

Original Research Article

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Effect of Crop Establishment Methods on Yield of Rice (*Oryza sativa* L.) during Summer under Lowland Farming Situation

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ABSTRACT

Keywords

Rice, Crop establishment methods, Summer, Grain and Straw yield

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A field experiment was conducted on “Effect of crop establishment methods on yield of rice (*Oryza sativa* L.) during summer under lowland farming situation” at Instructional cum research farm, S.G. College of Agriculture and Research Station, Jagdalpur, Chhattisgarh, India during summer 2019 in Randomized Complete Block Design (RCBD) with six treatments and four replications. Transplanting of 20 days old seedlings of MTU-1010 was carried out on 25th February 2019 maintaining crop geometry of 20 x 10 cm within each plot and rice was harvested on 31st May 2019. The result showed that maximum plant height, tillers number per hill, number of leaves per plant, leaf area index, relative growth rate N, P and K nutrient uptake in grain and straw, panicle per hill, panicle length, seeds per panicle and weight of 1000 seeds were obtained with transplanting of 20 days old seedling throughout the observations which was found significant and comparable to line sowing of normal seeds. The highest grain (58.22 q ha⁻¹) and straw yield (82.73 q ha⁻¹) of rice were noticed in transplanting of 20 days old seedling which was significantly more than rest of the treatments except the line sowing of normal seeds. The lowest grain and straw yield (34.18 and 71.40 q ha⁻¹) was recorded by broadcasting of sprouted seeds.

Introduction

Rice belongs to family Poaceae which is originated from South-East Asia. In world, the territory under rice cultivation is about 158.9 million hectares with 685.0 million tonnes of total production in 2011 (Anonymous, 2016) being major staple food and a mainstay for the rural population and their food security. Rice (*Oryza sativa* L.) is an important food for more than half of the global population is known as “Global Grain” in 89 nations. The slogan “Rice is life” can be

best fitted expression to our nation as this crop plays a vital role in our national food security. Among the rice growing countries, India has the largest area and it is the second largest producer of rice next to China (205.21 million tonnes). In India, rice is grown in 43.86 million ha, the production level is 104.80 million tones and the productivity is about 2390 kg/ha. To meet the needs of the ever-growing population, India has to produce about 130 million tonnes of rice by 2025 (Hugar *et al.*, 2009).

Transplanting is the most prevailing and conventional technique for establishment in irrigated lowland rice. The region under transplanted rice in world is diminishing because of shortage of water and labour. Hence, there is necessity to look for alternate method of crop establishment to increase the productivity of rice (Farooq *et al.*, 2011). Direct seeding produces similar grain yield as that of transplanted rice although it diminishes labour requirement and shortens the crop duration by 7-10 days. Direct seeding retains 29 % of the total cost and needs just 34 % of the total labour requirement of transplanted rice (Ho and Romil, 2000).

Chhattisgarh is a major rice growing state in our country known for a variety of cultivation practices with different genotypes. The state is recognized with the name “*Rice Bowl of India*”. Northern Hills, Chhattisgarh plains and Bastar plateau are the three agro-climatic zones of the state catering practices of rice cultivation. The area under rice cultivation is about 3.71 million hectares in around 37.10 lakh hectares with a total production of 7.29 million tonnes and 1.96 t ha^{-1} of productivity (Anonymous, 2019). The average area under summer rice cultivation is about 116.47 thousand hectare with an average production of 227.04 thousand tonnes. Chhattisgarh plains has the highest average area under summer rice cultivation with 112.69 thousand hectares followed by northern hills with 3.13 thousand hectare and Bastar plateau with 0.65 thousand hectare of the total area under summer rice cultivation. The area under summer rice cultivation is increasing in all agro-climatic zones (except northern hills) and in the state. The largest share of about 90.69 to 97.96 % of the total cultivated area was held by Chhattisgarh plains and 89.58 to 98.88 % of total production of summer paddy in the state with higher productivity level (Singh *et al.*, 2018).

Materials and Methods

A field experiment was carried out during summer season 2019 at the loamy soil of Instructional cum Research Farm, S.G. College of Agriculture and Research Station, Kumhrawand, Jagdalpur, Chhattisgarh, India. The state Chhattisgarh is located between $17^{\circ}30'$ and $24^{\circ}45'$ N latitude and $70^{\circ}30'$ and $84^{\circ}15'E$ longitude whereas Bastar lies at $19^{\circ}10'$ N latitude and $81^{\circ}95'$ E longitude with an altitude of 552 meters above mean sea level. The average annual rainfall and temperature of the area is about 2313 mm and 31.6°C respectively of 2019 were recorded via meteorological observatory of S.G. CARS, IGKV, Jagdalpur. The crop encountered 137.50 mm rainfall throughout its growth period and 39.1°C of maximum temperature in second week of May to minimum temperature of 12.2°C in second week of February as well as the maximum Sunshine was 9.3 hours in fourth week of April. The experiment was allocated in RCBD with four replications on *Inceptisol*. The treatments comprised of T₁: Transplanting of 20 days old seedling, T₂: Broadcasting of normal seeds, T₃: Line sowing of sprouted seeds, T₄: Broadcasting with *Biasi* (beushening) at 25 DAS, T₅: Broadcasting of sprouted seeds and T₆: Line sowing of normal seeds. The cultivar tested for the experiment was MTU-1010 (Krishnaveni x IR-64 is MTU-1010) having 120 days maturity with grains long slender and white with semi-dwarf (108 cm) stature, suitable for irrigated mid lands. As per the treatment, experimental plots were prepared and the nursery was transplanted in rows of spacing 20 cm and plant to plant spacing was about 10 cm on 25th February 2019 after the land preparation and incorporation of a basal dose of fertilizer were done in the plots simultaneously. A fertilizer dose of 80:60:40 N: P: K Kg ha⁻¹ was applied to the rice field. Basal application of fertilizers was done @ 100 % recommended dose of phosphorus and

potassium during transplanting as well as at direct seeding of normal seeds and the sprouted seeds and remaining 50% nitrogen at 30 days after establishment. A pesticide chlorpyrifos was sprayed @ 2 ml/l to control the damage caused by the stem borer and rice leaf folder twice at 15 days and 45 days after transplanting of rice. The rice crop was harvested on 31st May of 2019 after completion of the physiological maturity of the crop. All the observations recorded of pre and post-harvest during different intervals with respect to various growth, yield and laboratory studies were subjected to statistical analysis as per the guidelines of Gomez and Gomez (1984). The variance ratio (F-value) was used to test the significance of the treatment effect. Appropriate standard errors and critical difference at 5% probability level was used to test the statistical significance of the results.

Results and Discussion

Growth parameters

The data in respect to plant height are presented in Table 1. Transplanting of 20 days old seedling (T₁) attained higher plant height (98.41 cm), number of tillers (13.33), number of leaves per plant (27.63) as compared to rest of treatments except line sowing of normal seeds and line sowing of sprouted seeds, which were comparable to that of transplanting 20 days old seedling at 30 and 60 DAS. The lowest growth characters were recorded under broadcasting of sprouted seeds regardless observation recording stages throughout crop growth due to establishment of sown seeds took more time then attained faster growth. This result confirms with the findings of Aslam *et al.*, (2008). Number of tillers production per plant depends on the proper sunlight and space provided to the plant during its growth, spaced plant received proper growth resources reflected on growth

parameters and those conditions were fulfilled by transplanting method of rice appropriately. The result obtained was similar with the works of Ali *et al.*, (2013). Line sowing of sprouted seeds and broadcasting + biasi (beushening at 25 DAS) proved equal in attaining similar number of leaves at all stages of observations, but higher than broadcasting of sprouted or normal seeds, both were lower in number of leaves per plant. Baloch *et al.*, (2007) obtained similar result.

Leaf Area Index (LAI)

Leaf Area Index (LAI) is a measurement of land covered via growing biomass on surface directly proportionate to the production of crop in terms of yield (Table 1). The highest LAI was obtained from transplanting of 20 days old seedling (3.85) being significantly superior than remaining treatments except line sowing of normal seeds (3.39) at 60 DAS. Line sowing of normal seeds triggered higher growth as transplanted rice picked up, that is the reason of comparable LAI than rest of imposed treatments. The lowest (1.02) at 60 DAS was with broadcasting of sprouted seeds, which was drastically improved in LAI as broadcasting of normal seeds and even broadcasting + Biasi (beushening at 25 DAS) were practiced in all stages of growth. The higher LAI with transplanting was due to manual arrangement of geometry as well as proper planting in certain depth. Similar outcomes were accompanied with research work of Baloch *et al.*, (2006).

Relative Growth Rate (RGR)

The relative growth rate was more pronouncedly increased as growth proceeds from 0-30 to 30-60 DAS while it was decreased further during 60-90 DAS regardless the treatments. The lowest relative growth rate ($\text{g plant}^{-1} \text{day}^{-1}$) was noticed when sprouted seeds were sown (0.009, 0.011 and

0.007 during 0-30, 30-60 and 60-90 DAS, respectively), which was improved with imposing treatments being maximum (0.024, 0.027 and 0.017 g plant⁻¹ day⁻¹) RGR under transplanting of 20 days old seedling and broadcasting + Biasi (beushening at 25 DAS) and broadcasting of sprouted seeds during 0-30 DAS, in later period of growth (0-30 and 30-60 DAS), line sowing of normal seeds (0.16 and 0.29) were found statistical similar to transplanting of 20 days old seedling. The higher plant height, leaf area index with more number of tillers directly contributed to the growth parameters of rice resulted in higher RGR.

Yield attributes

Number of panicles hill⁻¹

The significantly highest number of panicles per hill was obtained by transplanting of 20 days old seedling which was about 11.47 followed by line sowing of normal seeds (10.70) and found comparable with transplanting of 20 days old seedling. However, remaining treatments were at par with each others. The least panicles hill⁻¹ was observed in broadcasting of sprouted seeds. Owing to maximum number of productive tillers recorded in transplanting method. Ali *et al.*, (2013) found similar results in obtaining panicles hill⁻¹.

Panicle length (cm)

The maximum panicle length was observed by transplanting of 20 days old seedling (22.61 cm) which was significant in enhancing panicle length followed by line sowing of normal seeds (22.25 cm) and similar panicle length found in rest of treatments (Table 2). As the panicles increased per hill the panicle length may be increased as mentioned by Hassan *et al.*, (2015).

Seeds per panicle

Seed formation is results of fertilization and panicle length of rice, which was dealt in Table 2. The highest seeds per panicle were recorded with transplanting of 20 days old seedling which was statistically similar to line sowing of normal seeds (76.80). Line sowing of sprouted seeds and broadcasting + biasi (beushening at 25 DAS) were found equal in attaining seeds per panicle but both were higher than broadcasting of sprouted or normal seeds (Table 2). The minimum seeds per panicle were recorded with broadcasting of sprouted seeds (48.81) due to low plant population and low tillering. This was comparative to the outcomes announced by Hossain *et al.*, (2002), Liu *et al.*, (2015), Bhardwaj *et al.*, (2018) and Rahman *et al.*, (2019).

1000 seed weight (g)

The 1000 seed weight did not show any significant difference among treatments imposed because seeds are almost similar in size and morphology which mostly shows similar weight (Table 2). The highest 1000 seed weight was recorded by transplanting of 20 days old seedling followed by line sowing of normal seeds (25.48 g) (Ehsanullah *et al.*, 2000).

Yields of rice

The seed yield of rice increased significantly with the crop establishment methods over the broadcasting of sprouted seeds (44.18 qha⁻¹). The maximum average seed yield was recorded with transplanting of 20 days old seedling (48.22 q ha⁻¹) which was statistically at par with line sowing of normal seeds (44.53 q ha⁻¹). Line sowing of normal seeds was statistically similar to line sowing of sprouted seeds and broadcasting + Biasi (beushening at 25 DAS) because crop establishment methods

did not vary in yielding seeds. The yield attributing characters provided better opportunity for higher yields. The minimum grain yield was recorded by broadcasting of sprouted seeds about 34.18 q ha⁻¹ (Table 3). These findings were similar to Javaid *et al.*, (2012). Similar trends were followed via straw yield and HI.

The highest straw yield was obtained via transplanting of 20 days old seedling which was about 82.73 q ha⁻¹ followed by line sowing of sprouted seeds (82.08 q ha⁻¹). The lowest straw yield was recorded by broadcasting of sprouted seeds which was 71.40 q ha⁻¹. Similar outcomes were obtained from the research work of Raj *et al.*, (2013).

The maximum HI was obtained significantly by transplanting of 20 days old seedling then line sowing of normal seeds which was at par with transplanting of 20 days old seedling. This was due to uniform distribution of crop plants over fields of transplanted rice. The minimum HI was recorded by broadcasting of sprouted seeds which was about 36.70 %. Mankotia *et al.*, (2009) found the similar result with the research work.

N uptake (kg ha⁻¹)

The data regarding N uptake in grain and straw were given in Table 4. The highest N uptake in grain (61.60 kg ha⁻¹) and straw (45.83 kg ha⁻¹) were recorded under transplanting of 20 days old seedling followed by line sowing of normal seeds (56.55 and 38.92 kg ha⁻¹ in grain and straw respectively), which was comparable to transplanting of 20 days old seedling remaining methods of crop establishment attained statistically similar in N uptake in grain and straw being higher than the broadcasting of normal and sprouted seeds. The lowest N uptake was observed in broadcasting of sprouted seeds (51.64 and 18.75 kg ha⁻¹ in grain and straw, respectively).

The higher biomass accumulation is directly reflected in uptake of N. Similar outcomes were accompanied by the research work of Jaiswal *et al.*, (2001).

P uptake (kg ha⁻¹)

The data including P uptake in grain and straw were shown in Table 4. The highest P uptake in grain and straw were recorded under transplanting of 20 days old seedling (16.31 and 12.69 kg ha⁻¹) followed by line sowing of sprouted seeds (16.12 and 12.03 kg ha⁻¹) being at par to transplanting of 20 days old seedling in P uptake of grain and straw.

The significantly lowest P uptake in grain and straw were observed in broadcasting of sprouted seeds (12.44 and 8.21 kg ha⁻¹). Mostly higher growth rate governs the uptake process which later diverts in reproductive parts. The result obtained was similar with the research work of Anbumani *et al.*, (2004).

K uptake (kg ha⁻¹)

The maximum K uptake in grain and straw were recorded significantly in transplanting of 20 days old seedling (24.85 and 93.46 kg ha⁻¹) and line sowing of normal seeds (22.32 and 91.61 kg ha⁻¹) and sprouted seeds (21.87 and 87.82 kg ha⁻¹) were comparable to that transplanting of 20 days old seedling. Establishment of seedling is more firmly in transplanting, whereas direct seeding might be similar if circumstance favour to sowing time and methods, both can attain similar in uptaking nutrients by balancing tillering presents in certain ground space.

The lowest K uptake in grain and straw were observed via broadcasting of sprouted seeds significantly which was 17.70 and 84.73 kg ha⁻¹ respectively. Sharma *et al.*, (2007) obtained similar result.

Table.1 Effect of crop establishment methods on plant growth of summer rice

Treatment	Plant height (cm) at harvest	No. of tillers plant-1 at harvest	No. of leaves at harvest	LAI (60 DAS)	Relative Growth Rate (RGR) (g plant ⁻¹ day ⁻¹)		
					0-30 DAS	30-60 DAS	60-90 DAS
T ₁ :Transplanting of 20 days old seedling	98.41	13.33	27.63	3.82	0.024	0.027	0.017
T ₂ :Broadcasting of normal seeds	89.08	8.2	14.17	2.31	0.011	0.014	0.009
T ₃ :Line sowing of sprouted seeds	94.94	11.87	18.03	2.86	0.02	0.023	0.015
T ₄ :Broadcasting + Biasi (beushening at 25 DAS)	90.86	7.53	15.60	2.55	0.018	0.021	0.013
T ₅ :Broadcasting of sprouted seeds	81.54	7.20	9.00	1.02	0.009	0.011	0.007
T ₆ :Line sowing of normal seeds	97.48	12.6	25.4	3.39	0.022	0.025	0.018
SEm±	2.54	0.66	1.43	0.24	0.002	0.002	0.001
CD (P=0.05)	7.62	2.11	4.52	0.77	0.006	0.007	0.004

Table.2 Effect of crop establishment methods on yield attributing characters of rice

Treatments	Yield attributing characters			
	No. of panicle hill ⁻¹	Panicle length (cm)	Seeds panicle ⁻¹	1000 seed weight (g)
T ₁ :Transplanting of 20 days old seedling	11.47	22.61	77.25	25.59
T ₂ :Broadcasting of normal seeds	6.43	21.24	49.57	25.32
T ₃ :Line sowing of sprouted seeds	7.23	22.23	57.70	25.42
T ₄ :Broadcasting + Biasi (beushening at 25 DAS)	7.20	21.73	55.75	25.40
T ₅ :Broadcasting of sprouted seeds	5.70	21.16	48.81	24.25
T ₆ :Line sowing of normal seeds	10.70	22.25	76.80	25.48
SEm±	0.35	0.12	2.34	0.27
CD (P=0.05)	1.09	0.38	7.40	NS

Table.3 Effect of crop establishment methods on yield of rice

Treatments	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)	Harvest Index (%)
T ₁ : Transplanting of 20 days old seedling	48.22	82.73	41.30
T ₂ :Broadcasting of normal seeds	39.43	75.22	38.81
T ₃ :Line sowing of sprouted seeds	42.03	78.67	39.88
T ₄ :Broadcasting + Biasi (beushening at 25 DAS)	40.88	76.18	35.91
T ₅ :Broadcasting of sprouted seeds	34.18	71.40	36.70
T ₆ :Line sowing of normal seeds	44.53	82.08	40.91
SEm±	1.22	1.88	0.96
CD (P=0.05)	3.72	2.08	1.23

Table.4 Effect of crop establishment methods on nutrient uptake (kg ha^{-1}) by grain and straw

Treatment	Nutrient uptake (kg ha^{-1})					
	N uptake		P uptake		K uptake	
	Grain	In straw	Grain	Straw	Grain	Straw
T ₁	61.60	45.83	16.31	12.69	24.85	93.46
T ₂	52.08	22.02	13.75	9.37	19.96	85.57
T ₃	53.42	29.02	15.53	11.95	21.87	87.82
T ₄	52.53	25.77	14.00	11.20	20.09	86.75
T ₅	51.64	18.75	12.44	8.21	17.70	84.73
T ₆	56.55	38.92	16.12	12.03	22.32	91.61
SEm±	1.90	2.24	0.72	0.32	1.18	1.83
CD (P=0.05)	5.99	7.05	2.28	1.02	3.71	5.77

Table.5 Effect of crop establishment methods on Economics of rice

Treatments	Cost of cultivation (₹ ha^{-1})	Gross Return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T ₁ : Transplanting of 20 days old seedling	27642.6	89207.0	61564.4	2.43
T ₂ : Broadcasting of normal seeds	23078.9	63233.0	40154.2	1.92
T ₃ : Line sowing of sprouted seeds	23720.6	77755.5	54034.9	2.18
T ₄ : Broadcasting + Biasi (beushening at 25 DAS)	22992.4	75628.0	52635.6	1.96
T ₅ : Broadcasting of sprouted seeds	21313.6	52945.5	39631.9	1.74
T ₆ : Line sowing of normal seeds	25517.6	82380.5	56862.9	2.23
SEm±	7531.0	2283.1	1572.4	0.17
CD (P=0.05)	2245.15	6931.5	4712.5	0.32

Economics

The economical analysis of trial was done on the basis of prevailing market price of rice consisted of cost of cultivation, gross return, net return and B:C ratio were depicted in Table 5. The maximum cost of cultivation (27642 ₹ ha^{-1}) was recorded with transplanting of 20 days old seedling being significantly superior over rest of treatment except line sowing of normal seeds ($25517.6 \text{ ₹ ha}^{-1}$) which was at par to that of transplanting of 20 days old seedling and the treatment broadcasting + biasi (beushening at 25 DAS) was found statistical similar to line sowing of normal seeds. The transplanting has elicited by higher cost of cultivation as compared to other methods of

sowing due to high input cost of manual transplanted, which reflected to be high cost of cultivation. Although the labour inputs was offset with more yields also advocated in the line of compensation that is a reason many farmers still adopted the transplanting. Whereas, the minimum cost of cultivation was analysed under broadcasting of sprouted seeds. This result confirms with the findings of Bhardwaj *et al.*, (2018). Income improved with imposing treatments like transplanting of 20 days old seedling ($89207.0 \text{ ₹ ha}^{-1}$) was found to be significant in gaining handsome gross returns followed by line sowing of normal seeds ($82380.5 \text{ ₹ ha}^{-1}$), which was comparable to transplanting. Similar results were found by Sanjay *et al.*, (2006).

The significantly highest net return was arrested by transplanting of 20 days old seedling (61564.4 ₹ ha⁻¹) and line sowing of normal seeds (56862.9 ₹ ha⁻¹) was equally recommended as transplanting in earning incomes, this was due to higher grain and straw yield of transplanted rice. All broadcasting methods had lesser net return and the lowest net return was observed in broadcasting of sprouted seeds (39631.9 ₹ ha⁻¹). This was comparative to the outcomes announced by Ali *et al.*, (2013). The highest B:C ratio was recorded when rice crop was established by transplanting of 20 days old seedling (2.43) then line sowing of normal seeds (2.23) showing comparable with each others. From the analysis, broadcasting of seeds registered statistical similar B:C ratio in earning incomes regardless the adopted crop establishment methods under the study. The more B:C ratio was recorded transplanting of 20 days old seedling because of the method gave higher yield attributes which contributed directly in yields which was ultimately enhanced the incomes of the mentioned treatment. Similar outcomes were observed by the research work of Awan *et al.*, (2007).

The study concluded that growth parameters of rice viz., plant height, tillers number per hill, number of leaves per plant, leaf area index and relative growth rate were obtained maximum with transplanting of 20 days old seedling throughout the observations which was found significant and comparable to line sowing of normal seeds while the minimum was noted by broadcasting of sprouted seeds. Similarly yield attributing parameters such as panicle hill⁻¹ (11.47), panicle length (22.61 cm), seeds per panicle (77.25) and 1000 seed weight (25.59 g) were arrested by in transplanting of 20 days old seedling when compared to other treatments except line sowing of normal seeds which was significant being at par to that of transplanting of 20 days old seedling. The highest grain (48.22 q ha⁻¹)

and straw yield (82.73 q ha⁻¹) of rice were noticed in transplanting of 20 days old seedling which was significantly more than rest of the treatments except the line sowing of normal seeds.

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