# GROWTH AND ENERGETICS OF RICE AS INFLUENCED BY PLANTING GEOMETRIES AND SEEDLING DENSITIES UNDER SRI BASED CULTIVATION PRACTICES

**Damini Thawait\*, Sanjay K. Dwivedi, Srishti Pandey and Kamla Gandharv**

*Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, India*
*Email : daminithawait@gmail.com*

**Abstracts :** All over the world, the importance of agriculture, especially rice production, is increasing. To cope with the rising population, rice production needs to increase following vertical, instead of horizontal, expansion. Varieties have a great effect on the growth performance and yield contributing characters. India is second largest producer after china and has an area of over 42.2 million hectares and production of 104.32 million tonnes with productivity of 2372 kg ha$^{-1}$(Anonymous, 2012). The productivity of rice in Chhattisgarh is 1.80 t ha$^{-1}$ and its area is 3.65 million ha (Anonymous, 2013). Country has also emerged as a major rice consumer. Rice is consumed both in urban and rural areas and its consumption is growing due to high-income elasticity of demand. To meet the growing demand, a rapid increase in paddy production is needed. But, there is little scope to increase the area; hence increase in production and productivity with an improvement in efficiency of production act as a technological breakthrough to meet the growing demand. New approaches in international trade for aromatic rice's have to be developed. The national governments are required to design policies for grain qualities of aromatic rice's for both domestic and international trade.

**Keywords :** Growth, Cultivation, Rice

## INTRODUCTION

The crop plant growing depends largely on temperature, solar radiation, moisture and soil fertility for their growth and nutritional requirements. An unsuitable population crop may have limitation in the maximum availability of these factors. It is, therefore necessary to determine the optimum density of plant population per unit area for obtaining maximum yield. There have been extensive studies on the relationship between yield and plant density. The optimum seedlings per hill ensure the plants to grow in their both aerial and underground parts through efficient utilization of solar radiation, water and nutrients (Miah *et al.,* 2004). When the planting densities exceed the optimum level, competition among plants becomes severe and consequently the plant growth slows and the grain yield decreases. As the tiller production in scented rice is very low and most of them are low yielding. So, it is essential to determine suitable spacing and number of seedlings for scented rice varieties to maximize their yield.

## MATERIAL AND METHOD

The experiment was carried out at Research Cum Instructional Farm, I.G.K.V., Raipur (C.G.) during *kharif* 2012. The soil of experiment field was '*Inceptisols*' (sandy loam) which is locally known as '*Matasi*'. The soil was neutral in reaction and medium in fertility having low N, medium P, high K Climate of this region is sub- humid with an average annual rainfall of about 1200-1400 mm and the crop received 1315.9 mm of the total rainfall during its crop growth. The weekly average maximum and minimum temperature varied in between $25.8^0$C – $31.9^0$C and $12.75^0$C – $25.8^0$C, respectively. The experiment consisting of scented rice variety *Dubraj* with five levels of spacing *viz.* 25 cm x 25 cm, 25 cm x 20 cm, 25 cm x 15 cm, 20 cm x 20 cm and 25 cm x 10 cm and four levels of number of seedlings hill$^{-1}$ *viz.* 1 seedlings hill$^{-1}$, 2-3 seedlings hill$^{-1}$, 4-5 seedlings hill$^{-1}$ and 2 seedlings hill$^{-1}$. The experiment was laid out in randomized block design (RBD) with three replication and fourteen treatments. The treatment *viz.* 25 cm x 25 cm + $S_1$ ($T_1$), 25 cm x 25 cm + $S_{2-3}$ ($T_2$), 25 cm x 25 cm +$S_{4-5}$ ($T_3$), 25 cm x 20 cm + $S_1$ ($T_4$), 25 cm x 20 cm + $S_{2-3}$ ($T_5$), 25 cm x 20 cm + $S_{4-5}$ ($T_6$), 25 cm x 15 cm + $S_1$ ($T_7$), 25 cm x15 cm + $S_{2-3}$($T_8$), 25 cm x 15 cm + $S_{4-5}$ ($T_9$), 25 cm x 10 cm + $S_1$ ($T_{10}$), 25 cm x 10 cm + $S_{2-3}$ ($T_{11}$), 25 cm x 10 cm + $S_{4-5}$ ($T_{12}$), 20 cm x 20 cm + $S_2$ ($T_{13}$), 20 cm x 10 cm + $S_{2-3}$ ($T_{14}$). Transplanting of one, two-three and three-four seedlings hill$^{-1}$, using seed rate of 10 kg ha$^{-1}$, 20 kg ha$^{-1}$, 35 kg ha$^{-1}$ and 40 kg ha$^{-1}$ at the spacing of 25 cm x 25 cm, 25 cm x 20 cm, 25 cm x 15 cm, 25 cm x10 cm, 20 cm x 20 cm, 20 cm x 10 cm respectively. The 12 days old seedlings were transplanted from $T_1$ to $T_{13}$ while 23 days old seedlings were transplanted in the treatment $T_{14}$. Energy inputs were calculated and estimated in Mega Joule (MJ) ha$^{-1}$ with reference to the standard values prescribed by Mittal *et al.* (1985). These inputs were taken to each treatment of rice crops. Energy values, which were taken for energy estimation (Appendix II, III and IV). The standard energy coefficient for seed and straw of rice was multiplied with their respective yields and summed up to obtain the total energy output. The energy input for rice was calculated by adding the respective values under rice

\*Corresponding Author

crops. Energy use efficiency, energy output–input ratio, was calculated as per the following formula:

Grain production efficiency ($q\ MJ^{-1} \times 10^{-3}$) =

$$\frac{\text{Total produce (q)}}{\text{Energy input (MJ} \times 10^{-3})}$$

Energy output input ratio =

$$\frac{\text{Energy input}}{\text{Energy output}}$$

Productivity rating index (PRI) was calculated by the actual yield data was used for calculating PRI. It was calculated by using the following formula:

$$PRI = \frac{\text{Yield obtained from experimental plot (q ha}^{-1})}{\text{Standard yield (q ha}^{-1})}$$

For scented rice, Standard yield was taken 33.13 q ha$^{-1}$ as reported by Bhandarkar and Sharma (2013). Production efficiency Production efficiency of scented rice was calculated by using formula given by Tomar and Tiwari (1990) as follows:

$$PE\ (kg\ ha^{-1}\ day^{-1}) = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Duration of crop (days)}}$$

## RESULT AND DISCUSSION

**Effects on energetic of scented rice**

The energy input and output, energy input: output ratio and grain production efficiency are presented in Table 1.1, indicating great variation in these parameters. However the maximum grain energy output was observed in the treatment 25 cm x 25 cm + $S_{2-3}$ ($T_2$) followed by the treatment 25 cm x 25 cm + $S_1$ ($T_1$) it was mainly due to increased grain and straw yield. Similar result was found in case of straw. In case of lowest energy output, it was observed under the treatment 20 cm x 10 cm + $S_{2-3}$ ($T_{14}$). Whereas, the net gain energy was found maximum under the treatment 25 cm x 25 cm + $S_{2-3}$ ($T_2$) followed by the treatment 25 cm x 25 cm + $S_1$ ($T_1$) whereas the lowest found in the treatment 20 cm x 10 cm + $S_{2-3}$ ($T_{14}$). The highest grain production efficiency was obtained under the treatment with 25 cm x 25 cm + $S_{2-3}$ ($T_2$) and lowest was found under the treatment 20 cm x 10 cm + $S_{2-3}$ ($T_{14}$). The data reveal that the maximum energy input was observed under the treatment 20 cm x 10 cm + $S_{2-3}$ ($T_{14}$), followed by the treatments 25 cm x 25 cm +$S_{4-5}$ ($T_3$),

$25x10cm^2+S_1$ ($T_{10}$) and $25x10cm^2+S_3$ ($T_{12}$). However the lowest energy input was obtained under the treatments 25 cm x 25 cm + $S_1$ ($T_1$), 25 cm x 20 cm + $S_1$ ($T_4$), 25 cm x 15 cm + $S_1$ ($T_7$) and 25 cm x 10 cm + $S_1$ ($T_{10}$). Similar findings were found by Mittal *et al.* (1958).

**Production efficiency and productivity rating index**

The production efficiency and productivity rating index are presented in Fig 1.1, indicating production efficiency (PE) and productivity rating index (PRI) influenced significantly due to different treatments and the values were recorded higher under the treatment 25 cm x 25 cm + $S_{2-3}$ ($T_2$), which was found to be at par with 25 cm x 25 cm + $S_1$ ($T_1$), 25 cm x 20 cm + $S_1$ ($T_4$), 25 cm x 20 cm + $S_{2-3}$ ($T_5$), 25cm x 15cm + $S_1$ ($T_7$) and 20 cm x 20 cm + $S_2$ ($T_{13}$), In case of productivity rating index, treatments 25 cm x 25 cm + $S_1$ ($T_1$), 25 cm x 25 cm + $S_{4-5}$ ($T_3$), 25 cm x 20 cm + $S_1$ ($T_4$), 25 cm x 20 cm + $S_{2-3}$ ($T_5$), 25 cm x 15 cm + $S_1$ ($T_7$) and 20 cm x 20 cm + $S_2$ (2S) ($T_{13}$) found to be at par with the same treatment 25 cm x 25 cm + $S_{2-3}$ ($T_2$). The lowest PE and PRI were recorded under the treatment 20 cm x 10 cm + $S_{4-5}$ ($T_{14}$) *i.e.* farmers practice.

**Effect on grain yield and straw yield**

The grain, straw yield were significantly influenced due to different treatments. The data are presented in Table 1.1. The treatment 25 cm x 25 cm + $S_{2-3}$ ($T_2$) produced significantly highest grain yield, which was statistically similar with the treatments 25 cm x 25 cm + $S_1$ ($T_1$), 25 cm x 20 cm + $S_1$ ($T_4$), 25 cm x 20 cm + $S_{2-3}$ ($T_5$), 25 cm x 15 cm + $S_1$ ($T_7$) and 20 cm x 20 cm + $S_2$ (2S) ($T_{13}$). The lowest grain yield was obtained under narrow spacing with higher seedling density *i.e.* 20 cm x 10 cm + $S_{2-3}$ ($T_{14}$) *i.e.* farmers practice. The higher grain yield may be due to the application of organic sources of nutrients with inorganic sources of nutrients resulted to greater availability of essential nutrients to plants similar result were found by Porpavi *et al.* (2006). Transplanting of younger seedlings in optimum density at wider spacing facilitate the root growth leading to higher absorption of water and nutrients and ultimately resulting in higher yield. These results are in accordance with Shrirame *et al.* (2000) and Singh *et al.* (2012).

**Table 1.** Energetic of scented rice as influenced by planting geometry and seedling density under SRI based cultivation practices

| Treatment | Energy input (MJ X $10^{-3}$) | Energy output (MJ X $10^{-3}$) | | Net gain energy (MJ X $10^{-3}$) | Energy output-input ratio (MJ X $10^{-3}$) | | Grain production efficiency (q.MJ X $10^{-3}$) | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| | | Grain | Straw | | Grain | Straw | | | |
| $T_1$ :25x25cm²+$S_1$ | 12.43 | 54.26 | 93.80 | 148.06 | 4.36 | 7.54 | 2.97 | 36.91 | 75.04 |
| $T_2$: 25x25cm²+$S_{2-3}$ | 12.58 | 56.15 | 97.39 | 153.54 | 4.46 | 7.74 | 3.04 | 38.20 | 77.91 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $T_3$ :25x25cm$^2$+S$_{4-5}$ | 12.80 | 50.49 | 89.96 | 140.46 | 3.94 | 7.03 | 2.68 | 34.35 | 71.97 |
| $T_4$ :25x20cm$^2$+S$_1$ | 12.43 | 52.89 | 81.95 | 134.84 | 4.25 | 6.59 | 2.89 | 35.98 | 65.56 |
| $T_5$ :25x20cm$^2$+S$_{2-3}$ | 12.58 | 54.15 | 90.41 | 144.57 | 4.30 | 7.19 | 2.93 | 36.84 | 72.33 |
| $T_6$: 25x20cm$^2$+S$_{4-5}$ | 12.80 | 48.66 | 81.54 | 130.19 | 3.80 | 6.37 | 2.59 | 33.10 | 65.23 |
| $T_7$ :25x15cm$^2$+S$_1$ | 12.43 | 53.51 | 83.00 | 136.51 | 4.30 | 6.68 | 2.93 | 36.40 | 66.40 |
| $T_8$ :25x15cm$^2$+S$_{2-3}$ | 12.58 | 49.80 | 78.70 | 128.50 | 3.96 | 6.26 | 2.69 | 33.88 | 62.96 |
| $T_9$ :25x15cm$^2$+S$_{4-5}$ | 12.73 | 49.26 | 75.45 | 124.71 | 3.87 | 5.93 | 2.63 | 33.51 | 60.36 |
| $T_{10}$:25x10cm$^2$+S$_1$ | 12.43 | 50.35 | 81.19 | 131.54 | 4.05 | 6.53 | 2.75 | 34.25 | 64.95 |
| $T_{11}$:25x10cm$^2$+S$_{2-3}$ | 12.58 | 48.35 | 74.76 | 123.11 | 3.84 | 5.94 | 2.61 | 32.89 | 59.81 |
| $T_{12}$:25x10cm$^2$+S$_{4-5}$ | 12.80 | 47.89 | 71.78 | 119.67 | 3.74 | 5.61 | 2.54 | 32.58 | 57.42 |
| $T_{13}$:20x20cm$^2$+S$_2$(2S) | 12.58 | 52.32 | 80.85 | 133.17 | 4.16 | 6.43 | 2.83 | 35.59 | 64.68 |
| $T_{14:}$ 20x10cm$^2$+S$_{2-3}$ | 12.92 | 45.26 | 70.26 | 115.52 | 3.50 | 5.44 | 2.38 | 30.79 | 56.21 |
| SEm $\pm$ | | | | | | | | 1.28 | 2.18 |
| CD- | | | | | | | | 3.74 | 3.09 |
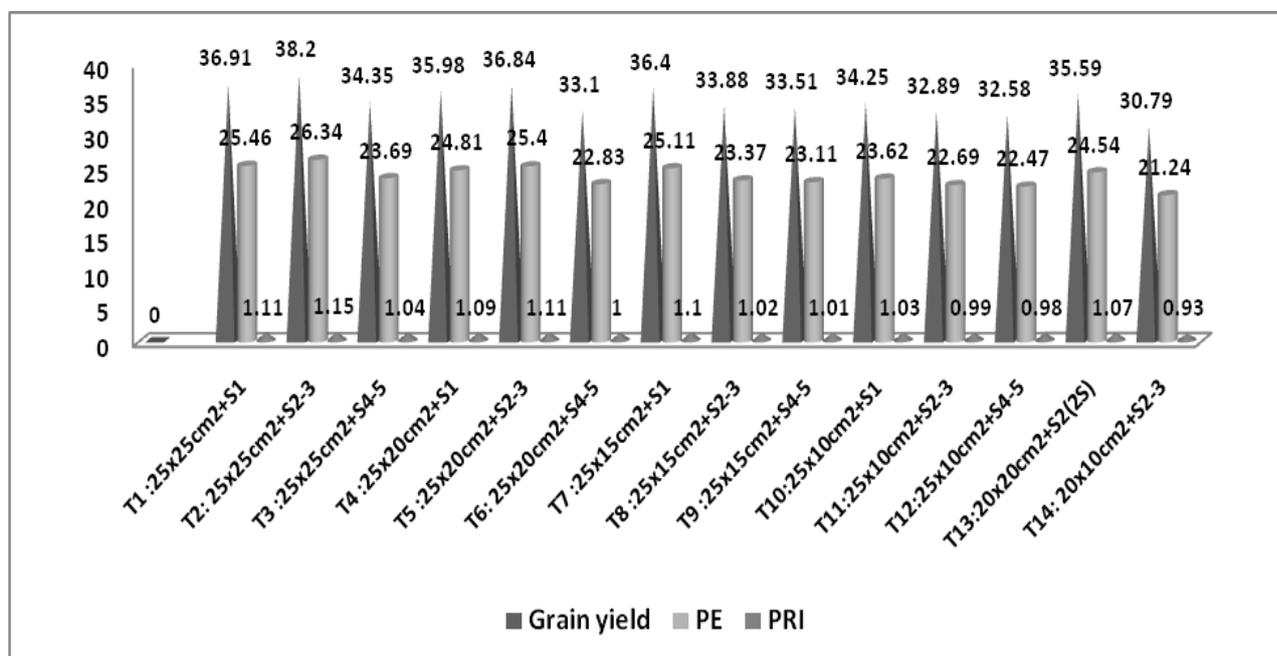


**Fig 1.1.** Grain yield, production efficiency and productivity rating index as of rice as influenced by planting geometries and seedling densities under SRI based cultivation practices

## REFERENCES

**Anonymous** (2013). Krishi Darshika 2013. Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, 2012. pp.17.

**Bhandarkar,S. and Sharma, B.** 2012. Results of all India Coordinated Rice Improvement Programme, Indira Gandhi Krishi Vishwavidyalaya. 07.

**Miah, M.N.H., Talukder, S., Sarker, M.A.R and Ansari,T.H.** (2004). Effect of Number of Seedling per Hill and Urea Supergranules on Growth and Yield of the Rice cv. BINA Dhan4. *Jour. Biol. Sci.* **4**(2):122-129.

**Mittal, N.K. Mittal, J.P.and Ddhawan, K.C.** (1985). Research digest on energy requirement in agriculture sector. ICAR/AICRA/ERAS. 85(1): 159-163.

*Plant Analysis*, 26, 1507–1523.

**Propavi, S., Anbumani, S., Sathiyabana, K. and Rav, V.** (2006). Evaluation of varietal performance under SRI. In: National symposium on system of rice intensification (SRI) - present status and future prospects November 17-18, 2006, ANGRU, Hyderabad. pp.74.

**Shrirame, M.D., Rajgire, H.J. and Rajgire, A.H.** (2000). Effect of spacing and number of   seedling

per hill on yield and yield attributes of rice hybrids under lowland condition. *Journal of Soils and Crops* **10** (1): pp. 109-113.

**Singh, N., Kumar, D.  and Tyagi, V.K.** (2012). Influence of spacing and weed management on rice (*Oryza sativa* L.) varieties under system of rice intensification. *Indian Journal of Agronomy* **57** (2): pp. 138-142.

**Tomar, A. and Tiwari, S.** (1990). Production potential and economics of different crop sequences. *Indian Journal of Agronomy.* **35**: 30-35.