

Original Research Article

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Effect of Spacing and Age of Seedling on Yield of Rice under System of Rice Intensification

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ABSTRACT

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A field study was conducted during *kharif* season of 2014 at Agronomy research farm of school of Agricultural sciences and Rural Development (SASRD), Nagaland University, Medziphema to study the effect of spacing and seedling age on yield under System of Rice Intensification. The Experiment was laid out in Split plot design with 3 replications having 3 main plot factors ($20 \times 20 \text{ cm}^2$, $30 \times 30 \text{ cm}^2$, $40 \times 40 \text{ cm}^2$) and 4 sub plot factors (9, 11, 13, and 15 days old seedling). The study depicted that plant height, LAI and number of tillers per hill showed an increase in its trend at 30, 60, 90 and 120 DAT. Dry matter accumulation was higher for $20 \times 20 \text{ cm}^2$ spacing treatment on unit area basis but under per plant basis $40 \times 40 \text{ cm}^2$ spacing treatment was better. 9 days old seedling planted at $40 \times 40 \text{ cm}^2$ spacing gave the highest yield (4.35 t ha^{-1}) and harvest index (35.11%) followed by 11 days old seedling (4.25 t ha^{-1}) planted at $30 \times 30 \text{ cm}^2$ spacing. The straw yield was however found to be inversely related with the grain yield.

Introduction

Rice (*Oryza sativa* L.) is one of the oldest domesticated crops known to mankind. It is the world's most important food crop and a primary food source for over one third of the world's population. World area under rice cultivation is about 162 M ha with a production of 755.5 Mt (FAOSTAT, 2019). India is the second largest producer and consumer of rice in the world. In India, rice occupies an area of 43.86 M ha with an annual production of 117.94 Mt (DAC & FW, 2019-20).

Rice is the staple food grain crop of the North Eastern hilly ecosystem (Roy *et al.*, 2015). The total area under rice cultivation in NE region is 3.38 M ha with a total production of 7051.3 t tonnes and average yield of $1977.86 \text{ kg ha}^{-1}$ (Anonymous, 2018-19). Assam has the highest area under rice cultivation covering an area of 2.43 M ha with a total production of 5.2 M tonnes followed by Tripura with an area of 0.3 M ha and a total production of 0.8 M tonnes. However, the average productivity of Tripura 2944 kg ha^{-1} is much higher than that of Assam 2153 kg ha^{-1} (Anonymous, 2018-19). Rice is the most important staple food of Nagaland. Dimapur district is the highest rice growing district. Around 214.5 t

ha area is under rice cultivation with an average productivity of 1663 kg ha⁻¹.

The low productivity in NER is because of considerably low yielding ability of upland rice. Therefore, modern agricultural technique such as SRI should be adopted for low land rice. System of rice intensification (SRI) is a set of modified practices for growing rice, developed in Madagascar in the early 1980's by Henri Laulanie where, it has been shown that yields can be enhanced by suitably modifying certain management practices such as controlled supply of water, planting of young and single seedling/hill and providing wider spacing (Laulanie, 1993). SRI method of cultivation is said to promote more tillers, healthy root growth, higher soil biological activity in the rhizosphere and more yield. By adopting this system of cultivation, we could save water (Shamshiri *et al.*, 2018) protect soil productivity, save environment by checking methane gas from water submerged paddy cultivation practices (Krishna *et al.*, 2008). 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. In SRI technique, phyllochron is formed up to 12 times. Phyllochron is a phytomer circuit which is formed for 3-5 days after planting depending on temperature (Dwipa *et al.*, 2018; Uphoff *et al.*, 2002). Seedlings should be transplanted before the fourth phyllochron begins to preserve the tillering potential, As phyllochron theory states that the chance of forming higher no. of tillers will be more if seedlings are transplanted in the early phase (Dwipa *et al.*, 2018). This stage usually occurs in about two weeks after sowing (Rafaralahy, 2002). Seedling age is known to influence the seed yield (Singh *et al.*, 2013; Singh *et al.*, 2004). 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 provide congenial condition for better establishment. Closer spacing hinders intercultural operations which further results in competition for water, nutrients, air and light among the plants. Consequently plants become skinny and fragile producing lesser yield (Salahuddin *et al.*, 2009). Hence, there is a need to standardize the plant population per unit area.

Materials and Methods

The experiment was conducted in the Agronomy experimental research farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema campus during *kharif* season of 2014. Rice (*Oryza sativa*) cultivar kumnupu (local) was grown with 3 replications and 12 treatments in Split Plot Design (SPD). Plot size is 3.6 x 3.6 m², with spacing of 20 x 20 cm², 30 x 30 cm² and 40 x 40 cm² and age of seedlings used for research is 8 days, 13 days and 15 days old seedlings. Well decomposed FYM (10 t/ha) was broadcasted over the field during land preparation. The recommended dose of nutrient in rice is 80 kg of N, 40 kg of P₂O₅ and 40 kg of K₂O/ha. Half dose of N and full dose of P and K in the form of Urea, SSP and MOP was given as basal dose. Remaining quantity of N was applied at tillering and panicle initiation (PI) stages. 15 cm raised Nursery bed measuring 4 x 1 m² was prepared and DAP@50g/m² was thoroughly mixed.

Transplanting was done on 19th June, 2014. Precautions were taken to transplant the seedling in L-shaped manner at the depth of 1-2 cm. Owing to heavy infestation by termites, gap filling was done through regular observation. Weeding was done 2-3 times at 15 days interval. Soil drenching of

Chloropyriphos 20EC@ 2ml/lit of water was done to control termites. Malathion 5% dust@ 25kg/ha was applied to control Gundhi bug and grasshopper at milking stage. Five plants from each plot were selected randomly and tagged with label for recording various growth parameters. The crop was harvested on 27th November, 2014. Seeds were sun dried up to 14% moisture level. The five tagged plants were used for recording various yield parameters and thereafter compilation and statistical analyses of the collected data was done.

Results and Discussion

Effect of spacing and seedling age on growth attributes

The study revealed that there was a significant difference among the growth attributes due to spacing and seedling age (Table 1). It was found that different spacing and age of seedling had no significant influence on plant height even though it was significant for spacing during the earlier stages of crop growth. Spacing and age of seedling had a significant influence on total dry weight. Among the spacing, the highest was recorded by 20 x 20 cm². The least was recorded by 40 x 40 cm². Likewise the highest total dry weight was recorded by 11 days old seedling which was at par with 9 days old seedling. The increase in total dry weight for closer spacing (20 x 20 cm²) might be due to the high number of plants per m² as compared to wider spacing. However, it was observed that dry matter per plant was higher for wider spacing (40 x 40 cm²) as compared to closer spacing. Similar finding was reported by Kumar *et al.*, (2000).

Spacing and age of seedling had a significant influence on root dry weight, even though it was non-significant for age of seedling during early stages of crop growth. Among

the spacing, the highest was recorded by 20 x 20 cm². Likewise, the maximum root dry weight was recorded by 13 days old seedlings. Spacing and age of seedling had a significant influence on stem dry weight. Among the spacing, the highest was recorded by 20 x 20 cm². The at par relationship was observed between 30 x 30 cm² and 40 x 40 cm² during early stages. Similarly, the highest stem dry weight was recorded by 9 days old seedling. Spacing and age of seedling again had a significant effect on leaf dry weight. Among the spacing, the highest was recorded by 20 x 20 cm² and the least was recorded by 40 x 40 cm². The maximum leaf dry weight was recorded by 9 days old seedlings which were at par with 11 days old seedlings. Crop growth rate was significantly influenced by spacing and age of seedling. Among the spacing, the highest crop growth rate was recorded by 30 x 30 cm² which was at par with 40 x 40 cm². The maximum crop growth rate was recorded by 11 days old seedling. At par relationship was found among 13 and 15 days old seedlings. Spacing also had a significant influence on leaf area index. Highest LAI was observed at 40 x 40 cm². It was however not significant for age of seedling. The highest LAI was recorded under wider spacing and younger age of seedlings which may be due to the better growth of crop under favorable crop establishment. These results are in conformity with the findings of Vijay kumar *et al.*, (2006). Spacing and age of seedling had a significant influence on the number of tillers per hill. Among the spacing, the highest was recorded by 40 x 40 cm² which was at par with 30 x 30 cm². Also, the maximum number of tillers per hill was recorded by 9 days old seedlings which were at par with 11 days old seedling. The increase in number of tillers per hill might be due to profuse tillering under wider spacing as compared to closer spacing. Similar finding has been reported by Narayana Reddy (2002).

Table.1 Effect of spacing and age of seedling on growth attributes

Treatments	Plant height (cm)	Total dry weight (gm ⁻²)	Root dry weight (gm ⁻²)	Stem dry weight (gm ⁻²)	Leaf dry weight (gm ⁻²)	CGR (gm ⁻² day ⁻¹)	Leaf area index	No. of tillers per hill
S1	34.29	564.69	219.83	203.17	141.68	2.60	2.28	16.83
S2	33.96	305.74	78.77	147.63	79.33	4.46	2.62	26.75
S3	34.96	236.56	59.78	107.51	69.27	4.24	3.33	27.50
SEm±	1.41	1.04	0.44	0.62	0.40	0.04	0.11	0.90
CD at 5%	NS	4.08	1.72	2.44	1.55	0.14	0.44	3.52
A1	32.94	377.61	106.97	161.58	109.06	3.82	2.99	25.89
A2	33.39	384.24	123.52	152.78	107.94	3.98	2.86	24.33
A3	34.83	368.07	138.98	145.31	83.77	3.66	2.47	21.44
A4	36.44	346.07	108.36	151.42	86.28	3.60	2.66	23.11
SEm±	1.50	1.16	0.44	0.88	0.61	0.03	0.11	0.87
CD at 5%	NS	3.46	1.30	2.63	1.80	0.09	0.33	2.58

Table.2 Effect of spacing and age of seedling on yield attributes of rice

Treatments	Panicle length (cm)	Total no of grains per panicles	No. of filled grains per panicle	Filled grains (%)	Test weight (g)	Straw yield (tha ⁻¹)	Grain yield (tha ⁻¹)	Harvest index (%)
S1	22.35	96.83	55.75	57.83	21.98	6.85	3.09	31.16
S2	22.73	135.42	98.75	73.00	22.45	6.39	3.18	33.32
S3	24.10	173.08	124.17	71.55	22.97	8.75	4.23	32.76
SEm±	0.20	2.14	3.17	2.48	0.12	0.47	0.11	1.36
CD at 5%	0.80	8.41	12.45	9.72	0.48	NS	0.41	NS
A1	23.11	130.00	103.44	75.30	22.44	6.88	3.48	33.46
A2	22.64	136.33	89.22	65.59	22.77	7.36	3.54	32.75
A3	23.65	150.56	98.33	63.48	22.34	7.80	3.45	30.69
A4	22.84	123.56	80.56	65.48	22.32	7.28	3.52	32.76
SEm±	0.16	5.45	5.35	2.88	0.11	0.23	0.09	0.83
CD at 5%	0.47	16.20	15.90	8.56	0.33	NS	NS	NS

Effect of spacing and seedling age on yield attributes

The study revealed that there was a significant difference among the yield attributes due to spacing and seedling age (Table 2). It was observed that spacing and age of seedling had a significant influence on length of panicle. Among the spacing, the highest was recorded by 40 x 40 cm² and among the age of seedling, the maximum length of panicle was recorded by 13 days old seedling which was at par with 9 days old seedling. The increase in panicle length for wider spacing and young seedlings might be due to vigorous growth at its vegetative stage which might have made the plant to focus more on source than sink, similar result was also reported by Thakur *et al.*, (2009). Spacing and age of seedling had a significant influence on total number of grains per panicle. Among the spacing, the highest was recorded by 40 x 40 cm². The least was recorded by 20 x 20 cm². The increase in total number of grains per panicle under wider spacing and younger age of seedling might be due to higher panicle length which might have accommodated more number of grains per panicle. This finding was similar to that reported by Zhao *et al.*, (2000). These results also corroborated with the findings of Randriamiharisoa and Uphoff (2002).

Spacing and seedlings age also had a significant influence on number of filled grains per panicle. Among the spacing, the highest was recorded by 40 x 40 cm² and among the seedling age, the highest was recorded by 9 days old seedling. At par relationship was found among all the different age of seedlings. The increase in the number of filled grains per panicle might be due to lower spikelet sterility and high fertilized sterility. These results are in conformity with the findings of Sridevi (1997). Spacing and age of seedling had a significant influence on filled grain percentage. Among the spacing,

the highest was recorded by 30 x 30 cm² which was at par with 40 x 40 cm² and among the seedling age, the highest percentage was recorded by 9 days old seedlings. The increase in filled grain percentage under wider spacing and younger age of seedling might be due to higher number of filled grains per panicle. In case of test weight, the highest was recorded by 40 x 40 cm² spacing. The at par relationship was found between 20 x 20 cm² and 30 x 30 cm². Similarly, the highest test weight was recorded by 11 days old seedlings. The increase in test weight under wider spacing and younger age of seedling might also be due to higher number of filled grains per panicle coupled with high panicle length.

Spacing and age of seedling was non significant for straw yield while for seed yield, spacing had a significant influence while it was insignificant for age of seedling. Among the spacing, the highest seed yield was recorded by 40 x 40 cm² while it was at par between 20 x 20 cm² and 30 x 30 cm². The increase in seed yield under 40 x 40 cm² might be due to better root development and more sunlight interception which might have led to more nutrient uptake to the source and ultimately to greater grain yield. The results were insignificant for harvest index.

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