Genetic Variability and Association of Rice (*Oryza sativa* L.) for Yield and Yield Components

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Authors' contributions

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

Original Research Article

ABSTRACT

The present study consists of 21 rice genotypes including one check variety that were evaluated in 2021 to study genetic variability, correlation and path coefficient for thirteen quantitative characters. Observation recorded to study the genetic variability parameters, correlation coefficient and path coefficient for yield and its attributing traits. On the basis of mean performance MTU-1224 was found to be superior in grain yield per hill followed by, BPT-329, KNM-118 and MTU-1001 to give higher yield over the check (NDR 359). High to moderate estimates of GCV and PCV were recorded for grain yield per plant followed by, harvest index, test weight, biological yield, number of spikelet per panicle, flag leaf width and number of total tillers. Grain yield indicated significant positive correlation with biological yield followed by harvest index and number of spikelet per panicle in terms of both phenotypic and genotypic level. Path coefficient analysis showed positive significant direct effects on number of spikelet's per panicle, number of productive tillers, harvest index, test weight, panicle length, days to fifty percent flowering, flag leaf length and biological yield at genotypic level whereas it showed positive and significant direct effect for harvest index, biological yield., test weight, flag leaf width, number of productive tillers, number of spikelet's per panicle and day to maturity at phenotypiclevel. Thus, these traits are identified as the efficient and potential for indirect selection for the improvement of rice productivity in the present experimental materials.

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1. INTRODUCTION

Rice (*Oryza sativa* L.) occupies a crucial position in the ancient and modern Indian agriculture as well as in the world as it feeds and fulfills the nutritional requirements of $1/3^{rd}$ of the world's population. Rice is also called as the "Grain of Life", because it is not only the staple food for more than 70 percent of the Indians but also a source of livelihood for about 120-150 million rural households. In order to develop high yielding varieties it is unavoidable for the rice breeders to understand how the grain quality traits are being inherited from their parents to offsprings [1,2]. Heritability estimates along with genetic advance are generally helpful in predicting the gain under selection than heritability (broad sense) estimates alone [3]. Therefore, estimates of GCV, PCV, heritability and genetic advance will play an important role in exploiting future research projections of rice improvement. Grain yield is a complex character, which depends on its several components. These components are further dependent for their expression on several morphological traits, which interrelated with each other showing a complex chain of relationship and also highly influenced by the environmental conditions [4]. Therefore, the parents selected for the breeding programmes with objectives to estimate genetic variability, heritability and genetic advance for quantitative traits in rice germplasm, to study the nature of character associations of yield and yield attributing traits by means of correlations coefficients and to assess the direct and indirect effect of yield components on grain yield path coefficient analysis.

2. MATERIALS AND METHODS

The present experiment was carried out at the field experimentation centre of the Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture Technology & Sciences. The site is located at 25.28 N latitude, 81.54 E longitude and 98 meter above the sea level. Itcomes under sub-tropical and semi-arid climate. Lies 102m above sea level. The average annual rainfall is 1042 mm. The present study consists of 20rice lines along with a check (NDR 359) which were collected from Department of Genetic and Plant breeding, SHUATS were grown in *fall,* 2021. The experiment was laid in a randomized block complete design (RCBD) with 21lines in three replications.

Total thirteen traits have been recorded *viz.*, days to fifty percent flowering, days to maturity, flag leaf length, flag leaf width, plant height, number of total tillers, panicle length, number of spikelet per panicle, number of productive tillers, test weight, biological yield, harvest index and grain yield per plant.

Firstly measure of variability is figured with the aid of Coefficient of variation, which is the ratio of standard deviation of a sample to its mean and expressed in percentage. In the present investigation two types of coefficient of variations were estimated *viz.*, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV).

Coefficient of variation (CV): It is the measure of variability evolved. Coefficient of variation is the ratio of standard deviation of a sample to its mean and expressed in percentage.

CV (%) = Standard deviation / Mean X 100

The formulae used to calculate PCV and GCV were stated by [5].

Chart 1. List of 20 rice genotypes along with a national check

S. No	Genotypes	S. No	Genotypes
1	NP 124 8	12	DHAN 50
2	RNR 15048	13	RP BIO 226
3	MTU 1001	14	ANKUR POOJA
4	MTU 1010	15	BPT 5204
5	MTU 1064	16	KNM 168
6	MTU 1224	17	BPT 3291
7	PLA 1100	18	NP 9558
8	KNM 118	19	KPH 376
9	KPH 370	20	SIDHASANNALU
10	DHAN 42	21	NDR 359 (CHECK)
11	DHAN 44		

PCV (%) = Phenotypic standard deviation /Grand mean X 100

GCV (%) = Genotypic standard deviation / Grand mean x 100

Heritability calculated by the formula given by Lush [6] and Burton and Devane [5]. Correlation Coefficient was calculated according to the formula suggested by Miller et al. (1958). Path coefficient analysisis normally to measures the direct and in direct effects of independent variables on the dependent variables. This technique was firstly used by Dewey and Lu [7].

3. RESULTS AND DISCUSSION

3.1 Genetic Variability

3.1.1 Genotypic Coefficient of Variation (GCV)

Highest estimates of genotypic coefficient of variation (GCV) were recorded for grain yield per plant (24.65), harvest index (22.30), test weight (21.58), biological yield per plant (19.94) and flag leaf width (17.85).

3.1.2 Phenotypic Coefficient of Variation (PCV)

High estimates of phenotypic coefficient of variation (PCV) were recorded for grain yield per plant (26.76), harvest index (23.20), number of spikelet per plant (22.33), biological yield (21.81), test weight (21.60) and number of total tillers (18.74).

The large difference between the GCV and PCV indicate high environmental influence on the expression of particular traits. Relatively low differences were observed between genotypic and phenotypic coefficient of variation for test weight (21.58, 21.60).

3.1.3 Heritability

Heritability (broad sense) estimated for the thirteen characters were ranged from number of days to maturity (55.38) to test weight (99.77). Heritability estimates were high for test weight(g) (99.77),plant height (cm) (96.38), harvest index (92.40) flag leaf width (cm) (92.21), grain yield per plant (84.41), biological yield (83.51),number of productive tillers (73.40),number of spikelet's per panicle (72.29) and panicle length (cm) (72.02).While it was moderate for days to 50% flowering(57.03) and days to maturity (55.38).

3.1.4 Genetic advance

High genetic advance was recorded for number of spikelet per panicle (70.47) followed by plant height (cm) (32.35). While moderate genetic advance was recorded for biological yield (24.07), harvest index (23.31), days to maturity (16.92) and grain yield per plant (15.56). Low genetic advance was recorded flag leaf width (0.43), number of productive tillers (3.02), number of total tillers (3.15) and panicle length (4.06).

Similar results were reported by Saha et al. [8] for number of grains per panicle; Nithya et al. [9] for grain yield per plant and productive tillers per plant; Umarani et al. [10] and Sundaram et al. [11] for zinc and iron content; Sandeep et al. [12] for panicle length; Amegan et al. [13] for 1000 grain weight; Maurya et al. [14] and Supriya et al. [15] for L/B ratio and Singh et al. (2020) and Sangamithra et al. [16] for protein content.

3.2 Correlation

Genotypic correlation for seed yield per plant showed highly significant and positive association with harvest index (0.909**), biological yield (0.805**), 100 seed weight (0.255**), number of pod clusters (0.796**), number of pods per plant (0.797**), number of primary branches (0.521**). It also showed negative but non-significant association with days to fifty percent flowering (-0.0531), days to maturity (-0.1215), plant height (-01588), number of pods per cluster (-0.1466), number of seeds per pod (-0.1407).Seed yield per plant showed significant and positive association with harvest index (0.812**) followed by biological yield (0.721**), number of pods per plant (0.867**), 100 seed weight (0.352*), number of primary branches (0.534*). It also showed negative and highly significant association with days to pod length (-0.485**).negative but non-significant with days to fifty percent flowering (-0.1177), number of seeds per pod (-0.1475), days to maturity (-0.1513). Both the genotypic and phenotypic values are clearly illustrated in Tables 1 and 2.

Preliminary studies also revealed the similar results were found in Mani et al. [17] and Maurya et al. [14] studies, that found significant positive correlation between seed yield and harvest index, similarly Bagheri et al. [18] found significant positive correlation between seed yield and biological yield.

Table 1. Genotypic correlation among the different traits evaluated in rice during *fall,* 2021

	DTF	DM	PH	FLL	FLW	NTT	NPT	PL	BY	HI	NSP	TW	GYP
DTF	1	0.573**	0.2321	0.1995	0.426**	-0.224	-0.2132	0.0745	0.683**	-0.418**	0.757**	-0.417**	0.1359
DM		1	0.250*	0.1915	0.434**	-0.424**	-0.296*	0.385*	0.398*	-0.522**	0.386*	-0.1306	-0.1565
PH			1	0.583**	0.2424	-0.430**	-0.473**	0.519**	0.134	-0.516**	0.193	0.1013	- 0.450**
FLL				1	0.2185	-0.290*	-0.267*	0.176	0.0627	-0.256*	-0.0219	0.1057	-0.249*
FLW					1	-0.1164	-0.1892	0.523**	0.1921	-0.468**	0.280*	0.1093	-0.2428
NTT						1	0.929**	-0.1664	-0.248*	0.2441	0.0082	0.1615	0.0537
NPT							1	-0.284*	-0.1802	0.251*	0.0423	0.0395	0.1203
PL								1	-0.1488	-0.508**	-0.0495	0.1599	- 0.601**
BY									1	-0.379*	0.781**	-0.2206	0.419**
HI										1	-0.351*	0.1374	0.670**
NSP											1	-0.484**	0.289*
TW												1	0.0001
GYP													1.00

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)

Table 2. Phenotypic correlation among the different traits evaluated in rice during *fall,* 2021

	DTF	DM	PH	FLL	FLW	NTT	NPT	PL	BY	HI	NSP	TW	GYP
DTF	1	0.550**	0.2184	0.1492	0.401*	-0.150	-0.1434	0.0669	0.613**	-0.384*	0.673**	-0.402*	0.1317
DM		1	0.2451	0.1715	0.408**	-0.36*	-0.261*	0.325*	0.357*	-0.491**	0.310*	-0.1315	-0.1411
PH			1	0.530**	0.232	-0.35*	-0.401*	0.416**	0.1311	-0.494**	0.1649	0.0985	-0.403*
FLL				1	0.1696	-0.25*	-0.252*	0.1347	0.0229	-0.2248	-0.0394	0.1006	-0.2428
FLW					1	-0.05	-0.1184	0.442**	0.1665	-0.430**	0.2442	0.1089	-0.2134
NTT						1	0.929**	-0.1876	-0.0818	0.2455	0.1128	0.1359	0.1744
NPT							1	-0.279*	-0.0425	0.255*	0.1192	0.035	0.2182
PL								1	-0.1534	-0.425**	0.0374	0.133	-0.515**
BY									1	-0.351*	0.672**	-0.2026	0.482**
HI										1	-0.268*	0.1306	0.636**
NSP											1	-0.411**	0.292*
TW												1	-0.0016
GYP													1.00

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)

Table 3. Genotypic direct (in bold) and indirect effects of thirteen traits on seed yield in rice evaluated in *fall,* 2021

	DTF	DM	PH	NPB	NPP	NPC	NCP	PL	NSP	100SW	HI	BYP	SYP
DTF	**0.2338**	0.1341	0.0543	0.0467	0.0996	-0.0525	-0.0499	0.0174	0.1598	-0.0977	0.1771	-0.0976	0.1359
DM	-0.2436	**-0.4249**	-0.1063	-0.0814	-0.1842	0.1803	0.1258	-0.1635	-0.1693	0.2216	-0.1641	0.0555	-0.1565
PH	-0.1453	-0.1566	**-0.6261**	-0.3648	-0.1518	0.2694	0.296	-0.3246	-0.0839	0.3231	-0.1209	-0.0634	-0.450**
FLL	0.0225	0.0216	0.0658	**0.1129**	0.0247	-0.0327	-0.0301	0.0199	0.0071	-0.0289	-0.0025	0.0119	-0.249*
FLW	-0.0804	-0.0818	-0.0457	-0.0412	**-0.1886**	0.0219	0.0357	-0.0986	-0.0362	0.0883	-0.0528	-0.0206	-0.2428
NTT	0.2699	0.5099	0.5171	0.3479	0.1398	**-0.702**	-0.824	0.1999	0.2981	-0.2933	-0.0099	-0.194	0.0537
NPT	-0.1537	-0.2134	-0.3407	-0.1922	-0.1364	0.6693	**0.7207**	-0.2047	-0.1298	0.181	0.0305	0.0284	0.1203
PL	0.0195	0.1008	0.1359	0.0461	0.1371	-0.0436	-0.0744	**0.2621**	-0.039	-0.1331	-0.013	0.0419	-0.601**
BY	0.0732	0.0427	0.0144	0.0067	0.0206	-0.0266	-0.0193	-0.0159	**0.1071**	-0.0406	0.0836	-0.0236	0.419**
HI	-0.2835	-0.354	-0.3503	-0.1736	-0.3179	0.1657	0.1705	-0.3446	-0.2573	**0.6788**	-0.238	0.0933	0.670**
NSP	0.6731	0.3433	0.1716	-0.0195	0.249	0.0073	0.0376	-0.044	0.6944	-0.3118	**0.8889**	-0.4301	0.289*
TW	-0.2498	-0.0781	0.0606	0.0633	0.0654	0.0967	0.0236	0.0957	-0.1321	0.0822	-0.2896	**0.5985**	0.0001

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)

Table 4. Phenotypic direct (in bold) and indirect effects of thirteen traits on seed yield in rice evaluated in *fall,* 2021

	DTF	DM	PH	NPB	NPP	NPC	NCP	PL	NSP	100SW	HI	BYP	SYP
DTF	**-0.0177**	-0.0097	-0.0039	-0.0026	-0.0071	0.0027	0.0025	-0.0012	-0.0109	0.0068	-0.0119	0.0071	0.1317
DM	0.0103	**0.0187**	0.0046	0.0032	0.0077	-0.0069	-0.0049	0.0061	0.0067	-0.0092	0.0058	-0.0025	-0.1411
PH	-0.0143	-0.0161	**-0.0655**	-0.0347	-0.0152	0.0236	0.0263	-0.0273	-0.0086	0.0324	-0.0108	-0.0065	-0.403*
FLL	-0.0066	-0.0076	-0.0235	**-0.0443**	-0.0075	0.0115	0.0112	-0.006	-0.001	0.0099	0.0017	-0.0045	-0.2428
FLW	0.0229	0.0233	0.0132	0.0097	**0.0571**	-0.0033	-0.0068	0.0252	0.0095	-0.0245	0.0139	0.0062	-0.2134
NTT	0.0108	0.0263	0.0259	0.0186	0.0042	**-0.0719**	-0.0668	0.0135	0.0059	-0.0177	-0.0081	-0.0098	0.1744
NPT	-0.0071	-0.0129	-0.0198	-0.0124	-0.0058	0.0458	**0.0493**	-0.0137	-0.0021	0.0126	0.0059	0.0017	0.2182
PL	-0.0016	-0.0078	-0.01	-0.0032	-0.0106	0.0045	0.0067	**-0.024**	0.0037	0.0102	-0.0009	-0.0032	- 0.515**
BY	0.4768	0.2774	0.1019	0.0178	0.1295	-0.0636	-0.0331	-0.1193	**0.7774**	-0.2725	0.5222	-0.1575	0.482**
HI	-0.3418	-0.4365	-0.4394	-0.2	-0.3826	0.2184	0.2266	-0.3784	-0.3118	**0.8897**	-0.2382	0.1162	0.636**
NSP	0.027	0.0125	0.0066	-0.0016	0.0098	0.0045	0.0048	0.0015	0.027	-0.0108	**0.0402**	-0.0165	0.292*
TW	-0.0271	-0.0089	0.0066	0.0068	0.0073	0.0092	0.0024	0.009	-0.0137	0.0088	-0.0277	**0.0675**	-0.0016

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)
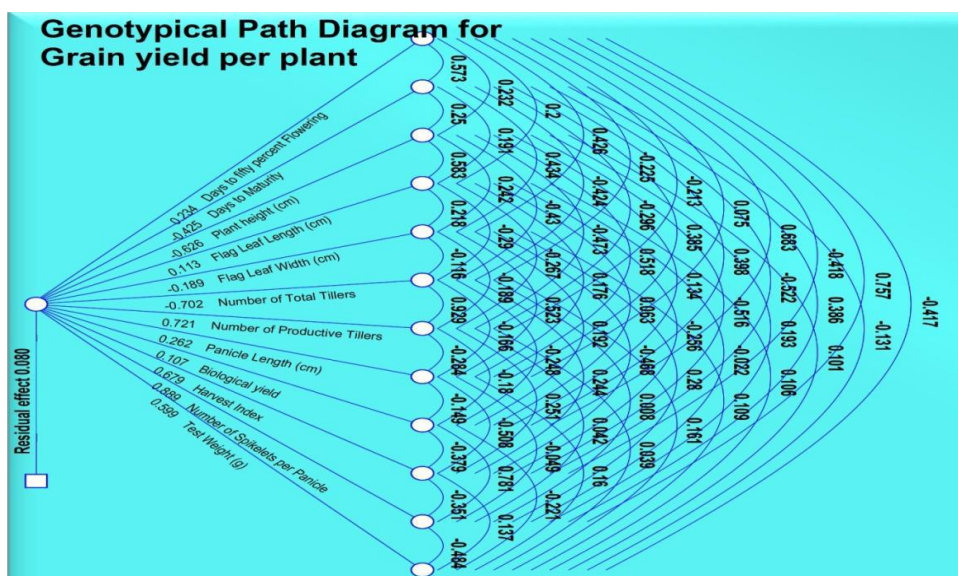
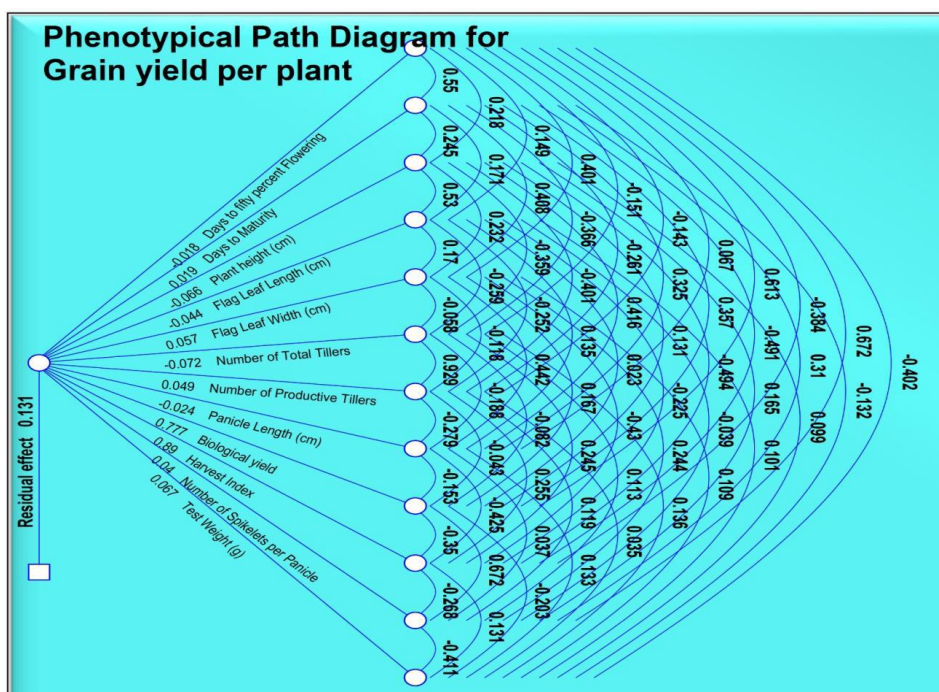**Fig. 1. Genotypic path coefficient**

Fig. 2. Phenotypic path coefficient

3.3 Path Analysis

The path coefficient analysis suggested by specified the effective measure of direct and indirect causes of association and also depicts the relative importance of each factor involved in contributing to the final product i.e., yield. In order to find out the cause and effect relationship between seed yield and its related characters, path analysis taken in the present investigation. Path coefficient analysis allows separating direct effect and indirect effects through other attributes by partitioning correlation. Path analysis in particular having the direct effect of seed yield on characters such as harvest index followed by biological yield and number of spikelet per panicle in descending order [19,20]. Phenotypic path coefficient analysis indicated that, the traits

having direct effects on grain yield are understood to be strongly associated with it.

4. CONCLUSION

The study was presented to estimate genetic variability, heritability and genetic advance for quantitative traits in rice germplasm. The path analysis results showed that positive and direct on grain yield were exhibited by harvest index, biological yield, test weight and flag leaf width. Phenotypic path coefficient analysis indicated that, the traits having direct effects on grain yield are understood to be strongly associated with it. The genotypic path analysis results showed that positive and direct on grain yield were exhibited by number of spikelet per panicle, number of productive tillers, harvest index and panicle length.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Fisher RA. The Use of Multiple Measurement in taxonomic problem. Annals of Eugenics. 1936;7(2):179-188.
2. Robinson HF, Comstock RE, Harvey PH. Genotypic & phenotypic correlation in maize and their implications in selection. Agr. Jou. 1951;43:282-287.
3. Shreya D, Deepak G, Sarawgi AK, Abhinav S. Genetic variability studies for yield and yield components in rice (*Oryza sativa* L.). The Pharma Innovation Journal. 2021;10(10):1057-1059.
4. Dhurai SY, Reddy DM, Ravi S. Correlation and path analysis for yield and quality characters in rice (*Oryza sativa* L.). Rice Genomics and Genetics. 2016;7.
5. Burton GW, Devane DE. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. Agr. Jour. 1953;45(10):478-481.
6. Lush JL. Heritability of qualitative traits in firm animals. Proceedings of eight international congresses genetic. Heidos (Suppl.). 1949;336-357.
7. Dewey DR, Lu KH. A correlation and path coefficient analysis of component of seed production. Agro. J. 1959;51:515-518.
8. Saha SR, Hassan L, Haque A, Islam MM, Rascl M. Genetic variability, heritability,

correlation and path analysis of yield components in traditional rice (*Oryza sativa* L.) landraces. Journal of Bangladesh Agricultural University. 2019; 17(l):26-32.
9. Nithya N, Beena R, Stephen R, Abida PS, Jayalakshmi VG, Viji MM. Genetic variability, heritability, correlation coefficient and path analysis of morpho physiological and yield related traits of rice under drought stress. Chemical Science Review and Letters. 2020;9(33): 48-54.
10. Umarani E, Radhika K, Padma V, Subbarao LV. Variability, heritability and genetic advance for agro-morphological and grain quality parameters in landraces of rice (*Oryza sativa* L.). Environment and Ecology. 2017;35(3):1682-1687.
11. Sundaram KM, Rajeswari S, Saraswathi R, Jayaprakash P. Genetic variability studies for yield and its Components and quality traits with high iron and zinc content in segregating population of rice (*Oryza sativa* L.). International Journal of Chemical Studies. 2019;7(3):800-805.
12. Sandeep S, Sujatha M, Subbarao LV, Nccraja CN. Genetic Variability, Heritability and Genetic Advance Studies in Rice (*Oryza sativa* L.). International Journal of Current Microbiology and Applied Science. 2018;7(12):3719-3727.
13. Amegan E, Efisuc A, Akoroda M, Shittu A, Toncgnikcs F. Genetic Diversity of Korean Rice (*Oryza sativa* L.) Germplasm for Yield and Yield Related Traits for Adoption in Rice Farming System in Nigeria. International Journal of Genetics and Genomics. 2020;8(l):19-28.
14. Maurya BK, Chand P, Tomar P, Kumar S, Singh RSS, Singh G. Studies on variability and genetic parameters for yield and its contributing traits in rice (*Oryza sativa* L.). Journal of Pharmacognosy and Phytochemistry. 2019; 8(4):2002-2005.
15. Supriya Anurag S, Jaiswal HK. Genetic variability for quality, yield and yield related parameters in basmati rice (*Oryza sativa* L.). AGRES an International Joumal. 2017;6(l):63-70.
16. Sanghamitra P, Sah RP, Bagchi TB, Sharma SG, Kumar A, Munda S. Evaluation of variability and environmental stability of grain quality and agronomic parameters of pigmented rice (*Oryza*

sativa L.). Journal of Food Science and Technology. 2018;55(3):879-890.

17. Mani BR, Kumar BM. Morphological characterization of rice (*Oryza sativa* L.) landraccs of the hilly zone of Karnataka. Indian Journal of Plant Genetic Resources. 2018;31(3):328-331.

18. Bagheri N, Babaeian-Jelodar N, Pasha A. Path coefficient analysis for yield and yield components in diverse rice (*Oryza sativa*

L.) genotypes. Biharean Biologist. 2011; 5(1):32-35.

19. Directorate of Economics and Statistics. Ministry of Agriculture & Farmers Welfare (DAC&FW), Govt. of India; IIIrd Advance Estimate; 2018-19.

20. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Adv. Agron. 1976;28:61-65.

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