} and F_3=15 t FYM ha^{-1}) and two spacings (S_1=20×20 cm^2 and S_2=25×25 cm^2) in the main-plots, and two basmati rice varieties (V_1=Geetanjali and V_2=Pusa Basmati-1) and two ages of seedlings (A_1=10 days-old and A_2=15 days-old) in the sub-plots with three replications. The soil was sandy loam with pH 5.7, organic carbon 3.5 g kg^{-1} soil, available N 153.0 kg ha^{-1}, available P 11.1 kg ha^{-1} and available K 135.5 kg ha^{-1}. The crop received 1373 and 1521 mm rainfall spread over 87 and 89 rainy days during 2007 and 2008, respectively. Seedlings were raised in wet garden-like nursery in which seeds of each variety were sown twice at a gap of 5 days to obtain 10 and 15 day-old seedlings to be planted in the main field on the same date. One seedling along with the soil and seed (embryo) attached to the seedling was placed on the grids marked by the marker at the specific spacing as per the treatments. The same layout plan was used for conducting the experiment during both the years. The manures and fertilizers were applied through FYM, urea, single super phosphate and muriate of potash as per treatments. Full dose of FYM, phosphorus and potassium and one-third of nitrogen were applied as basal. Top dressing of N was done one-third at 10 days after transplanting and remaining one-third at panicle initiation stage. The pH of the FYM used was 6.7 and nutrient contents were 0.83% N, 0.64% P_2O_5 and 0.92% K_2O. Weeding was done thrice at 10 days interval starting from 10 days after transplanting (DAT) using a cono-weeder. Experimental plots were kept moist up to panicle initiation stage by suitably maintaining the water level in the side channels of each bed. Thereafter a thin film of water was allowed to stand over the bed from panicle initiation stage to 10 days before harvest of the crop. Excess rain water was drained out as and when required. Gall midge was observed during the *kharif* season of 2007, which was controlled successfully by spraying triazophos @ 2 ml litre^{-1} of water.

Observations on plant height, tillers m^{-2}, LAI and dry mater accumulation were recorded at 14 days interval. Ten (10) hills were randomly tagged in each plot for recording plant height and number of tillers m^{-2}. Three (3) hills from second row of each plot were cut at the base at each stage, their fresh weights were recorded, the green leaf, culm and panicles were separated and dried in a hot air oven at 70^0C for 72 hours till constant weights were obtained. The dry weights of all the plant parts were recorded in each plot to get dry matter accumulation at each stage during both the years. Then LAI and CGR were estimated following standard procedures. The yield attributes and yield of the crop were recorded at harvest. The economics of basmati rice under SRI was calculated on the basis of prevailing market price of various inputs and the outputs.

3. Results and Discussion

3.1. Growth parameters

The growth parameters of basmati rice such as plant height, tiller production, LAI and CGR were influenced markedly by nutrient management practices, spacing and age of seedlings. The crop supplied with inorganic fertilizer (RDF) exhibited higher growth parameters at initial stage up to 14 DAT because of ready availability of plant nutrients from inorganic source. However, the plants under organic manuring were more vigorous at later stage from 21 DAT than those fed with inorganic source; but were of similar status to those under integrated nutrient management (INM) practices. Bera and Pramanik et al. (2012) also noticed similar beneficial effect of N nutrition on height of hybrid rice plants. This might be due to increase in use efficiency of nutrients particularly nitrogen because of slow release of the same from the organic source and blending effect of FYM on inorganic source under INM treatment that helped to reduce N loss, prolonged the availability of nitrogen to match with the absorption pattern of rice plant resulting in improvement of growth parameters (Upadhyaya et al., 2000; Kumari et al., 2010). The crop supplied with organic manure (15 t FYM ha^{-1}) or INM (50% RDF+7.5 t FYM ha^{-1}) had taller plants by 3 to 5 cm at harvest (Table 1) having more (21-30 m^{-2}) tillers and greater (0.34-0.38) LAI (Figure 1a) at peak period (42-56 DAT) of crop growth than that with only inorganic fertilizers (RDF). The leaves also remained photosynthetically active for 3-10 days more over RDF practice because of better matching between availability and absorption of nutrients. All these culminated in higher dry matter production as reflected by higher CGR (1.71, 1.87 and 1.17 g m^{-2} day^{-1}) over RDF during the periods of 28-42, 42-56 and 56-70 DAT, respectively (Figure 2a). Raju and Sreenivas (2008) also obtained superiority of organic manure and INM practice in SRI method because of better mineralization of FYM under prevailing aerobic condition and dissolution of minerals and chelating of micronutrients because of presence of humic acid in organic source.

Adjustment of planting density through appropriate plant spacing enhances source efficiency by reducing the competition variation through optimization of resource use. Close planted crop produced taller plants than wider ones particularly at later growth stages (Table 1), which might be due to mutual shading that resulted in low light intensity at the base of the plant that

leading to elongation of the lower internodes (Modal et al.,

Table 1: Effect of nutrient management practices, spacing and age of seedling on plant height, tiller production and tiller mortality of basmati rice varieties under SRI

Treatments	Tiller mortality (%)		Plant height (cm)		No. of Tillers m^{-2}	
Nutrient management	2007	2008	2007	2008	2007	2008
RDF	89.4	98.5	318	338	23.1	19.1
50% RDF+7.5 t FYM ha^{-1}	91.5	99.3	329	345	21.8	15.5
15 t FYM ha^{-1}	92.5	103.2	341	356	21.7	14.3
SEm±	1.05	1.07	5.2	4.4	1.76	2.0
CD (p=0.05)	3.2	3.4	16	14	NS	NS
Spacing						
20×20 cm^2	92.1	101.8	386	383	21.2	15.9
25×25 cm^2	89.2	98.9	272	310	23.2	16.8
SEm ±	0.86	0.92	4.4	4	1.25	1.64
CD (p=0.05)	2.7	2.8	14	12	NS	NS
Variety						
Geetanjali	92.3	102.1	317	340	22.6	19.6
Pusa Basmati-1	89.0	98.6	342	353	21.8	13
SEm±	0.78	0.69	4.0	3.8	0.77	1.0
CD (p=0.05)	2.3	2.1	12	11	NS	2.9
Age of seedling						
10 days	89.9	99.9	342	355	23.2	16
15 days	91.4	100.8	317	338	21.2	16.7
SEm±	0.78	0.69	4	3.8	0.77	1.0
CD (p=0.05)	NS	NS	12	11	NS	NS

2013). Number of tillers m^{-2} was higher at close spacing (Table 1) because of more number of hills per unit area than wider spacing. Tiller mortality was also higher at wide spacing because individual plant availed greater space for profuse tillering and some of the late tillers might have perished at later stages than that at close spacing. Other growth attributes like LAI and CGR were higher under close spacing because of more number of hills per unit area as compared to those of wide spacing (Figure 1b and 2b). Bommayasamy et al. (2010) and Mondal et al. (2013) also noticed taller plants, higher number of tillers m^{-2} and greater LAI and CGR with close spacing than those of wider spacing. The CGR showed a typical sigmoid curve. The pattern indicates that early vegetable growth in rice tends to be exponential but because of mutual interactions within the individuals that impose limitation on growth, the actual growth curve falls away in sigmoid manner which is more characteristic of its entire life span (Figure 2a, b, c and d).

Aromatic rice variety Pusa Basmati-1 was relatively shorter in height (Table 1) but produced more number of tillers m^{-2} (Table 1) with higher LAI (Figure 1c) and CGR (Figure 2c) than those of Geetanjali at almost all the growth stages in both the years. It also took 9 days more to attain flower and 10 days more to mature over those of Geetanjali. The results showed the superiority of Pusa Basmati-1 over Geetanjali and ultimately led to enhance rice productivity. The results are in conformity with the findings of Sheoran et al. (2007) who observed that Pusa Basmati-1 had better growth characteristics as compared to other basmati rice varieties.

Younger seedlings (10-days old) produced taller plants (Table 1) with greater number of tillers m^{-2} (Table 1) that resulted in higher LAI (Figure 1d) and CGR (Figure 2d) at all the stages than those of planting 15-days old seedlings. However, plant height and CGR did not vary much between the ages of seedlings at latter growth (reproductive) stages. The younger seedlings might have absorbed the transplanting shock quickly and established themselves well from the very early stage that helped in promoting early growth in terms of increasing plant height, tiller and leaf production than planting of older seedlings (Uphoff and Fernandes, 2002). Kumar and Shivay (2004) and Tsujimoto et al. (2009) opined that young seedlings should be transplanted quickly and carefully in SRI so that root tips do not bend upward and resume quick downward growth to have more number of phyllochrons for massive tillering, greater dry matter accumulation and grain yield when grown in optimal conditions. A seedling need to be transplanted carefully before the 4th phyllochron (before tillering process starts at 8-12 days old) to preserve its tillering potential (Satyanarayan et al., 2007; Manjunatha et al., 2010a).

3.2. *Yield attributes and yield*

Nutrient management options significantly influenced the number of panicles m^{-2}, grains $panicle^{-1}$, grain and straw yields. Application of organic manure @ 15 t ha^{-1} produced the highest number of panicles m^{-2} (284), grains panicle $^{-1}$ (89), grain (4.43 t ha^{-1}) and straw (6.57 t ha^{-1}) yields, but was comparable to those of INM (50% RDF+7.5 t FYM ha^{-1}). Use of RDF resulted in the lowest values of the above yield attributes and yields (Table 2). Organic manure alone or in combination with inorganic fertilisers might have minimised the N loss because of its slow release and have supplied nutrients in optimal congruence with crop demand resulting in improvement of its yield attributes and yield (Kumari et al., 2010). Organics were beneficial in reducing the fixation or precipitation of added or mineralised nutrients and played complementary role to boost the crop yield (Prakasha et al., 2010). Positive and significant effect on N nutrition was also noticed by Bera and Pramanik et al. (2013).

Transplanting at wide spacing (25×25 cm^2) exhibited significantly longer panicles (27.7 cm) bearing greater number

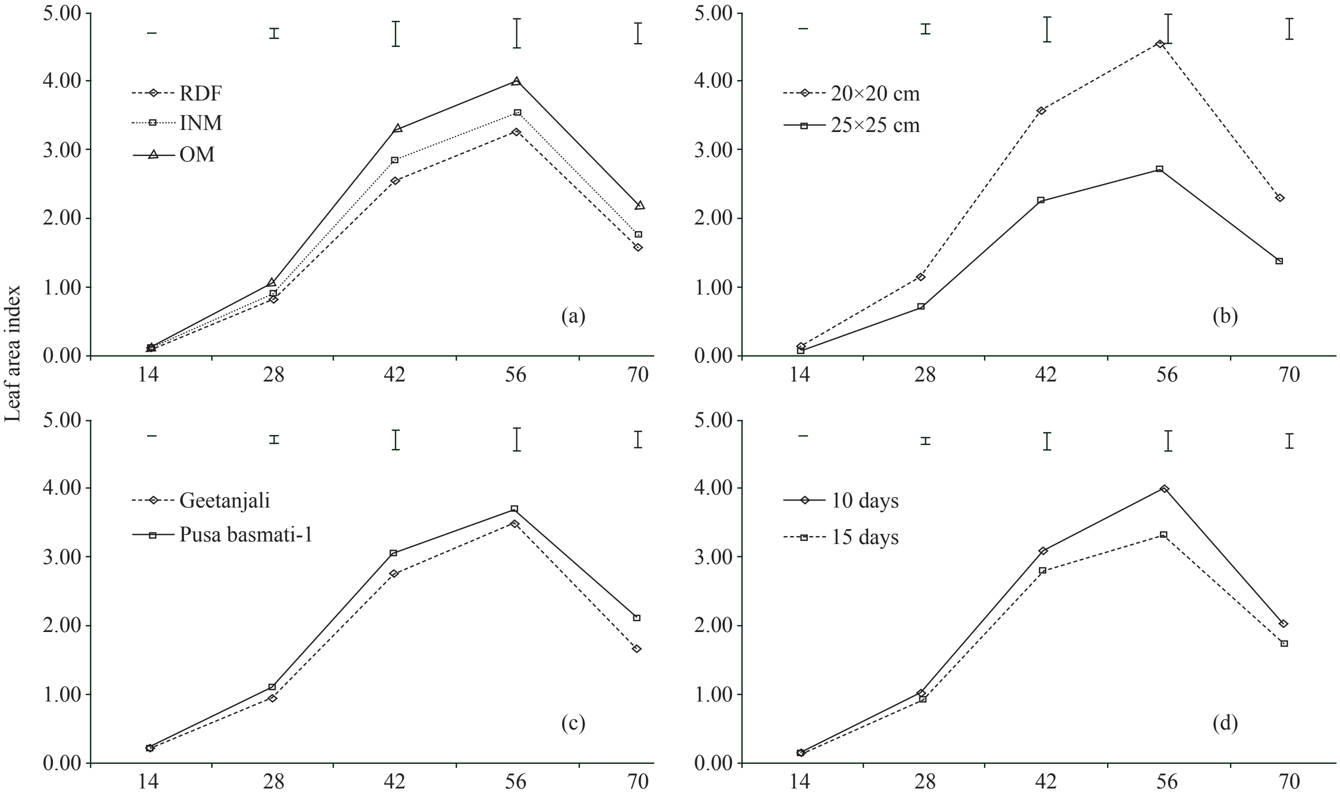

Figure 1: Effect of (a) nutrient management practices, (b) spacing, (c) varieties and (d) age of seedling on leaf area index of basmati rice under SRI method at different growth stages (pooled over two years); Vertical lines indicates the error bars

Table 2: Effect of nutrient management, spacing and age of seedling on performance of basmati rice varieties under SRI method

Treatments	Panicles m^{-2}		Grains $panicle^{-1}$		1000-grain wt. (g)		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
Nutrient management	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
RDF	239.0	264.1	79.6	84.1	22.9	21.9	3843	4363	6217	6264
50% RDF+7.5 t FYM ha^{-1}	260.6	289.0	83.6	88.5	23.0	22.0	3989	4560	6367	6452
15 t FYM ha^{-1}	261.6	305.2	87.1	91.6	23.3	22.2	4117	4712	6488	6541
SEm±	6.9	6.4	1.8	1.8	0.1	0.2	49.9	94.1	148.5	89.8
CD (p=0.05)	21.9	20.1	5.5	5.5	NS	NS	157	296	468	271
Spacing										
20×20 cm^2	300.6	316.3	85.7	89.6	23.1	22.2	4435	4739	6458	6589
25×25 cm^2	206.9	255.9	81.2	86.5	23.0	21.9	3531	4351	6256	6250
SEm±	5.7	5.2	1.4	1.4	0.1	0.2	40.8	76.8	121.2	73.3
CD (p=0.05)	17.9	16.4	NS	NS	NS	NS	128	242	342	231
Variety										
Geetanjali	242.1	269.8	80.9	86.8	23.5	22.0	3970	4265	6339	6321
Pusa Basmati-1	265.4	302.5	85.9	89.3	22.6	22.1	3995	4825	6376	6517
SEm±	4.7	3.4	1.0	1.3	0.1	0.1	85.9	68.7	168.5	109.4
CD (p=0.05)	13.4	9.7	3.0	NS	0.3	NS	NS	197	NS	NS
Age of seedling										
10 days	259.0	289.8	83.9	88.5	23.1	22.1	4035	4554	6476	6422
15 days	248.5	282.4	82.9	87.6	23.0	22.0	3930	4536	6238	6416
SEm±	4.7	3.4	1.0	1.3	0.1	0.1	85.9	68.7	168.5	109.4
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

of grains panicle^{-1} (87); whereas close spacing resulted in markedly higher number of panicles m^{-2} (308). The test weight (1000-grain weight) did not vary much between the crops planted at different spacing. Both grain (4.59 t ha^{-1}) and straw (6.55 t ha^{-1}) yields increased significantly at close (20×20 cm^2) spacing over that of wide (25×25 cm^2) spacing (Table 2). Though wide spacing favoured panicle length and number of grains panicle^{-1}, but it could not be extrapolated to grain yield (Harper, 1977) because of less number of plants (hills) per unit area in comparison to close spacing (Thakur et al., 2009). Close spacing with high plant density registered higher grain and straw yields than those of wide spacing having low plant density (Bommayasamy et al., 2010; Mondal et al., 2013).

The yield attributes and yield varied markedly between the basmati rice varieties. Both number of panicles m^{-2} and number of grains panicle^{-1} were significantly greater in Pusa Basmati-1 than those of Geetanjali. Thus Pusa Basmati-1 produced higher grain (4.46 t ha^{-1}) and straw (6.51 t ha^{-1}) yields than that of Geetanjali (Table 2). Similar varietal difference in rice yield due to differences in genetic makeup was also obtained by Sheoran et al. (2007) and Mondal et al. (2013). Age of seedling at transplanting did not cause much variation in the yield of basmati rice varieties under the study.

3.3. Economics

Nutrient management practices exerted significant effect on gross return, net return and return per rupee invested (Table 3). Organic nutrition of basmati rice through 15 t FYM ha^{-1} fetched the highest gross returns (₹ 44,310 ha^{-1}) followed by INM (₹ 42,958 ha^{-1}). Both of the above nutrient management practices paid markedly higher gross return than that of RDF (₹ 41,281 ha^{-1}). However, application of RDF to the crop registered the higher net returns (₹ 23,520 ha^{-1}) and returns per rupee invested (1.33), which were significantly greater than those of INM and only organic manuring. Organic manuring recorded the lowest net returns (₹ 20,501 ha^{-1}) and returns per rupee invested (0.86) among the nutrient management practices because of highest cost of organic manures.

Crop at close spacing (20×20 cm^2) paid greater gross and net returns and thus earned higher return per rupee invested than those obtained from the crop planted at wide spacing (Table 3). Similarly, Pusa Basmati-1 registered its superiority with respect to economics (gross return, net return and return

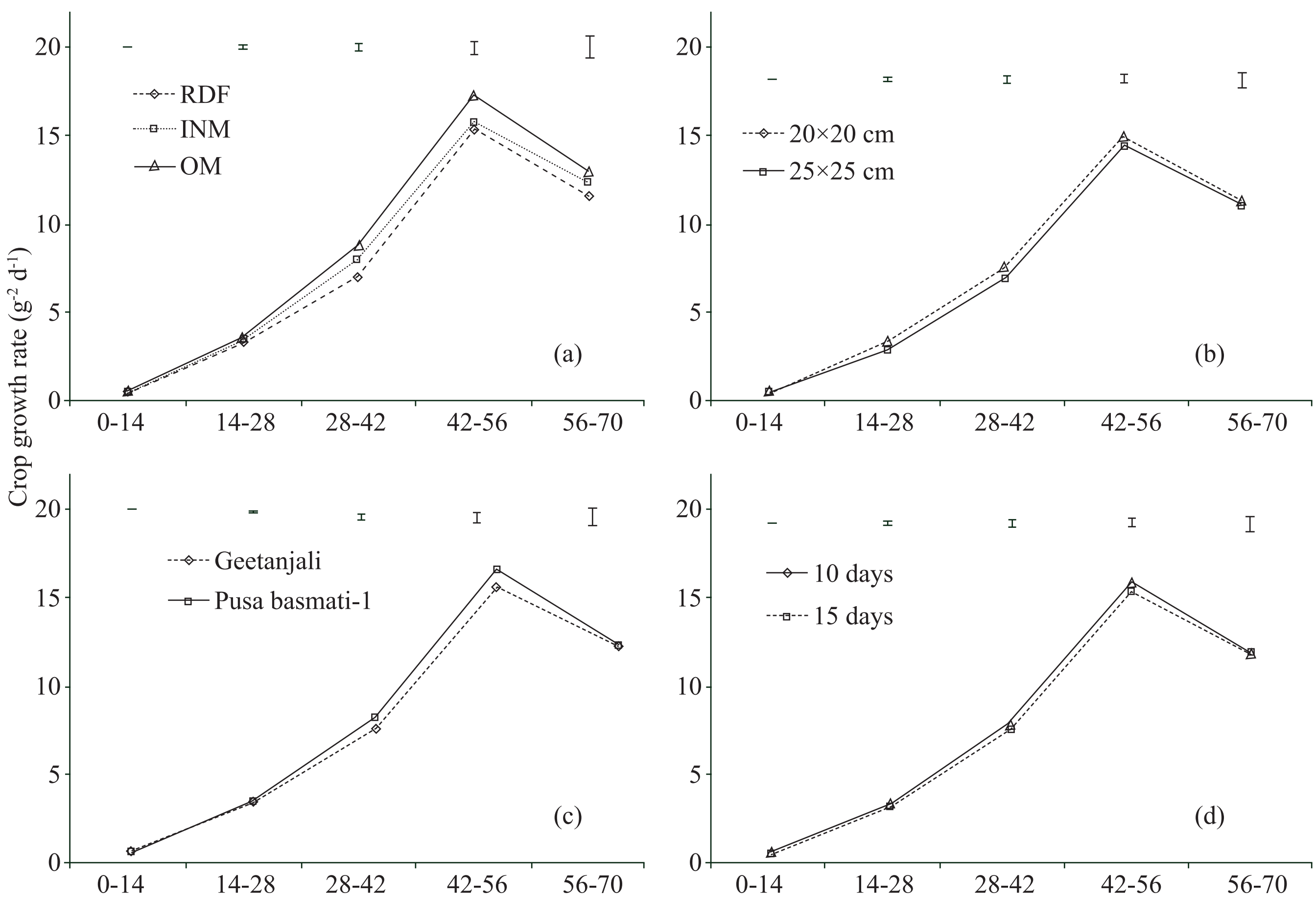

Figure 2: Effect of (a) nutrient management practices, (b) spacing, (c) varieties and (d) age of seedling on crop growth rate (g m^{-2} d^{-1}) of basmati rice under SRI method at different growth stages (pooled over two years); Vertical lines indicates the error bars

Table 3: Effect of nutrient management, spacing and age of seedling on economics of basmati rice varieties under SRI ($ 1.0 = ₹ 50.00)

Treatments	Gross returns (₹ ha^{-1})		Net returns (₹ ha^{-1})		$Return^{-1}$ ₹ invested	
Nutrient management	2007	2008	2007	2008	2007	2008
RDF	38,848	43713	21200	25839	1.20	1.45
50% RDF+7.5 t FYM ha^{-1}	40,281	45634	19620	24706	0.95	1.18
15 t FYM ha^{-1}	41,532	47087	17856	23145	0.75	0.97
SEm±	789	854	391	441	0.012	0.016
CD (p=0.05)	2328	2519	1154	1302	0.037	0.047
Spacing						
20×20 cm^2	44,475	47367	23237	25985	1.09	1.22
25×25 cm^2	35,966	43589	15880	23140	0.79	1.13
SEm±	644	697	319	360	0.010	0.013
CD (p=0.05)	1901	2057	942	1062	0.030	0.04
Variety						
Geetanjali	40,091	42825	19436	22035	0.94	1.06
Pusa Basmati-1	40,342	48131	19674	27091	0.95	1.29
SEm±	500	668	246	341	0.008	0.011
CD (p=0.05)	NS	1972	NS	1006	NS	0.031
Age of seedling						
10 days	40464	45563	19778	24651	0.96	1.18
15 days	39968	45393	19331	24475	0.94	1.17
SEm±	500	668	246	341	0.008	0.011
CD (p=0.05)	NS	NS	NS	NS	NS	NS

per $rupee^{-1}$ invested) of rice production over Geetanjali. The results are in conformity with the findings of Kumari et al. (2010). Transplanting of seedlings of different ages did not cause much variation in the economics of rice production under the study.

4. Conclusion

Rice variety Pusa Basmati-1 may be planted at close spacing (20×20 cm^2) with 10 to 15-days old seedlings under INM (50% RDF+7.5 t FYM ha^{-1}) practice for better growth, higher yield and greater profit from basmati rice under East and South-Eastern Coastal plain of Odisha.

5. References

Bera, A.K., Pramanik, K., 2012. Response of hybrid rice (*Oryza sativa* L.) to varying levels of nitrogen and homo-brassinosteroids in lateritic zone of West Bengal. International Journal of Bio-resource and Stress Management 3(2), 165-168.

Bera, A.K., Pramanik, K., 2013. Response of rice hybrids to nitrogen levels under lateritic zone of West Bengal, India. International Journal of Bio-resource and Stress Management 4(2), 139-143.

Bommayasamy, N., Rabisankar, N., Subramani, T., 2010. Influence of non-monetary inputs on growth and yield of rice under system of rice intensification (SRI). Indian Journal of Agronomy 55(2), 95-99.

Harper, J.L., 1977. Population Biology of Plants. Academic Press, London.

Kumari, N., Singh, A.K., Pal, S.K., Thakur, R., 2010. Effect of organic nutrient management on yield, nutrient uptake and nutrient balance sheet in scented rice. Indian Journal of Agronomy 55(3), 220-223.

Kumar, D., Shivay, V.S. 2004. System of rice intensification. Indian farming 54(8), 18-21.

Makarin, A.K., Balasubramanian, V., Zaini, Z., Syamsich, I., Ditratmadja, G.P.A., Hondo Ko Arafah, Wardana, I.P., Gaini, A., 2002. System of rice intensification: Evaluation of seedling age and selected components in Indonesia. In: Proceedings of the International Workshop on Water wise Rice Production held at Los Banos, IRRI, Phillipines, 129-139.

Manjunatha, B.N., Basavarajappa, R., Siddaram, Policepatil, A.S., Yogeeshappa, H. and Kalyanamurthy, K.N. 2010. Effect of age of seedlings under different system of rice intensification (SRI). International Journal of Agricultural Sciences 6(2), 377-379.

Mishra, D., Ispalasmed, M., Rao, K.V., Bentor, J.S., 2006. Rice research in India-Green revolution to gene revolution. Journal of Rice Research 1(1), 38-51.

Mondal, S., Bauri, A., Pramanik, K., Ghosh, M., Malik, G.C., Ghosh, D.C., 2013. Growth, productivity and economics of hybrid rice as influenced by fertility level and plant density. International Journal of Bio-resource and Stress Management 4(4), 548-555.

Prakasha, H.C., Sunitha, B.P., Gurumurthy, K., 2010. Effect of INM approach on productivity and economics of rice cultivation in Bhadra command, Karnataka, in relation to soil properties. Mysore Journal of Agriculture Sciences 44(4), 786-792.

Raju, R.A., Sreenivas, C., 2008. Agronomic evaluation of system of rice intensification method in Godabari Delta. Oryza 45(4), 280-283.

Sato, S., Uphoff, N., 2007. A review of on-farm evaluation of system of rice intensification methods in eastern Indonesia. *CAB* Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2, 12.

Satyanarayan, A., Thiyagarajan, T.M., Uphoff, N., 2007. Opportunities for water saving with higher yield from the system of rice intensification. Irrigation Science 25, 99-115.

Sheoran, P., Singh, K.P., Malik, R.K., Sardana, V.R., 2007. Effect of nitrogen scheduling practices on growth characteristics, yield and N uptake of medium duration rice varieties. Oryza 44(3), 251-255.

Thakur, A.K., Chaudhari, S.K., Singh, R., Kumar, A., 2009. Performance of rice varieties at different spacing grown by the system of rice intensification in eastern India. Indian Journal of Agricultural Sciences 79(6), 443-447.

Tsujimoto, Y., Horie, T., Randriamihary, H., Shiraiwa, T., Homma, K., 2009. Soil management: The key factors for higher productivity in the fields utilizing the system of rice intensification (SRI) in the central highland of Madagascar. Agricultural Systems 100, 61-71.

Upadhyaya, S.K., Sarkar, C., Bajpai, R.K., Joshi, B.S., Tripathi, R.S., 2000. Grain yield and N-uptake of rice as influenced by N management practices under rainfed low land. Oryza 37(1), 91-92.

Uphoff, N., Fernandes, E., 2002. System of rice intensification gains momentum. LEISA, India, 22-27.