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Maximizing Rice Production via Direct Seeded Rice: Insights from Correlation and Path Analysis

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ABSTRACT: Rice is an important food crop in the world by providing higher nutrition to half of the world population. To fulfill the rising demand for food, water and land resources have been extensively exploited in recent years. But with change in the climate and less availability of water there is a huge need of growing the rice with direct seeded condition. The direct seeded rice (DSR) technology has been adopted by rice experts and farmers in the tropics and subtropics as a result of the changing climate. Rice production using the DSR method uses much less freshwater and labor, while also producing more rice, using resources more effectively, and emitting less greenhouse gases. By keeping these aspects in to consideration present experiment was conducted. The present study was conducted on 202 genotypes from the Bengal and Assam Aus rice panels during the Rabi season of 2020-21 investigated nine quantitative traits impacting grain yield. The results observed that a significant positive correlation of grain yield with plant height, flag leaf length, flag leaf breadth, number of tillers per plant, and productive tillers per plant. Focusing on these attributes when selecting plants can enhance production. Furthermore, Path analysis identified the number of tillers per panicle as the primary driver of yield, followed by flag leaf width, productive tillers per plant, and flag leaf length. These results emphasize the importance of these traits in rice improvement programs and suggest their inclusion in selection models to achieve indirect enhancements in yield and overall crop performance. This study provides valuable insights into optimizing rice production by strategically considering specific plant characteristics.

Keywords: Correlation analysis, direct-seeded rice, path coefficient analysis, rice, yield attributes.

INTRODUCTION

Rice (*Oryza sativa*) is a staple food for over half of the world's population (Zhang *et al*., 2014), making it a critical crop for global food security. Traditional rice cultivation practices have long relied on flooded fields, known as paddies, which demand significant water resources, labor, and infrastructure. However, in a world facing escalating concerns over water scarcity, labor shortages, and the urgent need for sustainable agricultural practices, alternative rice cultivation methods are gaining prominence. Among these innovations, Dry Direct Seeded Rice (DDSR) has emerged as a promising and transformative approach. Rice is traditionally grown by transplanting seedlings into new soil, which creates favorable conditions for rice survival and roots. In addition, it offers a favorable setting for weed control (Singh *et al.* 2001). The introduction of a water-labor-energy efficient direct seeded aerobic rice cultivation system has been emphasized for a number of reasons including global climate change, water scarcity, labor shortages, declining water table levels, predicted significant shortfalls in rice production, increasing population, expensive labor, and rising greenhouse gas emissions (Monaco *et al*., 2016; Rasul, 2016; USGS, 2016).

Before, the United States, Europe, and other industrialized nations with high levels of agricultural mechanization employed direct seeding of rice technology extensively (Farooq *et al*., 2011). Direct seeding of rice technology has gained more attention recently as a result of the rapid advancement of science and technology, and many developing nations are now actively promoting it. According to Farooq *et al*. (2011), direct-seeded rice now occupies more than 50% of the land area in several nations. Direct Seeded conditions are rising throughout Asia, and India, the second-largest producer of rice after China, now has more than half of its rainfed rice fields under Direct Seeded cultivation (Anandan *et al*., 2016), up from 23% a decade ago (Rao *et al*., 2007). In terms of land preparation, direct seeding is substantially less disruptive (Chakraborty *et al*., 2017), and it can be mechanized on both a local and a big scale. Additionally, Direct Seeding has been associated with production gains (Chakraborty *et al.*, 2017), and the crop tends to develop more quickly, providing options for crop rotation and a way to avoid terminal drought. Few contemporary high-yielding varieties have been created expressly for this purpose, despite the growing significance of Direct Seeded rice in tropical farming systems (Farooq *et al.*, 2011).

Only a small number of cultivars of productive aerobic rice are developed now that have great production potential and a wide range of biotic and abiotic stress tolerance. More cultivars with a lower yield penalty must be created for the direct seeded situation though. In order to identify the lines with the best performance and traits that have a positive correlation with yield so that they can be used for the development of direct seeded varieties, this study used correlation analysis and Path analysis in the Bengal and Assam Aus Panel (BAAP) created by Gareth Norton *et al*. (2018). By considering all the above aspects in to consideration the present experiment was conducted on correlation and path analysis under conditions of dry direct seeded rice.

MATERIAL AND METHODS

202 genotypes from Bengal and Assam Aus Panel (BAAP) were used in the present research for the correlation and path analysis studies. The experiment was conducted during Rabi season of year 2020-21 at ICAR- National Rice Research Institute, Cuttack, Odisha, following Randomized Block Design with two Replications. Each genotype was directly sown in a soil, at a distance of 15 cm between plants and 20 cm between rows. To promote adequate germination, the field was watered right away after seeding. Thereafter, irrigation was administered once every 5-7 days. The plots were kept dry throughout the crop season to maintain aerobic conditions. To maintain a consistent and healthy crop stand, recommended cultural activities and plant protection measures were implemented. Nine morphological characteristics, including SPAD, days to 50% flowering, plant height, flag leaf length, flag leaf width, panicle length, number of tillers per plant, productive tillers per plant, and single plant yield, were recorded for three randomly chosen plants. The approach outlined by Johnson *et al*. (1955) was used to estimate correlations. The correlation coefficients were compared to the table values at (n-2) degrees of freedom at the 5% and 1% levels in order to ascertain whether or not they are significant and Path coefficient analysis was carried out at the genotypic level as subjected by Wright (1921) and discussed by Dewey and Lu (1959). Using R-software, the statistical analysis was completed.

RESULTS AND DISCUSSION

The direction and strength of the relationship between yield and yield-attributing traits should be taken into consideration when choosing the essential trait to use in crop improvement programs through appropriate breeding methods. In Table.1the Correlation coefficients between several biometrical features are displayed. Single plant Grain yield has shown highly positive significant correlation with number of tillers per plant, productive tillers per plant, flag leaf length, plant height, flag leaf width and SPAD. The findings of Shashidhar *et al*. (2018); Pavani *et al.* (2021); for productive tillers per plant, plant height, number of tillers per plant, flag leaf length, flag leaf width Pavani *et al.* (2021); Subedi *et al*. (2019); Nithika *et al*. (2019) for SPAD were in conformity with this result. Compared to days to 50% flowering, single plant yield showed a strong negative correlation. Similar findings for days to 50% flowering were reported by Gunasekaran *et al.* (2017; Srivastava *et al*. (2017); Rashad *et al*. (2019); Pavani *et al.* (2021). SPAD shown positive correlation with number of tillers per plant and productive tillers pe plant and negative correlation with days to 50% flowering. Plant height shown positive correlation with flag leaf length, number of tillers per plant. Days to 50% flowering shown positive correlation with Panicle length and negative correlation with number of tillers per plant. Flag leaf length shown positive correlation with flag leaf width and panicle length. Flag leaf width shown positive correlation with panicle length and negative correlation with number of tillers per plant and productive tillers per plant. Number of tillers per plant shown positive correlation with productive tillers per plant shown in Fig. 1.

Table 1: Correlation between yield and yield attributing characters.

Character	SPAD	DFF	PH	FL	FW	PL	NT	PT	YIELD
SPAD	1	**-0.390*****	-0.00787	0.07435	0.04587	-0.09665	**0.204****	**0.174***	**0.170***
DFF		1	0.10796	0.08183	0.121	**0.161***	**-0.171***	-0.12476	-0.07655
PH			1	**0.510*****	0.130	0.140	**0.262*****	**0.220****	**0.250*****
FL				1	**0.290****	**0.161***	0.1325	0.12288	**0.280*****
FW					1	**0.210****	**-0.141***	**-0.192****	**0.200****
PL						1	0.02207	0.04736	0.09174
NT							1	**0.812*****	**0.534*****
PT								1	**0.500*****

***Significance at 5% level of significance; **Significance at 1% level of significance; *Significance at 0.1% level of significance

SPAD= chlorophyl content, DFF= Days to 50% flowering, PH= Plant height(cm), FL= Flag leaf length(cm), FW= Flag leaf width(cm), PL= Panicle length(cm), NT= Number of tillers per plant, PT= Productive tillers per plant, Yield per plant(g)

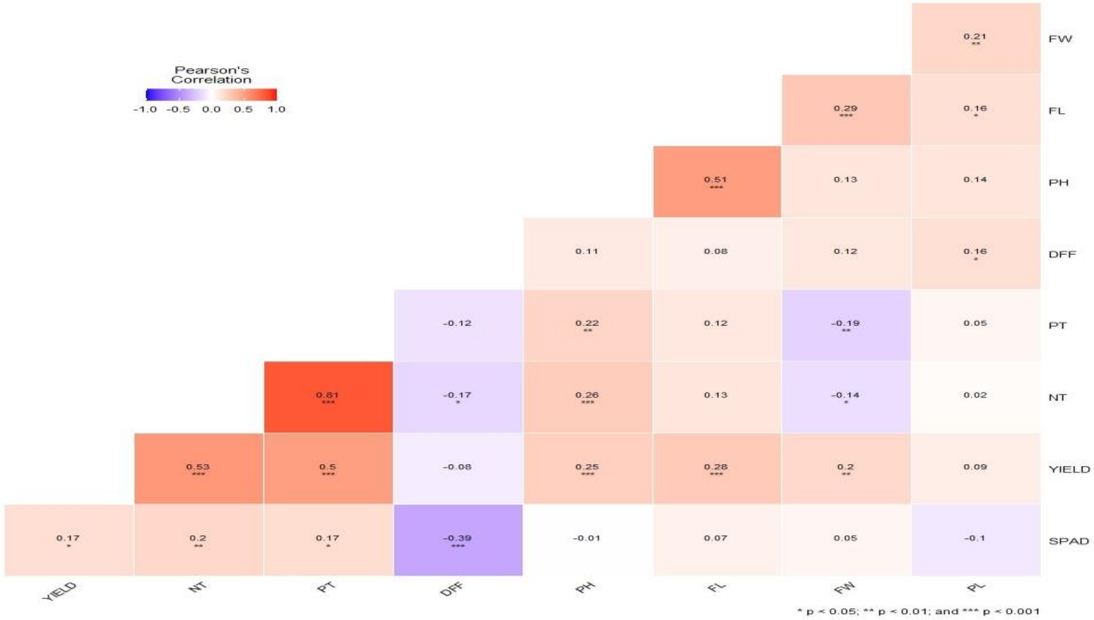

Fig. 1. Heat map is showing that Pearson correlation for yield and yield attributed traits.

The results of the path coefficient analysis used in the current study, which used the grain yield per plant as the dependent variable and the other characters as the independent variables, are shown in the Table 2. The direct and indirect effects were rated as negligible (0.00-0.09). Low (0.10-0.19), Moderate (0.20-0.29), High (more than 1.00) as suggested by Lenka and Mishra (1973), as the residual effect was more than moderate (0.54), it is therefore, indicated that the number of characters chosen for the study were appropriate for determination of yield in rice but can include more characters for study. Path coefficient analysis revealed that Number of tillers per plant (Pavani *et al*., 2021; Priyanka *et al*., 2016), Flag leaf width (Pavani *et al*., 2021), Productive tillers per plant (Manivelan *et al*., 2022; Ravindra *et al*., 2012; Satish *et al*., 2009) and Flag leaf length (Pavani *et al*., 2021), Plant height, SPAD shown positive direct effect on grain yield per plant. These features had positive direct effects, which suggested that selecting for them would probably increase grain yield. The direct effects were negative for days to 50% flowering. Results are in accordance with the findings of (Pavani *et al*., 2021, Priyanka *et al*., 2016) for Number of tillers per plant, (Pavani *et al*., 2021) for Flag leaf width, (Ravindra *et al*., 2012; Satish *et al*., 2009) for Productive tillers per plant, and (Pavani *et al*., 2021) for Flag leaf length. All had an impact on grain yield per plant, according to the study's path coefficient. Choosing plants based on these characteristics would undoubtedly increase grain yield.

Table 2: Path coefficient analysis showing direct (Bold) and indirect effect of component traits.

Character	SPAD	DFF	PH	FL	FW	PL	NT	PT	YIELD
SPAD	**0.02493**	0.00788	-0.00010	0.00884	0.01183	-0.00042	0.07262	0.04048	**0.170***
DFF	-0.00969	**-0.02026**	0.00144	0.00973	0.03122	0.00070	-0.06070	-0.02899	-0.07655
PH	-0.00020	-0.00219	**0.01334**	0.06012	0.03345	0.00060	0.09284	0.05088	**0.250*****
FL	0.00185	-0.00166	0.00674	**0.11891**	0.07381	0.00070	0.04695	0.02855	**0.280*****
FW	0.00114	-0.00245	0.00173	0.03403	**0.25792**	0.00089	-0.05018	-0.04462	**0.200****
PL	-0.00241	-0.00328	0.00184	0.01923	0.05322	**0.00432**	0.00782	0.01101	0.09174
NT	0.00511	0.00347	0.00349	0.01576	-0.03653	0.00010	**0.35435**	0.18876	**0.534*****
PT	0.00434	0.00253	0.00292	0.01461	-0.04952	0.00020	0.28785	**0.23236**	**0.500*****

Residual effect: 0.491, ***Significance at 5% level of significance, **Significance at 1% level of significance, *Significance at 0.1% level of significance

SPAD= chlorophyl content, DFF= Days to 50% flowering, PH= Plant height(cm), FL= Flag leaf length(cm), FW= Flag leaf width(cm), PL= Panicle length(cm), NT= Number of tillers per plant, PT= Productive tillers per plant, Yield per plant(g)

CONCLUSIONS

In conclusion, this study highlights the crucial role of specific traits in rice yield enhancement. Notably, traits such as the number of tillers per plant, flag leaf width, productive tillers per plant, flag leaf length, plant height, and SPAD exhibit strong positive correlations with grain yield. Path coefficient analysis underscores their direct positive effects on yield. Conversely, days to 50% flowering negatively impacts yield. These findings emphasize the importance of selecting rice plants based on these traits to maximize grain production. Such insights are vital for rice improvement programs, offering a clear path to enhance crop performance and address challenges related to changing climates and sustainable agriculture.

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Conflict of Interest. None.

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