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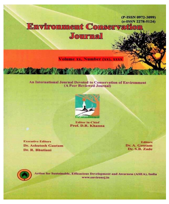

Trait association studies in diverse genotypes of rice for their utilization in biofortification

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ABSTRACT

Rice is the staple food crop for more than half of the world population. Thus, rice varieties enriched with various micronutrients qualifies as a better alternative to combat micronutrient deficiency. The present investigation was undertaken to study the degree and direction of association for grain characters especially grain Zinc (Zn) content and grain Iron (Fe) content in 30 genotypes of rice. The correlation coefficient analysis findings at the phenotypic level were used to determine whether the various traits were correlated with yield and the significance of the relationship among them. This data shows significant positive correlation at the phenotypic and genotypic level for grain yield per plant with days to 50% flowering (0.356 & 0.373), number of panicles per plant (0.340 & 0.522), panicle length (0.293 & 0.356), test weight (0.307 & 0.346) and kernel breadth (0.283 & 0.339). The signs (positive or negative) reflect the consequence of increasing or decreasing one variable over the other. The traits plant height ((-0.399 & -0.410) and kernel L/B ratio (-0.237 & -0.291) showed negative correlation with yield indicating that shorter plants as well as grains having shorter length with more breadth are more likely to produce more yield thus selection should be carried out against height . One possible reason for this could be that in plants with shorter stature have higher nutrient use efficiency and are resistant to lodging. The traits days to 50% flowering, number of panicles per plant, panicle length, and test weight and kernel breadth showed positive correlation indicating that selection towards higher values for these traits would consequently improve the yield. It was also found that the traits Zn and Fe content were positively correlated with each other implying that simultaneous selection of these traits could be done for the purpose of biofortification.

Introduction

Rice (*Oryza sativa L.*) is the single most important staple crop of the world. Asia is second to none in terms of production and constitutes 90% of the global rice cultivation area (Singh *et al.*, 2017). India produced an estimated 117.94 Mt of grain with a productivity of 2.7 t/ha during the 2019-2020 season. Although rice production is high in India, productivity is meager compared to other major producers such as China (6.5 t/ha) and Indonesia (5.2 t/ha) (MoA& FW, GoI,2019-2020).Though the

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progress in production of rice has moved forward by leaps and bounds, there is still a necessity to increase production and productivity to meet the needs of the growing population. However, feeding the growing population is not the only concern but we should also ensure the nutritional security especially with respect to essential micronutrients, vitamins and proteins as micronutrient deficiency is a major issue plaguing developing countries such as India (Bain *et al*., 2013). According to a survey by the WHO, more than two billion people are afflicted with micronutrient deficiencies. Development of rice cultivars that possess substantial yield with ample amount of micronutrients could create an avenue for solving two problems with a single solution. Yield is a very complex trait as this does not depend on a single factor; rather it is a function of the combination of several attributing factors in the form of different traits (Moosavi *et al.*, 2015**)**. Thus, selection procedures in crop improvement must take into consideration these factors or traits that. Therefore, the association studies between grain yield and its contributing trait is very much essential in making indirect selection. It aims at initiation of effective selection programme to achieve genetic improvement in crops so as to enhance their economic value and utility. It provides a statistical measure about the strength of association between two variables and also the direction in which they are associated.

Material and Methods

The present investigation was conducted at Research farm, RPCAU, Pusa, Bihar during *Kharif* 2019-2020. The experimental materials comprised of 29 rice genotypes acquired from HarvestPlus programme, ICRISAT, Hyderabad. The local check was taken from Rice breeding section, Department of Plant Breeding and Genetics, RPCAU, Pusa, Bihar. 21 days old seedlings were transplanted in an experimental unit of $5m^2$ adopting a spacing of 20cm between rows and 15cm between plants. Randomized Complete Block Design was followed with three replications. Eleven quantitative traits were taken into consideration for the present study. The observations on quantitative traits *viz* plant height, number of panicles per plants, panicle length and grain yield per plant were taken by selecting 5 random plants from each plot while days to 50% flowering was recorded on plot basis. Observation on test weight, kernel length, kernel breadth, kernel L/B ratio, grain Iron content and grain Zinc content was recorded from seeds taken from bulk harvest of individual plot. An instrument known as Energy Dispersive X-Ray Fluorescence(ED-XRF) was used for estimation of the grain Iron and Zinc content. Trait association between the various characters under study was analyzed using methods proposed by Galton **(**1889**)**; Fisher **(**1918**)** and Falconer (1964) for computation of correlation coefficient which gives an insight into the magnitude and direction of relationship between the various traits. The cause-&-effect relationship was established by dividing the correlation coefficient into measures of direct & indirect effects using the path analysis, as proposed by Wright (1921) and further illustrated by Dewey and Lu (1959). Computation of data was done using R software.

Results and Discussion

The correlation coefficient provides information on the nature of relationship between various traits. It gives the magnitude and direction of the relationships thereby making the process of selection more precise and efficient. The data on correlation for this research which has been presented in Table 1 shows significant positive correlation at the phenotypic and genotypic level for grain yield per plant with days to 50% flowering (0.356 & 0.373), number of panicles per plant (0.340 & 0.522), panicle length (0.293 & 0.356), test weight (0.307 & 0.346) and kernel breadth (0.283 & 0.339) suggesting that these component trait can be used as in indirect selection for grain yield per plant. Similar findings were also reported by previous workers such as Bhargava *et al.* (2021); Yadav *et al.* (2010) and Veni *et al.* (2013). Significant negative association of grain yield per plant with plant height (-0.399 & -0.410) and kernel L/B ratio (-0.237 & -0.291) suggests that these component trait can also be used in indirect selection for grain yield per plant wherein exercising selection for lower values for this trait can lead to an increment in yield per plant. These traits may be utilized in crop improvement to obtain yield increases *via* indirect selection.

Table 1: Correlation coefficient among 11 quantitative traits of rice

Traits		PH	DFF	NPP	PL	1000-GW	KL	KB	L/B	FeC	ZnC
PH	**P**	**-0.357**	0.062	0.139	0.001	0.051	-0.030	-0.062	0.025	0.020	-0.054
	G	**-0.2347**	0.0416	0.1208	-0.0064	0.0343	-0.0213	-0.0368	0.0082	0.0190	-0.0386
DFF	**P**	-0.036	**0.206**	0.078	-0.025	0.042	0.013	0.021	-0.010	-0.006	-0.032
	G	-0.0244	**0.1380**	0.0650	-0.0185	0.0287	0.0085	0.0195	-0.0090	-0.0042	-0.0228
NPP	**P**	-0.053	0.052	**0.136**	-0.026	0.020	0.006	0.004	-0.001	-0.023	-0.044
	G	-0.1853	0.1696	**0.3601**	-0.0806	0.0557	0.0530	0.0632	-0.0113	-0.0621	-0.1590
PL	**P**	-0.001	-0.030	-0.047	**0.249**	0.043	-0.082	0.061	-0.111	-0.034	0.075
	G	0.0083	-0.0405	-0.0674	**0.3013**	0.0531	-0.1130	0.1470	-0.2046	-0.0480	0.1105
1000-GW	**P**	-0.025	0.036	0.026	0.031	**0.176**	-0.034	-0.026	0.001	-0.042	-0.020
	G	-0.0311	0.0443	0.0329	0.0375	**0.2128**	-0.0413	-0.0399	0.0027	-0.0541	-0.0277
KL	**P**	-0.049	-0.037	-0.027	0.196	0.115	**-0.593**	-0.146	-0.314	0.064	0.073
	G	-0.0406	-0.0274	-0.0659	0.1677	0.0867	**-0.4471**	-0.1293	-0.2640	0.0548	0.0528
KB	**P**	0.182	0.108	0.032	0.252	-0.156	0.255	**1.037**	-0.714	-0.070	-0.168
	G	0.1073	0.0964	0.1199	0.3333	-0.1280	0.1977	**0.6834**	-0.4107	-0.0755	-0.1533
L/B	**P**	-0.063	-0.040	-0.005	-0.393	0.004	0.469	-0.608	**0.884**	-0.015	0.055
	G	-0.0207	-0.0387	-0.0186	-0.4017	0.0076	0.3492	-0.3554	**0.5914**	-0.0054	0.0564
FeC	**P**	0.003	0.002	0.008	0.007	0.012	0.005	0.003	0.001	**-0.049**	-0.015
	G	0.0009	0.0003	0.0019	0.0018	0.0028	0.0014	0.0012	0.0001	**-0.0111**	-0.0036
ZnC	**P**	0.001	-0.001	-0.001	0.001	-0.0004	-0.0004	-0.001	0.0002	0.001	**0.003**
	G	0.0097	-0.0098	-0.0261	0.0217	-0.0077	-0.0070	-0.0133	0.0056	0.0193	**0.0592**
YPP	**P**	**-0.399****	**0.356****	**0.340****	**0.293***	**0.307***	**0.01**	**0.283***	**-0.237**	**-0.154**	**-0.127**
	G	**-0.410****	**0.373****	**0.522****	**0.356****	**0.346****	**-0.019**	**0.339****	**-0.291**	**-0.167**	**-0.126**

The negative correlation of plant height with yield was supported by the findings of workers *viz.* Singh *et al.* (2017) and Patil and Sarawgi (2005). Non significant association of the traits kernel length (0.01 & -0.019), grain Iron content (0.154 & -0.167) and grain Zinc content (0.127 & -0.126) with yield suggests that they play no role in yield determination. However if for any reason one wishes to combine high yield with any of these traits, one may have to independently select for the two traits in a single genotype. The traits grain Zn and Iron (0.301 & 0.326) content showed significant positive correlation between each other indicating that simultaneous selection could be done to improve nutritional quality in crop improvement programmes to enrich the rice grain with both these micronutrient serving as a potent weapon against the battle on malnutrition. The probable reason for this association may be attributed to common transporters involved in absorption of these micronutrients from soil to the plant system. Path analysis separates the correlation coefficient into measurements of direct and indirect effects of aset of independent variables on the dependent variable using the standardized partial regression coefficient. If the correlation between yield and trait is due to the trait's direct effects, it represents the true relationship between them, and selection may be used to improve yield. If, on the other hand, the link is due to the trait's indirect effects through another component trait, the breeder must choose the latter trait. This knowledge gives a better insight into the nature of relationship between traits and thus helps to make selection more effective. The perusal of data on path coefficient analysis (Table 2) from this research revealed that the following traits *viz.* days to 50% flowering (0.206 & 0.138), panicle length (0.249 & 0.301), test weight (0.176 & 0.212), number of panicles per plant (0.136 & 0.360), kernel breadth (1.037 & 0.683), kernel L/B ratio (0.884 & 0.591), and grain Zn content (0.003 & 0.059) were all observed to exert positive direct effect on the dependent variable *i.e.* grain yield per plant, indicating a strong positive association between these traits. This implies that selection for these

Table 2: Path analysis coefficient analysis among 11 quantitative traits of rice

Traits		PH	DFF	NPP	PL	1000-GW	KL	KB	L/B	FeC	ZnC
PH	**P**	**-0.357**	0.062	0.139	0.001	0.051	-0.030	-0.062	0.025	0.020	-0.054
	G	**-0.2347**	0.0416	0.1208	-0.0064	0.0343	-0.0213	-0.0368	0.0082	0.0190	-0.0386
DFF	**P**	-0.036	**0.206**	0.078	-0.025	0.042	0.013	0.021	-0.010	-0.006	-0.032
	G	-0.0244	**0.1380**	0.0650	-0.0185	0.0287	0.0085	0.0195	-0.0090	-0.0042	-0.0228
NPP	**P**	-0.053	0.052	**0.136**	-0.026	0.020	0.006	0.004	-0.001	-0.023	-0.044
	G	-0.1853	0.1696	**0.3601**	-0.0806	0.0557	0.0530	0.0632	-0.0113	-0.0621	-0.1590
PL	**P**	-0.001	-0.030	-0.047	**0.249**	0.043	-0.082	0.061	-0.111	-0.034	0.075
	G	0.0083	-0.0405	-0.0674	**0.3013**	0.0531	-0.1130	0.1470	-0.2046	-0.0480	0.1105
1000-GW	**P**	-0.025	0.036	0.026	0.031	**0.176**	-0.034	-0.026	0.001	-0.042	-0.020
	G	-0.0311	0.0443	0.0329	0.0375	**0.2128**	-0.0413	-0.0399	0.0027	-0.0541	-0.0277
KL	**P**	-0.049	-0.037	-0.027	0.196	0.115	**-0.593**	-0.146	-0.314	0.064	0.073
	G	-0.0406	-0.0274	-0.0659	0.1677	0.0867	**-0.4471**	-0.1293	-0.2640	0.0548	0.0528
KB	**P**	0.182	0.108	0.032	0.252	-0.156	0.255	**1.037**	-0.714	-0.070	-0.168
	G	0.1073	0.0964	0.1199	0.3333	-0.1280	0.1977	**0.6834**	-0.4107	-0.0755	-0.1533
L/B	**P**	-0.063	-0.040	-0.005	-0.393	0.004	0.469	-0.608	**0.884**	-0.015	0.055
	G	-0.0207	-0.0387	-0.0186	-0.4017	0.0076	0.3492	-0.3554	**0.5914**	-0.0054	0.0564
FeC	**P**	0.003	0.002	0.008	0.007	0.012	0.005	0.003	0.001	**-0.049**	-0.015
	G	0.0009	0.0003	0.0019	0.0018	0.0028	0.0014	0.0012	0.0001	**-0.0111**	-0.0036
ZnC	**P**	0.001	-0.001	-0.001	0.001	-0.0004	-0.0004	-0.001	0.0002	0.001	**0.003**
	G	0.0097	-0.0098	-0.0261	0.0217	-0.0077	-0.0070	-0.0133	0.0056	0.0193	**0.0592**
YPP	**P**	**-0.399****	**0.356****	**0.340****	**0.293***	**0.307***	**0.01**	**0.283***	**-0.237**	**-0.154**	**-0.127**
	G	**-0.410****	**0.373****	**0.522****	**0.356****	**0.346****	**-0.019**	**0.339****	**-0.291**	**-0.167**	**-0.126**

traits in the positive direction could directly lead to an increase in yield. These results were similar to those of Lakshmi *et al*. (2014); Sadeghi (2011) and Sankar *et al*. (2006) who also found that traits such as test weight, and number of panicles per plant had large positive association with grain yield and apart from these traits, the results of the present investigation imply that traits such as panicle length, kernel breadth and kernel L/B ratio have a direct positive association with grain yield. Negative direct effect was exerted by the traits plant height (-0.357 & -0.234), kernel length (-0.593 & -0.447), and grain Fe content (-0.049 & -0.011). Negative direct effect implies that these traits have a direct negative effect on the dependant variable *i.e* grain yield, implying that selection for these traits should be done in negative direction to increase grain yield. This could be attributed to the fact that plants with short stature have been found to exhibit higher nutrient use efficiency and are resistant to lodging. These findings were in conjunction with the findings of Babu *et al*. (2012) and Nayak *et al*. (2001) who also reported a negative direct effect of plant height on grain yield.

Conclusion

The analysis of trait association and subsequent path analysis revealed that the traits, plant height, days to 50% flowering, number of panicles per plant, panicle length, test weight and kernel breadth are the major determinant of grain yield per plant as they showed significant association as well as high direct effect on the latter. These traits could be utilized in the selection for improvement of yield in crop breeding programmes. Further the grain Iron(Fn) and Zinc(Zn) content while not showing any significant association with grain yield displayed a significant positive association with each other signifying that improvement of these two traits could be done simultaneously in biofortification programmes.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Babu, V. R., Shreya, K., Dangi, K. S., Usharani, G., & Shankar, A. S. (2012). Correlation and path analysis studies in popular rice hybrids of India. *International Journal of Scientific and Research Publications*, *2*(3), 1-5.

Bain, L.E., Awah, P.K., Geraldine, N., Kindong, N.P., Siga, Y., Bernard, N. & Tanjeko, A.T. (2013). Malnutrition in Sub-Saharan Africa: burden, causes and prospects. *Pan African Medical Journal*, 15(1),120

Bhargava, K., Shivani, D., Pushpavalli, S. N. C. V. L., Sundaram, R. M., Beulah, P., & Senguttuvel, P. (2021). Genetic variability, correlation and path coefficient analysis in segregating population of rice. *Electronic Journal of Plant Breeding*, 12(2), 549-555.

Dewey, D.R. & Lu, K.H. (1959). A Correlation and Path Coefficient Analysis of Components of Crested Wheatgrass Seed Production. *Agronomy journal*, 57(9), 515-518.

Fisher, R. A. (1918). The correlation between relatives on the supposition of Mendelian inheritance. *Transactions of the Royal Society of Edinbergh*, 52, 399-433.

Falconer, D.S. 1960**.** Introduction to quantitative genetics. *Ronald Press, New York*. pp. 247-281.

Galton, F. (1889). I. Co-relations and their measurement, chiefly from anthropometric data. *Proceedings of the Royal Society of London*, *45*(273-279), 135-145.

Lakshmi, M. V., Suneetha, Y., Yugandhar, G., & Lakshmi, N. V. (2014). Correlation studies in rice (Oryza sativa L.). *International Journal of Genetic Engineering and Biotechnology*, 5(2), 121-126.

Ministry of Agriculture and Farmers Welfare, Government of India, 2020. Available at http://www.indiastat.com

Moosavi, M., Ranjbar, G., Zarrini, H.N. & Gilani, A. (2015). Correlation between morphological and physiological traits and path analysis of grain yield in rice genotypes under Khuzestan conditions. *Biological Forum*, 7(1), 43-47.

Nayak, A. R., Chaudhury, D., & Reddy, J. N. (2001). Correlation and path analysis in scented rice (Oryza satna L.). *Indian Journal of Agricultural Research*, 35(3), 186-189.

Patil, P. V., & Sarawgi, A. K. (2005). Studies on genetic variability, correlation and path analysis in traditional aromatic rice accessions. *Annals of plant physiology*, 19(1), 92.

Singh, M. K., Singh, S., Nautiyal, M. K., Pandey, I. D., & Gaur, A. K. (2017). Variability, heritability and correlation among grain quality traits in basmati rice (Oryza sativa L.). *International Journal of Chemical Studies*, *5*(5), 309-312.

Sadeghi, S.M. (2011). Heritability, phenotypic correlation and path coefficient studies for some agronomic characters in land race rice varieties. *World Applied Sciences Journal*. 13(5), 1229-1233.

Sankar, P. D., Sheeba, A., & Anbumalarmathi, J. (2006). Variability and character association studies in rice (Oryza sativa L.). *Agricultural Science Digest*, *26*(3), 182-184.

Veni, B. K., Lakshmi, B. V. & 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.

Wright, S. (1921). Systems of mating. I. The biometric relations between parent and offspring. *Genetics*, **6**(2): 111.

Yadav, S. K., Suresh, B. G., Pandey, P. & Kumar, B. (2010). Assessment of genetic variability, correlation and path association in rice (*Oryza sativa* L.). *Journal of bio-science*, 18, 1-8.

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