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Estimation of path coefficient analysis to identify the yield contributing traits in rice (*Oryza sativa* L.) under saline and non-saline coastal regions of West Bengal

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ABSTRACT

The study was conducted out for three consecutive years (2009, 2010, and 2011) at Baruipur, a non-saline zone. Parallel field trials were conducted at Sagardeep, a saline zone in 24Pgns, south in 2009 and 2010 and at Hingalganj (24Pgns, North) another saline prone zone in 2011. At maturity plants were harvested taking five randomly selected plants from each replication and eight different agro-morphological characters namely plant height, tillers per hill, panicles per plant, grains per panicle, panicle length, 1000 seed weight, seed yield per plant and days to maturity were recorded. The objectives were to determine traits affecting grain yield in forty three paddy genotypes and to establish the nature of relation between grain yield and yield components. In the path coefficient analysis, it was observed that the direct effects on seed yield per plant were exhibited by grains per panicle, tillers per hill, and days to maturity. On the other hand, the indirect effects of grains per panicle through other traits also indicated that direct selection using grains per panicle to select high yielding genotypes will be effective.

Indexing terms/Keywords:- Path coefficient analysis; seed yield; grains per panicle; saline zone.

Academic Discipline And Sub-Disciplines

Agriculture

SUBJECT CLASSIFICATION

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TYPE (METHOD/APPROACH)

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INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for about 2.5billion world's population which may escalate to 4.6 billion by the year 2050 [1]. It fulfills the nutritional requirements of 50% of the total world population and occupies a pivotal place in Indian agriculture as it is a staple food for more than 70% of population and a source of lively hood for about 120 to 150 million rural households. At the current rate of population growth, which is 1.8%, rice requirement by 2020 would be around 140 million tons [2].

Generally the main aim of crop improvement is to increase the yield of the crop substantially. Yield being a very complex character, it is governed by many other different characters either directly or indirectly. So the study of the information of different agro-morphological characters and its direct and indirect effects on yield is of huge importance. Hence path analysis is very important for any plant breeding program. Path analysis is a pre-requisite for any crop improvement including cereals like paddy for establishment of genotypes with increase in yield potential or improvement of any other trait [3].

The primary objective of path coefficient analysis is that it furnishes information on influence of each contributing trait to yield directly as well as indirectly and also enables breeders to rank the genetic attributes according to their contribution [4]. In agriculture, path analysis is an important tool used by the plant breeders to identify the traits that are useful according to the selection criteria to improve crop yield or any other character of interest. [5,6]. Keeping the stated viewpoints under consideration an attempt was made to understand the variability for the grain yield and its related attributes, study path analysis of yield attributing traits among forty three paddy genotypes.

MATERIALS AND METHODS

Forty three paddy genotypes were grown for three consecutive years (2009, 2010, and 2011) at Baruipur, a non-saline zone. Parallel field trials were conducted at Sagardeep, a saline zone in 24Pgns, south in 2009 and 2010 and at Hingalganj (24Pgns, North) another saline prone zone in 2011.

The field experiment for non-saline zone was conducted in the Calcutta University Experimental Farm, Baruipur 24Parganas (S) in the aman season for three consecutive years i.e. 2009, 2010 and 2011. The seeds of forty three paddy genotypes were sown in Randomized Block Design (RBD) with three replications. Normal inter-culture operations were practiced throughout the growing period. At maturity plants were harvested taking five randomly selected plants from each replication and eight different agro-morphological characters namely plant height, tillers per hill, panicles per plant, grains per panicle, panicle length, 1000 seed weight, seed yield per plant and days to maturity were recorded.

The second field experiment was conducted in the farmer's field of Muriganga, Sagardeep 24Parganas (S) in the same way as in previous location. It lies on the continental shelf of Bay of Bengal having low laying rice production system is pre-dominant. Irrigation system is very poor in this study area. Here screening was done twice in the aman season for two consecutive years in 2009 and 2010.The soil salinity was analyzed five times through the growing season i.e. at the time of sowing, one month after sowing, at the time of tillering, panicle initiation and finally at maturity of the grains. The soil salinity range was from 5 to 8dSm^{-1}.

The third trial was conducted in the farmer's field of Hingalganj, 24Parganas (N) in the aman season of the year 2011. Surrounded by rivers on all sides, this is a small island. Similar experiment material was used as for the previous locations. The soil salinity was analysed five times same as in Sagardeep. The soil salinity range was from 5 to 9dSm^{-1}.

The path coefficient analysis was calculated as described by Dewey and Lu (1959) at phenotypic level [4]. Eight characters as stated were included in the path coefficient analysis. The path coefficients were computed by solving a set of following simultaneous equation, which express the basic relationships between correlation and path coefficients.

RESULTS AND DISCUSSION

From path analysis (Table 1) it was revealed that grains per panicle (0.967) exhibited maximum positive direct effect on grain yield (three years) followed by tillers per hill, panicles per plant, length of the panicle, 1000 seed weight and days to maturity (for two consecutive years).Path analysis of pooled mean for non-saline zone was also computed (Table 2). The characters which exhibited positive direct effect on grain yield were tillers per hill, grains per panicle, length of the panicle and 1000 seed weight. The seed yield has been reported to be effected by high direct positive effects of productive tillers and grains per panicle [7, 8, 9].

TABLE1. PATH COEFFICIENT ANALYSIS FOR THREE CONSECUTIVE YEARS FOR NON-SALINE ZONE

	Plant Height (cm)			No. of tillers/hill			No. of panicles/plant			No. of grains/panicle			Length of panicle (cm)			1000 seed weight(g)			Days to maturity		
	I*	II**	III***	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Plant Height (cm)	***-0.01***	***0.11***	***-0.04***	*0.006*	*-0.006*	*-0.004*	*-0.010*	*0.001*	*0.003*	*0.258*	*0.701*	*0.616*	*-0.008*	*0.045*	*-0.029*	*0.011*	*-0.035*	*0.020*	*0.009*	*-0.009*	*0.027*
No. of tillers/hill	*-0.01*	*-0.01*	*-0.005*	***0.111***	***0.09***	***-0.03***	*-0.104*	*0.005*	*0.019*	*0.218*	*-0.085*	*0.472*	*-0.001*	*-0.019*	*0.012*	*-0.005*	*-0.011*	*0.019*	*0.004*	*-0.001*	*0.001*

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No. of panicles/ plant	-0.01	0.02	-0.005	0.098	0.073	-0.030	**-0.11**	**0.01**	**0.02**	0.323	0.069	0.445	0.003	-0.017	0.027	-0.005	-0.016	0.010	0.003	-0.004	-0.001
No. of grains/p anicle	-0.01	0.09	-0.024	0.023	-0.009	-0.015	-0.036	0.001	0.009	**1.006**	**0.891**	**1.006**	-0.007	0.054	-0.037	-0.001	-0.031	0.012	0.008	-0.009	0.026
Length of panicle (cm)	0.01	0.057	-0.008	-0.002	-0.021	0.003	-0.006	-0.001	-0.004	-0.149	0.553	0.269	**0.05**	**0.09**	**-0.14**	0.01	-0.04	0.04	-0.001	-0.001	0.01
1000 seed weight(g)	-0.01	0.041	-0.011	-0.023	0.011	-0.009	0.023	0.001	0.003	-0.032	0.291	0.160	0.023	0.034	0.068	**0.003**	**-0.096**	**0.010**	-0.004	-0.004	0.133
Days to maturity(days)	-0.003	0.067	-0.022	0.023	0.005	-0.001	-0.017	0.002	-0.001	0.424	0.468	0.563	-0.019	0.053	-0.036	0.003	-0.026	0.015	**0.019**	**-0.016**	**0.047**

*I-2009, II- 2010, III-2011

*Residual effect (I) is 0.1162; *Residual effect (II) is 0.1197; *Residual effect (III) 0.187

TABLE2. PATH COEFFICIENT ANALYSIS OF POOLED MEAN (3 YEARS) OF THREE CONSECUTIVE YEARS FOR NON-SALINE ZONE

	Plant Height (cm)	***No. of Tillers / hill***	***No. of panicles/plant***	***No. of grains/panicle***	***Length of panicle (cm)***	***1000 seed weight(g)***	***Days to Maturity (days)***
Plant Height (cm)	***-0.1033***	*0.0301*	*-0.0922*	*0.7945*	*0.0665*	*0.0028*	*-0.0313*
No. of tillers/hill	*-0.0046*	***0.6712***	*-0.6824*	*0.2628*	*0.0165*	*0.0001*	*-0.0099*
No. of panicles/plant	*-0.0142*	*0.6812*	***-0.6724***	*0.3386*	*0.0057*	*0.0006*	*-0.0115*
No. of grains/panicle	*-0.0695*	*0.1494*	*-0.1928*	***1.1808***	*-0.0344*	*0.0012*	*-0.0317*
Length of panicle (cm)	*-0.0825*	*0.1331*	*-0.0459*	*-0.4878*	***0.0832***	*0.0046*	*-0.0238*
1000seed weight(g)	*-0.0549*	*0.0045*	*-0.0748*	*0.2813*	*0.0725*	***0.0052***	*-0.0134*
Days to maturity (days)	*-0.0609*	*0.1249*	*-0.1453*	*0.7053*	*0.0373*	*0.0013*	***-0.0531***

* Residual effect is 0.0328

Plant height resulted in positive indirect effect on seed yield via grains per panicle for three consecutive years and panicles per plant, 1000 seed weight and days to maturity for two seasons and positive indirect effect via tillers per hill, grains per panicle, length of panicle and 1000 seed weight for the pooled mean. Tillers per hill had positive indirect effect on seed yield via panicles/plant, grains/panicle and days to maturity for two consecutive years and positive indirect effect on grains per panicle, length of panicle and 1000 seed weight for the pooled mean of non-saline zone. Panicles per plant had positive indirect effect on seed yield via grains per panicle for three consecutive year, panicle length and tillers per hill for two consecutive years and same characters showed positive indirect effect on grain yield for the pooled mean also. Grains per panicle had positive indirect on grain yield via panicles per plant and days to maturity for two years. Length of the panicle had positive indirect effect through plant height, number of grains/panicle and 1000 seed weight for two consecutive years. Grains per panicle and length of the panicle recorded positive indirect effect for tillers per hill and 1000 seed weight for the pooled mean. 1000 seed weight had positive indirect effect on seed yield via grains per panicle (2 years) and panicle length (3 consecutive years). While for the pooled mean 1000 seed weight and days to maturity recorded positive indirect effect through tillers per hill, grains per panicle and length of panicle.

From path analysis computed of saline zone over the years (Table 3), revealed that grains per panicle (0.954) again exhibited maximum positive direct effect on grain yield followed by length of the panicle, days to maturity and number of tillers per hill. While pooled mean for three consecutive years of saline zone exhibited (Table 4) positive direct effect on grain yield were plant height, tillers per hill, grains per panicle, length of the panicle and days to maturity. High positive

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direct effect has also been reported for number of productive tillers per hill, days to maturity and panicle number in rice[10, 11,12, 13].

TABLE3. PATH COEFFICIENT ANALYSIS FOR THREE CONSECUTIVE YEARS FOR SALINE ZONE

	Plant Height (cm)			No. of tillers/hill			No. of panicles/plant			No. of grains/panicle			Length of panicle (cm)			1000 seed weight(g)			Days to maturity (days)		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Plant Height (cm)	**0.017**	**-0.056**	**0.074**	-0.013	0.010	-0.002	-0.002	-0.003	-0.015	0.267	0.223	0.478	-0.001	0.067	0.001	-0.014	0.001	-0.03	0.038	0.005	0.013
No. of tillers/hill	-0.003	-0.025	-0.012	**0.086**	**0.022**	**0.009**	-0.108	-0.008	0.030	0.161	0.383	-0.061	-0.006	0.049	-0.001	0.005	0.001	0.014	0.041	0.003	-0.011
No. of panicles /plant	0.001	-0.02	-0.029	0.072	0.020	0.008	**-0.128**	**0.009**	**0.038**	0.145	0.337	-0.209	-0.006	0.04	-0.001	0.04	0.001	0.018	0.066	0.002	-0.009
No. of grains/panicle	0.004	-0.013	0.037	0.014	0.009	-0.001	-0.019	-0.003	-0.008	**0.965**	**0.936**	**0.961**	-0.003	0.054	0.004	-0.009	0.001	-0.019	0.043	0.006	0.013
Length of panicle (cm)	-0.002	-0.029	0.025	-0.043	0.009	-0.001	0.058	-0.003	-0.003	-0.249	0.414	0.316	**0.012**	**0.121**	**0.001**	-0.013	0.002	-0.016	-0.023	0.011	0.007
1000 seed weight(g)	0.006	-0.024	0.049	-0.011	0.006	-0.003	0.012	-0.002	-0.015	0.227	0.456	0.407	0.004	0.071	0.001	**-0.041**	**0.003**	**-0.044**	0.027	0.004	0.013
Days to maturity (days)	0.007	-0.019	0.038	0.036	0.005	-0.004	-0.087	-0.001	-0.014	0.431	0.447	0.486	-0.003	0.098	0.003	-0.012	0.001	-0.023	**0.096**	**0.013**	**0.025**

#I-2009, II- 2010, III-2011

*Residual effect (I) is 0.0968; *Residual effect (II) is 0.1041; *Residual effect (III) is 0.17

TABLE4. PATH COEFFICIENT ANALYSIS OF POOLED MEAN (3 YEARS) OF THREE CONSECUTIVE YEARS FOR SALINE ZONE

	Plant Height (cm)	No. of Tillers / hill	No. of panicles/plant	No. of grains/panicle	Length of panicle (cm)	1000 seed weight(g)	Days to Maturity (days)
Plant Height (cm)	**0.0665**	0.2571	-0.2656	0.3285	0.0344	-0.0700	0.0821
No. of tillers/hill	0.0723	**0.2364**	-0.3495	0.8562	0.2614	-0.0219	0.1046
No. of panicles/plant	0.0493	0.2308	**-0.3581**	0.3577	0.1729	-0.0092	0.1061
No. of grains/panicle	0.0270	0.2506	-0.1586	**0.8078**	0.0516	-0.0437	0.0645
Length of panicle (cm)	0.0254	0.6852	-0.6867	0.4624	**0.0902**	-0.0877	0.1596
1000seed weight(g)	0.0472	0.0526	-0.033	0.3579	0.0802	**-0.0987**	0.0571
Days to maturity (days)	0.0436	0.1974	-0.3032	0.4161	0.1149	-0.0449	**0.1253**

*Residual effect of (II) is 0.0713

Plant height exhibited positive indirect effect on seed yield via grains per panicle and days to maturity for three consecutive years and length of the panicle for two consecutive years. Tillers per hill showed positive indirect effect for seed yield through 1000 seed weight for three consecutive years, grains per panicle and days to maturity for two years. While for the pooled mean plant height and tillers per hill had positive indirect effect on seed yield via tillers per hill (for plant height), grains per panicle, length of panicle and days to maturity. Panicles per plant had positive indirect effect on

seed yield via tillers per plant and 1000 seed weight for three consecutive years, while grains per panicle and days to maturity for two year. For the pooled mean of saline zone Panicles per plant also recorded positive indirect effect via plant height, tillers per hill, grains per panicle, length of the panicle and days to maturity. Grains per panicle had positive indirect effect on seed yield via days to maturity for three consecutive years, plant height, tillers per hill and panicle length, for two years and plant height, tillers per hill, panicle length and days to maturity for the pooled mean. Length of the panicle had positive indirect effect on seed yield via grains per panicle and days to maturity for two consecutive years and for the pooled mean it exhibited positive indirect effect through plant height, tillers, grains per panicle and days to maturity. 1000 seed weight had positive indirect effect through grains per panicle, length of the panicle and days to maturity (3 consecutive years). While for the pooled mean the 1000 seed weight and days to maturity recorded positive indirect effect through plant height, tillers per hill, grains per panicle and length of panicle. Days to maturity reflected positive indirect effect on seed yield through grains per panicle for three consecutive years, while plant height, tillers per hill and length of the panicle for two consecutive years. Grains per panicle showed the highest genotypic correlation(r = 0.983) with grain yield. This strong genetic correlation resulted in high positive direct effect on grain yield and it is in accordance with many researchers [14, 15, 7, 16,17].

Thus at three different locations, different genotypes gave different performance. First season at Sagardeep recorded outstanding results with respect to other salinity trials. But when another trial was conducted in similar location with same set of genotypes, they did not yield satisfactory result as that of the first. A possible reason for this difference in performance could be the management practices. Similar view was reported [18] Cardon *et al.* (2013) who reported that proper management of soil moisture, irrigation system and local drainage can be useful in managing soil salinity and thus lead to healthy seed yield. Thus it can be concluded that in the stress areas like that of salt, management practices are very essential. A better management practice can result in good crop yield.

By path coefficient analysis it was observed that the direct effects on seed yield per plant were exhibited by grains per panicle, tillers per hill, and days to maturity. On the other hand, the indirect effects of grains/ panicle through other traits also signifies that direct selection using grains/panicle to select high yielding genotypes for the coastal saline zone will be effective.

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Author' biography with Photo

Dr. Sritama Kundu completed her PhD from University of Calcutta in Genetics and Plant Breeding on "Screening for salinity tolerance in rice and its management". She did her post graduation from the same department in University of Calcutta. Sritama stood third at the University level.