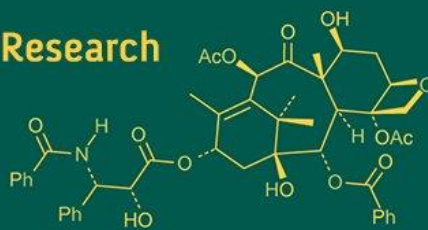


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 446-451
www.biochemjournal.com
Received: 02-06-2026
Accepted: 05-07-2026

Bandari Vidya Sagar
Department of Genetics and
Plant Breeding, Agricultural
College, Polasa, PJTAU,
Hyderabad, Telangana, India

P Madhukar
Scientist (Plant Breeding),
RARS, Jagtial, PJTAU,
Hyderabad, Telangana, India

K Rajendra Prasad
Assistant Professor,
Department of Genetics and
Plant Breeding, Agricultural
College, Polasa, Jagtial,
PJTAU, Hyderabad,
Telangana, India

N Balram
Scientist, Plant Pathology,
SRTC, Rajendranagar,
PJTAU, Hyderabad,
Telangana, India

Correlation and path coefficient studies for yield and yield attributes of rice (*Oryza sativa* L.) maintainer lines

Bandari Vidya Sagar, P Madhukar, K Rajendra Prasad and N Balram

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7Sf.9009>

Abstract

Grain yield in rice is a complex trait influenced by various yield-attributing and quality factors. The present study was conducted to assess the association among these traits and their direct and indirect effects on grain yield in 44 rice maintainer lines (42 test entries and two standard checks) during *Kharif* 2025 at the Regional Agricultural Research Station, Jagtial, Telangana, India. The experiment was laid out in a randomized block design with three replications, and phenotypic and genotypic correlation and path coefficient analyses were performed. The results showed significant positive phenotypic correlations between grain yield per plant and several traits: number of effective tillers per plant (0.61**), plant height (0.59**), panicle length (0.53**), head rice recovery (0.34**), number of grains per panicle (0.33**), and days to 50% flowering (0.23**). Significant negative correlations were found with the kernel length/breadth ratio (-0.48**) and kernel length (-0.18*). Path analysis revealed that 1000-grain weight had the highest positive direct effect on grain yield (0.388), followed by number of grains per panicle (0.346) and plant height (0.274). Negative direct effects were noted for days to 50% flowering (-0.207) and milling (-0.149). The findings suggest that selecting for higher 1000-grain weight, more grains per panicle, effective tillers, plant height, panicle length, and improved head rice recovery would enhance grain yield and help develop superior rice maintainer lines for hybrid breeding.

Keywords: Rice maintainer lines, yield, yield attributes, correlation, path correlation

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. In India, rice plays a vital role in food security, rural livelihoods and agricultural development. According to the Third Advance Estimates, India produced 154.02 million tonnes of rice during 2025–26, highlighting the continued importance of the crop in meeting the food requirements of a growing population (Ministry of Agriculture and Farmers Welfare, 2026). Therefore, the development of high-yielding and climate-resilient rice varieties remains a major objective of rice improvement programmes. Grain yield in rice is a complex quantitative trait influenced by several interrelated characters and environmental factors. Correlation analysis provides valuable information on the nature and extent of associations among traits, whereas path coefficient analysis helps partition these associations into direct and indirect effects, thereby identifying traits with the greatest influence on yield. Positive associations of grain yield with productive tillers per plant, panicle length, grains per panicle and spikelet fertility have been reported, indicating their importance in enhancing productivity (Kiran *et al.*, 2023) ^[9]. Likewise, effective tillers, panicle length and filled grains per panicle were found to contribute significantly to grain yield and may serve as reliable selection criteria in breeding programmes (Paramanik *et al.*, 2023) ^[14]. Direct positive effects of biological yield, harvest index and test weight on grain yield have also been reported, emphasizing their importance in improving rice productivity (Ratnam *et al.*, 2024) ^[17].

Materials and Methods

The experiment was conducted at the Regional Agricultural Research Station, Jagtial, Telangana, India, during *Karif*, 2025 (June–November), where it was laid out in an RBD with

Corresponding Author:
Bandari Vidya Sagar
Department of Genetics and
Plant Breeding, Agricultural
College, Polasa, PJTAU,
Hyderabad, Telangana, India

three replications, and each plot was raised in 2 rows of 4 meters in length. Seeds of all 42 maintainer lines, along with 2 standard checks, were sown with a spacing of 20cm × 15cm². Seedlings were transplanted in the main field at the age of twenty-eight days, and all the necessary package of practices were followed for raising a healthy crop. Observations on yield, yield-attributing features and quality traits were recorded on five randomly selected competing plants from each entry in each replication for characters viz., DFF: Days to 50% flowering, NET: Number of effective

tillers per plant, PH: Plant height, PL: Plant length, NGP: Number of Grains per panicle, TW: 1000-grain weight, GYPP: Grain yield per plant, HRR: Head Rice Recovery, KL: Kernel Length, KL/KB: Kernel length/kernel breadth ratio. The analysis was done as per Singh and Chaudhary (1985)^[20] for the correlation coefficient and Dewey and Lu (1959)^[4] for path analysis, which were standard procedures used till today. Table 1: List of rice genotypes (Maintainer lines) utilised for the study.

Table 1: List of Rice genotypes (Maintainer lines) used in the study

S.NO	Name of the entry		
1	ORJ 1349	23	KNM 1638
2	WGL 1513	24	KPS 10631
3	OR 2546-5-1	25	VT 110
4	RP6520-IR16A4938	26	CR 4379-4-3-1-1-5-1
5	UPR 4697-10-1-1-1	27	RP6744-19408-1-1
6	HKR 16-58	28	SHUATS Dhan10-IR 18A1926
7	RP 6488-MAID-1-180-119-1-1-1-1	29	JGL 37088
8	NDR 359	30	R 2282-556-1-312-1
9	OROI-8-IR88228-33-3-5-2	31	RP 6744-19023-1-1
10	HKR-16-35	32	KMP 244
11	CR 3580-3-1-1-1-1-2	33	RP 6680-RMS-3-5-9-16
12	RP 6494-MAID-162-27-9-3-1-1-1	34	JMS 13B
13	KNM 7715	35	JMS 24B
14	JGL 41666	36	RMS 2B
15	JGL 44034	37	RMS 5B
16	JGL 44317	38	RMS 6B
17	JGL 42646	39	RMS 9B
18	JGL 46239	40	CMS 46B
19	JGL 46298	41	CMS 59B
20	RNR 28399	42	CMS 64B
21	JGL 47849	43	JGL 27356
22	JGL 41240	44	JGL 24423

Results and Discussions

Association between yield, its attributing traits and floral traits

The study of the association between grain yield and its component traits helps to reveal their importance in rice breeding programs (Table 2).

The genotypic and phenotypic correlations are nearly equal, indicating little or no effect of environment on the relationship of traits, strong genetic control, and stable trait expression.

1. Grain yield per plant

Phenotypic correlations revealed that grain yield per plant had significant and positive association with number of effective tillers per plant (0.61**), plant height (0.59**), panicle length (0.53**), number of grains per panicle (0.33**), head rice recovery (0.34**), and days to 50% flowering (0.23**), which indicated that all these characters were important for yield improvement. However, it had a negative and significant correlation with kernel length/breadth ratio (-0.48**), and kernel length. Similar results were reported by Tiwari *et al.* (2026)^[22] for panicle length, no of effective tillers per plant, Dinesh *et al.* (2025), Das *et al.* (2024)^[1] for no of effective tillers per plant, number of grains per panicle, Maneesha *et al.* (2024)^[12] for plant height, panicle length, number of grains per panicle, Pathak *et al.* (2024)^[16] for plant height, no of effective tillers per plant, Saketh *et al.* (2023)^[18] for number of effective tillers per plant, plant height, panicle length,

number of grains per panicle, and days to 50% flowering, Edukondalu *et al.* (2023)^[6] for panicle length, number of effective tillers per plant, Devi *et al.* (2022)^[3] number of effective tillers per plant, plant height, number of grains per panicle, Umarani *et al.* (2019)^[23] for panicle length, number of grains per panicle.

2. Days to 50% flowering

The trait days to 50% flowering showed a significant positive correlation with plant height (0.48**), head rice recovery (0.46**), and number of effective tillers per plant (0.24**).

Similar results were reported by Tiwari *et al.* (2026)^[22], Jasmine *et al.* (2022)^[7] for the number of effective tillers per plant, Devi *et al.* (2022)^[3] for head rice recovery, Das *et al.* (2024)^[1] for plant height, Saketh *et al.* (2023)^[18] for plant height and head rice recovery, Rukmini Devi *et al.* (2019)^[2] for plant height.

3. Plant height (cm)

The trait plant height showed a significant positive correlation with number of effective tillers per plant (0.36**), panicle length (0.27**), head rice recovery (0.28**), number of grains per panicle (0.19*). It also has a significant negative correlation with kernel length (-0.20*) and kernel length/breadth ratio (-0.49**).

Similar results were reported by Parimala *et al.* (2020)^[15], Umarani *et al.* (2019)^[23], for panicle length, Pathak *et al.* (2024)^[16], Jasmine *et al.* (2022)^[7], for panicle length and

number of effective tillers per plant, Saketh *et al.* (2023) ^[18], for number of grains per panicle, panicle length, and head rice recovery.

4. Number of effective tillers per plant

The trait number of effective tillers per plant showed a significant positive correlation with panicle length (0.051**), number of grains per panicle (0.53**), head rice recovery (0.46**). it also has a significant negative correlation with test weight (-0.29**), kernel length (-0.34**), and kernel length/breadth ratio (-0.35**). Similar results were reported by Parimala *et al.* (2020) ^[15] and Edukondalu *et al.* (2023) ^[6] for panicle length.

5. Panicle length

The trait panicle length showed a significant positive correlation with number of grains per panicle (0.38**) and head rice recovery (0.21*). it has a significant negative correlation with kernel length (-0.17*). Similar results were reported by Devi *et al.* (2022) ^[3] for head rice recovery, Saketh *et al.* (2023) ^[18] for the number of grains per panicle and head rice recovery, and Rukmini Devi *et al.* (2019) ^[2] for the number of grains per panicle.

6. Number of grains per panicle

The trait number of grains per panicle showed a significant positive correlation with head rice recovery (0.41**). it has

a significant negative correlation with test weight (-0.67**), kernel length (-0.68**), kernel length/breadth ratio (-0.32**).

Similar results were reported by Saketh *et al.* (2023) ^[18] for head rice recovery, 1000 grain weight, and kernel length.

7. 1000 grain weight

The trait test weight showed a significant positive correlation with kernel length (0.63**). It has a significant negative correlation with head rice recovery (-0.35**). Similar results were reported by Saketh *et al.* (2023) ^[18] for kernel length, head rice recovery.

8. Head rice recovery

The trait head rice recovery showed a significant negative correlation with kernel length (-0.23**). Similar results were reported by Maneesha *et al.* (2024) ^[12] and Rukmini Devi *et al.* (2019) ^[2] for kernel length.

9. Kernel length

The trait kernel length showed a significant positive correlation with kernel length/breadth ratio (0.57**). Similar results were reported by Singh *et al.* (2024) ^[19], Devi *et al.* (2022) ^[3], Kumar *et al.* (2020) ^[10] for the kernel length/breadth ratio.

Table 2: Phenotypic (P) and Genotypic (G) correlation coefficients of yield and quality traits in rice

characters		DFF	PH	NET	PL	NGP	TW	M	HRR	KL	KL/KB	GYP
DFF	G	1.00	0.50	0.29	0.18	0.16	-0.04	0.13	0.47	-0.11	-0.18	0.25
	P	1.00	0.48**	0.24**	0.15	0.15	-0.04	0.13	0.46 **	-0.10	-0.16	0.23**
PH	G		1.00	0.40	0.27	0.19	0.12	-0.07	0.29	-0.21	-0.55	0.61
	P		1.00	0.36 **	0.27**	0.19*	0.12	-0.06	0.28 **	-0.20*	-0.49**	0.59**
NET	G			1.00	0.59	0.58	0.31	0.19	0.50	-0.38	-0.39	0.68
	P			1.00	0.51 **	0.53 **	-0.29 **	0.17	0.46 **	-0.34 **	-0.35 **	0.61**
PL	G				1.00	0.39	-0.03	0.05	0.23	-0.20	-0.20	0.56
	P				1.00	0.38 **	-0.02	0.03	0.21*	-0.17 *	-0.16	0.53**
NGP	G					1.00	-0.69	0.15	0.42	-0.73	-0.36	0.34
	P					1.00	-0.67 **	0.14	0.41 **	-0.68 **	-0.32 **	0.33**
TW	G						1.00	-0.05	-0.36	0.68	-0.06	0.15
	P						1.00	-0.04	-0.35 **	0.63 **	-0.05	0.14
M	G							1.00	0.64	-0.01	-0.02	0.12
	P							1.00	0.60 **	0.02	0.00	0.10
HRR	G								1.00	-0.24	-0.14	0.34
	P								1.00	-0.23 **	-0.13	0.34**
KL	G									1.00	0.57	-0.18
	P									1.00	0.57**	-0.18*
KL/KB	G										1.00	-0.50
	P										1.00	-0.48**

* Significant at 5 per cent level; ** Significant at 1 per cent level

DFF: Days to 50% flowering, **NET:** Number of Effective tillers per plant, **PH:** plant height, **PL:** Plant Length, **NGP:** Number of Grains per panicle, **TW:** 1000-grainweight, **GY:** Grain Yield per plant, **M:** Milling, **HRR:** Head Rice Recovery, **KL:** Kernel Length, **KL/KB:** Kernel length/Kernel breadth

Table 3: Phenotypic (P) and Genotypic (G) path coefficients of yield, yield-attributing traits and floral traits in rice

CHARACTERS		DFF	PH	NET	PL	NGP	TW	M	HRR	KL	KL/KB	GY
DFF	G	-0.081	-0.040	-0.023	-0.014	-0.013	0.003	-0.010	-0.038	0.009	0.014	0.246
	P	-0.207	-0.099	-0.049	-0.031	-0.031	0.007	-0.026	-0.095	0.020	0.034	0.235**
PH	G	0.072	0.145	0.058	0.040	0.030	0.017	-0.011	0.015	-0.031	-0.079	0.606
	P	0.131	0.274	0.100	0.073	0.052	0.032	-0.018	0.078	-0.055	-0.135	0.591**
NET	G	0.131	0.182	0.457	0.272	0.264	-0.143	0.088	0.228	-0.176	-0.179	0.682
	P	0.062	0.095	0.261	0.134	0.139	-0.076	0.045	0.119	-0.088	-0.091	0.610**
PL	G	0.030	0.047	0.103	0.173	0.068	-0.006	0.008	0.039	-0.035	-0.035	0.563
	P	0.030	0.041	0.079	0.154	0.058	-0.003	0.005	0.033	-0.027	-0.024	0.534**
NGP	G	0.044	0.052	0.161	0.109	0.279	-0.192	0.042	0.118	-0.204	-0.100	0.343

	P	0.052	0.065	0.184	0.131	0.346	-0.232	0.047	0.142	-0.234	-0.110	0.329**
TW	G	-0.020	0.056	-0.146	-0.016	-0.321	0.467	-0.024	-0.167	0.317	-0.030	0.150
	P	-0.014	0.045	-0.114	-0.008	-0.261	0.388	-0.017	-0.136	0.244	-0.021	0.145
M	G	-0.017	0.010	-0.026	-0.006	-0.020	0.007	-0.135	-0.086	0.001	0.003	0.120
	P	-0.019	0.010	-0.025	-0.005	-0.020	0.007	-0.149	-0.089	-0.003	0.000	0.099
HRR	G	0.099	0.061	0.105	0.047	0.088	-0.075	0.134	0.210	-0.050	-0.029	0.341
	P	0.097	0.061	0.097	0.045	0.088	-0.075	0.128	0.213	-0.048	-0.029	0.337**
KL	G	-0.002	-0.004	-0.008	-0.004	-0.014	0.013	0.000	-0.005	0.019	0.011	-0.175
	P	-0.008	-0.170	-0.029	-0.015	-0.057	0.053	0.001	-0.019	0.085	0.048	-0.180*
KL/KB	G	0.017	0.052	0.038	0.019	0.035	0.006	0.002	0.013	-0.055	-0.096	-0.502
	P	0.017	0.050	0.036	0.016	0.032	0.006	0.000	0.014	-0.058	0.102	-0.477**

DDF: Days to 50% flowering, **NET:** Number of effective tillers per plant, **PH:** Plant height, **PL:** Panicle Length, **NGP:** No of grains per panicle, **TW:** 1000-grain weight, **GY:** Grain yield per plant, **M:** Milling, **HRR:** Head rice recovery, **KL:** Kernel length, **KL/KB:** Kernel length/Kernel breadth

Traits other than yield direct and indirect effects on the grain yield

Path coefficient analysis divides the correlations for a lucid understanding of the cause-and-effect relationship; correlation only assesses the relationship between two variables. Path coefficient analysis employs other attributes to describe the direct and indirect causes of association (Wright, 1921) [24]. The path coefficient analysis estimates for yield and its related traits are shown in Table 3).

Grain yield per plant

Path coefficient analysis revealed that 1000 grain weight showed the highest positive direct effect on the grain yield per plant followed by number of grains per panicle, plant height, number of effective tillers per plant, head rice recovery, and panicle length.

1. Days to 50% flowering

The trait days to 50% flowering had a direct negative phenotypic effect on grain yield per plant (-0.207). The correlation between days to 50% flowering and grain yield per plant is positive (0.235) and significant.

The trait exhibited positive indirect effects through the traits, 1000-grain weight, and kernel length.

Similar results are reported by Jasmine *et al.* (2022) [7], Umarani *et al.* (2019) [23], Maneesha *et al.* (2024) [12] for grain yield per plant, Devi *et al.* (2022) [3] for grain yield per plant, 1000 grain weight, and kernel length, and Saketh *et al.* (2023) [18] for kernel length.

2. Plant height

The trait plant height had a direct positive phenotypic effect on grain yield per plant (0.274). Its association with the grain yield per plant is highly positive and significant (0.591) due to high direct positive indirect effect through days to 50% flowering (0.131), number of effective tillers per plant (0.100).

The trait also surfaces negative indirect effects with the kernel length/ breadth ratio (-0.135)

Similar results were reported by Tiwari *et al.* (2020) [22] for the direct effect of plant height on grain yield per plant, Edukondalu *et al.* (2023) [6] for the kernel length/breadth ratio, Saketh *et al.* (2023) [18] for grain yield per plant, and Days to 50% flowering.

3. Number of effective tillers per plant

The trait number of effective tillers per plant showed a direct positive phenotypic effect on grain yield per plant (0.261). The correlation between this trait and grain yield per plant is high and significant (0.610) due to positive

indirect phenotypic effects through plant height (0.134), number of grains per plant (0.139), and head rice recovery (0.119).

Similar results were reported by Edukondalu *et al.* (2023) [6], Das *et al.* (2024) [1], Rukmini Devi *et al.* (2019) [2] for the direct effect on grain yield, Parimal *et al.* (2019), Rukmini Devi *et al.* (2019) [2] for plant height, Saketh *et al.* (2023) [18] for grain yield, plant height, Number of grains per plant, and head rice recovery.

4. Panicle length

The trait panicle length had a direct positive effect on grain yield per plant (0.154). Its association with grain yield per plant is high positive.

The trait also manifested with indirect positive and negative effects on other traits which are negligible

Similar results were reported by Tiwari *et al.* (2020) [22], Edukondalu *et al.* (2023) [6], Maneesha *et al.* (2024) [12], Lakshmi *et al.* (2020) [11], Rukmini Devi *et al.* (2019) [2] for the direct effect of panicle length on grain yield per plant, Parimala *et al.* (2020) [15] for the indirect positive effect through plant height, Devi *et al.* (2022) [3] for head rice recovery, and Saketh *et al.* (2023) [18] for grain yield.

5. Number of grains per panicle

The trait number of grains per panicle had a direct positive effect on the grain yield per plant (0.346). This trait is also associated with grain yield per plant, which is positive mainly due to positive indirect contribution through number of effective tillers per plant (0.184), panicle length (0.131), and head rice recovery (0.142).

The trait also revealed negative indirect effects through 1000 grain weight (-0.232), Kernel length (-0.234), and Kernel length/Kernel breadth ratio (-0.110).

Similar results were reported by Edukondalu *et al.* (2023) [6] for panicle length, Saketh *et al.* (2023) [18] for grain yield per plant, and panicle length.

6. 1000 grain weight

The trait 1000 grain weight expressed a positive high direct effect on Grain yield per plant (0.388). The correlation between the trait and Grain yield per plant is positive but not significant, due to positive indirect effects through kernel length (2.44), and negative indirect effects through Number of grains per panicle (-0.261), Number of effective tillers per plant (-0.114), and Head rice recovery (-0.136).

Similar results were reported by Das *et al.* (2024) [1], Jasmine *et al.* (2022) [7] for the direct effect on grain yield, Parimala *et al.* (2020) [15] for grain yield, number of effective tillers per plant, Saketh *et al.* (2023) [18] for grain

yield per plant, kernel length, number of grains per panicle, and head rice recovery.

7. Milling

The trait milling shows a negative direct effect on the grain yield per plant (-0.149). The association of this trait with grain yield per plant is positive but not significant due to negligible positive and negative indirect effects through other traits.

Similar results were reported by Ratnam *et al.* (2024) ^[17] and Singh *et al.* (2020a) ^[21] for the negative direct effect of milling on grain yield per plant.

8. Head rice recovery

The trait head rice recovery had a positive direct phenotypic effect on grain yield per plant (0.213). Its correlation with the grain yield per plant is positive and significant due to a positive indirect contribution through milling (0.128)

The trait also surfaced with positive and negative indirect effects through other traits, but those are negligible or insignificant.

Similar results were reported by Edukondalu *et al.* (2023) ^[6], Maneesha *et al.* (2024) ^[12], Ratnam *et al.* (2024) ^[17] and Das *et al.* (2024) ^[1] for the direct effect on grain yield.

9. Kernel length

The trait kernel length had a positive direct effect on grain yield per plant (0.085). Its association with the grain yield per plant is negative, mainly due to the negative indirect effect through plant height (-0.170). Though this trait, together with other traits like days to 50% flowering, number of effective tillers per plant, number of grains per panicle, and panicle length, shows a negative indirect effect, it is negligible.

Similar results were reported by Edukondalu *et al.* (2023) ^[6] for plant height, Saketh *et al.* (2023) ^[18], and Maneesha *et al.* (2024) ^[12] for grain yield per plant.

10. Kernel length/kernel breadth ratio

The trait kernel length/kernel breadth ratio shows a positive direct effect on grain yield per plant (0.102). Where its correlation with the grain yield per plant is negative

The trait materialised negative indirect effects through kernel length, and positive indirect effects with the remaining traits, but those are negligible

Similar results were reported by Nanda *et al.* (2026) ^[13] and Lakshmi *et al.* (2020) ^[11] for grain yield per plant.

Residual effect

Residual effect was 0.52 for phenotypic and 0.4620 for genotypic path coefficient analysis. High values of residual effect could be due to the influence of other traits, which were not included in this study.

Conclusion

The correlation and path coefficient analyses revealed that the number of effective tillers per plant, plant height, panicle length, number of grains per panicle, head rice recovery and days to 50% flowering were the important yield-contributing traits due to their significant positive association with grain yield. Path coefficient study revealed that 1000-grain weight was the most influential variable, followed by number of grains per panicle, plant height, number of effective tillers per plant, head rice recovery and

panicle length through their positive direct effects on grain yield. Therefore, these features should be given more importance in selection programs to improve grain yield in rice. Simultaneous enhancement of these traits is likely to create superior high-yielding genotypes.

Acknowledgements

The work was conducted as a part of the research work of an M.Sc. student of the Professor Jayashankar Telangana Agricultural University.

Research content: The research content in this manuscript is original and has not been published or submitted elsewhere for publication.

Funding: The financial assistance for the said experiments was provided by Professor Jayashankar Telangana Agricultural University.

Conflict of interest: The authors have no conflict of interest.

Author's contribution: All the authors have contributed equally.

References

1. Das I. Assessment of genetic variability and character association for morpho-physiological and quality traits in rice under aerobic conditions. *Int J Bio-resource Stress Manag.* 2024;15(8):1-13. DOI:10.23910/1.2024.5448.
2. Devi KR, Chandra BS, Venkanna V, Hari Y. Variability, correlation and path studies for yield and quality traits in irrigated upland rice (*Oryza sativa* L.). *J Pharmacogn Phytochem.* 2019;8(6):676-684.
3. Devi KR, Hari Y, Chandra BS, Prasad KR. Genetic association, variability and path studies for yield components and quality traits of high yielding rice (*Oryza sativa* L.) genotypes. *Int J Bio-resource Stress Manag.* 2022;13(1):81-92.
4. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron J.* 1959;51:515-518.
5. Dhinesh R, Krishnan V, Vengadessan V, Mohan R, Anuratha A, Pushpa R, *et al.* Characterizing grain quality and breeding implications in rice genotypes across cropping durations. 2025.
6. Edukondalu V, Ram Reddy V, Shobha Rani T, Aruna Kumari C, Soundharya B. Correlation and path analysis for yield and yield attributes in maintainer lines of rice (*Oryza sativa* L.). *Int J Bio-resource Stress Manag.* 2023;14(6).
7. Jasmine C, Shivani D, Senguttuvel P, Naik SD. Genetic variability and association studies in maintainer and restorer lines of rice (*Oryza sativa* L.). *Pharma Innov J.* 2022;11(1):569-576.
8. Pearson K. On the general theory of skew correlation and non-linear regression. London: Dulau and Co.; 1905.
9. Kiran AK, Sharma DJ, Subbarao LV, Gireesh C, Agrawal AP. Correlation coefficient and path coefficient analysis for yield, yield attributing traits and nutritional traits in rice genotypes. *Pharma Innov J.* 2023;12(2):1978-1983.

10. Kumar A, Kumar S, Singh S, Prasad J, Jeena AS, Upreti MC. Association studies for yield components and quality traits in Basmati rice (*Oryza sativa* L.). Int J Curr Microbiol Appl Sci. 2020;8(3):2081-2084.
11. Lakshmi VG, Sreedhar M, Gireesh C, Vanisri S. Genetic variability, correlation and path analysis studies for yield and yield attributes in African rice (*Oryza glaberrima*) germplasm. Electron J Plant Breed. 2020;11(2):399-406.
12. Maneesha M, Shankar VG, Srinivas B, Hari Y. Correlation and path coefficient analysis for grain yield, head rice recovery, and quality traits in rice hybrids (*Oryza sativa* L.). Int J Plant Soil Sci. 2024;36(8):808-816.
13. Nanda KP, Vavdiya PA, Jadav RV, Sorathia AM, Mungra KS, Naghera YV. Correlation and path coefficient analysis of yield and its contributing traits in red rice (*Oryza sativa* L.). J Adv Biol Biotechnol. 2026;29(1):962-972.
14. Paramanik S, Rao MS, Purkaystha S, Singamsetti A. Character association and path coefficient analysis in selected genotypes of rice (*Oryza sativa* L.). Biol Forum Int J. 2023;15(10):902-911.
15. Parimala K, Raju CS, Prasad AH, Kumar SS, Reddy SN. Studies on genetic parameters, correlation and path analysis in rice (*Oryza sativa* L.). J Pharmacogn Phytochem. 2020;9(1):414-417.
16. Pathak V, Prasuna CH, Umakanth B, Surekha K, Subbarao LV, Padmavathi G. Genetic variability, association and diversity analysis of yield and its component traits in rice (*Oryza sativa*) germplasm. Indian J Agric Sci. 2024;94(7):786-790.
17. Ratnam TV, Kumar BR, Rao LS, Srinivas T, Kumar AA. Assessment of genetic variability, character association and path analysis for yield and quality traits in zinc and iron rich landraces of rice. Agric Sci Dig. 2024;44(2):289-294.
18. Saketh T, Shankar VG, Srinivas B, Hari Y. Correlation and path coefficient studies for grain yield and yield components in rice (*Oryza sativa* L.). Int J Plant Soil Sci. 2023;35(19):1549-1558.
19. Singh B, Verma Y, Karishma DG, Sao A. Association studies for quality traits in advanced breeding lines of rice (*Oryza sativa* L.). 2024.
20. Singh RK, Chaudhary BD. Biometrical methods in quantitative genetic analysis. New Delhi: Kalyani Publishers; 1985.
21. Singh SK, Suneetha Y, Vinay Kumar G, Srinivasa Rao V, Sandeep Raja D, Srinivas T. Variability, correlation and path studies in coloured rice. Int J Chem Stud. 2020;8(4):2138-2144.
22. Tiwari H, Singh PK, Nayak AK, Sharma AK. Genetic divergence and character association studies for yield and yield attributing traits in aromatic rice (*Oryza sativa* L.). J Adv Biol Biotechnol. 2026;29(1):756-772.
23. Umarani E, Hemalatha V, Subbarao LV, Neeraja CN, Suneetha K, Reddy NS. Studies on character association and path coefficient analysis for anaerobic germination traits, yield and its contributing characters in rice (*Oryza sativa* L.). Int J Curr Microbiol Appl Sci. 2019;8(4):355-362.
24. Wright S. Correlation and causation. J Agric Res. 1921;20:557-585.
25. Wright S. The method of path coefficients. Ann Math Stat. 1934;5(3):161-215.
26. Wright S. The analysis of variability and correlations between relatives with respect to deviation from an optimum. J Genet. 1935;30:243-256.