



Evaluation of Rice Varieties under Different Systems of Cultivation for Central Telangana Zone

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field study was conducted during *kharif*, 2021 at Regional Agricultural Research Station, Warangal to evaluate the performance of rice varieties under different systems of cultivation for central Telangana zone. The treatment consisted of three systems of cultivation i.e., transplanted rice system with 15x10 cm spacing, wet direct seeded rice (Drum seeding) with 30x6-8 cm spacing and dry direct seeded rice at 30 cm row spacing in main plots and four varieties i.e., RNR 15048 (Telangana sona), WGL 44 (Siddi), WGL 915 (Warangal Rice-1) and KNM 118 (Kunaran sannalu)

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in sub plots. Experimental data revealed that transplanted rice recorded significantly superior growth components and yield attributing characters i.e., number of tillers m², number of effective tillers m², dry matter production, grain yield, straw yield and harvest index (%) compared to other systems of cultivation. Significant higher grain and straw yield was recorded with transplanted rice system followed by wet DSR and least in dry DSR. Under varieties KNM 118 registered higher dry matter production, grain yield, straw yield and harvest index (%) as compared to remaining varieties.

Keywords: Dry DSR; wet DSR; varieties; grain yield; harvest index.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the principle source of food for almost 60% population of India Biswas et al. [1]. The area under rice cultivation in India is the largest among all the rice growing countries and is second in production. Annually in India, around 124 million tonnes of rice is produced in an area of 46 million hectares with a productivity of over 2.5 tonnes per hectare of milled rice [2]. It was predicted that a 50 - 60% increases in rice production will be required to meet the food demand of population growth by 2025 Banerjee et al. [3]. In telangana state, rice is the principal crop extensively cultivated in all the districts both *kharif* and *rabi* seasons. In telangana the rice area under production was 42.45 lakh ha and produced 252.63 lakh tons with the productivity of 5948.75 kg/ha during 2020-21 (Agriculture action plan report 2021-22 of Department of Agriculture, Telangana [4]).

About 77% of the global rice production in the world is cultivated by conventional transplanting method in puddled soil (Chakraborty et al. [5], Xu et al. [6]). Conventional transplanting system (TPR) of rice crop production requires labour, water, capital, and energy in large amount so that it has become less profitable at present due to the lack of these resources Chakraborty et al. [5], Guruprem et al. [7], Mahajan et al. [8]. Transplanting takes roughly 25 per cent of the total labour requirement of the crop. A shortage of labour during peak periods causes transplanting operation delayed, which end in transplanting of above-optimal age of rice seedlings that record lower productivity as well as increasing transplanting shock. Decreased availability and increasing cost of labour have increased the cost of rice cultivation through conventional methods. All these factors demand a major shift from puddle transplanted rice production to direct seeding of rice. As the seeds are sown directly, the dry and wet-seeding methods are often jointly referred to as direct

seeding method, for both the methods mentioned above.

Wet direct seeding is one of the oldest method of crop establishment, it refers to the process of establishing rice crop by sowing sprouted seeds directly on wet puddled soil (wet seeding) (Farooq et al. [9]). Absence of nursery management, rapid and easy sowing, reduced labour requirement, increased water use efficiency, lower methane emission and higher profit are the advantages of wet direct seeding over transplanted rice (Chauhan et al. [10]). Direct seeded rice matures 1-2 weeks before transplanted rice, thus reducing the risk of terminal drought and allowing earlier planting of a following non-rice crop (Rana et al. [11]).

Dry direct seeding is one of the resource conservation technique, it avoids drudgery of land preparation, nursery raising and transplanting. It saves time and investment compared to transplanting. In normal transplanting, repeated puddling adversely affects soil physical properties by destroying soil aggregates, reducing permeability in subsurface layers and forming hard pans at shallow depths. Dry direct seeding also saves water volume which is essential for puddling. Puddling consumes about 20-40 per cent of the total water required for growing the transplanted rice crop, which can be saved in direct seeded rice.

The characteristics of the cultivar such as morphology and growth rate can have a significant effect on crop development and ultimately its yield potential. The morphological and physiological traits of a strongly competitive crop will enable it to capture resources and utilize resources more efficiently. Rice breeders continue to combine the important yield component traits (including 2Gs for the yield ceiling) by utilizing modern breeding tools in rice Singh et al. [12] Correct choice of cultivar may also be essential to get higher yields. Hence, it is need of the hour to assess the performances of

different high yielding varieties of rice under these alternate crop establishment strategies. A single variety may not always perform better under all crop establishment techniques. Therefore, the present investigation was initiated to study the differences in growth and yield potential of local rice cultivars as affected by different crop establishment methods.

2. MATERIALS AND METHODS

The present investigation was under taken during *kharif* 2021 at Regional Agricultural Research Station, situated in the same campus of Agricultural College, Warangal. The research station is geographically situated at an altitude of 259 m above mean sea level on 18°07'911" N latitude and 79°59'752" E longitude. It is in the central Telangana zone of Telangana state. The genotypes used in this experiment listed in Table 3. The soil was clay loam (Table 1) in nature.

Table 1. Initial soil values

Soil reaction (pH)	7.72
Electrical conductivity (d Sm ⁻¹)	0.45
Organic carbon (%)	0.65
Available nitrogen (kg ha ⁻¹)	275
Available phosphorus (kg ha ⁻¹)	75
Available potassium (kg ha ⁻¹)	256

The experiment was laid out in strip plot design with 12 treatment combinations (Table 2) and three replications.

The recommended dose of fertilizer for wet DSR and transplanted system was 120 kg N: 60 kg P₂O₅: 40 kg K₂O ha⁻¹. Entire dosage of phosphorus and half of the dosage of potash were applied as basal in the form of single super phosphate (SSP) and murate of potash (MOP),

respectively. Nitrogen was applied in the form of urea. It was applied in three equal splits viz., 1/3rd of the dosage as basal, 1/3rd of the dosage at maximum tillering and remaining 1/3rd at panicle initiation stage for transplanting method. For wet DSR method, N was applied in three equal splits viz., 1/3rd dose at 10 DAS (days after sowing), 1/3rd dose at maximum tillering and remaining 1/3rd at panicle initiation stage. A fertilizer dose of 150:50:40 kg ha⁻¹ N, P₂O₅ and K₂O were applied to all the plots of dry DSR method. The dosage of phosphorus and potash are applied similar like other methods of establishment except for nitrogen which is applied as 1/3rd dose at 30 DAS (maximum tillering), 1/3rd dose at 60 DAS and remaining 1/3rd at panicle initiation stage with ½ Potash.

In case of wet direct seeding sprouted seeds were sown on thoroughly puddled and well leveled main field at 30 cm spacing drum seeder provides 30 cm spacing between the rows and 7 cm spacing between the plants of the row. About 6 rows can be laid with this drum seeder across a given area. Whereas in dry direct seeded, lines were formed with the help of cultivator at 30 cm row spacing and manual sowing of seeds was done into the main field with spacing of 30 cm x 10 cm. After completion of sowing, the field was given light irrigation to provide moisture required for germination of seed and regular irrigations was provided. Sowing of wet and dry DSR along with nursery for transplanting was carried out on 26th August. The software used for data analysis is OPSTAT.

For number of tillers m⁻² in each treatment, one m⁻² area was demarcated in the net plot with small colored pegs. The total number of tillers m⁻² were recorded at 30, 60 and 90 DAS/DAT in the same selected area.

Table 2. Details of main plot and sub plots

Main plots (3)	
Systems of cultivation	Spacing
M1 - Transplanted rice	15x10 cm
M2 - Wet direct seeded rice (Drum seeding)	30x6-8 cm
M3 - Dry direct seeded rice	30 cm row spacing
Sub plots (4) – Varieties	
S1 - RNR 15048 (Telangana sona)	
S2 - WGL 44 (Siddi)	
S3 - WGL 915 (Warangal Rice 1)	
S4 - KNM 118 (Kunaram sannalu)	



Fig. 1. Satellite view of the experimental site (Downloaded from Google Earth)

Table 3. Characteristic features of varieties

Characteristics	RNR-15048	WGL-44	WGL-915	KNM-118
Duration	125 days	140-145 days	135 days	125 days
Grain type	Short slender very fine	Medium slender fine	Long bold fine grain	Long slender grain
Resistant	Blast	Gall midge	BPH, Blast	Blast
Average yield	5500-6500 kg ha ⁻¹	7000-8000 kg ha ⁻¹	7500-8000 kg ha ⁻¹	7000-8000 kg ha ⁻¹
Habit	Non lodging Non shattering	Non shattering	Non lodging Non shattering	Less prone to grain shattering and lodging
Release Year	2015	2012	2020	2015

For dry matter of plants, it was recorded for five hills at 30, 60, 90 DAS/DAT and at harvest by destructive sampling. Five hills were harvested from each net plot periodically, at 30, 60, 90 DAS/DAT and at harvest for determining dry matter production. The roots were clipped off from each hill, the remainder was cleaned, transferred to properly labeled brown paper bags and then partially dried in sun and later in oven at 60°C till to attain constant weight. Sample dry weights were summed up to arrive at mean dry matter per square meter in individual treatment and expressed in kg ha⁻¹

3. RESULTS AND DISCUSSION

3.1 Number of Tillers m⁻²

A perusal of the data on number of tillers m⁻² revealed that, it was higher under transplanted

(Table 4) rice system (M₁) at all stages (30 DAS-202, 60 DAS-356, 90 DAS-305) which was at par with wet DSR system (M₂) during 30, 60 and 90 DAS (30 DAS-189, 60 DAS-336, 90 DAS-275). Significantly lowest tillers number m⁻² was recorded with dry DSR system (M₃) at all stages of crop growth (30 DAS-175, 60 DAS-307, 90 DAS-252). This is mainly due to maintenance of crop plants with proper plant to plant and row to row spacing, which not only reduce competition among plants but also increase the nutrient uptake and light availability to plants leading to more number of tillers in transplanting system. This work was supported by Mohanty et al. [13], Tomar et al. [14], Poudel et al. [15], Mohanta et al. [16]. Least number of tillers m⁻² under dry DSR system (M₃) may be due to closer spacing among plants leading to more competition for available nutrients. In addition to this poor growth than all other systems has resulted in lower

number of tillers due to continuous rainfall immediately after sowing and poor plant stand.

In case of varieties, number of tillers m^{-2} ranged from 133 to 223 at 30 DAS, 234 to 387 at 60 DAS and 200 to 327 at 90 DAS. At all the stages of crop growth, higher number of tillers was observed with WGL 44 (S_2) which is at par with RNR 15048 (S_1) and least was in WGL 915 (S_3). This might be due to genetical inherent character of variety to produce lower number of tillers as influenced by different systems of cultivation. These are in line with the findings of Sampath et al. [17], Chandrika et al. [18], Anil and Siddi [19] and Nayaka et al. [20].

3.2 Number of Effective Tillers m^{-2}

Number of effective tillers m^{-2} differed significantly by different systems of cultivation and varieties. The data in Table 4 indicates that highest number of effective tillers m^{-2} was recorded in transplanted rice system (M_1) (264) which is on par with wet DSR (M_2) (237). Lower number of effective tillers was recorded from dry DSR (M_3) (208). Highest number of panicles per square meter in transplanting establishment method might be due to highest plant stand and more number of tillers to panicle conversion ratio. Wet DSR performed superior over the dry DSR in production of number of panicle was due to favourable condition to establish and translocate the assimilates to sink from the source. The similar results were also reported in findings of Barla and Kumar [21], Mohanty et al. [13], Bohra and Kumar [22] and Mohanta et al. [16].

Among the varieties, significantly higher number of effective tillers m^{-2} were recorded in WGL 44 (S_2) (283) which is statistically on par with RNR 15048 (S_1) (262) over KNM 118 (S_4) (243) and least number effective tillers were recorded in WGL 915 (S_3) (159). The difference in number of effective tillers among the genotypes might be due to their genetic potential, number of tillers, uptake of nutrients by varieties and crop weed competition ability of variety at all crop growth stages. The results are in close conformity by Kumhar et al. [23], Chowhan et al. [24], Dileep et al. [25], and Mangaraj et al. [26].

3.3 Dry Matter Production ($kg\ ha^{-1}$)

Dry matter production recorded at different intervals during crop growth is presented in the Table 4. Higher dry matter production per unit area is the pre-requisite for high grain yield. The

amount of dry matter production depends on effectiveness of photosynthesis of crop.

From the data it is evident that the dry matter production was highest under transplanted rice system (M_1) during all the crop stages. At 30 DAS significantly maximum dry matter production was recorded under transplanted rice (M_1) (2489 $kg\ ha^{-1}$) over wet DSR system (M_2) (1975 $kg\ ha^{-1}$) and minimum dry matter production was observed under dry DSR system (M_3) (1677 $kg\ ha^{-1}$). Dry matter production for 60 DAS ranged between (8135 and 6850 $kg\ ha^{-1}$) for 90 DAS ranged between (12200 and 11079 $kg\ ha^{-1}$) and for harvest ranged between (13133 and 12087 $kg\ ha^{-1}$). At 60 DAS significantly higher dry matter was observed under transplanted rice system (M_1) as compared to dry DSR and which was statistically at par with the wet DSR system (M_2). The same trend was reported at 90 DAS and at harvest. Higher dry matter production in transplanted rice is mainly due to better establishment of seedlings and more number of tillers m^{-2} whereas lowest dry matter production in dry DSR is mainly due to lower plant stand and less number of tillers m^{-2} . This was supported by Shan et al. [27], Mohanty et al. [13], Singh et al. [28], Tomar et al. [14].

Among varieties, more dry matter accumulation was recorded by KNM 118 (S_4) at all crop growth stages (30 DAS-2272, 60 DAS-8237, 90 DAS-12344 and at harvest-13356 $kg\ ha^{-1}$) which was on par with WGL 44 (S_2) (30 DAS-2030, 60 DAS-7862, 90 DAS-11850 and at harvest-12850 $kg\ ha^{-1}$). Lowest dry matter production was recorded by RNR 15048 (M_1) (30 DAS-1910, 60 DAS-6711, 90 DAS-10900 and at harvest-11800 $kg\ ha^{-1}$). The difference in dry matter production among the genotypes might be due to their genetic potential, capacity towards uptake of nutrients by varieties, competition of variety for space, light, nutrients and differential plant height. The results are similar to the findings of Harish et al. [15], Sampath et al. [17], Chandrika et al. [18], Sharath chandra et al. [8], Anil and Siddi [19] and Nayaka et al. [20].

3.4 Grain Yield ($kg\ ha^{-1}$)

Grain yield is the interaction of various growth and yield attributing characters which includes dry matter production, number of tillers, number of panicles, length of panicle, weight of panicle and number of grains panicle $^{-1}$. The experimental data revealed that highest grain yield of 6806 kg

ha⁻¹ was obtained with transplanted system (M₁) of cultivation (Table 5). Wet DSR (M₂) system was on par with transplanting system with 6247 kg ha⁻¹ of grain yield. The lowest grain yield was recorded with dry DSR (M₃) (5058). This is mainly due to high dry matter production, number of tillers, number of effective tillers and number of

grains panicle⁻¹ in transplanted rice system compared to other systems of cultivation.

Higher grain yield in transplanted rice system can be attributed to optimum plant population resulting in good rooting and better nutrient uptake of plant, reduced pest and disease

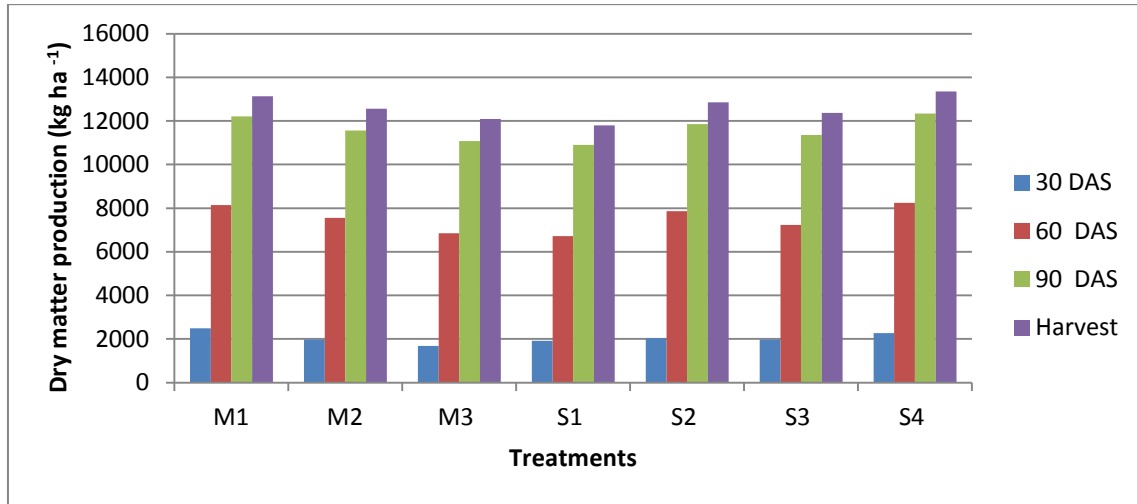


Fig. 2. Dry matter production (kg ha⁻¹) of varieties as influenced by different systems of cultivation

Table 4. Number of tillers, number of effective tillers m⁻² and dry matter production (kg ha⁻¹) of rice varieties as influenced by different systems of cultivation

Treatments	Number of tillers m ⁻²			Number of effective tillers m ⁻²	Dry matter production (kg ha ⁻¹)			
	30 DAS	60 DAS	90 DAS		30 DAS	60 DAS	90 DAS	Harvest
Main plot treatments								
M1	202	356	305	264	2489	8134	12200	13133
M2	189	336	275	237	1975	7550	11558	12558
M3	175	307	252	208	1677	6850	11079	12087
SEm (±)	5	9	8	8	89	207	213	199
CD (p=0.05)	19	35	30	31	350	811	835	780
Sub plot treatments								
S1	203	374	301	262	1910	6711	10900	11800
S2	223	387	327	283	2030	7861	11850	12850
S3	133	234	200	159	1977	7237	11356	12367
S4	197	337	282	243	2272	8237	12344	13356
SEm (±)	9	8	8	9	72	265	284	301
CD (p=0.05)	32	27	28	31	248	916	983	1041
Interaction								
Sub plot treatment at same level of main plot treatment								
SEm (±)	14	16	15	14	164	372	612	781
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Main plot treatment at same/different level of sub plot treatment								
SEm (±)	13	17	15	15	168	382	571	705
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Main plots: M1 : Transplanted rice, M2 : Wet direct seeded rice (drum seeding) M3 : Dry direct seeded rice
 Sub plots: S1 : Telangana sona (RNR-15048), S2 : Siddi (WGL-44), S3 : Warangal Rice-1 (WGL-915), S4 : Kunaram sannalu (KNM-118)

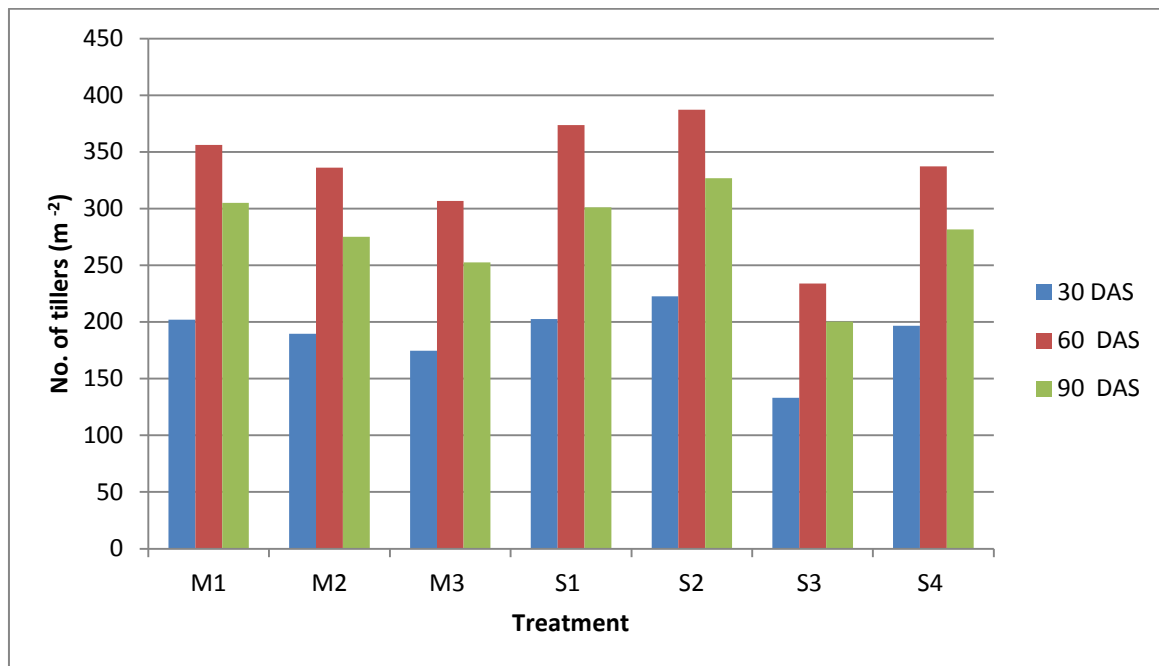


Fig. 3. Number of tillers m⁻² of varieties as influenced by different systems of cultivation

Table 5. Grain yield (kg ha⁻¹), straw yield (kg ha⁻¹) and harvest index of rice varieties as influenced by different systems of cultivation

Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index (%)
Main plot treatments			
M ₁ : Transplanted rice	6806	7692	46.87
M ₂ : Wet direct seeded rice (Drum seeder)	6247	7153	46.55
M ₃ : Dry direct seeded rice	5058	5992	45.67
SEm (±)	271	241	0.29
CD (p=0.05)	1065	946	NS
Sub plot treatments			
S ₁ : RNR 15048	5343	6250	45.95
S ₂ : WGL 44	6244	7159	46.53
S ₃ : WGL 915	5943	6832	46.41
S ₄ : KNM 118	6617	7543	46.58
SEm (±)	190	197	0.13
CD (p=0.05)	656	683	NS
Interaction			
Sub treatment at same level of main treatment			
SEm (±)	575	590	0.37
CD (p=0.05)	NS	NS	NS
Main treatment at same/different level of sub treatment			
SEm (±)	567	565	0.43
CD (p=0.05)	NS	NS	NS

incidence and low weed infestation than dry DSR system. The results are in accordance with the findings of Yadav and Singh [29], Shan et al. [27], Singh et al. [30].

Significantly higher grain yield in wet DSR as compared to dry DSR might be due to proper spacing between plant to plant, good sunlight and immediate establishment of seedlings in wet

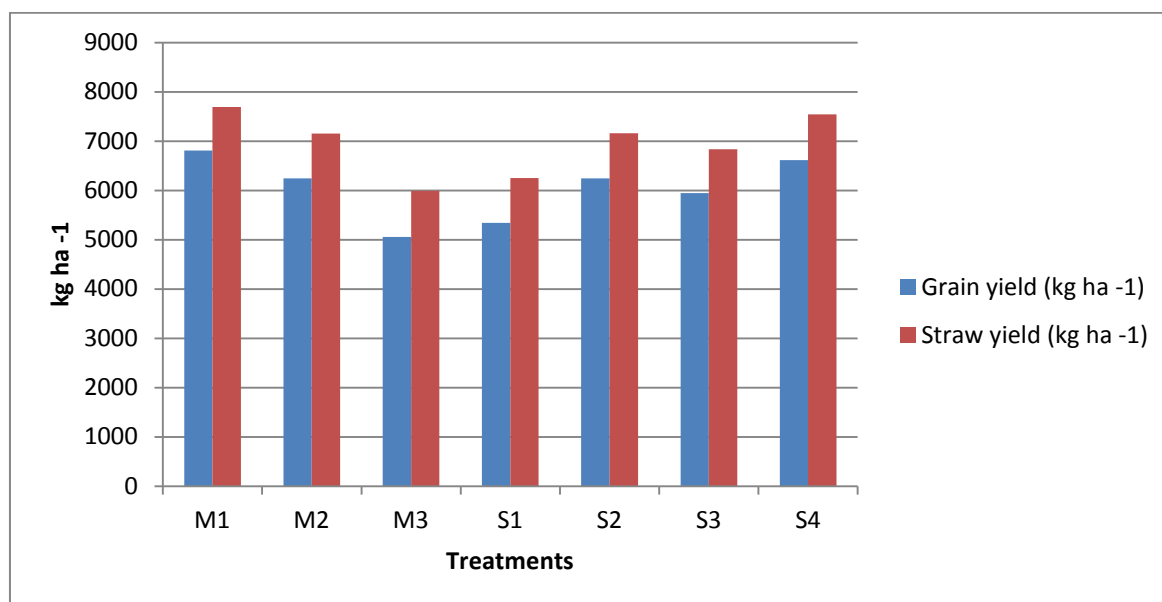


Fig. 4. Grain yield (kg ha⁻¹) and straw yield (kg ha⁻¹) of rice varieties as influenced by different systems of cultivation

DSR system. The results are in accordance with the findings of Mandhata Singh and Singh [31].

In subplots, significantly higher grain yield was recorded in KNM 118 (S₄) (6617) which is statistically on par with WGL 44 (S₂) (6244), closely followed by WGL 915 (S₃) (5943) and grain yield was recorded in RNR 15048 (S₁) (5343). Lower grain yield might be due to lower dry matter production, number of tillers, test weight, panicle weight, number of filled grains panicle⁻¹ and panicle length. The results are in conformity with the findings of Kumhar et al. [23], Harish et al. [15], Chandrika et al. [18], Dileep et al. [25], Sharath Chandra et al. [32], Anil and Siddi [19], Mangaraj et al. [26].

3.5 Straw Yield (kg ha⁻¹)

Straw yield (kg ha⁻¹) is presented in Table 5. The data in table revealed that highest straw yield 7692 kg ha⁻¹ was obtained with transplanted rice system (M₁) which was on par with wet DSR (M₂) (7153 kg ha⁻¹). The lowest straw yield 5992 kg ha⁻¹ was recorded with dry DSR (M₃). This is mainly due to higher dry matter production by good nutrient uptake from soil, increased rate of metabolic processes, good light absorption rate and photosynthetic activity in transplanted rice system compared to other systems of cultivation whereas lower straw yield might be due to lower dry matter production and lower number of tillers per hill. The results were supported by Shan et

al. [27], Sandhya Kanthi et al. [33] and Singh et al. [30].

Among genotypes, significantly higher straw yield was recorded in KNM 118 (S₄) (7543) which is statistically on par with WGL 44 (S₂) (7159), closely followed by WGL 915 (S₃) (6832) and least straw yield was recorded in RNR 15048 (S₁) (6250). Higher straw yield might be due to adequate supply of resources which results higher dry matter production, more number of tillers, maximum leaf area and better portioning of photosynthates resulting maximum straw yield. The results are in line with the findings of Kumhar et al. [16], Harish et al. [34], Chandrika et al. [18], Dileep et al. [25], Sharath Chandra et al. [32], Anil and Siddi [19] and Mangaraj et al. [26].

3.6 Harvest Index (%)

The harvest index was not significantly influenced either by different systems of cultivation or varieties and even the interaction effect remained non significant as presented in Table 5. The results were supported by Barla and Kumar [21], Lavanya and Mallareddy [35].

4. CONCLUSION

In conclusion from the above study, transplanted rice system recorded superior growth and yield attributing characters and ultimately higher yield.

It is due to optimum spacing leading to more light interception, as well as puddling operation resulting in efficient control of weeds and readily availability of nutrients to rice. This resulted in more number of tillers and effective tillers, higher dry matter accumulation ultimately increasing yield. Among varieties KNM 118 was found to be superior in all the yield attributing characters and yield. This might be due to the capacity of variety towards uptake of nutrients, competition for space, light and nutrients which improved better N uptake and leading to greater dry matter production and its translocation to sink. Interaction effect of main plot and sub plots was found to be non significant regarding yield attributing characters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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