



Correlation and Path Analyses on Yield and Drought Tolerant Attributes Under Drought Stress in Rice (*Oryza sativa* L.)

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ABSTRACT

Correlation and path coefficient analyses were undertaken on 15 yield attributing and drought tolerant traits utilizing 37 genotypes in rice. Filled grains/ panicle, grains/panicle, relative water content and chlorophyll content index expressed highly positive correlation with grain yield. Selection based on chlorophyll content index and relative water content will bring about simultaneous improvement of all other drought tolerant traits. Path analysis revealed that chlorophyll content index, relative water content and grains/ panicle were major yield contributing traits to be given selection pressure for improving yield in drought stress situation.

Key words : Correlation, Drought, Path Analysis, Rice

Drought is a major production constraint reducing crop yield in water-limited area. This situation becomes precarious year after year in terms of both area grown and severity of stress. Hence, attention is now focussed on genetic improvement of rice for drought tolerance coupled with high yield.

MATERIAL AND METHODS

The germplasm known to have drought tolerance was obtained from various sources viz., Central Rice Research Institute (CRRI) Cuttack, National Bureau of Plant Genetic Resources (NBPGR) Hyderabad and Directorate of Rice Research (DRR), Rajendranagar Hyderabad, and evaluated during *kharif* 2006 at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Station Maruteru, West Godavari. The experiment was laid out with two replications in randomized block design. The plot size was 5x5m and the material was sown adopting inter- and intra-row spacing of 10x10cm. Plants were watered daily up to 40 DAS and later stress was imposed by not giving irrigation for fifteen days at maximum tillering stage and at weekly intervals at flowering stage. Observations were recorded on five plants selected at random or on plot basis in each entry in each replication. For recording panicle characters and grain quality characters, five mother panicles one from each of the above five plants were used. Correlation (Al-Jibouri *et al.*, 1959) and path coefficient analysis (Dewey and Lu, 1959) were carried out using mean values.

RESULTS AND DISCUSSION

The genotypic correlation of yield and drought related attributes with grain yield are presented in Table 1. In the present investigation, all the characters except days to 50% flowering, plant height, leaf water potential and stomatal conductivity showed positive and significant association with grain yield as also reported by Yogameenakshi *et al.* (2004) for days to 50% flowering; Nadarajan and Kumaravelu (1994) for plant height; Sharma *et al.* (2003) for leaf water potential.

Plant height exhibited positive and significant correlation with root length, root volume, relative water content; confirming the results of Michael Gomez and Rangaswamy (2002) for root length. Ear bearing tillers exhibited positive significant correlation with panicle length, filled grains per panicle, length and breadth ratio and relative water content. Grains per panicle exhibited positive significant correlation with days to 50% flowering, ear bearing tillers, panicle length, filled grains per panicle, test weight, root length, relative water content and chlorophyll content index. Panicle length exhibited positive and significant correlation with ear bearing tillers, filled grains per panicle and grains per panicle in accordance with Rao and Shrivastav (1999) for number of grains per panicle.

Grains per panicle exhibited positive significant correlation with days to 50% flowering, ear bearing tillers, panicle length, filled grains per panicle, test weight, root length, relative water content and chlorophyll content index as reported

Table 1. Phenotypic (above diagonal) and genotypic (below diagonal) correlations for 15 characters in 37 rice (*Oryza sativa* L.) genotypes.

Genotypes	Plant height	Days to flowering	Ear bearing tillers plant ⁻¹	Panicle length	Filled grains / panicles	Grains/ panicle weight	Test weight	L/b ratio	Root length	Root volume	Leaf water potential	Stomatal conductivity (mmol)	Relative water content	Chlorophyll content index	Yield/ m ²
Plant height	—	0.04	-0.18	0.15	0.19	0.16	0.19	-0.03	0.51**	0.53**	-0.06	0.43**	0.36**	0.14	-0.00
Days to 50% flowering	0.04	—	0.00	0.07	0.12	0.23*	0.20	-0.05	-0.08	-0.17	0.26**	0.41**	-0.21	0.07	-0.13
Ear bearing tillers plant ⁻¹	-0.25*	0.00	—	0.32*	0.39**	0.37**	0.20	0.35*	0.11	-0.09	-0.38**	-0.17	0.37**	0.10	0.42**
Panicle length	0.22*	0.10	0.42**	—	0.63**	0.65*	0.10	0.18	0.12	0.04	-0.04	-0.03	0.19	0.21	0.28*
Filled grains per panicle	0.19	0.15	0.49**	0.84*	—	0.80*	0.27*	0.01	0.28*	0.21	-0.28*	-0.21	0.36**	0.30**	0.55**
Grains per panicle	0.20	0.25*	0.53**	0.72*	1.00**	—	0.36**	-0.01	0.26*	0.22	-0.23*	-0.14	0.38**	0.39**	0.57**
Test weight	0.19	0.20	0.23*	0.13	0.31**	0.38**	—	0.11	0.23*	0.44**	-0.25*	-0.03	0.28*	0.36**	0.36**
L/b ratio	-0.04	-0.05	0.44**	0.19	0.02	-0.00	0.12	—	0.11	0.01	-0.13	-0.12	0.16	-0.10	0.01
Root length	0.58**	-0.08	0.19	0.16	0.35**	0.31*	0.25*	0.11	—	0.62**	-0.61	-0.63**	0.52**	0.25*	0.45**
Root volume	0.57**	-0.18	-0.09	0.03	0.27*	0.21	0.46**	0.01	0.70**	—	-0.44	-0.50**	0.46**	0.37**	0.39**
Leaf water potential	-0.08	0.27*	-0.52*	-0.04	-0.30**	-0.25*	-0.27*	-0.14	-0.65**	-0.47*	—	0.53**	-0.55**	-0.27*	-0.64*
Stomatal conductivity	-0.46	0.42**	-0.22	-0.03	-0.24*	-0.13	-0.03	-0.12	-0.68*	-0.53*	0.54**	—	-0.81**	-0.30*	-0.50*
Relative water content	0.38**	-0.22	0.45**	0.22	0.42**	0.43*	0.30**	0.16	0.58**	0.50**	-0.58**	-0.86**	—	0.39**	0.61**
Chlorophyll content index	0.14	0.07	0.08	0.21	0.40**	0.42*	0.39**	-0.11	0.29*	0.40**	-0.33**	-0.32**	0.42**	—	0.56**
Yield/ m ²	-0.00	-0.13	0.50**	0.34**	0.67**	0.63*	0.37**	0.01	0.41**	0.41**	-0.67*	-0.52**	0.64**	0.59**	—

*Significant at 5% level

**Significant at 1% level

Table 2. Estimation of genotypic and phenotypic direct and indirect effects of yield components on yield/m² in rice (*Oryza sativa* L.)

Genotypes	Plant height	Days to 50% flowering	Ear bearing tillers	Panicle length	Filled grains panicle ⁻¹	Grains panicle ⁻¹	Test weight	L/b ratio	Root length	Root volume	Leaf water potential	Stomatal conductivity	Relative water content	Chlorophyll content index
Plant height G	-3.699	-0.016	0.095	-0.084	-0.073	-0.075	-0.073	0.015	-0.214	-0.210	0.031	0.169	-0.141	-0.055
P	-0.331	-0.014	0.062	-0.051	-0.065	-0.055	-0.066	0.012	-0.170	-0.177	0.023	0.143	-0.121	-0.048
Days to 50% G	0.003	0.008	0.001	0.008	0.001	0.002	0.002	-0.004	-0.007	-0.001	0.002	0.003	-0.001	0.006
P	-0.002	-0.043	-0.001	-0.003	-0.005	-0.010	-0.009	0.002	0.003	0.007	-0.011	-0.017	0.009	-0.003
Ear bearing G	0.051	-0.006	-0.199	-0.085	-0.098	-0.107	-0.047	-0.088	-0.038	0.018	0.103	0.044	-0.090	-0.017
P	-0.006	0.001	0.034	0.011	0.013	0.012	0.007	0.012	0.004	-0.003	-0.013	-0.006	0.013	0.003
Panicle G	-0.015	-0.006	-0.028	-0.066	-0.056	-0.048	-0.008	-0.013	-0.011	-0.002	0.003	0.002	-0.014	-0.014
P	-0.005	-0.002	-0.011	-0.034	-0.022	-0.022	-0.003	-0.006	-0.042	-0.001	0.001	0.001	-0.007	-0.007
Filled grains G	0.105	0.080	0.358	0.446	0.526	0.529	0.165	0.011	0.185	0.146	-0.160	-0.130	0.222	0.215
P	0.034	0.021	0.068	0.109	0.173	0.139	0.047	0.003	0.048	0.037	-0.049	-0.036	0.063	0.053
Grains G	0.014	0.017	0.037	0.050	0.069	0.068	0.026	-0.003	0.022	0.014	-0.017	-0.009	0.030	0.029
P	0.039	0.055	0.088	0.156	0.190	0.237	0.086	-0.002	0.062	0.054	-0.056	-0.034	0.091	0.092
Panicle ¹ G	0.029	0.030	0.035	0.019	0.046	0.057	0.148	0.018	0.038	0.068	-0.040	-0.005	0.045	0.057
P	0.018	0.018	0.018	0.009	0.024	0.032	0.090	0.010	0.021	0.040	-0.023	-0.003	0.025	0.032
L/b ratio G	0.006	0.007	-0.006	-0.002	-0.003	0.001	-0.002	-0.013	-0.002	-0.002	0.002	0.002	-0.002	0.001
P	0.002	0.004	-0.026	-0.013	-0.001	0.008	0.008	-0.072	-0.008	-0.001	0.010	0.009	-0.011	0.007
Root length G	-0.051	0.007	-0.017	-0.015	-0.031	-0.028	-0.023	-0.010	-0.088	-0.062	0.058	0.060	-0.051	-0.025
P	0.039	-0.006	0.008	0.009	0.021	0.019	0.018	0.008	0.076	0.047	-0.046	-0.048	0.039	0.019
Root volume G	-0.013	0.004	0.002	-0.007	-0.006	-0.005	-0.010	-0.003	-0.016	-0.023	0.011	0.012	-0.011	-0.009
P	0.028	-0.009	-0.005	0.002	0.011	0.012	0.023	0.007	0.033	0.053	-0.024	-0.027	0.025	0.020
Leaf water G	0.033	-0.106	0.201	0.019	0.117	0.098	0.106	0.057	0.253	0.183	-0.386	-0.212	0.226	0.128
P	0.014	-0.057	0.083	0.009	0.611	0.051	0.055	0.029	0.132	0.094	-0.213	-0.114	0.117	0.059
Stomatal G	0.162	-0.148	0.079	0.012	0.088	0.049	0.012	0.046	0.240	0.187	-0.193	-0.353	0.305	0.115
P	0.096	-0.092	0.040	0.008	0.047	0.032	0.007	0.029	0.141	0.111	-0.119	-0.222	0.181	0.067
Relative G	0.027	-0.015	0.032	0.016	0.030	0.031	0.022	0.011	0.042	0.036	-0.041	-0.016	0.071	0.030
P	0.036	-0.021	0.037	0.019	0.036	0.038	0.028	0.016	0.052	0.046	-0.054	-0.081	0.995	0.040
Chlorophyll G	0.021	0.011	0.012	0.030	0.058	0.060	0.055	-0.016	0.041	0.056	-0.047	-0.046	0.060	0.141
P	0.034	0.018	0.024	0.050	0.072	0.091	0.085	-0.023	0.060	0.087	-0.065	-0.070	0.092	0.234
Correlation G	-0.003	-0.134	0.504**	0.340**	0.671**	0.633**	0.373**	0.017	0.451**	0.411**	-0.675**	-0.524**	0.646**	0.598**
P	-0.001	-0.130	0.422**	0.283**	0.558**	0.580**	0.361**	0.018	0.451**	0.396**	-0.643**	-0.507**	0.618**	0.570**

G = Genotypic P = Phenotypic Genotypic residual effect = 0.378 Phenotypic residual effect = 0.472

** significant at 1% level Bold and diagonal values indicate direct effects

by Das *et al.* (2005) for chlorophyll content index. Root length exhibited positive and significant correlation with plant height, filled grains per panicle, grains per panicle, test weight, root volume, relative water content and chlorophyll content index conforming to the results of Sinha *et al.* (2000). Relative water content and chlorophyll content index expressed positive and significant inter-correlation among themselves and also with filled grain per panicle, grains per panicle, test weight, root length, root volume and chlorophyll content in line with Yogameenakshi *et al.* (2004). Hence, the characters to be given importance in selection are number of grains per panicle, chlorophyll content index and relative water content as they exhibited highly positive correlation with grain yield and also a positive inter-correlation among themselves. Selection based on chlorophyll content index and relative water content is highly suitable for drought tolerance breeding, as it will bring about simultaneous improvement of all other drought tolerant traits.

Partitioning the genotypic correlation coefficient into direct and indirect effects through path analysis (Table 2) revealed that relative water content, grains per panicle, chlorophyll content index and ear bearing tillers per plant exhibited high direct effects on grain yield, in conformity with Somonte *et al.*, (1998) for grains panicle⁻¹, Yogameenakshi *et al.*, (2004) for chlorophyll stability content index. The results indicated the high direct effect of chlorophyll content index was mainly due to its high indirect effects through grains per panicle. Likewise, the traits relative water content and grains per panicle showed high indirect effects *via* chlorophyll content index. Other traits also showed low to moderate indirect effects on grain yield through number of grains/ panicle, chlorophyll content index and relative water content.

Hence, number of grains per panicle, chlorophyll content index and relative water content are major yield contributing traits under drought condition and have to be given importance in selection process for improving the yield under drought stress conditions in rice.

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