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Path and Correlation Analysis of Elite Rice (*Oryza sativa* L.) Genotypes under Diverse Situations

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ABSTRACT: Rice is the second most consumed cereal crop and staple food in the world. Demand of rice is steadily increasing due to unhindered population expansion. So, increase in the yield of varieties is more important. 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 present study was undertaken to evaluate twenty-three genotypes for correlation and path coefficient analysis for yield and yield component traits. The studies on correlation values indicated the intensity and direction of character association in a crop. Path co-efficient analysis is used to detect characters having direct and indirect effects on grain yield. Correlation studies indicated that number of panicles hill^{-1}, number of panicles sqm^{-1}, days to 50% flowering had the strongest and high significant positive phenotypic correlation with grain yield. Kernel length, number of panicles hill^{-1}, days to 50% flowering had a positive and very high direct effect on grain yield at phenotypic level, in which kernel length had highest positive direct effect on grain yield. Hence, the traits showing positive correlation and high direct effect on yield are useful in improving the yield of rice.

Keywords: Path co-efficient analysis, correlation, association analysis.

INTRODUCTION

Rice (*Oryza sativa* L.) is a short day monocotyledonous annual self-pollinated angiosperm within the genus *Oryza* of family Poaceae with chromosome number 2n=2x=24. More than forty per cent of the global population depends on rice as one of the major sources of calories. Asia is considered as Rice basket of the world, as more than ninety per cent of the rice is produced and consumed in Asia, a region with high population density. There are 24 species of rice in which 22 are wild and two are cultivated species *viz*., *Oryza sativa and Oryza glaberrima* (Marathi *et al.*, 2014). To increase the food supply for the growing population and to attain self-sufficiency of food in the country, the present production levels should be increased by two million tonnes every year.

Globally, rice is grown in an area of 167.2 mha with production of 769.6 mt annually and productivity of 4,600 Kg ha^{-1}. Rice is grown on 43.77 mha with an annual production of 117.47 mt and productivity of 2,570 Kg ha^{-1} in India. In Karnataka it has the area of 1.24 mha and production of 3.54 mt with a productivity of 2,670 Kg ha^{-1} (Anonymous, 2019).

Association between the variables is estimated by correlation studies. Correlation is positive or negative, positive correlation of component traits with yield is highly desirable because we can go for indirect selection for yield by selecting the highly heritable correlated traits. But negative correlation may decrease the yield, which are not desirable for indirect selection. Correlation between the traits is due to either pleiotropy or linkage. If it is due to pleiotropy, it never lost in segregating generations but if it is due to linkage, we may lose that in segregating generations. Phenotypic correlation coefficients were studied in order to assess the direction and magnitude of association existing among grain yield and its components in rice over three locations. Measurement of correlation coefficient aids to find the relative influence of component traits toward yield. Direct and indirect effects of yield contributing traits on yield are also essential in selecting high yielding genotypes. Path co-efficient analysis is used to detect characters partaking in direct and indirect effects on yield. An effort was made in the present study to identify the inter relationship of grain yield and yield components in 23 genotypes of rice under three environments *viz.*, Sirsi, Dharwad and Malagi.

MATERIAL AND METHODS

The present investigation on "Stability analysis of elite Rice (*Oryza sativa* L.) genotypes under diverse situations" was carried out during *kharif* 2020 at AICRIP (All India Coordinated Rice Improvement Project), ARS (Paddy) Sirsi, ARS Malagi, and UAS Dharwad. The material used and methods followed pertaining to the present investigation are presented here under.

Association analysis of elite rice (*Oryza sativa* L.) genotypes derived from a cross between: BPT 5204 (Mega variety P1) X D-6-2-2 (Local variety P2, Drought tolerant) and BPT 5204 (Mega variety P1) X A67 (Local variety P2, Drought tolerant). The experimental seed material for the present investigation comprised of 20 advanced breeding lines as presented in the Table 1.

All the 23 rice genotypes were sown during *kharif* 2020 in three locations i.e., Sirsi (Zone IX- Hilly zone-high rainfall area, transplanted), Malagi (Zone IX Hilly zone - low rainfall area, direct seeded) and Dharwad (Zone VIII- Northern transition zone, direct seeded) of Karnataka State. Experiment layout was a Completely Randomized Block Design consisted of 23 genotypes with two replications, each experimental plot comprised of five rows of five metres length, with a spacing of 20 x 15 cm between rows and plants respectively.

Randomly selected five competitive plants in each plot were used to record observations on yield and yield component traits. The averages of the observations were considered for analysis. Genotypic and phenotypic correlation coefficients were calculated using the method given by Johnson *et al.* (1955). Partitioning of the genotypic correlation coefficient of traits into direct and indirect effects was carried out using the procedure suggested by Dewey and Lu (1959). The experimental data are analyzed through statistical software tool *viz.* Indostat over the three locations with proper data arrangement.

RESULTS AND DISCUSSION

In the present study phenotypic correlation coefficients were studied in order to assess the direction and magnitude of association existing among grain yield and its components in rice over three locations *i.e.,* E1 (Sirsi), E2 (Dharwad) and E3 (Malagi) in 23 rice genotypes. A result recorded from present investigation had been presented in Table 2. The results showed that Grain yield plant^{-1}had positive significant correlation with days to 50% flowering (r = 0.597), number of panicles hill^{-1} (r = 0.518), number of panicles sqm^{-1} (r = 0.465). Similar results were shown by Allam *et al.* (2015); Ramya *et al.* (2017); Reetisana *et al.* (2022) for the characters like number of productive tillers plant^{-1}, panicle length and number of grains panicle^{-1}.

Days to 50 % flowering had positive significant correlation with plant height, plant length, chlorophyll content (SPAD), number of panicles hill^{-1}, number of panicles sqm^{-1}, grain yield plant^{-1}. Similar results were reported by Debendra *et al.* (2022) for the characters like Plant height and grain yield plant^{-1}. Plant height had positive significant correlation with panicle length, chlorophyll content (SPAD), number of panicles sqm^{-1}. Panicle length had positive significant correlation with chlorophyll content, number of panicles sqm^{-1}, number of panicles hill^{-1}. Chlorophyll content (SPAD) had positive significant correlation with number of panicles sqm^{-1} (r = 0.671), number of panicles hill^{-1}. Number of panicles hill^{-1} had positive significant correlation with number of panicles sqm^{-1}, grain yield plant^{-1}. Number of panicles sqm^{-1} had positive significant correlation with grain yield plant^{-1} similar results reported by Nagabhushan *et al.* (2003); Nayak *et al.* (2001); Nayak and Reddy (2005).

Grain length had positive significant correlation with grain length to breadth ratio, kernel length, kernel length to breadth ratio. Similarly, Krishna *et al.* (2010) study showed positive effect of grain length and breadth on yield. Grain breadth had positive significant correlation with kernel breadth. Grain length to breadth ratio had positive significant correlation with kernel length kernel length to breadth ratio. Kernel length had positive significant correlation with kernel length to breadth ratio. The relationship between kernel length and kernel length breadth ratio was positive and significant comparable to that of Archana *et al.* (2018); Singh *et al.* (2020) in rice. The results were in line with Manivelan *et al.* (2022); Himaja *et al.* (2022). The studies on inter se association between yield components will reveal the favorable or unfavorable association among themselves as well as with the grain yield. The improvement in favorable components will increase the grain yield.

The direct and indirect effects of different characters on grain yield per plant at phenotypic level are presented in Table 3. High positive direct effect on grain yield plant^{-1} was showed by kernel length, number of panicles hill^{-1}, days to 50% flowering, these results are in agreement with Dhurai *et al*. (2016). Also, similar results were recorded by Nandan *et al.* (2010) for the characters like kernel length and days to 50% flowering. High negative direct effect on grain yield plant^{-1} was showed by grain length to breadth ratio, grain breadth, kernel length to breadth ratio, panicle length. Moderate negative direct effect on grain yield plant^{-1} was showed by grain length, number of panicles sqm^{-1}, kernel breadth and low negative direct effect showed by plant height. Days to 50 % flowering had high positive direct effect on grain yield plant^{-1} coupled with moderate positive indirect effect via number of panicles sqm^{-1}. Plant height showed negative direct effect on grain yield plant^{-1}. Similar results were also reported by Bhadru *et al.* (2011) for Days to 50% flowering, Plant height and panicle length.

Panicle length had negative direct effect on grain yield plant^{-1}. Similar result was obtained by Rashid *et al.* (2014); Kulsum *et al.* (2019). Chlorophyll content had negligible positive direct effect on grain yield plant^{-1} and showed negligible indirect effects via other component traits. Number of panicles hill^{-1} had high positive direct effect on grain yield plant^{-1} and had high positive indirect effect via number of panicles sqm^{-1}, panicle length, chlorophyll content, days to 50 % flowering, moderate indirect effect via plant height. These results are in line with the results of Saleh *et al.* (2020) for number of panicles hill^{-1}(direct), indirectly through traits like panicle length, plant height.

Grain length had moderate negative direct effect on grain yield plant^{-1} and low indirect effects via other component traits. However, Grain breadth showed non-significant positive correlation with grain yield plant^{-1}. It had high negative direct effect on grain yield plant^{-1} and showed positive high indirect effect via grain length to breadth ratio, kernel length to breadth ratio. While, Grain L/B ratio had high negative direct effect on grain yield plant^{-1} and showed positive high indirect effect via kernel breadth, grain breadth, plant height, high negative indirect effect via kernel length to breadth ratio, grain length, kernel length. Similar results were reported by Kumar and Senapati (2013) for grain breadth and grain L/B ratio.

Kernel length had high positive direct effect on grain yield plant^{-1} and showed positive high indirect effect via grain length, grain length to breadth ratio, kernel L/B ratio. Kernel breadth had moderate negative direct effect on grain yield plant^{-1} and showed negligible indirect effect via other component traits. Whereas, kernel L/B ratio had high negative direct effect on grain yield plant^{-1} and showed positive high indirect effect via kernel breadth, grain breadth. Similar results were also reported by Khan *et al.* (2020) for characters like kernel length, kernel breadth and kernel L/B ratio, Dhurai *et al.* (2014) for kernel breadth and kernel L/B ratio.

The residual effect (R = 0.579) was high indicated that the measure of the effect of other possible independent variables, which were not include in the study were high in the present study, the studied traits contribute only 42.10 % to the variability for grain yield plant^{-1}, suggesting the necessity of inclusion of some more traits to explain residual variability present in the present genotypes which were not included now. The path coefficient analysis shown that kernel length, number of panicles hill^{-1}, days to 50 % flowering would be helpful in improving the grain yield in rice through selection.

CONCLUSIONS

From the results showed that grain yield plant^{-1} had positive significant correlation with days to 50 % flowering, number of panicles hill^{-1}, number of panicles sqm^{-1} and high positive direct effect on grain yield plant^{-1} was showed by kernel length, number of panicles hill^{-1}and days to 50 % flowering. So, these traits are useful in improving the yield of rice. The high residual effect indicated that the measure of the effect of other possible independent variables, which were not included in the study were high. Hence present study suggesting the necessity of inclusion of some more traits to explain residual variability present in the genotypes which were not included now.

Table 1: List of 20 advanced breeding lines used under present investigation along with parents.

<table>
<tr><th>Genotypes</th><th>Pedigree/Parentage</th><th>Genotypes</th><th>Pedigree/Parentage</th><th>Developed / Identified</th></tr>
<tr><td>BA - 1</td><td>BPT 5204/ ANTHRASALI-1</td><td>BD - 7</td><td>BPT 5204/DODDIGA -07</td><td rowspan="10">GPB, AICRIP (VC) ARS (Paddy), Banavasi Road, Sirsi -581 401, (UASD)</td></tr>
<tr><td>BA - 4</td><td>BPT 5204/ ANTHRASALI-4</td><td>BD - 8</td><td>BPT 5204/DODDIGA -08</td></tr>
<tr><td>BA - 7</td><td>BPT 5204/ ANTHRASALI-7</td><td>BD - 10</td><td>BPT 5204/DODDIGA -10</td></tr>
<tr><td>BA - 8</td><td>BPT 5204/ ANTHRASALI-8</td><td>BD - 11</td><td>BPT 5204/DODDIGA -11</td></tr>
<tr><td>BA - 9</td><td>BPT 5204/ ANTHRASALI-9</td><td>BD - 12</td><td>BPT 5204/DODDIGA -12</td></tr>
<tr><td>BA - 27</td><td>BPT 5204/ ANTHRASALI-27</td><td>BD - 13</td><td>BPT 5204/DODDIGA -13</td></tr>
<tr><td>BA - 31</td><td>BPT 5204/ ANTHRASALI-31</td><td>BD - 15</td><td>BPT 5204/DODDIGA -15</td></tr>
<tr><td>BA - 32</td><td>BPT 5204/ ANTHRASALI-32</td><td>BD - 16</td><td>BPT 5204/DODDIGA -16</td></tr>
<tr><td>BA - 34</td><td>BPT 5204/ ANTHRASALI-34</td><td>BD - 36</td><td>BPT 5204/DODDIGA -36</td></tr>
<tr><td>BA - 36</td><td>BPT 5204/ ANTHRASALI-36</td><td>BD - 41</td><td>BPT 5204/DODDIGA -41</td></tr>
<tr><td>BPT5204</td><td colspan="2">GEB-24 × TN1 × Mahsuri</td><td colspan="2">ARS, Bapatla, ANGRAU</td></tr>
<tr><td>D6-2-2</td><td colspan="2">Local Selection from Doddiga</td><td colspan="2">ARS Mugad, UASB</td></tr>
<tr><td>A-67</td><td colspan="2">Local Selection from Anthrasali</td><td colspan="2">ARS Mugad, UASB</td></tr>
</table>

Table 2: Phenotypic correlation coefficients among grain yield and its 12 component traits in rice genotypes (*Oryza sativa* L.) over three locations.

	Days to 50 % flowering	Plant Height (cm)	Panicle length (cm)	SPAD	Number of Panicles hill^{-1}	Number of Panicles sqm^{-1}	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Grain yield hill^{-1} (g)
Days to 50 % flowering	1	0.490**	0.448**	0.451**	0.491**	0.609**	-0.396*	-0.041	-0.241	-0.277	0.033	-0.199	0.597**
Plant height (cm)		1	0.7916**	0.5113**	0.253	0.560**	-0.327	0.108	-0.364*	-0.197	0.133	-0.221	0.035
Panicle length (cm)			1	0.4232**	0.519**	0.591**	-0.225	0.098	-0.263	-0.035	0.099	-0.138	0.146
SPAD				1	0.517**	0.671**	-0.063	0.083	-0.113	-0.066	0.109	-0.099	0.218
Number of panicles hill^{-1}					1	0.860**	0.014	0.092	-0.001	0.091	0.072	-0.018	0.518**
Number of panicles sqm^{-1}						1	-0.235	0.054	-0.144	-0.084	0.053	-0.080	0.465**
Grain length (mm)							1	0.194	0.520**	0.883**	0.117	0.448**	-0.352
Grain breadth (mm)								1	-0.699**	0.179	0.916**	-0.667**	0.065
Grain L/B ratio									1	0.495**	-0.701**	0.905**	-0.279
Kernel length (mm)										1	0.065	0.538**	-0.257
Kernel breadth (mm)											1	-0.793**	0.118
Kernel L/B ratio												1	-0.284

*, ** Significant at 5% and 1% levels, respectively

Table 3: Phenotypic path coefficients among grain yield and its twelve components in rice (*Oryza sativa* L).

	Days to 50 % flowering	Plant Height (cm)	Panicle length (cm)	SPAD	Number of Panicles hill^{-1}	Number of Panicles sqm^{-1}	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Grain yield hill^{-1} (g)
Days to 50 % flowering	**0.3869**	0.1896	0.1734	0.1748	0.1902	0.2357	-0.1534	-0.016	-0.0933	-0.1075	0.0131	-0.0771	0.5970
Plant height (cm)	-0.0568	**-0.1159**	-0.0918	-0.0593	-0.0294	-0.0650	0.0380	-0.0126	0.0423	0.0229	-0.0154	0.0256	0.0355
Panicle length (cm)	-0.2004	-0.3539	**-0.4471**	-0.1892	-0.2323	-0.2643	0.1007	-0.0441	0.118	0.0159	-0.0445	0.0618	0.1461
SPAD	0.0128	0.0145	0.0120	**0.0283**	0.0147	0.0190	-0.0018	0.0024	-0.0032	-0.0019	0.0031	-0.0028	0.2180
Number of panicles hill^{-1}	0.3997	0.2064	0.4225	0.4208	**0.8131**	0.6998	0.0115	0.0754	-0.0013	0.0742	0.0590	-0.0152	0.5189
Number of panicles sqm^{-1}	-0.1651	-0.1519	-0.1602	-0.1820	-0.2332	**-0.2710**	0.0639	-0.0148	0.0393	0.0228	-0.0146	0.0217	0.4653
Grain length (mm)	0.1153	0.0953	0.0655	0.0185	-0.0041	0.0686	**-0.2907**	-0.0567	-0.1514	-0.2568	-0.0340	-0.1303	-0.3527
Grain breadth (mm)	0.0321	-0.0847	-0.0767	-0.0648	-0.0722	-0.0425	-0.1517	**-0.7781**	0.5443	-0.1397	-0.7132	0.5194	0.0658
Grain L/B ratio	0.2064	0.3119	0.2259	0.0969	0.0014	0.1240	-0.4456	0.5986	**-0.8558**	-0.4241	0.6002	-0.7747	-0.2793
Kernel length (mm)	-0.2323	-0.1650	-0.0298	-0.0559	0.0762	-0.0702	0.7385	0.1501	0.4144	**0.8361**	0.0544	0.4504	-0.2574
Kernel breadth (mm)	-0.0071	-0.0279	-0.0209	-0.0230	-0.0152	-0.0113	-0.0246	-0.1923	0.1471	-0.0137	**-0.2098**	0.1666	0.1188
Kernel L/B ratio	0.1055	0.1171	0.0733	0.0528	0.0099	0.0425	-0.2375	0.3537	-0.4797	-0.2855	0.4207	**-0.5299**	-0.2844

*, ** Significant at 5% and 1% levels, respectively; Diagonals =Direct effects (bold), Off-diagonals = Indirect effects (normal)

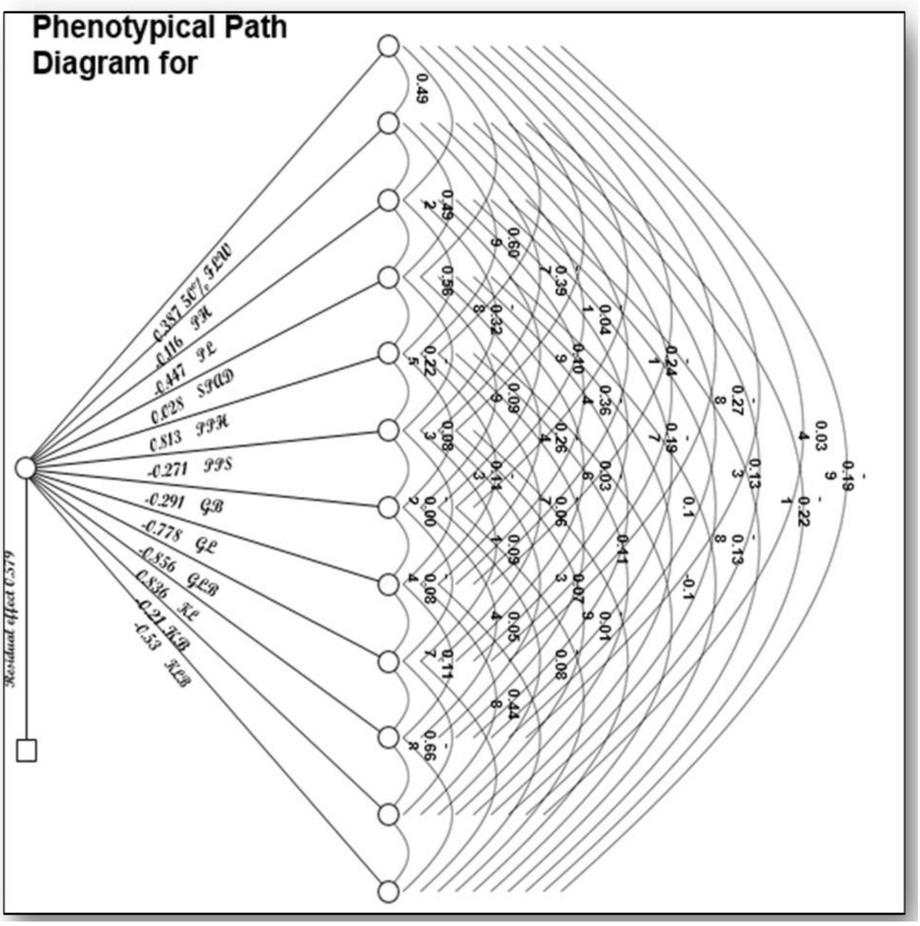

Fig. 1. Phenotypic Path diagram of yield and yield components in rice over three environments.

FUTURE SCOPE

The traits which were showing highly significant positive correlation and also high direct positive effect on grain yield can be used to select the superior lines which are suitable for the all the location. The selected plants can be subjected to genetic analysis to understand the genes expressing the particular traits.

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Conflicts of Interests. None.

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