



Assessment of Correlation of Morphological, and Physiological Traits with Seed Yield in Rice (*Oryza sativa* L.)

**Akshay S. Magar^{a++*}, Pratibha Katiyar^{a#},
Bhumika Banjare^{a++} and Neha Thakur^{a++}**

^a *Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic Plants, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur-492012 Chhattisgarh, India.*

Authors' contributions

This work was carried out in collaboration among all authors. Authors ASM, PK, BB and NT contributed significantly, directly, and intellectually to the data collection, analysis, experimentation and manuscript preparation. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/jsrr/2024/v30i92341>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/121940>

Original Research Article

Received: 22/06/2024

Accepted: 24/08/2024

Published: 28/08/2024

ABSTRACT

Thirty-six rice varieties were evaluated at the instructional farm, College of Agriculture, IGKV, Raipur (C.G.) during the years 2021-22 and 2022-23 under the *Kharif* season. The correlation studies with different morphological, and physiological traits were carried out and suggested that traits e.g. number of tillers, productive tiller, number of leaves, total dry weight, SCMR value of flag leaf, second leaf, third leaf, net assimilation rate, specific leaf weight, light interception, Harvest index,

⁺⁺ *Ph.D. Scholar;*

[#] *Professor;*

^{*} *Corresponding author: E-mail: akshaymagar944@gmail.com;*

Cite as: Magar, Akshay S., Pratibha Katiyar, Bhumika Banjare, and Neha Thakur. 2024. "Assessment of Correlation of Morphological, and Physiological Traits With Seed Yield in Rice (*Oryza Sativa* L.)". *Journal of Scientific Research and Reports* 30 (9):174-80. <https://doi.org/10.9734/jsrr/2024/v30i92341>.

panicle weight plant⁻¹, total grain panicle⁻¹, fertile grains panicle⁻¹, number of primary branches panicle⁻¹, and number of fertile grains on primary branch content were positively correlated at $p < 0.001$ significant level, while Flag leaf length, angle of top three leaves, specific leaf area, sterile grains panicle⁻¹, number of sterile grains on primary branch, and number of sterile grains on the secondary branch were negatively associated with grain yield during both the years. Hence, these traits could be considered as the principal traits. Thus, correlation analysis suggested that these parameters contribute to the seed yield of rice.

Keywords: Correlation analysis; SCMR; NAR; plant architecture; HI, yield attributes.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important essential primary nutritive source of food grain crops [1]. It is consumed as food by more than 85% population in the world and 90% of Asia and grown in 115 countries hence it is also known as “Global grain” [2]. About 21% of calories come from rice crops and it plays an essential role in global food security [3]. Rapid increase of population and decrease in agricultural land are the challenges in the future to feed each one. For this reason we need high yielding varieties of rice. There are morphological (number of tillers, productive tiller, panicle weight plant⁻¹, total grain panicle⁻¹, fertile grains panicle⁻¹, number of primary branches panicle⁻¹, and number of fertile grains) and physiological traits (total dry weight, SCMR value of flag leaf, second leaf, third leaf, net assimilation rate, specific leaf weight, light interception, Harvest index) which are contribute towards the high grain yield in rice.

In rice leaf orientation patterns, leaves are essential for crop growth and grain yield since they are the primary source of photosynthesis. In comparison to other leaves, the flag leaf contributes 42–45% of the rice crop production. This is primarily because it plays a major role in the synthesis of photo-assimilates that are translocated to the panicle, as well as in the high levels of chlorophyll, leaf N, and photosynthetic enzymes per unit leaf area [4,5]. According to Wang et al. [6] found that leaves with more erectness have lower midday heat loads. This reduces the risk of overheating, maximizes water usage efficiency, and decreases water consumption related to daily carbon uptake. The rice crop with a narrow leaf angle and a high leaf orientation value will be better able to absorb light for photosynthesis, improve grain filling, and increase grain yield [7]. It has a major role in grain output in agriculture through enhanced glucose transport from the leaf to the spikelet during grain filling. Many of the techniques used

to increase rice yield potential also involve canopy architecture, HI, and total biomass production, according to many predictions [8,9].

Panicle architecture is one of the most important traits related to rice grain yield and affects crop productivity. According to Agata et al. [10], panicle architecture is significantly influenced by panicle length, which also plays a crucial role in rice seed output. Many rice cultivars that yield more have longer primary branches and more secondary branches than conventional varieties. The length of the panicle rachis and the primary branch, thus, affects the overall grain quantity, rice production, and branching number [11].

Efforts are being made in the direction of breaking the yield barriers that are present in rice breeding schemes. Additionally, grain yield is a complicated characteristic that is dependent on a large number of component characteristics viz. morphological, physiological and it does not react well to direct selection. Increasing rice production is necessary to feed the growing population and will improve crop yield. Agricultural land is being held by fewer people on a daily basis. Thus, adding yield-enhancing characteristics to plants is a smart idea to boost their potential for yield, which is the main focus of this study, in order to increase rice output. The connection between the properties of grain's component parts and grain production. This is why the current study was conducted to learn more about the connection between grain production and the properties of its component elements.

2. MATERIALS AND METHODS

The thirty-two improved rice cultivars along with four local checks (MTU-1001, Rajeshwari, Swarna, and MTU-1010) used for the study under upland irrigated conditions. All these 36 rice cultivars were collected from IGKV, Raipur (C.G.) under the IRRI project. The experiment was conducted under irrigated conditions at the experimental field, and the laboratory analysis

was conducted in the Department of Plant Physiology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Krishak Nagar, Raipur (C.G.) during *Kharif* season 2021-22 and 2022-2023. The experiment was laid out in a Randomized complete block design with two replications. The observations were recorded for different morphological, and physiological traits. These traits were chosen following the standard evaluation system for Rice IRRI, [12], and data was subjected to statistical analysis to estimate the correlation of phyllotaxy and panicle architecture with seed yield in rice crops according to Searle [13]. Correlation coefficient analysis measures the mutual relationship between various characters at genotypic (g), phenotypic (p), and environmental levels with the help of the formula suggested by Lerner [14]. The schedule of various recommended cultural operations was carried out during the investigation.

3. RESULTS AND DISCUSSION

The correlation coefficient serves as a statistical tool employed to measure the magnitude of the association among two or more variables. It plays a pivotal role in assessing the usefulness of the selection procedure. Consequently, correlation offers valuable insights into the extent of the relationship among various contributing traits.

3.1 Association of Plant Architecture with Seed Yield Attributing Traits

The correlation analysis measured the joint relationship between various plant traits and determined the traits on which the selection can be made for improvement in yield under irrigated conditions. The correlations between seed yield and plant architecture traits such as Number of Tillers (NT), Productive Tiller (PT), number of Leaves (NL), Days to 50% Flowering (DFF), Total Dry Weight (TDW), Flag Leaf Length (FLL), Flag Leaf Width (FLW), flag leaf area (FLA), leaf area (LA), Plant Height (PH) were carried out and presented in Table 1.

During year both years, the correlation analysis suggested that seed yield was significantly correlated with traits viz., number of tillers (0.695**), productive tiller (0.591**), number of leaves (0.695**), and total dry weight (0.887**, 0.909**) with $p < 0.01$ significance level in a positive manner, while; the traits flag leaf length (-

0.55**) at the flowering stage were found negatively associated with seed yield. Mohanan and Pavithran [15] found that the ideal number of tillers yielded higher economic yields. Makino *et.al.* [16] also reported that flag leaf length was negatively correlated with seed yield in rice crop. This result was in close agreement with the present study.

3.2 Association of Seed Yield with Phyllotaxy and Growth Traits

Similarly, the correlation analysis was carried out between seed yield and growth characters (Table 2). The data suggested that the seed yield was positively correlated with SCMR value of flag leaf, second leaf, third leaf (0.955**, 0.943**, 0.941** respectively), net assimilation rate (NAR) (0.961**), specific leaf weight (SLW) (0.898**), and light interception (LI) (926**) with $p < 0.01$ significance level, whereas; angles of flag leaf (FLA), second leaf (SELA), and third leaf (TLA) (-0.916**, -0.853**, -0.793** respectively), and specific leaf area (SLA) (-0.778**) were also found in associated with seed yield negatively. Guru et al. [17] Grain yield, SCMR, and CCI (chlorophyll content index) have all demonstrated a much positive correlation with flag leaf thickness. Higher chlorophyll content per unit area in thicker leaves could be the cause of this, leading to better photosynthesis. Banjare et al. [18] reported that SLW, a measure of leaf thickness, had a high positive connection with leaf photosynthesis in numerous crops.

3.3 Association of Seed Yield with Panicle Architecture Traits

Similarly, the correlation analysis was carried out between seed yield and traits related to panicle architecture. The data suggested that the seed yield was positively correlated with viz., Harvest index (HI) (0.899**), panicle weight plant⁻¹ (PWP) (0.909**), total grain panicle⁻¹ (TGP) (0.619**), fertile grains panicle⁻¹ (FGP) (0.781**), number of primary branches panicle⁻¹ (NPB) (0.643**), and number of fertile grains on primary branch (PFBG) (0.643**) with $p < 0.01$ significance level, while; the traits sterile grains panicle⁻¹ (SGP) (-0.772**), number of sterile grains on the primary branch (PBSG) (-0.872**), and number of sterile grains on the secondary branch (SBSG) (-0.569**) were found in association with seed

Table 1. Correlation study of plant architecture attributes of long, medium, and short-duration rice varieties

	SYP	PH (F)	PH (M)	NT(F)	PT	NL	DFF	FLL	FLW	FA	LA	TDW(F)	TDW(M)
SYP	1												
PH (F)	-0.454*	1											
PH (M)	-0.456*	1**	1										
NT(F)	0.695**	-0.865**	-0.861**	1									
PT	0.591**	-0.866**	-0.863**	0.913**	1								
NL	0.695**	-0.865**	-0.861**	1**	0.913**	1							
DFF	-0.153	0.408	0.405	-0.419*	-0.424*	-0.419	1						
FLL	-0.55**	0.87**	0.866**	-0.941**	-0.873**	-0.941**	0.521*	1					
FLW	-0.161	0.852**	0.846**	-0.739**	-0.752**	-0.74**	0.505*	0.818**	1				
FA	-0.475*	0.904**	0.899**	-0.93**	-0.88**	-0.93**	0.528**	0.985**	0.903**	1			
LA	-0.061	0.792**	0.786**	-0.67**	-0.721**	-0.67**	0.547**	0.809**	0.925**	0.863**	1		
TDW(F)	0.887**	-0.274	-0.281	0.456*	0.401	0.456*	-0.029	-0.297	0.055	-0.226	0.147	1	
TDW(M)	0.909**	-0.277	-0.283	0.468*	0.412	0.468*	-0.046	-0.307	0.048	-0.236	0.145	0.996**	1

*** Correlation is significant at 0.001 level (two-tailed)*** Correlation is significant at 0.001 level (two-tailed)

Table 2. Correlation study of phyllotaxy and growth attributes of long, medium, and short-duration rice varieties

	SYP	FLA	SELA	TLA	FSV	SSV	TSV	LAI	NAR	SLA	SLW	LI
SYP	1											
FLA	-0.916**	1										
SELA	-0.863**	0.974**	1									
TLA	-0.793**	0.937**	0.979**	1								
FSV	0.955**	-0.954**	-0.895**	-0.836**	1							
SSV	0.943**	-0.967**	-0.931**	-0.876**	0.98**	1						
TSV	0.941**	-0.968**	-0.933**	-0.878**	0.978**	0.999**	1					
LAI	-0.062	0.355	0.471*	0.599**	-0.175	-0.25	-0.253	1				
NAR	0.961**	-0.943**	-0.901**	-0.849**	0.959**	0.961**	0.962**	-0.155	1			
SLA	-0.778**	0.904**	0.947**	0.974**	-0.793**	-0.83**	-0.831**	0.604**	-0.827**	1		
SLW	0.898**	-0.976**	-0.974**	-0.957**	0.925**	0.948**	0.947**	-0.438*	0.928**	-0.95**	1	
LI	0.926**	-0.951**	-0.905**	-0.844**	0.972**	0.977**	0.977**	-0.22	0.937**	-0.792**	0.918**	1

*** Correlation is significant at 0.001 level (two-tailed)*** Correlation is significant at 0.001 level (two-tailed)

Table 3. Correlation study of panicle architecture attributes of long, medium, and short-duration rice varieties

	SYP	PL	PBL	SBL	NPB	NSB	GL	GW	L:B R	PBFG	PBSG	SBFG	SBSG	TGP	FGP	SGP	PWP	TW	HI
SYP	1																		
PL	0.025	1																	
PBL	-0.144	0.309	1																
SBL	-0.302	0.323	0.345	1															
NPB	0.643**	-0.216	-0.235	-0.217	1														
NSB	-0.075	-0.143	0.127	0.116	0.219	1													
GL	0.44*	0.23	0.11	-0.064	0.157	-0.014	1												
GW	0.285	0.502*	0.282	0.031	0.217	0.045	0.699**	1											
L:B R	-0.007	-0.513*	-0.304	-0.147	-0.13	-0.015	-0.091	-0.751**	1										
PBFG	0.684**	0.208	0.115	-0.08	0.396*	0.091	0.468*	0.486*	-0.274	1									
PBSG	-0.872**	-0.034	0.115	0.163	-0.538**	0.134	-0.344	-0.196	-0.007	-0.535**	1								
SBFG	0.286	0.188	0.414	0.047	0.063	0.224	0.111	0.099	-0.095	0.387	-0.149	1							
SBSG	-0.569**	0.116	-0.018	0.161	-0.216	0.183	-0.244	-0.042	-0.108	-0.319	0.617**	-0.312	1						
TGP	0.619**	0.012	0.004	-0.124	0.768**	0.314	0.325	0.441*	-0.3	0.824**	-0.389	0.315	-0.14	1					
FGP	0.781**	0.056	-0.012	-0.144	0.776**	0.209	0.389	0.448*	-0.271	0.883**	-0.624**	0.338	-0.319	0.96**	1				
SGP	-0.772**	-0.121	0.056	0.127	-0.277	0.276	-0.321	-0.145	-0.033	-0.461*	0.953**	-0.166	0.692**	-0.173	-0.441*	1			
PWP	0.909**	-0.102	-0.22	-0.247	0.752**	0.053	0.365	0.251	-0.01	0.674**	-0.758**	0.261	-0.468*	0.734**	0.837**	-0.604**	1		
TW	0.274	-0.287	0.128	0.027	0.187	0.011	0.469*	0.113	0.335*	0.181	-0.191	0.089	-0.028	0.195	0.205	-0.11	0.333	1	
HI	0.899**	-0.173	-0.268	-0.428*	0.678**	-0.019	0.297	0.116	0.107	0.498*	-0.788**	0.241	-0.574**	0.532**	0.674**	-0.674**	0.899**	0.316	1

*** Correlation is significant at 0.001 level (two-tailed)*** Correlation is significant at 0.001 level (two-tailed)

yield negatively (Table 3). Grain yield in cereals can be raised by raising the harvest index, biomass production, or both Yoshida [19]. Gautam et al. [20] investigated, that between the number of spikelets and the length of the secondary branches, there is no discernible correlation. Ashrafuzzaman et al., [21] reported that the correlation between grain yields and their component in rice lines was noted by Konate et al. [22]. However, grain yield per plant exhibits a strong positive correlation with stem weight and biomass. Both at the genotypic and phenotypic levels, grain yield per plant/kernel weight was positively and significantly correlated with days to maturity [23]. Grain weight, grain length/breadth ratio, and grain length are all positively correlated. Both phenotypic and genotypic levels of correlation between panicle length were found to be positive and significant. These outcomes were also observed by Ramkrishnan et al. [24].

4. CONCLUSION

The significance of many characteristics in predicting yield potential, including tiller number, top three leaf angles, LAI, SLA, SLW, NAR, and LI. However, the relationships between these traits and yield can vary significantly across different groups of long, medium, and mid-early duration varieties and environments. As a result, clarifying these relationships in certain situations can offer insightful information for breeding initiatives targeted at raising rice output. The primary objective of this research is to establish a correlation between different rice varieties' morpho-physiological properties, and seed yield characteristics. When the characteristics that have a major impact on yield are identified.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the writing or editing of manuscripts.

ACKNOWLEDGEMENTS

We sincerely appreciate the support provided by the Department of Plant Physiology, IGKV, Raipur; the SARTHI Government of Maharashtra Scholarship program, which provided the funds needed to complete this study; and plant breeder Dr. Sanjay Katiyar, an IRRI scientist, who lent us the rice varieties for his course.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Li G, Zhang H, Li J, Zhang Z, Li Z. Genetic control of panicle architecture in rice. *The Crop Journal*. 2021;9(3):590-597.
2. Singh M, Chouhan P, Chaudhari P. Agromorphological characterization of indigenous germplasm accessions of rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*. 2021;10(2):1378-1385.
3. Mohidem NA, Hashim N, Shamsudin R, Che Man H. Rice for food security: Revisiting its production, diversity, rice milling process, and nutrient content. *Agriculture*. 2022;12(6), 741.
4. Liu CG, Zhou XQ, Chen DG, Li LJ, Li JC, Chen YD. Natural variation of leaf thickness and its association to yield traits in indica rice. *Journal of integrative agriculture*. 2014;13(2):316-325.
5. Mahesh G, Chandra Mohan Y, Saida Naik D, Narender Reddy S. Study on flag leaf and its penultimate leaves for their association with grain yield in rice (*Oryza sativa* L.). *International Journal Biological Forum*. 2022;14(2):270-274.
6. Wang K, Li MQ, Chang YP, Zhang B, Zhao QZ, Zhao WL. The basic helix-loop-helix transcription factor OsBLR1 regulates leaf angle in rice via brassinosteroid signalling. *Plant Molecular Biology*. 2020; 102:589-602.
7. Ku LX, Zhao WM, Zhang J, Wu LC, Wang CL, Wang PA, Chen YH. Quantitative trait loci mapping of leaf angle and leaf orientation value in maize (*Zea mays* L.). *Theoretical and Applied Genetics*. 2010; 121:951-959.
8. Akter MB, Islam MT, Mondal MMA, Hoque MI, Kamruzzaman M, Nafis MH, Ali MS. Morpho-physiological Basis of Yield Performance of Early Maturing Rice Varieties in Bangladesh. *Annual Research and Review in Biology*. 2019;1-13.
9. Shindo M, Yamamoto S, Shimomura K, Umehara M. Strigolactones decrease leaf angle in response to nutrient deficiencies in rice. *Frontiers in Plant Science*. 2020; 11:135.
10. Agata A, Ando K, Ota S, Kojima M, Takebayashi Y, Takehara S, Hobo T.

- Diverse panicle architecture results from various combinations of Prl5/GA20ox4 and Pbl6/APO1 alleles. *Communications Biology*. 2020;3(1):302.
11. Mohapatra PK, Sahu SK. Heterogeneity of primary branch development and spikelet survival in rice panicle in relation to assimilates of primary branches. *J. Exp. Bot.* 1991;42:871–879.
 12. IRRI; 1996. Available:<http://www.knowledgebank.irri.org/images/docs/rice-standard-evaluation-system.pdf>.
 13. Searle SR. Phenotypic, Genotypic, and environmental correlations. *Biometrics*. 1961;47:474-480.
 14. Lerner M. The genetic basis of selection. *John wheat grass seed production*. Agron. J., 51: 515-518. Willey and sons. New York. 1958;145.
 15. Mohanan KV, Pavithran K. Chronology of tiller emergence and tiller orientation in rice (*Oryza sativa* L.). *Crop Improvement* Oryza. 2007;44(4):307-310.
 16. Makino Y, Hirooka Y, Homma K, Kondo R, Liu TS, Tang L, Nakazaki T, Xu Z, Shiraiwa T, Effect of flag leaf length of erect panicle rice on the canopy structure and biomass production after heading. *Plant Production Science*. 2022;25(1): 1-10.
 17. Guru T, Padma V, Reddy DVV, Rao PR, Sanjeeva Rao D, Ramesh T, Radhakrishna KV. (2017). Natural variation of top three leaf traits and their association with grain yield in rice hybrids. *Indian Journal of Plant Physiology*. 2017;22(1):141-146.
 18. Banjare B, Katiyar P, Magar AS, Thakur N. Exploring the Correlation between Morpho-physiological Traits and Growth Attributes Associated with Yield Characteristics in Rice (*Oryza sativa* L.). *Journal of Experimental Agriculture International*. 2024;46(8):158-164.
 19. Yoshida S. Physiological analysis of rice yield. In: *Fundamentals of Rice Crop Science*. International Rice Research Institute, Makita City, Philippines. 1981; 231-25.
 20. Gautam A, Shrestha A. Evaluation of panicle architecture traits in rice genotypes using PTRAP. *Nepal Agriculture Research Journal*. 2023;15(1):115-124.
 21. Ashrafuzzaman M, Rafiqul Islam, Razi Ismail, Shahidullah SM, Hanafi MM. Evaluation of Six Aromatic Rice Varieties for Yield and Yield Contributing Characters. *Int. J Agric. Biol*. 2009;11(5):616-620.
 22. Konate AK, Zongo A, Kam H, Sanni A, Audebert A. Genetic variability and correlation analysis of rice inbred lines based on agro-morphological traits. *African Journal of Agricultural Research*. 2016; 11(35):3340-3346.
 23. Habib SH, Bashar MK, Khalequzzaman M, Ahmed MS, Rashid ESMH. Genetic analysis and morphological selection criteria for traditional Broin rice germplasm. *J. Boil. Sci*. 2005;5(3):315-318.
 24. Ramkrishnan SH, Anandakumar CR, Sarvanan S, Malini N. Association analysis of some yield traits in rice (*Oryza sativa* L.). *J. Appl. Sci. Res*. 2006;2(7):402-404.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/121940>