INTERRELATIONSHIP AND CAUSE EFFECT ANALYSIS OF RICE GENOTYPES GROWN UNDER SALINE LOW LAND CONDITION

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ABSTRACT: *A study on interrelationship and cause effect of grain yield and its component traits was carried out using 40 rice genotypes. Grain yield per plant had positive and significant correlation with number of panicles per plant followed by number of tillers per plant, number of grains per panicle and thousand grain weights. The path analysis reveled that the maximum direct effect of number of panicles per plant was noted over grain yield per plant, followed by number of grains per panicle and thousand grain weight. Indirect effect of number of tillers per plant via number of panicles per plant was high and positive on grain yield per plant. Hence, these traits can be used for selection criteria in breeding programme to develop high yielding new plant type rice varieties.*

Key Words: *Interrelationship and Cause Effect Analysis*

INTRODUCTION

The basic objective of most of the crop improvement programs is to realize a marked improvement in crop yield. But yield is a complex character which is controlled by association of various characters. Before placing strong emphasis on breeding for yield improvement trait, the knowledge on the association between yield and yield attributes will enable the breeder in the improvement of yield. The correlation coefficient may also help to identify characters that have little or no importance in the selection programme. The existence of correlation may be attributed to the presence of linkage or pleiotropic effect of genes or physiological and development relationship or environmental effect or incombination of all (Oad*et al*., 2002).The information on association of yield attributes and their direct and indirect effects on grain yield are of paramount significance. Hence, path analysis is of much importance in any plant breeding program. Path analysis is that, it permits the partitioning of the correlation coefficient into its components, one component being the path coefficient that measures the direct effect of a predictor variable upon its response variable; the second component being the indirect effect(s) of a predictor variable on the response variable through another predictor variable (Dewey and Lu, 1959). In agriculture, path analysis has been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield (Milligan *et al*, 1990; Surek and Beser, 2003). The present research study was conducted to find out the genetic variability among different plant traits, direct and indirect contribution of these parameters towards paddyyield andto identify better combinations as selection criteria for developing high yielding rice genotypes.

MATERIALS AND METHODS

The present investigation was conducted at the Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India during the year 2015-16.

MATERIALS

Seeds of forty rice genotypes collected from various places were utilized for the study. The details of the materials are presented in Table 1.

METHODS

Field Plot Technique

Seeds of the forty genotypes were sown in raised nursery beds during January, 2018. The 25-days old seedlings were transplanted to the main field. These genotypes were grown in saline soil with electrical conductivity (EC) of 3.83 dsm^{-1}. The experiments were conducted at the experimental Farm of Plant Breeding (11°24' N latitude and 79°44' E longitude, + 5.79 m MSL), Annamalai University, Tamil Nadu, India.

The experiment was laid out in a Randomized Block Design with three replications, using 20 × 20 cm spacing.

Observations recorded on 40 rice genotypes for eight characters viz., days to first flower, plant height, number of tillers per plant, number of panicles per plant, panicle length, number of grains per panicle, thousand grain weight and grain yield per plant were subjected to statistical analysis and the results are presented below.

Observations were recorded and the data was subjected to statistical analysis. Statistical analysis for the above characters were done following Singh and Chaudhary (1985) for correlation coefficients and Dewey and Lu (1959) for path analysis.

RESULTS AND DISCUSSION

The present investigation was carried out with 40 rice genotypes collected from different eco - geographical regions of India. Observations were recorded on various quantitative and qualitative characters as per the standard evaluation system descriptor. The data recorded were subjected to various statistical analysis namely correlation, path analysis and analysis of variance. The experimental result of the investigation was presented in this chapter.

Table 1. List of genotypes used in study

S. No.	Name of genotype	ORIGIN	S. No.	Name of genotype	ORIGIN
1	ADT36	TRRI, TN, India	21	TKM9	RRS, Tirur, India
2	ADT37	TRRI, TN, India	22	PMK3	ARS, Paramkudi, India
3	ADT39	TRRI, TN, India	23	AD 06207	TRRI, Aduthurai, T.N, India
4	ADT41	TRRI, TN, India	24	TPS5	ARS, Thirupathisaram, India
5	ADT42	TRRI, TN, India	25	ANNA 4	ARS, Paramkudi, India
6	ADT43	TRRI, TN, India	26	MDU4	Agricultural College, Madurai, India
7	ADT45	TRRI, TN, India	27	NLR 34449	A.N.G.R.A.U Research station, A.P, India
8	ADT46	TRRI, TN, India	28	RNR 1446	A.N.G.R.A.U Research station, A.P, India
9	ADT47	TRRI, TN, India	29	BPT 5204	Agricultural college, Bapatla, India
10	ADT48	TRRI, TN, India	30	MTU 1001	ARS, Maruteru, A.P, India
11	ADT49	TRRI, TN, India	31	MTU 1010	ARS, Maruteru, A.P, India
12	ADT51	TRRI, TN, India	32	Vijay masoori	Land race, Telangana, India
13	CO 49	AC & RI, Coimbatore, India	33	Jaijailu	Land race, Telangana, India
14	CO 51	AC & RI, Coimbatore, India	34	Jai shriram	Land race, Telangana, India
15	CO 50	AC & RI, Coimbatore, India	35	Swarna	CRRI, Cuttack, India
16	IR64	IRRI, Philippines	36	TNI	Directorate of Rice Research Institute, Hyderabad
17	IR72	IRRI, Philippines	37	Gayathri	CRRI, Cuttack, India
18	ASD 16	RRS, Ambasamudram, T.N, India	38	UMA	Rice Research Station, Monocompu, Kerala
19	TRY 2	Agricultural college and research institute, Trichy, T.N, India.	39	PY3	KVK, Pondicherry, India
20	TRY 3	Agricultural college and research institute, Trichy, T.N, India.	40	ASD 19	RRS, Ambasamudram, T.N, India

The analysis of variance for different characters are presented in Table 2. The treatment *i.e* mean sum of square due to genotypes showed significant differences for all eight characters under study at 5 per

cent level of significant suggesting that the genotypes selected for the present study were genetically divergent. This indicates that there is ample scope for selection of promising varieties from the present gene pool for yield and its components.

Correlation between yield and yield attributing characters in rice genotypes are estimated and are presented in Table 3.

Days to first flower: Days to first flower had significant positive association with grain yield per plant at genotypic level. For phenotypic level, days to first flower shows non-significant association with grain yield per plant and except panicle length all the other characters recorded non-significant association with this trait. Panicle length recorded negative non-significant association with grain yield per plant.

Plant height: All the characters observed non-significant correlation with plant height at both genotypic and phenotypic level.

Number of tillers per plant: Number of tillers per plant recorded significant positive correlation with number of panicles per plant and grain yield per plant at both genotypic level and phenotypic level. For the remaining traits showed non-significant correlation withthis trait.

Number of panicles per plant: Number of panicles per plant had significant positive correlation with grainyield per plant at genotypic and phenotypic level. For the remaining traits observed non-significant positive and negative low values with number of panicles per plant both at genotypic and phenotypic level.

Panicle length: All the characters observed non-significant correlation with panicle length at both genotypic and phenotypic level.

Number of grains per panicle: Number of grains per panicle recorded significant positive association with grain yield per plant at genotypic and phenotypic level. It had negative non-significant association with thousand grain weight at both genotypic and phenotypic level.

Thousand grain weight: Thousand grain weight had positive significant association with grain yield per plant at genotypic and phenotypic level. For all the other characters observed non-significant association with thousand grain weight at both genotypic and phenotypic level.

Grain yield per plant: This character was recorded positive significant association with number of panicles per plant, number of tillers per plant, number of grains per panicle and thousand grain weight at both genotypic and phenotypic level. With days to first flower it had significant positive correlation at genotypic level and non-significant positive association at phenotypic level. It had non-significant positive association with, plant height and panicle length at both genotypic and phenotypic level.

The direct and indirect contribution of various characters on yield in rice genotypes are measured and are presented in Table 4.

The trait, number of panicles per plant, number of grains per panicle and thousand grain weight registered high direct effect on grain yield per plant. While the character number of tillers per plant observed low negative direct effect on grain yield per plant. Panicle length and days to first flower recorded negligible positive direct effect on grain yield per plant. Plant height recorded negligible negative direct effect on grain yield per plant.

Days to first flower: This character had low positive indirect effect on grain yield per plant via number of panicles per plant and number of grains per panicle. The character, thousand grain weight showed negligible positive indirect effect on grain yield per plant whereas the characters plant height, number of tillers per plant and panicle length had negligible negative indirect effect on grain yield per plant.

Plant height: This character had negligible indirect positive effect on grain yield per plant via panicle length, days to first flower, thousand grain weight, and number panicles per plant. While negligible negative indirect effect was observed for number of tillers per plant and number of grains per panicle.

Number of tillers per plant: This character had high positive indirect effect on grain yield per plant through number of panicles per plant. While the characters panicle length and days to first flower observed negligible positive indirect effect on grain yield per plant. Number of grains per panicle, thousand grain weight and plant height showed negligible negative indirect effect on grain yield per plant.

Number of panicles per plant: This character had low negative indirect effect via number of tillers per plant on grain yield per plant whereas the character days to first flower and panicle length had negligible positive indirect effect on grain yield per plant. Negligible negative indirect effect was observed via number of grains per panicle, plant height and thousand grain weight on grain yield per plant.

Panicle length: This character had negligible indirect positive effect on grain yield per plant via thousand grain weight and number of panicles per plant. While negligible indirect negative effect on grain yield per plant through number of grains per panicle, plant height, number of tillers per plant and days to first flower.

Number of grains per panicle: This character had low negative indirect effect on grain yield per plant via

thousand grain weight and number of panicles per plant. Negligible positive indirect effect was recorded through plant height, days to first flower and number of tillers per plant while the characters number of panicles per plant and panicle length showed negligible negative indirect effect on grain yield per plant.

Thousand grain weight: This character had low negative indirect effect on grain yield per plant via number of grains per panicle. Negligible positive indirect effect was recorded through panicle length, days to first flower and number of tillers per plant. While the characters plant height and number of panicles per plant showed negligible negative indirect effect on grain yield per plant.

The ultimate aim of any crop improvement programme is yield improvement. Since yield is a complex trait, knowledge of association of different yield components with yield and inter correlations among themselves are important. A study of phenotypic correlation is adequate while correlation coefficients based on the heritable part of the values (genotypic correlation) provide a dependable basis for selection. Estimation of phenotypic and genotypic correlations between the response variable (yield) and the predictor (yield components) and among the yield component themselves, may provide information for the breeding programme when selection is based on two or more characters simultaneously.

In the present investigation, the genotypic correlation coefficient was higher in magnitude than the corresponding phenotypic correlation coefficient in general for most of the characters. This is possibly due to the linkage or modifying effect of the gene and environment in genetic association between characters.

In this study, there were strong positive and significant correlation between grain yield per plant and number of panicles per plant followed by number of tillers per plant, number of grains per panicle and thousand grain weight. This positive association of these yield contributing characters with grain yield per plant was also reported by Kannan and Sarvanan. (2013). This indicates that vigorous plant population may enhance economic yield. This relationship reflected that grain yield and aforesaid traits can be appropriately used as selection criteria for the improvement of grain yield per plant in rice.

The trait, daystofirst flower registered positive and non-significant association with grain yield per plant. Such type of results are reported by Nayak*et al.,*2004 and Augustina*et al*., 2013. This could be considered for selection criteria for earliness.

While studying the association of more number of independent variables with a particular dependent variable, it necessitates the study of inter dependence of each component by partitioning them into direct and indirect effects exerted through other characters arising inevitably as an integral part of the growth pattern. Under such complex situations, the total correlations are insufficient to explain the true associations for effective manipulation of the characters. Path analysis furnishes a method of partitioning the correlation coefficients into direct and indirect effects and measures the relative importance of the casual factors involved. Yield is a complex character dependent upon a number of contributory factors. These factors also exhibit different degrees of association between themselves. A change in one character results in a corresponding change in its relationship with the other characters and finally is reflected on yield. In order to get an insight into these chain relations the cause and effect between grain yield per plant and seven component characters were investigated by path analysis.

In the present investigation, the residual effect was 0.1790843. The maximum direct effect of number of panicles per plant was noted over grain yield per plant, followed by number of grains per panicle and thousand grain weight. Almost similar results were reported by Ramesh Babu and Raghava Reddy (2006). With the exception of plant height and number of tillers per plant all other remaining characters showed positive direct effect on grain yield per plant. Similar results by RomelBiswash*et al.,* (2015) was recorded for plant height, Babu and Karthikeyan (2012) for number of tillers per plant.

In addition to its direct effect, indirect effect of number of tillers per plant via number of panicles per plant was high and positive on grain yield per plant. The indirect effect of thousand grain weight was positive via days to first flower, number of tillers per plant and panicle length. From the above discussion, it is inferred that the pattern of path coefficient observed in the present study is in agreement with the correlation obtained. In general, the characters, number of panicles per plant and number of grains per panicle recorded positive significant correlation and high direct effect with grain yield per plant. Hence, these traits can be used for selection criteria in breeding programme to develop high yielding new plant type rice varieties.

The character days to first flower, panicle length, number of tillers per plant and plant height exhibited variable performance for direct and indirect effect and more similarly for correlation coefficient. Hence, selection of such characters could be postponed to later generations until there is favorable and constant association of genes controlling the characters.

In the present study it may be concluded that genotype BPT 5204 showed significant mean values for desirable characters viz., plant height, number of tillers per plant, panicle length, number of grains per

panicle, thousand grain weight and grain yield per plant. For earliness and quality characters the genotype IR 64 showed significant mean values for days to first flower, number of tillers per plant, number of panicles per plant, thousand grain weight, and grain yield per plant. Based on mean performance, these genotypes may be selected for further improvement through hybridization and selection.

For association analysis, direct yield contributing characters, namely, number of panicles per plant, number of grains per panicle and thousand grain weight showing positive association with grain yield per plant reflected that these characters can be enhanced simultaneously to improve grain yield per plant.

Table 2. Analysis of variance for eight characters in rice genotypes

S. No.	Source	df	Days to first flower (days)	Plant height (cm)	No. of tillers per plant	No. of panicles per plant	Panicle length (cm)	No. of grains per panicle	Thousand grain weight (g)	Grain yield per plant (g)
			MSS							
1	Replication	2	47.12	28.37	4.14	6.54	1.31	1.30	1.29	26.91
2	Genotype	39	77.02**	506.66**	54.71**	38.86**	16.76**	2190.58**	26.34**	312.97**
3	Error	78	8.41	10.99	2.32	2.89	1.64	46.05	0.59	16.37

**Significant at 1 per cent level

Table 3. Phenotypic and genotypic correlations coefficients among yield attributing characters in rice genotypes

Sl. No	Characters		Days to first flower (days)	Plant height (cm)	No. of tillers per plant	No. of panicle per plant	Panicle length (cm)	No. of grains per panicle	Thousand grain weight (g)	Grain yield per plant (g)
1	Days to first flower (days)	P	1.00	0.14	0.08	0.13	0.03	0.16	0.02	0.25
		G	1.00	0.17	0.13	0.21	-0.03	0.19	0.06	0.36**
2	Plant height (cm)	P		1.00	0.10	0.09	0.23	0.00	0.06	0.08
		G		1.00	0.10	0.10	0.29	-0.00	0.06	0.09
3	No. of tillers per plant	P			1.00	0.92**	0.01	-0.11	-0.03	0.64**
		G			1.00	0.96**	0.02	-0.12	-0.03	0.63**
4	No. of panicles per plant	P				1.00	0.05	-0.13	0.00	0.71**
		G				1.00	0.05	-0.13	-0.00	0.68**
5	Panicle length (cm)	P					1.00	-0.02	0.01	0.05
		G					1.00	-0.03	0.04	0.05
6	No. of grains per panicle	P						1.00	-0.23	0.37*
		G						1.00	-0.23	0.42**
7	Thousand grain weight (g)	P							1.00	0.32*
		G							1.00	0.33*
11	Grain yield per plant (g)	P								1.00
		G								1.00

*Significant at 5 per cent level P- Phenotypic correlation coefficient
**Significant at 1 per cent level G- Genotypic correlation coefficient

Table 4. Path coefficient analysis showing direct and indirect effects of yield attributing characters on grain yield per plant in rice genotypes

Sl. No.	Character	Days to first flower (days)	Plant height (cm)	No. of tillers per plant	No. of panicle perplant	Panicle length (cm)	No. of grains per panicle	Thousand grain weight (g)	Grain yield per plant (g)
1	Days to first flower (days)	**0.043**	-0.005	-0.020	0.195	-0.000	0.120	0.033	0.365
2	Plant height (cm)	0.007	**-0.034**	-0.016	0.096	0.006	-0.000	0.031	0.092
3	No. of tillers per plant	0.005	-0.003	**-0.154**	0.881	0.000	-0.077	-0.016	0.635
4	No. of panicles per plant	0.009	-0.003	-0.149	**0.915**	0.001	-0.087	-0.000	0.685
5	Panicle length (cm)	-0.001	-0.010	-0.003	0.051	**0.021**	-0.024	0.020	0.055
6	No. of grains per panicle	0.008	0.000	0.019	-0.126	-0.000	**0.634**	-0.112	0.421
7	Thousand grain weight (g)	0.003	-0.002	0.005	-0.001	0.000	-0.149	**0.476**	0.333

Residual effect = 0.1790843

Direct effect - diagonal bold values
Indirect effect - un bold values

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