

GENETIC VARIABILITY AND PATH ANALYSIS FOR YIELD AND GRAIN YIELD COMPONENT CHARACTERS IN RICE (*Oryza sativa* L.) GENOTYPES

ABSTRACT:

The present investigation consists of 21 genotypes of Rice including one check, which were grown under the Field Experiment Centre of the Department of GPB, SHUATS, Prayagraj during *Kharif* 2021 following RBD with three replications. The data was collected on 13 characters to evaluate the analysis of variance, heritability, genetic advance, correlation and path analysis. Based on the mean performance genotypes **NUMALI** showed high grain yield per hill followed by **KALINGA** and **MTU-1155** were identified as desirable genotypes with highest grain yield per hill. High estimates of PCV, GCV, heritability coupled with high genetic advance as percent of mean were recorded for grain yield per hill, biological yield and flag leaf length. Biological yield and harvest index showed positive and highly significant association with grain yield per hill and recorded high positive direct effect on grain yield per hill at both the genotypic and phenotypic levels. These characters such as biological yield, and harvest index should be given prior consideration during selection for grain yield improvement in rice.

Keywords: Rice, GCV, PCV, Heritability, Genetic advance, correlation and path analysis

INTRODUCTION:

Rice, *Oryza sativa* L. (2n=24) belongs to family Poaceae (Graminae) and the genus *Oryza* has two cultivated species namely: *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice). About 90% of the world's rice is grown and consumed by Asians and subfamily of *Oryzoidea*. The rice genus comprises 24 species, 22 of which are wild and 2 of which are grown, i.e. *O. sativa* and *O. glaberrima*. Rice is one of the world's most important food crops. It absorbs almost 50 % of the total land occupied by cereals and accounts for about one fifth of the global population. Of the two species cultivated, *O. Sativa* is grown worldwide. In West Africa *O. glaberrima* has been cultivated for the last 3500 years. Inflorescence of rice is known as Panicle. Nutritional components include proteins and micronutrients like Iron and Zinc. The average percentage of protein in rice grains is 8 per cent, Fe is 1.2 mg/100 g and Zn is 0.5 mg/100 g. Malnutrition is a large and growing problem in the developing world mostly in South and S.E. Asia and Sub Sahara Africa (**Reddy et al., 2005**). Rice plays a crucial role in the Indian economy being the two-thirds of the population's staple food. The majority of rice produced in Asian countries is in China, India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, and Pakistan. Asian farmers already account for 87 per cent of the overall production of rice in the world. By 2050, the world's population is anticipated to reach 9.1 billion, necessitating a 70 percent increase in food production (Godfray et al., 2010; Hodges et al., 2011;

Parfitt *et al.*, 2010). The International Rice Research Institute (IRRI 2000) studied the food problem in relation to world population, and they predict that 800 million tons of rice will be required in 2025. Most of the increase in demand will occur in Asia and Africa, where the population lives on rice. High yielding varieties is essential in order to meet the food requirement of growing population. The success of plant breeding depends on the extent of genetic variability present in a crop.

MATERIALS AND METHODS:

An investigation consists of 21 rice genotypes accessions collected from the branch of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (Uttar Pradesh) during the time of kharif-2021. Current investigation is an effort has been made toward assess the amount of genetic variability, correlation and path analysis in the rice accessions. Data were recorded on 13 characters *viz*; Days to 50% flowering, Days to maturity, plant height (cm), flag leaf length (cm), flag leaf width (cm), number of tillers per plant, number of panicles per hill, panicle length (cm), number of spikelets per panicle, biological yield (g), harvest index (%), test weight (g), and grain yield per hill (g).

RESULT AND DISCUSSION

A perusal of mean performance among 21 rice genotypes recorded that NUMALI genotype showed high grain yield per hill followed by KALINGA and MTU-1155

High estimates of GCV and PCV were recorded for grain yield per hill (28.89 and 30.22) and biological yield (28.11 and 28.88). Moderate estimates of GCV and PCV were recorded in Flag leaf length (16.61 and 17.81), Harvest index (15.51 and 19.03), Flag leaf width (13.99 and 15.33), Plant height (13.76 and 15.39), Test weight (13.69 and 14.75), number of spikelets per panicle (11.3 and 13.46), days to 50% flowering (11.05 and 12.68) and number of tillers per hill (10.91 and 14.07). Low estimates of GCV and PCV were observed for number of panicles per hill (7.68 and 11.49), panicle length (7.68 and 11.16) and days to maturity (6.27 and 10.16).

The estimates of heritability from present investigation are presented in (Table 1). In the present study, heritability (broad sense) ranged from 38.19% to 94.77%. The highest heritability (above 60%) was observed for biological yield (94.77%), followed by, grain yield per hill (91.44%), Flag leaf length (86.95%), test weight (86.22%), flag leaf width (83.26%), plant height (79.98%), days to 50% flowering (75.86%), number of spikelets per panicle (70.59), harvest index (66.44%) and number of tillers per hill (60.12%) respectively.

Moderate estimates of heritability (30-60%) were observed for days to maturity (38.19%), number of panicles per hill (44.68%) and panicle length (47.38%). All the characters showed high to moderate heritability. None of the characters showed low estimates of heritability (below 10%).

In the present study, high genetic advance (above 20%) was observed for biological yield (56.06%), followed by number of spikelets per panicle (37.41), plant height (37.38%), grain yield per hill (28.16%) and days to 50% flowering (20.46%). Moderate (10-20%) values of genetic advance were observed for flag leaf length (14.78%) followed by harvest index (13.08%) and days to maturity (10.57%). Lowest (below 10%) values of genetic advance was observed for test weight (6.10%), panicle length (3.07%), number of tillers per hill (1.93%), number of panicles per hill (1.16%) and flag leaf width (0.33%).

Highest estimates of genetic advance as per cent mean was recorded for grain yield per hill (56.92%), biological yield (56.38%), flag leaf length (31.90%), flag leaf width (26.30%), test weight (26.19%), harvest index (26.05%) and plant height (21.35%). Moderate estimates of genetic advance as per cent mean was recorded for days to 50% flowering (19.82%), number of spikelets per panicle (19.58%), number of tillers per hill (17.43%), panicle length (10.89%) and number of panicles per hill (10.58%). Lowest estimates of genetic advance as per cent mean was observed for days to maturity (7.99%).

High heritability coupled with high genetic advance as per cent mean was recorded for biological yield (94.77% and 56.38%), grain yield per hill (91.44% and 56.92%), flag leaf length (86.95% and 31.90%), test weight (63.95% and 16.61%), flag leaf width (81.74% and 22.36%), harvest index (66.44%) and plant height (90.33% and 17.21%). High heritability coupled with moderate genetic advance as per cent mean was observed in Days to 50% flowering (75.86% and 19.83%), number of spikelets per panicle (70.59% and 19.59%) and number of tillers per hill (60.12% and 17.43%) in the present investigation.

In the present investigation grain yield per hill showed positive significant association with biological yield (0.766**) and harvest index (0.480**). while positive and non-significant association showed with flag leaf width (0.1209), test weight (0.0501), number of spikelets per panicle (0.0687), panicle length (0.1008) and days to maturity (0.0122). Negative and significant association showed with number of tillers per hill (-0.286*) and number of panicles per hill (-0.2982), whereas negative and non-significant association showed with flag leaf length (-0.0631), plant height (-0.0414) and days to 50% flowering (-0.1337).

The correlation among the yield and yield attributing characters revealed that grain yield per hill was positively and significantly associated with biological yield (0.832**) and harvest

index (0.455**). But positively and non-significant correlation was found with days to maturity (0.0277), number of spikelets per panicle (0.0774), flag leaf width (0.1657), panicle length (0.1674) and test weight (0.0472). Negative and significant association showed with number of tillers per hill (-0.338*) and number of panicles per hill (-0.461**), while negative and non-significant correlation were found with flag leaf length (-0.1312), days to 50% flowering (-0.0929) and plant height (-0.0429).

In the present investigation, at phenotypic level the maximum positive direct effects were depicted by days to 50% flowering, days to maturity, plant height, flag leaf length, flag leaf width, number of panicles per hill, biological yield and harvest index with grain yield per hill. At genotypic level, the maximum positive direct effects were depicted by days to maturity, flag leaf length, number of tillers per hill, number of panicles per hill, panicle length, harvest index and biological yield.

CONCLUSION

From the present investigation, it is concluded that **NUMALI** was found to be superior followed by **KALINGA** and **MTU-1155** for higher grain yield per hill. Genotypes **POONGAR** is earliest for days to 50% flowering and days to maturity. High PCV, GCV, heritability and genetic advance as percentage of mean were recorded for grain yield per hill, biological yield and flag leaf length. Biological yield and harvest index showed positive and highly significant association with grain yield per hill and recorded high positive direct effect on grain yield per hill at both the genotypic and phenotypic level. These characters such as biological yield and harvest index should be given prior consideration and were found most promising for commercial cultivation and hence it can be useful during selection for grain yield improvement in rice.

Chart 1. Analysis of variance for 13 quantitative characters among 22 genotypes of Rice.

S. No	Features	Mean Sum of Squares		
		Replications (d. f=02)	Treatments (d. f=20)	Error (d. f=40)
1	Days to 50 flowering	57.2130	431.319**	41.366
2	Plant height	10.60	318.438**	111.571
3	Flag leaf length	15.8720	1337.757**	102.969
4	Flag leaf width	8.3120	186.681**	8.894
5	Number of total tillers per hill	0.0130	0.103**	0.006
6	Number of panicles per hill	0.6780	5.332**	0.965
7	Panicle length	2.1610	3.01**	0.879
8	Number of spikelets per panicle	9.4290	19.291**	5.212
9	Days to maturity	6.074*	32.189**	1.628
10	Biological yield	32.5090	1596.617**	194.704
11	Harvest Index	19.2810	2387.334**	43.114
12	Test weight	0.4430	212.831**	30.666
13	Grain yield per hill	1.1460	632.17**	19.135

Chart 2. Estimates of components of variance and genetic parameters for different characters in rice.

S. No	Characters	Coefficient of variation		Heritability	Genetic advance	Genetic advance as % of mean (5%)
		GCV	PCV			
1.	Days to 50% flowering	11.052	12.689	75.859	20.456	11.052
2.	Plant height	6.277	10.157	38.197	10.572	6.277
3.	Flag leaf length	13.76	15.386	79.989	37.378	13.76
4.	Flag leaf width	16.61	17.812	86.95	14.787	16.61
5.	Number of tillers per plant	13.993	15.336	83.26	0.337	13.993
6.	Number of panicle per plant	10.914	14.075	60.123	1.927	10.914
4	Panicle length	7.687	11.499	44.682	1.161	7.687
7.	Number of spikelets per panicle	7.683	11.162	47.378	3.072	7.683
8.	Days to maturity	13.696	14.75	86.22	6.105	13.696
9.	Biological yield	11.313	13.465	70.589	37.414	11.313
10.	Harvest index	28.115	28.88	94.771	56.059	28.115
11.	Test weight	15.515	19.034	66.444	13.085	15.515
12.	Grain yield per hill	28.898	30.221	91.438	28.159	28.898

Table: 3: Direct and indirect effects of yield related traits on grain yield in 21 rice genotypes at phenotypic level.

Traits	DF	DM	PH	FL	FW	NTPH	NPPH	PL	TW	NSPP	BY	HI	GYPH
DF	0.0203	0.0144	0.0018	-0.0080	0.0051	0.0069	0.0065	0.0003	-0.0012	0.0068	0.0047	-0.0086	-0.0631
DM	0.0176	0.0247	0.0035	-0.0087	0.0052	0.0046	0.0045	0.0037	-0.0024	0.0088	0.0061	-0.0085	0.0122
PH	0.0006	0.0010	0.0073	0.0005	-0.0035	-0.0012	-0.0012	0.0035	0.0000	0.0000	0.0020	-0.0033	-0.0414
FL	-0.0091	-0.0081	0.0017	0.0229	-0.0031	-0.0065	-0.0053	-0.0025	-0.0028	-0.0082	-0.0053	0.0015	-0.1337
FW	0.0026	0.0022	-0.0050	-0.0014	0.0103	0.0039	0.0020	-0.0026	-0.0018	0.0037	0.0013	0.0002	0.1209
NTPH	-0.0168	-0.0092	0.0080	0.0140	-0.0186	-0.0494	-0.0313	0.0017	-0.0051	-0.0055	0.0126	0.0018	-0.286*
NPPH	0.0028	0.0016	-0.0014	-0.0020	0.0017	0.0054	0.0085	-0.0001	0.0021	0.0003	-0.0025	-0.0003	-0.298*
PL	-0.0001	-0.0011	-0.0034	0.0008	0.0018	0.0002	0.0001	-0.0072	-0.0016	-0.0002	-0.0015	0.0007	0.1008
TW	0.0014	0.0022	-0.0001	0.0028	0.0039	-0.0023	-0.0057	-0.0051	-0.0227	0.0080	0.0018	-0.0052	0.0501
NSPP	-0.0045	-0.0048	0.0001	0.0048	-0.0049	-0.0015	-0.0004	-0.0005	0.0047	-0.0135	-0.0041	0.0040	0.0687
BY	0.2004	0.2135	0.2387	-0.2011	0.1129	-0.2218	-0.2517	0.1769	-0.0692	0.2624	0.8682	-0.1557	0.766**
HI	-0.2783	-0.2243	-0.2925	0.0417	0.0100	-0.0241	-0.0235	-0.0674	0.1500	-0.1939	-0.1172	0.6538	0.480**

Table: 4: Direct and indirect effects of yield component traits on grain yield for 21 rice genotypes at Genotypic level.

Traits	DF	DM	PH	FL	FW	NTPH	NPPH	PL	TW	NSPP	BY	HI	GYPH
DF	-0.0156	-0.0182	-0.0020	0.0076	-0.0040	-0.0077	-0.0070	-0.0026	0.0015	-0.0074	-0.0039	0.0094	-0.0929
DM	0.0356	0.0305	0.0029	-0.0178	0.0103	0.0158	0.0119	0.0072	-0.0068	0.0181	0.0111	-0.0170	0.0277
PH	-0.0121	-0.0087	-0.0933	-0.0098	0.0507	0.0270	0.0201	-0.0671	-0.0016	0.0018	-0.0294	0.0547	-0.0429
FL	-0.0317	-0.0379	0.0068	0.0648	-0.0138	-0.0247	-0.0210	-0.0078	-0.0101	-0.0329	-0.0177	0.0104	-0.1312
FW	-0.0155	-0.0207	0.0331	0.0130	-0.0610	-0.0338	-0.0210	0.0150	0.0118	-0.0248	-0.0093	-0.0032	0.1657
NTPH	0.0083	0.0088	-0.0049	-0.0064	0.0094	0.0169	0.0215	-0.0008	0.0026	0.0031	-0.0053	-0.0022	-0.338*
NPPH	0.0131	0.0113	-0.0062	-0.0094	0.0100	0.0368	0.0290	-0.0053	0.0090	0.0008	-0.0129	-0.0033	-0.461**
PL	0.0073	0.0103	0.0314	-0.0053	-0.0107	-0.0020	-0.0080	0.0437	0.0091	-0.0008	0.0146	-0.0104	0.1674
TW	0.0022	0.0052	-0.0004	0.0037	0.0045	-0.0036	-0.0073	-0.0049	-0.0234	0.0100	0.0018	-0.0056	0.0472
NSPP	-0.0026	-0.0033	0.0001	0.0028	-0.0022	-0.0010	-0.0001	0.0001	0.0023	-0.0055	-0.0021	0.0026	0.0774
BY	0.2346	0.3442	0.2980	-0.2584	0.1447	-0.2951	-0.4204	0.3148	-0.0726	0.3606	0.9446	-0.1064	0.832**
HI	-0.3165	-0.2937	-0.3083	0.0840	0.0279	-0.0671	-0.0590	-0.1249	0.1254	-0.2455	-0.0592	0.5258	0.455**

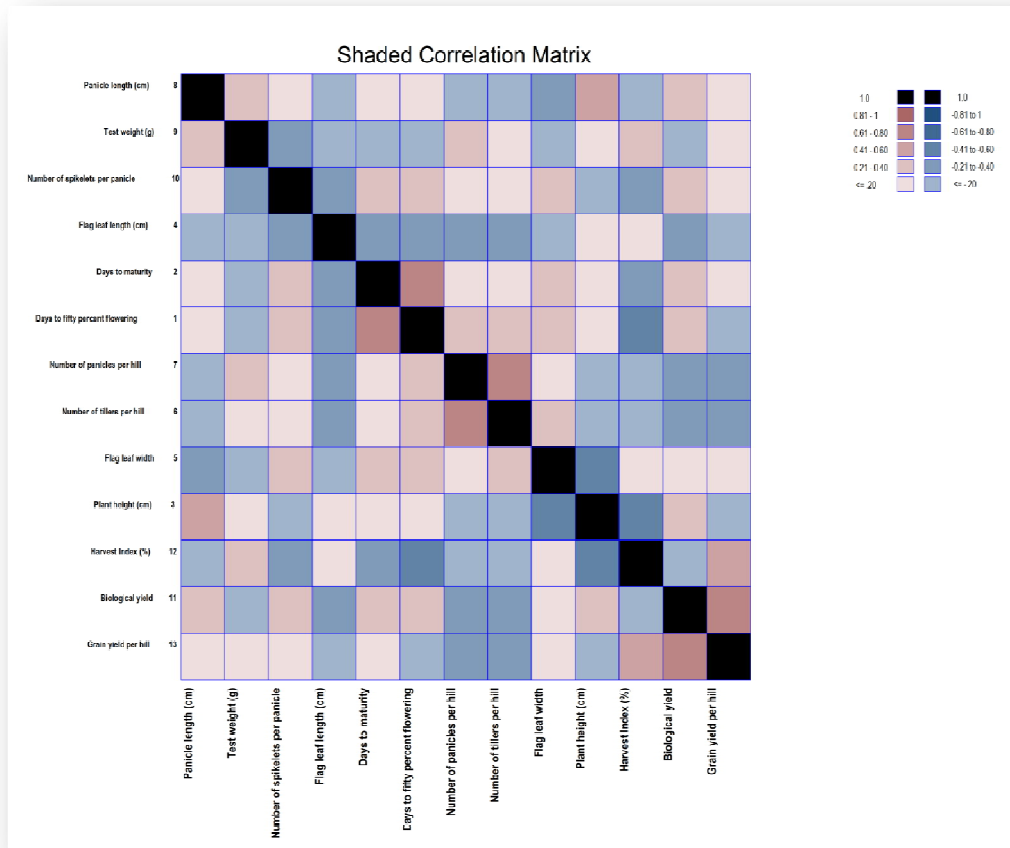


Fig. 1 Phenotypic path diagram for 13 quantitative characters of rice genotypes

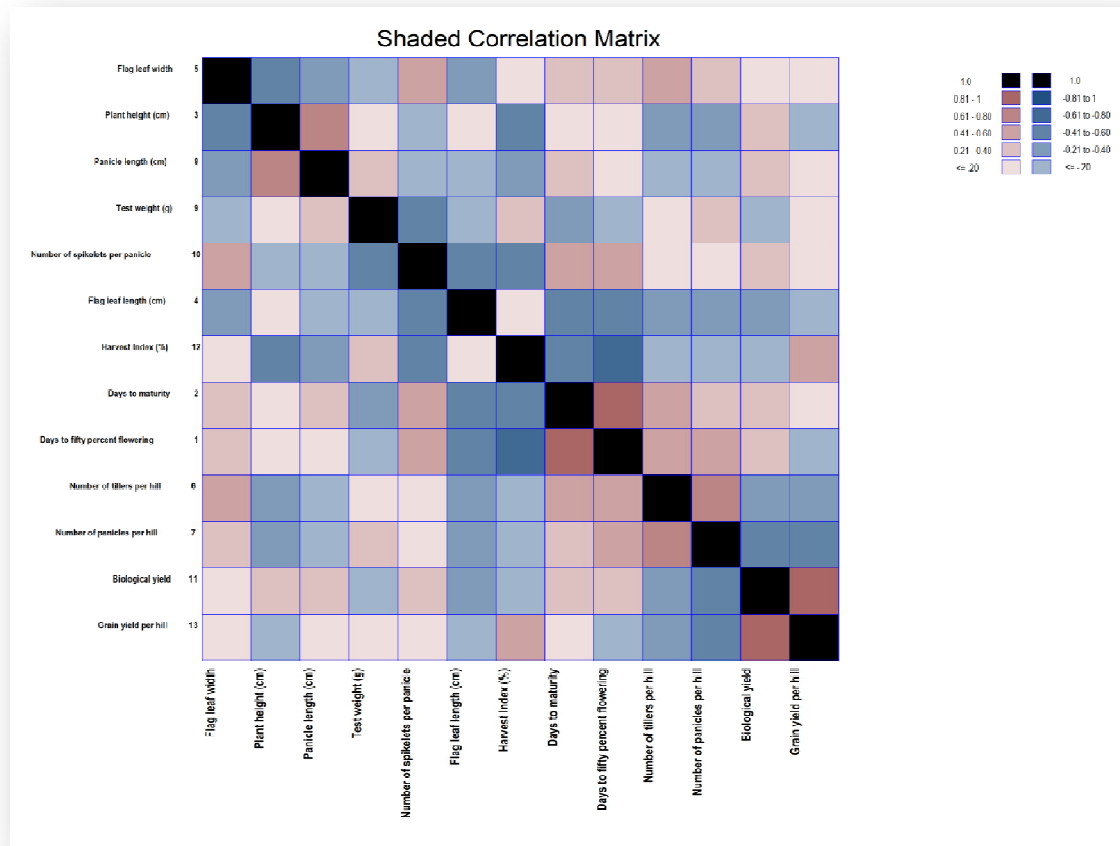


Fig 2: Genotypical Path diagram for grain yield per hill for 13 Quantitative characters of rice genotypes

UNDER PEER REVIEW

References :

- Ajmera, S., Kumar, S. S. and Ravindrababu, V. (2017).** Studies on Stability Analysis for Grain Yield and its Attributes in Rice (*Oryza sativa* L.) Genotypes. *International Journal of Pure & Applied Bioscience*, **5**(4), 892-908.
- Ali, E. N., Rajeswari, S., Saraswathi, R. and Jeyaprakash, P. (2018).** Genetic variability and character association for earliness, yield and its contributing traits in F₂ population of rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*, **9**(3), 1163-1169.
- Allam, C. R., Jaiswal, H. K. and Qamar, A. (2015).** Character association and path analysis studies of yield and quality parameters in basmati rice (*Oryza sativa* L.). *Journal of Progressive Agriculture*, **6**(1), 117-121.
- Babu, V. R., Shreya, K., Dangi, K. S., Usharani, G. and Nagesh, P. (2012).** Genetic variability studies for qualitative and quantitative traits in popular rice (*Oryza sativa* L.) hybrids of India. *International Journal of Scientific and Research Publications*, **2**(6), 1-5.
- Bagheri, N., Babaeian-Jelodar, N. and Pasha, A. (2011).** Path coefficient analysis for yield and yield components in diverse rice (*Oryza sativa* L.) genotypes. *Biharean biologist*, **5**(1), 32-35.
- Bagudam, R., Eswari, K. B., Badri, J. and Rao, P. R. (2018).** Research Note Variability, heritability and genetic advance for yield and its component traits in NPT core set of rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*, **9**(4), 1545- 1551.
- Chandra, B. S., Reddy, T. D., Ansari, N. A. and Kumar, S. S. (2009).** Correlation and path analysis for yield and yield components in rice (*Oryza sativa* L.). *Agricultural Science Digest*, **29**(1), 45-47.
- Devi, K. R., Chandra, B. S., Lingaiah, N., Hari, Y. and Venkanna, V. (2017).** Analysis of variability, correlation and path coefficient studies for yield and quality traits in rice (*Oryza sativa* L.). *Agricultural Science Digest*, **37**(1), 1-9.
- Ekka, R. E., Sarawgi, A. K. and Kanwar, R. R. (2011).** Correlation and path analysis in traditional rice accessions of Chhattisgarh. *Journal of rice research*, **4**(1), 11- 18.
- Gopikannan, M. and Ganesh, S. K. (2013).** Inter-relationship and path analysis in rice (*Oryza sativa* L.) under sodicity. *Indian Journal of Science and Technology*, **6**(9), 5223-5227.

- Hossain, M., Ivy, N., Raihan, M., Kayesh, E., & Maniruzzaman, S. (2021).** Genetic Variability, Correlation and Path Analysis of Floral, Yield and its Component Traits of Maintainer Lines of Rice (*Oryza sativa* L.). *Bangladesh Rice Journal*, 24(1), 1–9.
- Jan, N., Lal, E. P., Kashyap, S. C., Gaur, A. and Parray, G. A. (2017).** Genetic Variability, Character Association and Path Analysis Studies for Grain Yield and Contributing Traits in Rice (*Oryza Sativa* L.) under Temperate Conditions of Kashmir. *Vegetos*, **30**: 2.
- Kritika Williams, Aman Mishra, Akansha Verma, BG. Suresh and Lavanya, G. R. (2021).** Genetic Variability and Correlation Studies for Yield and Yield Related Traits in Rice (*Oryza sativa* L.) Genotypes. *Int.J.Curr.Microbiol.App.Sci.* 10(01): 752-764.
- Lakshmi, M. V., Suneetha, Y., Yugandhar, G. and Lakshmi, N. V. (2014).** Correlation studies in rice (*Oryza sativa* L.). *International Journal of Genetic Engineering and Biotechnology*, 5(2), 121-126.
- Veerabhadhiran, P., Umadevi, M. and Pushpam, R. (2009).** Genetic variability, heritability and genetic advance of grain quality in hybrid rice. *Madras Agricultural Journal*, 96(1/6), 95-99.
- Veni, B. K., Lakshmi, B. V. and Ramana, J. V. (2013).** Variability and association studies for yield components and quality parameters in rice genotypes. *Journal of rice research*, 6(2), 16-23.