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Effect of age of seedling and plant spacing on yield and attributing traits of rice varieties under SRI method of rice cultivation

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Abstract
A field experiment was conducted at Instructional Farm of Krishi Vigyan Kendra, Masodha Faizabad to evaluate the influence of age of seedling and planting geometry on yield and attributing traits of rice varieties under system of rice intensification (SRI) method of crop establishment during kharif 2012 and 2013. The experimental material was consist of the popular rice varieties/ hybrid viz. NDR 359, Sarjoo-52 & Arize 6444, three different planting geometries viz. 20 cm × 20 cm, 25 cm × 25 cm & 30 cm × 30 cm between hills and rows and three age of seedlings viz. 8, 10 & 12 days. Planting of 12 days age seedling along with the plant geometry of 25 X 25 cm produced higher grain yield in the both years of the study. The optimum level of plant population coupled with better yield attributing traits might have resulted in higher grain yield with 25 x 25 cm spacing. Among tested rice varieties Sarjoo-52 was found most suitable for SRI method of rice cultivation

Keywords: SRI, age of seedlings, planting geometry, effective tillers/m^2, grains/panicle

Introduction
Rice is the most widely distributed and cultivated crop of the world. It is not only the staple food of more than half of the population of the world but also the main source of dietary energy of rice eating population of Asia and South East Asia. India is the second largest producer and consumer of rice after China. In India rice is in cultivation since ages and it was cultivated in almost all the states of the country. Area under rice cultivation in India was about 44.4 million hectare with an annual production of 104 million ton. Rice export is the backbone of agriculture based economy of the country. To feed growing population, country has to produce about 130 million tones of rice by 2025. To meet these targeted demands of rice is a challenging task for the stake holders. Uttar Pradesh is the 2nd largest rice producer of the country after west Bengal with the annual production of 14416 thousand tons from an area of 5.90 million hectare. The average productivity of the state is about 2.35 t/ha which much below the national level of rice productivity. The major constraints in rice production in the state are low coverage by hybrids and high yielding varieties, soil salinity/alkalinity and micro and secondary nutrient deficiency, imbalanced fertilizer use, decreasing organic carbon content in soils; changing climatic condition resulted in flash floods, submergence and drought, very low seed replacement rate (SRR) and shortage of farm laborers. Rice cultivation demands huge amount of water. It was estimated that more than 50 per cent of total irrigation water available was used for rice cultivation. Changing climatic situations coupled with inadequate monsoon rainfall, lack of water harvesting measures and improper use of water for irrigation, has brought down water table in many countries including India. This alarming situation limiting the scope for rice cultivation. Rice being the crop having high water requirement, there is a need to develop/search for alternate methods of rice production which requires less water without affecting the yield potential of the varieties. System of Rice Intensification (SRI) is a water saving technology, with many fold increase in crop yield (Laulanie, 1993) [12]. This method of crop establishment was developed in Madagascar in 1980's, where, it has shown its yield superiority over the most common method of crop establishment i.e. transplanting. In SRI technique rice productivity can be enhanced by suitably modifying certain management practices such as controlled supply of water, planting of younger seedlings and providing wider spacing (Laulanie, 1993) [12]. This water saving technology of rice crop establishment is gaining momentum all over the world. With the successful adoption of this water saving technology we can not only save water but also protect soil, save environment by checking methane gas emission from the submerged paddy fields and bring down the input cost. In SRI method of crop establishment transplanting of younger seedlings (8-15 days old) at a wider spacing was done and field is kept moist and not flooded through

appropriate water management strategies. Wider plant spacing promotes better root growth and good tillering potential. Working of rotary weeder churns the soil and provides greater aeration which helps in buildup of enormous microbial growth, thereby enhancement of nutrient supply to root which ultimately result in healthy plant growth and higher yields at lower costs. Transplanting of younger rice seedlings assumes special significance and principal means in obtaining higher yields in SRI cultivation. Enormous loss in growth potential of rice seedlings was observed if they are transplanted more than 15 days after they emerge in their nursery. Seedlings should be transplanted before the fourth phyllochron begins to preserve the tillering potential. This stage usually occurs in about two weeks after sowing (Rafaralahy, 2002) [18]. Seedling age is well known to influence the grain yield (Singh et al., 2004) [23].

In view of the above observations a field experiment was conducted to find out the effect of age of seedling and planting geometry on yield and attributing traits under SRI (System of Rice Intensification) method of cultivation.

2. Material and Methods

The field experiment was conducted at Instructional Farm of Krishi Vigyan Kendra, Masodha, P.O. Dabhasemer, Faizabad during *kharif* 2012 and 2013 to evaluate the influence of age of seedling and planting geometry on yield and attributing traits under SRI method of rice cultivation. Popular high yielding rice variety NDR 359 & Sarjoo-52 and rice hybrid Arize 6444 were used as test variety. Experimental material was consist of three different planting geometries viz. 20 cm × 20 cm, 25 cm × 25 cm & 30 cm × 30 cm between hills and rows and three age of seedlings viz. 8, 10 & 12 days. Seeds were soaked for 24 h and incubated in moist gunny bag for 1-2 days. Pre-germinated seeds were broadcasted uniformly on nursery beds. After broadcasting the seed, again 1:1 soil-FYM mixture was spread in a thin layer of one centimeter. Sowings were done at different dates to get respective aged seedlings (8, 10 and 12 days old) to plant at same day. The beds were irrigated with a rose can daily in the morning and evening to maintain the moisture of the soil. Before lifting the seedlings, nursery beds were thoroughly irrigated. After lifting, seedlings were immediately transplanted in the main field. Soil of the experimental field was sandy loam in texture and slightly alkaline in nature (pH-7.4). Soil chemical analysis shows that the available nitrogen in the soil was 210 kg/ha and soil is deficient in phosphorous (available P2O5 (kg/ha) – 24). The layout of the experiment was split-split plot design with three replications having planting geometry as main plots, rice varieties as sub plot treatments and age of seedling as sub-sub plot treatments. The area of each plot was 20 m^2. Seedlings were transplanted with an average of one seedling per hill in the SRI method of planting. 10 t FYM/ha was applied to all the experimental plots uniformly before final puddling and leveling. Recommended dose of fertilizer (120: 60: 60 kg NPK/ hectare) was applied uniformly in all the plots. Half dose of nitrogen and full dose phosphorus and potassium were applied as basal application just before transplanting while the remaining half dose of nitrogen was applied in two equal split doses at tillering and panicle initiation stages of crop growth. Observations on Effective tillers /m^2, grains/ panicle, panicle weight and grain yield were recorded. The data was analyzed statistically as per the procedure prescribed for split-split plot design (Panse and Sukhatme, 1995) [16] to obtain analysis of variance.

3. Results and Discussion

Effect of planting geometry on yield attributes and yield

The result presented in table-1 showed that the yield and attributing traits were highly influenced by the planting geometry. Results indicate that wider spacing between row to row and plant to plant provides plants more opportunity for better root growth and draw nutrition. Plants grown with wider spacing also absorb more solar radiation for photosynthesis. gave plants had linearly increasing effect on the performance of individual plants. Profuse tillering due to lower plant density was noticed under wider spacing compared to closer spacing. A spacing of 25 x 25 cm had given more number of effective tillers/ m^2 (393.85) than the plant geometry of 20 X 20 cm (342.85) and 30 X 30 cm (300.15). Similar findings were reported by Narayana Reddy (2002) [13] and Tusekelege *et al.* (2014) [26].Yield attributing traits viz. panicle weight and grains/ panicle were significantly higher in wider spacing of 30 cm × 30 cm as compared to closer spacing of 20 cm × 20 cm and 25 cm × 25 cm. Similar observations were also reported by Gorgy (2010) [10] and, Ogbodo *et al.* (2010) [15].

The grain yield was significantly influenced by planting geometries at harvest during both the years of the study. Maximum grain yield was recorded with 25 cm × 25 cm planting geometries (6.98 t/ha) followed by 20 cm × 20 cm planting geometries (6.24 t/ha) and 30 cm × 30 cm planting geometries (5.59 t/ ha). Higher grain yield with the planting geometry 25 X 25 cm might be due to the optimum plant population, less chaffy grains/panicle along with higher no. of tillers/hill. These findings are conformity with findings of Ceesay and Uphoff (2003) [5], Sreedhar *et al.* (2010) [24], Ahmed *et al*. (2015) [1], Alam *et al.* (2015) [2], Baskar *et al*. (2013) [4] and Zhang *et al*. (2004) [28].

Effect of age of seedlings on yield attributes and yield

Number of tillers and productive tillers per plant varied significantly due to age of the seedlings at different growth stages of the crop growth. Twelve days old seedlings recorded maximum effective tillers m^{-2} (355.38), as compared to other age of seedlings. The present findings are in conformity with the results of Manhan and Siddique (1990) [14] and Das *et al.* (1988). Panicle weight and grains/panicle also varied with age of seedlings. Grain yield was highly influenced by the age of seedlings. Maximum grain was recorded with 12 days old seedling (6.20 t/ha) followed by 10 days old seedlings (6.04 t/ha) and 8 days old seedlings (3.45 t/ha).

Effect of varieties on yield attributes and yield

Rice variety Sarjoo-52 was significantly superior than other tested rice varieties/hybrid NDR 359 and Arize 6444 under SRI method of crop establishment in yield and yield attributing traits viz.; effective tillers/m2, panicle weight and grains/panicle with wider spacing. High spikelet fertility % was also observed for rice variety Sarjoo-52. Similar findings were also reported by the. Dahal and Khadka (2012) [6]. The cumulative effects of superior growth and yield attributes were finally reflected in terms of higher grain yield.

Table 1: Effect of age of seedling and planting geometry on yield and attributing traits of rice under SRI method of cultivation

Treatments	Effective tillers/ m^2			Panicle weight (g)			No. of grains/panicle			Grain yield (t/ha)		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
Planting geometry												
S1- 20 X 20 cm	330.20	355.50	342.85	6.25	6.35	6.30	245	265	255	6.05	6.42	6.24
S2- 25 X 25 cm	385.50	402.20	393.85	6.70	6.90	6.80	277	291	284	6.70	7.25	6.98
S3- 30 X 30 cm	282.60	300.15	291.38	7.15	7.25	7.20	305	321	313	5.45	5.72	5.59
SEm±	7.57	8.05	7.81	0.80	0.95	0.88	3.35	4.45	3.90	1.10	1.31	1.21
CD ($p \leq 0.05$)	17.71	19.25	18.48	1.55	1.68	1.62	11.10	13.25	12.18	3.55	5.10	4.33
Variety												
NDR - 359	310.25	335.35	322.80	6.75	7.05	6.90	253	270	262	5.60	5.85	5.73
Sarjoo-52	373.10	410.20	391.65	6.35	6.58	6.47	300	315	308	6.65	7.35	7.00
Arize 6444	345.40	377.25	361.33	5.99	6.15	6.07	265	282	274	6.10	6.50	6.30
SEm±	3.15	4.12	3.64	0.45	0.71	0.58	2.45	2.95	2.70	0.63	0.71	0.67
CD ($p \leq 0.05$)	11.30	12.57	11.94	1.03	1.25	1.14	3.85	4.35	4.10	1.05	1.11	1.08
Age of Seedling												
A1- 8 days	295.40	300.15	297.78	6.00	6.22	6.11	255	270	263	5.35	5.55	5.45
A2- 10 days	335.25	340.30	337.78	6.30	6.65	6.48	290	305	298	5.90	6.18	6.04
A3- 12 days	350.50	360.25	355.38	6.82	7.10	6.96	300	325	313	6.05	6.35	6.20
SEm±	4.15	5.20	4.68	0.52	0.65	0.59	3.60	3.85	3.73	1.25	1.31	1.28
CD ($p \leq 0.05$)	13.35	15.10	14.23	1.15	1.27	1.21	5.50	6.05	5.78	4.10	4.95	4.53

4. Conclusion

It is clear from the present investigations that 12 days old seedling and 25 x 25 cm plant geometry is the,most suitable under SRI method of rice cultivation in agro climatic of eastern Uttar Pradesh. Among tested rice varieties Sarjoo-52 was found superior under SRI method of rice production and produced higher grain yield with the wider plant geometry.

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