INTERRELATIONSHIP AND PATH ANALYSIS OF DIFFERENT TRAITS UNDER COASTAL SALINITY IN RICE (*ORYZA SATIVA* L.)

Vanave P.B*., Vaidya G.B., Dapke J.S., Narwade A.V. and Jadhav B.D.

Department of Genetics and Plant Breeding, N. M. College of Agriculture N.A.U.
Navsari, Gujarat-396 450
Email: pbvanave@gmail.com

Received-02.11.2015, Revised-10.11.2015

Abstract: An investigation was carried out using 17 rice genotypes for grain yield and contributing characters to understand the association among yield components and their direct and indirect influence on the grain yield under saline condition. Analysis of variance revealed considerable variability among the genotypes for all the characters. Character association of the yield and its attributing traits revealed that significant positive association of grain yield plant^{-1} with productive tillers hill^{-1}, length breadth ratio, straw yield, harvest index, number of grains panicle^{-1} and 1000-grain weight. The salinity related traits *viz.*, Na+: K+ ratio and chlorophyll content as well as days to 50% flowering expressed significant negative association with grain yield plant^{-1}. Investigation on path coefficient analysis showed that straw yield plant^{-1} had highest direct positive effect on grain yield plant^{-1} followed by harvest index, plant height, Na/K ratio, days to 50% flowering, 1000 grain weight, days to maturity, productive tillers hill^{-1}, number of grains panicle^{-1}, chlorophyll content. Hence, selection based on these traits could help to bring simultaneous improvement of yield and yield attributes characters under saline condition.

Keywords: Chlorophyll, Grain, Rice, Soil

INTRODUCTION

In India nearly 9.38 million ha area is occupied by salt-affected soils out of which 5.5 million ha are saline soils (including coastal) and 3.88 million ha alkali soils (IAB, 2000). In Tamil Nadu, out of 4.7 lakh hectares of salt affected soils, about 3.0 lakh hectares are in inland and 1.7 lakh hectares are confined to coastal areas. In inland salt affected soils, about 2.0 lakh hectares are alkali and 1.0 lakh ha are saline in nature. Grain yield is a polygenically controlled character with complex in inheritance Selvaraj *et al*. (2011). It is influenced by number of component characters and environment either directly or indirectly. Hence, selection for one component may simultaneously affect related traits in a favorable direction. Therefore, identifying the characters, which are closely related and which have contributed to grain yield becomes highly essential Rangare *et al.* (2012). The knowledge on association among different traits with yield and interrelationship is essential to improve the selection efficiency. Keeping this objective in view, the present study was conducted to observe any influence on correlations among plant attributes under saline environment.

MATERIAL AND METHOD

The material for the present study consisted of 17 genotypes of rice. Field experiment was conducted at Coastal Soil Salinity Research Station, Danti, Gujarat. The experiment laid out in Randomized Complete Block Design (RCBD) with three replications. All cultural practices followed as per the package of practices adopted for irrigated rice. Soil samples from all the three replications collected and they analyzed for parameters such as pH, electrical conductivity using standard procedures.

Observations were recorded on five randomly selected plants in each replication for days to 50% flowering, productive tillers hill^{-1}, plant height (cm), panicle length (cm), number of grains panicle^{-1}, spikelet fertility (%), days to maturity, grain yield plant^{-1}, straw yield plant^{-1}, 1000-grain weight (gm), L/B ratio, harvest index (%), K^+/Na^+ ratio, proline content (ug g^{-1} fw) and chlorophyll content (mg g^{-1} fw). Correlation analysis was computed as per Karl Pearson (1932) and path coefficient analysis was carried out as suggested by Wright (1921).

RESULT AND DISCUSSION

Correlation between characters: In the present study, grain yield plant^{-1} showed positive and significant correlation with six traits viz., productive tillers hill^{-1}t (0.59), length breadth ratio (0.583), straw yield plant^{-1} (0.43), harvest index (0.34), number of grains panicle^{-1} (0.30) and 1000-grain weight (0.28). Genotypic correlations between yield attributes were given in (Table 1). These results were in agreement with the earlier findings of Selvaraj et al. (2011) and Premkumar *et al.* (2015) for all the traits. The salinity related trait chlorophyll content expressed significant negative association grain yield plant^{-1} whereas, proline content and Na/K ratio, showed negatively non-significant association with grain yield plant^{-1}. Significant negative correlation recorded for chlorophyll content close conformity with the results of Hussein *et al.* (2007) for chlorophyll content and Arunroj *et al.* (2004) for shoot Na+: K+ ratio. Since these two traits had negative association with grain yield, selection of

*Corresponding Author

plants with short duration will alleviate salt related problems. Similarly, selection of plants with less crop chlorophyll a/b ratio and shoot Na+: K+ ratio might help for salinity tolerance (Hussein *et al.* 2007).

Knowledge on inter-correlation between yield components traits may facilitate breeder to decide upon the intensity and direction of selection pressure to be given on related traits for the simultaneous improvement of these traits. In light of the above, panicle length had positive and significant association with spikelet fertility, days to 50% flowering, proline content, total chlorophyll content. It suggests that priority should be given to these traits while making selection for yield improvement. This was in confirmation with the earlier findings of Babu *et al.* (2006) and Mahmood *et al.* (2009). Number productive tillers hill^{-1} expressed positive and significant inter-correlation as that of spikelets panicle^{-1}, length breadth ratio and harvest index. Spikelet fertility percent registered significant positive inter-association with chlorophyll content, plant height, proline content, test weight and Na+: K+ ratio. Similar findings were also reported by Shanthi *et al.* (2011). These above correlations also indicated that by selecting any one of the above traits might be useful to improve the grain yield along with salinity tolerance. Babu *et al.* (2006) also reported the positive association with the above traits. Na+: K+ ratio and chlorophyll content.

It could be concluded from the above discussion that six traits viz., productive tillers hill^{-1}, length breadth ratio, straw yield, harvest index, number of grains panicle^{-1} and 1000-grain weight might be given importance in selection of promising genotypes coupled with salinity tolerance. All these traits exhibited positive significant association with grain yield plant^{-1} and appeared to be primary yield contributing traits and could be relied upon.

Path coefficient analysis

Path analysis furnishes information of influence of each contributing trait to yield under salinity stress directly as well as indirectly and enables the breeders to rank the genetic attributes according to their contribution.

Path coefficient analysis was carried out both at phenotypic and genotypic levels considering the grain yield plant^{-1} as dependent character and yield attributes as independent characters. Each component has two-path action *viz*., direct effect on yield and indirect effects through component characters, which were not revealed by correlation studies. The phenotypic and genotypic correlations were partitioned into direct and indirect effects on grain yield plant^{-1} and the data is presented in Table 2. Among the characters studied at genotypic level, straw yield plant^{-1} had highest direct positive effect on grain yield plant^{-1} followed by harvest index, plant height, Na/K ratio, days to 50% flowering, 1000 grain weight, days to maturity, productive tillers hill^{-1}, number of grains panicle^{-1}, chlorophyll content similar finding also observed by Gopikannan and Ganesh (2013) for harvest index, plant height, Na/K ratio, days to 50 per cent flowering, 1000 grain weight, days to maturity, productive tillers hill^{-1}, number of grains panicle^{-1}, chlorophyll content. The highest direct negative contribution to the grain yield plant^{-1} was recorded by proline followed by spikelet fertility (%), panicle length and L/B ratio present finding conformity with Shanthi *et al.* (2011) and Gopikannan and Ganesh (2013). First three characters *i.e.* straw yield plant^{-1}, harvest index and plant height having maximum direct impact on grain yield plant^{-1} are seen to have closely related to each other. The residual effect of 0.04 is low since the traits contributed more to the variability in grain yield of rice. All these characters govern the growth rate and biomass production of the crop. In breeding for salinity tolerance, the dilution of salts by increasing in height of genotypes followed by biomass is one of the proved mechanisms behind salinity tolerance. Therefore, the maximum focus should be on selection of plant types those are having vigorous growth and more biomass to ensure prolong source and sink.

From the foregoing discussion of association studies in the present set of breeding materials pointed out that, there is much scope for selecting high yielding genotypes with salinity tolerance in rice under salt stress condition, if selection pressure is exerted on productive tillers hill^{-1}, length breadth ratio, straw yield, harvest index, number of grains panicle^{-1} and 1000-grain weight in positive direction and low Na+: K+ ratio and chlorophyll content towards negative direction for yield improvement in salinity tolerance breeding programme. This was in accordance with Shanthi *et al.* (2011).

Table 1. Genotypic correlation coefficients between yield and yield attributes in rice

Traits	CHL	DFF	GY	PH	PRO	SPF	NGP	TW	LB	DM	HI	NA/K	SY	PL
DFF	0.206^{NS}													
GY	-0.445^{**}	-0.536^{**}												
PH	0.347^{*}	-0.319^{*}	-0.264^{NS}											
PRO	0.620^{**}	0.297^{*}	-0.013^{NS}	0.106^{NS}										
SPF	0.854^{**}	-0.014^{NS}	-0.058^{NS}	0.273^{*}	0.913^{**}									

NGP	0.020^{NS}	0.044^{NS}	0.302*	-0.483**	0.282*	-0.065^{NS}								
TW	0.296*	0.113^{NS}	0.280*	-0.174^{NS}	0.452**	0.561**	-0.108^{NS}							
LB	-0.329*	-0.385**	0.583**	-0.363**	-0.431**	-0.499**	0.333*	-0.097^{NS}						
DM	-0.268^{NS}	0.567**	-0.227^{NS}	-0.514**	0.067^{NS}	-0.362**	0.336*	-0.439**	-0.280*					
HI	-0.333*	0.040^{NS}	0.348*	0.045^{NS}	-0.084^{NS}	-0.310*	-0.053^{NS}	0.116^{NS}	0.003^{NS}	0.035^{NS}				
NA/K	0.624**	0.247^{NS}	-0.235^{NS}	-0.105^{NS}	0.693**	0.914**	0.180^{NS}	0.356**	-0.391**	0.116^{NS}	-0.369**			
SY	-0.015^{NS}	-0.471**	0.434**	-0.247^{NS}	0.070^{NS}	0.237^{NS}	0.259^{NS}	0.090^{NS}	0.478**	-0.223^{NS}	-0.688**	0.159^{NS}		
PL	0.361**	0.399**	-0.068^{NS}	0.078^{NS}	0.444**	0.409**	0.197^{NS}	-0.029^{NS}	0.034^{NS}	-0.027^{NS}	-0.079^{NS}	0.472**	0.011^{NS}	
PT	0.074^{NS}	-0.446**	0.598**	0.195^{NS}	0.214^{NS}	0.150^{NS}	0.552**	-0.031^{NS}	0.368**	-0.358**	0.342*	-0.178^{NS}	0.150^{NS}	0.208^{NS}

*, ** indicate significance at 0.05 and 0.01 levels, respectively

DFF-days to 50% flowering, **PT**-productive tillers hill^{-1}, **PH**-plant height (cm),**PL**- panicle length (cm),**NGP**-number of grains panicle^{-1}, **SPF**-spikelet fertility (%), **DM**- days to maturity, **GY**-grain yield plant^{-1}, **SY**- straw yield plant^{-1}, **TW**-1000-grain weight (gm), **LB**- L/B ratio, **HI**-harvest index (%),**Na^+/ K^+** ratio, **PRO**- proline content (ug g^{-1} fw) and **CHL-** chlorophyll content (mg g^{-1} fw).

Table 2. Path coefficient analysis showing direct and indirect effect of fourteen causal variables on grain yield per plant of rice.

Traits	CHL	DFF	PH	PRO	SPF	NGP	TW	LB	DM	HI	NA/K	SY	PL	PT	Geno. correlation with grain yield
CHL	**0.007**	0.094	0.248	-0.408	-0.242	0.002	0.133	0.033	-0.101	-0.495	0.330	-0.029	-0.039	0.022	-0.445**
DFF	0.001	**0.457**	-0.228	-0.195	0.004	0.004	0.051	0.038	0.214	0.060	0.130	-0.896	-0.043	-0.133	-0.536**
PH	0.002	-0.146	**0.716**	-0.070	-0.077	-0.047	-0.078	0.036	-0.194	0.067	-0.055	-0.469	-0.008	0.058	-0.264NS
PRO	0.004	0.135	0.076	**-0.658**	-0.258	0.027	0.203	0.043	0.025	-0.126	0.366	0.134	-0.048	0.064	-0.013NS
SPF	0.006	-0.007	0.196	-0.601	**-0.283**	-0.006	0.252	0.049	-0.137	-0.461	0.483	0.450	-0.044	0.045	-0.058NS
NGP	0.000	0.020	-0.346	-0.186	0.019	**0.096**	-0.048	-0.033	0.127	-0.079	0.095	0.493	-0.021	0.165	0.302*
TW	0.002	0.052	-0.125	-0.297	-0.159	-0.010	**0.449**	0.010	-0.166	0.172	0.188	0.171	0.003	-0.009	0.280*
LB	-0.002	-0.176	-0.260	0.284	0.141	0.032	-0.044	**-0.099**	-0.106	0.004	-0.207	0.909	-0.004	0.110	0.583**
DM	-0.002	0.259	-0.368	-0.044	0.102	0.032	-0.197	0.028	**0.377**	0.052	0.061	-0.424	0.003	-0.107	-0.227NS
HI	-0.002	0.018	0.032	0.056	0.088	-0.005	0.052	0.000	0.013	**1.489**	-0.195	-1.308	0.009	0.102	0.348*
NA/K	0.004	0.113	-0.075	-0.456	-0.259	0.017	0.160	0.039	0.044	-0.550	**0.529**	0.303	-0.051	-0.053	-0.235NS
SY	0.000	-0.215	-0.177	-0.046	-0.067	0.025	0.040	-0.047	-0.084	-1.024	0.084	**1.902**	-0.001	0.045	0.434**
PL	0.002	0.182	0.056	-0.292	-0.116	0.019	-0.013	-0.003	-0.010	-0.118	0.249	0.022	**-0.108**	0.062	-0.068NS
PT	0.000	-0.204	0.140	-0.141	-0.042	0.053	-0.014	-0.036	-0.135	0.509	-0.094	0.286	-0.023	**0.298**	0.598**

*, ** indicate significance at 0.05 and 0.01 levels, respectively. Residual effect = 0.04; Diagonal and bold indicates the direct effects

DFF-days to 50% flowering, **PT**-productive tillers hill^{-1}, **PH**-plant height (cm),**PL**- panicle length (cm),**NGP**-number of grains panicle^{-1}, **SPF**-spikelet fertility (%), **DM**- days to maturity, **GY**-grain yield plant^{-1}, **SY**- straw yield plant^{-1}, **TW**-1000-grain weight (gm), **LB**- L/B ratio, **HI**-harvest index (%),**Na^+/ K^+** ratio ,**PRO**- proline content (ug g^{-1} fw) and **CHL-** chlorophyll content (mg g^{-1} fw).

CONCLUSION

Direct yield improvement under salinity stress condition is difficult. Hence, yield improvement in saline environments could be achieved by identifying secondary traits contributing to salt tolerance and selecting for those traits in a breeding programme. Hence, selection on the following secondary traits *viz.*, productive tillers hill^{-1}, length breadth ratio, straw yield, harvest index, number of grains panicle^{-1}and 1000-grain weight, Na+: K+ ratio, proline content and chlorophyll content may be used as reliable criteria for improving yield coupled with salinity tolerance in rice.

REFERENCES

Pearson, K. (1932). Tables for statisticians and biometricians, Stat .J. Biometrics.

Wright, S. (1921). Correlation and causation. *J. Agric. Res*., **20**: 557-585.

Premkumar, R., Gnanamalar, R. P. and Anandakumar, C. R. (2015). Correlation and path coefficient analysis among grain yield and kernel characters in rice (*Oryza sativa* L.) *Electronic J. Plant Bre.*, **6**(1): 288-29. Indian Agriculture in Brief, 27th 2000. Edn., Agri-culture Statistics Division, Ministry of Agriculture, Government of India, New Delhi.

Selvaraj I. C., Nagarajan P. M., Thiyagarajan, Bharathi and Rabindran, R. (2011). Genetic parameters of variability, correlation and path coefficient studies for grain yield and other yield attributes among rice blast disease resistant genotypes of rice (*Oryza sativa* L.). *African J. Biotech.*, **10:** 3322–3334.

Rangare, N. R., Krupakar, A., Ravichandra, K., Shukla, A.K., and Mishra, A.K (2012). Estimation of characters association and direct and indirect effects of yield contributing traits on grain yield in exotic and Indian rice (*Oryza sativa* L.) germplasm. *Int. J. Agri. Sci.*, **2**(1): 54–61.

Arunroj, D. S., Supapoj, N. Theerayut T. and Apichart V. (2004). Relative leaf water content as an efficient method for evaluating rice cultivars for tolerance to salt stress. *Sci. Asia*, **30**(4): 411–415.

Hussein, M. M., Balbaa, L. K. Gaballah, M. S. (2007). Salicylic acid and salinity effect on growth of maize plants. *J. Agri. and Bio. Sci.*, **3**(4):321–328.

Babu, S., Yogammenakshi, P. Sheeba, J. Anbumalarmathi and Rangasamy, P. (2006). Path analysis in hybrid rice (*Oryza sativa* L.) over salt environments. *Oryza*, **43**(3): 238–240.

Shanthi, P., Jebaraj, S. and Geetha, S. (2011). Correlation and path coefficient analysis of some sodic tolerant physiological traits and yield in rice (*Oryza sativa* L.). *Indian J. Agric. Res.*, **45** (3): 201–208.

Mahmood, A., Latif, T. and Khan, M. A. (2009). Effect of salinity on growth, yield and yield components in basmati rice germplasm. *Pak. J. Botany*, **41**(6):3035–3045.

Gopikannan, M. and Ganesh, S. K. (2013). Inter-relationship and path analysis in rice (*oryza sativa* l.) under sodicity. *Indian J. Sci. and Technology*, **6** (9) : 5223-5227.