Plant Archives Vol. 26, Supplement 1, 2026 pp. 881-885 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.118

CORRELATION STUDY FOR SEEDLING VIGOUR AND YIELD RELATED TRAITS IN SELECTED LAND RACES OF RICE (*ORYZA SATIVA.* L)

Kishore Kumar T.[1,2], Divya Balakrishnan[1*], Kalyani M Barbadikar[1], Darshini M. Pujar[2*], Kanika [1], Santosh V.[1] and Pranay G.[1]

[1]ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, India - 500030
[2]School of Agricultural Sciences, Malla Reddy University, Hyderabad- 500100, Telangana, India
*Corresponding authors: dbiirr23@gmail.com; drdarshini@mallareddyuniversity.ac.in
(Date of Receiving : 05-09-2025; Date of Acceptance : 27-11-2025)

ABSTRACT

Early seedling vigour is a critical trait in direct-seeded rice systems because it influences crop establishment, weed competitiveness, and yield potential. Seedling vigour is an agronomical trait along with uniform seed germination and essential for proper crop growth and development. It improves the uniformity of the seedlings with good crop stand and establishment ultimately results in better grain yield. The present study was undertaken to assess seedling vigour in 24 rice genotypes with an aim to identify better genotypes exhibiting high seedling vigour traits, we phenotyped the seedling vigour index-related traits *viz*., germination percentage, root length and shoot length, fresh and dry weights on 7th day and 14th day in a set of germplasm consisting of landraces, using the paper towel method. The results exhibited shoot length on the 7th, 14th day, root length on the 7th, 14th day, seedling vigour index-1,2 on the 7th day, fresh weight on the 7th, 14th day and dry weight on the 7th day showed positive significance among the traits. Correlation estimates revealed the selection of suitable contributing characters for identification of high seedling vigour.

Keywords **:** Seedling vigour, Yield related traits, Rice (*Oryza sativa.* L).

Introduction

Rice is one of the most important food crops and the global consumption has seen increased from 437.18 million metric tons in the year 2008 to 486.62 million metric tons in the year 2019 (www.statista.com, 2020). It is the sole crop cultivated under the world's most sensitive ecological conditions ranging from high altitudes to below sea level. Second green revolution is possible only if rice research is undertaken vigorously and persistently to address s higher yield under stress prone environments (Bouman and Tuong, 2001). As the first step of rice seedling development, high quality seed germination can essentially overcome adverse environmental impacts and then, directly and indirectly, influence yield (Ellis *et al*. 1992). Major challenge is due to existence of different type of rice ecologies in India, like upland, rainfed lowland, hills, deep water, saline, acidic and alkaline soils along with large irrigated ecology each with specific growing conditions and requirements (Perry *et al.,* 1973). The cultivated germplasm in the major vulnerable areas involve landraces which are important sources of genes that enhance the resistance of crops to adverse conditions (Dwivedi *et al*., 2016). They usually have better alleles that improve their adaptation to stress conditions, they are a good source of stress tolerance potential (Redona & Mackill *et al.,* 1996). The insight of their adaptive characteristics and the mechanism will help in breeding rice varieties that are compatible with direct-seeding regime and enhance the waterlogging tolerance before and after germination (Miro and Ismail, 2013). It is worth noting that anaerobic germination and adaptive traits has been detected in several Indian landraces, *viz*., Vellai Kavuni and Karuppu Kavuni (Mohanapriya *et al*., 2022) and other land races of south east Asian countries viz., Khaiyan and Khao Hlan (Miro and Ismail, 2013).

Large scale transformation from transplanting to direct sowing was made possible by the development of weed control methods and high-yielding, high seedling vigour and early maturing cultivars. A gradual

transition from irrigated to rainfed rice cultivation has been documented, with direct-seeded rice accounting for 50% of India's rainfed rice area (Anandan *et al*., 2016). Because of this, direct-seeded rice has emerged as a workable way to save labour and water, lower methane emissions, and increase rice yields especially on fine-textured soils. Yield is a complicated quantitative trait that is influenced by a number of component attributes, their interactions with one another, and the environment (Balakrishnan *et al*., 2020). In order to better understand the diversity of these qualities and improve them through breeding programs, our study aims to characterize a set of landraces for attributes linked to seedling vigour and yield and to identify the correlations.

Materials and Methods

Plant material

The present research work was conducted during *Rabi* 2024-25 at ICAR- Indian Institute of Rice Research (ICAR- IIRR), Rajendranagar, Hyderabad, Telangana (17.32° N, 78.39° E, 536 MSL). The experimental material consists 24 landraces obtained from ICAR- IIRR, Hyderabad.

Methods

Phenotyping of Seedling vigour related traits

Germination test

The germination test was done using petriplate method, in petriplate 100 well dried seeds were placed in sterilized petriplate lined with Whatman filter paper with sufficient moisture for seedling emergence under normal room temperature, counted the number of seeds germinated in 100 seeds.

Seedling growth test

This experiment was done using the using the paper towel method. The traits were recorded under lab conditions at 7^{th} and 14^{th} days evaluated. In which 10 seeds were placed with equidistantly in brown germination sheet that has a water absorbing capacity and rolled carefully with two distal edges tied with rubber bands and arranged vertically in a tray filled with water and incubated at room temperature. At 7^{th} day and 14^{th} day after incubation, the 10 seedlings from each genotype were measured for shoot length and root length. The seedlings were dried in an oven and dry matter weight of the seedlings were measured. The data obtained from three replications were subjected to the following analysis. The correlation coefficient was worked out as the method suggested by Dewey *et al*. (1959), and the correlogram was constructed in RStudio using "metan" package suggested by Olivoto *et al*. (2020).

Seedling vigour index-I=

$$\frac{\text{germination percentage x seedling length (cm)}}{100}$$

Seedling vigour index-II=

$$\frac{\text{germination percentage x total weight of seedlings (g)}}{100}$$

Results and Discussion

Seedling vigour in rice is an important trait for better crop establishment in direct seeded rice and associated traits are quantitatively inherited (Zhang, 1995). Correlation between traits is of interest to determine whether selection for one trait will have an effect on another. Simple correlation coefficient from the combined data was shown in Table 1. Correlation coefficient determined over the 24 rice genotypes for 14 seedling vigour traits revealed significant correlation among shoot length on the 7^{th} day had showed positively significant with root length on the 7^{th} day (0.538**), dry weight on the 7^{th} day (0.585**), seedling vigour index-1 on the 7^{th} day (0.991***), shoot length on the 14^{th} day (0.528**), fresh weight on the 14^{th} day (0.427*), seedling vigour index-1 on the 14^{th} day (0.55**) Similar type of results was obtained by (Sujay *et al.,* 2007 & Bharamappanavara *et al*., 2023).

Root length on the 7^{th} day showed positively significant association with dry weight on the 7^{th} day (0.553**), seedling vigour index-1 on the 7^{th} day (0.529**) similar to the results of (Beerelli *et al*. 2020). Shoot length on the 14^{th} day at (0.552**), fresh weight on the 14^{th} day (0.475*), seedling vigour index-1 on the 14^{th} day (0.573**). This highlights the significance of early root establishment, since early root length was positively correlated with fresh and dry weights and later root growth (Cui *et al*. 2002). Fresh weight on the 7^{th} day had showed positively significant association with dry weight on the 7^{th} day (0.429*), seedling vigour index-2 on the 7^{th} day (0.967***), shoot length on the 14^{th} day (0.454*) and dry weight on 7^{th} day is positively significant association with seedling vigour index-1 on the 7^{th} day (0.56**), shoot length on the 14^{th} day (0.457*), seedling vigour index-1 on the 14^{th} day (0.427*), fresh weight showed positive associations with dry weight, seedling vigour indices, and later shoot growth, reflecting the contribution of biomass accumulation to plant performance. These results are supported by (Tejaswi *et al.,* 2012, Padmashree *et al*., 2022 & Barik *et al.,* 2019).

Seedling vigour index-1on 7^{th} day showed positively significant association with shoot length on the 14^{th} day (0.516**), fresh weight on the14^{th} day (0.443*), seedling vigour index-1 on the 14^{th} day

(0.571**) these results are similar to (Gomez *et al*., 1984) and seedling vigour index-2 on 7th day positively significant association with shoot length on the 14th day (0.426*) seedling vigour indices positively correlated to the shoot length and fresh weight these correlations among the parameters were calculated according to (Sangamitra *et al*., 2021 & Jan and Kashyap *et al.* 2019). Shoot length on the 14th day had showed positive significant association with root length on the 14th day (0.461*), fresh weight on the 14th day (0.58**), seedling vigour index-1 on the 14th day (0.963***) these result are in agreement with the finding of (Lee *et al*. 1986) and root length on the 14th day is positively significant association with seedling vigour index-1 on the 14th day (0.461*) these results were in agreement with the findings of (Addanki *et al.* 2018), (Katiyar *et al*. 2019). Fresh weight on the 14th day is positively significant association with seedling vigour index-1 on the 14th day (0.661**), seedling vigour index-2 on the 14th day (0.573**). These interrelationships among traits suggest that selecting for one key vigour trait can indirectly enhance others as reported by Bordoloi D Sarma *et al.* 2018 & Beerelli *et al*. 2020.

Table 1 : Phenotypic correlations of yield and seedling vigour traits

	G %	SL(7)	RL(7)	FW(7)	DW(7)	SVI-1(7)	SVI-2(7)	SL(14)	RL(14)	FW(14)	DW(14)	SVI-1(14)	SVI-2(14)	SPY
G%	1	0.08	0.06	-0.24	-0.1	0.21	-0.09	0.01	0.05	0.13	-0.007	0.25	0.19	0.28
SL (7)		1	0.53**	0.1	0.58**	0.99***	0.11	0.52**	0.04	0.42*	0.01	0.55**	0.06	-0.17
RL (7)			1	0.34	0.55**	0.52**	0.35	0.55**	0.39	0.47*	-0.32	0.57**	0.01	-0.45*
FW (7)				1	0.42*	0.06	0.96***	0.45*	0.3	0.18	-0.07	0.36	-0.2	-0.45*
DW (7)					1	0.56**	0.36	0.45*	0.25	0.36	0.16	0.42*	0.09	-0.1
SVI-1(7)						1	0.09	0.51**	0.05	0.44*	0.02	0.57**	0.09	-0.13
SVI-2(7)							1	0.42*	0.3	0.17	-0.09	0.37	-0.17	-0.39
SL (14)								1	0.46*	0.58**	0.11	0.96***	0.11	-0.51**
RL (14)									1	0.29	-0.26	0.46*	0.18	-0.01
FW (14)										1	0.27	0.61**	0.57**	-0.35
DW (14)											1	0.11	0.29	0.22
SVI-1(14)												1	0.17	-0.45*
SVI-2(14)													1	0.06
IRSPY														1

*** Significant at 0.001% level; ** significant at 0.01% level; * significant at 0.05% level

Morphological traits observed are *G%* Germination percentage, *SL* (7) Shoot length on the 7th day, *RL* (7) Root length on the 7th day, *FW* (7)-Fresh weight on the 7th day, *DW* (7) Dry weight on the 7th day, *SVI*-1 (7) Seedling vigour index-1 on the 7th day, *SVI-2* Seedling vigour index-2 on the 14th day, *SL* (14) Shoot length on the 14th day, *RL* (14) Root length on the 14th day, *FW* (14) Fresh weight on the 14th day, *DW* (14) Dry weight on the 14th day, *SVI*-1 (14) Seedling vigour index-1 on the 14th day, *SVI*-2 (14) Seedling vigour index-2 on the 14th day, *IR SPY* – Control field single plant yield

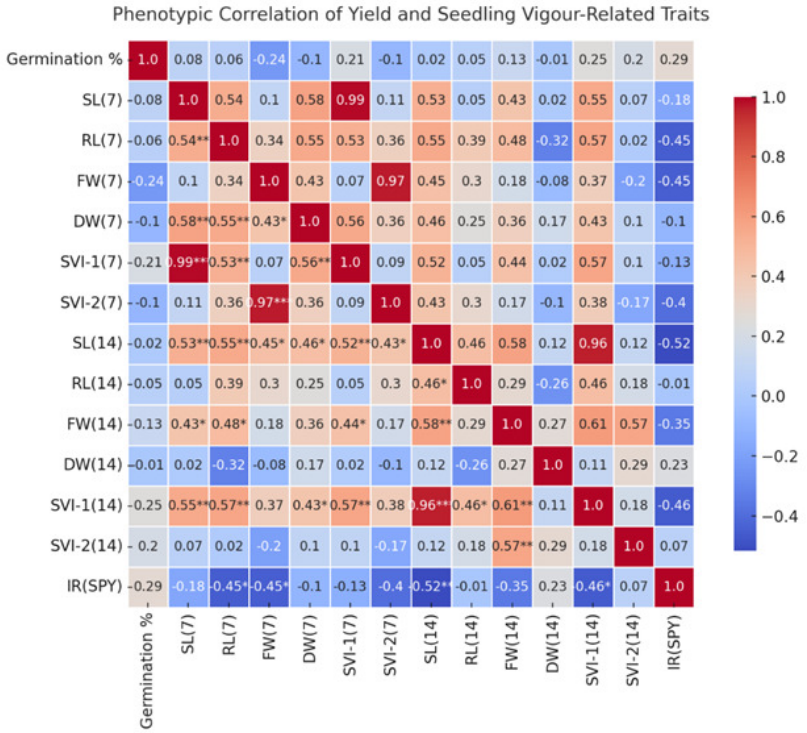

Fig. 1 : Correlation among seedling vigour traits in rice genotypes

*** Significant at 0.001% level; ** significant at 0.01% level; * significant at 0.05% level

Morphological traits observed are *SL* (7) Shoot length on the 7th day, *RL* (7) Root length on the 7th day, *FW* (7)-Fresh weight on the 7th day, *DW* (7) Dry weight on the 7th day, *SVI*-1 (7) Seedling vigour index-1 on the 7th day, *SVI-2* Seedling vigour index-2 on the 14th day, *SL* (14) Shoot length on the 14th day, *RL* (14) Root length on the 14th day, *FW* (14) Fresh weight on the 14th day, *DW* (14) Dry weight on the 14th day, *SVI*-1 (14) Seedling vigour index-1 on the 14th day, *SVI*-2 (14) Seedling vigour index-2 on the 14th day, , IR *SPY* – Control field single plant yield.

Conclusion

According to the findings of this study the traits shoot length, root length, fresh weight, dry weight and seedling vigour indices 1, 2 on the 7th day and 14th day showed positive significant correlation and these traits are important for selection for crop improvement. Based on all the vigour parameters recorded, better genotypes can be identified that might be suitable to direct seeded rice conditions.

Acknowledgment

This research was carried out as a part of the MSc research work entitled "Genome wide association study in Rice (*Oryza sativa* L.) for yield traits under limited nutrient conditions" of the first author. This research was supported from project funding of ICAR-NASF Harnessing haplotype diversity of genes controlling yield, stress tolerance and resource use efficiency traits in rice for accelerating genetic gains and SERB POWER project SPG/2021/000317 to corresponding author. First author acknowledges ICAR-IIRR and MRU for providing all the necessary facilities for the research work.

Competing Interests

Authors have declared that no competing interests exist.

Authors' Contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript

References

Addanki, K.R., Balakrishnan, D., Yadavalli, V.R., Surapaneni, M., Mesapogu, S., Beerelli, K. and Neelamraju, S. (2019). Swarna× *Oryza nivara* introgression lines: a resource for seedling vigour traits in rice. *Plant Genetic Resources*, **17**(1), 12-23.

Anandan, A., Anumalla, M., Pradhan, S.K. and Ali, J. (2016). Population structure, diversity and trait association analysis in rice (*Oryza sativa* L.) germplasm for early seedling vigor (ESV) using trait linked SSR markers. *PloS one*, **11**(3), e0152406.

Balakrishnan, D., Surapaneni, M., Yadavalli, V.R., Addanki, K.R., Mesapogu, S., Beerelli, K. and Neelamraju, S. (2020). Detecting CSSLs and yield QTLs with additive, epistatic and QTL× environment interaction effects from *Oryza sativa*× *O. nivara* IRGC81832 cross. *Scientific Reports*, **10**(1), 7766.

Barik, J., Kumar, V., Lenka, S.K. and Panda, D. (2019). Genetic potentiality of lowland indigenous indica rice (*Oryza sativa* L.) landraces to anaerobic germination potential. *Plant Physiology Reports*, **24**(2), 249-261.

Beerelli, K., Balakrishnan, D. and Neelamraju, S. (2020). Variability and correlation of yield traits in BIL x BIL populations derived from Swarna x *O. nivara*. *Journal of Rice Research*, **13**(1), 1.

Bharamappanavara, M., Madhyavenkatapura, A.S., Appaiah, M.C., Patil, B.S., Vijjeswarapu, A., Senguttuvel, P., Madhav, M.S., Rathod, S., Mondal, T.K., Ramappa, L. and Mathada, U.R. (2023). Genetic analysis of early seedling vigour in *Oryza glaberrima* accessions under laboratory and direct-seeded rice conditions. *Cereal Research Communications*, **51**(4), 991-1002.

Bordoloi, D. and Sarma, D. (2018). Aerobic versus anaerobic germination performance of selected rice (*Oryza sativa* L.) genotypes with or without submergence tolerance. *Journal of Experimental Biology and Agricultural Sciences*, ***6*(6),** 947-958.

Bouman, B.A.M. and Tuong, T.P. (2001). Field water management to save water and increase its productivity in irrigated lowland rice. *Agricultural water management*, **49**(1), 11-30.

Cui, K., Peng, S., Xing, Y., Xu, C., Yu, S. and Zhang, Q. (2002). Molecular dissection of seedling-vigor and associated physiological traits in rice. *Theoretical and Applied genetics*, **105**(5), 745-753.

Dewey, D.R. and Lu, K. (1959). A correlation and path‐coefficient analysis of components of crested wheatgrass seed production 1. *Agronomy journal*, **51**(9), 515-518.

Dwivedi, S.L., Ceccarelli, S., Blair, M.W., Upadhyaya, H.D., Are, A.K. and Ortiz, R. (2016). Landrace germplasm for improving yield and abiotic stress adaptation. *Trends in plant science*, **21**(1), 31-42.

Ellis, F., Trotter, B. and Magrath, P. (1992). *Rice marketing in Indonésia: methodology, results and implications of a research study* (Vol. **4**). Natural Resources Institute.

Gomez, K.A. and Gomez, A.A. (1984). *Statistical procedures for agricultural research*. John wiley & sons.

https://www.statista.com/statistics/255977/total-global-rice-consumption

Jan, N. and Kashyap, S.C. (2019). Correlation and path analysis in rice (*Oryza sativa* L.) for seed and seed vigour traits. *Journal of Pharmacognosy and Phytochemistry*, **8**(1), 222-226.

Katiyar, D., Srivastava, K.K., Prakash, S., Kumar, M. and Gupta, M. (2019). Study correlation coefficients and path analysis for yield and its component characters in rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*, **8**(1), 1783-1787.

Lee, C.C., Li, C.C. and Sung, F.J.M. (1986). Physiological and genetic studies on seedling vigor in rice (*Oryza sativa* L.) II. Inheritances of alpha-amylase activity and seedling vigor in rice.

Lu, X.L., Niu, A.L., Cai, H.Y., Zhao, Y., Liu, J.W., Zhu, Y.G. and Zhang, Z.H. (2007). Genetic dissection of seedling and early vigor in a recombinant inbred line population of rice. *Plant Science*, **172**(2), 212-220.

Miro, B. and Ismail, A.M. (2013). Tolerance of anaerobic conditions caused by flooding during germination and early growth in rice (*Oryza sativa* L.). *Frontiers in plant science*, **4**, 269.

Mohanapriya, G., Thiruvengadam, S.K.V., Raveendran, M. and Manonmani, S. (2022). Identification of anaerobic germination tolerant landraces and validation of molecular marker in rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*, **13**(3), 873-881.

Olivoto, T. and Lúcio, A.D.C. (2020). metan: An R package for multi-environment trial analysis. *Methods in Ecology and Evolution*, **11**(6), 783-789.

Padmashree, R., Barbadikar, K.M., Honnappa, Magar, N.D., Balakrishnan, D., Lokesha, R., Gireesh, C., Siddaiah, A.M., Madhav, M.S., Ramesha, Y.M. and Bharamappanavara, M. (2023). Genome-wide association studies in rice germplasm reveal significant genomic regions for root and yield-related traits under aerobic and irrigated conditions. *Frontiers in Plant Science*, **14**, 1143853.

Perry, D.A. (1973). Seed vigour and field establishment. Horticulture Abstracts. **42**: 334-342.

Redona, E.D. and Mackill, D.J. (1996). Genetic variation for seedling vigor traits in rice. *Crop Science*, **36**(2), 285-290.

Sanghamitra, P., Nanda, N., Barik, S.R., Sahoo, S., Pandit, E., Bastia, R., Bagchi, T.B. and Pradhan, S.K. (2021). Genetic structure and molecular markers-trait association for physiological traits related to seed vigour in rice. *Plant Gene*, **28**, 100338.

Sujay, V. (2007). Evaluation of early vigor related traits in upland rice (*Oryza sativa*). *Master of Science Thesis, University of Agricultural Sciences, Dharwad*.

Talai, S. and Sen-Mandi, S. (2010). Seed vigour-related DNA marker in rice shows homology with acetyl CoA carboxylase gene. *Acta physiologiae plantarum*, **32**(1), 153-167.

Tejaswi, N.L. (2012). Identification of molecular markers for seedling vigour traits in rice (*Oryza sativa* L.) genotypes. *M.Sc. (Ag.) Thesis.*