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GROWTH PARAMETERS AND YIELD OF *SALI* RICE (*ORYZA SATIVA L*) AS AFFECTED BY DATE OF TRANSPLANTING AND METHOD OF CULTIVATION IN ASSAM

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Abstract

A field experiment was conducted to study the effect of different dates of rice transplanting and methods of cultivation on growth parameters and yield of *Sali* rice in a factorial randomized block design with four replications at Regional Agricultural Research Station, Shillongani, Nagaon, Assam during 2014 and 2015. The treatments of the experiment comprised three dates of rice transplanting *viz.*, 20 June, 5 July and 20 July and two methods of rice cultivation *viz.*, conventional method and SRI. The results of the investigation showed that 20 June transplanting and SRI method of cultivation enhanced the growth parameters which in turn increased the grain yield of rice. Among the different dates of rice transplanting, 20 June transplanted crop recorded significantly higher values in all the growth parameters and yield (59.19 q/ha) than 5 July and 20 July transplanted rice. SRI method recorded significantly higher values in respect of all the growth parameters and yield (60.34 q/ha) of rice as compared to conventional method.

Keywords: Date of transplanting, Grain yield, Growth parameters, Method of cultivation, Rice, SRI,

Introduction

Rice (*Oryza sativa* L.*)* is the most important food crop of Assam, occupying first position in respect of both area and production compared to other food crops. In 2015-16, the state was able to produce about 51.25 lakh tones of total rice from an area of 24.85 lakh hectares with productivity of 2087 kg/ha (Anon., 2016). Among the three different types of rice grown in Assam, winter rice, locally known as S*ali* rice, is the most important one, which occupies about 75 per cent of total rice area, covering an area of 18-19 lakh hectares. Sali rice contributes about 65.37 per cent of the total rice production in the state. Low productivity of rice especially *Sali* rice in Assam is a major concern for food security. In such scenario, the system of rice intensification (SRI) appears to be a viable alternative for increasing *Sali* rice productivity by changing the management of rice plants, soil, water and nutrients. The SRI

method of rice cultivation saves the expensive inputs, improves growth parameters and yield, soil health and protects the environment (Satyanarayana *et al*., 2007). Study on growth parameters of rice is one of the very important aspects in respect of getting higher yield which can be increased by adoption of improved package of practices such as method of cultivation and time of transplanting. Rajakumar, 2013 reported that SRI method of cultivation is an opportunity for improving growth parameters and thereby increasing the productivity of rice per unit area. Time of rice transplanting is also essential for improving growth attributes and parameters of *Sali* rice responsible for high yield (Lakpale *et al*., 1994). Therefore, an experiment was undertaken to evaluate different dates of transplanting and methods of cultivation on the growth parameters and yield of *Sali* rice.

Materials and Methods

A field experiment was carried out during the *kharif* seasons of 2014-15 and 2015-16 at Research Farm of Regional Agricultural Research Station, Shillongani, Nagaon, Assam (26^0 N latitude, $90^0 45^/$ E longitude and at an altitude of 50.2 m above from the mean sea level). The climate of this region is sub-tropical with hot humid summer and relatively dry and cold winter. The crop experienced favorable weather conditions in both the years of experimentation. Total amount of rainfall received during the crop growth period were 1207.5 mm during 2014 and 1124.2 mm during 2015 with relative humidity from 82 to 95 % in the morning and from 64 to 85 % in the evening. The maximum temperature rises up to 36 ^{0} C in July-August and the minimum falls to 7 ^{0}C in January. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.61), medium in organic carbon (0.84 %), available N (296 kg/ha) and available K_2O (195 kg/ha) and low in available P_2O_5 (21 kg/ha). The treatments comprised three dates of rice transplanting *viz*., 20 June, 5 July and 20 July and two methods of rice cultivation *viz*., conventional and SRI method. The experiment was laid out in a factorial randomized block design with four replications.

In conventional method of rice cultivation, *Sali* rice variety “Ranjit” was sown in three different dates *viz*. 20 May, 5 June and 20 June. The seedlings of 30 days-old were transplanted on 20 June, 5 July and 20 July as per recommended package of practices (Anon., 2009a). Whereas, in SRI method, same variety was sown on seedbed as per standard procedure (Anon., 2008) in three different dates *viz*. 10 June, 25 June and 10 July, where 10 days-old seedlings were transplanted on 20 June, 5 July and 20 July, respectively (Anon., 2009b) so that transplanting of seedlings were done on same date in both methods. In the conventional method of rice cultivation, 30 day-old seedlings were transplanted maintaining

row to row and hill to hill spacing of 20 cm with two to three seedlings per hill. In SRI method, 10 day-old rice seedlings were transplanted maintaining row to row and hill to hill spacing of 25 cm with only one seedling per hill.

The growth parameters recorded at different stages of rice were discussed below -

Leaf area index (LAI)

For recording the average leaf area of middle tiller, 10 hills were selected randomly in each plot. Ten middle tillers from each selected hill were collected at 8.0 am in the morning at maximum tillering, flowering and dough stages of rice and leaf area of middle tiller was recorded with the help of leaf area meter 211 and thereafter leaf area per hill was calculated using the formula given below and then the mean was calculated:

Leaf Area/hill=Total leaf area of middle tiller x total number of tillers per hill

LAI was computed with the following relationship:

$$LAI = \frac{\text{Leaf area per hill}}{\text{Land area occupied by the hill}}$$

Crop Growth rate (CGR)

Crop growth rate was measured by sampling a plant sample at 30 days intervals from maximum tillering to dough stage and calculating the increase in dry weight from one sample date to the next.

CGR was calculated using the following formula:

$$CGR = \frac{W_2 - W_1}{(t_2 - t_1) \times GA} \quad g/m^2/day$$

Where,

W_1 = Dry weight of shoot at the time of fist sampling (t_1)

W_2 = Dry weight of shoot at the time of second sampling (t_2)

GA = Ground area.

Relative growth rate (RGR)

It is a measurement of dry weight increase in plant matter over a time interval and in relation to initial dry weight.

Relative growth rate was computed using the following formula:

$$RGR = \frac{1}{W} \times \frac{dw}{dt} \text{ g/g/day}$$

Where,

$\frac{dw}{dt}$ = CGR ($g/m^2/day$)

W=Initial dry weight of shoot (g)

Root-shoot ratio

Root-shoot ratio was computed dividing dry weight of root by dry weight of shoot at 60 and 90 DAT of rice.

The data were analyzed by factorial RBD as per standard procedure described by Panse and Sukhatme (1985) and the significance or non-significance of the variances due to treatment effects was tested by 'F' test. Critical difference (CD) was calculated wherever 'F' test was found significant.

Results and Discussions

The data recorded under different growth parameters were discussed below:

Plant height

Rice transplanting on 20th June recorded significantly higher plant height (152.02 cm and 151.03 cm in 2014 and 2015, respectively) than 20th July transplanting in both the years (Table 1). Similar result was obtained by Yadav (2007), Ashem *et al*. (2010) and Changmai (2015). The taller plants in early transplanting might be due to availability of longer vegetative growth period of rice as compared to the delayed transplanted transplantin. The maximum plant height of 151.99 cm and 151.65 cm in 2014 and 2015 respectively was recorded in the rice grown under SRI method which was significantly higher than conventional method (Hossain *et al.*, 2003; Singh *et al*., 2013 and Baro, 2015). The taller plants under SRI method might be due to transplanting of younger seedlings, wider spacing and extensive root growth.

Number of total tillers/m^2

The maximum number of tillers per m^2 was obtained on 20th June transplanting which was significantly higher than other dates in both the years (Table 1). Similar findings were recorded by Singh *et al.* (1997), Patel (1999) and Yadav (2007). The higher number of tillers per m^2 in early transplanted crop might be due to availability of more time for the vegetative growth period. However, method of rice cultivation had no significant effect on number of tillers per m^2 in both the years.

Table 1. Plant height and number of tillers per m^2 of rice as influenced by date of transplanting and method of cultivation of rice

Treatment	Plant height (cm) at harvest		Number of total tillers/m^2	
	2014	2015	2014	2015
Date of transplanting				
20th June	152.02	151.03	395.35	390.70
5th July	148.33	147.71	368.03	369.54
20th July	147.09	146.39	349.40	358.40
S. Em (±)	1.22	1.44	4.49	3.20
C.D. (0.05)	3.84	4.53	14.16	10.08
Method of cultivation				
Conventional	146.31	145.11	371.97	374.94
SRI	151.99	151.65	370.55	370.82
S. Em (±)	1.13	1.36	3.66	2.61
C.D. (0.05)	3.56	4.28	NS	NS

Leaf area index (LAI)

Irrespective of transplanting date and methods of cultivation, the LAI increased with the advancement of crop growth stages, which reached the maximum at flowering stage and thereafter, a gradual declining trend was observed up to the dough stage in both the years (Table 2). Maximum LAI at flowering stage under different dates of transplanting and methods of cultivation might be due to the highest number of intact functional leaves at the flowering stage as compared to other stages. Reduced LAI after flowering stage might be attributed to reduction of functional leaves due to drying up of lower leaves after anthesis. Similar findings were reported by Mandal *et al.*,1984. Different dates of transplanting showed significant effect on LAI only at the dough stage in the year 2015. However, the highest LAI was noted in rice transplanted on 20 June at all the stages as compared to

delayed transplanting dates. In case of methods of rice cultivation, significantly higher values of LAI were recorded under SRI as compared to conventional method at all the growth stages during both the years. The higher value of LAI in SRI over conventional method might be attributed to early establishment of canopies, large leaf size, production of more number of leaves/tiller and more number of tillers/hill. Singh *et al*., 2013 and Kumar *et al*., 2013 also recorded similar observations.

Table 2. Leaf area index (LAI) of rice at different growth stages as influenced by date of transplanting and method of cultivation of rice

Treatment	Maximum tillering stage		Flowering stage		Dough stage	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
Date of transplanting						
20th June	4.83	4.80	6.74	6.63	4.92	4.85
5th July	4.74	4.74	6.62	6.47	4.83	4.77
20th July	4.62	4.63	6.40	6.32	4.65	4.61
S. Em (±)	0.08	0.05	0.16	0.10	0.08	0.05
C.D. (0.05)	NS	NS	NS	NS	NS	0.17
Method of cultivation						
Conventional	4.43	4.44	6.32	6.18	4.53	4.46
SRI	5.02	5.01	6.84	6.74	5.07	5.02
S. Em (±)	0.06	0.04	0.13	0.08	0.06	0.04
C.D. (0.05)	0.21	0.15	0.33	0.26	0.20	0.14

Crop Growth Rate (CGR; $gm^{-2}day^{-1}$)

The crop growth rate increased with the advancement of the crop growth stages up to the flowering and thereafter, it declined in all the dates of transplanting and method of cultivation (Table 3) which was due to increase in dry matter in the leaf and culm of rice and production of more number of functional leaves upto flowering stage. Similar result was also observed by Mandal *et al.* (1984) and Changmai (2015). The CGR differed significantly due to different dates of transplanting only at dough stage in both the years. However, at all the growth stages, the highest CGR was recorded on 20 June transplanting as compared to 5 July and 20 July during both the years. Significantly higher CGR was recorded in rice cultivated by SRI at all the growth stages in both the years over the conventional method and similar result was found by Nissanka and Bandara (2004) and Prema (2007). The higher CGR in SRI might be due to better vegetative as well as reproductive growth in rice plants resulting in

production of more number of tillers and leaves per hill and consequently more dry matter production per unit land area and better root growth.

Table 3. Crop growth rate (g/m^2/day) of rice at different growth stages as influenced by date of transplanting and method of cultivation of rice

Treatment	Maximum tillering stage		Panicle initiation stage		Flowering stage		Dough stage	
	2014	2015	2014	2015	2014	2015	2014	2015
Date of transplanting								
20th June	7.58	6.57	10.25	10.07	17.47	17.35	15.58	15.44
5th July	7.40	6.41	10.07	9.77	17.30	17.18	15.45	15.31
20th July	7.29	6.29	9.89	9.48	17.25	17.13	15.37	15.23
S. Em (±)	0.10	0.09	0.19	0.16	0.19	0.19	0.03	0.03
C.D. (0.05)	NS	NS	NS	NS	NS	NS	0.11	0.11
Method of cultivation								
Conventional	6.46	5.45	8.39	8.09	16.28	16.16	14.44	14.29
SRI	8.38	7.39	11.74	11.45	18.39	18.27	16.50	16.36
S. Em (±)	0.08	0.07	0.15	0.13	0.15	0.15	0.02	0.02
C.D. (0.05)	0.25	0.24	0.50	0.43	0.50	0.50	0.09	0.09

Relative Growth Rate (RGR; g g^{-1}day^{-1})

The highest RGR was found at the initial stage and it declined gradually with advancement of crop growth till dough stage (Table 4). Date of transplanting had no significant effect on the RGR of the crop. However, methods of cultivation affected significantly on RGR at maximum tillering stage during both the years. Significantly higher RGR was recorded under SRI at maximum tillering stage over the conventional method.

Table 4. Relative growth rate (g/g/day) of rice at different growth stages as influenced by date of transplanting and method of cultivation of rice

Treatment	Maximum tillering stage		Flowering stage		Dough stage	
	2014	2015	2014	2015	2014	2015
Date of transplanting						
20th June	0.091	0.075	0.045	0.039	0.028	0.028
5th July	0.095	0.081	0.046	0.040	0.026	0.027
20th July	0.098	0.084	0.045	0.039	0.025	0.027
S. Em (±)	0.004	0.004	0.001	0.002	0.001	0.001
C.D. (0.05)	NS	NS	NS	NS	NS	NS
Method of cultivation						
Conventional	0.089	0.074	0.045	0.039	0.026	0.027
SRI	0.100	0.086	0.046	0.039	0.027	0.028
S. Em (±)	0.003	0.003	0.001	0.001	0.001	0.001
C.D. (0.05)	0.007	0.008	NS	NS	NS	NS

Root-shoot ratio

Transplanting dates had no significant effect on root-shoot ratio of rice at both 60 and 90 days after transplanting (Table 5). However, SRI recorded significantly higher root-shoot ratio of rice over conventional method at all the stages of crop growth in both the years. This might be due to wider spacing in SRI that allowed enough sunlight to reach most of the leaves of rice plant and also reduced competition for water, space and nutrients and thereby, resulting in proliferation of roots in wider and deeper layers. Moreover, in SRI, weeding by cono weeder helped in aeration in root zone which ultimately resulted in vigorous root growth. Similar findings were reported by Dass *et al*. (2015).

Table 5. Root –shoot ratio of rice as influenced by date of transplanting and method of cultivation of rice at 60 and 90 days after transplanting (DAT)

Treatment	Root –shoot ratio			
	60 DAT		90 DAT	
	2014	2015	2014	2015
Date of transplanting				
20th June	0.346	0.331	0.355	0.352
5th July	0.343	0.329	0.350	0.349
20th July	0.338	0.328	0.349	0.344
S. Em (±)	0.004	0.004	0.003	0.003
C.D. (0.05)	NS	NS	NS	NS
Method of cultivation				
Conventional	0.332	0.327	0.341	0.339
SRI	0.354	0.333	0.362	0.357
S. Em (±)	0.003	0.003	0.002	0.002
C.D. (0.05)	0.008	0.007	0.004	0.006

Grain yield

Rice transplanting on 20 June recorded significantly higher grain yield (59.19 q/ha) over 20 July transplanting and at par with 5 July transplanting (Table 6). Higher grain yield at early transplanting was owing to relatively early crop establishment and better yield attributes resulting from improved growth parameters of rice plant (Ashem *et al.*, 2010 and Changmai, 2015). The SRI method recorded significantly higher grain yield of rice (60.34 q/ha) than the conventional method. The increase in grain yield under SRI might be attributed to increase in growth parameters and better rooting ability resulting into higher dry matter production (DMP). This is in accordance with the findings of Thakur and Patel (1998) who reported that DMP, LAI, CGR and RGR are ultimately reflected in higher grain yield of rice.

Table 6. Grain yield of rice influenced by date of transplanting and method of cultivation of rice

Treatment	Grain yield (q/ha)		
	2014	2015	Pooled
Date of transplanting			
20th June	59.61	58.79	59.19
5th July	58.44	57.73	58.09
20th July	55.92	55.16	55.55
S. Em (±)	1.11	1.02	0.99
C.D. (0.05)	3.49	3.21	3.12
Method of cultivation			
Conventional	55.21	54.54	54.99
SRI	60.77	59.91	60.34
S. Em (±)	1.04	0.96	0.88
C.D. (0.05)	3.28	3.05	2.77

Conclusion

From this study, it is concluded that agronomic manipulation like dates of transplanting and method of rice cultivation had contribution for the enhancement of growth parameters *viz*, Plant height, number of tillers, LAI, CGR, RGR, root: shoot ratio and yield of *Sali* rice. The highest values of growth parameters were obtained on 20 June transplanted *Sali* rice as compared to 5 and 20 July. SRI method also resulted in significantly higher values in plant height, LAI, CGR, RGR, root: shoot ratio and yield of rice. Hence it is indicated that SRI method with early transplanting around 20 June is advisable to improve growth parameters and yield of *Sali* rice in Assam.

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