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EFFECT OF DIFFERENT SEED RATES ON RICE YIELD FOLLOWING DSR TECHNOLOGY IN POTOHAR REGION

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ABSTRACT

Rice is the most important cereal crop that plays a multifarious role in the agricultural economy of Pakistan along with its utilization as second staple crop after wheat. The production capacity of varieties in all crops mainly depend on optimized seed rate. We carried out this study at Rice Program NARC during the kharif 2021 to find out the optimal seed rate of most cultivated varieties of fine (Super Basmati) and coarse rice (IR-6) in Pakistan by using direct seeded rice (DSR) drill sowing method with four varied seed rates i.e 11kg, 9kg, 7kg and 5kg/acre. Paddy yield depended on different yield related attributes i.e plant height, total number of plants/m^2, total tillers/m^2, number of productive tillers/m^2, panicle length, number of grains/m^2 and yield. Our results indicated that maximum grain yield was obtained at seed rate 11kg (3149.915 kg/acre and 1598.565kg/acre) in IR-6 and Super basmati respectively. Lowest yield was observed at 5kg seed rate (2239.34kg/acre and 836.38kg/acre) in IR-6 and Super Basmati. Based on these findings, it is concluded that using optimal seeding rate of 11kg/acre for direct seeded fine and coarse rice cultivars is beneficial in terms of productive tillers and higher yield.

Keywords: drill sowing, reduced irrigation, sowing method, weed management

INTRODUCTION

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world's population occupying 11% of all cultivated land worldwide (Khush, 2013). Being a cash crop, rice holds an important place in the agriculture of Pakistan. Among the cereal crops, rice is one of the most important commodities for Pakistan as it occupies second position in staple food crops followed by wheat, and similarly second in exportable commodities after cotton (Economic Survey of Pakistan, 2021). In terms of value added in agriculture, it contributes 3.1% while in GDP its share is 0.6%. Rice cropped area increased by 8.0% (3,034 million hectare) in 2020-21 as compared to last year (2,810 thousand hectares) while the production increased by 2.9% in 2020-21 (7.410 million tonnes) as compared to last year (7.202 million tonnes) (Economic Survey of Pakistan, 2020-21). Rice is the crop having the highest water requirement among all the cultivated crops. Water requirement and uptake fluctuates depending on the variety and crop duration.

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To produce 1kg of basmati rice, about 25,000 liters of water is being used in Pakistan while in China and India two to 5kg of rice is being produced with this water respectively (Ali *et al.,* 2014). Pakistan has ample supply of fresh water but 21% of it is being taken up by rice crop. Traditionally, seed is sown for nursery purpose and then it is transplanted to the standing water puddled field after the age of one month. Irrigation is provided on continuous basis to keep standing water in the field which also causes water loss because of evaporation, puddling process and percolation (Mann *et al.,* 2007). Rice crop production is laborious and time-consuming as its field management requires larger number of manpower and availability of irrigation water, which also makes it very expensive (Singh, 2013; Dongarwar *et al.,* 2018;).

Direct-seeded Rice (DSR) has emerged as a very useful and Revolutionary cropping method to overcome the water and labor shortages (Sun and Hussain, 2015). Overall water demand of rice can be reduced through direct seeded rice culture as it does not require continuous flooding and submergence. Variable rainfall may cause production risk in tradional method, but DSR may reduce this loss (Singh *et al*., 2006). Plant population is determined by the seed rate which

also have influence over the crop growth, its competitiveness and ultimately the yield. Poor sowing method leading to low plant density are the main constraints posing a threat to crop growth and have a negative influence on the yield of rice (Sivaesarajah *et al.,* 1995; Dongarwar *et al.,* 2018). This study was planned to find out the suitable seed rate and their effect on yield and yield related attributes by drill sowing of coarse and fine rice varieties.

MATERIALS AND METHODS

The study was aimed to find out the effect of different seed rates on yield and growth of rice varieties. Study was conducted during (kharif) season of 2019-20 at experimental area of Rice Program, Crop Sciences Institute, National Agriculture Research Centre (NARC) Islamabad, Pakistan. The experiment was conducted by using coarse (IR 6) and fine (Super Basmati) varieties of rice in factorial randomized complete block design with three replications on varied seed rates i.e. 11kg/acre, 9kg/acre, 7kg/acre and 5kg/acre on plot size of 27m x 9m. For weed control in DSR sowing method of rice, Pendimethaline was was sprayed @ 1litre acre^{-1} at saturated soil condition after seeding as pre-emergence herbicide whereas post-emergence Pyranex Gold was sprayed 25 days after seeding @ 120g/acre at saturated soil condition. Standard dose of Fertilizer @ 49-36-24kg NPK acre^{-1} was applied. Full dose of phosphorous and potash and 1/3 nitrogen was applied at the time sowing while rest of nitrogen was applied in two splits at 35 and 55 days after seeding. Irrigation was applied at 4-6 days interval starting from seeding till maturity (25 days before harvesting). Required recommended measures were adopted to control the insects and diseases. The crop was harvested mechanically at full maturity.

Data recording

Data regarding number of plants per square meter was recorded at 10 days after seeding. Plant height was measured in centimeters, total tillers, number of productive tillers, panicle length were recorded at maturity. Numbers of grains per panicle were counted manually and grain yield per square meter was measured in kg by using weighing balance.

Statistical analysis

The data collected was statistically analyzed by using statistical software Statistix 8.1 for analysis of variance

RESULT AND DISCUSSION

Growth and yield traits

Plant height within treatment and the interaction between treatment and genotypes showed significant difference (Table 1). Maximum plant height (107cm) was recorded at 5kg seed rate followed by 7kg seed rate (106cm) and minimum plant height (104.8cm) was recorded at 9kg and 11kg (105cm) in coarse rice (IR-6) Figure 1(a). In fine rice cultivar (Super Basmati) maximum plant height was found at 9kg seed rate (130.5cm) followed by 11kg (129cm) whereas at 7kg minimum plant height (127cm) was observed Figure 1(b). Figure 1(a,b) showed 66% and 44% positive association of grain yield with plant height both for IR-6 and Super Basmati. These results are in accordance with the results of Akbar and Ehsanullah (2004) who reported that the seed rate has non-significant effect on plant height. For number of plants per square meter analysis of variance showed significant differences across treatments as represented in (Table 1). Maximum number of plants (39) were observed at 11kg seed rate in while minimum number of plants (30) were observed at 5kg seed rate in coarse rice (IR-6) Figure 2(a). Super Basmati showed maximum number of plants (43) at 11kg seed rate whereas minimum number of plants per square meter was observed at 7kg seed rate (30) Figure 2(b). Number of plants per square meter has direct link with the paddy yield having 86% and 76% determination coefficient in IR-6 and Super Basmati Figure 2(a,b). The maximum number of plants/m^2 at 11kg/acre seed rate might be contributed to optimal plant population in DSR which lead to higher yield per square meter. These results are in accordance with Chauhan *et al.,* 2011 who reported that number of plants/ square meter increase with the increase in seed rate.

Table 1. Mean square analysis for yield and yield related attributes

Source	PH	PL	NGP	NP/sqm	NT/sqm	PTM/sqm	Yield kg/a
Replication	18.01	5.255	145.505	21.937	5889	7670	14917.5
Treatment	4.72	7.700	18.672	272.833**	13214	11243	1374708**
Genotype	6292.92**	174.422*	100.630*	18.750	130208**	173401	2.666 E+07**
Treatment * Genotype	13.95**	0.450	2.686	46.806	334	1646	9419.36
Error	0.85	1.935	13.822	53.617	2639	2588	132366
CV	0.79	5.03	2.84	21.54	16.70	17.67	18.38

PH : Plant height, PL : Panicle Length, NGP: Number of Grains per Panicle, NP/sqm: number of plants per square meter, NT/sqm: number of tillers per square meter, PTM/sqm: number of productive tillers per square meter.

The analysis of variance for number of tillers per square meter showed significant difference among treatments (Table 1). Maximum number of tillers (283, 393) were recorded at 9kg seed rate among IR6 and Super basmati followed by 11kg seed rate (277,386) Figure 3. Number of tillers showed positive correlation with paddy yield having 76% and 82.3% coefficient determination in IR-6 and Super basmati Figure 3(a,b).The greater number of tillers per square meter also contributed to optimal plant population in DSR. Rice varieties sown with higher seeding density showed higher number of tillers per square meter and these results are in accordance with the results of Phuong *et al.,* 2005 and Ameen *et al.,* 2014 in which they reported that increase in seed rate cause the increase in number of tillers /m^2. For productive tillers our result shows significant differences across varied seed rate (Table 1). Highest number of productive tillers were observed at 11kg in IR 6 and Super Basmati (272,381) whereas minimum number of productive tillers were found in case of IR6 at 9kg (203) and in Super basmati at 5kg (307) Figure 4 (a,b).

Positive association of 68% and 58% was found between productive tillers and paddy yield in IR6 and Super basmati Figure 4(a,b). At 11kg seed rate higher number of tillers/square meter might attributed to optimal plant population therefore more appropriation for exploitation of resources between panicles which lead to a greater number of panicles bearing tillers per unit area. Similar results were found by Chuhan *et al*., 2011 and Aslam *et al*., 2002 who reported that increase in number of number of panicle bearing tillers/m^2 (productive tillers) was due to increase in the seeding density (seed rate). It might be attributed to optimum plant population due to higher initial seeding density/m^2 in this treatment. More efficient utilization of available resources was found to be linked with higher number of tillers per unit area. These results are confirmed by Pedroso *et al.,* 1986; Sharma 1994 and Aslam *et al.,* 2002. Who observed that the seeding rate was significantly influenced, the panicle bearing tillers/m^2 and significantly increased the productive tillers per unit area.

Panicle length showed significant effect across different seed rate and among genotypes whereas the interaction effect of seed rate and genotypes did not significantly affect the panicle length as shown in (Table 1).

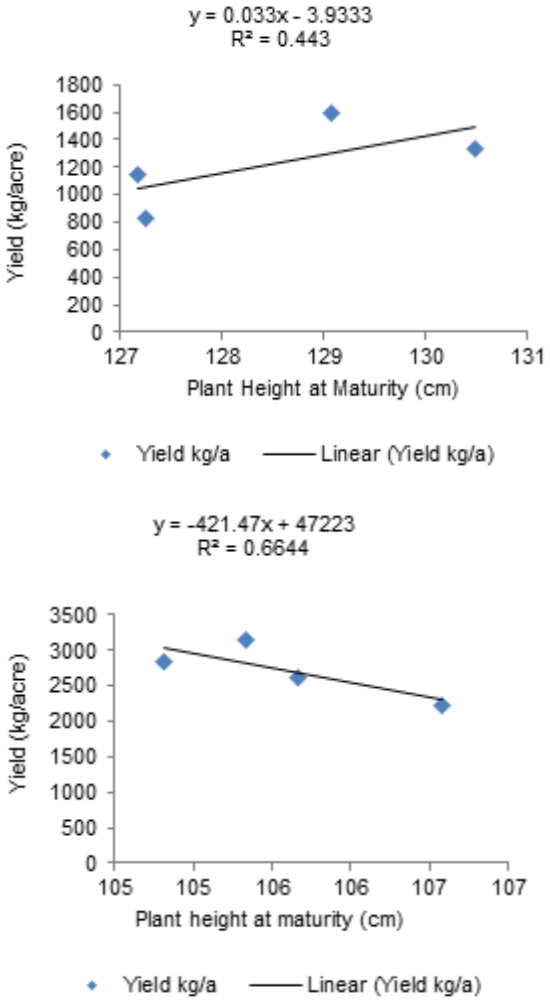
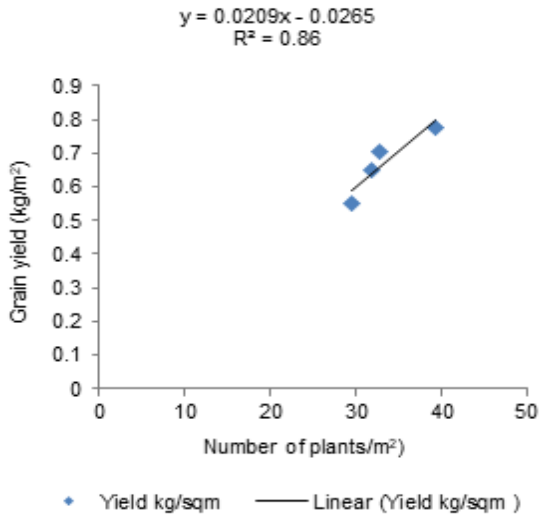
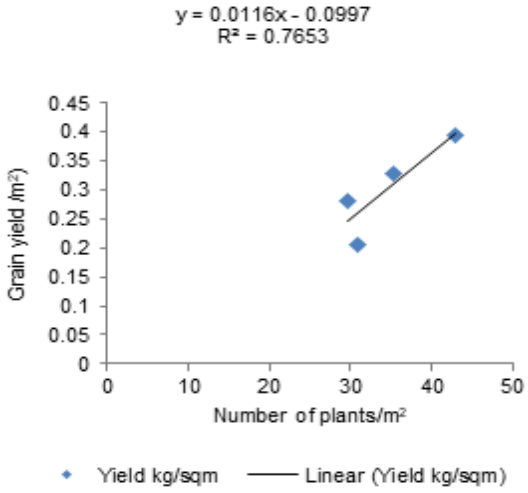


Figure 1. Relationship of plant height at maturity with grain yield (kg/acre) in IR-6 (a) and Super basmati (b)





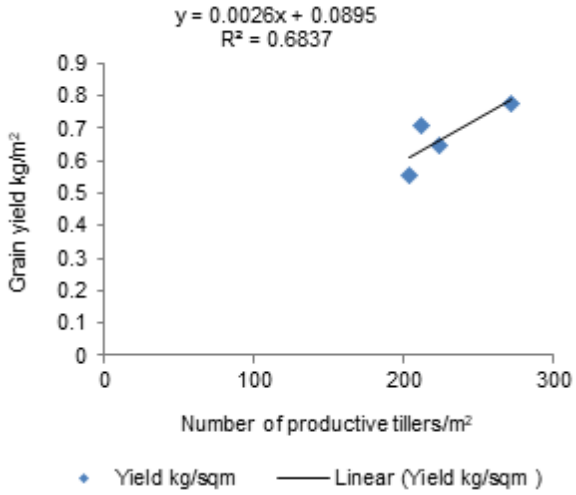
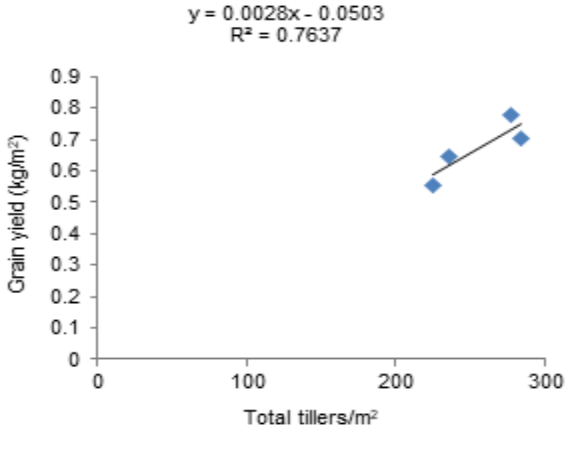


Figure 2. Relationship of number of plants/m^2 with grain yield (kg/m^2) in IR6 (a) and Super Basmati (b)



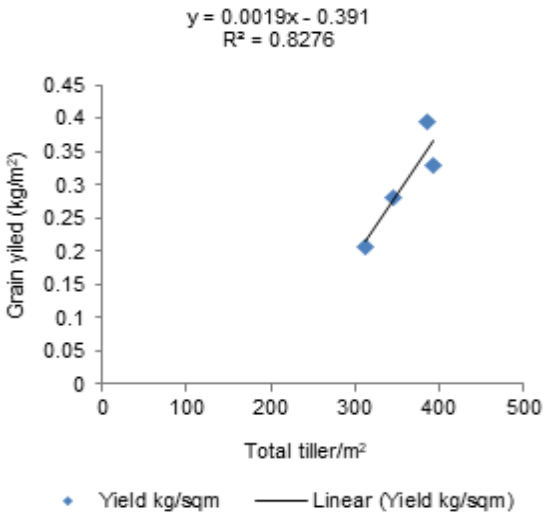


Figure 3. Relationship of total number of tillers/m^2 with grain yield (kg/m^2) in IR-6 (a) and Super Basmati (b)

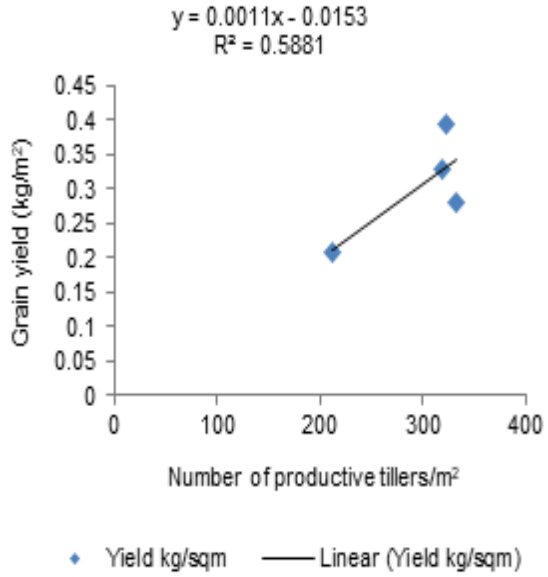
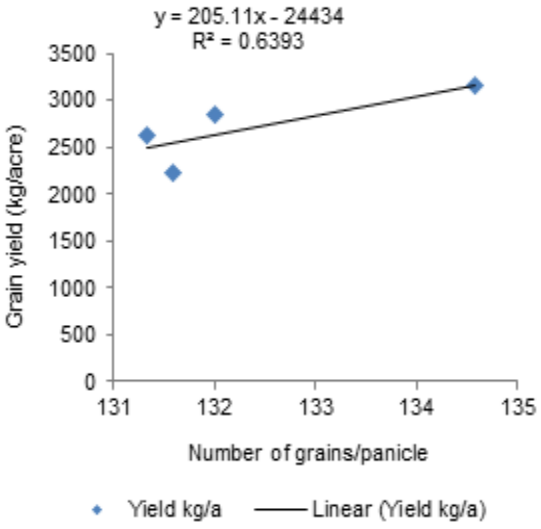


Figure 4. Relationship of number of productive tillers/m^2 with grain yield (kg/m^2) in IR-6 (a) and Super basmati (b)

Among coarse rice cultivar maximum panicle length (26.3cm) was observed at 11kg seed rate whereas minimum panicle length (24.8cm) was recorded at 5kg seed rate Figure 6(a). Fine rice cultivar showed maximum panicle length (30.6cm) at 11kg seed rate and minimum panicle length (28.6cm) at 5kg seed rate Figure 6(b)**.** Panicle length is positively correlated with paddy yield having coefficient determination of 90% and 93% in IR6 and Super Basmati Figure 6(a,b).). The results are confirmed by (Ameen *et al.,* 2014 and Jayanti *et al.,* 2015) who observed that seeding rate influenced the panicle length, optimal seed

rate shows maximum panicle length. The mean square analysis shows non-significant differences across treatment whereas among genotypes shows significant difference as represented in (Table 1). The interaction effect of seed rate with rice genotypes was found non-significant. Among IR6 and Super Basmati maximum number of grains per panicle (134 and 131) was recorded at 11kg seed rate followed by 9kg seed rate (132 and 130) respectively Figure 5. Number of grains per panicle has weak positive association with paddy yield having coefficient determination of 63% in IR6 whereas Super basmati showed strong association with paddy yield having coefficient determination of 99% Figure 5(a,b).



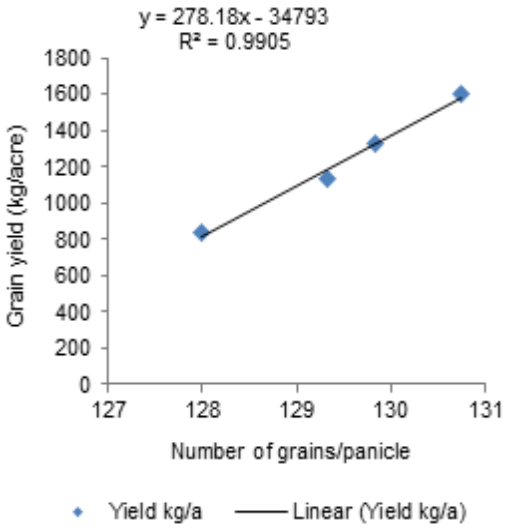
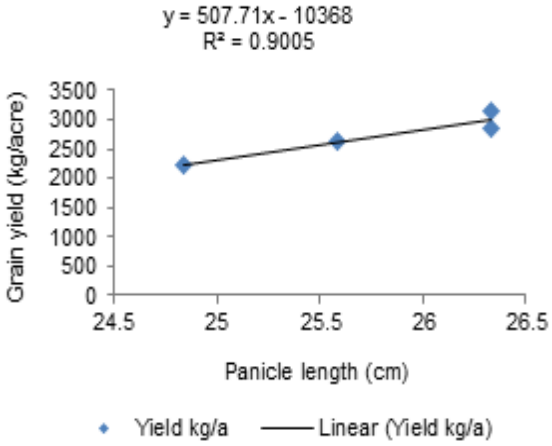


Figure 5. Relationship of number of grains per panicle with grain yield (kg/acre) in IR-6 and Super Basmati



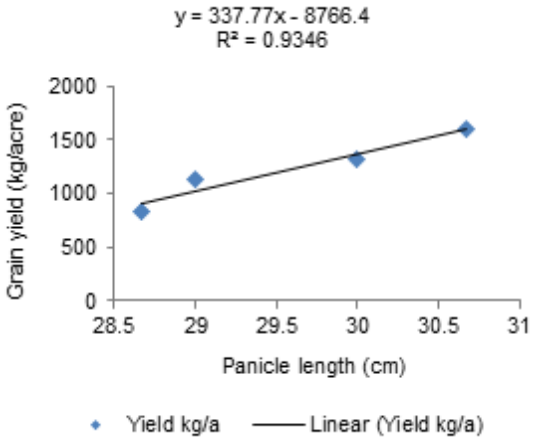


Figure 6. Relationship of panicle length with grain yield (kg/acre) in IR-6 (a) and Super basmati (b)

A significant increase in grain yield was recorded by increasing the seed rate as shown in (Table 1). IR6 and Super basmati produce higher grain yield (3149.915kg/acre and 1598.565 Kg/acre) respectively at 11kg seed rate followed by 9kg (2853.135kg/acre and 1328.765kg/acre) whereas minimum yield was recorded at 5kg seed rate (2239.34kg/acre and 836.38kg/acre) Figure 7. These results are in accordance with the findings of earlier researcher who reported that increased in seeding density cause an increase in the grain yield (Morales *et al*.,1984; Romyen *et al.,* 2002 and Jayanti *et al.,* 2015). The grain yield is affected by various yield components such as number of plants /m^2, number of productive tillers, panicle length and number of grains/panicle (Hassan *et al*., 2003). Higher grain yield recorded at 11kg seed rate was due to higher panicle density number of productive tillers/m^2 with maximum utilization of resources at grain filling stage. Our study suggested that there was a significant.

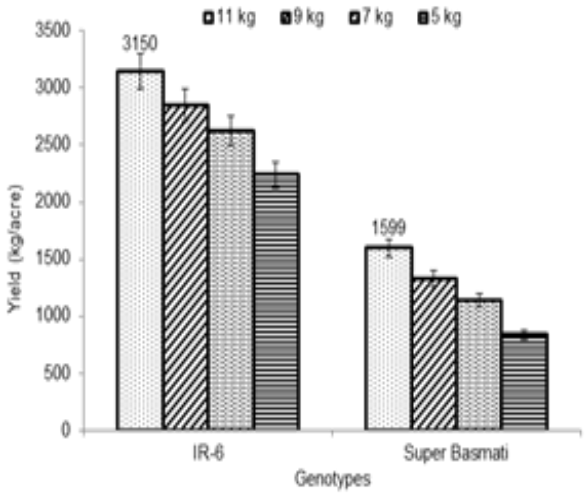


Figure 7. Effect of seed rate and rice varieties on grain yield (kg/acre)

CONCLUSION

It was concluded on the basis of growth traits and as well as yield traits that optimal seed rate of 11kg is suitable for DSR method of sowing for both fine and coarse rice. DSR is a water-wise technique, because no puddling is required and water is given just to meet the water requirement of rice plant. Overall performance of coarse rice was better in terms of yield as compared to fine rice varieties in Potohar region. For Potohar region coarse rice is recommended for general cultivation on the basis of this study. However, agronomic management and a suitable variety with appropriate traits would be needed to achieve maximum potential under DSR.

CONFLICTS OF INTEREST

There are no conflicts of interest regarding the publication of this manuscript.

AUTHOR'S CONTRIBUTION

A. Majeed: Planned the research work and supervised the experiment.
M. S. Ahmed: Helped in field layout and conducting the research in field.
R. A. Javaid: Performed statistical analysis and its scientific interpretation.
F. Siddique: Monitored field activities and performed the experiment according to the plan
M. J. Hassan: Participated in field data collection and crop observational studies.

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