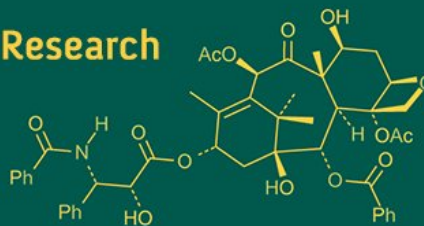


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(8): 696-701
www.biochemjournal.com
Received: 05-05-2026
Accepted: 15-06-2026

Parnandi Sai Pranav
Department of Genetics and
Plant Breeding, Agricultural
College, Jagtial, Professor
Jayashankar Telangana State
Agricultural University
(PJ TSAU), Telangana, India

B Srinivas
Scientist (Plant Breeding),
Regional Agricultural
Research Station (RARS),
Jagtial, Professor Jayashankar
Telangana State Agricultural
University (PJ TSAU),
Telangana, India

K Rajendra Prasad
Assistant Professor,
Department of Genetics and
Plant Breeding, Agricultural
College, Polasa, Jagtial,
Professor Jayashankar
Telangana State Agricultural
University (PJ TSAU),
Telangana, India

K Rajesh
Scientist (Crop Physiology),
Regional Agricultural
Research Station (RARS),
Polasa, Jagtial, Professor
Jayashankar Telangana State
Agricultural University
(PJ TSAU), Telangana, India

Corresponding Author:
Parnandi Sai Pranav
Department of Genetics and
Plant Breeding, Agricultural
College, Jagtial, Professor
Jayashankar Telangana State
Agricultural University
(PJ TSAU), Telangana, India

Correlation and path coefficient studies for yield and lodging resistance traits in rice (*Oryza Sativa* L.)

Parnandi Sai Pranav, B Srinivas, K Rajendra Prasad and K Rajesh

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Si.9515>

Abstract

Rice (*Oryza sativa* L.) is one of the most important cereal crops and a staple food for more than half of the world's population. The present investigation was conducted to study the association among yield, quality and lodging-related traits through correlation and path coefficient analyses in 31 rice genotypes evaluated in a randomized block design with two replications. Genotypic correlation coefficients were generally higher than the corresponding phenotypic coefficients, indicating a stronger genetic association among the traits. Grain yield per plant showed significant positive correlation with culm physical strength (0.65 and 0.60), number of productive tillers per plant (0.58 and 0.24), panicle weight (0.49 and 0.43), hulling percentage (0.47 and 0.37), 1000-grain weight (0.39 and 0.36) and plant height (0.36 and 0.31) at genotypic and phenotypic levels, respectively, whereas head rice recovery (-0.32 and -0.30) was negatively associated with grain yield. Path coefficient analysis revealed that culm physical strength (1.15), hulling percentage (1.03), 1000-grain weight (0.87), number of grains per panicle (0.62), silicon content (0.30) and plant height (0.28) exerted positive direct effects on grain yield, while days to 50% flowering, head rice recovery, panicle weight, stem thickness, number of productive tillers per plant, panicle length and internodal length exhibited negative direct effects. The low residual effect at the genotypic level (0.15) indicated that the traits included in the study explained a major proportion of the variation in grain yield. Therefore, culm physical strength, hulling percentage, 1000-grain weight, number of grains per panicle, silicon content and plant height may be considered as important selection criteria for improving grain yield and lodging-related traits in rice

Keywords: Rice, grain yield, correlation, path coefficient analysis, lodging resistance

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops and serves as the staple food for more than half of the world's population. It plays a significant role in ensuring food and nutritional security, particularly in Asian countries where it constitutes the primary dietary component. Increasing rice productivity is essential to meet the growing food demand of an expanding population under changing climatic conditions. Improvement in grain yield remains one of the major objectives of rice breeding programmes. However, grain yield is a complex quantitative trait controlled by several component characters and is greatly influenced by environmental conditions. Therefore, direct selection based solely on grain yield is often ineffective, emphasizing the need to identify key yield-contributing traits through appropriate statistical approaches.

Correlation analysis is widely employed to determine the degree of association among different characters affecting grain yield. Although correlation provides valuable information regarding the relationship among traits, it does not distinguish whether the association is due to direct or indirect effects. To overcome this limitation, Wright (1921) proposed path coefficient analysis, which was later adapted for plant breeding by Dewey and Lu (1959) [4]. This technique partitions the correlation coefficients into direct and indirect effects, thereby providing a clearer understanding of the relative importance of individual characters in determining grain yield.

Several researchers have successfully utilized path coefficient analysis to identify major yield-contributing traits in rice. Patel *et al.* (2014) [12] emphasized that simultaneous consideration of direct and indirect effects enhances the efficiency of selection in rice breeding programmes. Besides yield attributes, quality traits such as hulling percentage, milling percentage and head rice recovery have gained considerable importance in modern

rice breeding programmes owing to their direct influence on grain quality and market value. Similarly, stem-related traits including culm physical strength, stem diameter, stem thickness and silicon content play a vital role in improving lodging resistance and maintaining stable grain yield under diverse environmental conditions. Therefore, simultaneous evaluation of yield, quality and lodging-related traits provides a comprehensive approach for the identification of superior rice genotypes.

Keeping the above facts in view, the present investigation was undertaken to estimate the direct and indirect effects of yield, quality and lodging-related traits on grain yield through path coefficient analysis in 31 rice genotypes evaluated under field conditions. The findings of the present study are expected to facilitate the identification of key selection criteria for the development of high-yielding and lodging-resistant rice cultivars.

Materials and methods

The present investigation was carried out during Rabi 2025-26 at the Regional Agricultural Research Station (RARS), Polasa, Jagtial, Telangana, to identify the important yield-contributing and lodging resistance traits through path coefficient analysis in rice (*Oryza sativa* L.). The experimental material comprised 31 rice genotypes, evaluated in a Randomized Block Design (RBD) with two replications under recommended agronomic and plant protection practices.

Observations were recorded on five randomly selected competitive plants from each genotype in each replication for sixteen traits, namely days to 50% flowering, plant height (cm), panicle length (cm), number of productive tillers per plant, panicle weight (g), 1000-grain weight (g), number of grains per panicle, hulling percentage (%), milling percentage (%), head rice recovery (%), culm physical strength, silicon content (%), internodal length (cm), stem diameter (mm), stem thickness (mm) and grain yield per plant (g). The mean values of each genotype were used for statistical analysis.

Analysis of variance (ANOVA) was carried out to determine the existence of significant differences among the genotypes for all the characters under study. Genotypic and phenotypic correlation coefficients among different characters were estimated following standard biometrical procedures. Path coefficient analysis was performed to partition the correlation coefficients into direct and indirect effects in order to identify the traits contributing directly and indirectly towards grain yield. The methodology proposed by Wright (1921) [21] and subsequently modified for plant breeding by Dewey and Lu (1959) [4] was adopted for estimating path coefficients.

The direct and indirect effects of individual characters on grain yield per plant were estimated separately at both genotypic and phenotypic levels. Genotypic and phenotypic correlation coefficients were estimated following the method described by Johnson *et al.* (1955) [6], and path coefficient analysis was performed according to Singh and Chaudhary (1979) [20]. The adequacy of the characters included in the path model was assessed through the residual effect, which indicates the proportion of variation in grain yield not explained by the characters included in the analysis. A low residual effect suggests that the selected traits adequately explain the variability in grain yield. All statistical analyses, including analysis of variance,

correlation coefficients and path coefficient analysis, were carried out using Windostat Version 9.1.

Results and Discussion

Correlation analysis

The genotypic and phenotypic correlation coefficients among yield and quality traits are presented in Table 1. In general, the genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients, indicating that the associations among the traits were mainly controlled by genetic factors and were less affected by the environment. Similar results were reported by Seyoum *et al.* (2012) [19] and Bhadru *et al.* (2012) [3], who also observed higher genotypic correlations than phenotypic correlations in rice.

Grain yield per plant showed significant positive association with culm physical strength (0.65 and 0.60), number of productive tillers per plant (0.58 and 0.24), panicle weight (0.49 and 0.43), hulling percentage (0.47 and 0.37), 1000-grain weight (0.39 and 0.36), milling percentage (0.39 and 0.35), plant height (0.36 and 0.31), panicle length (0.31 and 0.28), stem thickness (0.25 and 0.24), silicon content (0.25 and 0.22) and number of grains per panicle (0.24 and 0.22) at both genotypic and phenotypic levels. On the other hand, head rice recovery (-0.32 and -0.30) was negatively associated with grain yield.

The positive association of these traits with grain yield indicates that improvement in these characters is likely to increase grain yield. Therefore, these traits can be considered as important selection criteria in rice breeding programmes, which is similar to the findings of Kumar *et al.* (2018) [8], Marimuthu *et al.* (2018) [10] and Patel *et al.* (2014) [12].

The positive association of silicon content with grain yield may be attributed to its beneficial role in improving plant vigour and enhancing resistance to biotic and abiotic stresses, as reported by Ma (2004) [9]. The present findings are in agreement with Basavaraja *et al.* (2011) [2], who reported that productive tillers per plant, panicle length, 1000 Grain weight and spikelet fertility had significant positive association with grain yield. They suggested that these characters should be given priority during selection because they contributed directly to grain yield. Similarly, Ratna *et al.* (2015) [15] observed that productive tillers, plant height, panicle length and 1000 Grain weight were positively associated with grain yield and concluded that simultaneous improvement of these traits would help in developing high-yielding rice varieties. Among all the traits, culm physical strength (0.65 and 0.60) showed the highest positive association with grain yield. This indicates that plants with stronger culms are better able to support heavy panicles and resist lodging, resulting in better grain filling and higher yield. Ookawa *et al.* (2010) [13] also reported that stronger culms improved lodging resistance and helped maintain higher grain yield by supporting efficient movement of photosynthates from leaves to grains. The positive association between panicle weight (0.49 and 0.43) and grain yield indicates that heavier panicles generally contain more well-filled grains, leading to higher productivity. Similar findings were reported by Agahi *et al.* (2007) [1], Marimuthu *et al.* (2018) [10] and Ogunbayo *et al.* (2014) [11], who observed that panicle weight had a strong influence on grain yield because of its positive relationship with grain number and grain filling.

Likewise, number of productive tillers per plant (0.58 and 0.24) showed a significant positive association with grain yield. This suggests that plants with more productive tillers produce more effective panicles, which ultimately increase grain yield. Sabesan *et al.* (2009) ^[17] also reported that productive tillers had a strong positive effect on grain yield and recommended this trait as one of the major selection criteria in rice breeding programmes. Similarly, 1000-grain weight (0.39 and 0.36) showed a positive association with grain yield, indicating that heavier grains contribute directly to increased yield. Hasan *et al.* (2013) ^[5] reported that 1000 Grain weight played an important role in determining grain yield and suggested that improving grain weight would enhance overall productivity.

Path coefficient analysis

Path coefficient analysis was carried out at both phenotypic and genotypic levels to partition the correlation coefficients into direct and indirect effects and to identify the most important yield-contributing characters influencing grain yield per plant. The estimates of phenotypic and genotypic path coefficients are presented in Table 2.

Genotypic path coefficient analysis

Genotypic path coefficient analysis revealed that 1000-grain weight (1.55) exerted the highest positive direct effect on grain yield per plant, followed by plant height (1.32), hulling percentage (1.23), number of grains per panicle (0.62), culm physical strength (0.40) and silicon content (0.30). The high positive direct effects of these characters indicate that they are important yield determinants and may be considered as effective selection criteria in rice breeding programmes aimed at improving grain yield. These findings are in agreement with Sadhana *et al.* (2022) ^[18], who also reported that grain yield was largely influenced by traits exhibiting high positive direct effects and suggested their use as effective selection criteria in rice improvement programmes. Similar observations were reported by Seyoum *et al.* (2012) ^[19], who identified thousand-grain weight and grains per panicle as major contributors to grain yield through high positive direct effects. Likewise, Rukmini Devi *et al.* (2017) ^[16] reported that plant height and 1000 Grain weight exerted substantial positive direct effects on grain yield, while Kishore *et al.* (2018) ^[7] emphasized the importance of grain weight and yield component traits in the selection of superior rice genotype

Table 1: Phenotypic and Genotypic Correlation Matrix of Yield and Quality Characters in Rice

characters		DFP	PH	PL	NPT	PW	TGW	NGP	HP	MP	HRR	PS	SC	IL	SD	ST	GYP
DFP	G	1.00	0.7*	0.55**	0.58**	0.48**	0.17	0.36*	0.11	-0.06	-0.09	-0.07	0.32*	0.10	0.36**	0.34**	0.07
	P	1.00	0.70*	0.44***	0.29*	0.43***	0.17	0.28*	0.13	-0.07	-0.08	-0.04	0.30*	0.09	0.30*	0.26*	0.06
PH	G		1.00	0.78***	0.48***	0.68***	0.45***	0.28*	-0.03	-0.00	-0.08	0.21	-0.04	0.19	0.34**	0.52***	0.36***
	P		1.00	0.69***	0.29 *	0.63***	0.44***	0.22	-0.00	-0.00	-0.09	0.21	-0.03	0.19	0.29 *	0.42***	0.31*
PL	G			1.00	0.54***	0.72***	0.69***	-0.00	-0.31*	-0.28*	-0.32**	0.41***	0.13	0.09	0.33**	0.55***	0.31*
	P			1.00	0.36***	0.63***	0.61***	-0.02	-0.26*	-0.25*	-0.30*	0.29*	0.12	0.08	0.24	0.48***	0.28*
NPT	G				1.00	0.40***	0.63***	-0.00	-0.01	-0.09	-0.46***	0.30*	0.23	-0.21	0.40***	0.38***	0.58***
	P				1.00	0.22	0.35**	-0.01	0.10	-0.03	-0.26*	0.13	0.14	-0.11	0.17	0.18	0.24
PW	G					1.00	0.56***	0.32**	-0.03	-0.00	-0.36***	0.50***	0.31*	0.13	0.32**	0.66***	0.49***
	P					1.00	0.53***	0.33**	-0.03	0.00	-0.36***	0.44**	0.30*	0.12	0.28*	0.55***	0.43***
TGW	G						1.00	-0.48***	-0.36***	-0.28*	-0.53***	0.56***	-0.00	0.25*	0.30*	0.46***	0.39***
	P						1.00	-0.44***	-0.31*	-0.27 *	-0.51***	0.54***	0.00	0.25*	0.27*	0.41***	0.36***
NGP	G							1.00	0.38***	0.32**	0.06	0.03	0.34**	-0.13	0.07	0.20	0.24
	P							1.00	0.25 *	0.26 *	0.06	0.02	0.28 *	-0.11	0.06	0.18	0.22
HP	G								1.00	0.84***	0.23	-0.08	0.26*	0.06	-0.12	-0.14	0.47***
	P								1.00	0.74 **	0.20	-0.03	0.25 *	0.05	-0.11	-0.11	0.37***
MP	G									1.00	0.15	-0.04	0.05	0.01	-0.07	-0.02	0.39***
	P									1.00	0.14	-0.01	0.05	0.01	-0.04	-0.03	0.35***
HRR	G										1.00	-0.38***	-0.05	-0.21	-0.31**	-0.27**	-0.32**
	P										1.00	-0.33 **	-0.04	-0.21	-0.30 *	-0.24	-0.30*
PS	G											1.00	0.15	0.21	0.39***	0.30*	0.65***
	P											1.00	0.16	0.20	0.34 **	0.23	0.60***
SC	G												1.00	-0.08	0.05	0.08	0.25*

	P												1.00	0.08	0.06	0.08	0.22
IL	G													1.00	-0.07	-0.16	0.12
	P													1.00	-0.07	-0.12	0.13
SD	G														1.00	0.29*	0.12
	P														1.00	0.22	0.09
ST	G															1.00	0.25*
	P															1.00	0.24
*Significant at 5 per cent level; **Significant at 1 percent level; ***Significant at 0.1 percent level																	

DFF: Days to 50% flowering, **NPT:** Number of Productive tillers per plant, **PH:** plant height, **PL:** Plant Length, **NGP:** Number of Grains per panicle, **PW:** Panicle weight, **TGW:** 1000-grain weight, **HP:** Hulling Percentage, **MP:** Milling Percentage, **HRR:** Head Rice Recovery, **PS:** Culm physical strength, **SC:** Silicon content, **IL:** Internodal Length, **SD:** Stem diameter, **ST:** Stem thickness

Table 2: Phenotypic (P) and Genotypic (G) Path Coefficient Analysis for Grain Yield and Its Component Traits in Rice

characters		DFF	PH	PL	NPT	PW	TGW	NGP	HP	MP	HRR	PS	SC	IL	SD	ST	GYP
DFF	G	-0.38	-0.27	-0.21	-0.22	-0.18	-0.06	-0.13	-0.04	0.02	0.03	0.02	-0.12	-0.03	-0.13	-0.13	0.07
	P	0.29	-0.21	-0.13	-0.08	-0.12	-0.05	-0.08	-0.04	0.02	0.02	0.01	-0.09	-0.02	-0.09	-0.08	0.06
PH	G	0.96	1.32	1.04	0.64	0.90	0.59	0.37	-0.04	-0.00	-0.11	0.28	-0.05	0.26	0.45	0.68	0.36***
	P	0.22	0.31	0.22	0.09	0.20	0.14	0.07	-0.00	-0.00	-0.03	0.06	-0.01	0.06	0.09	0.13	0.31*
PL	G	-0.31	-0.45	-0.57	-0.30	-0.41	-0.39	0.00	0.18	0.16	0.18	-0.23	-0.07	-0.05	-0.19	-0.31	0.31*
	P	0.06	0.09	0.13	0.05	0.08	0.08	-0.00	-0.03	-0.03	-0.04	0.04	0.01	0.01	0.03	0.06	0.28*
NPT	G	-0.39	-0.32	-0.36	-0.66	-0.27	-0.42	0.00	0.00	0.06	0.31	-0.20	-0.15	0.14	-0.27	-0.25	0.58***
	P	-0.01	-0.01	-0.02	-0.05	-0.01	-0.02	0.00	-0.00	0.00	0.01	-0.00	-0.00	0.00	-0.00	-0.01	0.24
PW	G	-0.35	-0.50	-0.54	-0.30	-0.74	-0.42	-0.24	0.02	0.00	0.27	-0.37	-0.23	-0.09	-0.23	-0.49	0.49***
	P	-0.10	-0.15	-0.15	-0.05	-0.24	-0.13	-0.08	0.00	-0.00	0.08	-0.11	-0.07	-0.03	-0.07	-0.13	0.43***
TGW	G	0.26	0.70	1.08	0.99	0.88	1.55	-0.76	-0.56	-0.44	-0.83	0.87	-0.01	0.40	0.47	0.72	0.39***
	P	0.08	0.20	0.28	0.16	0.25	0.47	-0.20	-0.15	-0.12	-0.24	0.25	0.00	0.11	0.13	0.19	0.36***
NGP	G	0.22	0.17	-0.00	-0.00	0.20	-0.30	0.62	0.24	0.20	0.04	0.02	0.21	-0.08	0.04	0.12	0.24
	P	0.10	0.08	-0.01	-0.00	0.12	-0.16	0.37	0.09	0.09	0.02	0.01	0.10	-0.04	0.02	0.06	0.22
HP	G	0.14	-0.03	-0.39	-0.01	-0.04	-0.44	0.47	1.23	1.03	0.29	-0.10	0.32	0.08	-0.15	-0.18	0.47***
	P	0.06	-0.00	-0.12	0.04	-0.01	-0.15	0.11	0.47	0.35	0.09	-0.01	0.11	0.02	-0.05	-0.05	0.37***
MP	G	0.04	0.00	0.16	0.05	0.00	0.16	-0.18	-0.49	-0.58	-0.09	0.02	-0.03	-0.00	0.04	0.01	0.39***
	P	-0.00	-0.00	-0.01	-0.00	0.00	-0.01	0.01	0.05	0.06	0.01	-0.00	0.00	0.00	-0.00	-0.00	0.35**
HRR	G	0.05	0.04	0.17	0.25	0.20	0.29	-0.03	-0.13	-0.08	-0.54	0.21	0.02	0.11	0.16	0.14	-0.32**
	P	0.01	0.02	0.06	0.05	0.07	0.11	-0.01	-0.04	-0.03	-0.21	0.07	0.01	0.04	0.06	0.05	-0.30*
PS	G	0.02	0.08	0.16	0.12	0.20	0.22	0.01	-0.03	-0.01	-0.15	0.40	0.06	0.08	0.16	0.12	0.65***
	P	0.01	0.07	0.10	0.04	0.15	0.19	0.01	-0.01	-0.00	-0.11	0.35	0.05	0.07	0.12	0.08	0.60***
SC	G	0.10	-0.01	0.04	0.07	0.09	-0.00	0.10	0.08	0.01	-0.01	0.04	0.30	-0.02	0.01	0.02	0.25*
	P	0.03	-0.00	0.01	0.01	0.03	0.00	0.02	0.02	0.00	-0.00	0.01	0.09	-0.00	0.00	0.00	0.22
IL	G	0.07	-0.14	-0.06	0.15	-0.09	-0.18	0.09	-0.04	-0.00	0.15	-0.15	0.06	-0.71	0.05	0.12	0.12
	P	-0.01	-0.02	-0.01	0.01	-0.01	-0.03	0.01	-0.00	-0.00	0.02	-0.02	0.01	-0.12	0.00	0.01	0.13
SD	G	-0.07	-0.07	-0.07	-0.08	-0.06	-0.06	-0.01	0.02	0.01	0.06	-0.08	-0.01	0.01	-0.21	-0.06	0.12
	P	-0.04	-0.04	-0.03	-0.02	-0.04	-0.04	-0.01	0.01	0.00	0.04	-0.05	-0.01	0.01	-0.15	-0.03	0.09
ST	G	-0.09	-0.14	-0.15	-0.10	-0.18	-0.12	-0.05	0.041	0.00	0.07	-0.08	-0.02	0.04	-0.08	-0.27	0.25*
	P	-0.01	-0.02	-0.02	-0.01	-0.031	-0.02	-0.01	0.00	0.00	0.01	-0.01	-0.00	0.00	-0.01	-0.05	0.24

Although panicle weight (-0.74), internodal length (-0.71), number of productive tillers per plant (-0.66), panicle length (-0.57), head rice recovery (-0.54), days to 50% flowering (-0.3827), stem thickness (-0.27) and stem diameter (-0.21) exhibited negative direct effects on grain yield, some of these characters contributed positively through indirect effects via plant height, 1000-grain weight, hulling percentage and culm physical strength. This suggests that these traits should not be considered independently during selection, but rather in combination with traits exhibiting strong positive direct effects. Similar observations were made by Patel *et al.* (2014) [12], who reported that traits with negative direct effects may still contribute positively to grain yield through favourable indirect effects. Ravindrababu *et al.* (2012) [14] also emphasized that path

coefficient analysis is useful in distinguishing the actual contribution of each character by separating direct and indirect effects.

The residual effect at the genotypic level was 0.15, indicating that the characters included in the present investigation accounted for a major proportion of the total variation in grain yield. The low residual effect suggests that the selected characters were sufficient to explain the variability in grain yield, whereas only a small proportion of variation was attributed to factors not included in the present study. Similar findings were reported by Rukmini Devi *et al.* (2017) [16] and Seyoum *et al.* (2012) [19], who also observed low residual effects in rice, indicating the adequacy of the selected characters for explaining grain yield variation.

Phenotypic path coefficient analysis

At the phenotypic level, hulling percentage (0.47) exerted the highest positive direct effect on grain yield per plant, closely followed by 1000-grain weight (0.47), number of grains per panicle (0.37), culm physical strength (0.35), plant height (0.31), panicle length (0.13) and silicon content (0.09). These findings indicate that these traits contributed directly to grain yield and may therefore be considered as useful selection criteria under field conditions. Similar results were reported by Rukmini Devi *et al.* (2017) ^[16] and Kishore *et al.* (2018) ^[7], who observed positive direct effects of grain weight, plant height and grains per panicle on grain yield through phenotypic path coefficient analysis.

The traits days to 50% flowering (-0.29), panicle weight (-0.24), head rice recovery (-0.21), stem diameter (-0.15), internodal length (-0.12), number of productive tillers per plant (-0.05) and stem thickness (-0.05) showed negative direct effects on grain yield. However, some of these characters exhibited favourable indirect effects through traits having strong positive direct effects, suggesting that simultaneous consideration of direct and indirect effects would improve the efficiency of selection. Similar conclusions were drawn by Patel *et al.* (2014) ^[12] and Ravindrababu *et al.* (2012) ^[14], who reported that indirect effects often compensate for the negative direct influence of certain yield component traits.

The residual effect at the phenotypic level was 0.53, indicating that although the characters studied explained a substantial proportion of the variation in grain yield, environmental factors also influenced the expression of grain yield and its associated traits. The comparatively higher residual effect at the phenotypic level than at the genotypic level suggests a greater environmental influence on phenotypic expression, which is in agreement with the observations of Seyoum *et al.* (2012) ^[19] and Rukmini Devi *et al.* (2017) ^[16].

Conclusion

The present investigation demonstrated that path coefficient analysis is an efficient statistical approach for identifying the major traits contributing to grain yield in rice. Among the sixteen characters studied, 1000-grain weight, plant height, hulling percentage, number of grains per panicle, culm physical strength and silicon content exhibited high positive direct effects on grain yield at the genotypic level, indicating their importance as reliable selection criteria in rice improvement programmes. Although certain traits such as panicle weight, panicle length, productive tillers per plant and head rice recovery recorded negative direct effects, their indirect contribution through other yield-attributing characters emphasized the importance of considering both direct and indirect effects during selection. The comparatively lower residual effect at the genotypic level further indicated that the characters included in the present study adequately explained the variation in grain yield. Therefore, simultaneous selection for 1000-grain weight, plant height, number of grains per panicle, hulling percentage, culm physical strength and silicon content would be effective in developing high-yielding and lodging-resistant rice genotypes for future breeding programmes.

References

1. Agahi K, Fotokian MH, Farshadfar E, Agahi H. Correlation and path coefficient analysis for some

- yield-related traits in rice (*Oryza sativa* L.). Asian Journal of Plant Sciences. 2007;6(3):513-517.
2. Basavaraja T, Gangaprasad S, Dhushantha Kumar BM, Shilaja Hittalmani. Correlation and path analysis of yield and yield attributes in local rice cultivars (*Oryza sativa* L.). Electronic Journal of Plant Breeding. 2011;2(4):523-526.
3. Bhadru D, Rao VT, Mohan YC. Correlation and path coefficient analysis of yield and yield contributing traits in rice hybrids and their parents. International Journal of Scientific and Research Publications. 2012;2(7):1-5.
4. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheatgrass seed production. Agronomy Journal. 1959; 51:515-518.
5. Hasan MJ, Kulsum MU, Hossain E, Hossain MM, Rahman MM. Genetic variability and character association for agronomic traits in hybrid rice. Bangladesh Journal of Plant Breeding and Genetics. 2013;26(1):1-8.
6. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybeans. Agronomy Journal. 1955;47(7):314-318.
7. Kishore NS, Srinivas T, Nagabhushanam U, Pallavi M, Sameera SK. Correlation and path coefficient analysis for yield and yield contributing traits in rice (*Oryza sativa* L.). International Journal of Current Microbiology and Applied Sciences. 2018;7(3):3269-3277.
8. Kumar A, *et al.* Correlation and path coefficient analysis for yield and its contributing traits in rice (*Oryza sativa* L.). International Journal of Current Microbiology and Applied Sciences. 2018; 7:250-258.
9. Ma JF. Role of silicon in enhancing the resistance of plants to biotic and abiotic stresses. Soil Science and Plant Nutrition. 2004; 50:11-18.
10. Marimuthu S, *et al.* Character association and path coefficient analysis in rice for yield and its component traits. Electronic Journal of Plant Breeding. 2018; 9:1264-1270.
11. Ogunbayo SA, *et al.* Correlation and path analysis of yield and yield-contributing traits in rice under irrigated conditions. African Journal of Agricultural Research. 2014; 9:2388-2396.
12. Patel JR, Saiyad MR, Prajapati KN, Patel RA, Bhavani RT. Correlation and path coefficient analysis in rice (*Oryza sativa* L.). The Bioscan. 2014;9(4):1543-1546.
13. Ookawa T, *et al.* New approach for improving culm strength and lodging resistance in rice. Plant Production Science. 2010; 13:1-10.
14. Ravindrababu V, Shreya K, Dangi KS, Usharani G, Siva Shankar A. Correlation and path coefficient analysis studies in popular rice hybrids of India. International Journal of Scientific and Research Publications. 2012;2(3):1-5.
15. Ratna M, Begum S, Husna A, Dey SR, Hossain MS. Correlation and path coefficient analyses in basmati rice. Bangladesh Journal of Agricultural Research. 2015;40(1):153-161.
16. Rukmini Devi K, Satyanarayana Rao V, Siva Sankar A, Lal Ahamed M. Character association and path coefficient analysis for grain yield and its components in rice (*Oryza sativa* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(7):2360-2367.

17. Sabesan T, Suresh R, Saravanan K. Genetic variability and correlation for yield and grain quality characters in rice. *Electronic Journal of Plant Breeding*. 2009; 1:56-59.
18. Sadhana K, *et al.* Correlation and path coefficient studies for grain yield and its component traits in rice. *The Pharma Innovation Journal*. 2022; 11:2050-2055.
19. Seyoum M, Alamerew S, Bantte K. Genetic variability, heritability, correlation coefficient and path analysis for yield and yield-related traits in upland rice. *Journal of Plant Sciences*. 2012;7(1):13-22.
20. Singh RK, Chaudhary BD. *Biometrical Methods in Quantitative Genetic Analysis*. New Delhi: Kalyani Publishers; 1979.
21. Wright S. Correlation and causation. *Journal of Agricultural Research*. 1921; 20:557-585.