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Impact of different age of seedlings and double transplanting on growth and yield of rice under rainfed condition

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Abstract
A two-year field experiment was conducted during the kharif season of 2021-22 and 2022-23 at Student's Instructional Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh to evaluate the effect of different ages of seedling and double transplanting on the growth and yield of rice crop. Three different seedling age were taken as the treatment T1-14 days old seedling, T2-21 days old seedling, T3-28 days old seedling and two popular high yielding varieties of rice V1- DRR-44, V2- Sahbhagi Dhan were used for the study. It was observed that different seedling ages and double transplanting substantially decreased almost all the yield components measured *viz*; panicle length, panicle weight, number of grains per panicle, ear length (cm), grain yield per m^2 (g), biomass per m^2 (g), when 14 and 28 days old seedlings were double transplanted. However, 21 days old seedling significantly reduced the detrimental effect of double transplanting on both the varieties by improving physiological traits which ultimately helped in obtaining higher yield. Thus, it is recommended that under double transplanting 21 days old seedlings are beneficial for the farmers to minimize yield losses under sanda cultivation.

Keywords: Rice, seedling age, double transplanting, grain yield

Introduction
Rice (*Oryza sativa* L.) is a semi-aquatic annual grass plant and is the most important cereal crop in the developing world covering 165.25 million hectares with annual production of 787.29 million tonnes of grain with average productivity of 4.76 tonnes per hectare (FAO, 2021) [1]. That is why the rice production always holds a key role in the overall food situation of the whole world. However, with increasing population and its per capita consumption in near future will increase manifold. It is a principal source of food for more than half of the world population, and more than 90% of rice worldwide is grown and consumed in Asia (Chauhan, 2012) [18]. Rice is an excellent source of carbohydrate. To a certain extent it gives protein component of regular human diet, so it is used as staple food crop and eaten as cooked rice and also used for several preparations and has commercial and industrial importance. Rice provides 35–60% of the dietary calories and 50-80% of the energy intake of the people in developing countries (Fageria *et al*., 2003) [2]. As the population rises, so does the demand for rice. Yet, yields of the crop are levelling out.

Rice crop production is a very intensive process and is affected by several factors. Optimum age of seedling is one of the most important factors affecting crop establishment because transplanting of very young seedling at a wider spacing is generally recommended leading to greater rooting growth and better tillering potential. The age of seedling exploits the initial vigor of the genotypes and provides congenial condition for better establishment. Age of seedlings at transplanting is considered for influencing grain yield in water scarce rice production systems, primarily by laying the foundation for determining the number of panicles at harvest. Rice seedlings transplanted after 25 days are usually termed as "delayed rice transplantation" or "older seedlings" (Liu *et al*. 2015, 2017) [3-4]. Delayed transplantation has been reported with less tillering capacity, short vegetative growth phase, and lower dry matter accumulation in rice (Liu *et al*. 2015) [3]. Late transplanting or use of older age seedlings significantly affect rice growth, tillering pattern, vegetative and reproductive period of crop, and thus the detrimental impacts on grain yield (Liu *et al*. 2017) [4]. Besides, stand and establishment of rice is directly related with the seedling age at the time of transplanting (Brar *et al*. 2012) [5].

Double transplanting is an indigenous crop cultivation system in rice where farmers transplant the seedlings twice during the season. This system is practiced in medium to low land flood affected area, due to heavy rains. This method of rice cultivation is called Bolon system in Bangladesh (Md Abdus Samad Azad &Mahabub Hossain, 2006) [6]. In double transplanting system, first the seedlings are prepared in medium land for about a month and the seedlings are transplanted in a plot with 30% of total area to be cultivated or transplanted. The double transplanting system permits a flexible late transplanting during the rainy season, which is its prime advantage. Double transplanting of aged seedlings gives higher yield over single transplanting because it ensures optimum crop stand. The mortality rate of young seedlings under adverse weather (flood/ drought) situation is more. Whereas, under double transplanted system, tall and aged seedling survive adverse environment better than young and single transplanted seedlings. Seedlings produced in this method is taller, healthier and easily overcome the high-water depth at the time of transplanting or immediately after transplanting Under double transplanting, seedlings have thick culm and better food reserve. Thick culm prevents the lodging of rice crop and better food reserve helps the plants to withstand prolonged period of water logging. The plants under the double transplanted plots are usually healthy, have longer panicles and more filled grains than the plants on the single transplanted parcels (Kumar *et al.* 2018) [7]. Therefore, a study was planned to access the impact of seedling age and double transplanting system of crop establishment on the growth and yield of rice crop.

Materials and Methods

The field study was conducted at Student's Instructional Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh during the Rabi season of 2020-21. Geographically the experimental site is situated 42 km away from Ayodhya on Ayodhya-Raibarielly Road between latitude of 26.47° North and longitude of 81.12° East on an elevation of 113 meters in the gangetic alluvium of eastern Uttar Pradesh. The weather conditions in terms of minimum and maximum temperature, relative humidity (RH), rainfall (mm) and sunshine hours were recorded during the crop season *i.e.*, from June to November during 2021-22 and 2022-23. The data were collected from metrological observatory situated in the main campus of university, Kumarganj, Ayodhya. The experiment was conducted infactorial randomized block design (FRBD) with three replications. Nursery were raised on three different dates on a plot of size $1m^2$ which were subsequently transplanted on the main field during the years 2021-22 and 2022-23. Two popular varieties of rice V1- DRR-44, V2-Sahbhagi Dhan were used for the study. Three different seedling age were taken as the treatment T1-14 days old seedling, T2-21 days old seedling, T3-28 days old seedling. The plot size of 5 m*4 m and spacing of 20 cm*15 cm was maintained for the transplanting of seedlings. Seedlings of different age were double transplanted i.e. first the nursey was transplanted into the main field and then after 20 days the seedlings were again retransplanted. A total of five plants were taken from each plot as sample for recording the observations. Tillers were recorded at maximum tillering stage and effective tillers were observed at physiological maturity. Dry matter of plant was recorded by oven drying the plant sample at 80 ℃ for 24 hours. Yield attributes such as, panicle length and panicle weight, number of grains per panicle were recorded a few days before harvesting. Total number of seeds per panicle were counted and categorized into sterile and fertile seed per plant. The fertility percentage was calculated by formulae given as under:

$$\text{Fertility (\%)} = \frac{\text{Fertile seeds per panicle}}{\text{Total no. of seeds per panicle}} \times 100$$

The sterility percentage was calculated by formula given as under:

$$\text{Sterility(\%)} = \frac{\text{Sterile seeds per panicle}}{\text{Total no. of seeds per panicle}} \times 100$$

The grain yield and biomass were observed after harvesting. Harvest index was calculated using formula by **(**Donald and Hamblin, 1976) [8]:

Harvest Index (%) = (Economic Yield/Biological Yield) * 100.

Test weight was recorded by taking 1000 well filled grains having moisture content 12-15% from the samples of each treatment and measuring their weight. The data recorded on various growth and yield attributes was subjected to statistical analysis by Fisher method of analysis of variance. Significance of various treatments was judged by comparing calculated, F value with Fisher's F value at 5 percent level.

Results

Growth parameters

The data on plant height, tiller number per plant, dry weight was recorded at 45, 75, at physiological maturity DAT as affected by different age of seedling and double transplanting have been summarized in Table 1. An interception of the data revealed that shoot elongation continued to increase plant height with the advancement of crop stages and a gradual increase in plant height was found in the early stages of the growth up to at physiological maturity.

Effect of age of seedlings

Plant height showed decreased trend in transplanting. The data (Table 1) on plant height revealed that age of seedling affected the plant height significantly. It is clearly visible in data that DRR-44 and Sahbhagi Dhan remarkable reduction in plant height is observed. However, significant reduction observes in plant height in 14 days old seedling. Maximum reduction was recorded up to the (7.8%-8.43%) in different age of seedling. It is apparent from the data that maximum number of tillers $plant^{-1}$ was recorded at 75 DAT irrespective of treatments. age of seedling considerably decreased number of tillers $plant^{-1}$. This is due to onset of unfavorable environment for crop. Data related to dry weight $plant^{-1}$ is shown in (Table 4.4). Significant variation was found among age of seedling and genotypes with respect to dry weight $plant^{-1}$. 21 days old seedling showed significantly maximum dry weight $plant^{-1}$ as compared to other seedling ages during two consecutive years in both the (DRR-44 and (Sahbhagi Dhan).

Effect of double transplanting (Sanda Cultivation)

Data (Table 1) on plant height at 45 DAT shows only the response of varietal difference with respect to control in both rice varieties (DRR-44 and Sahbhagi Dhan). However, plant height ranges from (42.36 cm) to (49.53 cm) and (43.10 cm) to (51.96 cm) respectively in both the varieties under double transplanting. double transplanting significantly increased number of tillers plant^{-1} at 75 DAT of observations in both the varieties (DRR-44 and Sahbhagi Dhan). Maximum number of tillers plant^{-1} was obtained at 75 DAT in T_2 (V_1-18.33, V_2-20.00) followed by T_3 (V_1-16.67, V_2-17.00) and T_1 (V_1-12.33, V_2-14.00) as compare to other seedling age in both the varieties. However, at physiological maturity maximum number of tillers plant^{-1} was obtained in T_2 (V_1-17.33, V_2-18.67) followed by T_3 (V_1-14.33, V_2-15.67) and T_1 (V_1-10.33, V_2-12.33) in both the varieties. Data on dry weight plant^{-1} at 45 DAT show only the response of time of transplanting. Significant reduction was observed in dry weight plant^{-1} with respect to seedling ages in both (DRR-44 and Sahbhagi Dhan). Double transplanting significantly increased dry weight plant^{-1} up to 75 DAT and at physiological maturity of observations in both varieties. At 75 DAT maximum dry weight plant^{-1} was obtained in T_2 (V_1-46.25 g, V_2-47.58 g) followed by T_3 (V_1-44.95 g, V_2-45.77 g) as compared to T_1 (V_1-39.10 g, V_2-41.55 g) in both the varieties. Similarly, at physiological maturity maximum dry weight plant^{-1} was obtained in T_2 (V_1-54.77 g, V_2-57.47 g) followed by T_3 (V_1-51.66 g, V_2-55.07 g) as compared to T_1 (V_1-46.57 g, V_2-47.99 g) under various seedling age of rice varieties.

Table 2: Effect of seedling age and double transplanting on plant height (cm), number of tillers per plant and dry weight per palnt (g) of rice varieties

	Plant Height (cm)						Number of tillers per plant								Dry weight per plant (g)					
Treatments	**Plant height before re-transplanting at 45 days**		**Plant height at 75 days**		**Plant height at physiological maturity**		**Tillers per plant before re-transplanting at 45 days**		**Tillers per plant at 75 days**		**Tillers per plant at physiological maturity**		**Tiller mortality (%)**		**Dry weight before re-transplanting at 45 days**		**Dry weight at 75 days**		**Dry weight at physiological maturity**	
T_1V_1	42.36		70.14 (39.61)		121.66 (42.34)		9.00		12.33		10.33		20.74		19.81		39.10 (49.33)		46.57 (16.04)	
T_2V_1	46.03		74.33 (38.08)		129.00 (42.37)		11.00		18.33		17.33		6.13		23.87		46.25 (48.39)		54.77 (15.56)	
T_3V_1	49.53		75.22 (34.15)		124.33 (39.50)		12.33		16.67		14.33		14.29		26.24		44.95 (41.62)		51.66 (12.99)	
T_1V_2	43.10		77.67 (44.51)		125.66 (38.18)		10.33		14.00		12.33		13.74		23.51		41.55 (43.42)		47.99 (13.42)	
T_2V_2	48.13		84.70 (43.18)		132.33 (35.99)		12.00		20.00		18.67		5.00		24.53		47.58 (48.44)		57.47 (17.21)	
T_3V_2	51.96		82.49 (37.01)		127.33 (35.21)		13.33		17.00		15.67		8.81		28.23		45.77 (38.32)		55.07 (16.89)	
Interaction	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety (V)	0.59	1.86	0.97	3.06	0.75	2.36	0.41	1.29	0.36	1.15	0.38	1.19	0.38	1.19	0.50	1.57	0.41	1.28	0.31	0.91
Treatment (T)	0.72	2.28	1.19	3.75	0.92	2.89	0.50	1.58	0.45	1.40	0.46	1.46	0.47	1.43	0.61	1.93	0.50	1.57	0.38	1.21
VxT	1.02	3.22	1.68	5.30	1.30	4.09	0.71	2.23	0.63	1.90	0.66	2.07	0.60	1.87	0.86	2.72	0.71	2.22	0.54	1.71

Note-T1- 14 day's old seedling, T2- 21 day's old seedling and T3- 28 day's old seedling. The values were analyzed with analysis of variance (ANOVA); S.Em± represents standard error of mean; CD represent the critical difference value to test the level of significance between means (p>0.05)

*Pooled data of two successive year's (2021-22 & 2022-23)

Parenthesis indicate percent increase/decrease

Components of yield

Data on panicle length, panicle weight, number of fertile grains per panicle, number of sterile grains per panicle, fertility%, sterility% and total grains per panicle of rice varieties as influenced by age of seedling and double transplanting have been presented in (Table 2). Data further showed that the panicle length differed significantly under different cultivars of rice.

Effect of age of seedling

Data pertaining to panicle length showed in (Table 2) indicated that age of seedling significantly increased the panicle length. Maximum enhancement was recorded up to the range of (6.37%). However, it is clear from data presented in table (2) that maximum enhancement (%) was obtained in (Sahbhagi Dhan) (9.04%) under different age of seedling. Age of seedling significantly censored the panicle length of both the varieties. Data reveal that the panicle weight was also differed significantly under cultivars of rice. It evident from the pooled data (Table 2) that panicle weight of DRR-44 and Sahbhagi Dhan highly influenced with age of seedling resulting in panicle weight was obtained. Data pertaining to fertile grains plant^{-1} showed in (Table 2) indicated that age of seedling significantly reduced the number of fertile grains plant^{-1}. Maximum number of fertile grains plant^{-1} was recorded up to the range of (121-192). However, it is clear from data presented in table (2) that maximum enhancement (%) was obtained in (Sahbhagi Dhan) (12.49%) under different age of seedling. Age of seedling significantly suppressed the number of fertile grains plant^{-1} of both the varieties. Data pertaining to number of sterile grains plant^{-1} showed in (Table 2) indicated that age of seedling significantly increases the number of sterile grains plant^{-1}. Maximum number of sterile grains plant^{-1} was recorded up to the range of (28-35). However, it is clear from data presented in table (2) that maximum enhancement (%) was obtained in (Sahbhagi Dhan) (2.85%) under different age of seedling. Age of seedling significantly suppressed the number of sterile grains plant^{-1}of both the varieties. Data pertaining to fertility% showed in (Table 2) indicated that age of seedling significantly increase the fertility%. Maximum fertility% was recorded up to the range of (81.39-84.36%). However, it is clear from data presented in table (2) that maximum enhancement (%) was obtained in (Sahbhagi Dhan) (84.36%) under different age of seedling. Age of seedling significantly suppressed the fertility% of both the varieties. Data pertaining to sterility% showed in (Table 2) indicated that age of seedling significantly increased the sterility%. Maximum

sterility% was recorded up to the range of (15.64-18.61%). However, it is clear from data presented in table (2) that maximum enhancement (%) was obtained in (DRR-44) (18.61%) under different age of seedling. Age of seedling significantly suppressed the sterility% of both the varieties. Data pertaining to number of grain panicle^{-1} of different rice varieties transplanted in different seedling ages presented in (Table 2) depicted that age of seedling significantly affect the number of grain panicle^{-1} of both the varieties.

Effect of double transplanting (Sanda Cultivation)

Double transplanting significantly increased panicle length of both the varieties (DRR-44 and Sahbhagi Dhan).Maximum panicle length was obtained in T_3 (V_1-30.13, V_2-32.53) followed by T_2 (V_1-28.21, V_2-29.47) and as compare to T_1 (V_1-23.48, V_2-25.57) in both the varieties. In general, double transplanting in both the varieties (DRR-44 and Sahbhagi Dhan) maximum panicle weight was recorded with T_2 (V_1-5.32, V_2-4.10) followed by T_3 (V_1-4.65, V_2-3.44) as compare to T_1 (V_1-3.98, V_2-3.19). Interaction in varieties and treatments was found significant. Double transplanting significantly increased number of fertile grains plant^{-1} of both the varieties (DRR-44 and Sahbhagi Dhan). Maximum number of fertile grains plant^{-1} was obtained in T_2 (V_1-161, V_2-192) followed by T_3 (V_1-146, V_2-170) and T_1 (V_1-121, V_2-166) in both the varieties. Double transplanting significantly increased number of sterile grains plant^{-1} of both the varieties (DRR-44 and Sahbhagi Dhan). Maximum number of sterile grains plant^{-1} was obtained in T_3 (V_1-32, V_2-35) followed by T_2 (V_1-31, V_2-35) and T_1 (V_1-28, V_2-34) in both the varieties. Double transplanting significantly increased fertility% of both the varieties (DRR-44 and Sahbhagi Dhan). Maximum fertility% was obtained in T_2 (V_1-83.88, V_2-84.36) followed by T_3 (V_1-81.97, V_2-82.96) and T_1 (V_1-81.39, V_2-82.68) in both the varieties. Double transplanting significantly increased sterility% of both the varieties (DRR-44 and Sahbhagi Dhan). Maximum sterility% was obtained in T_1 (V1-18.61, V2-17.27) followed by T_3 (V1-18.03, V2-17.04) and T_2 (V1-16.12, V2-15.64) in both the varieties. All the treatments significantly increased number of grain panicle-1 in both the rice varieties (DRR-44 and Sahbhagi Dhan). Maximum number of grain panicle-1 was obtained in T_2 (V1-192, V2-228) followed by T_3 (V1-179, V2-205) as compare to T_1 (V1-149, V2-200) in both the varieties.

Table 2: Effect of seedling age and double transplanting on panicle length (cm), panicle weight (g), number of fertile grain panicle^{-1}, number of sterile grain panicle^{-1}, fertility%, sterility% and total grain panicle^{-1}of rice varieties

Treatments	Panicle length (cm)		Panicle weight (gm)		Number of fertile grain panicle^{-1}		Number of sterile grain panicle^{-1}		Fertility%		Sterility%		Total grain panicle^{-1}	
T_1V_1	23.48		3.98		121		28		81.39		18.61		149	
T_2V_1	28.21 (16.76)		5.32 (25.18)		161		31		83.88		16.12		192	
T_3V_1	30.13 (6.37)		4.65 (-15.05)		146		32		81.97		18.03		179	
T_1V_2	25.57		3.19		166		34		82.68		17.27		200	
T_2V_2	29.47 (13.23)		4.10 (22.19)		192		35		84.36		15.64		228	
T_3V_2	32.53 (9.04)		3.44 (-19.18)		170		35		82.96		17.04		205	
Interactions	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety (V)	0.43	1.36	0.14	0.45	1.78	5.61	-	-	-	-	-	-	2.18	6.86
Treatment (T)	0.53	1.67	0.17	0.55	2.18	6.87	-	-	-	-	-	-	2.67	8.40
VxT	0.75	2.36	0.25	0.77	3.09	9.72	NS	NS	NS	NS	NS	NS	3.77	11.88

Note-T1- 14 day's old seedling, T2- 21 day's old seedling and T3- 28 day's old seedling. The values were analyzed with analysis of variance (ANOVA); S.Em± represents standard error of mean; CD represent the critical difference value to test the level of significance between means (p>0.05)

*Pooled data of two successive year's (2021-22 & 2022-23)

Parenthesis indicate percent increase/decrease

Yield

Statistics applied to total biomass m^{-2} as affected by various seedling ages and double transplanting are presented in (Table 3). A perusal of data reveals that the total biomass m^{-2}was also differed significantly under cultivars of rice.

Effect of age of seedling

It is clear from the data (Table 3) that the age of seedling significantly affects the total biomass m^{-2}of both the varieties (DRR-44 and Sahbhagi Dhan). It is clear from the data (Table 3) that the age of seedling significantly affects the yield m^{-2} of both the varieties (DRR-44 and Sahbhagi Dhan). Data pertaining to harvest index of different rice varieties transplanted in different age of seedling presented in (Table 3) depicted that age of seedling significantly influenced the harvest index of both the varieties. Data pertaining to test weight showed in (Table 3) indicated that age of seedling significantly reduced the test weight. Maximum reduction was recorded up to the range of (12.66%). However, it is clear from data presented in table (3) that maximum reduction (%) was obtained in Sahbhagi Dhan (12.66%) under different age of seedling. Age of seedling significantly suppressed the test weight of both the varieties.

Effect of double transplanting (Sanda Cultivation)

Double transplanting was found effective in increasing total biomass m^{-2} significantly in both the varieties i.e. DRR-44 and Sahbhagi Dhan. Maximum total biomass m^{-2}was obtained in T_2 (V_1-6.00, V_2-6.66) followed by T_3 (V_1-5.22, V_2-5.73) and T_1 (V_1-4.70, V_2-4.80) in both the varieties. Double transplanting was found effective in increasing yield^{-m2} significantly in both the varieties i.e. DRR-44 and Sahbhagi Dhan. Maximum yield^{-m2} was obtained in T_2 (V_1-2.70, V_2-3.17) followed by T_3 (V_1-2.13, V_2-2.41) and T_1 (V_1-1.78, V_2-1.95) in both the varieties. All the age of seedling and double transplanting significantly increased harvest index in both the varieties (DRR-44 and Sahbhagi Dhan). Maximum harvest index was obtained in T_2 (V_1-45.26, V_2-47.73) followed by T_3 (V_1-40.95, V_2-42.28) and T_1 (V_1-38.35, V_2-41.73) in both the varieties. Double transplanting significantly increased the test

weight of both varieties (DRR-44 and Sahbhagi Dhan). Maximum test weight was obtained in T_2 (V_1-29.38, V_2-28.56) followed by T_3 (V_1-27.59, V_2-25.35) and T_1 (V_1-23.53, V_2-22.00) in both the varieties.

Table 3: Effect of seedling age and double transplanting on biomass m^{-2} (kg), yield m^{-2} (kg), harvest index (%) and test weight (g) of rice varieties

Treatments	Biomass m^{-2} (kg)		Yield m^{-2} (kg)		Harvest Index (%)		Test weight (gm)	
T_1V_1	4.70		1.78		38.35		23.53	
T_2V_1	6.00 (21.66)		2.70 (34.07)		45.26		29.38 (19.91)	
T_3V_1	5.22 (-14.94)		2.13 (-26.76)		40.95		27.59 (-6.48)	
T_1V_2	4.80		1.95		41.73		22.00	
T_2V_2	6.66 (27.92)		3.17 (38.48)		47.73		28.56(22.96)	
T_3V_2	5.73 (-16.23)		2.41 (-31.53)		42.28		25.35 (-12.66)	
Interaction	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety (V)	0.14	0.44	0.06	0.20	-	-	0.67	2.10
Treatment (T)	0.17	0.54	0.08	0.24	-	-	0.82	2.57
VxT	0.24	0.76	0.11	0.34	NS	NS	1.15	3.64

Note-T1- 14 day's old seedling, T2- 21 day's old seedling and T3- 28 day's old seedling. the values were analyzed with analysis of variance (ANOVA); S.Em± represents standard error of mean; CD represent the critical difference value to test the level of significance between means (p>0.05)

*Pooled data of two successive year's (2021-22 & 2022-23)

Parenthesis indicate percent increase/decrease

Discussion and Conclusion

Range of plant height and other growth parameters in both the varieties i.e. DRR-44 (39.50-42.34%) and Sahbhagi Dhan (35.21-38.18%) respectively, clearly showed that age of seedling and double transplanting are significantly influenced the growth as well as development of crop. interception of the data revealed that shoot elongation continued to increase plant height with the advancement of crop stages and a gradual increase in plant height was found in the early stages of the growth up to at physiological maturity. Similar result of varietal variation in plant height was also reported by Basavaraja *et al*., (2010) [9]. The ill-effect of aged seedlings can be overcome by transplanting seedlings from primary to secondary nursery (Sarma *et al*. 2010) [10]. It is apparent from the data that maximum number of tillers plant-1 was recorded at 75 DAT irrespective of treatments. Tillering is one of the most important agronomic traits for grain production in rice because tiller number per plant determines panicle number, a key component of grain yield (Hazmy *et al*., 2018) [11]. Late transplanting or use of older age seedlings significantly affect rice growth, tillering pattern, vegetative and reproductive period of crop, and thus the detrimental impacts on grain yield (Liu *et al*. 2017) [4]. Dry-matter accumulation by plant continued to increase at successive growth stages and the highest dry-matter plant-1 was recorded at physiological maturity. Thus, the growth attributes (plant height, number of tillers plant-1 and dry weight plant-1) appears to be modified by the adverse condition and it took the normal course of happening. These findings of the investigation fall in line with those observed by Rao and Raju (1987) [12] reported that by planting of 25 days old seedlings, increased dry matter production as compared to 35- and 45-days old seedlings. Transplanting older seedlings reduced plant height and dry matter production as compared to younger seedling.

Different age of seedling and double transplanting decreased substantially almost all the yield and yield components measured *viz*; number of panicle plant-1, panicle length, number of grains plant-1, test weight and biological yield which caused severe reduction in grain yield. Reduction percentage was more in case of DRR-44 compared to Sahbhagi Dhan. Seedling age and double transplanting plays an important role in reduction of yield and yield components. Similarly, maximum yield per plot was correspondingly recorded in T_2 (21 days old seedling) par with T_3 (28 days old seedling) and T_1 (14 days old seedling) in both wheat varieties. Positive correlation was obtained between yield and yield attributes (r=0.34), (r=0.77) and (r=0.54) respectively. Mondal *et al*. (2013) [13] reported that significant variation in panicle length, number of grains panicle-1 and 1000 grains due to different seedling ages. Virk *et al*. (2020) [14] observed that among yield contributing traits, panicle length and filled grains panicle-1 exhibited significantly differed across the seedling age. Significant variation in panicle length, number of grains panicle-1 and 1000 grains weight were also reported by Mondal *et al*. (2013) [13] as a result of double transplanting of rice crop. Salem *et al*. (2011) worked on rice with three different ages of seedling (20, 30 and 40 days) and found that 20-day old seedling scored the highest value in respect of 1000-grain weight, panicle length, grains panicle-1 and grain yield over 30 and 40 days old seedlings. Md. Babul Akter*et al*., (2019) [17]. Studied that age of seedling also affecting the morphological parameters on plant height, root structure, tillering ontogeny, internode elongation pattern, flag leaf length, flag leaf width, flag leaf angle, number of primary & secondary rachis, branches and also physiological traits on chlorophyll content, photosynthesis rate, total dry mass, growth rate, number of vascular bundles, harvest index with yield and yield. The interaction effect of various seedling age and double transplanting on both the varieties were found non-significant during both the years. Thus on the basis of the study useful conclusions, both having fundamental and applied values drawn are that the overall growth attributes physiological traits and yield as well as yield components of rice crop was adversely affected by age of seedling and double transplanting during crop growth and particularly vegetative stage and reproductive stage. 21 days old seedling significantly influenced the detrimental effect of double transplanting on both the varieties by improving physiological traits which ultimately helped in obtaining higher yield. It is recommended that under double transplanting 21 days old seedlings are beneficial for the farmers to minimize yield losses under sanda cultivation.

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