Ann. Agric. Res. New Series Vol. 38 (4) : 363-367 (2017)

Productivity and seed quality of hybrid rice (*Oryza sativa* L.) genotypes as influenced by age of seedling and spacing under SRI

Rajiv K. Singh*, P.K. Upadhyay[1], S.S. Rathore[2], S.K. Singh[3] and Saurbh[4]

ICAR-Indian Institute of Seed Science, Kushmaur, Mau-275103, U.P.
e-mail: rajiv1571975@rediffmail.com

Received : June 2017 ; Revised Accepted: November 2017

ABSTRACT

A field experiment was conducted during rainy season (2014) to evaluate the effect of age of seedlings and spacing on growth, yield and yield attributes and seed quality of hybrid rice (*Oryza sativa* L.) under system of rice intensification. The 8 treatments were laid out in split plot design, keeping combinations of two hybrid (DRRH-2 and DRRH-3) and seedlings age (12 and 25 days old) in main plots and two spacings (25×25 cm and 20×15 cm) in sub-plots with 3 replications. The hybrid rice genotype DRRH-3 was significantly superior than DRRH-2 with respect to growth parameters, yield attributes, seed yield and seed quality. Among the age of seedlings, 12 days old seedlings registered higher growth, yield & yield attributes and seed quality parameters and it produced 1.23 q/ha more seed yield than 25 days old seedlings. Similarly wider row spacing of 25×25 cm recorded higher growth parameters, yield attributes, seed yield, seed quality and soil health due to profuse root growth. Among the hybrid rice, root length (cm), shoot length (cm) & seedling dry weight (g) were higher in DRRH-3 (20.22, 11.98 & 0.772, respectively) and vigour index-II (66.9) was highest in DRRH-2.

Key words: Age of seedling Growth and yield, Hybrid, Seed quality, Spacing and SRI.

Rice (*Oryza sativa* L.) is the staple food of a millions of people in the world particularly in developing countries. Therefore it plays a vital role in the national food and livelihood security system. India ranks first in rice acreage (43.85 Mha), second in production (104.79 MT) with a productivity of 2.37 t/ha (Anon., 2014). Uttar Pradesh is the largest rice growing state after West Bengal in India, but the productivity lies below the national average. In Uttar Pradesh, rice is grown over an area of about 5.86 Mha with the production and productivity of 12.22 MT and 2.08 t/ha respectively (Anon., 2014). At current rate of population growth (1.5%), the rice requirement by 2025 would be about 125 Mt in the country. Challenges in maintaining the sustainability of rice farming have been increasing with the increased scarcity and competition for declining yield levels, water resources, fertilizer cost and negative environmental impact due to the increasing use of agro-chemicals for rice production. Despite these constraints, rice production must rise over the next generation to meet the world's food needs. Hence, producing more rice with limited resources is a formidable challenge for ensuring the food, and water security of the Asian region.

SRI is a combination of several agronomic practice that includes changes in nursery

*Corresponding Author :
[1&2] *Scientist, Division of Agronomy, ICAR-IARI, New Delhi-110012. E-mail: rajiv1571975@rediffmail.com*
[3] *Subject Matter Specialist, KVK, Auraiya, UP*
[4] *Kisan P.G. College, Simbhawali, Hapur*

management, age of seedling, nutrient management, alternate drying and wetting and mechanical weed management (Hussain *et al.,* 2012). In this method seedlings should be transplanted before the fourth phyllochron begins, to preserve the tillering potential. SRI also reduces the need for irrigation water by about 25-30% and diminishes the requirements for external inputs and seed (Choudhary *et al.*, 2010 and Thiyagarajan *et al.*, 2002), protect soil productivity and environment by checking methane gas emission from submerged water cultivation practices (Krishna *et al.*, 2008). Similarly plant spacing plays a significant role for optimization of rice yield due to efficient utilization of solar radiation as well as nutrients. Age of seedling is an important factor for uniform rice stands which regulates potential agronomic traits to sustained rice production (Ginigaddara and Rana-mukhaarachchi, 2011). Keeping these facts in view, the experiment was conducted to study the effect of SRI on seed yield and quality of hybrid rice and their impact on soil health.

Materials and Methods

The experiment was conducted during rainy season of 2014 at the Research Farm, ICAR-IISS, Mau, U.P. located at 25° 89' N latitude and 83° 46' E longitudes at an altitude of 209 m above mean sea level in NEPZ. The soil of the experimental field was clay loam in texture. The soil had pH value of 8.2, low in organic carbon (0.32%) and available N (215.5 kg/ha), medium in available P (12.80 kg/ha) and available K (178.0 kg/ha). The electrical conductivity of the soil was 0.45 dS/m. The experiment was laid out in split plot design (SPD), comprising hybrid rice (DRRH-2 and DRRH-3) genotypes in main plot and age of seedlings (12 and 25 days of sowing) in sub plot treatments with three replications. A well-drained fertile soil having good irrigation facility near to nursery plot was selected for raising nursery. The hybrid rice nursery was grown separately on puddled raised beds of 5×1.0 m with 50 cm wide irrigation cum drainage channel prepared all around the beds. On these nursery beds 1:1, soil: decomposed FYM mixture was spread to 3-4 cm thickness besides adding recommended dose of nutrients *viz.*, 1.0: 0.5: 0.5: kg/100m^2 NPK in the form of urea, DAP and MOP, respectively. Using a seed rate of 6 kg/ha and seeds were soaked in water for 24 hour and incubated in moist gunny bags for 1-2 days. Pre-germinated seeds were broadcasted uniformly on nursery beds. For better aeration as well as avoiding the flooding of nursery beds a rose can was used for sprinkling water on beds. The both the hybrids were sown on 30th of July, (R&A line) and transplanting was done in staggered fashion depending on the requisite age of seedlings. Seedlings were pulled from the nursery bed along with soil, intact seed sac and roots and carried to transplanting site. The seedlings were separated carefully to avoid any damage to roots. These separated seedlings were immediately transplanted in the main field with gentle placement to avoid transplanting trauma. Marked ropes were used to achieve square planting in spacing. Irrigation up to 2 cm depth was given while hairline-cracks was noticed. After flowering to milking stage, a thin film of water was maintained at 3-4 cm depth. Weeding between rows was done by cono-weeder at every two weeks after transplanting and no herbicides were used for this propose.

The recommended dose of N, P and K (120:60:50 kg/ha) was applied through urea (46% N), DAP (46% P_2O_5 and 18% N) and Muriate of potash (60% K_2O), respectively. Half dose of nitrogen and full dose of P and K were applied as basal and remaining half N was applied as top dressing in two equal splits, at active tillering and panicle initiation stages. Irrigation scheduling in rice was done with saturation to submergence (5+2.5 cm) up to the physiological maturity. The field observations on growth, yield attributes and seed yield were taken. Processed seed yield was computed based on the data on seed yield and expressed in quintal/ha. Observations on seed quality parameters were observed as per standard procedure (ISTA, 1993). One hundred seeds was put for germination in three replication, using top of the paper method. Vigour index of the seeds was assessed based on germination percentage; seedling length and seedling dry weight as suggested by Abdul-Baki and Anderson (1973). For determination of the seedling dry weight, ten normal seedlings from

each replication of the germinated seeds were selected at randomly and kept for oven drying, overnight at 80°C temperature (ISTA, 1993). All the data were statistically analyzed using the analysis of the variance (ANOVA) technique (Cochran and Cox 1957). The critical differences at 0.05% level of probability were calculated to assess the significance between treatments.

Germination percentage (%)

$$= \frac{\text{Number of normally germinated seeds}}{\text{Total number of seeds}} \times 100$$

Seedling length

Root and shoot length of five fresh seedlings was measured in centimeters up to one decimal. Total seedling length was calculated by adding root and shoot length.

Seedling dry weight

The seedlings were dried in an oven at 103°C+1°C for 12 hours. Measurement of dried samples was record on an electronic balance upto three decimals in mg.

Vigour Index (I) = Germination percentage × Seedling length (cm)

Vigour Index (II) = Germination percentage × Dry weight (mg)

Results and Discussions

Effect on growth parameters

Among the hybrid rice genotypes no significant differences were observed at 30 DAT for plant height, but result was significant at 60, 90 DAT and at harvest with maximum height recorded by DRRH-3 (103.7 cm). Similarly, for number of tillers / hill, there was no significant difference observed after 30 DAT, but higher number of tillers / hill was observed at harvest for DRRH-3 (20.6). LAI at 60 DAT was more in DRRH-3 (4.06) (Choudhary *et al.*, 2010). DRRH-3 took higher number of days for 50% flowering (93.5) compared to DRRH-2 (87.50) and similar results were observed with respect to days to maturity 122.1 & 119.9 days for DRRH-3 & DRRH-2, respectively. Effect of age of seedling on plant height and number of tillers / hill were found non-significant at 30 DAT but differences were significant at 60, 90 DAT and at harvest stage. The maximum plant height (104.4 cm) and number of tillers / hill (21.2) were observed in SRI. LAI at 60 DAT and days to 50% flowering with

Table 1. Growth parameters of rice as influenced by hybrid, age of seedlings and spacing.

Treatment	Plant height (cm)				No. of tillers / hill				LAI at 60 DAT	Days to 50% flowering	Days to maturity
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest			
Hybrid Rice											
DRRH-2	38.8	81.6	95.2	99.4	14.8	16.5	18.2	18.8	3.03	87.5	119.9
DRRH-3	43.2	91.3	97.4	103.7	15.6	17.8	20.7	20.6	4.06	93.5	122.1
Sem+	2.02	0.59	0.22	0.29	0.35	0.04	0.15	0.51	0.09	0.67	0.682
LSD (P=0.05)	NS	3.61	1.33	1.78	NS	0.24	0.92	NS	0.57	4.07	NS
Age of Seedlings (days)											
12	41.9	88.2	98.1	104.4	15.5	18.3	20.7	21.2	3.87	91.9	120.2
25	40.1	84.7	94.6	98.7	14.9	16.0	18.3	18.2	3.23	89.1	121.9
Sem+	2.43	0.69	0.42	0.45	0.22	0.18	0.40	0.29	0.10	0.48	0.853
LSD (P=0.05)	NS	2.70	1.63	1.76	NS	0.72	1.57	1.13	0.38	1.88	NS
Spacing											
25×25 cm	41.2	87.9	97.3	103.2	16.1	18.8	20.2	20.6	3.97	89.0	119.4
20×15 cm	40.9	85.0	95.3	99.9	14.3	15.5	18.7	18.9	3.12	92.0	122.6
Sem+	3.00	0.58	0.59	0.62	0.52	0.47	0.46	0.48	0.10	0.85	1.880
LSD (P=0.05)	NS	1.89	1.94	2.01	1.68	1.54	1.49	1.58	0.31	2.78	NS

*NS, Non-Significant

respect to age of seedling were recorded maximum in SRI method *i.e.* 3.87 and 91.9, respectively. No significant difference was observed in days to maturity with respect to age of seedlings during transplanting (Table 1).

Effect on yield and yield attributing characters of hybrid rice

Panicle length (cm), panicle weight (g) and harvest index (%) were recorded higher in DRRH-3. Number of seed / panicle, test weight (g), seed yield (q / ha), straw yield (q / ha) and biological yield (q / ha) were recorded higher for DRRH-3 *i.e.*, 10.66, 19.27, 8.03, 40.59 & 48.61, respectively (Table 2) over DRRH-2. Among the age of seedling, 12 days old seedling recorded maximum number of seed / panicle, test weight (g), seed yield (q / ha), straw yield (q / ha) and biological yield (q / ha) *i.e.*, 9.93, 19.0, 7.16, 39.8 & 47.1, respectively over 25 days old seedling.

Table 2. Yield and yield attribute of rice as influenced by hybrid, age of seedlings and spacing.

Treatment	Panicle length (cm)	Seeds / panicle	Panicle weight (g)	Test weight (g)	Seed yield (q / ha)	Straw yield (q / ha)	Biological yield (q / ha)	Harvest index (%)
Hybrid Rice								
DRRH-2	22.0	7.58	2.29	16.0	5.07	31.3	36.5	14.1
DRRH-3	23.0	10.66	3.14	19.2	8.03	40.5	48.6	16.6
Sem+	0.64	0.13	0.36	0.38	0.36	1.19	1.43	0.93
LSD (P=0.05)	NS	0.80	NS	2.31	2.18	7.22	8.69	NS
Age of Seedlings (days)								
12	22.7	9.93	3.05	19.0	7.16	39.8	47.1	14.9
25	22.3	8.32	2.38	16.3	5.93	32.1	38.0	15.8
Sem+	0.43	0.22	0.35	0.46	0.10	1.01	1.05	0.54
LSD (P=0.05)	NS	0.85	NS	1.82	0.41	3.98	4.11	NS
Spacing								
25×25 cm	22.5	8.83	3.03	17.7	7.28	38.1	45.5	15.9
20×15 cm	22.5	9.41	2.41	17.5	5.81	33.8	39.6	14.9
Sem+	0.27	0.38	0.22	0.60	0.43	1.03	0.84	1.21
LSD (P=0.05)	NS	NS	NS	NS	1.40	3.37	2.73	NS

Table 3. Seed quality parameters of rice as influenced by hybrid, age of seedlings and spacing.

Treatment	Germination %	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling dry weight (g)	Vigour index I	Vigour index II
Hybrid Rice							
DRRH-2	95.92	18.64	9.98	29.28	0.772	2213.6	66.9
DRRH-3	95.33	20.22	11.98	30.17	0.739	2079.1	53.4
Sem+	0.54	0.13	0.13	0.33	0.002	48.57	1.47
LSD (P=0.05)	NS	0.80	0.77	NS	0.013	NS	8.94
Age of Seedlings (days)							
12	96.67	20.43	11.13	29.94	0.770	2185.2	61.2
25	94.58	18.43	10.83	29.50	0.741	2107.5	59.1
Sem+	0.97	0.34	0.26	0.37	0.011	61.93	1.88
LSD (P=0.05)	NS	1.32	NS	NS	NS	NS	NS
Spacing							
25×25 cm	96.50	19.75	10.73	29.92	0.779	2164.1	61.5
20×15 cm	94.75	19.11	11.23	29.53	0.732	2128.6	58.8
Sem+	0.69	0.36	0.22	0.44	0.020	62.07	1.24
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Younger seedlings recovered fast enough to transplanting shock for faster growth to achieve higher yield (Sarath and Thilak 2004). The effect of spacing on panicle length (cm), number of seed / panicle, test weight (g), panicle weight (g) and harvest index (%) showed non-significant difference but the cultivation of hybrid rice at 25×25 cm spacing recorded maximum seed yield (q / ha), straw yield (q / ha) and biological yield (q / ha).

Effect of seed quality parameter

Both the hybrids showed no difference in germination (%), seedling length (cm) and vigour index-I but root length (cm), shoot length (cm) and seedling dry weight (g) were higher in DRRH-3 (20.22, 11.9, & 0.772, respectively) and vigour index-II (66.9) was higher in DRRH-2 (Table 3). Germination (%), shoot length (cm), seedling length (cm), seedling dry weight (g) and both vigour index were not affected by age of seedling resulted but 12 days old seedling highest root length (20.4 cm) recorded was recorded while 12 days old seedling used for transplanting. These results are in conformity with the findings of Manonmani and Jacqulin (1995) and Udaykumar (2005).

Thus, on the basis of results it is concluded that use of 12 days old seedlings of hybrid DRRH-3 at spacing of 25x25 cm is most suitable to increase seed yield and profitability of hybrid rice.

REFERENCES

Abdul-Baki A.A. and Anderson J.D. 1973. Vigor determination in soybean by multiple criteria. *Crop Science* **13**: 630-633.

Anonymous. 2014. Agricultural Statistics at a Glance. Technical Bulletin, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, GOI, New Delhi.

Choudhary R.L., Kumar D., Shivay Y.S., Lata. S. and Singh N. 2010. Performance of rice *(Oryza sativa)* hybrids grown by the system of rice intensification with plant growth-promoting rhizobacteria. *Indian Journal of Agricultural Sciences* **80**(10): 917-20.

Cochran W.G. and Cox G.M. 1957. Experimental Designs. *Asia Publishing House, New Delhi.*

Ginigaddara S.G.A. and Ramanukhaarachchi, S.L. 2011. Study of age of seedlings at transplanting as growth dynamics & yield of rice under alternating flooding and suspension of irrigation of water management. *Recent Research Science & Technology* **3**(3): 76-88.

Hussain A., Bhat M.A. and Ganie M.A. 2012. Effect of number and age of seedling on growth, yield, nutrient uptake and economics of rice *(Oryza sativa)* under SRI in temperate conditions. *Indian Journal of Agronomy* **57**(2): 133-37.

ISTA 1993. International rules for seed testing. *Seed Science and Technology* **21**: 288-96.

Krishna. A., Biradarpatil N.K. and Channappagoudar B.B. 2008. Influence of system of rice intensification (SRI) cultivation on seed yield and quality. *Karnataka Journal of Agricultural Science* **21**(3): 369-72.

Krishna A. and Biradarpatil N.K. 2009. Influence of seedling age and spacing on seed yield and quality of short duration rice under system of rice intensification cultivation. *Karnataka Journal of Agricultural Science* **22**(1): 53-5

Manonmani V. and Jacquilin A.S. 1995. Storage potential of rice seeds. *Oryza,* **32**: 133-135.

Sarath P.N. and Thilak B. 2004. Comparison of productivity of system of rice intensification and conventional rice farming system in the dry-zone region of Sri Lanka. 4th *International Crop Science Congress.*

Thiyagarajan T.M., Senthilkumar K., Bindraban P.S., Hengsdijk H. and Ramaswamy S. 2002. Crop management options for increasing water productivity in rice. *Journal of Agricultural Resource Management*, pp. 169-81.

Kumar Udaya. 2005. Studies on System of Rice Intensification (SRI) for seed yield and seed quality. M. Sc. (Agri) Thesis, *Acharya N.G. Ranga Agricultural University, Hyderabad.*