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Correlation and Path Analysis for Yield Determing Traits in Sabita/Sambamahsuri Derivatives of Rice (*Oryza sativa* L.) Genotypes

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Authors' contributions

This work was carried out in collaboration between all the both authors. Author AT designed the study, performed the statistical analysis, wrote the protocol and first draft of the manuscript. Author BP managed the analyses of the study and the literature searches and also provide guidance. Both authors read and approved the final manuscript.

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ABSTRACT

The present investigation carried out to study the character association and path analysis in twenty three recombinant inbred lines (RILs) of Sabita/Sambamahsuri derivatives and four check varieties of rice (*Oryza sativa* L.). Character association of the yield attributing traits revealed significantly positive association of grain yield per plant with number of panicles per plant (genotypic), panicle weight, panicle length, number of florets per panicle, number of grains per panicle, kernel breadth and harvest index. Hence, selection for these traits can improve yield. Path coefficient analysis revealed that ten characters viz. days to maturity, panicle length, number of primary branches per panicle, number of florets per panicle, number of grains per panicle, fertility percentage, grain length, kernel breadth, kernel Length/Breadth (L/B) ratio and harvest index had positive direct effect on yield.

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1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the pivotal cereal crops feeding more than half of the world population. India is one of the world's largest producers of rice, just after China. It is being consumed by almost two- thirds of the population and it plays a pivotal role in Indian economy. It has been estimated that the world will have to produce 60% more rice by 2030 than what it produced today. Theoretically, rice still has great yield potential to be tapped and there are many ways to raise rice yield, such as building of irrigation works, improvement of soil conditions, cultural techniques and breeding of high yielding varieties. A successful breeding programme will depend on the genetic diversity of a crop for achieving the goals of improving the crop and producing high yielding varieties [1].

Yield enhancement is the major breeding objective in rice breeding programmes and knowledge on the nature and magnitude of the genetic variation governing the inheritance of quantitative characters like yield and its components is essential for effective genetic improvement [2].

The knowledge on the association between yield and its component characters and their direct and indirect impact on grain yield will be helpful for the improvement of grain yield. Ultimately, this kind of analysis could help the breeder to design his selection strategies to improve grain yield. So the present study was undertaken to understand the association among yield and its component characters along with the nature and extent of direct and indirect effects of yield components on yield through correlation and path analysis in sabita/sambamahsuri derivatives of rice.

2. MATERIALS AND METHODS

The experimental materials consisted of twenty-three F_8 recombinant inbred lines (RILs) of Sabita/Sambamahsuri derivatives designated S_1 to S_{23} and four check varieties viz. Swarna sub1, Dhanarasi, Sambamahsuri and Sabita. RILs were developed at RRS, NAZ, Bidhan Chandra Krishi Vishwavidyalaya, SC-Chakdaha, Nadia. Each genotype was grown in 5 m^2 plot with the spacing of 20 × 20 cm and recommended management practices were followed to obtain good harvest. Observations were recorded from each entry on 20 yield attributing characters. The data were used for statistical analysis following appropriate computer based statistical software (OPSTAT) for the estimation of correlation and path. The genotypic and phenotypic correlation coefficients were estimated as suggested by [3] and path-coefficient analysis was done following [4]. Correlation is partitioned into direct and indirect effects through genotypic path coefficient analysis. The direct and indirect effects was rated as negligible (0.00-0.09), low (0.10-0.19), moderate (0.20-0.29), high (0.30-1.00) and very high (More than 1.00) as suggested by Lenka and Mishra [5].

3. RESULTS AND DISCUSSION

Selection based on the detailed knowledge of magnitude and direction of association between yield and its attributes is very important in identifying the key characters, which can be exploited for crop improvement through suitable breeding programme [6]. The genotypic and phenotypic correlation coefficients for 20 yield attributing characters were presented in Table.1. The results revealed that the estimates of genotypic correlation coefficients were higher than phenotypic correlation coefficients for most of the characters under study which indicated strong inherent association between the characters which might be due to masking or modifying effects of environment.

In the character association studies it was observed that grain yield per plant exhibited significant positive correlation with number of panicles per plant (genotypic), panicle weight, panicle length, number of florets per panicle, number of grains per panicle, kernel breadth and harvest index. Hence, selection for these traits can improve yield. [7] reported significant positive correlation of grain yield for productive tillers per plant, number of tillers per square meter, panicle length, number of grains per panicle, 1000 grain weight, straw yield per plant and harvest index. Grain yield per plant showed negative significant correlation with days to maturity.

Days to 50% flowering had positive significant correlation with days to maturity, grain length, grain breadth and kernel length but significant negative correlation was observed with kernel L/B ratio (genotypic), number of grains per panicle and fertility percentage. Days to maturity showed positive significant correlation with plant

height, number of primary branches per panicle, grain length and grain breadth while it had negative significant correlation with number of florets per plant and grain yield per plant (genotypic). Plant height showed positive significant correlation with number of panicle per plant, Panicle length, fertility percentage, 1000 grain weight, grain (brown rice) length, kernel length and kernel L/B ratio. Number of panicle per plant showed positive significant correlation with panicle weight, panicle length, number of grains per panicle, fertility percentage, and grain yield per plant (genotypic). Positive significant correlation was observed for panicle weight with panicle length, number of secondary branches (genotypic), and number of florets per panicle, number of grains per panicle, harvest index and grain yield per plant. Panicle length had positive significant correlation with number of primary branches per panicle, number of secondary branches per panicle, number of florets per panicle, number of grains per panicle, harvest index (genotypic) and grain yield per plant. These results were in accordance with [2], [8] and [9].

Number of primary branches per panicle showed significant positive correlation with number of secondary branches per panicle. Number of secondary branches showed positive significant correlation with florets number per panicle, while it had negative significant correlation with fertility percentage (genotypic), 1000 grain weight, grain L/B ratio. Number of florets per panicle showed positive significant correlation with number of grains per panicle, harvest index and grain yield per plant, while it had negative significant correlation with fertility percentage, 1000 grain weight grain length and grain L/B ratio. Number of grains per panicle showed positive significant correlation with harvest index and grain yield per plant, while it had negative significant correlation with grain length (genotypic) and kernel length (phenotypic). Fertility percentage showed positive significant correlation with 1000 grain weight, grain length, grain L/B ratio and kernel length at genotypic level. 1000 grain weight showed positive significant correlation with grain length, grain L/B ratio and kernel length (genotypic). Similar findings were observed by [10] and [11].

Grain length had positive significant correlation with grain breadth, kernel length and, kernel breadth. It showed positive significant correlation with kernel breadth while it had negative significant correlation with grain L/B and kernel L/B ratio. It had positive significant correlation with kernel L/B ratio while it had negative significant correlation with kernel breadth. Kernel length showed significant positive correlation with kernel L/B ratio. A significant positive correlation observed for kernel breadth with harvest index and grain yield per plant while negative significant correlation for kernel L/B ratio. Kernel L/B ratio showed negative significant correlation with harvest index. Harvest index showed positive significant correlation with grain yield per plant at both genotypic and phenotypic level.

Path coefficient analysis was based on genotypic correlation coefficient using grain yield as the dependent factor (effect) and other traits as independent factor (cause). Residual effect of path coefficient analysis was very low (0.088). It indicated that the number of characters chosen for study were very much appropriate for yield determination in rice. About 50% of the characters possessed positive direct effects towards yield. Grain yield per plant showed positive significant correlation with number of panicle per plant, panicle weight, panicle length, number of floret per panicle, number of grain per panicle, kernel breadth and harvest index and negatively significant correlation with days to maturity. [9] and [12] showed similar result.

Path coefficient analysis (Table 2) revealed that ten characters viz. days to maturity (0.13676), panicle length (0.45517), number of primary branches per panicle (0.20665), number of florets per panicle (0.2793), number of grains per panicle (0.31383), fertility percentage (0.10961), grain length (0.84746), kernel breadth (1.24355), kernel L/B ratio (1.54476) and harvest index (0.60068) had positive direct effect on yield, while rest of the characters, namely days to 50% flowering (-0.21627), plant height (-0.00373), number of panicle per plant (-0.27426), panicle weight (-0.1746), number of secondary branches per panicle (-0.74545), 1000 grain weight (-0.24474), grain breadth (-0.76869), grain L/B ratio (-0.96826) and kernel length (-0.94281) imparted negative direct effect on grain yield per plant. Kernel L/B ratio imparted the highest positive direct effect on grain yield per plant followed by kernel breadth, grain length and harvest index respectively. The correlation coefficient of panicle length, number of grains per panicle, kernel breadth and harvest index with grain yield per plant was highly significant and had high positive direct effect. Such findings were earlier reported by [13] and [14]. Therefore, correlation explained the true relationship and a

Table 1. Genotypic and phenotypic correlation coefficient between yield attributing characters of sabita/sambamahsuri deivatieves

Characters		Days to maturity	Plant height (cm)	No. of panicle per plant	Panicle weight (g)	Panicle length (cm)	No. of primary branches per panicle	No. of secondary branches per panicle	No. of florets Per Panicle	No. of grains per panicle	Fertility percent (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Harvest index (%)	Grain yield per plant (g)
1. Days to 50% flower	G	0.696**	0.173	-0.089	-0.097	-0.197	-0.072	-0.039	-0.219	-0.165	0.179	0.131	0.528**	0.350**	-0.012	-0.004	0.379**	-0.334*	0.093	-0.076
	P	0.577**	0.142	-0.041	-0.119	-0.152	-0.048	-0.019	-0.148	-0.216	-0.029	0.117	0.443**	0.265	0.014	0.066	0.281*	-0.161	0.037	-0.071
2. Days to maturity	G		0.404**	0.051	-0.129	-0.185	0.306*	0.137	-0.295*	-0.261	0.195	0.132	0.511**	0.356**	-0.025	0.217	0.070	0.077	-0.263	-0.276*
	P		0.279*	0.023	-0.066	-0.089	0.162	0.096	-0.109	-0.254	-0.122	0.159	0.414**	0.220	0.049	0.146	0.039	0.069	-0.122	-0.151
3. Plant height (cm)	G			0.481**	0.115O	0.361**	0.227	0.030	-0.189	0.011	0.365**	0.351**	0.461**	0.225	0.009	0.552**	0.007	0.340*	-0.087	0.126
	P			0.458**	0.101	0.330*	0.220	0.016	-0.168	0.011	0.260	0.325*	0.453**	0.218	0.009	0.488**	-0.000	0.298*	-0.057	0.124
4. No. of panicle per plant	G				0.542**	0.478**	-0.001	-0.007	0.081	0.444**	0.431**	-0.006	0.240	0.264	-0.173	0.183	0.166	-0.034	0.162	0.336*
	P				0.439**	0.396**	0.008	-0.012	0.077	0.305*	0.239	0.020	0.226	0.231	-0.144	0.202	0.127	0.022	0.091	0.267
5. Panicle weight (g)	G					0.677**	0.136	0.289*	0.455**	0.766**	0.195	0.045	-0.078	0.073	-0.186	-0.037	0.182	-0.161	0.622**	0.623**
	P					0.549**	0.082	0.189	0.398**	0.686**	0.218	0.067	-0.067	0.066	-0.161	-0.149	0.179	-0.237	0.602**	0.647**
6. Panicle length (cm)	G						0.393**	0.505**	0.339*	0.470**	0.022	0.010	-0.083	0.088	-0.219	0.089	-0.049	0.064	0.354**	0.410**
	P						0.348**	0.471**	0.290*	0.356**	0.007	-0.004	-0.068	0.097	-0.210	0.041	-0.034	0.023	0.261	0.300*
7. No. of primary branches per panicle	G							0.837**	0.129	-0.015	-0.223	-0.168	0.076	0.230	-0.240	0.115	0.106	-0.037	0.035	-0.049
	P							0.822**	0.097	-0.008	-0.129	-0.176	0.053	0.232	-0.253	0.107	0.090	-0.020	0.017	-0.039
8. No. of secondary branches per panicle	G								0.409**	0.252	-0.361**	-0.350**	-0.138	0.162	-0.311*	-0.133	0.072	-0.161	0.263	0.059
	P								0.336*	0.179	-0.245	-0.332*	-0.139	0.164	-0.304*	-0.101	0.068	-0.124	0.169	-0.001
9. No. of florets Per Panicle	G									0.802**	-0.692**	-0.273*	-0.377**	0.068	-0.342*	-0.264	0.087	-0.244	0.659**	0.639**
	P									0.660**	-0.608**	-0.233	-0.343*	0.037	-0.279*	-0.218	0.048	-0.173	0.612**	0.588**
10. No. of grains per panicle	G										-0.125	-0.093	-0.276*	-0.102	-0.107	-0.154	0.094	-0.123	0.821**	0.827**
	P										0.192	-0.071	-0.253	-0.051	-0.140	-0.278*	0.117	-0.247	0.734**	0.752**
11. Fertility percentage (%)	G											0.326*	0.315*	-0.206	0.417**	0.285*	-0.002	0.253	-0.099	-0.054
	P											0.220	0.199	-0.083	0.205	0.010	0.074	-0.033	-0.022	0.032
12. 1000 grain weight (g)	G												0.528**	0.053	0.292*	0.277*	0.046	0.147	-0.049	0.016
	P												0.499**	0.021	0.301*	0.240	-0.000	0.161	-0.016	0.049
13. Grain length (mm)	G													0.435**	0.173	0.694**	0.367**	0.166	-0.053	0.067
	P													0.413**	0.188	0.612**	0.336*	0.153	-0.040	0.054
14. Grain breadth (mm)	G														-0.806**	0.239	0.749**	-0.483**	0.174	0.250
	P														-0.812**	0.169	0.738**	-0.468**	0.163	0.211
15. Grain L/B ratio	G															0.171	-0.584**	0.630**	-0.245	-0.256
	P															0.193	-0.587**	0.600**	-0.217	-0.219
16. Kernel length (mm)	G																0.098	0.560**	-0.072	0.230
	P																0.023	0.638**	-0.151	0.022
17. Kernel breadth (mm)	G																	-0.764**	0.435**	0.371**
	P																	-0.747**	0.356**	0.305*
18. Kernel L/B ratio	G																		-0.360**	-0.102
	P																		-0.339*	-0.197
19. Harvest index (%)	G																			0.917**
	P																			0.890**

**=Significant at 1% level* **= Significant at 5% level. G = Genotypic correlation coefficient and P = phenotypic correlation coefficient*

Table 2. Path coefficient (genotypic) analysis showing direct (bold) and indirect effect of yield components of rice

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of panicle per plant	Panicle weight (g)	Panicle length (cm)	No. of primary branches per panicle	No. of secondary branches per panicle	No. of florets Per Panicle	No. of grains per panicle	Fertility percent (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Harvest index (%)	Grain yield per plant (g)
1. Days to 50% flowering	**-0.21627**	0.09518	-0.00065	0.02452	0.01701	-0.08984	-0.0149	0.02885	-0.06117	-0.05192	0.01961	-0.03212	0.44732	-0.26916	0.0121	0.00403	0.4717	-0.51564	0.05562	-0.076
2. Days to maturity	-0.15052	**0.13676**	-0.00151	-0.01386	0.02258	-0.08417	0.06331	-0.10191	-0.08247	-0.08199	0.02135	-0.03236	0.43312	-0.27345	0.02424	-0.20421	0.08729	0.11969	-0.15774	-0.276*
3. Plant height (cm)	-0.03743	0.05522	**-0.00373**	-0.1319	-0.02003	0.16416	0.04698	-0.02262	-0.05282	0.00337	0.04003	-0.08586	0.39074	-0.17274	-0.00868	-0.52008	0.00859	0.5252	-0.05229	0.126
4. No. of panicle per plant	0.01933	0.00691	-0.00179	**-0.27426**	-0.09463	0.21741	-0.00024	0.00528	0.02252	0.13941	0.04727	0.00139	0.20346	-0.20283	0.16737	-0.1722	0.20648	-0.05219	0.09738	0.336*
5. Panicle weight (g)	0.02107	-0.01769	-0.00043	-0.14863	**-0.1746**	0.30807	0.02806	-0.21513	0.12719	0.24039	0.02133	-0.011	-0.06568	-0.05633	0.17987	0.03507	0.22633	-0.24897	0.37365	0.623**
6. Panicle length (cm)	0.04269	-0.02529	-0.00135	-0.131	-0.11817	**0.45517**	0.08115	-0.37635	0.09467	0.14744	0.00246	-0.00255	-0.07046	-0.06768	0.21183	-0.08375	-0.06092	0.09955	0.21248	0.410**
7. No. of primary branches per panicle	0.01559	0.0419	-0.00085	0.00032	-0.02371	0.17873	**0.20665**	-0.62383	0.03616	-0.00463	-0.02446	0.0412	0.06462	-0.17653	0.23223	-0.10827	0.13158	-0.05688	0.02088	-0.049
8. No. of secondary branches per panicle	0.00837	0.0187	-0.00011	0.00194	-0.05039	0.22979	0.17293	**-0.74545**	0.11428	0.07916	-0.03955	0.0857	-0.11694	-0.12454	0.30087	0.125	0.08994	-0.24859	0.15811	0.059
9. No. of florets Per Panicle	0.04736	-0.04038	0.00071	-0.02211	-0.07951	0.15427	0.02676	-0.305	**0.2793**	0.25164	-0.07581	0.06686	-0.3192	-0.05239	0.33136	0.24914	.10795	).37745	0.39581	0.639**
10. No. of grains per panicle	0.03578	-0.03573	-0.00004	-0.12183	-0.13374	0.21385	-0.00305	-0.18803	0.22395	**0.31383**	-0.01374	0.0228	-0.23381	0.07812	0.10348	0.14515	.1165	).19023	0.4934	0.827**
11. Fertility percentage (%)	-0.0387	0.02663	-0.00136	-0.11828	-0.03398	0.01023	-0.04611	0.26895	-0.19318	-0.03935	**0.10961**	-0.0799	0.26656	0.15854	-0.40373	-0.26895	).00211	.39093	-0.0593	-0.054
12. 1000 grain weight (g)	-0.02838	0.01808	-0.00131	0.00156	-0.00785	0.00475	-0.03479	0.26105	-0.07631	-0.02924	0.03578	**-0.24474**	0.44769	-0.04067	-0.28315	-0.26161	.05716	.22742	-0.02958	0.016
13. Grain length (mm)	-0.11416	0.0699	-0.00172	-0.06584	0.01353	-0.03784	0.01576	0.10286	-0.1052	-0.08658	0.03448	-0.12929	**0.84746**	-0.33465	-0.16778	-0.65428	.45608	.25648	-0.0321	0.067
14. Grain breadth (mm)	-0.07573	0.04865	-0.00084	-0.07237	-0.0128	0.04007	0.04746	-0.12078	0.01904	-0.03189	-0.02261	-0.01295	0.36894	**-0.76869**	0.7807	-0.22511	.93082	).74634	0.10443	0.25
15. Grain L/B ratio	0.0027	-0.00342	-0.00003	0.04741	0.03244	-0.09958	-0.04956	0.23164	-0.09558	-0.03354	0.0457	-0.07157	0.14685	0.61979	**-0.96826**	-0.16162	).72594	.97329	-0.14688	-0.256
16. Kernel length (mm)	0.00092	0.02962	-0.00206	-0.05009	0.00649	0.04043	0.02373	0.09884	-0.07381	-0.04831	0.03127	-0.06791	0.58811	-0.18353	-0.16598	**-0.94281**	.12236	.86582	-0.04295	0.23
17. Kernel breadth (mm)	-0.08204	0.0096	-0.00003	-0.04554	-0.03178	-0.0223	0.02187	-0.05391	0.02425	0.0294	-0.00019	-0.01125	0.31081	-0.57538	0.56523	-0.09277	**.24355**	1.17957	0.26108	0.371**
18. Kernel L/B ratio	0.07219	0.0106	-0.00127	0.00927	0.02814	0.02933	-0.00761	0.11996	-0.06825	-0.03865	0.02774	-0.03603	0.14071	0.37139	-0.61006	-0.52844	).94957	**.54476**	-0.216	-0.102
19. Harvest index (%)	-0.02003	-0.03591	0.00032	-0.04446	-0.10861	0.16101	0.00718	-0.19622	0.18405	0.25778	-0.01082	0.01205	-0.04529	-0.13364	0.23676	0.06742	.5405	).55549	**0.60068**	0.917**

***=Significant at 1% level* **= Significant at 5% level.* *Residual effect: 0.088*

direct selection through these characters would be effective for yield improvement in rice. The panicle weight and number of panicle per plant (genotypic) had significantly positive correlation with grain yield per plant but their direct effects were negative. It indicated that indirect effects would be the cause of correlation. In this situation the indirect causal factors were to be considered simultaneously for selection. Therefore, it would be better to consider the characters that showed high indirect effect on grain yield per plant.

The number of florets per panicle had positive significant correlation with grain yield per plant but had moderate direct effect. Therefore indirect effects of these characters through other component characters are mainly responsible for existence of such correlation coefficient. In this circumstance indirect selection through such characters may be practiced for yield improvement in rice. The days to maturity showed negative significant correlation with grain yield per plant and had positive direct effect on it. Thus this trait is useful for improving grain yield in rice.

4. CONCLUSION

Partitioning of correlation values showed that some of the characters could not produce significant correlation with grain yield per plant which might be either due to very high negative direct effects. Critical analysis of results obtained from character association and path analysis indicated the importance of panicle length, number of grains per panicle, kernel breadth and harvest index for yield determination in rice as these characters had positive significant correlation with grain yield per plant with high positive direct effect. Therefore these characters should be taken in consideration for rice improvement programme.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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