International Journal of Plant & Soil Science

33(19): 94-99, 2021; Article no.IJPSS.73212
ISSN: 2320-7035

Genetic Association and Path Coefficient Analysis for Grain Yield Characters in Elite Rice (*Oryza sativa* L.) Germplasm

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Authors' contributions

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

Article Information

DOI: 10.9734/IJPSS/2021/v33i1930604
Editor(s):
(1) Prof. Hakan Sevik, Kastamonu University, Turkey.
Reviewers:
(1) Sonam Sureshrao Kale, MGM College of Agricultural Biotechnology, India.
(2) Marwan Noori Ramadhan, University of Basrah, Iraq.
(3) Prashant Shrivastava, Jawaharlal Nehru Agriculture University, India.
Complete Peer review History: https://www.sdiarticle4.com/review-history/73212

Original Research Article

Received 26 June 2021
Accepted 06 September 2021
Published 13 September 2021

ABSTRACT

The study was carried out to study the correlation and path coefficient analysis for grain yield characters in 36 rice genotypes including one check for 13 quantitative parameters. The experimental material was carried out during *Kharif*, 2020, in a randomized block design with three replications obtained from the Department of Genetics and Plant Breeding, SHUATS, Allahabad, U.P., India. Analysis of variance revealed that there is significant variability among the genotypes. Correlation coefficient analysis at genotype level and phenotypic level revealed that plant height, flag leaf length, flag leaf width, number of tillers per hill, number of panicles per hill, number of spikelets per panicle, biological yield, and harvest index, showed positive significant correlation with grain yield per plant. Path coefficient analysis at both genotypic and phenotypic levels revealed that flag leaf length, number of panicles per hill, days to maturity, biological yield, harvest index and test weight had positive direct effect on grain yield per hill. Biological yield per hill (0.8481) exerted high positive direct effect as well as high positive significant association (0.809**) with grain yield per hill thus this character resulted as most essential direct yield character.

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Keywords: Rice; correlation; path analysis; direct effects; yield

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the staple cereal crops of the world and it is one of the main sources of carbohydrates for nearly one half of the world population. Rice belongs to the genus Oryza, under the subfamily Pooideae in the grass family Graminae (Poaceae). Rice has fed many people over a very long period than any other crop. Rice is the essential food for 2.5 billion individuals and developing rice is the biggest single utilization of land for delivering food, covering 9% of the world's arable land. Rice gives 21% of worldwide human per capita energy and 15% of per capital protein [1]. The current global population of 7.7 billion is expected to reach 9.7 billion by 2050 (Department of Economics and Social Affairs-2018-19) [2]. Globally rice is cultivated now on 166.5 million hectares with annual production if around 760 million tones and average productivity of 2.65 tons/ha (Food and Agriculture Organization, 2018).In India the production of rice was 116.42 Million tons from 43.79 million ha of area and it stands in second position in the world production after china. In Uttar Pradesh area, production and productivity is 5.75 million ha, 15.54 Million tons and 2.70 q/ha respectively. It is estimated that in India, the demand for rice will be 129.6 million tons by 2040 and 137.3 million tons by 2040 and 137.3 million tons by 2050 for internal consumption. (Directorate of Economics and Statistics, 2018-19) [3].

India's rice production is predicted at a record of 102.36 million tonnes during kharif season of 2020-2021 crop year with good monsoon rains, according to government data. Rice production recorded 101.98 MT during the kharif season of the 2019-2020 crop year (Directorate of Economics and Statistics). Yield is a complex polygenic character largely influenced by its various component characters as well as by the environment. Hence, it becomes essential to estimate association of the yield with component characters and among themselves. The efficiency of selection thus can be increased, if it is simultaneously practiced for characters which are correlated with yield. The correlation analysis provide an information which is incomplete in the sense that it does not throw light on the underlying cause that are operative for the various interrelationship. The expression of a complex character such as grain yield per plant depends upon the interaction of a number of component attributes [4]. Path analysis splits the correlation coefficient into direct and indirect effects so as to measure the relative contribution of each variable towards yield [5]. Correlation and path analysis establish the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield. Ultimately, this kind of analysis could help the breeder to design selection strategies to improve grain yield.

2. MATERIALS AND METHODS

The present investigation was worked out to measure the genetic association and path coefficients using 36 rice genotypes including a check variety. The present investigation was worked out at the Field Experimentation Centre, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Naini Agricultural Institute, U.P. India in *kharif* season,2020. The experimental trial was laid out in a Randomized Block design with three replications under proper irrigated conditions. Twenty two days old seedlings of each genotype were transplanted with a spacing of 20 x 15 cm between row to row and plant to plant. Regular agronomic practices were followed throughout the crop growth period to raise a good crop. For recording observation, randomly five (5) plants from each replication of each genotype were selected for thirteen grain yield contributing quantitative traits viz., Days to 50% flowering, Flag leaf length, Flag leaf width, Number of tillers per hill, Number of panicles per hill, Plant height, Panicle length, Number of spikelet's per panicle, Days to maturity, Biological yield per hill, Harvest index, Test weight, and Grain yield per hill were recorded in each replication of each genotype. Correlation coefficient was worked as method suggested by Al Jibouri et al. [6], and path coefficient was carried out as method suggested by Dewey and Lu [7], respectively.

3. RESULTS AND DISCUSSION

Direct selection is not effective for yield as yield is a complex and quantitatively inherited character with low heritability. Therefore, indirect selection can be made for the characters adding to yield through character association as it gives information about the characters that are

Table 1. Correlation coefficient between yield and its related traits in 36 rice genotypes

	DF (50%)	PH	FL	FW	T	P	PL	SPP	DM	BYH	HI	TW	GYPH
DF (50%)	1	0.0246	0.2058 *	0.2019 *	-0.0702	-0.0736	-0.0417	0.1095	0.9904 ***	0.1091	-0.4383 ***	-0.1941 *	-0.1615
PH		1	0.3535 ***	0.0986	-0.185	-0.1161	0.0983	0.2886 **	0.0134	0.3704 ***	0.0666	-0.0585	0.370**
FL			1	0.4633 ***	0.3325 ***	0.3210 ***	0.3631 ***	0.3078 **	0.2042 *	0.4342 ***	-0.0488	-0.0502	0.346**
FW				1	0.5323 ***	0.4841 ***	0.2212 *	0.1111	0.2224 *	0.5609 ***	0.0978	-0.0048	0.529**
T					1	0.8830 ***	0.4226 ***	0.0575	-0.0333	0.3541 ***	0.0472	0.3073 **	0.312**
P						1	0.3801 ***	0.0347	-0.0485	0.3291 ***	0.0209	0.2692 **	0.279**
PL							1	0.1445	-0.0115	0.2536 **	-0.1302	0.3763 ***	0.1268
SPP								1	0.119	0.2177 *	0.0135	-0.4143 ***	0.190*
DM									1	0.1134	-0.4373 ***	-0.1825	-0.1574
BYH										1	-0.0709	0.0837	0.809**
HI											1	0.0472	0.522**
TW												1	0.0991
GYPH													1

DF: Days to 50% flowering, DM: Days to maturity, FLG: Flag leaf length (cm),FLW: Flag leaf width (cm), PH: Plant height (cm), NT: Number of total tillers per hill, NP: Number of panicles per hill, PL: Panicle length (cm), NSP: Number of spikeletes per panicle, BYP: Biological yield per hill (g), TW: Test weight (g), HI: Harvest index (%), GYPH: Grain yield per hill (g)

Table 2. Direct and indirect effects for different quantitative characters on grain yield

PATH matrix of GY/hill													
	DF(50%)	**PH**	**FL**	**FW**	**NT**	**NP**	**PL**	**NSP**	**DM**	**BYH**	**HI**	**TW**	**GYPH**
DF (50%)	-0.0547	-0.0013	-0.0113	-0.011	0.0038	0.004	0.0023	-0.006	-0.0542	-0.006	0.024	0.0106	-0.1615
PH	0.0003	0.0125	0.0044	0.0012	-0.0023	-0.0015	0.0012	0.0036	0.0002	0.0046	0.0008	-0.0007	0.3700
FL	0.0032	0.0054	0.0154	0.0071	0.0051	0.0049	0.0056	0.0047	0.0031	0.0067	-0.0008	-0.0008	0.3460
FW	0.0004	0.0002	0.001	0.0022	0.0012	0.0011	0.0005	0.0002	0.0005	0.0012	0.0002	0	0.5290
NT	0.0015	0.0039	-0.0071	-0.0113	-0.0212	-0.0187	-0.009	-0.0012	0.0007	-0.0075	-0.001	-0.0065	0.3120
NP	-0.0003	-0.0004	0.0012	0.0019	0.0034	0.0038	0.0015	0.0001	-0.0002	0.0013	0.0001	0.001	0.2790
PL	0.0008	-0.0019	-0.0068	-0.0042	-0.008	-0.0072	-0.0188	-0.0027	0.0002	-0.0048	0.0025	-0.0071	0.1268
NSP	-0.0003	-0.0007	-0.0008	-0.0003	-0.0001	-0.0001	-0.0004	-0.0025	-0.0003	-0.0005	0	0.001	0.1900
DM	0.0512	0.0007	0.0106	0.0115	-0.0017	-0.0025	-0.0006	0.0062	0.0517	0.0059	-0.0226	-0.0094	-0.1574
BYH	0.0925	0.3141	0.3682	0.4757	0.3003	0.2791	0.2151	0.1847	0.0962	0.8481	-0.0602	0.071	0.8090
HI	-0.2536	0.0386	-0.0282	0.0566	0.0273	0.0121	-0.0753	0.0078	-0.2531	-0.0411	0.5787	0.0273	0.5220
TW	-0.0025	-0.0007	-0.0006	-0.0001	0.0039	0.0034	0.0048	-0.0052	-0.0023	0.0011	0.0006	0.0126	0.0991

DF: Days to 50% flowering, DM: Days to maturity, FLG: Flag leaf length (cm),FLW: Flag leaf width (cm), PH: Plant height (cm), NT: Number of total tillers per hill, NP: Number of panicles per hill, PL: Panicle length (cm), NSP: Number of spikeletes per panicle, BYP: Biological yield per hill (g), TW: Test weight (g), HI: Harvest index (%), GYPH: Grain yield per hill (g)

correlated with each other in improving yield. Estimates of correlation between yield and yield attributing traits in rice genotypes are presented in Table 1.

Days to 50% flowering showed positive significant correlation with flag leaf length, flag leaf width and days to maturity. Plant height showed positive.

Significant association with flag leaf length, number of spikelets per panicle, biological yield per hill and grain yield per hill. Moreover, Flag leaf length showed a positive significant correlation with flag leaf width, number of tillers per panicle, number of panicles per hill, panicle length, number of spikelets per panicle, days to maturity and grain yield per hill. Flag leaf width showed positive significant correlation with number of tillers per panicle, number of panicles per hill, panicle length, days to maturity and grain yield per hill. Number of tillers per hill showed positive significant association with number of panicles per hill, panicle length, biological yield per hill, test weight and grain yield per hill. Number of panicles per hill showed positive significant correlation with panicle length, biological yield per hill, test weight and grain yield per hill. Panicle length showed positive significant correlation with biological yield per hill and test weight.

Grain yield per hill showed the positive significant correlation at both genotypic and phenotypic level with biological yield per hill (0.809**), flag leaf width (0.529**), harvest index (0.522**), plant height (0.370**), flag leaf length (0.346**), number of tillers per hill (0.312**), number of panicles per hill (0.279**) and number of spikelets per panicle (0.190*). The positive correlation of grain yield with various traits was supported by the Nandan et al. [8] for plant height, [9] for number of tillers per plant, [10] for flag leaf length, [11] for panicle length, [12] for number of panicles, [13] for number of grains per panicle, [14] for biological yield, [15] for harvest index.

The correlation showed positive non-significant correlation with panicle length (0.1268) and test weight (0.0991). The characters like days to 50% flowering (-0.1615) and days to maturity (-0.1567) showed negative non-significant correlation with grain yield per hill.

Path coefficient analysis splits the correlation coefficient into direct and indirect contribution of various independent characters on a dependent character. The results of path coefficient analysis has been presented in Table 2. The high positive direct effect on grain yield per hill was exerted by biological yield per hill (0.8481) followed by harvest index (0.5787) and thus these character resulted as most essential direct yield character on which importance should be given during selection aimed at improving grain yield per hill. Biological yield has also been identified as major direct contributors towards grain yield by Kishore et al., [16] and Sivasankar et al., [17]. Biological yield had positive indirect effect on all the quantitative parameters except harvest index. [18-19] and have also exerted biological yield per hill as most important yield contributing traits which merit due consideration at the time of selection strategy aimed at developing high yielding varieties in rice.

4. CONCLUSION

The correlation coefficient and Path coefficient analysis revealed that plant height, flag leaf length, flag leaf width, number of panicles per hill, biological yield, and harvest index showed positive significant correlation and positive direct effect with grain yield per hill at both genotypic and phenotypic levels. Biological yield per hill exerted high positive significant and high positive direct effect on grain yield. Selection of plants on these traits would prompt to improvement in grain yield.

ACKNOWLEDGEMENT

The author is very thankful to the advisor (Dr. G. M. Lal).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/73212