Path analysis in hybrid rice (*Oryza sativa* L.) over salt environments

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ABSTRACT

Path analysis was studied for eleven traits in 49 rice genotypes in three different salt prone environments to know the association of characters on yield and yield attributing components. The correlation and path analysis values revealed the association of productive tillers plant^{-1}, leaf proline content and chlorophyll stability index with yield in almost all the environments under pooled condition. The direct and indirect effect showed the influence of productive tillers plant^{-1} and chlorophyll stability index through almost all the traits related to yield and hence its importance in the selection of salt tolerant rice genotypes.

Key words: *Oryza sativa L., path, salinity, association analysis*

Grain yield in rice is governed by poly genes. Knowledge on the correlation between yield and its component characters can help improve the efficiency of selection. Correlation studies permit only a measure of relationship between two traits. Hence, path coefficient analysis becomes necessary as it indicate separation of direct and indirect effects via other related characters by partitioning through correlation coefficients, that helps in designing appropriate breeding procedure for evolving high yielding genotypes. The present investigation was conducted in three different salt affected environments to study the direct and indirect effects of yield contributing and salt tolerant traits on single plant yield.

Correlation and path analysis was carried out using 36 rice hybrids along with their parents raised in a randomized block design during wet season 2002 at three different salt affected zones namely Anbil Dharmalingam Agricultural College and Research Institute, Trichy (E_1) (soil and irrigation water EC- 7.25 and 1.84 ds/m); Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal (E_2) (EC- 4.81 and 0.86 ds/m) and a farmer's field in Konthagai-Elanthakulum, Madurai (E_3) (EC- 4.26 and 2.38 ds/m). Observations were made in five randomly selected plants for eleven different yield and salt tolerant traits. Path coefficient analysis was carried out following the method suggested by Dewey and Lu (1959) for partitioning the correlation coefficients into direct and indirect effects.

The genotypic correlation coefficients of different components with seed yield were partitioned into direct and indirect effects and the results were presented in the Table 1. The days to 50% flowering showed positive and non significant association with single plant yield in E_3 (0.098). its direct influence on yield was high in E_1 (0.384) followed by E_3 (0.143) whereas, the indirect effect of this trait over yield through other traits was negative and low in all the environment except in 100 grain weight (0.212), leaf proline content (0.163) and Chlorophyll stability index in E_1 (0.382). The plant height had negative and significant association with yield in all the environments indicating less importance of this trait in selection process. Whereas its direct and indirect effects showed its influence on yield via other traits under different locations. The direct effect was high and positive in E_1 (0.858) and E_2 (0.299). Whereas, the indirect effect of this trait on yield through productive tillers plant^{-1} (0.255), number of grains panicle^{-1} (0.354), spikelet fertility (0.174), Na^+:K^+ ratio (0.127)and chlorophyll stability index (0.157) were moderate to high.

The genotypic correlation values showed that the productive tillers plant^{-1} had significant positive relationship with single plant yield in all the environments *viz.*, E_1 (0.491), E_2 (0.803), E_3 (0.749) and pooled (0.917).

Table 1. Direct and indirect effects of different characters on yield over environments

Character	Envt.	DFF	PH	PT	PL	NGP	SF	100 GW	LPC	Na^+: K^+ ratio	CSI	Genotypic correlation
Days to 50 per cent flowering (DFF)	E_1	**0.384**	0.010	-0.007	-0.023	-1.216	0.105	0.212	0.163	-0.188	0.381	-0.179
	E_2	**0.069**	0.005	-0.068	-0.021	-0.012	-0.001	-0.001	0.005	-0.015	-0.013	-0.053
	E_3	**0.142**	0.001	-0.031	0.020	0.030	-0.004	0.001	-0.043	-0.002	-0.014	0.098
	Pooled	**0.045**	0.039	-0.363	-0.072	0.075	-0.010	-0.009	0.081	0.114	0.011	-0.088
Plant height (PH)	E_1	0.004	**0.858**	0.255	-0.009	0.354	0.173	-2.213	0.076	0.127	0.156	-0.216*
	E_2	0.009	**0.034**	-0.325	-0.015	0.000	-0.002	-0.002	-0.001	-0.011	0.066	-0.249*
	E_3	-0.001	**-0.178**	-0.079	0.019	-0.015	0.027	-0.006	0.009	-0.010	0.071	-0.164
	Pooled	0.006	**0.299**	-0.710	0.007	0.003	-0.020	-0.077	-0.064	0.050	0.003	-0.506*
Productive tillers /plant (PT)	E_1	0.001	-0.097	**-2.251**	0.002	0.411	-0.539	3.039	0.091	0.251	-0.418	0.491*
	E_2	-0.006	-0.014	**0.759**	0.001	-0.004	0.001	0.001	-0.023	-0.084	0.173	0.803*
	E_3	-0.014	0.044	**0.322**	0.005	0.049	-0.031	0.009	0.141	0.025	0.197	0.749*
	Pooled	-0.032	-0.417	**0.509**	0.498	-0.056	-0.094	0.306	-0.576	0.877	-0.096	0.917*
Panicle length (PL)	E_1	0.145	0.136	0.085	**-0.061**	-0.675	-0.375	0.397	-0.053	-0.051	0.149	-0.302*
	E_2	0.022	0.008	-0.006	**-0.066**	-0.024	-0.001	-0.000	0.009	0.031	0.026	-0.002
	E_3	0.041	-0.049	0.022	**0.071**	0.065	-0.030	0.001	0.081	0.007	0.084	0.294*
	Pooled	0.056	-0.036	-3.258	**-0.060**	0.159	0.139	0.285	1.028	1.096	-0.040	-0.771*
Number of grains/ panicle(NGP)	E_1	0.151	-0.098	0.301	-0.013	**-3.075**	0.961	1.649	0.019	-0.230	0.235	-0.100
	E_2	0.009	0.000	0.036	-0.017	**-0.093**	0.002	0.001	0.002	-0.103	0.187	0.024
	E_3	0.030	0.020	0.113	0.033	**0.140**	-0.099	0.004	0.101	0.006	0.097	0.449*
	Pooled	0.028	0.008	-0.233	-0.076	**0.123**	-0.028	-0.011	-0.033	-0.004	0.030	-0.198
Spikelet fertility(SF)	E_1	0.020	0.076	0.625	0.011	1.521	**1.942**	-1.095	-0.144	0.054	0.123	0.092
	E_2	-0.005	-0.004	0.068	0.005	-0.016	**0.016**	-0.0003	-0.016	0.006	0.172	0.226*
	E_3	0.002	0.022	0.045	0.009	0.062	**-0.223**	-0.000	0.097	0.024	0.088	0.130
	Pooled	-0.003	-0.043	-0.340	0.058	-0.024	**0.141**	0.006	0.162	0.022	-0.009	-0.029
100 grain weight(100GW)	E_1	-0.018	0.433	1.561	0.005	1.156	0.485	**-4.383**	0.058	-0.221	0.818	-0.103
	E_2	0.011	0.016	-0.084	-0.001	0.009	0.001	**-0.005**	-0.008	-0.020	0.099	0.016
	E_3	-0.002	-0.021	-0.055	-0.001	-0.011	-0.001	**0.054**	-0.003	0.001	0.012	-0.026
	Pooled	0.001	0.088	-0.597	0.065	0.005	-0.003	**0.261**	-0.038	0.017	0.007	-0.192
Leaf proline content(LPC)	E_1	0.070	0.074	-0.234	0.003	-0.066	-0.319	-0.290	**0.880**	-0.183	0.456	0.391*
	E_2	-0.005	0.001	0.260	0.009	0.003	0.004	-0.001	**-0.068**	-0.041	0.042	0.204*
	E_3	-0.018	-0.005	0.138	0.017	0.043	-0.066	0.001	**0.329**	0.073	0.174	0.687*
	Pooled	-0.010	0.054	0.837	0.174	0.011	-0.065	-0.028	**-0.350**	-0.031	0.004	0.597*
Na^+: K^+ ratio	E_1	0.131	-0.196	1.023	-0.005	-1.278	-0.192	-1.752	0.292	**0.553**	0.922	-0.503*
	E_2	-0.013	-0.005	-0.759	-0.024	0.114	0.001	0.001	0.034	**-0.085**	1.240	0.505*
	E_3	0.006	-0.026	-0.119	-0.007	-0.013	0.079	0.001	-0.348	**0.069**	-0.135	-0.494*
	Pooled	-0.013	-0.039	-1.180	0.172	0.001	-0.008	0.011	-0.028	**0.378**	0.039	-0.667*
Chlorophyll stability index (CSI)	E_1	-0.088	-0.081	-0.572	0.005	0.439	-0.145	2.182	-0.244	0.310	**-1.647**	0.158
	E_2	-0.001	0.004	0.232	-0.003	-0.030	0.005	-0.001	-0.005	-0.185	**0.566**	0.581*
	E_3	-0.006	-0.036	0.181	0.017	0.039	-0.056	-0.001	0.164	0.027	**0.349**	0.679*
	Pooled	-0.006	-0.001	0.636	-0.030	-0.049	0.016	0.025	0.019	0.193	**-0.077**	0.725*
Residual effect	E_1 = 0.619			E_2 = 0.502			E_3 = 0.399			Pooled = 0.751		

Direct effects are in bold

Its direct effect on yield was also high in E_2 (0.760), pooled (0.509) and E_3 (0.323). The indirect effect through other component traits was also high *viz*., panicle length (0.499), 100 grain weight (0.306), Na^+:K^+ ratio (0.878) in pooled condition, number of grains panicle^{-1} (0.411), 100 grain weight (3.040), Na^+:K^+ ratio (0.252) in E_1 and moderate value for chlorophyll stability index in E_2 (0.174) and E_3 (0.177). Except in E_3 (0.294), panicle length registered showed negatively significant association on single plant yield in all the environments. The direct effect of this trait on yield is negligible in all the environments. The indirect influence of this trait via some other trait on yield is moderate in some of the environment. Hence the importance of this trait while selecting a salt tolerant genotype is not much.

The trait number of grains panicle^{-1} registered a high and positive correlation value in E_3 (0.449) alone showed the selection of genotypes based on this trait will be good in that particular environment. The direct effect also showed the same trend. Whereas, the indirect influence of this trait via some other component characters such as productive tillers plant^{-1} (0.301), spikelet fertility (0.961) and chlorophyll stability index (0.235) on yield showed the importance of this traits inclusion in the selection of genotypes in E_1 is found good. Even though the 100 grain weight not showed any significant correlation with single plant yield, its indirect influence through plant height (0.433), productive tillers plant^{-1} (1.561), number of grains panicle^{-1} (1.157), spikelet fertility (0.485) and chlorophyll stability index (0.823) on yield was high in E_1, keeping this traits as criteria for selection will give better genotypes to that particular environment.

The leaf proline content was one of the traits related to salt tolerance showed highly significant and positive association with single plant yield in all the environments (0.391, 0.204, 0.687 and 0.597). The direct effects on yield in E_1 (0.881) and E_3 (0.331) showed its importance as selection criteria. Apart from direct effect it also had indirect influence via productive tillers plant^{-1} in E_2 (0.261) and pooled (0.837) and chlorophyll stability index (0.456) I E_1 on single plant yield. Na^+:K^+ ratio showed positive and highly significant association with yield in E_2 (0.505) and pooled (0.515) condition. The direct effect of this trait on yield also showed that selection of genotypes based on this trait will be good to get a salt tolerant genotypes with good yield potential in E_1 (0.553) and pooled condition (0.379). Along with direct effect, it also indirectly influences the yield through productive tillers plant^{-1} (1.023), leaf proline content (0.293) and chlorophyll stability index (0.923) in E_1, chlorophyll stability index (1.240) in E_2 and productive tillers plant^{-1} (1.181) in pooled condition. Except in E_1, the chlorophyll stability index showed a positive and high correlation with yield. The direct effect was positive and high E_3 (0.350). It also indirectly influences the yield via productive tillers plant^{-1} (0.636) in pooled condition, number of grains/ panicle (0.439), 100 grain weight (2.182) and Na^+:K^+ ratio (0.310) in E_1.

The present investigation gives an idea about the association of characters for the improvement of single plant yield in salt affect areas. Among the traits studied, the productive tillers/plant, leaf proline content and chlorophyll stability index showed very high association with yield in almost all the environments and pooled condition (Sathya *et al*. 1999; Venkataramana and Shailaja Hittalmani, 2000; Michael Gomez and Rangasamy, 2002). The pooled environment correlation and path values are collective performance of genotypes in all the salt affect areas studied. Based on that the direct effect recorded in path analysis showed that, except days to 50% flowering, leaf proline content and chlorophyll stability index all other traits registered their direct influence on yield. The results indicated that, in the selection programme of salt tolerant rice hybrids or variety, productive tillers plant^{-1} and chlorophyll stability index should be given importance because of their high association with other traits on improvement of high yielding salt tolerant rice genotypes.

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