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Influence of dry direct seeding on phenological development of diverse rice genotypes

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Abstract

Rice (*Oryza sativa* L.) is a major staple crop, and dry direct-seeded rice (DDSR) is gaining importance as a resource-conserving cultivation method, due to lower water utilization. A field experiment was conducted during *kharif*, 2024 and *kharif*, 2025 at S.V. Agricultural College, Tirupati. To evaluate the performance of nine rice genotypes were evaluated under DDSR conditions. The experiment was laid out in randomized block design with three replications. Observations were recorded on leaf area index (LAI), tiller number, days to 50% flowering, and productive tillers. Significant differences were observed for all the traits. LAI increased with crop growth across all genotypes. MTU 1121 recorded the highest LAI at both 60 DAS (1.91) and 90 DAS (2.78). IR 64 and DRR Dhan 55 also showed superior canopy development. IR 64 and MTU 1121 recorded the maximum productive tillers (16). Days to 50% flowering ranged from 70 days in NLR 33358 to 82 days in MTU 1121. The variation indicated substantial genetic diversity in flowering behavior under DDSR. The genotypes with early flowering may help in drought escape, while medium-duration types showed greater biomass accumulation. MTU 1121, IR 64, and DRR Dhan 55 performed best due in terms of high tillering and efficient conversion of tillers into productive tillers. These genotypes show promise for cultivation and utilization in breeding programmes that aimed at enhancing productivity under DDSR system.

Keywords: Dry direct-seeded rice, phenology, leaf area index, tillering, productive tillers, flowering duration, rice genotypes

Introduction

Rice (*Oryza sativa* L.) is a major staple crop that provides food and nutritional security to more than half of the world's population, particularly in Asian countries such as India. Conventional puddled transplanted rice (TPR) cultivation has been widely adopted due to its stable productivity; however, it requires substantial amounts of water, labor and energy, making it increasingly unsustainable under conditions of resource scarcity and climate variability (Sandhu and Kumar, 2017) [8]. Direct-seeded rice (DSR) has emerged as a promising alternative because it reduces water consumption, labor requirements and cultivation costs. Despite these advantages, DSR often records lower yields than transplanted rice due to challenges related to weed competition, water management and environmental stresses. Nevertheless, appropriate agronomic practices, improved irrigation scheduling and favorable soil conditions can significantly narrow the yield gap and enhance the productivity and sustainability of DDSR systems (Xu *et al.*, 2019) [10].

Materials and Methods

The present field investigation was carried out during *kharif*, 2024 and *Kharif*, 2025 in Wetland Farm of S.V. Agricultural College, Tirupati with an aim to study "Influence of Dry Direct Seeding on Phenological development of Diverse Rice Genotypes",

The experiment was laid out in a Randomized block design with three replications. A spacing of 20 cm between the rows and 15 cm between plants within a row was provided. Nine contrasting rice genotypes along with two checks were selected under Dry direct seeded rice conditions.

One pre-sowing irrigation was given three days prior to sowing for good germination and better seedling establishment. Sowing was done by opening small furrows with the help of hand hoes at a distance of 20 cm between the lines. The seed was sown at a depth of 2 to 3 cm deep by manual labours at a distance of 15 cm from seed to seed and covered with soil. Initially the crop was raised aerobically under rainfed condition with life-saving irrigations at 7 days interval then after 45 DAS the whole crop was converted to lowland conditions by providing continuous irrigations on every 3-4 day to maintain stagnation of water in the field. Data was recorded for the following traits

1. Leaf Area Index (LAI)

The leaf area index was calculated by dividing the total leaf area with the corresponding ground area as suggested by Watson (1952) [9]. LAI was calculated using:

$$LAI = \frac{\text{Leaf area per plant}}{\text{Ground area occupied by the plant}}$$

2. Number of Tillers (plant⁻¹)

The total number of tillers produced per plant was counted manually from tagged plants and averaged.

3. Days to 50% Flowering (Days)

The number of days from sowing to the stage when 50% of plants in a treatment exhibited flowering was recorded.

4. Number of productive tillers (plant⁻¹)

Number of ear (panicle) bearing tillers with uniformly matured grains at the time of harvest was counted manually from tagged plants and averaged. The observations were expressed as number of productive tillers plant⁻¹.

Statistical analysis

The data collected on various phenological parameters were statistically analyzed using the Analysis of Variance (ANOVA) procedure, following Randomized Block Design (RBD) as described by Panse and Sukhatme (1978) and Gomez and Gomez (1984). The significance of differences among treatments/genotypes was evaluated by the F-test. Wherever the F-test indicated significant differences, treatment means were compared using the Critical Difference (CD) at the 5 per cent level of significance.

Results and Discussion

1. Leaf Area Index

Leaf area index (LAI) differed significantly among the rice genotypes under dry direct-seeded rice (DDSR) conditions, was shown in Table 1. The pooled mean LAI increased progressively from 0.897 at 30 DAS to 1.757 at 60 DAS and 2.568 at 90 DAS,

indicating continuous canopy development with crop growth. Among the genotypes, MTU 1121 consistently recorded the highest LAI at 60 DAS (1.912) and 90 DAS (2.784), followed by IR 64 and DRR Dhan 55, whereas MTU 1153 exhibited the lowest LAI throughout the growth period. The superior LAI observed in MTU 1121, IR 64 and DRR Dhan 55 may be attributed to greater leaf area development, enhanced tillering capacity and efficient utilization of water and nutrients under DDSR conditions. Higher LAI contributes to improved light interception and photosynthetic activity, thereby promoting biomass production and yield potential. Similarly, Li *et al.* (2025) [4], stated that leaf area index (LAI) is a crucial indicator of rice growth, canopy development and yield prediction, as it directly influences light interception, photosynthetic efficiency and biomass accumulation. Chakraborty *et al.* (2014) [1] reported that LAI significantly affects dry matter production and crop productivity in rice, with higher LAI contributing to greater radiation interception and enhanced canopy photosynthesis. Zhong *et al.* (2002) [11] further observed a strong relationship between LAI and tillering in rice, indicating that genotypes maintaining higher LAI exhibit improved vegetative growth and canopy establishment. Higher LAI observed in MTU 1121 might be attributed to greater leaf expansion, enhanced photosynthetic efficiency and improved assimilate production under DDSR conditions.

2. Number of Tillers (plant⁻¹)

The number of tillers differed significantly among the rice genotypes under dry direct-seeded rice (DDSR) conditions and increased progressively from 30 to 90 DAS, reflecting active vegetative growth and canopy development. Among the genotypes, MTU 1121 consistently recorded the highest number of tillers at all growth stages, followed by IR 64, DRR Dhan 55 and Shabagidhan, whereas MTU 1153 recorded the lowest tiller production. The superior tillering ability of MTU 1121, IR 64 and DRR Dhan 55 may be attributed to better crop establishment, greater seedling vigour, enhanced root development and higher leaf area, which collectively promoted dry matter accumulation under DDSR conditions, were shown in Table 2. Since tiller number is a major yield-determining trait in rice, genotypes with higher tillering potential are likely to produce more productive tillers and ultimately higher grain yield. The present findings are supported by Mubarak *et al.* (2025) [5], who reported higher tiller and panicle density in direct-seeded rice compared with transplanted rice, highlighting the importance of tillering in enhancing productivity under DSR systems. Similarly, Kanno *et al.* (2023) [2] observed that crop establishment conditions significantly influence tiller production in dry direct-seeded rice. Greater tiller production may result from efficient root development and improved nutrient acquisition.

Table 1: Leaf Area Index of Rice Genotypes under Dry Direct Sown Conditions

S. No.	Variety	30 DAS			60 DAS			90 DAS		
		2024	2025	Pooled	2024	2025	Pooled	2024	2025	Pooled
1	MTU 1153	0.81	0.80	0.81	1.56	1.56	1.56	2.31	2.31	2.31
2	IR 64	0.96	0.93	0.94	1.88	1.88	1.88	2.75	2.74	2.75
3	DRR DHAN 55	0.96	0.94	0.95	1.83	1.83	1.83	2.67	2.67	2.67
4	MTU 1121	0.96	0.93	0.95	1.91	1.91	1.91	2.79	2.78	2.78
5	DRR DHAN 44	0.93	0.95	0.94	1.81	1.81	1.81	2.63	2.63	2.63
6	NLR 33671	0.81	0.91	0.86	1.57	1.57	1.57	2.33	2.32	2.33
7	SHABAGIDHAN	0.93	0.83	0.88	1.83	1.83	1.83	2.65	2.65	2.65
8	NLR 33358	0.92	0.92	0.92	1.79	1.79	1.79	2.59	2.59	2.59
9	MTU1001	0.84	0.80	0.82	1.63	1.63	1.63	2.40	2.39	2.40
	GRAND MEAN	0.89	0.90	0.90	1.76	1.76	1.76	2.57	2.57	2.57
	SE(m)±	0.00	0.04	0.02	0.07	0.02	0.03	0.03	0.02	0.03
	CD (P=0.05)	0.04**	0.15*	0.52**	0.25*	0.05**	0.13**	0.04**	0.07**	0.02**

3. Days to 50% flowering

Days to 50 per cent flowering showed significant variation among rice genotypes under DDSR conditions, ranging from 70 days in NLR 33358 to 82 days in MTU 1121, with a pooled mean of 77 days are presented in Table 3. Early flowering genotypes may offer an advantage through drought escape, while later flowering genotypes can benefit from greater biomass accumulation and yield potential. These results indicate substantial genetic diversity for flowering duration and highlight

the importance of considering flowering behaviour alongside growth and yield traits when selecting genotypes for DDSR systems. The findings are in agreement with reports by Sahu *et al.* (2024) ^[6], Kesh *et al.* (2022) ^[3], who also emphasized the role of flowering duration in adaptation and productivity under direct-seeded rice conditions. Variation in flowering duration reflects genotypic differences in photoperiod sensitivity and thermal time requirements.

Table 2: No. of Tillers (no.) of Rice Genotypes under Dry Direct Sown Conditions

S. No.	Variety	30 DAS			60 DAS			90 DAS		
		2024	2025	Pooled	2024	2025	Pooled	2024	2025	Pooled
1	MTU 1153	4.0	3.5	3.7	10.0	9.6	9.8	18.0	17.5	17.7
2	IR 64	6.0	5.6	5.8	13.0	12.6	12.8	22.0	21.6	21.8
3	DRR DHAN 55	6.0	5.6	5.8	12.0	11.7	11.8	21.0	20.6	20.8
4	MTU 1121	6.0	5.7	5.9	13.0	12.8	12.9	22.0	21.7	21.8
5	DRR DHAN 44	5.0	4.9	4.9	11.0	10.9	11.0	20.0	19.8	19.9
6	NLR 33671	5.0	4.8	4.9	10.0	9.8	9.9	18.0	17.8	17.9
7	SHABAGIDHAN	5.0	4.7	4.8	12.0	11.7	11.9	21.0	20.6	20.8
8	NLR 33358	5.0	4.9	4.9	11.0	10.9	10.9	19.0	18.8	18.9
9	MTU1001	5.0	4.7	4.9	10.0	9.8	9.9	19.0	18.7	18.9
	GRAND MEAN	5.2	4.9	5.1	11.3	11.1	11.2	20.0	19.7	19.8
	SE(m)±	0.2	0.2	0.2	0.4	0.4	0.4	0.8	0.8	0.8
	CD (P=0.05)	0.62**	0.589**	0.61**	1.33**	1.31**	1.32**	2.33**	2.30**	2.32**

4. No. of Productive tillers (Plant⁻¹)

The number of productive tillers varied significantly among the rice genotypes under dry direct-seeded rice (DDSR) conditions and the results are presented in Table 3., with a pooled mean of 13.8 productive tillers per plant. IR 64 and MTU 1121 recorded the highest number of productive tillers (16.0), followed by DRR Dhan 55 (15.0), DRR Dhan 44 and Shabagidhan (14.5), whereas MTU 1153 recorded the lowest value (11.5). The superior productive tillering ability of IR 64, MTU 1121 and DRR Dhan 55 may be attributed to better crop establishment, enhanced root growth, higher leaf area development and efficient partitioning of assimilates towards reproductive growth. Since productive tillers directly determine

panicle number and grain yield, genotypes with a higher proportion of productive tillers are considered better adapted to DDSR ecosystems. The present findings are supported by Mubarak *et al.* (2025) ^[5], who reported higher tiller and panicle density in direct-seeded rice, resulting in enhanced grain yield compared with transplanted rice. Similarly, Sambegowda *et al.* (2024) ^[7] observed that improved crop and nutrient management practices increased tiller production and productivity under direct-seeded conditions. The higher productive tiller number recorded in IR 64 and MTU 1121 in the present study therefore indicates their greater potential for achieving superior productivity under DDSR conditions.

Table 3: Days to 50% Flowering and Productive tillers of Rice Genotypes under Dry Direct Sown Conditions

S.NO	Variety	Days to 50% Flowering (Days)			Productive tillers (Plant ⁻¹)		
		2024	2025	Pooled	2024	2025	Pooled
1	MTU 1153	74.71	73.82	74.30	12.0	11.0	11.5
2	IR 64	81.70	80.80	81.29	16.0	16.0	16.0
3	DRR DHAN 55	80.77	79.79	80.28	15.0	15.0	15.0
4	MTU 1121	82.74	81.84	82.31	16.0	16.0	16.0
5	DRR DHAN 44	77.77	76.80	77.29	13.0	16.0	14.5
6	NLR 33671	75.72	74.82	75.30	12.0	12.0	12.0
7	SHABAGIDHAN	78.77	77.79	78.28	15.0	14.0	14.5
8	NLR 33358	70.71	69.81	70.29	13.0	13.0	13.0
9	MTU1001	75.77	74.82	75.30	12.0	12.0	12.0
	GRAND MEAN	77.65	76.70	77.18	13.8	13.9	13.8
	SE(m)±	3.01	2.98	3.00	0.5	0.5	0.5
	CD (P=0.05)	NS	NS	NS	1.63**	1.64**	1.63**

Conclusion

The study revealed significant variability among rice genotypes for LAI, tillering, flowering time, and productive tillers under DDSR. MTU 1121 showed superior performance, followed by IR 64 and DRR Dhan 55. NLR 33358 was the earliest flowering genotype, indicating drought escape potential. Productive tiller number was a key trait contributing to adaptation and productivity under DDSR.

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