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Research Article

Correlation and path coefficient analysis among yield and yield attributing traits of rice landraces

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ABSTRACT

Growing under a variety of ecological conditions, rice holds a significant position in Indian agriculture. However, yield mostly depends on net impact of yield component traits. Hence, the present investigation was carried out to study the correlation and path analysis in forty rice (*Oryza sativa* L.) landraces. Trait association of the yield and its attributing traits revealed that significant positive correlation of single plant yield with plant height, days to 50 percent flowering, flag leaf length and hundred seed weight. Thus, selecting for these traits might increase yield. Path coefficient analysis research revealed that the following characters had a favourable direct impact on the single plant yield: kernel breadth, length to breadth ratio, days to fifty percent flowering, number of productive tillers, and hundred seed weight. These characteristics might be used as selection indicators to increase rice yield in future breeding programmes.

KEY WORDS: Rice landraces; Yield; Correlation; Direct and Indirect effects

1. Introduction

Rice (*Oryza sativa* L.) is rich in genetic diversity, with thousands of varieties grown throughout the world. In Asia, rice fulfils 50% of the dietary calorie needs of almost 520 million people (Zhou *et al*., 2016) and provides, good supply of vitamins and minerals like thiamine, niacin, iron, riboflavin, vitamin D, calcium and fibre (Schenker, 2012). While the demand for rice is continuously increasing with the rapid growth in the human population, the land area available for rice production is decreasing as a result of rapid urbanisation, impeding climate change and changing lifestyles. By 2025, there will be a 758 million tonnes of rice needed to meet the world's consumption, which is currently approximately 600 million tonnes (Nakano *et al*., 2019). To satisfy future consumer demands, there is an urgent need for new rice cultivars with high yield

Grain yield is a complexly inherited characteristic that is polygenically regulated (Immanuel *et al*., 2011). It is directly or indirectly impacted by a multitude of component traits and the environment factors. As a result, selection favouring one component may favourably influence linked qualities at the same time. Grain size, grain number and panicle number are reported to play major role and having high correlation with yield

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in rice (Kim *et al*., 2016). Direct selection for yield is not considered effective due to their low heritability. This is mainly due to heterozygosity, environmental influences and G × E (genotype × environment) interactions. To avoid these problems, indirect selection for yield is relatively better by selecting the traits which shows the high positive correlation with high heritability as compared to direct selection.

Correlation studies are useful in identifying the association among grain yield and its component traits (Lakshmi *et al*., 2019), enabling plant breeders to select genotypes possessing desirable traits that are associated to grain yield. Due to various environmental influences on polygenic traits, significant selection based on yield alone may not be effective. In order to improve yield, the selection must be achieved through component traits (Rangare *et al*., 2012; Debsharma *et al*., 2023). With this goal in mind, the current study was carried out to look for any effects on correlations between plant properties with yield potential.

2. Materials and Methods

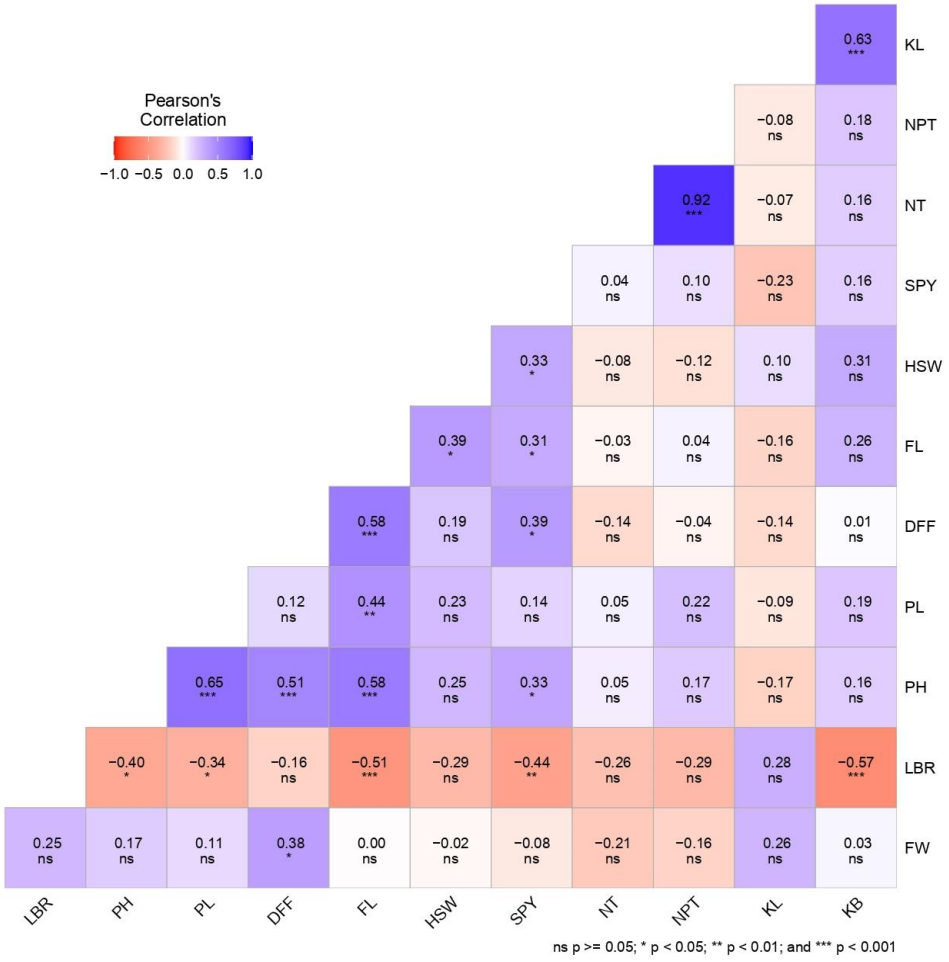
In Rabi, 2022, a set of forty landraces were cultivated at the Tamil Nadu Rice Research Institute (TRRI), Aduthurai, Thanjavur, Tamil Nadu, India. TRRI is located at latitude 10.99ºN and longitude 79.48ºE. Forty landraces were transplanted 21 days after sowing as two seedlings per hill with three replications in randomized block design with spacing of 20 × 20cm. The recommended package of practices for rice was followed for the proper establishment and growth of the crop. Observations were recorded on five random plants in each genotype in each replication for morphological characters *viz*., days to fifty percent flowering, plant height, number of tillers, number of productive tillers, flag leaf length, flag leaf width, panicle length, kernel length, kernel breadth, length to breadth ratio, hundred seed weight and single plant yield.

Analysis of variance for twelve morphological traits were analyzed using R software using "agricolae" package (Mendiburu and Yaseen, 2020). Correlation between the traits were estimated using "corrplot" package (Wei *et al*., 2017). Path analysis were estimated using "Semplot" package (Epskamp *et al*., 2017)

3. Results and Discussion

3.1 Correlation analysis

In the present study, significantly positive association was found between plant height ($r = 0.33$, $p< 0.05$), days to 50 percent flowering ($r = 0.39$, $P < 0.05$), flag leaf length ($r = 0.31$, $p< 0.05$) and hundred seed weight ($r = 0.33$, $p< 0.001$) with single plant yield (Fig. 1). Selection for these traits would be helpful in enhancing grain yield as this indicates a high correlation between these traits with single plant yield (Khan *et al*., 2020; Surjaye *et al*., 2022; Shanmugam *et al*., 2023; Thuy *et al*., 2023). Similar findings were reported by Saha *et al*., 2019; Ata-Ul-Karim *et al*., 2022; Faysal *et al*., 2022). Negative correlation was found between length breadth ratio ($r = -0.44$, $p< 0.01$) with single plant yield. In agreement to this finding, Ata-Ul-Karim *et al*. (2022) reported negative association of LBR with yield per plant. Hence, indirect selection for these traits would improve single plant yield. Since rice consumers have strong preferences for grain types, grain shape is given top consideration in all rice breeding programmes. It is important for breeders to carefully analyse the negative association between traits like grain width, length to breadth ratio and



DFF-Days to 50% flowering; FL-Flag leaf length; FW-Flag leaf width; HSW-Hundred seed weight; KB-Kernel breadth; KL-Kernel length; LBR- Length to breadth ratio; NPT-Number of productive tillers; NT-Number of tillers; PH-Plant height; PL-Panicle length; SPY-Single plant yield

Fig. 1 Correlation analysis of twelve morphological traits.

yield, as goals may limit or compromise efforts to improve yield (Ata-Ul-Karim *et al*., 2022).

Understanding the interrelationships between yield component traits can help breeders determine the direction and strength of selection pressure to apply to related traits in order to simultaneously improve these traits (Gopikannan and Ganesh, 2013). Days to fifty percent flowering was found to exhibit strong and significant ($0.75 \leq r < 1.00$) correlation with plant height ($r = 0.51$, $p< 0.001$) and flag leaf length ($r = 0.58$, $p< 0.001$) while flag leaf width had a significant positive association ($r = 0.38$, $p< 0.05$). Strong and significant association was noted between number of tillers and number of productive tillers. Panicle length had strong and positive correlation with plant height ($r = 0.65$, $p<$

0.001) and had highly significant positive correlation with flag leaf length (r = 0.44, p< 0.01) while had negative and significant association with length breadth ratio (r = -0.34, p< 0.05). Flag leaf length detected significant (p < 0.05) and positive association with hundred seed weight (r = 0.33) and plant height (r = 0.58, p< 0.001). Length to breadth had a negative association with kernel breadth (r = -0.57, p< 0.001), flag leaf length (r = -0.51, p< 0.001), panicle length (r = -0.34, p< 0.05) and plant height (r = -0.40, p< 0.05). Strong and significant association was noted between kernel length and kernel breadth (r = 0.63, p< 0.001). Similar findings were reported by Khan *et al*., 2016; Priyanka *et al*., 2018; Prasannakumari *et al*., 2020; Shanmugam *et al*., 2023. It could be concluded from the above discussion that four traits *viz*., panicle length, days to 50 percent flowering, plant height, flag leaf length were directly associated with single plant yield and while length breadth ratio had an indirect association with yield. This implied that traits panicle length, days to 50 percent flowering, plant height, flag leaf length might be important for determining yield. These characteristics all showed a positive, substantial correlation with the single plant yield, suggesting that they are the main factors that contribute to yield and could be relied upon.

3.2 Path analysis

Correlation measures simply the link between two variables while path coefficient analysis, on the other hand, divides the correlations to clearly describe the cause-and-effect relationship and employs additional traits to explain the direct and indirect reasons of association (Wright, 1921). The direct and indirect effects of yield component traits studied as partitioned by path analysis were given in Table 1, Fig. 2.

The study reveals that kernel breadth and length to breadth ratio had high and positive direct effect on single plant yield. Days to fifty percent flowering,

Table 1: Direct and indirect effects of different yield components as partitioned by path analysis

Traits	DFF	PH	NT	NPT	FL	FW	PL	KL	KB	LBR	HSW	SPY
DFF	**0.401**	0.055	0.039	-0.011	-0.139	-0.059	-0.007	0.173	0.012	-0.127	0.052	0.389*
PH	0.206	**0.106**	-0.015	0.047	-0.139	-0.026	-0.038	0.214	0.219	-0.310	0.069	0.334*
NT	-0.056	0.006	**-0.284**	0.254	0.007	0.033	-0.003	0.087	0.217	-0.203	-0.021	0.036
NPT	-0.016	0.018	-0.261	**0.276**	-0.009	0.025	-0.013	0.096	0.246	-0.230	-0.032	0.100
FL	0.233	0.061	0.009	0.011	**-0.240**	0.001	-0.026	0.198	0.358	-0.400	0.109	0.313*
FW	0.152	0.018	0.060	-0.044	0.001	**-0.157**	-0.007	-0.329	0.041	0.196	-0.007	-0.077
PL	0.047	0.069	-0.013	0.060	-0.106	-0.018	**-0.059**	0.111	0.251	-0.267	0.064	0.139
KL	-0.055	-0.018	0.020	-0.021	0.038	-0.041	0.005	**-1.258**	0.847	0.222	0.028	-0.235
KB	0.003	0.017	-0.045	0.050	-0.063	-0.005	-0.011	-0.787	**1.355**	-0.443	0.086	0.157
LBR	-0.065	-0.042	0.074	-0.081	0.123	-0.039	0.020	-0.357	-0.767	**0.782**	-0.082	-0.435**
HSW	0.076	0.027	0.022	-0.032	-0.094	0.004	-0.014	-0.127	0.418	-0.230	**0.277**	0.327*

DFF-Days to 50% flowering; FL-Flag leaf length; FW-Flag leaf width; HSW-Hundred seed weight; KB-Kernel breadth; KL-Kernel length; LBR- Length to breadth ratio; NPT-Number of productive tillers; NT-Number of tillers; PH-Plant height; PL-Panicle length; SPY-Single plant yield

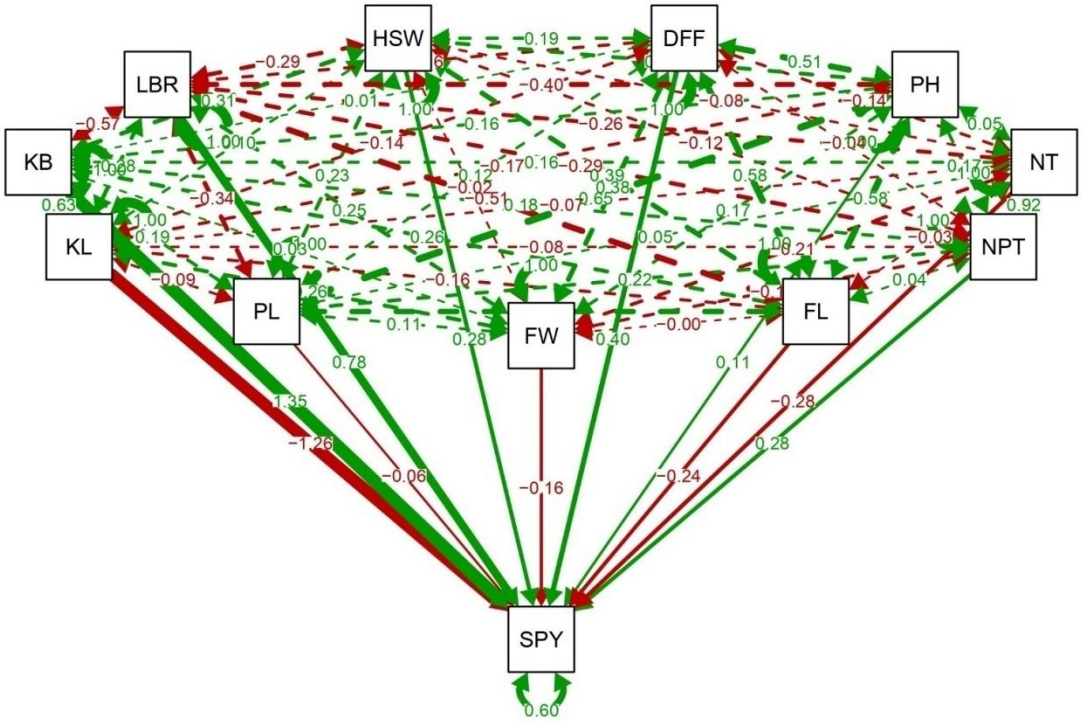


Fig. 2 Phenotypic path diagram

number of productive tillers and hundred seed weight expressed positively moderate direct effects on single plant yield. These results indicates yield improvement is directly associated with these traits. Similar findings were reported by Bhargava *et al*., 2021. The trait kernel length showed negatively high direct effect while flag leaf length and number of tillers had negatively moderate effect on single plant yield.

Kernel length, flag leaf length and hundred seed weight expressed high and positive indirect effects on single plant yield through kernel breadth. Plant height, number of tillers and number of productive tillers and panicle length exhibited moderately positive indirect effects on single plant through kernel breadth and exhibited moderately negative indirect effects through length breadth ratio. The traits *viz*., plant height and flag leaf length showed moderate and positive indirect effects via, days to 50 percent flowering. It could be inferred that kernel breadth, plant height, number of tillers and length to breadth ratio contributed equally through direct and indirect effects for yield improvement. These characteristics are thought to be significant yield factors, and each of them enhances grain yield through the interaction of other yield component traits. Since the studied characteristics contributed more to the variability in single plant yield, the residual effect of the study (0.20) is modest.

Under changing climatic conditions, direct yield enhancement is challenging. It is therefore possible to increase yield by identifying secondary traits that contribute to yield and making selective

breeding decisions for those traits. Therefore, selection based on the subsequent secondary traits plant height, number of tillers, days to 50 percent flowering, kernel breadth, panicle length, length to breadth ratio may be utilised as trustworthy criteria for enhancing rice yield.

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5. Conflict of Interest

None declared. The authors affirm no financial or personal relationships that could influence the objectivity or interpretation of the findings.

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