The Bioscan 12(1): 557-560, 2017 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

INFLUENCE OF PLANTING GEOMETRY ON GROWTH AND YIELD OF RICE (*ORYZA SATIVA* L.) UNDER SRI PRACTICES

N. THAVAPRAKAASH*, P. BASKAR AND A. VELAYUTHAM
Department of Agronomy,
Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, INDIA
e-mail: agronthava@gmail.com

KEYWORDS
Rice
SRI
Planting geometry
Growth characters
Yield attributes
Grain yield

Received on :
18.06.2016

Accepted on :
12.12.2016

***Corresponding author**

ABSTRACT
Field experiment was conducted during three consecutive *Kharif* seasons at Tamil Nadu Agricultural University, Coimbatore to study the influence of planting geometry levels on productivity of rice. Five square planting patterns *viz.* 25 x 25 cm (T_1), 30 x 30 cm (T_2), 35 x 35 cm (T_3), 40 x 40 cm (T_4), 50 x 50 cm (T_5) along with conventional planting of 20 x 15 cm (T_6) as control were tested in Randomized complete block design with three replications. Growth characters such as DMP and LAI were significantly higher under planting geometry of 20 x 15 cm compared to others. Whereas, number of tillers/m^2 and productive tillers/m^2 were higher with 25 x 25 cm and 30 x 30 cm compared to other levels. Panicle length, number of grains/panicle and number of filled grains/ panicle were the maximum under wider planting geometry (50 x 50 cm). Significantly higher grain yield (6721 and 6587 kg/ha) of rice were recorded with 25 x 25 cm and 30 x 30 cm, respectively compared to others. Straw yield was also significantly more (7771 kg/ha) at 25 x 25 cm level and was on par with 30 x 30 cm plant geometry level. Hence, either 25 x 25 cm or 30 x 30 cm planting geometry levels under SRI method is the most suitable for obtaining the maximum production of rice in Tamil Nadu.

INTRODUCTION

Rice is a staple food crop of India and the second largest producer in the World. But, burgeoning population is increasing the rice demand enormously. To meet the demands of increasing population and to maintain the self-sufficiency, the current production level needs to be increased to 120 million tonnes by 2020. This increase in production has to be achieved in the backdrop of declining and deteriorating resource-base such as land, water, labour and other inputs and without adversely affecting the quality of environment (Viraktamath *et al*. 2006). Though India tops the list in terms of area of rice, the productivity is much lower compared to leading rice growing countries. Major constraint in rice production is lack of suitable crop management practices. To meet the food requirement of the growing population, the rice production has to be enhanced with good Agronomic management practices. Therefore, a promising method of rice cultivation called as System of Rice Intensification (SRI) is to be standardized with suitable alterations in its components.

Planting geometry is one of the essential components of SRI to exploit the genetic potential of individual plant through exposing rice plants to more light and air (Satyanarayana *et al*. 2007). Though many research workers reported that wider planting geometry under SRI improved the productivity of rice up to 50 x 50 cm depending on the supportive nature of soil and other conditions (Uphoff, 2001), looking towards an increase in area under SRI cultivation, as well as, farmers' individual experiments with different modification of planting geometry, it was felt necessary to conduct present experiment to specify suitable planting geometry levels for rice under SRI. Therefore, the present study was undertaken to study the influence of planting geometry levels on growth and yield of rice under SRI in Tamil Nadu condition.

MATERIALS AND METHODS

The field experiment was conducted at Wetland farms, Tamil Nadu Agricultural University, Coimbatore, India during *Kharif* season of three consecutive years (2010, 2011 and 2012) under irrigated lowland condition. The soil of the experimental field was a clay loam in texture belonging to *Typic Haplustalf* with medium in organic carbon (0.50-0.56%), low in available nitrogen (216-243 kg/ha), high in available phosphorus (35.2-45.6 kg/ha) and high in available potassium (416-505 kg/ha). Wet-oxidation method (Walkley and Black, 1934), Alkaline Permanganate method (Subbiah and Asija, 1956), Olsen's method (Olsen *et al*. 1954) and Neutral Normal Ammonium Acetate method (Stanford and English, 1949) were used for analyzing organic carbon, available nitrogen, phosphorus and potassium, respectively. The experiment was laid out in Randomized Complete Block Design with four replications. There were six treatments with five square planting patterns *viz*. 25 x 25 cm (T_1), 30 x 30 cm (T_2), 35 x 35 cm (T_3), 40 x 40 cm (T_4), 50 x 50 cm (T_5) along-with conventional planting of 20 x 15 cm (T_6) as control. The rice variety ADT 43 with field duration of 110 days was used for the study. The SRI components such organic manure application, single seedling, young seedlings (14 days old), square planting (as per treatment), operating cono-weeding in inter and intra-rows, irrigating the field after disappearance of water and need based nitrogen application using Leaf colour chart were followed for T_1 to T_5 as recommended. Conventional cultivation was followed for treatment T_6 as recommended. All other package of practices was followed as per CPG (2005).

Growth parameters such as plant height, Leaf area index (LAI) and Drymatter production (DMP) (kg/ha) were recorded at critical stages such as active tillering (AT), panicle initiation (PI), flowering (FL) and maturity (MT) of rice using standard procedure. The total tillers were counted in five randomly tagged plants and expressed as number of tillers/m^2. Ear bearing tillers at maturity were counted and expressed as number of productive tillers/m^2. The number of filled and unfilled spikelets was counted in the panicles selected. Yield attributes such as panicle length (cm) and 1000 grain weight; and grain and straw yields were arrived by using standard procedure. The observations recorded were analyzed by following standard methods (Gomez and Gomez, 2010).

RESULTS AND DISCUSSION

Growth characters

Mean of three years data indicated that plant height had not significantly influenced by varied planting geometry levels at all the stages of rice (Table 1). This was due to the fact that the treatments have not provided with any additional inputs such as fertilizer, irrigation, etc. and have not created any competition for light, air, space, etc. due to wider spacing and hence, not affected.

Planting geometry treatments had striking effect on LAI during all stages of rice (Table 1). Closer planting geometry of 20 x 15 cm recorded perceptibly higher LAI (1.66, 3.42, 6.09 and 3.11) at AT, PI, FL and MT stages of rice, respectively than others. This was closely followed by 25 x 25 cm and 30 x 30 cm planting geometry levels. LAI determines the total photosynthesizing area available to the plant and quantum of source that would be translocated to sink. Higher LAI at closer spacing might be due to the presence of more number of tillers/unit area which resulted in more leaves leading to higher LAI values. Similar findings were also reported by Amin and Haque (2009) in rice.

The maximum DMP (1248 kg/ha) was recorded under closer planting geometry of 20 x 15 cm and wider planting of 50 x 50 cm registered the minimum DMP (435 kg/ha) at AT stage of rice. Similar results were noted at later stages (PI, FL and MT stages) too. Similar to LAI, rice planted at 25 x 25 cm and 30 x 30 cm were closely followed to 20 x 15 cm. Higher DMP with closer planting geometry was mainly due to higher plant population, greater tiller number/m^2, larger root length and better LAI than wider planting geometry levels. This is in accordance with the earlier findings of Vijayakumar *et al.* (2006) and Dwivedi *et al.* (2015).

Tillers and productive tillers

Number of tillers/m^2 of rice was varied significantly due to different planting geometry levels (Table 2). Significantly higher number of tillers (394 and 380/m^2) were recorded with 25 x 25 cm and 30 x 30 cm planting geometry levels, respectively compared to all other square planting and control. Though there was more tillers/hill in wider planting geometry levels, due to higher population under closer planting geometry levels increased the tillering/unit area. Too wider planting geometry might have left the resources such as light, air, space, etc.

Table 1: Effect of planting geometry levels on growth characters of rice (Mean of three years data)

Treatment	Plant height (cm)				LAI				DMP (kg/ha)			
	AT	PI	FL	MT	AT	PI	FL	MT	AT	PI	FL	MT
T_1 - 25 x 25 cm	40.2	63.8	76.5	82.9	1.42	3.27	5.76	2.86	946	4978	9876	12784
T_2 - 30 x 30 cm	38.9	62.5	75.9	81.6	1.37	3.28	5.63	2.81	865	4743	9521	12168
T_3 - 35 x 35 cm	38.2	62.8	74.9	81.8	1.22	3.11	5.41	2.63	654	4045	8432	10335
T_4 - 40 x 40 cm	38.4	63.1	74.2	81.6	1.10	3.02	5.28	2.55	555	3765	8189	10091
T_5 - 50 x 50 cm	38.6	62.4	75.0	80.2	0.99	2.78	5.09	2.22	435	3467	7770	9675
T_6 - 20 x 15 cm	40.6	64.1	76.9	82.8	1.66	3.42	6.09	3.11	1248	6374	10689	13887
SEm ±	1.12	1.59	1.98	1.89	0.02	0.04	0.06	0.03	28	116	212	296
CD (P=0.05)	NS	NS	NS	NS	0.06	0.12	0.18	0.10	87	358	657	916

AT – Active tillering; PI – Panicle initiation; FL – Flowering; MT – Maturity

Table 2: Effect of planting geometry levels on yield attributes and yields of rice (Mean of three years data)

Treatment	No. of tillers/m^2	No. of productive tillers/m^2	Panicle length (cm)	No. of grains/ panicle	No. of filled grains/ panicle	1000 grain weight	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1 - 25 x 25 cm	394	358	22.64	157.6	139.5	16.13	6721	7771
T_2 - 30 x 30 cm	380	312	22.34	162.3	143.3	16.10	6587	7705
T_3 - 35 x 35 cm	295	277	22.68	167.6	149.6	16.13	5496	6270
T_4 - 40 x 40 cm	242	225	23.01	172.4	154.2	16.18	4209	5240
T_5 - 50 x 50 cm	206	199	23.50	181.8	167.7	16.28	3339	3988
T_6 - 20 x 15 cm	340	317	20.42	147.9	123.7	16.11	5509	8075
SEm ±	9.7	9.1	0.50	3.8	3.6	0.42	157	229
CD (P=0.05)	30.1	28.2	1.55	11.8	11.3	NS	487	709

under or un-utilized and have ultimately influenced on tillers/ unit area. The similar findings were opined by Hardev *et al.* (2014); Sihag *et al.* (2015).

Number of productive tillers/m^2 was also varied significantly due to planting geometry levels in rice. Closer planting geometry of 25 x 25 cm had recorded significantly higher number of productive tillers (358/m^2) compared to other wider square planting geometry levels and control. The discussion made to number of tillers/hill holds good here also. Though there was decreased number of productive tillers/hill in closer square planting geometry (25 x 25 cm), due to more population/ unit area and better conversion of tillers to productive tillers ultimately increased the number of productive tillers/m^2. These findings are in conformity with the results of Ashraf *et al.* (2014).

Yield attributes

Panicle length (cm) of rice was varied significantly due to alteration of planting geometry levels (Table 2). Longer panicles were recorded with wider planting geometry level and were on par with all other square planting treatments over control. Presence of more resources due to wider planting geometry might have provided improved plant stature and in turn lengthier panicle of rice.

Rice transplanted under 50 x 50 cm recorded the highest number grains and filled grains/panicle (181.8 and 167.7, respectively). As the area of the plant was widened, the competition for nutrients, water and sunlight were minimized. Better assimilation of photosynthates due to better utilization of incident solar radiation might have increased the size of sink and effective translocation of assimilates, which led to improved filled grains/panicle. Rajesh and Thanunathan (2003) and Singh *et al.* (2015) also opined that wider planting geometry had reduced above ground competition for better grain filling and number of filled grains.

Test weight is genetically made character and hence, the planting geometry levels did not have any significant influence.

Grain and straw yields

Discernible variation on grain yield of rice was observed due to varied planting geometry levels during three years of field experimentation (Table 2). Transplanting of rice at 25 x 25 cm and 30 x 30 cm resulted in higher grain yield (6721 and 6587 kg/ha, respectively) compared to others. Percentage yield increase due to these treatments over conventional planting was 22.0 and 19.6, respectively. More number of tillers and productive tillers/unit area and better number of grains and filled grains besides, optimum population/unit area encouraged better grain yields of rice than other too wider and too closer planting geometry levels. Similarly, better performance of optimum planting geometry levels were also reported earlier (Dahal and Khadka, 2012; Jogi *et al.* 2013; Dwivedi *et al.* 2015; Nandhakumar *et al.* 2015).

Higher straw yield (8075 kg/ha) was recorded under closer planting geometry of 20 x 15 cm than others and it was comparable with 25 x 25 cm and 30 x 30 cm planting geometry levels. More number of plants/unit area, higher leaf area index and better DMP contributed higher straw yield. This is in conformity with the findings of Rasool *et al.* (2013).

From three years of field experiments, it can be concluded that planting of rice at either 25 x 25 cm or 30 x 30 cm planting geometry levels under SRI method is the most suitable for obtaining the maximum production in Tamil Nadu.

REFERENCES

Amin, A. K. M. K. and Haque, M. A. 2009. Seedling age influence rice (*Oryza sativa* L.) performance. *Philippine J. Science.* **138(2):** 219-226.

Ashraf, U., Shakeel, A., Ehsanullah, A., Khan, I. and Tanveer, M. 2014. Planting geometry-induced alteration in weed infestation, growth and yield of puddled rice. *Pakistan J. Weed Science Research.* **20(1):** 77-89.

CPG 2005. Crop Production Guide. Published by Directorate of Agriculture, Chennai and Tamil Nadu Agricultural University, Coimbatore.

Dahal, K. R. and Khadka, R. B. 2012. Performance of rice with varied age of seedlings and planting geometry under System of rice intensification (SRI) in farmers' field in Western Terai, Nepal. *Nepal J. Science and Technology.* **13(2):** 1-6.

Dwivedi, S. K., Meshram, M. R., Pal, A. and Kanwar, P.C. 2015. Effect of planting geometry and seedling density on growth and yield of scented rice under SRI based cultivation practices. *The Bioscan.* **10(1):** 455-458.

Gomez, K. A. and Gomez. A. A. 2010. Statistical Procedures for Agricultural Research. *Wiley India Pvt. Ltd., New Delhi, India.*

Hardev, R. P., Singh, J. P., Bohra, J. S., Rajiv, K. S. and Sutaliya, J. M. 2014. Effect of seedlings age and plant planting geometry on growth, yield, nutrient uptake and economics of rice (*Oryza sativa*) genotypes under system of rice intensification. *Indian J. Agronomy.* **59(2):** 256-260.

Jogi, N. G., Rao, K. T., Rao, A. U. and Reddy, D. S. 2013. Age of seedlings and planting pattern on grain yield, protein content, NPK uptake and post-harvest status of rice under SRI. *J. Academia and Industrial Research.* **2(6):** 334-337.

Nandhakumar, M. R., Velayudham, K. and Thavaprakaash, N. 2015. Influence of crop geometry, age and number of seedlings in tillering behavior and yield of rice (*Oryza sativa* L.). *The Ecoscan.* **9(3&4):** 995-1000.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *Circular* No. 939, USDA.

Rajesh, V. and Thanunathan, K. 2003. Effect of seedling age, number and planting geometry on yield and nutrient uptake of traditional Kambanchamba rice. *Madras Agricultural J.* **90(1-3):** 47-49.

Rasool, F., Habib, R. and Bhat, M. I. 2013. Agronomic evaluation of rice (*Oryza sativa* L.) for plant planting geometry and seedlings per hill under temperate conditions. *African J. Agricultural Research.* **8(37):** 4650-4653.

Satyanarayana, A., Thiyagarajan, T. M. and Uphoff, N. 2007. Opportunities for water saving with higher yield from the system of rice intensification. *Irrigation Sciences.* **25:** 99-115.

Sihag, S. K., Singh, M. K., Meena, R. S., Naga, S. R., Bahadur, S., Gaurav and Yadav, R. S. 2015. Influence of spacing on growth and yield potential of dry direct seeded rice (*Oryza sativa* L.). *The Ecoscan.* **9(1&2):** 517-519.

Singh, K. L., Nandini Devi, K., Singh, A. K. and Sagoslam, K. S. 2015. Evaluation of rice cultivars under planting geometry in mid altitude lowland condition of Meghalaya, India. *The Ecoscan.* **9(1&2):** 343-347.

Stanford, G. and English, L. 1949. Use of flame photometer in rapid soil test for K and Ca. *Agronomy J.* **41:** 446-447.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Sciences.* **25:** 598-609.

Uphoff, N. 2001. Scientific issues raised by the System of Rice Intensification (SRI): A less water cultivation rice system. *Paper presented at Workshop of System of Rice Intensification.* p. 3. April 2-4, 2001. Nanjing.

Vijayakumar, M., Ramesh, S., Chandrasekaran, B. and Thiyagarajanm T. M. 2006. Effect of system of rice intensification (SRI) practices on yield attributes, yield and water productivity of rice (*Oryza sativa* L.). *Research J. Agriculture and Biological Sciences.* **2(6):** 236-242.

Viraktamath, B. C., Ilyas, A. M. and Singh, A. K. 2006. Hybrid rice. *Indian Farming.* **56(1):** 25-32.

Walkley, A. and Black, C. A. 1934. An estimation of wet oxidation method for determining sol organic matter and proposed modification of chromic acid titration method. *Soil Science,* **31:** 29-34.