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CORRELATION AND PATH COEFFICIENT ANALYSIS FOR YIELD AND GRAIN QUALITY PARAMETERS IN RICE (*O. sativa L*)

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Abstract- The degree of association between yield, quality and the characters that contribute to the direct and indirect effects on grain yield in rice (*Oryza sativa* L.) was analyzed. Fourteen lines and testers and 48 hybrids (F_1s) were evaluated for identifying their efficiency with respect to 14 yield and quality traits. Association analysis studies indicated that grain yield per plant had positive significant correlation with panicles per plant; grains per panicle and the quality attribute alkali spreading value. A positive and association of grains per panicle with head rice recovery and milling percentage was also observed. Path coefficient analysis revealed that direct selection for panicles per plant, grains per panicle and grain weight would likely be effective for increasing grain yield. Direct selection for grains per panicle would increase head rice recovery percentage whereas increase in the grain length and grain weight would result in higher grain yield per plant along with head rice recovery percentage.

Keywords- Rice, Correlation, path analysis.

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Introduction

Rice (*Oryza sativa L.*) is an important crop, which supplies staple food for nearly 50% of the global population [1]. Development of high yielding genotypes with desirable agronomic traits for diverse ecosystem is therefore a necessity [2]. The primary concern in rice productivity was on only quantity enhancement. In spite of continued emphasis on yield, food consumption patterns have encouraged attention to grain quality. Quality traits are yet another important consideration of rice breeding in India [3]. Information on association of characters, direct and indirect effects contributed by each character towards yield will assist in fastening the selection process. Path coefficient analysis is important for partitioning the genotypic correlation coefficient and has effectively been used as a selection criteria in identifying useful traits for improving the grain yield in rice [4, 5, 6].

MaterialsandMethods

The materials for the study consisted of fourteen rice (*Oryza sativa* L.) genotypes collected from Paddy Breeding Station, Coimbatore and Agricultural College and Research Institute, Madurai. All the 14 parents and their 48 hybrids obtained from the crosses were planted in Randomized Block Design with two replications. Within each replication, each genotype had 15 single plants in a single row. A spacing of 20 cm between rows and 10 cm between plants was adopted. Recommended cultural and plant protection schedules of rice were followed. Observations were recorded on five randomly chosen plants in each replication in the F1's and parents after eliminating the two border plants on either side and the mean values used for statistical analyses. The following quantitative and qualitative characters ie. Panicles per plant, panicle length, grains per panicle, grain weight, single plant yield, milling percentage, head rice recovery, kernel length and kernel breadth before cooking, linear elongation ratio, volume expansion ration, alkali spreading value, gel consistency and amylose content were studied in F_1 generation. Hulling was carried out using Satake laboratory sheller and Satale Grain Testing mill was used to obtain uniformly polished seeds. Grain dimensions were measured using graph paper. L/B ratio was determined using Ramaiah's classification (1969), volume expansion ratio [7], Alkali Spreading Value [8], Gel consistency [9] and amylose content [10].

The association between yield and component traits and among themselves were computed as genotypic and phenotypic correlation based on per se performance of parents and hybrids in line x tester analysis [11]. Path coefficient analysis is important for partitioning the genotypic correlation coefficient into direct and indirect effects of component characters [12]. Through this we can estimate the actual contribution of an attribute and its influence through other characters. The direct and indirect effects were classified based on the scale given by [13].

Results and Discussion

Selection for yield in rice is not effective as yield is a complex and quantitatively inherited character with low heritability. Therefore, indirect selection for yield should be made through other characters through character association studies. Correlation provides information on the nature and extent of relationship between characters and facilitates in simultaneous improvement of two or more characters. Genotypic correlation coefficients calculated using variance and covariance analysis revealed significant differences within the genotypes for all the 14 characters studied indicating the presence of sufficient variation [Table-1]. In general, increased panicles per unit area is the most important, component of yield associated with yield followed by grains per panicle. In the present study grain yield had significant and positive association with panicles per plant [14,15], grains per panicle [6,16,17,18,19] and quality attributes such as alkali spreading value at genotypic level, while it had only positive association with other characters [20] [Table-2]. The positive correlation of panicles per plant with single plant yield was also reported by [21]. It is thus evident that the above characters would serve as useful indices of selection for improvement of single plant yield.

Table-1 *Analysis of variance for combining ability for yield, yield components and quality characters*

Source	df	Mean squares													
		PP	PL	GP	GW	MP	HRR	KL	L/B ratio	LER	VER	ASV	GC	AC	SPY
Hybrids	47	19.70**	14.65**	1155.36**	0.08**	64.01**	124.05**	0.35**	0.92**	0.03**	0.60**	6.19**	767.23**	9.17**	19.21**
Lines	7	26.04**	16.37**	1238.18**	0.26**	36.21**	143.76**	0.88**	2.01**	0.05**	0.70**	2.07**	1970.22**	7.34**	23.56**
Testers	5	13.37**	20.41**	574.95**	0.05**	11.54**	198.36**	0.60**	1.30**	0.01*	2.33**	37.79*	747.97**	9.53**	43.09**
Line / tester interaction	35	19.34**	13.48**	1221.71**	0.04**	77.07**	109.50**	0.21**	0.64**	0.02**	0.33**	2.49**	529.39**	9.48**	14.92**
Error	47	0.81	1.34	6.62	0.01	2.18	2.84	0.01	0.01	0.00	0.10	0.11	1.69	0.13	1.57

* and ** significant at P = 0.05 and 0.01 respectively

PP	Panicles per plant	GW	Grain weight	KL	Kernel length	VER	Volume expansion ratio	AC	Amylose content
PL	Panicle length	MP	Milling per cent	L/B	Length / breadth ratio	ASV	Alkali spreading value	SPY	Single plant yield
GP	Grains per panicle	HRR	Head rice recovery	LER	Linear elongation ratio	GC	Gel consistency		

Table-2 *Genotypic correlation coefficient*

Sl.No.	Characters	PP	PL	GP	GW	MP	HRR	KL	L/B	LER	VER	ASV	GC	AC	SPY
1.	PP	1.000	0.027	-0.578**	0.069	0.057	-0.158	0.199	0.166	-0.046	0.217	0.170	0.302*	-0.015	0.423**
2.	PL		1.000	0.164	-0.120	0.049	-0.103	0.040	-0.014	0.199	0.202	0.225	0.021	0.513**	0.129
3.	GP			1.000	-0.543**	0.046	0.403**	-0.371**	-0.161	-0.051	-0.244	-0.054	-0.159	-0.011	0.271*
4.	GW				1.000	0.071	-0.222	0.588**	0.250*	-0.250*	0.132	0.134	0.131	0.073	0.034
5.	MP					1.000	0.444*	0.122	-0.171	-0.101	-0.010	0.147	0.067	-0.067	0.151
6.	HRR						1.000	-0.215	-0.116	-0.171	-0.264*	-0.012	0.132	-0.205	0.223
7.	KL							1.000	0.527**	-0.518**	0.569**	0.392**	0.230	0.093	0.130
8.	L/B								1.000	-0.228	0.638**	0.413**	0.130	0.042	0.213
9.	LER									1.000	-0.152	-0.014	-0.159	0.190	-0.248
10.	VER										1.000	0.617**	0.238	0.208	0.053
11.	ASV											1.000	0.281*	0.198	0.291*
12.	GC												1.000	0.095	0.248
13.	AC													1.000	0.052
14.	SPY														1.000

PP	Panicles per plant	L/B	Length/breadth ratio	Residual value =0.1489
PL	Panicle length	LER	Linear elongation ratio	*Significant at 5% levels
GP	Grains per panicle	VER	Volume expansion ratio	**Significant at 1% level
GW	Grain weight	ASV	Alkali spreading value	
MP	Milling per cent	GC	Gel consistency	Diagnol values denotes the direct effect
HRR	Head rice recovery	AC	Amylose content	
KL	Kernel length	SPY	Single plant yield	

Panicles per plant had significant negative association with grains per panicle and Grains per panicle had significant negative association with grain weight as observed by [22] and kernel length suggesting that yield improvement could be done by only by improving one of the characters and simultaneous improvement is not possible.

The grain weight had a significant positive association with length/breadth ratio and kernel length as reported by [21,15]. There was a positive significant association of kernel length with Length/Breadth ratio as reported by [21] suggesting that increase in kernel length might help in obtaining higher grain yield.

A positive association of grains per panicle was observed with head rice recovery. Milling per cent also exhibited positive and significant correlation with head rice recovery which was also reported by [14,23] whereas head rice recovery showed negative correlation with L/B ratio, linear elongation ratio, volume expansion ratio, alkali spreading value and amylose content. However lower head rice recovery for varieties with slender grains than bold grains were also reported by [24].

The traits volume expansion ratio, length/breadth ratio, kernel length alkali spreading value and gel consistency had a significant positive correlation among themselves. Gel consistency had a positive association with amylose content in contrary to the significant association as reported by [22] indicating that higher amylose content may lead to the recovery of genotypes with soft gel consistency. But none of the quality characters had got significant association with single plant yield as reported by [23,25].

When many traits are affecting a character, splitting the total correlation into direct and indirect effects of cause will be more helpful in identifying the character that contributes more towards yield [15]. In the present study the genotypic correlation coefficients of grain yield with its components were further partitioned into direct and indirect effects. Path coefficient analysis revealed that panicles per plant, grains per panicle and grain weight had registered maximum positive direct effect on grain yield as reported by [21,26] [Table 3].

Panicles per plant-exerted maximum negative indirect effect through grains per panicle while, effect through other characters was very low. The indirect effect of panicle length through grains per panicle was moderate and positive while it had negative indirect effect via grain weight, milling per cent, head rice recovery, kernel length, length/breadth ratio and volume expansion ratio to a negligible extent. Grains per panicle exerted maximum indirect effect on plant.

Table-3 *Direct and indirect effects of yield as partitioned by path analysis*

Sl.no	Characters	PP	PL	GP	GW	MP	HRR	KL	L/B	LER	VER	ASV	GC	AC	SPY
1	PP	**1.086**	-0.002	-0.710	0.043	-0.001	-0.008	-0.006	0.014	-0.001	-0.010	0.017	0.002	-0.001	0.423**
2	PL	0.030	**-0.071**	0.201	-0.074	-0.001	-0.005	-0.001	-0.001	0.005	-0.010	0.023	0.000	0.034	0.129
3	GP	-0.628	-0.012	**1.228**	-0.336	-0.001	0.019	0.011	-0.013	-0.001	0.012	-0.005	-0.001	-0.001	0.271*
4	GW	0.075	0.009	-0.667	**0.619**	-0.001	-0.11	-0.018	0.021	-0.007	-0.006	0.014	0.001	0.005	0.034
5	MP	0.062	-0.004	0.056	0.044	**-0.020**	0.021	-0.004	-0.014	-0.003	0.000	0.015	0.000	-0.004	0.151
6	HRR	-0.172	0.007	0.495	-0.138	-0.009	**0.048**	0.006	-0.010	-0.005	0.013	-0.001	0.001	-0.013	0.223
7	KL	0.216	-0.003	-0.456	0.364	-0.002	-0.010	**-0.030**	0.044	-0.014	-0.027	0.040	0.002	0.006	0.130
8	L/B	0.180	0.001	-0.197	0.155	0.003	-0.006	-0.016	**0.083**	-0.006	-0.030	0.042	0.001	0.003	0.213
9	LER	-0.050	-0.014	-0.063	-0.155	0.002	-0.008	0.015	-0.019	**0.026**	0.007	-0.001	-0.001	0.012	0.248
10	VER	0.235	-0.014	-0.300	0.082	0.000	-0.013	-0.017	0.053	-0.004	**-0.048**	0.063	0.002	0.014	0.053
11	ASV	0.184	-0.016	-0.066	0.083	-0.003	0.001	-0.012	0.034	0.000	-0.029	**0.102**	0.002	0.013	0.291*
12	GC	0.328	-0.001	-0.196	0.081	-0.001	0.006	-0.007	0.011	-0.004	-0.011	0.029	**0.007**	0.006	0.248
13	AC	-0.016	-0.037	-0.014	0.045	0.001	-0.010	-0.003	0.004	0.005	-0.010	0.020	0.001	**0.065**	0.052

PP	Panicles per plant	L/B	Length/breadth ratio	Residual value =0.1489
PL	Panicle length	LER	Linear elongation ratio	*Significant at 5% levels
GP	Grains per panicle	VER	Volume expansion ratio	**Significant at 1% level
GW	Grain weight	ASV	Alkali spreading value	
MP	Milling per cent	GC	Gel consistency	Diagnol values denotes the direct effect
HRR	Head rice recovery	AC	Amylose content	
KL	Kernel length	SPY	Single plant yield	

yield through panicles per plant and grain weight which was negative while the effect through other characters being negligible indicating that when one of the characters is improved the improvement in other one is affected.

Milling per cent exhibited indirect effects through other characters, which was negligible. Head rice recovery exhibited high positive direct effect through grains per panicle, low negative effects through panicles per plant and grain weight while its effect through other characters was negligible.

Kernel length showed high and positive indirect effect through grain weight, moderate and positive effect through panicles per plant and negative and high effect through grains per panicle. So the plant yield could be improved by increasing the grain weight along with kernel length. The indirect effect of length/breadth ratio through panicles per plant and grain weight was low and positive, while the effect through grains per panicle was low and negative. Linear elongation ratio had low and negative indirect effect through grain weight whereas the effect through other characters being negligible. Volume expansion ratio exerted moderate and positive effect through panicles per plant while its effect through grains per panicle was moderate and negative. Low and positive indirect effect was exhibited by panicles per plant on alkali spreading value.

Gel consistency had high and positive effect exerted through panicles per plant and low and negative effect through grains per panicle. Amylose content exerted negligible positive and negative effects through other characters. The residual effect was also negligible in the present study indicating the sufficiency of characters for assessing the various yield contributing characters to yield. Hence panicles per plant, grains per panicle and grain weight can be given due importance in increasing the yield.

Conclusion

Among the various characters analysed for contribution towards yield, panicles per plant, grains per panicle and grain weight are the important traits that affect the yield. But when yield is considered along with the quality traits panicles per plant and grains per panicle cannot be given due importance as increasing these two will result in reduction in quality in this study. Hence increasing the kernel length along with grain weight should be given importance in order to increase both the yield and quality.

Conflict of Interest: None declared

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