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A Study on Correlation and Path Analysis for Yield and Yield Components in Rice (*Oryza sativa* L.) under Sodic Soil

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A B S T R A C T

Rice is known as major staple food crop in India by providing food to more than 70 per cent population. An experiment was carried out in Augmented Design for evaluation of eighty eight (88) diverse rice genotypes including three checks (NarendraUsarDhan 3, Jaya and CSR-36) under timely sown and irrigated conditions in sodic soil. The observation on eleven (11) characters was utilized for estimation of mean, range, least significant differences, correlations and path-coefficient. The genotype, NDRK 5018, followed by NDRK 50023, NDRK 5082, NDR 507, NDRK 5070, CSR 13 and NDRK 5029 produce highest grain yield per plant. High mean performance for several other characters was also found in the above mentioned genotypes and can be useful as parental materials in future breeding programme in sodic soil. Character association studies divulged that grain yield per plant (GYPP) showed high positive association with biological yield per plant (BYPP), spikelets per panicle (SPP), panicle bearing tillers per plant (TPP), flag leaf area (FLA) and harvest index (HI). Path analysis revealed that biological yield per plant (BYPP) and harvest index (HI) are the major direct contributors towards expression of grain yield per plant (GYPP) whereas biological yield per plant (BYPP) came out as the most important indirect yield component. Hence, these characters need to emphasize as a selection criteria for rice improvement under sodic soil condition.

Introduction

Rice (*Oryza sativa* L.) is one of the important staple food crops with an annual production of 759.6 million tonnes (FAOSTAT, 2018). Rice feeds more than 70percent population in India and contributes especially towards the global food security. However, rapidly increasing population has forced us to look for another quantum jump in rice production.

Economics of Salt-Induced Land Degradation and Restoration Forum (2014) has found that about 6.73 million hectares of land is affected by salt. Out of which saline soil covers 2.96 million hectares and sodic soils cover 3.77 million hectares (Sharma and Chaudhari, 2012). Salt affected soil covered a total of 2.348 million hectares area in Indo-gangetic plains in India, out of which Uttar Pradesh has a share of 1.37 million hectares. To control

the transport of salts it was reported initially through selective uptake by root cells and ions entering into the root along with water through symplastic and apoplastic pathways (Das *et al.,* 2015). Based on the quantitative characters identification of genotypes is very important for rice improvement in sodic soil. Different statistical parameters like correlation and path analysis will be useful for the selection of appropriate genotypes for any environmental condition. Correlation studies helps in identifying the important traits that influence yield directly and indirectly. Selection for one component may simultaneously affect related traits in a favourable direction. Therefore, identifying the characters, which are closely related and have contributed to grain yield, becomes highly essential. The knowledge on association among different traits with yield and interrelationship is essential to improve the selection efficiency. Path coefficient analysis using correlations helps to increase in yield by identifying the most important characters for selection. Direct and indirect effect of different component traits on grain yield may differ from one environment to another. Therefore, it is essential to conduct path analysis under defined environmental conditions as the results may useful to that specific environment only (Rai *et al.,* 2020). Keeping this information in mind a study was formulated to assess the character association in a set of rice genotypes for the traits contributing to yield under sodic soil condition.

Materials and Methods

The present investigation was conducted at the experimental farm of Acharya Narendra Deva University of Agriculture & Technology, Ayodhya under the Department of Genetics and Plant Breeding with an aim to study the trait association among rice genotypes under sodic soil. The trial was laid out in natural sodic soil condition with a soil pH of 9.3 with ECe = 2.24 (dS^{m-1}). In augmented experimental design, a total of eighty eight (88) diverse germplasms were evaluated along with three checks (CSR 36, Jaya and Narendra Usar Dhan 3) in a fashion that field was sub-divided in to 8 blocks comprising of 14 plots each. Twenty eight (28) days old seedlings were transplanted in the experimental site under sodic soil by maintaining a spacing of 20 cm x 15 cm. For recording observation, randomly five (5) plants of each genotype were selected. Different yield related traits such as plant height in centimeter (PH), days to 50% flowering (DTF), flag leaf area in cm^2 (FLA), panicle length in centimeter (PL), panicle bearing tillers per plant (TPP), spikelets per panicle (SPP), 1000-grain weight in gram (GW), spikelet fertility % (SF%), biological yield per plant in gram (BYPP), harvest-index % (HI) and grain yield per plant in gram (GYPP) were taken into consideration while taking observations. Analysis of variance was estimated with the recorded mean values of genotypes in each replication. Path coefficient analysis was conducted according to the methods of Dewey and Lu (1959). GYPP was considered to be dependent variable (effect) which was influenced by the other ten characters, the independent variables (causes). The variation in trait GYPP was unexplained by the ten causes which were presumed to be contributed by a residual factor (x).

Results and Discussion

The variation due to blocks was found significant or highly significant in analysis of variance for majority of the characters under study except for spikelet fertility where non-significant means squares were observed. The differences between the checks were also found to be highly significant except TPP, GW, BYPP, SF (%) and HI where mean squares were non-significant.

Correlation coefficients

It is desirable to understand the nature and magnitude of association between yield and its components for development of efficient breeding strategy and in this regard correlation coefficients play an important role. The estimates of correlation coefficients between different characters have been presented in Table 1. Highly significant and positive correlations was seen in grain yield per plant (GYPP)with majority of the characters under study such as plant height (PH), panicle bearing tillers per plant (TPP), flag leaf area (FLA), harvest index (HI), biological yield per plant (BYPP) and spikelets per panicle (SPP) with an exception of days to 50% flowering (DTF) and 1000-grain weight (GW) where non-significant association was observed. Harvest index (HI) showed highly significant and positive correlation value (0.28) with panicle length (PL).In case of biological yield per plant (BYPP) the highest significant and positive correlation value (0.62) was observed with panicle bearing tillers per plant (TPP) followed by spikelets per panicle (SPP) and plant height (PH).Significant positive correlation value was also observed in spikelets per panicle (SPP) with panicle length (PL), panicle bearing tillers per plant (TPP), plant height (PH) and flag leaf area (FLA) and there values are (0.44), (0.44), (0.39) and (0.33) respectively. In case of panicle length (PL) the highest significant and positive correlation value (0.39) was observed with flag leaf area (FLA) followed by plant height (PH) with value (0.32). Panicle bearing tillers per plant (TPP) showed highly significant and positive correlation value with flag leaf area (FLA), days to 50% flowering (DTF) and plant height (PH) and their values are (0.19), (0.14) and (0.13) respectively. So genotypes performing well in sodic soil should have higher panicle bearing tillers per plant (TPP), flag leaf area (FLA), panicle

length (PL), biological yield per plant (BYPP), spikelets per panicle (SPP) and harvest index (HI).Similar reports were found in rice where grain yield shows strong positive associations with other characters (Sarawgi *et al.,* 2000; Shivani and Reddy, 2000; Sashidhar *et al.,* 2005; Agahi *et al.,* 2007; Bughio *et al.,* 2009; Pandey *et al.,* 2012; Lakshmi *et al.,* 2014).In a recent study, grain yield per plant gives positive significant correlation in different crosses with majority of the important traits such as panicle per plant, spikelet fertility, biological yield and harvest index although traits like days to 50% flowering and spikelet fertility showed significant negative correlation (Dutt *et al.,* 2020). A total fifty five (55) correlations were obtained between different character pairs. Out of thirty seven (37) significant correlation coefficients, only few estimates were negative in nature. The remaining 18 estimates of correlation coefficients were found to be non-significant in the present study. Due to correlated response, selection practiced for one character also brings improvement in other traits. Present study represents a number of traits which are correlated and take part in improving yield and its component in respect to sodic soil condition. A sensible compromise would be required for obtaining maximum combined contribution towards grain yield in order to take care of the traits days to 50% flowering (DTF) and spikelet fertility (SF%) where negative correlations was observed. The estimates of correlation coefficient observed in present study are broadly in conformity with a previous report in rice (Janardanam *et al.,* 2002). Although in the present study out of fifty five (55) character pairs only one character shows significant negative correlation which revealed far less complex situation in respect of character associations as compare with general trait association encountered in rice. This would help researcher to maintain proper balance with yield and its components in

reference with rice germplasm used in the study.

Path coefficient analysis

Path coefficient analysis is a statistical measure which separates the correlation coefficients into direct and indirect effects.

Direct effect represents the immediate effect on a dependent character by an independent one whereas effect of an independent character on a dependent one with the help of other independent characters is called as indirect effect. Residual effects give an idea of the effects which were not covered in the study.

Table.1 Estimates of correlation coefficients between different characters under sodic soil

Characters/Traits	FLA	PH	TPP	PL	SPP	SF (%)	GW	BYPP	HI	GYPP
DTF	0.12	0.29**	0.14*	-0.02	0.22*	-0.25**	-0.04*	0.30**	-0.01*	0.12
FLA		0.28**	0.19**	0.39**	0.33**	0.19*	0.03	0.41**	0.16*	0.37**
PH			0.13*	0.32**	0.39**	-0.01	0.10	0.52**	-0.03	0.39**
TPP				0.08	0.44**	0.07	0.06	0.62**	0.26*	0.54**
PL					0.44**	0.05	0.20**	0.29**	0.28**	0.26*
SPP						0.03	-0.17	0.56**	0.21*	0.51**
SF (%)							0.04	0.06	0.03	0.08*
GW								0.03	0.13*	0.07
BYPP									0.14*	0.83**
HI										**0.34**

* Significant at 5% level
** Significant at 1% level

Table.2 Estimates of direct and indirect effects between grain yield per plant (GYPP) and its component characters under sodic soil

Characters/Traits	DTF	FLA	PH	TPP	PL	SPP	SF (%)	GW	BYPP	HI
DTF	**-0.05**	-0.002	-0.03	-0.004	0.002	-0.007	0.006	0.003	-0.007	0.006
FLA	0.004	**0.03**	0.009	0.008	0.014	0.01	0.005	0.002	0.013	0.005
PH	-0.011	-0.009	**-0.03**	-0.005	-0.010	-0.012	0.000	-0.002	-0.017	0.002
TPP	-0.006	-0.009	-0.006	**-0.03**	-0.003	-0.017	-0.003	-0.003	-0.023	-0.010
PL	0.003	-0.022	-0.017	-0.004	**-0.05**	-0.024	-0.003	-0.011	-0.016	-0.015
SPP	0.013	0.018	0.019	0.023	0.023	**0.05**	0.002	-0.009	0.029	0.011
SF (%)	0.000	0.000	0.000	0.000	0.000	0.000	**0.002**	0.001	0.000	0.000
GW	-0.002	0.001	0.002	0.002	0.002	-0.001	0.002	**0.020**	0.031	0.011
BYPP	0.22	0.322	0.437	0.508	0.236	0.457	0.071	0.043	**0.814**	0.133
HI	-0.036	0.031	-0.013	0.052	0.057	0.043	0.009	0.029	0.033	**0.200**

Residual effects: 0.099
Bold figures represent direct effects

In the present study, under sodic soil a total of ten (10) independent characters were covered on dependent character grain yield per plant. The estimates of direct and indirect effects for grain yield and its components are presented in table 2. In the present investigation most of the characters showed negligible direct effects on grain yield per plant (GYPP) but biological

yield per plant (BYPP) and harvest index (HI) showed a very positive direct effects value (0.814 and 0.200 respectively) on grain yield per plant (GYPP). In some similar studies, traits like biological yield per plant and harvest index has a direct contribution to grain yield per plant (Sashidhar *et al.,* 2005; Pandey *et al.,* 2012; Venkanna *et al.,* 2014). Regarding indirect effects, biological yield per plant (BYPP) exhibited high order value on grain yield per plant (GYPP) via different components such as panicle bearing tillers per plant (TPP), spikelets per panicle (SPP), plant height (PH), flag leaf area (FLA), panicle length (PL), days to 50% flowering (DTF) and harvest index (HI).The estimate of residual factor (0.099) was found to be low. Similar reports showed that biological yield per plant was found as an important contributor to grain yield in rice crop (Madhavilatha *et al.,* 2005; Yadav *et al.,* 2008; Venkanna *et al.,* 2014).

It can be concluded that a smaller proportion of direct and indirect effects get high order values in the present investigation; this may be due to presence of very high genetic variability in the germplasm lines which leads to different kinds of character association and ultimately cancellation of each other. However, biological yield per plant and harvest index act as a major direct contributors towards grain yield. Therefore these characters need to be further validated for future rice breeding program.

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