Estimation of correlation coefficient and path coefficient for yield and its components in rice (*Oryza sativa* L.) under sodic soil condition

Abstract:

Information on the nature and magnitude of population variation, character correlation with yield among individuals, and the level of environmental influence on the expression of these characters are all required for effective selection. This study was conductedin Augmented Block Design to determine correlations and path coefficient between yield and yield components in 85 germplasm including 4 checks (Pusa sungandha-4, NDR-2065, sarjoo-52, Narendra usar-3) under timely sown and irrigated conditions in sodic soil. The correlation coefficient expresses the relationship between two variables, but it says nothing about the cause and effect, such as which variable is dependent and which is independent. As a result, path-coefficient analysis must be used to assess the impact of several independent characters on a dependent character, both directly and indirectly. The grain yield per plant exhibited highly significant and positive correlations with biological yield per plant (0.866) and harvest index (0.491) whereas, Plant height (0.271), flag leaf area (0.231), spikelet fertility% (0.258) and no. of Productive tillers per plant (0.263) were showed significant positive correlation. When assigning the genotypic correlation it was observed that positive direct effect was showed for traits like plant height (0.0095) and flag leaf area (0.0080) whereas days to 50% flowering (-0.0063), days to maturity (-0.0011) exhibited negative direct impact**.** The most important indirect yield component was biological yield per plant (0.866). As a result, these characteristics should be highlighted and further validated as a selection criterion for future rice improvement programme under sodic soil.

Keywords: Correlation, path coefficient, grain yield, direct impact, indirect impact, breeding programme.

Introduction:

Rice is a globally important staple food crop. This crop's productivity can be increased significantly by varietal improvement and hybrid development. By 2030, the global population is predicted to exceed 8 billion people, necessitating a 50 percent increase in rice production to fulfil the rising demand (Khush and Brar, 2002). As a result, rice breeders are working to create cultivars with higher yields and other desirable agronomic characteristics. According to Sharma and Chaudhari (2012), saline soils cover 2.96 million hectares and sodic soils cover 3.77 million hectares. In India's Indo-gangetic plains, salt-affected soil covers a total of 2.348 million hectares, with Uttar Pradesh accounting for 1.37 million hectares. For the selection of optimal genotypes for every environmental condition, several statistical factors such as correlation and path analysis would be effective.

The relationship between rice yield and yield components has been studied extensively at phenotypic level; Sharma and Choubey (1985) and Dhanraj and Jagadish (1987) reported that yield per plant was positively correlated with the number of productive tillers per plant, the number of panicles per plant and spikelets per plant and 1000 grain weight while Prasad *et al.* (1988) observed positive correlations between grain yield per plant and the number of spikelets per panicle, the number of fertile grains per panicle and 1000 grain weight. Bai *et al.* (1992) reported that grain yield is positively correlated with the number of productive tillers per plant, and the number of grains per panicle. Sürek and korkut (1998) reported that grain yield per plant was significantly correlated with the number of panicles per plant and 1000 grain weight.

Yield component breeding to increase grain yield would be most effective, if the components involves are genetically positively correlated with grain yield. The correlation coefficient is a statistical measure that is used to determine the strength (or direction) of a relationship between two or more variables. However, it is very difficult to judge about the cause and effect, such as which variable is dependent and which is independent; as a result path-coefficient analysis must be used. Moreover, it assesses the impact of several independent characters on a dependent character, both directly and indirectly. Indirect selection can benefit from path analysis since it indicates the relative value of yield-

contributing characters. Therefore, the present study was conducted to compute the character association for the traits contributing to yield under sodic soil condition.

MATERIALS AND METHODS

For this investigation, 85 rice germplasm/genotypes and four check varieties were used as the experimental material at Crop Research Station unit 1st, Masodha, Ayodhya (UP) under natural sodic condition with an EC = 2.24 and pH of 9.3 (dSm-1). In an augmented experimental design, a total of 85 germplasms were examined, along with four checks (Pusa sungandha-4, NDR-2065, sarjoo-52 and Narendra Usar Dhan 3), in such a way that the field was divided into 5 blocks, each with 21 plots. Twenty-eight (28)-day-old seedlings were transplanted onto the experimental location under sodic soil with 20 cm x 10 cm spacing. Observations were recorded on five randomly selected plants without border effect, in each genotype. The average values were evaluated and subjected to statistical analysis. Observation was recorded on plant basis for all characters, except days to maturity, which was recorded on plot basis. Details of the 13 characters studied are as viz., days to 50% flowering, days to maturity, plant height, flag leaf area, plant height (cm), flag leaf area (cm^2), number of productive tillers / plant, panicle length (cm), number of fertile spikelets / panicle, spikelet fertility (%), biological yield / plant (g), harvest index, 1000-grain weight (g), L: B ratio and grain yield / plant (g).

The data collected for the characters mentioned above was subjected to statistical analysis as follows:

a. Estimation of correlation coefficients as per method given by (**Searle, 1961**).

b. Estimation of Path-coefficient analysis method given by (**Dewey and Lu, 1959**).

Result and discussion:

Correlation coefficients analysis:

The degree of correlation between the characters is a significant factor, particularly in economic and complex characters such as yield. The correlation coefficient is a statistical measure that is used to determine the strength (or direction) of a relationship between two or more variables. Selection based on a thorough understanding of the amount and direction of the relationship between yield and its features is essential for identifying important characters that can be used to improve crops through a breeding programme. Correlations between yield and yield components viz., days to 50 per cent flowering, days to maturity, plant height, flag leaf area, number of productive tillers per plant, panicle length, number of fertile spikelets per panicle, spikelet fertility, biological yield per hill, harvest index 1000-grain weight, L:B ratio and grain yield per plant were computed separately for rice genotypes. The results are presented in Table 1.

Table 1 : Displays the estimations of simple correlation coefficients between thirteen characters.

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Flag leaf area(cm)2	No. of productive tillers/plant	Panicle length (cm)	No. of fertile spikelets /panicles	Spikelet fertility (%)	Biological yield/plant (g)	Harvest index (%)	1000 grain weight (g)	L:B ratio	Grain yield/plant (g)
Days to 50 % flowering	1.000	0.112	0.044	0.065	0.021	-0.091	0.132	0.067	-0.033	-0.045	0.239*	-0.123	-0.056
Days to maturity		1.000	-0.048	0.028	-0.028	0.034	0.090	0.188	-0.187	0.058	0.070	-0.148	-0.134
Plant height(cm)			1.000	0.386**	0.048	0.029	-0.052	0.193	0.296**	0.005	-0.067	-0.165	0.271*
Flag leaf area(cm)2				1.000	0.032	0.015	0.156	0.144	0.240*	0.031	0.049	-0.108	0.231*
No. of productive tillers/plant					1.000	0.016	-0.045	0.004	0.261*	0.053	0.100	0.110	0.263*
Panicle length (cm)						1.000	0.309**	-0.063	0.088	-0.035	0.076	-0.008	0.047
No. of fertile spikelets/panicles							1.000	0.373**	0.031	0.040	0.106	0.021	0.038
Spikelet fertility(%)								1.000	0.169	0.205	-0.011	-0.207	0.258*
Biological yield/plant(g)									1.000	-0.001	-0.087	0.050	0.866**

Harvest index(%)										1.000	0.170	0.031	0.491**
1000 grain weight (g)											1.000	0.057	0.004
L:B ratio												1.000	0.063
Grain yield/plant(g)													1.000

*, ** significant at 5% and 1% level, respectively

The grain yield per plant exhibited highly significant and positive correlations with biological yield per plant (0.866) and harvest index (0.491) whereas, Plant height (0.271), flag leaf area (0.231), spikelet fertility% (0.258) and no. of Productive tillers per plant (0.263) were showed significant and positive correlation. It has been also showed that grain yield per plant was non-significant and positive correlation with panicle length (0.047), no. of fertile spikelet per panicle (0.038), 1000-grain weight (0.004) and L:B ratio (0.063) but non- significant and negative correlation showed by days to 50% flowering (-0.056) , days to maturity (-0.056).

Similar kind of association was revealed by Ratna *et al*., (2015) for plant height, Idris and Mohamed (2013) for number of tillers per plant, Rahman *et al*., (2014) for panicle length, Mohammed *et al*., (2007) for the number of panicles per plant and Edukondalu *et al.*, (2017) results indicated that grain yield per plant showed significant positive association with number of tillers per plant, panicle length and milling percentage

Path coefficient analysis:

Using simple correlation coefficients, the path coefficient analysis was used to analyse the direct and indirect effects of eleven independent characters on the dependent character grain yield per plant. Table 4.4 shows the direct and indirect effects of different characters on grain yield per plant.

Table-2 Estimates of direct and indirect impact between grain yield per plant and its component characters under sodic soil

Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Flag leaf area(cm)2	No. of productive tillers/plant	Panicle length (cm)	No. of fertile spikelets / panicles	Spikelet fertility (%)	Biological yield/plant (g)	Harvest index (%)	1000 grain weight (g)	L:B ratio	R with Grain yield/plant(g)
Days to 50 % flowering	**-0.0063**	-0.0001	0.0004	0.0005	0.0003	0.0007	-0.0013	0.0010	-0.0279	-0.0219	-0.0004	-0.0011	-0.056
Days to maturity	-0.0007	**-0.0011**	-0.0005	0.0002	-0.0003	-0.0003	-0.0009	0.0029	-0.1601	0.0281	-0.0001	-0.0013	-0.134
Plant height(cm)	-0.0003	0.0001	**0.0095**	0.0031	0.0006	-0.0002	0.0005	0.0029	0.2533	0.0025	0.0001	-0.0015	0.271*
Flag leaf area(cm)2	-0.0004	0.0000	0.0037	**0.0080**	0.0004	-0.0001	-0.0016	0.0022	0.2052	0.0152	-0.0001	-0.0010	0.231*
No. of productive tillers/plant	-0.0001	0.0000	0.0005	0.0003	**0.0119**	-0.0001	0.0005	0.0001	0.2232	0.0261	-0.0002	0.0010	0.263*
Panicle length (cm)	0.0006	0.0000	0.0003	0.0001	0.0002	**-0.0081**	-0.0031	-0.0010	0.0757	-0.0172	-0.0001	-0.0001	0.047
No. of fertile spikelets/panicles	-0.0008	-0.0001	-0.0005	0.0013	-0.0005	-0.0025	**-0.0100**	0.0057	0.0262	0.0193	-0.0002	0.0002	0.038
Spikelet fertility(%)	-0.0004	-0.0002	0.0018	0.0012	0.0001	0.0005	-0.0037	**0.0152**	0.1451	0.0999	0.0000	-0.0019	0.258*
Biological yield/plant(g)	0.0002	0.0002	0.0028	0.0019	0.0031	-0.0007	-0.0003	0.0026	**0.8565**	-0.0004	0.0002	0.0005	0.866**
Harvest index(%)	0.0003	-0.0001	0.0001	0.0003	0.0006	0.0003	-0.0004	0.0031	-0.0008	**0.4880**	-0.0003	0.0003	0.491**
1000 grain weight (g)	-0.0015	-0.0001	-0.0006	0.0004	0.0012	-0.0006	-0.0011	-0.0002	-0.0746	0.0829	**-0.0018**	0.0005	0.004
L:B ratio	0.0008	0.0002	-0.0016	-0.0009	0.0013	0.0001	-0.0002	-0.0032	0.0425	0.0151	-0.0001	**0.0091**	0.063

Resi = 0.0061

*, ** significant at 5% and 1% level, respectively

Bold digit = Direct impact

The path analysis identified the major direct effect showed for trait biological yield per plant per plant followed by harvest index, plant height, L: B ratio. While biological yield per plant and harvest index showed highly significant and positive indirect impact on grain yield per plant. When assigning the genotypic correlation it was observed that days to 50% flowering (-0.0063), days to maturity (-0.0011), no. of fertile spikelet per panicle(-0.0100), 1000-grain weight (-0.0018) exhibited **negative direct impact** and **Positive direct effect** showed by the trait plant height (0.0095), flag leaf area (0.0080), no. of productive tillers per plant (0.0119), (0.0152) on biological yield per plant, harvest index (0.4880), L:B ratio (0.0091). Therefore, the results suggest that these traits can be used for grain yield selection

The similar results were reported by Ravindra Babu *et al*., (2012), Mulugeta Seyoum *et al*., (2012) and Imad Naseem *et al*., (2014). Biological yield per plant was found to be a substantial contribution to grain production in rice crops in studies of (Madhavilatha *et al*., 2005; Yadav *et al*., 2008; Venkanna *et al*., 2014). Singh *et al.,* (2020) reported in their study that 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)

Conclusion

Keeping in view of the facts, by considering all factors performance the grain yield per plant exhibited highly significant and positive correlations with biological yield per plant (0.866) and harvest index (0.491). It can be concluded that in the current study, a smaller proportion of direct and indirect effects have high order values; this could be due to the presence of high genetic variability in the germplasm lines, which leads to different types of character association.The path analysis identified the major direct effect on biological yield per plant followed by harvest index, plant height, L:B ratio. While biological yield per plant and harvest index were showed highly significant and positive indirect impact on grain yield per plant. Therefore, the results suggest that these characters after further validation can be used for grain yield selection in future breeding programme.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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