International Journal of Agricultural Sciences
Volume **11** | Issue 1 | January, 2015 | 50-53 ■ e ISSN-0976-5670
DOI: 10.15740/HAS/IJAS/11.1/50-53
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RESEARCH PAPER

Effect of planting geometry and timing and source of nitrogen application on yield and yield attributing character of rice (*Oryza sativa* L.) under system of rice intensification

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Abstract : An experiment was conducted at Agronomy Research Station, Orissa University of Agriculture and Technology, Bhubaneswar during *Kharif* season of 2012 to study the effect of different fertility levels, planting patterns per hill and their interaction on productivity of rice variety 'Lalat' under SRI. F_2 (FYM @ 15 t ha^{-1} + vermicompost 2 t ha^{-1} + neem cake 250 kg ha^{-1}) gave highest yield (8.76 t ha^{-1}). It was found that twice or thrice splitting of N was at par (7.62 and 7.57 t ha^{-1}). Highest harvest index was recorded from F_2 (51.11 %) among main plots and P_1 (25×25cm spacing with 1 seedling hill^{-1}) *i.e.* 50.41 per cent among subplots. F_4 (FYM @ 5 t ha^{-1} + N : P_2O_5 : K_2O @ 30:30:30 kg ha^{-1} basal) and P_3 (30×30 cm spacing with 1 seedling hill^{-1}) gave the lowest harvest index (45.74 % and 43.33 %, respectively). Three plants per hill with wider spacing of 30×30 cm gave the highest yield among all planting patterns. Wider spacing was found more beneficial. More than one plant per hill had given increased yield due to higher plant population per m^2 in comparison to one plant per hill. Fertility level (F_4) with half of RDF of nitrogen, recorded the lowest yield (5.87 t ha^{-1}). Among the subplots the lowest yield was recorded in P_3 *i.e.* one seedling per hill at 30×30 cm spacing (6.75 t ha^{-1}).

Key Words : SRI, Nitrogen, Splitting of nitrogen, Wider spacing, Seedling/hill

View Point Article : Pandey, Pragya, Barik, Trilochan, Deva, Sahaja and Rathore, Anoop Kumar (2015). Effect of planting geometry and timing and source of nitrogen application on yield and yield attributing character of rice (*Oryza sativa* L.) under system of rice intensification. *Internat. J. agric. Sci.*, **11** (1): 50-53.

Article History : Received : 14.05.2014; **Revised :** 01.11.2014; **Accepted :** 18.11.2014

INTRODUCTION

Rice (*Oryza sativa* L.), is a semi-aquatic annual grass plant and is the most important cereal crop. As the population rises, so does the demand for rice. Rice being the staple food for 65 per cent of Indian population, it occupies about 24 per cent of gross cropped area of our country and contributes to 40 per cent of total food grains production as well as 45 per cent of total cereal production in particular. Yet, productivity of the crop is leveling out. In a state like Odisha, where agriculture is taken as foremost profession, rice is the major crop grown on about 70 per cent and 50 per cent of the gross cropped area during *Kharif* (rainy) and *Rabi* (winter), respectively. But still there is a long way to go.

The SRI is a combination of set of practices and methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients resulting in both healthy soil and plants, supported by greater root growth and the soil microbial abundance and diversity.

With less water, less seed, no fertilizers, no pesticides, more soil organic matter and more soil aeration, the productive

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potential of rice can be unleashed --As a new way of looking at rice cultivation and solely driven by the innovative farmers, system of rice intensification (SRI) is emerging as an alternative to conventional water and chemical intensive rice cultivation (Rao, 2006 and Krishna *et al.*, 2008).

In this field various researches have been conducted and are going on also at present to improve SRI methodology. In this field experiment some changes in application of recommended dose of fertilizers with organics like FYM, vermicompost and neemcake and adjustment of the timing of application with spacing of 25×25 cm and 30×30 cm and transplanting of one, two and three seedlings, in different patterns, per hill have been tested on the productivity of *Kharif* rice under system of rice intensification.

MATERIAL AND METHODS

Field study was conducted in *Kharif* season of the year 2012 at Agronomy Research Station, Orissa University of Agriculture and Technology, Bhubaneswar. The latitude and the longitude of the research station are $21^0$15' N and $85^0$52'E, respectively, with an altitude of 25.9 m above the mean sea level. The soil of the experimental field texturally was sandy loam with chemical properties like pH 5.38, EC 0.051 dS m^{-1} at 25^{o}C, organic carbon 0.36 per cent, available N 176.25 kg ha^{-1}, available P 48.85 kg ha^{-1} and available K 330.40 kg ha^{-1}. The experiment consisted of 24 treatments and laid out in a Split Plot Design with three replications. The experiment was laid out on 'Lalat' variety of rice with 4 fertility levels in main plots and 6 planting patterns (Fig. A) in subplots. The fertility levels were F_1 [FYM @ 5 t ha^{-1} + P_2O_5 : K_2O @ 30:30 kg ha^{-1} basal + N 60 kg ha^{-1} in 3 splits (1/4th basal + 1/2 21 DAT + 1/4th PI)]; F_2 (FYM @ 15 t ha^{-1} + vermicompost 2 t ha^{-1} + neem cake 250 kg ha^{-1}); F_3 [FYM @ 5 t ha^{-1} + P_2O_5 : K_2O @ 30:30 kg ha^{-1} basal + N 60 kg ha^{-1} in 2 splits (1/2 basal+ 1/2 21 DAT)] and F_4 (FYM @ 5 t ha^{-1} + N : P_2O_5 : K_2O @ 30:30:30 kg ha^{-1} basal) and planting patterns were P_1 (25×25cm spacing with 1 seedling $hill^{-1}$), P_2 (25×25cm spacing with 2 seedlings $hill^{-1}$ at a linear distance of 5 cm from plant to plant in the same hill), P_3 (30×30cm spacing with 1 seedling $hill^{-1}$), P_4 (30×30cm spacing with 2 seedlings $hill^{-1}$ at a linear distance of 5 cm from plant to plant in the same hill), P_5 (30×30cm spacing with 3 seedlings $hill^{-1}$ in a triangular method with 5 cm distance from plant to plant in the same hill) and P_6 (Random planting of 1 seedling $hill^{-1}$). Incorporation of *Dhaincha* (*Sesbania aculeata*) was common for all fertility levels. The yield attributing characters like number of panicle m^{-2}, length of panicle, weight of panicle, number of grains per panicle and 1000-grain weight were studied at harvest of the rice crop. The mean data of these characters were collected replication wise and analyzed statistically.

Fig. A : Planting of 1, 2 and 3 seedlings per hill

RESULTS AND DISCUSSION

All the parameters presented in Table 1 were significantly influenced by all fertility levels and planting patterns imposed under study at different stages of observations, but the interaction among main plots and subplots was found non-significant in all cases.

Number of panicles (effective tillers) :

Among the main plots highest number of mean productive tillers per m^{-2} was recorded in plot treated with FYM @ 15 t ha^{-1} + vermicompost 2 t ha^{-1} + neem cake 250 kg ha^{-1} (331.09). It was due to increased photosynthetic ability and dry matter accumulation due to higher LAI as well as slow release of nitrogen from FYM and availability of plant-growth regulators and mineral nutrients into more plant-available forms due to the application of vermicompost. Main plot treated with FYM @ 5 t ha^{-1} + N : P_2O_5 : K_2O @ 30:30:30 kg ha^{-1} basal recorded the lowest number (251.55 tillers per m^{-2}) due to lower availability of N for conversion of tillers to effective tillers as only half dose of RDN was applied in this treatment. In case of subplots significantly higher mean number of effective tillers m^{-2} was recorded in plot with 3 seedlings $hill^{-1}$ in a triangular method planted at 30x30cm spacing and 5 cm distance from plant to plant in the same hill(370.96 effective tillers m^{-2}). It might have facilitated better utilization of resources by the plants converting majority of the tillers into productive tillers. The lowest number of panicles was recorded in plot with 30x30cm spacing with 1 seedling $hill^{-1}$ (236 effective tillers m^{-2}).

Panicle length :

The length of the panicle was highest in FYM @ 15 t ha^{-1} + vermicompost 2 t ha^{-1} + neem cake 250 kg ha^{-1} (28.13 cm) treated mainplot. It shows that organics produced the longest panicle and proved even to be beneficial in the first year of conversion period. FYM @ 5 t ha^{-1} + N : P_2O_5 : K_2O @ 30:30:30 kg ha^{-1} basal treated plot recorded lowest value of panicle length (26.39 cm). At panicle initiation stage lack of availability of N might be the reason for lower panicle length in this plot. Among the subplots highest mean panicle length value was recorded in plot with 30x30cm spacing with 1 seedling $hill^{-1}$ (28.10 cm) where wider spacing helped this plot for getting highest panicle length and lowest in plot of random planting of 1 seedling $hill^{-1}$ (25.28 cm). Hossain *et al*. (2003) reported that the SRI produced the highest panicle length than the conventional planting method.

Panicle weight :

Among mainplots, plot treated with FYM @ 15 t ha^{-1} + vermicompost 2 t ha^{-1} + neem cake 250 kg ha^{-1} (658.69 g) recorded the highest panicle weight which was significantly higher over lowest weight recorded plot (FYM @ 5 t ha^{-1} + N: P_2O_5 : K_2O @ 30:30:30 kg ha^{-1}) 502.22 g. The reason for lower panicle weight was lack of N availability during grain filling stage as only half dose of RDF of N was applied in this plot. Out of all subplots, plot with (30×30cm) spacing with 3 seedlings hill^{-1} in a triangular method with 5 cm distance from plant to plant in the same hill recorded highest mean value of panicle weight per m^{-2} (688.52 g) and the lowest performer was the plot with random planting of 1 seedling hill^{-1} (484.08 g). Wider row spacing can improve plants' total seasonal light exposure resulting higher dry matter accumulation and thus, resulted in higher panicle weight and increase yield (Lin *et al*., 2006).

1000- grain weight :

Main plots treated with FYM @ 5 t ha^{-1} + P_2O_5 : K_2O @ 30:30 kg ha^{-1} basal + N 60 kg ha^{-1} in 3 splits (1/4th basal + 1/2 21 DAT + 1/4th PI) recorded 28.29 g 1000-grain weight which was highest. Nitrogen helps to attain higher 1000-grain weight (Gulati *et al.*, 1987). Lowest was recorded in subplot treated with FYM @ 5 t ha^{-1} + P_2O_5 : K_2O @ 30:30 kg ha^{-1} basal + N 60 kg ha^{-1} in 2 splits (1/2 basal+ 1/2 21 DAT). In case of subplots, the plot with 30x30cm spacing with 3 seedlings hill^{-1} in a triangular method with 5 cm distance from plant to plant in the same hill recorded the highest value (28.15 g) which was 11.17 per cent higher over the lowest recorded plot with random planting of single seedling hill^{-1}. Hossain *et al*. (2003) also observed higher 1000-grains weight under SRI compared to the farmers' practice. Thousand-grain weight, an important yield-determining component, is a genetic character least influenced by environment (Ashraf *et al*., 1999).

Grain yield :

Among the fertility levels significantly highest yield obtained was 8.76 t ha^{-1} in plot treated with FYM + vermicompost + neem cake. The lowest value was recorded in FYM @ 5 t ha^{-1} + N : P_2O_5 : K_2O @ 30:30:30 kg ha^{-1} basal that was 5.87. Increasing nitrogen efficiency through the use of optimum nitrogen fertilizer level is very important factor to obtain high yield of rice. In organic mainplot sufficient amount of FYM had already been applied and there was constant release of nitrogen due to favourable soil conditions maintained due to SRI type of management which led to production of highest grain yield.

Among different planting patterns 8.55 t ha^{-1} was the significantly higher grain yield obtained from plot with 30×30cm spacing with 3 seedlings hill^{-1}, this shows that grain yield responded more to spacing and more number of plants per hill. Lowest grain yield was recorded (6.75 t ha^{-1}) plot with 30×30cm spacing with 1 seedling hill^{-1}. Instead of producing higher number of effective tillers this subplot has given lowest

Table 1 : Yield and yield attributing characters of rice variety Lalat during *Kharif* 2012

Treatments	Effective tillers m^{-2} (panicles m^{-2})	Length of panicle	Weight of panicle	1000- grain weight	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
F_1	289.68	27.06	658.69	26.62	7.57	7.86
F_2	331.09	28.13	627.95	28.29	8.76	8.45
F_3	275.56	26.84	596.77	25.79	7.62	9.04
F_4	251.55	26.39	502.22	25.86	5.87	7.02
S.E. ±	12.09	0.32	24.24	0.35	0.36	0.21
C.D. (P=0.05)	41.82	1.11	83.86	1.21	1.26	0.73
P_1	256.31	28.05	615.53	26.90	7.58	7.40
P_2	309.40	26.71	626.92	26.97	7.62	7.62
P_3	236.00	28.10	517.89	26.12	6.75	8.25
P_4	263.49	27.54	645.51	26.39	7.33	8.73
P_5	370.96	26.95	688.52	28.15	8.55	9.54
P_6	285.68	25.28	484.08	25.32	6.97	7.03
S.E. ±	10.38	0.27	22.68	0.31	0.23	0.19
C.D. (P=0.05)	29.67	0.77	64.82	0.88	0.67	0.54
F within PP S.E. ±	22.48	0.77	41.41	0.67	0.55	0.82
F within PP C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
PP within F S.E. ±	20.76	0.54	45.36	0.62	0.46	0.872
PP within F C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

NS=Non-significant

yield because of low 1000-grain weight and lower dry matter accumulation.

Straw yield :

Among mainplots the highest value was 9.04 t ha^{-1} and lowest was 7.02 t ha^{-1} in FYM @ 5 t ha^{-1} + P_2O_5 : K_2O @ 30:30 kg ha^{-1} basal + N 60 kg ha^{-1} in 2 splits (1/2 basal+ 1/2 21 DAT) and FYM @ 5 t ha^{-1} + N : P_2O_5 : K_2O @ 30:30:30 kg ha^{-1} basal treated plots, respectively. This shows that N obtained at early growth stages resulted in the production of more straw than grain. Basal application of nitrogen can produce higher straw yield than split application. This shows that application of nitrogen at later stages (mostly after maximum tillering stage) doesn't contribute much towards straw yield. Out of 6 subplots, the plot with 30×30cm spacing with 3 seedlings $hill^{-1}$ in a triangular method recorded highest straw yield of 9.54 t ha^{-1} and the plot with single seedling planted at random spacing recorded the lowest straw yield of 7.03 t ha^{-1}. Similar work related to the present investigation was also carried out by Bommayasamy *et al.* (2010); Kumar and Shivay (2004); Manjunatha *et al.* (2010); Sato and Uphoff (2007) and Raju and Sreenivas (2008).

Conclusion :

From the above experiment it is concluded that under system of rice intensification method of cultivation, fertilizer and nutrient management with organic manures only gave significantly higher yield. Splitting of nitrogen either in two or three splits was found equally beneficial. Triangular method of planting with 30×30 cm spacing gave the significantly higher yield over one and two seedlings.

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