

Influence of Age of Seedlings and Spacing on Seed Yield and Quality under SRI Cultivation in ES-18 Rice Variety

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ABSTRACT The Influence of age of seedlings and spacing on seed yield and quality under SRI (system of rice intensification) method of cultivation with ES-18 variety during *rabi* 2004-05 at two locations *viz.*, Agricultural Research Station (Paddy), Sirsi and Gangavati, Karnataka. The 12 days old seedlings produced more number of tillers per plant, leaf area per plant and dry matter per plant at harvest. Wider spacing of 40 x 40 cm found to have significant influence on growth parameters. The 8 days-old seedlings flowered and matured about four to five days early compared to 25 days-old seedlings. Significantly higher seed yield per ha ((3.27 t) and less spikelet sterility (16.72 %) was recorded by 12 days seedlings. The treatment combination of 12 days old seedling with wider spacing recorded maximum seed yield per ha. The 12 days old seedlings and seeds produced under wider spacing recorded significantly high seed quality parameters.

Key words: Age of seedlings, spacing, seed yield and seed quality

In India, rice is the most important staple food for over two thirds of the population. It is a means of livelihood for millions of rural households and it plays a vital role in our national food security, hence the slogan "Rice is Life" is most appropriate. In India, rice occupies an area of 42.3 million ha with an annual production of 87.0 million tonnes and a productivity of little more than 3 tonnes ha⁻¹. Rice is being grown extensively in the state of Karnataka under 1.45 million ha with a production and productivity of 3.64 million tonnes and 2.51 tonnes ha⁻¹, respectively [1].

Early transplanting of rice seedlings assumes special significance and principle means in obtaining higher yields in SRI cultivation. Rice seedlings lose much of their growth potential 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 [2]. Seedling age is known to influence

the seed yield [3]. Hence, it is essential to find out the influence of age of seedling on transplanting trauma, tillering behaviour and seed yield and quality.

Among the various cultural practices, the spacing is a crucial factor, which influences the growth and yield of paddy. One of the sound principles of SRI is, wider spacing of plants leading to greater root growth and better tillering potential. The plant geometry and spatial configuration exploit the initial vigour of the genotypes, enhances soil aeration and provides congenial condition for better establishment. Hence, there is a need to standardize the plant population per unit area, so that higher seed yield of better quality could be obtained. A study was undertaken to know the influence of age of seedlings and spacing on seed yield and quality under SRI (system of rice intensification) method of cultivation in ES-18 rice variety.

MATERIALS AND METHODS

The study was carried out at two locations *viz.*,

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Agricultural Research Station (Paddy), Sirsi and Agricultural Research Station, Gangavati during *rabi* season of 2004-05. The seeds of ES-18 collected from Agricultural Research Station, Gangavati were used in both the locations. The experiment was laid out in factorial randomized block design with three replications. Seeds were soaked for 24h 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. Seeds were sown at different dates to get different aged seedlings. The beds were irrigated with a rose can daily in the morning and evening. Sowings were done to get respective aged seedlings to plant at same day. Before lifting the seedlings, nursery beds were thoroughly irrigated. Seedlings were not pulled from the nursery, rather they were lifted from nursery bed along with soil, intact seed sac and roots and carried to transplanting site, and seedlings were separated carefully to avoid any damage to roots. These separated seedlings were immediately transplanted in the main field with gentle placement but not with harsh pushing, which may revert root direction to cause transplanting trauma. The seedlings *viz.*, 8, 12, 16 and 25 days old were also transplanted with different spacing in square pattern according to the treatment *i.e.* 20 x 20, 30 x 30 and 40 x 40 cm. Marked ropes were used to achieve square planting in different spacings. Eighty per cent field capacity was maintained throughout the vegetative phase. This was achieved by irrigating the field at fine cracks stage. From flowering to 10-12 days before harvesting, a thin film of water was maintained continuously by frequent irrigation. The rotary weeder was employed on 15 days after transplanting (DAT). Irrigation was given on the previous day to facilitate smooth functioning of weeder. During the entire crop growth period weeding with rotary weeder was done four times at the interval of eight days in both the directions. Only one manual weeding was taken up at peak tillering stage to remove weeds around the clumps. Five plants were selected at random and labelled in each net plot for recording observations on growth parameters *viz.*, plant height, tiller number, number of leaves,

leaf area per plant dry matter per plant at 50 DAT and at harvest. Ten panicles were selected at random from the area outside the net plot for recording yield components like total number of spikelets and filled spikelets per panicle, seed yield per ha. Pure seed fractions of freshly harvested seeds of all the treatments were used to record the seed quality parameters.

RESULTS AND DISCUSSION

The plant geometry and spatial configuration is a crucial factor, which influence the growth, yield and initial vigour of the genotypes. Transplanting of younger seedlings in rice assumes special significance for obtaining higher yields in SRI cultivation. Rice seedling loses much of their growth potential if they are transplanted more than 15 days after they emerge in the nursery. The seedlings transplanted before the fourth phyllochron begins helps to preserve the tillering potential [2]. Twelve days old seedlings recorded maximum tillers per plant (23.66 at harvest), compared to other age of seedlings (Table 1). The present findings are in conformity with results of Manhan and Siddique [4]. A spacing of 40 x 40 cm had given more number of tillers per plant at all the stages of growth (23.20 at harvest). Number of tillers per plant reduced significantly with decrease in spacing. Similar findings have been reported by Narayana Reddy [5]. Number of tillers per plant (30.89) was significantly higher with 12 days old seedlings planted with wider spacing of 40 x 40 cm. The favourable growth conditions provided by younger seedlings and wider spacing might have resulted in better plant growth with these treatments.

Planting of younger seedlings (8 days) resulted in early flowering (90.3 days) compared to 25 days old seedlings. Aged seedlings required more days to panicle initiation due to the slow establishment of these seedlings in the main field unlike the younger seedlings. Similar results of delayed flowering with increase in age of seedlings were reported by Rao and Raju [6], Kulkarni and Eswari [7], Biradarpatil [8] and Zhu Defung *et al.* [9]. Days to 50 per cent flowering and maturity did not vary due to spacing. However, close spacing of 20 x 20 cm took lesser

Table 1. Influence of the age of tillers, productive tillers the seedlings and spacing on number of and days to 50% flowering

Treatments	No. of tillers/plant			No. of productive tillers/plant			Days to 50 per cent flowering		
	L ₁	L ₂	Pooled	L ₂	L ₂	Pooled	L ₂	L ₂	Pooled
Age of seedlings (A)									
A ₁	22.64	21.32	21.98	19.38	17.65	18.52	90.1	90.5	90.3
A ₂	23.80	23.52	23.66	21.69	19.85	20.77	91.2	92.2	91.7
A ₃	20.87	19.32	20.10	18.68	16.93	17.81	92.2	93.6	92.9
A ₄	19.56	18.26	18.91	17.05	15.00	16.03	93.3	94.5	93.9
SEm±	0.06	0.04	0.05	0.60	0.90	0.75	0.1	0.1	0.1
CD (P=0.05)	0.18	0.12	0.13	1.80	2.97	2.39	0.3	0.4	0.3
Spacings (S)									
S ₁	15.08	14.07	14.58	12.89	11.02	11.96	91.5	92.3	91.9
S ₂	21.93	21.88	21.91	21.31	18.54	19.93	91.6	92.8	92.2
S ₃	27.42	25.88	26.65	23.40	22.93	23.17	92.0	93.1	92.6
SEm±	0.54	0.04	0.29	0.90	1.54	1.22	0.1	0.12	0.2
CD (P=0.05)	0.15	0.12	0.14	2.70	4.50	3.60	NS	NS	NS
Interactions (A X S)									
A ₁ S ₁	16.33	14.62	15.48	13.60	10.57	12.09	90.0	90.0	90.0
A ₁ S ₂	23.33	22.72	23.03	21.83	18.62	20.23	90.2	90.3	90.3
A ₁ S ₃	28.26	26.61	27.44	22.72	23.75	23.24	90.3	91.3	90.8
A ₂ S ₁	17.12	15.50	16.31	14.65	13.12	13.89	91.0	91.9	91.5
A ₂ S ₂	23.2	24.50	23.85	23.73	20.67	22.20	91.2	92.3	91.8
A ₂ S ₃	31.20	30.58	30.89	26.72	25.63	26.18	91.4	92.4	91.9
A ₃ S ₁	15.38	13.60	14.49	12.70	10.65	11.68	92.1	93.01	92.6
A ₃ S ₂	21.21	20.71	20.96	20.85	18.50	19.68	92.2	93.8	93.0
A ₃ S ₃	26.12	23.67	24.90	22.50	21.62	22.06	92.4	93.9	93.2
A ₄ S ₁	14.37	12.55	13.46	10.62	15.00	12.81	93.1	94.1	93.6
A ₄ S ₂	20.10	19.60	19.85	18.87	16.37	17.62	93.0	94.7	93.9
A ₄ S ₃	24.12	12.65	18.39	21.67	20.70	21.19	94.0	94.8	94.4
Mean	21.72	20.61	21.17	19.20	20.85	20.03	91.7	92.7	92.2
SEm±	0.10	0.07	0.09	0.10	1.10	0.60	0.2	0.2	0.2
CD (P=0.05)	0.30	0.21	0.26	0.30	3.30	1.80	0.5	0.7	0.6

Locations: L₁ Sirsi, L₂ = Gangavati; Age of seedlings: A₁ = 8 days, A₂ = 12 days, A₃ = 16 days, A₄ = 25 days; Spacings: S₁ = 20 x 20 cm, S₂ = 30 x 30 cm, S₃ = 40 x 40 cm; NS = Non-significant

days to flowering (91.9 days) as compared to wider spacing. This difference in flowering and maturity may be due to quick vegetative growth of the plants under closer spacing and then resulting in early switch over to reproductive phase. The interaction between the age of seedlings and spacings for days to 50 per cent flowering was found to be significant. The

treatment combination of 12 days old seedlings with 20 x 20 cm spacing took significantly lesser days for flowering. These findings are in conformity with the findings of Krupakar Reddy [10] and Udayakumar [11].

The 12 days old seedlings recorded significantly higher number of productive tillers

(20.77) as compared to 25 days old seedlings (16.03). These results are in conformity with the results of Mandal *et al.* [12] and Fernandes and Uphoff [13]. The number of tillers per plant was significantly higher under wider spacing of 40 x 40 cm as compared to closer spacing of 20 x 20 cm. These results are in conformity with the findings of Nandisha and Mahadevappa [14] and Singh *et al.* [15]. The earlier studies have also indicated that wider spacing results in higher productive tillers than closer spacings [10, 16, 17].

Significantly higher filled spikelets per panicle and less spikelet sterility noticed with 12 days old seedlings (Table 2). The higher seed yield recorded with 12 days old seedlings may be due to higher filling percentage and lower spikelet sterility. These results are in conformity with findings of Sridevi [18]. The wider spacing of 40 x 40 cm recorded significantly higher number of filled spikelets per panicle as compared to that under 30 x 30 cm and 20 x 20 cm spacing. These results corroborate with results of Raju *et al.* [19] and Singh *et al.* [3]. The seed yield ha⁻¹ was significantly higher with 12 days old seedlings. The per cent increase in the seed yield per ha by 12 days old seedlings was 21.56 per cent over 25 days old seedlings. The reduction in seed yield with 25 days old seedlings was attributed to the lower productive tillers per plant, lower number of spikelets per panicle and higher spikelet sterility observed with these seedlings. The reduction in yield with older seedlings was reported by Rao and Raju [6], Thakur [20] and Biradarpatil [8] in rice. It is evident from the present investigation that the optimum age of seedlings for getting higher seed yield per ha under SRI method was 12 days old seedlings. Significantly higher seed yield ha⁻¹ was noticed with a spacing of 30 x 30 cm (3.27 t) as compared to 40 x 40 and 20 x 20 cm spacing respectively. The optimum level of plant population coupled with better yield parameters might have resulted in higher seed yield ha⁻¹ with 30 x 30 cm spacing. These findings are in conformity with findings of Ceesay and Uphoff [21]. The interaction effects of 12 days with 30 x 30 cm recorded significantly higher productive tillers per plant (26.18) and number of filled spikelets (127.2) as compared to all other interactions.

No significant differences were observed for seed germination due to age of the seedlings and spacings. However, seed produced with 12 days old seedlings under wider spacing of 40 x 40 cm recorded higher germination (98.2%) as compared to 25 days old seedlings (97.3%) with close spacing of 20 x 20 cm (Table 3). The root length and vigour index (2239) were significantly higher with 12 days old seedling with wider spacing. The better seed quality with seed produced from wider spacing may be due to higher test weight values. These results are in conformity with Nandisha and Mahadevappa [14] and Manonmani and Jacquelin [22].

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Table 2. Influence of the age of the seedlings and spacing on number of filled spikelets per panicle spikelet sterility and seed yield

Treatments	No. of filled spikelets per panicle			Spikelet sterility (%)			Seed yield ha ⁻¹ (t)		
	L ₁	L ₂	Pooled	L ₂	L ₂	Pooled	L ₂	L ₂	Pooled
Age of seedlings (A)									
A ₁	83.0	82.8	82.9	17.14	18.48	17.81	3.06	3.14	3.10
A ₂	90.0	103.8	96.9	17.22	16.21	16.72	3.29	3.25	3.27
A ₃	78.3	73.8	76.0	19.14	20.18	19.66	2.87	2.93	2.90
A ₄	65.6	72.8	69.2	20.70	20.91	20.81	2.66	2.71	2.69
SEm±	0.2	0.4	0.3	0.70	1.58	1.14	0.10	0.08	0.09
CD (P=0.05)	0.6	1.1	0.8	NS	NS	NS	0.30	0.24	0.27
Spacings (S)									
S ₁	65.7	63.0	64.3	18.65	20.24	19.45	2.45	2.50	2.48
S ₂	80.5	85.8	83.1	16.58	19.05	17.82	3.20	3.33	3.27
S ₃	91.5	101.1	96.3	20.42	17.56	18.99	3.27	3.19	3.23
SEm±	0.2	0.3	0.2	0.70	1.37	1.04	0.09	0.07	0.08
CD (P=0.05)	0.6	0.9	0.7	NS	NS	NS	0.27	0.21	0.24
Interactions (A X S)									
A ₁ S ₁	70.0	54.4	62.2	17.27	22.16	19.72	2.28	2.43	2.36
A ₁ S ₂	96.1	102.2	99.1	15.11	15.16	15.14	3.56	3.55	3.56
A ₁ S ₃	83.0	91.8	87.4	19.05	18.13	18.59	3.35	3.43	3.39
A ₂ S ₁	71.1	91.7	81.4	20.11	18.12	19.12	2.77	2.57	2.67
A ₂ S ₂	106.1	116.1	111.1	12.11	16.10	14.11	3.67	3.65	3.66
A ₂ S ₃	93.1	103.7	98.4	19.44	14.40	16.92	3.45	3.55	3.50
A ₃ S ₁	66.0	54.1	60.0	18.11	18.56	18.30	2.69	2.30	2.50
A ₃ S ₂	90.0	96.6	93.3	19.10	22.86	21.00	2.77	3.30	3.04
A ₃ S ₃	79.0	70.8	74.9	20.20	18.14	19.20	3.15	3.20	3.18
A ₄ S ₁	56.0	91.9	73.9	19.10	22.11	20.61	3.05	2.70	2.88
A ₄ S ₂	74.0	89.7	81.8	20.00	22.06	21.00	2.79	2.83	2.81
A ₄ S ₃	67.0	76.9	71.9	23.00	18.56	20.81	3.16	2.60	2.88
Mean	79.2	83.3	81.3	18.55	18.95	18.75	2.97	3.01	2.99
SEm±	0.3	0.6	0.4	0.18	2.74	0.85	0.18	0.14	0.16
CD (P=0.05)	0.6	1.9	1.1	NS	NS	NS	NS	NS	NS

Locations: L₁ Sirsi, L₂ = Gangavati; Age of seedlings: A₁ = 8 days, A₂ = 12 days, A₃ = 16 days, A₄ = 25 days; Spacings: S₁ = 20 x 20 cm, S₂ = 30 x 30 cm, S₃ = 40 x 40 cm; NS = Non-significant

Table 3. Influence of the age of the seedlings and spacing on germination root length, dry weight of seedling and vigour index

Treatments	Germination (%)			Root length (cm)			Vigour index		
	L ₁	L ₂	Pooled	L ₂	L ₂	Pooled	L ₂	L ₂	Pooled
Age of seedlings (A)									
A ₁	98.0	98.1	98.1	12.20	11.64	11.79	2070	2083	2077
A ₂	98.2	98.3	98.2	11.63	11.95	11.92	2135	2138	2137
A ₃	97.9	97.2	97.5	11.40	11.37	11.39	2033	2061	2047
A ₄	97.6	97.0	97.3	11.27	11.22	11.25	2017	1994	2006
SEm±	1.1	1.8	1.6	0.06	0.02	0.04	16.0	27.1	22.0
CD (P=0.05)	NS	NS	NS	0.18	0.06	0.12	48.0	81.3	65.0
Spacings (S)									
S ₁	98.0	98.0	98.0	10.91	11.31	11.11	1960	2014	1987
S ₂	97.6	98.0	97.8	10.70	11.44	11.07	2059	2063	2061
S ₃	97.2	98.2	97.7	12.27	11.87	12.07	2173	2131	2152
SEm±	1.0	1.2	0.9	0.06	0.03	0.05	19.0	23.5	21.0
CD (P=0.05)	NS	NS	NS	0.18	0.09	0.14	57.0	69.0	63.0
Interactions (A X S)									
A ₁ S ₁	98.0	97.2	97.6	11.82	11.33	11.58	2064	2009	2037
A ₁ S ₂	98.3	98.0	98.1	11.91	11.47	11.69	2117	2087	2102
A ₁ S ₃	98.2	98.1	98.2	12.89	12.10	12.50	2226	2155	2191
A ₂ S ₁	98.0	97.0	97.5	10.55	11.63	11.09	1927	2055	1991
A ₂ S ₂	98.0	98.0	98.0	11.65	11.77	11.71	2037	2122	2080
A ₂ S ₃	98.3	98.3	98.3	12.69	12.42	12.56	2250	2238	2244
A ₃ S ₁	97.7	97.0	97.3	10.78	11.15	10.97	1942	2018	1980
A ₃ S ₂	97.3	97.5	97.4	11.66	11.37	11.52	2049	2061	2055
A ₃ S ₃	96.6	98.0	97.3	11.77	11.60	11.69	2110	2106	2108
A ₄ S ₁	97.0	97.0	97.0	10.50	11.15	10.83	1910	1974	1942
A ₄ S ₂	97.0	97.0	97.0	11.61	11.15	11.38	2033	1982	2008
A ₄ S ₃	97.2	97.5	97.4	11.72	11.35	11.54	2108	2027	2068
Mean	97.6	97.6	97.6	11.63	11.54	11.59	2064	2070	2067
SEm±	1.5	1.8	2.0	0.11	0.05	0.08	38	47	43.0
CD (P=0.05)	NS	NS	NS	0.33	0.15	0.24	NS	NS	NS

Locations: L₁ Sirsi, L₂ = Gangavati; Age of seedlings: A₁ = 8 days, A₂ = 12 days, A₃ = 16 days, A₄ = 25 days; Spacings: S₁ = 20 x 20 cm, S₂ = 30 x 30 cm, S₃ = 40 x 40 cm; NS = Non-significant

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