CORRELATION AND PATH COEFFICIENT ANALYSIS FOR GRAIN YIELD, HEAD RICE RECOVERY AND QUALITY TRAITS IN RICE HYBRIDS (*Oryza sativa* L.)

ABSTRACT

The present study focused on examining the correlation among various traits and to perform path coefficient analysis in rice. Using a Line × Tester design, four CMS lines were crossed with six elite restorers, producing 24 hybrids. These hybrids, along with the parental lines and two checks were evaluated in a randomized block design with two replications during the *rabi* 2023-2024. The correlation analysis revealed that grain yield was positive significantly associated with plant height(cm), panicle length(mm), number of grains per panicle,1000 grain weight(g) and kernel breadth(mm) and negative significantly associated with number of productive tillers per plant and hulling percentage(%). Plant height (mm), panicle length (mm), number of grains per panicle, 1000 grain weight (g), kernel length (mm), milling percentage (%) and head rice recovery had exhibited direct positive effect on grain yield per plant. Therefore, selection based on these traits could facilitate simultaneous improvements in yield and related attributes.

Key words: Rice, Correlation, Path co-efficient analysis, grain yield per plant, quality, residual effect

1.INTRODUCTION

Rice (*Oryza sativa* L. 2n=2x=24) is a crucial food crop that provides a major portion of carbohydrates to the global population. In Asia, rice demand continues to rise, with consumption at around 90%, and it is projected that global demand for rice will reach 650 million tonnes by 2050 (Chukwu *et al.*, 2019). Rice serves as the main dietary staple for over half of the world's population. It is cultivated in an approximately 165 million hectares globally, producing about 508.9 million tonnes (INDIASTAT, 2022-2023). In India, rice is grown on 47.83 million hectares, with a production of 135.75 million tonnes and a productivity of 2838 kg/ha (INDIASTAT, 2022-23). In Telangana, rice is cultivated on 4.66 million hectares, yielding 15.87 million tonnes with a productivity of 3406 kg/ha (INDIASTAT, 2022-23). Enhancing yield and yield related traits in rice is critical to meet the growing global food demand. The interest in food is consistently extending with the increment of populace, making a yearly increment of 3% for each year's popular rice (Sujarwo *et al*., 2022).

Correlation is the mutual relationship between two variables (Karl pearson,1905). Correlation coefficient is a statistical measure of degree (strength) and direction of relationship between two or more variables. Correlation coefficient analysis is useful for understanding the relationships between different plant traits and identifying the key components that can be targeted for selection to achieve genetic improvement in yield. Selections based on the results of correlation coefficient analysis may not produce the expected outcome, it is necessary to include path coefficient analysis for estimation of degree of association (Prasanna Kumari *et al*., 2020) insight into cause and effect relationship between different pairs of character. Path analysis helps to study the direct and indirect effects of the different traits on yield, the dependent variable. The nature of effect like direct or indirect effect of yield and its characteristics can be explained through path coefficient analysis (Baye *et al*., 2020). Correlation in combination with path analysis would give a better yield.

2. **Material and Methods**

The current study was conducted during the *Kharif* season of 2023 (for production of F_1 hybrids) and the *Rabi* season of 2023-2024 (for evaluation) at the Regional Agricultural Research Station, PJTSAU, Polasa, Jagtial, Telangana. The experimental materials consisted of four lines (CMS 52A, CMS 64A, JMS 18A and RMS 2A) with proven high head rice recovery and six testers (SN 233, SN 232, SN 223, SN 2397, SN 1326 and BV 166), along with their twenty four hybrids produced through the Line × Tester mating design described by Kempthorne in 1957. Two standard hybrid checks Shabnam and KPH 473, were included for comparative purposes. The genotypes were arranged using a randomized block design (RBD) with two replications and spacing of 20 × 15 cm. Data collection included recording of information related to grain yield, yield contributing and quality traits. This data was gathered from five randomly selected healthy plants per entry within each replication viz., plant height (cm), panicle length (cm), number of productive tillers per plant, number of grains per panicle and grain yield per plant (g). The attribute, days to 50% flowering, was recorded on a plot basis. 1000 grain weight (g) and quality traits were gathered from five randomly selected samples per entry within each replication.

Correlation was worked out using the formulae suggested by Falconer (1964). Partitioning of the correlation coefficients into direct and indirect effects was carried out using the procedure suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The analysis procedures followed the guidelines provided by Singh and Chaudhary for correlation coefficient analysis. The characterization of path coefficients was carried out as suggested by Lenka and Mishra (1973).

3.Results and Discussion

Analysis of variance revealed the presence of significant differences among the genotypes for all traits under investigation (Table 1) and it indicating the presence of considerable amount of genetic variation in the material studied.

Correlation coefficient analysis

Studies on the nature of association of yield and quality traits is crucial for simultaneous improvement of yield and quality. In this context, correlation studies provide valuable information on the nature and extent of relationship between the characters. Analyzing genetic correlation also gives us an idea about the extent to which the characters are under the control of genes and this kind of analysis could help in developing more effective selection strategies for crop improvement. (table 2) presents the correlations between yield and quality traits, as well as their relationships with grain yield per plant and among each other.

Table1. Analysis of variance for grain yield and quality traits in rice.

	Character	Mean sum of squares		
S.No	Source of variation	Replications	Genotypes	Error
	d.f.	1	35	35
1	Days to 50 % flowering	0.12	119.66 **	1.41
2	Plant height (cm)	0.40	103.34 **	2.84
3	Panicle length (cm)	4.01	4.52 **	1.07
4	Number of productive tillers per plant	0.93	1.47**	0.31
5	Number of filled grains per panicle	1842.24	7064.65 **	499.48
6	1000 grain weight (g)	0.15	30.64 **	0.49
7	Grain yield per plant (g)	23.12	49.87 **	8.21
8	Kernel length (mm)	0.22	0.71 **	0.05
9	Kernel breadth (mm)	0.02	0.04 **	0.006
10	Kernel L/ B Ratio.	0.001	0.23 **	0.005
11	Hulling (%)	10.88	8.00 *	3.83
12	Milling (%)	10.88	20.27 **	4.40
13	Head rice recovery (%)	6.12	380.98 **	3.41

Grain yield per plant was noticed to be positively and significantly associated with plant height, panicle length, number of grains per panicle, 1000 grain weight and kernel breadth at both genotypic and phenotypic levels indicating a scope for simultaneous improvement of these traits during selection for high yield levels. Singh *et al*. (2020), Buelah *et al*. (2022) and Saketh *et al*. (2023) also reported similar findings for plant height. Choosing plants based on their height can also enhance the grain yield per plant. Sharma and Hemanth, (2020), Jangala *et al*. (2022) and Kiruba *et al*. (2023) reported comparable results for number of grains per panicle. The number of grains per panicle is a key factor in yield, particularly in hybrids, which are noted for their larger sink size. These results are in line with the earlier reports of Sharma and Hemanth,(2020), Begum *et al*. (2021), Sujitha *et al*. (2022), Devi *et al*. (2022) and Manivelan *et al*. (2022) for 1000 grain weight. These results are in line with the earlier report of Priyanka *et al*. (2020) for kernel breadth.

The highest degrees of associations were observed in accordance with panicle length, plant height, number of grains per panicle, kernel breadth and 1000 grain weight.

A significant negative association was observed for number of productive tillers per plant and hulling percentage with grain yield per plant. These findings align with the results reported by Sujitha *et al*. (2020), Devi *et al*. (2022), and Manivelan *et al*. (2022) for number of productive tillers per plant. Similar reports are reported by Prem Kumar *et al.* (2016), Devi *et al.* (2017) and Edukondalu *et al.* (2017) for hulling percentage.

Head rice recovery had significant association with milling percent at phenotypic and genotypic correlation indicated that milling percent and head rice recovery are important quality attributes for rice. Simultaneous improvement of these two quality traits *viz*; milling percent and head rice recovery can be made with the selection of a single traits is either milling percent or head rice recovery. Head rice recovery showed negative significant association with kernel breadth and positive significant association with Kernel length/breadth ratio. Hulling percent had significant positive association with milling percent. In the present study the positive significant correlation of hulling percent with milling percent and milling percentage with head rice recovery indicated that genotypes with high hulling percent also showed higher estimates for milled rice and head rice.

However, non-significant associations of grain yield per plant were observed with days to 50 % flowering, kernel length, L/B ratio, milling percentage, hulling percentage and head rice recovery indicating the ineffectiveness of simultaneous selection for yield and these quality traits. These results were in confirmation with Edukondalu *et al.* (2017), Devi *et al.* (2017), Adjah *et al*. (2020), Hossain *et al*. (2020), Gupta *et al*. (2020), Lakshmi *et al*. (2020), Vennela *et al*. (2021), Manasa *et al*. (2022) and Devi *et al*. (2022) for these traits.

Path coefficient analysis

The outcomes of the path coefficient analysis for grain yield and quality traits in rice (Table 3).

Path coefficient analysis using grain yield per plant as a dependent variable and other yield contributing and grain quality traits were considered as independent variable. Analysis revealed a very high (>1) positive direct effect for kernel length (1.7582) and a high (>0.3) positive direct effect for panicle length (0.7081) and milling percentage (0.3868) whereas head rice recovery (0.2335) showed a moderate positive direct on grain yield per plant (Table 3).

Similar results were reported by Arulmozhi *et al.* (2019), Gupta *et al*. (2020) and Kujur *et al*. (2023) for number of grains per panicle. Plant height show positive direct effect on grain yield per plant these results are in accordance with Nath and kole (2021), Begum *et al*. (2021) and Vennela *et al*. (2021). Similar findings by Paramanik *et al*. (2023) for panicle length and plant height has reported. Similar reports by Singh *et al*. (2022) for panicle length and 1000 grain weight. Similar results for 1000 grain weight reported by Parimala *et al*. 2020, Vennela *et al*. (2021), Nath and kole (2021) and Jasmine *et al*. (2022). Thus it reveals these traits were found to be the important direct contributors for grain yield.

The grain quality traits *viz*., kernel length, milling percentage and head rice recovery showed positive direct effects on grain yield per plant. Similar results were reported by Prem kumar *et al*. (2015) and Panika *et al*. (2022) for kernel length. Similar findings reported by Prem kumar *et al*. (2015), Devi *et al*. (2022) for milling percentage. Similar results was reported by Edukondalu *et al*. (2017) for head rice recovery.This results indicating that selection for these quality traits is likely to result in a direct increase in grain yield per plant. These traits also recorded positive and significant association with grain yield per plant, except head rice recovery indicating the effectiveness of direct selection for this quality traits in improvement of grain yield per plant.

Table 2. Phenotypic (P) and Genotypic (G) correlation coefficients for grain yield and quality traits in rice.

SOURCE		DFF	PH	PL	NPT	NGP	1000 GW	KL	KB	L/B	HP	MP	HRR	GYP
DFF	**G**	**1.0000**	0.5092**	0.4087**	-0.2287*	0.4166**	-0.1670	-0.1594	-0.1496	-0.0105	-0.1716	-0.0523	0.3970**	-0.0552
	P	**1.0000**	0.4832**	0.2970*	-0.1559	0.3747**	-1.665	-0.1560	-0.1502	-0.0049	-0.0950	-0.0301	0.3892**	-0.0505
PH	**G**		**1.0000**	0.6152**	-0.2316*	0.5958**	0.1061	0.0118	0.3561**	-0.3116**	-0.3526**	-0.1602	0.0653	0.4727**
	P		**1.0000**	0.5355**	-0.1940	0.5470**	0.1013	0.0147	0.3450**	-0.2972*	-0.2514*	-0.1371	0.0619	0.4487**
PL	**G**			**1.0000**	-0.2315*	0.6286**	0.2218*	0.1715	0.1217	0.0744	-0.1150	-0.0863	-0.1190	0.6330**
	P			**1.0000**	-0.1941	0.5447**	0.1756	0.1436	0.0884	0.0761	-0.0469	-0.0584	-0.1008	0.5363**
NPT	**G**				**1.0000**	-0.4738**	0.2136*	0.4166**	0.0580	0.3825**	0.1443	0.5449**	0.2880*	-0.2141*
	P				**1.0000**	-0.3282**	0.1616	0.3385**	0.0556	0.2979*	0.1514	0.4517**	0.2455*	-0.1673
NGP	**G**					**1.0000**	-0.3533**	-0.3089**	-0.1385	-0.1924	-0.0386	-0.0419	0.1162	0.4350**
	P					**1.0000**	-0.3341**	-0.2805*	-0.1222	-0.1730	-0.0015	0.0050	0.1120	0.3931**
1000 GW	**G**						**1.0000**	0.8058**	0.6997**	0.1996	-0.1651	-0.1712	-0.3990**	0.2560*
	P						**1.0000**	0.7865**	0.6735**	0.1930	-0.1172	-0.1439	-0.3858**	0.2426*
KL	**G**							**1.0000**	0.4849**	0.5923**	-0.1078	-0.0323	-0.1321	0.1705
	P							**1.0000**	0.4769**	0.5868**	0.0628	-0.0200	-0.1298	0.1664
KB	**G**								**1.0000**	-0.4152**	-0.3810**	-0.1953	-0.4232**	0.3678**
	P								**1.0000**	-0.4290**	-0.2616*	-0.1686	-0.4137**	0.3552**
L/B	**G**									**1.0000**	0.2505*	0.1611	0.2466*	-0.1722
	P									**1.0000**	0.1847	0.1473	0.2411*	-0.1639
HP	**G**										**1.0000**	0.4179**	0.0246	-0.3796**
	P										**1.0000**	0.5031**	0.0346	-0.2509*
MP	**G**											**1.0000**	0.2647*	-0.0386
	P											**1.0000**	0.2488*	-0.0293
HRR	**G**												**1.0000**	-0.1817
	P												**1.0000**	-0.1622

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

DFF: Days to 50 % flowering, PH: Plant height (cm), PL: Panicle length (cm), NPT: Number of productive tillers per plant, NGP: Number of filled grains per panicle, 1000 GW: 1000 grain weight(g), KL: Kernel length (mm), KB: Kernel breadth (mm), L/B: Length/Breadth Ratio, HP: Hulling percentage, MP: Milling percentage, HRR: Head rice recovery (%), GYP: Grain yield per plant (g)

Days to 50% flowering, number of productive tillers per plant, kernel breadth, kernel L/B ratio and hulling percentage recorded direct and negative genotypic effect on grain yield per plant. Similar findings are reported by Kumar *et al*. (2016), Hemalatha *et al*. (2018) and Yadav *et al*. (2022). The negative direct effects showed that selection through these traits would be ineffective for enhancing grain yield per plant. But when the yield is influenced by some component traits as a consequence of their indirect effect via some other traits, selection of the trait through which the indirect effect has been exerted is beneficial for the improvement of yield.

Residual effect

In plant breeding, it is very difficult to have whole understanding of all component traits related to yield. This residual effect permits accurate explanation about the pattern of interaction of other possible components of yield which was not included in the study. The residual effect was 0.4580 for genotypic and 0.6645 for phenotypic path coefficient. This denotes that contribution of component traits that are studied on yield per hectare was 54.2% at genotypic level and 33.55% at phenotypic level, the rest 45.80% at genotypic level and 66.45% at phenotypic level was the contribution of other characters which were not included in the study on dependent variable.

Table 3. Phenotypic (P) and Genotypic (G) path coefficients for grain yield and quality traits in rice

SOURCE		DFF	PH	PL	NPT	NGP	1000 GW	KL	KB	L/B	HP	MP	HRR	GYP
DFF	**G**	**-0.5342**	0.0196	0.2894	0.0862	0.0160	-0.0190	-0.2802	0.2111	0.0182	0.0653	-0.0202	0.0927	-0.0552
	P	**-0.3000**	0.0574	0.1160	0.0236	0.0899	-0.0283	-0.2849	0.2241	0.0090	0.0247	-0.0078	0.0257	-0.0505
PH	**G**	-0.2720	**0.0384**	0.4355	0.0873	0.0228	0.0121	0.0207	-0.5023	0.5426	0.1342	-0.0619	0.0153	0.4727**
	P	-0.1450	**0.1188**	0.2091	0.0293	0.1313	0.0172	0.0268	-0.5148	0.5421	0.0654	-0.0357	0.0041	0.4487**
PL	**G**	-0.2183	0.0236	**0.7081**	0.0873	0.0241	0.0253	0.3016	-0.1717	-0.1296	0.0438	-0.0333	-0.0278	0.6330**
	P	-0.0891	0.0636	**0.3906**	0.0289	0.1307	0.0298	0.2622	-0.1319	-0.1389	0.0122	-0.0152	-0.0067	0.5363**
NPT	**G**	0.1222	-0.0089	-0.1639	**-0.3769**	-0.0182	0.0244	0.7324	-0.0818	-0.6661	-0.0549	0.2105	0.0672	-0.2141*
	P	0.0468	-0.0230	-0.0747	**-0.1512**	-0.0788	0.0275	0.6182	-0.0829	-0.5433	-0.0394	0.1175	0.0162	-0.1673
NGP	**G**	-0.2225	0.0229	0.4451	0.1786	**0.0383**	-0.0403	-0.5432	0.1954	0.3350	0.0147	-0.0162	0.0271	0.4350**
	P	-0.1124	0.0650	0.2128	0.0496	**0.2400**	-0.0568	-0.5122	0.1824	0.3155	0.0004	0.0013	0.0074	0.3931**
1000 GW	**G**	0.0892	0.0041	0.1571	-0.0805	-0.0135	**0.1141**	1.4168	-0.9870	-0.3476	0.0628	-0.0661	-0.0932	0.2560*
	P	0.0500	0.0120	0.0686	-0.0244	-0.0802	**0.1699**	1.4362	-1.0049	-0.3521	0.0305	-0.0374	-0.0255	0.2426*
KL	**G**	0.0851	0.0005	0.1215	-0.1570	-0.0118	0.0919	**1.7582**	-0.6840	-1.0315	0.0410	-0.0125	-0.0308	0.1705
	P	0.0468	0.0017	0.0561	-0.0512	-0.0673	0.1336	**1.8260**	-0.7116	-1.0703	0.0163	-0.0052	-0.0086	0.1664
KB	**G**	0.0799	0.0137	0.0862	-0.0219	-0.0053	0.0798	0.8525	**-1.4107**	0.7229	0.1450	-0.0754	-0.0988	0.3678**
	P	0.0451	0.0410	0.0345	-0.0084	-0.0293	0.1144	0.8708	**-1.4921**	0.7824	0.0680	-0.0439	-0.0273	0.3552**
L/B	**G**	0.0056	-0.0120	0.0527	-0.1442	-0.0074	0.0228	1.0414	0.5857	**-1.7413**	-0.0953	0.0622	0.0576	-0.1722
	P	0.0015	-0.0353	0.0297	-0.0450	-0.0415	0.0328	1.0716	0.6401	**-1.8239**	-0.0480	0.0383	0.0159	-0.1639
HP	**G**	0.0917	-0.0136	-0.0814	-0.0544	-0.0015	-0.0188	-0.1895	0.5375	-0.4363	**-3.805**	0.1614	0.0058	- 0.3796**
	P	0.0285	-0.0299	-0.0183	-0.0229	-0.0004	-0.0199	-0.1147	0.3903	-0.3368	**-0.2600**	0.1309	0.0023	-0.2509*
MP	**G**	0.0279	-0.0062	-0.0611	-0.2054	-0.0016	-0.0195	-0.0567	0.2755	-0.2806	-0.1590	**0.3868**	0.0618	-0.0386
	P	0.0090	-0.0163	-0.0228	-0.0683	0.0012	-0.0245	-0.0364	0.2516	-0.2687	-0.1308	**0.2601**	0.0164	-0.0293
HRR	**G**	-0.2121	0.0025	-0.0843	-0.1086	0.0045	-0.0455	-0.2322	0.5970	-0.4295	-0.0094	0.1022	**0.2335**	-0.1817
	P	-0.1167	0.0073	-0.0394	-0.0371	0.0269	-0.0655	-0.2369	0.6172	-0.4397	-0.0090	0.0647	**0.0661**	-0.1622
	Genotypic Residual effect = 0.4580					**Phenotypic Residual effect = 0.6645**					**Bold values are direct effects**			

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

DFF: Days to 50 % flowering, PH: Plant height (cm), PL: Panicle length (cm), NPT: Number of productive tillers per plant, NGP: Number of filled grains per panicle, 1000 GW: 1000 grain weight, KL: Kernel length (mm), KB: Kernel breadth (mm), L/B: Length/Breadth Ratio, HP: Hulling percentage, MP: Milling percentage, HRR: Head rice recovery (%), GYP: Grain yield per plant (g).

4. CONCLUSION

Studies on correlation and path coefficient analysis, emphasized the need for selection, based on panicle length, plant height, number of grains per panicle, kernel breadth and 1000-grain weight exhibited significant positive genotypic correlation and would result in improvement of yield. The path analysis studies showed panicle length, 1000-grain weight, plant height and number of grains per panicle expressing positive direct effect and significant association with grain yield per plant, whereas kernel length, milling percentage and head rice recovery recorded positive direct effect on grain yield per plant.

4.REFERENCES

Adjah KL, Abe A and Adentimirin VO. Genetic variability, heritability and correlations for milling and grain appearance qualities in some accessions of rice (*Oryza sativa* L.). *Physiology and Molecular Biology of Plants*. 2020; 26: 1309-1317.

Arulmozhi R and Muthuswamy A. Path coefficient analysis studies in rice (*Oryza sativa* L.) for quantitative and qualitative traits. *Electronic Journal of Plant Breeding*. 2019; 10(4):1576-1580.

Begum S, Srinivas B, Reddy VR and Kumari CA. Multiple regression, correlation and path Analysis of gall midge incidence, yield and yield Components in rice (*Oryza sativa* L.) hybrids. *Current Journal of Applied Science and Technology*. 2021; 40(2): 33-45.

Buelah J, Reddy VR, Srinivas B and Balram N. correlation and path analysis for yield and quality traits in hybrid Rice (*Oryza sativa* L.). *International Journal of Environment Climate Change*. 2022; 12(10): 723-728.

Chukwu SC, Rafii MY, Ramlee SI, Ismail SI, Oladosu Y, Okporie E, Onyishi G, Utobo E, Ekwu L, Swaray S and Jalloh M. Marker-assisted selection and gene pyramiding for resistance to bacterial leaf blight disease of rice (*Oryza sativa* L.). *Biotechnology & Biotechnological Equipment*. 2019; 33 (1): 440-455.

Devi RK, Chandra SB, Lingaiah N, Hari Y and Venkanna V. Analysis of variability, correlation and path coefficient studies for yield and quality traits in rice (*Oryza sativa* L.). *Agricultural Science Digest*. 2017; 37 (1):1-9.

Dewey, J.R and Lu, K.H. 1959. Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*. 51: 515-518.

Devi KR, Hari Y, Chandra BS and Prasad KR. Genetic association, variability and path studies for yield components and quality traits of high yielding rice (*Oryza sativa* L.) genotypes. *International Journal of Bio-resource and Stress Management*. 2022; 13(1): 81-92.

Edukondalu B, Reddy VR, Rani TS, Kumari CA and Soundharya B. Studies on variability, heritability, correlation and path analysis for yield, yield attributes in rice (*Oryza sativa*

L.). *International journal of current microbiology and applied sciences*. 2017; 6(10): 2369-2376.

Falconer, D.S. 1964. Introduction to quantitative genetics. Longmann. 294-300.

Gupta S, Upadhyay S, Koli GK, Rathi SR, Bisen P, Loitongbam B, Singh PK and Sinha B. Trait association and path analysis studies of yield attributing traits in rice (*Oryza sativa* L.) germplasm. *International Journal of Bio-resource and Stress Management*. 2020;11(6): 508-517.

Hemalatha M, Aananthi N, Suresh R and Sassikumar D. Cause and effect analysis for yield and grain quality traits in rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding.* 2018: 9(3): 1226-1233.

Hossain MS, Ivy NA, Raihan MS, Kayesh E and Maniruzzaman S. Genetic variability, correlation and path analysis of floral, yield and its component traits of maintainer lines of rice (*Oryza sativa* L.). *Bangladesh Rice Journal*. 2020; 24(1):1-9.

INDIANSTAT. 2023. https://www.indiastat.com

Jangala DJ, Amudha K, Geetha S and Uma D. Studies on genetic diversity, correlation and path analysis in rice germplasm*.* *Electronic Journal of Plant Breeding*. 2022; 13(2): 655-662.

Jasmine C, Shivani D, Senguttuvel P and Naik SD. Genetic variability and association studies in maintainer and restorer lines of rice (*Oryza sativa* L.). *The Pharma Innovation Journal*. 2022; 11(1): 569-576.

Karl Pearson. 1905. On the general theory of skew correlation and non- linear regression. Dulau and Co; 1905.

Kempthorne O. An introduction to genetic statistics, John Wiley and Sons Inc: New York; 1957.

Kiruba G, Geetha S, Saraswathi R, Santhi R, Uma D and Pushpa R. Heterosis, character association and path analysis for grain protein content in rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*. 2023; *14*(3): 876-883.

Kujur VK, Abhinav Sao MK and Tiwari A . Genetic variability, heritability and association analyses for yield and related characters in rice germplasm (*Oryza sativa* L.). *The Pharma Innovation Journal*. 2023; *12*(4): 2236-2240.

Kumar NS, Reddy VR and Chandramohan Y . Correlation and path coefficient Studies of yield and quality traits in rice (*Oryza sativa* L.). *Research Journal of Agricultural Sciences*. 2016; *7*(3): 606-609.

Lakshmi VI, Sreedhar M, Gireesh C and Vanisri S. Genetic variability, correlation and path analysis studies for yield and yield attributes in African rice (*Oryza glaberrima*) germplasm. *Electronic Journal of Plant Breeding*. 2020; 11(02): 399-404.

Manasa S, Reddy SM, Murthy K and Meena A. Studies on correlation and path coefficient analysis of yield and yield attributing characters in rice landraces (*Oryza sativa* L.). *International Journal of Environment and Climate Change*. 2022; 12(11): 442-451.

Manivelan K, Juliet Hepziba S, Suresh R, Theradimani M, Renuka R and Gnanamalar RP. Inherent variability, correlation and path analysis in lowland rice (*Oryza sativa* L.). In *Biological Forum–An International Journal*. 2022; 14(2): 771-778).

Nath S and Kole PC. Genetic variability and yield analysis in rice. *Electronic Journal of Plant Breeding*. 2021; 12(1): 253-258.

Lenka, D and Mishra B. (1973). Path coefficient analysis of yield in rice varieties. Indian J. of Agri. Science. 43:376-379.

Panika N, Singh Y, Singh SK, Rahangdale S and Shukla RS 2022. Genetic variability, correlation and path coefficient study of indigenous rice (*Oryza sativa* L.) accessions for different yield and quality contributing traits.

Parimala K, Raju CS, Prasad AH, Kumar SS and Reddy SN. Studies on genetic parameters, correlation and path analysis in rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*. 2020; 9(1): 414-417.

Prasanna Kumari M, Akilan M, Kalaiselvan S, Subramanian A, Janaki P and Jeyaprakash P. Studies on genetic parameters, correlation and path analysis for yield attributes and Iron content in a backcross population of rice (*Oryza sativa* L). *Electronic Journal of Plant Breeding*. 2020; 11(03): 881-886.

Premkumar R, Gnanamalar RP and Anandakumar CR. Correlation and path coefficient analysis of grain quality traits in rice (*Oryza sativa* L.). *Indian Journal of Agricultural Research*. 2016; 50(1): 27-32.

Premkumar R, Gnanamalar RP and CR A . Correlation and path coefficient analysis among grain yield and kernel characters in rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*. 2015; *6*(1): 288-291.

Paramanik S, Rao MS, Purkaystha S and Singamsetti A. Character Association and Path Coefficient Analysis in Selected Genotypes of Rice (*Oryza sativa* L.) 2023;15(10): 902-911.

Priyanka AR, Jeyaprakash P, Baghyalakshmi K and Ramchander. Association studies in yield and grain quality traits in aromatic and non aromatic families of rice. *International Journal of Current Microbiology and Applied Sciences*. 2020; 9(5): 1-8.

Saketh T, Shankar VG, Srinivas B and Hari Y. Correlation and Path Coefficient Studies for Grain Yield and Yield Components in Rice (*Oryza sativa* L.). *International Journal of Plant Soil Science*. 2023; 35(19): 1549-1558.

Sharma A and Hemant KJ. Coefficient of variation, heritability and correlation coefficient in basmati rice hybrids (*Oryza sativa* L.) For yield and quality traits. *Plant Archives*. 2020; 20(2): 5854-5858.

Singh AK, Alok KS, Tarkeshwar, AG and Shiv PM. Analysis of Correlation and Path coefficients for Yield and its Attributes in CMS Lines and Their F1's of Rice (*Oryza sativa* L.). In *Biological Forum–An International Journal*. 2022; 14(4): 19-23.

Singh KS, Suneetha Y, Kumar GV, Rao VS, Raja DS and Srinivas T. Variability, correlation and path studies in coloured rice. *International Journal Chemical Studies*. 2020; 8(4): 2138-2144.

Singh RK and Chaudhary BD. 1985. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, New Delhi, 308.

Sujitha R, Pillai MA, Kannan R and Shoba D. Genetic diversity and association studies in Rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*. 2020; 9(6): 487-492.

Vennela M, Srinivas B, Reddy VR and Balram N. Studies on correlation and path coefficient analysis in hybrid rice (*Oryza sativa* L.) for yield and quality traits. *International Journal of Bio-resource and Stress Management*. 2021;12(5): 496-505.

Wright, S. 1921. Correlation and causation. *Journal of Agricultural Research*. 20: 557- 585.

Baye A, Berihun B, Bantayehu M and Derebe B. Genotypic and phenotypic correlation and path coefficient analysis for yield and yield-related traits in advanced bread wheat (*Triticum aestivum* L.) lines. *Cogent Food Agriculture. (*2020); 6(1) :1752603.

Sujarwo, Putra AN, Setyawan RA, Teixeira HM and Khumairoh U. Forecasting Rice Status for a Food Crisis Early Warning System Based on Satellite Imagery and Cellular Automata in Malang, Indonesia. *Sustainability.* (2022);14(15): 8972.

Yadav, EK and Pitha CC Studies on Genetic Variability, Divergence and Characters Associated with Yield Components in Rice. *International Journal of Environment and Climate Change*. 2022;12(11): 2105-2115.