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Growth and Yield Attributes of Rice as Influenced by Systems of Cultivation in different Varieties

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ABSTRACT: With increasing cost of labour and water shortage the farmers are forced to look substitute present existing system of cultivation from transplanting to dry and wet direct seeded rice. Keeping in view a field experiment was conducted during *kharif* season, 2021-22 at Regional Agricultural Station, Jagtial to evaluate the varieties suitable under different systems of cultivation. The experiment was laid out in strip plot design with three main plots (systems of cultivation) *viz.*, transplanted rice (S_1), dry Direct seeded rice (dry DSR) (S_2) and wet direct seeded rice (wet DSR) (S_3) and four sub-plots (varieties) *viz.*, BPT-5204 (V_1), JGL-11470 (V_2), JGL-24423 (V_3) and RNR-15048 (V_4). The experimental results revealed that transplanted rice recorded significantly higher dry matter production (10170 kg ha^{-1}) and yield attributes *i.e.*, effective tillers m^{-2} (230), spikelets per panicle (211), test weight (15.5). Among the varieties JGL-24423 (V_3) recorded significantly higher yield attributes and grain yield (4716 kg ha^{-1}) was at par with RNR-15048 (V_4). Interaction effect revealed that significantly higher grain yield obtained in transplanted system of cultivation with variety JGL-24423 (S_1V_3) than other treatment combinations.

Keywords: Systems of cultivation, growth and yield attributes.

INTRODUCTION

Rice is one of the most important food crops and it feeds more than half of the world's population and provide 20% of daily calories (Carrijo *et al*., 2017). The global area under rice is 165.2million hectares with a production of 509.3 million tonnes with productivity of 4600 kg ha^{-1}. In India, it is grown in about 45.8 m ha with a production of 124 million tonnes and productivity of 2717 kg ha^{-1}, whereas in Telangana State, it is grown in 3.2m ha with the production of 10.22 million tonnes and productivity of 3206 kg ha^{-1} (www.indiastat.com 2020-21). To safe guard and sustain the food security in India, it is important to increase the production productivity of rice under limited water resources. It is estimated that India needs to increase the production up to 37 per cent by 2050.

About 77 percent of the world's rice production is done by traditional transplanting method in puddled condition (Chakraborty *et al.,* 2017). Traditional transplanting system of rice cultivation requires labour, water and energy in greater amounts, due to this it has become less profitable. Now-a-days a shortage of labour during peak periods, increased labour wages and made the transplanting operation costly (Mahajan *et al.*, 2009). In addition the event of delayed release of water from the canal invariably delay the puddling and sowing of rice. This situation is forcing the farmers to deviate from normal date of sowing to delayed sowing. The late planted crop has low productivity per plant due to restricted vegetative growth. Hence, in order to reap maximum returns, the cost of cultivation has to be reduced through minimizing the dependence on labour for some of the operations like transplanting and with less dependence on water at initial stages. To overcome all these problems, direct seeding of rice has been found most appropriate alternative to transplanting. In water scarce areas, the farmers may prefer for direct seeding method as an alternative to traditional method of transplanting.

Direct-seeded rice occupies 26 per cent of the total rice production area in South-Asia. In direct seeded rice, maintenance of nursery area and transplanting are not needed and the crop under this system attains maturity 7-12 days in advance than transplanted rice (Gill, 2008) thus it decreases the overall water requirement of rice cultivation and it also saves the time, input supplements, labour and energy consumption. Proper management of direct seeded rice can produce higher yields than that of conventional transplanted rice cultivation (Ali *et al*., 2007).

Direct seeded rice (DSR) both wet and dry systems of cultivations can increase the water productivity and reduce the labour and energy of rice cultivation. Dry DSR sown with tractor drawn seed drill in unpuddled soil and wet DSR sown with drum seeder in puddled soil condition results in good crop establishment and better emergence of the seedings in pertaining to Northern Telangana Zone.

MATERIALS AND METHODS

The present investigation was conducted in *kharif* 2021-22, at Regional Research Agricultural Station, Jagtial under Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana. The farm geographically situated at an altitude of 234.4 m above mean sea level (MSL) on18º49′40″N latitude and 78º56′45″E longitude in the Northern Agro-Climatic Zone of Telangana State. The experimental soil was clay loam texture. The experiment was laid out with three systems of rice cultivation [transplanted rice (S_1), dry direct seeded rice (S_2) and wet direct seeded rice (S_3)] as main plots and four varieties [BPT-5204 (V_1), JGL-11470 (V_2), JGL-24423 (V_3) and RNR-15048 (V_4)]as sub-plots with three replications in strip plot design.

The pre germinated seeds were sown in nursery for transplanted rice system at seed rate of 62 kg ha^{-1}, dry DSR system seeds were directly sown with tractor drawn at seed drill seed rate of 23 kg ha^{-1} and in wet DSR system seeds were sown with drum seeder at seed rate of 28 kg ha^{-1}. For control of weeds, pretilachlor @ 1200 ml in 45 kg of sand was applied, while 2,4-D salt is applied as post-emergence application. Nitrogen is applied in the form of urea with a fertilizer dose of (120 kg ha^{-1} for transplanted and wet DSR and 150 kg ha^{-1} for dry DSR) was applied in three equal splits *viz.*, at the time of sowing or transplanting, maximum tillering stage and panicle initiation stage. Phosphorus is applied as the basal dose in the form of SSP (single super phosphate) with a dose of 50 kg ha^{-1} (for transplanted and wet DSR) and 60 kg ha^{-1} (dry DSR). Potassium is applied in the form of MoP (Muriate of Potash) with a dose of 40 kg ha^{-1} is applied in two equal splits *viz.*, at the time of sowing or transplanting and panicle initiation stage. The plant height (cm), dry matter production (kg ha^{-1}), effective tillers m^{-2}, test weight (g), grain and straw yield (kg ha^{-1}) were measured at harvest and the data was statistically analyzed by applying the technique of analysis of variance for strip plot design and was tested by F-test using Gomez and Gomez (1984). Critical difference for treatmental significant means was examined at 5 percent level of probability.

RESULTS AND DISCUSSION

A. Growth parameters

The data relevant to plant height and dry matter production at harvest of rice under different systems of cultivation and varieties were recorded and presented in Table 1. The plant height is significantly higher in wet DSR (S_3) which is at par with the transplanted rice (S_1) and higher dry matter production was observed under transplanted rice (S_1) which is at par with wet DSR (S_3). Plant height is one of most important morphological character and is function of combined effect of genetic character, soil and nutrient availability and environmental conditions of area which it is grown. The dry matter accumulation is a function of number of leaves and tillers, plant height and panicle weight, translocation and conversion of food material for growing parts and wetness with continuous water supply to crop that maintained good rooting condition and metabolic process that perform timely nutrient mobilization. The lower plant height and dry matter accumulation was recorded under dry DSR (S_2). Increase in plant height and dry matter accumulation is slow during the initial growth stages of dry DSR (S_2) and it linearly increased till the maturity. Similar results were found in Choudhary *et al.* (2021); Mali *et al.* (2018); Gangwar *et al.* (2009).

Among the varieties significant higher plant height recorded from RNR-15048 (V_4) followed by JGL 24423 (V_3) and BPT-5204 (V_1). This may be due to the inherent genetic character of the variety and the environment in which the plant is grown. However, the lowest was recorded from JGL-11470 (V_2). While the dry matter accumulation was significantly higher in JGL-24423 (V_3) which is at par with BPT-5204 (V_1). These may be due to the variation in duration of crop growth period between the varieties, more plant population per unit and higher panicle weight.

The interaction effect of different systems of cultivation and varieties was found to be not significant regarding plant height and dry matter production.

B. Yield parameters

Highest number of effective tillers was recorded under transplanted rice (S_1) which is on par with wet DSR (S_3) (Table 1). Tillering plays a very important role in determining grain yield as it represents the number of panicles in a unit area the higher number of tillers under transplanted rice may be due to favourable edaphic conditions for plant to grow than under wet and dry conditions, also may be due to more availability and utilization of nutrients in transplanted rice at panicle development stage. The lowest number of effective tillers were recorded under dry DSR. The similar results were also reported in findings of Javid *et al.* (2012); Meena *et al.* (2016). The test weight of 1000-grains data revealed that there was no significant difference among the different systems of cultivation of rice. These results were in accordance with Prathiksha *et al.* (2017); Mali *et al.* (2018).

Among the varieties significantly highest number of effective tillers m^{-2} were recorded from BPT-5204 (V_1) over the JGL-24423 (V_3) and RNR-15048 (V_4). Test weight among the varieties recorded to be significantly highest by Jgl-24423 (V_3) over the BPT-5204 (V_1) and RNR-15048 (V_4). The lowest number of effective tillers and test weight was recorded from JGL-11047 (V_2).

Table 1: Plant height, dry matter production, effective tillers, test weight, grain yield and straw yield of rice as influenced by different systems of cultivation and varieties.

Treatment	Plant height (cm)	Dry matter production (kg ha^{-1})	Effective tillers m^{-2}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Main plot: Systems of cultivation						
S_1 – Transplanted rice	101.2	10170.0	230.4	15.5	4762	5858
S_2 – dry DSR	96.2	9120.0	195.8	15.1	4058	4979
S_3 – wet DSR	103.6	9897.5	213.0	15.3	4478	5617
SEm±	1.4	204.1	6.3	0.4	126	138
CD(P=0.05)	5.4	801.4	24.6	NS	496	540
CV %	4.7	7.3	10.2	8.5	9.9	8.7
Sub plots: Varieties						
V_1 – BPT 5204	97.8	9817.8	235.8	14.0	4180	5057
V_2 – JGL 11470	95.7	9237.8	198.9	11.9	4352	5341
V_3 – JGL 24423	101.9	10235.6	214.4	22.2	4716	6000
V_4 – RNR 15048	105.9	9625.6	202.8	13.2	4482	5540
SEm±	0.9	183.6	6.1	0.5	103	125
CD (P=0.05)	3.2	635.3	21.2	1.7	356	432
CV %	2.8	5.7	8.6	9.8	6.9	6.8
Interaction (S × V)						
V at same level of S						
SEm±	1.5	350.3	11.9	0.6	140	215
CD (P=0.05)	NS	NS	39.8	NS	429	NS
CV %	2.7	6.2	9.6	7.0	5.4	6.8
S at same or different level of V						
SEm±	1.9	365.6	12.0	0.7	174	232
CD (P=0.05)	NS	NS	36.5	NS	615	NS
CV %	2.7	6.2	9.6	7.0	5.4	6.8

Interaction between the systems of cultivation and varieties on number of effective tillers m^{-2} were found to be significant (Table 2). Highest number of effective tillers m^{-2} was recorded in BPT-5204 (S_1V_1) and was at par with S_1V_2, S_1V_3, S_2V_1 and S_3V_3. Higher of tillers may be due to the varietal character and adequate availability of photosynthates under transplanted system of cultivation, produce higher dry matter, good maintenance of source-sink relationship due to longer reproductive phase. While the lowest number of effective tillers recorded by S_2V_3 across three different systems of rice, this may be due to lower source-sink relation under dry direct seeding condition. This is supported by Singh *et al.* (2015); Raj *et al.* (2017).

Table 2: Interaction on effective tillers m^{-2} of rice as influenced by different systems of cultivation and varieties.

Varieties	Systems of cultivation			Mean
	S_1	**S_2**	**S3**	
V_1	256	236	215	236
V_2	223	180	193	199
V_3	244	172	228	214
V_4	198	195	215	203
Mean	230	196	213	
		SEm±	**CD(P=0.05)**	**CV %**
S		6.3	24.6	10.2
V		6.1	21.2	8.6
Interaction				
V at same level of S		11.9	39.8	9.6
S at same or different level of V		12.0	36.5	9.6

C. Grain and straw yield (kg ha^{-1})

Among the different systems of cultivation transplanted rice has significantly recorded the highest gain and straw yield over the dry DSR and it is statistically on par with the wet DSR (Table 1). The transplanted rice registered an increase of 14.8 and 6 per cent in grain yield over dry DSR and wet DSR systems of cultivation, respectively. This can be attributed in facilitating the proper planting which resulted in optimum plant population, providing good rooting and better nutrient uptake of plant, reduced pest and disease incident and low weed infestation over wet DSR and dry DSR systems. These results was supported Mai *et al.* (2021); Mankotia *et al.* (2009); Javaid *et al.* (2012); Raj *et al.* (2012); Singh *et al.* (2013); Shan *et al.* (2012).

The data revealed that JGL-24423 (V_3) recorded highest grain yield of all the varieties and it remained statistically at par with RNR-15048 (V_4). The grain yield was greatly influenced by varietal genetic makeup and the many characters *i.e.,* number of effective tillers, panicle weight and test weight. While straw yield of variety JGL-24423 (V_3) significantly recorded higher straw yield over the RNR-15048 (V_4) and JGL-11470 (V_2). Dry matter production mainly determines the straw yield of a variety, also micro environment of crop and photosynthetic and metabolic activity of a plant also effect on straw yield. While the lowest grain yield and straw yield was recorded by BPT-5204.

It was observed there is significant interaction effect (Table 3) of systems of cultivation and varieties this might be due to the different growing conditions among the systems of cultivations and the varieties are different among their varietal characters and the highest yield recorded from transplanted system of cultivation with JGL-24423 (S_1V_3) which was at par with S_1V_1, S_1V_2, S_1V_4, S_3V_3 and S_3V_4. The difference in the grain yield among the varieties greatly influenced by the inherent genetic characters, another due to edaphic factors in which it grown and the micro environment conditions of the different systems also shows variable effect on the different varieties. However, the lowest grain yield and straw yield was recorded by BPT-5204 (S_2V_1), this might be due to lower productive tillers and low spikelets per panicle.

Table: 3 Interaction on grain yield of rice as influenced by different systems of cultivation and varieties.

Varieties	Systems of cultivation			Mean
	S_1	**S_2**	**S3**	
V_1	4757	3770	4013	4180
V_2	4572	4187	4297	4352
V_3	5137	4437	4573	4716
V_4	4583	3837	5027	4482
Mean	4762	4058	4478	
		SEm±	**CD(P=0.05)**	**CV %**
S		126	496	9.9
V		103	356	7.0
Interaction				
V at same level of S		140	429	5.4
S at same or different level of V		174	615	5.4

CONCLUSION

In this study, higher rice yield was obtained from transplanted rice. The yield mainly depends on dry matter production and number of productive tillers. The yield of rice varieties is mostly influenced by individual genetic character and environment conditions. The variety JGL-24423 resulted higher yield, this is mainly due to higher dry matter production and test weight among all the varieties.

FUTURE SCOPE

Practicing alternate system of cultivation from transplanting to direct seeding system, eliminates nursery, reduce the sowing cost and enhance the water managements when compared to transplanted rice. Rapid emergence and good establishment during the early crop growth stages of rice in dry seeded rice. Alike agronomic measures, breeding approaches of specific varieties is also need to achieve maximum potential under different systems of cultivation.

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