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Original Research Article

Path Coefficient Analysis for Yield and Yield Components in Diverse Rice Genotypes

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A B S T R A C T

The objective of this study was to determine the relationship between grain yield and yield components in rice (*Oryza sativa* L.). Sixteen rice genotypes were used in this research procured from IRRI, Phillipines. A field experiment was conducted in a randomized complete block design with three replications at the field experimentation center of the department of Genetics and Plant Breeding of the SHIATS, Allahabad. The traits, harvest index, biological yield/plant, flag leaf width, tillers/plant, number of panicles/plant and number of spikelets/panicle correlated significantly with grain yield. Path coefficient analysis revealed that harvest index had the highest positive direct effect (1.02) on grain yield. Grain yield linearly correlated with number of spikelets/panicle, tillers/plant, panicles/plant, biological yield and harvest index. Therefore, these traits may be used in the selection for improvement of yield components in rice.

Keywords

Path coefficient analysis, Correlation, Rice grain yield, Yield component, Rice genotypes

Introduction

Path coefficient analysis is a statistical tool developed by Wright (Wright, 1921). It has been used to organize and present the casual relationship between predictor variables and response variables through a path diagram that is based on experimental results. The advantage of path analysis is that it permits the partitioning of the correlation coefficients into its components- one component being the path coefficient (or standardized partial regression coefficient) that measures the direct effect of a predictor variable upon its response variable, the second component being the indirect effects of a predictor variables on the response variable through other predictor variables (Dewey and Lu, 1959). In breeding system, path analysis has been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield.

In a breeding programme direct estimation of yield which has low heritability is difficult to obtain so plant breeders commonly select for yield components that indirectly increased yield (Gravois and McNew, 1993). Yield component breeding would be most effective if the components involved were highly heritable and positively correlated. Grain yield has been reported to be influenced by productive tillers/plant (Ibrahim *et al.,* 1990), panicles/plant (Kumar, 1992), gains per panicles and productive tillers (Sundaram and Palanisamy, 1994) and biological yield and harvest index (Surek *et al.*, 1998). The objective of this study was to determine the relationships between gran yield and yield components. After determining the characters which have high correlation with grain yield and positive effect on it, selection indices may be developed for rice breeding.

Materials and Methods

The present experiment was carried out at experimentation centre of the Department of Genetics and Plant Breeding, Allahabad school of agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India, situated at 25.87^0 N latitude, 81.5^0 E Longitude and altitude of 78 meters above mean sea level. The experiment was laid out in a Randomized Block Design (RBD) with three replications in *Kharif*-2015. The experimental material was planted in three blocks. Each block consisted of sixteen genotypes procured from IRRI, Phillipines (Table 1) randomized and replicated within each block. Twenty seven days old seedlings were transplanted 20cm apart between rows and 15 cm within the row. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Observations were recorded and the data was subjected to statistical analysis. The mean performance of individual genotype employed for statistical analysis.

Variability was measured by estimation of biometric parameters like coefficient of variation (genotypic and phenotypic), heritability and genetic advance. Environment plays an important role in the expression of phenotypic and genotypic facts, which are inferred from phenotypic observations. This would of great help to breeder in evolving a selection program improvement. The estimates of variance, coefficient of variation, heritability and genetic advance for all 13 characters studied (Table 4). Coefficient of variation is the percent ratio of standard deviation of sample to its mean value. Analysis of variance provides estimates of phenotypic and genotypic variance used for the estimation of respective coefficient of variation.

Analysis of variance to test the significance for each character was carried out as per methodology advocated by Panse and Sukhatme (IRRI, 2002), PCV and GCV were calculated by the formula given by Burton (Burton and Devane, 1953), heritability in broad sense (h^2) by Burton and De Vane (Burton and Devane, 1953) and genetic advance i.e., the expected genetic gain were calculated by using the procedure given by Johnson *et al.*, (IRRI, 2002) Statistical analyses for the above characters were done following (Al Jibouri *et al.,* 1958) for correlation coefficient and (Dewey and Lu, 1959) for path analysis. The estimated values were compared with table values of correlation coefficient to test the significance of correlation coefficient prescribed by (Fisher and Yates, 1967).

Results and Discussion

The correlation between all pairs of variables is show in table.2. The traits significantly correlated with grain yield were harvest index (0.93), biological yield (0.56), flag leaf width (0.37), tillers per plant (0.35), and panicles per plant (0.35). Previous papers have mentioned rice grain yield as a function of maximum tiller density, number of filled grains per panicle (Samonte *et al.*, 1998).

Path coefficients which are worked out from phenotypic correlation coefficient are referred to as phenotypic path. It splits the phenotypic correlation coefficients into the measures of direct and indirect effects. Table 3 shows the results of the path analysis for the examined traits. Path coefficient analysis of yield and its components revealed that harvest index had the highest positive direct effect (1.01) on grain yield. High positive direct effect of this character was nullified by the negative indirect effect of plant height (-0.41**), tillers per plant (-0.39**), spikelets per panicle (-0.35*) and panicles per plant (-0.31*), however it indirect effect via biological yield (0.33*), test weight (0.009), days to maturity (0.13), panicle length (0.18), flag leaf length (0.25) and flag leaf width (0.29). Similar results reported by (Ibrahim *et al.*, 1990). The biological yield per plant was the second most important character, it showed high positive direct effect (0.36) on yield. Its indirect effect via test weight and harvest index was very high, whereas its effect via panicles/plant and flag leaf length was negative. This was similar to previous reports (Sundaram and Palanisamy, 1994). Panicles per plant were the third most important trait which showed high positive direct effect (0.24) on yield. Its indirect effect via tillers per plant was positive whereas its effect via biological yield was negative.

Though the correlation coefficient of tillers per plant (0.35) and panicles per plant (0.35) with the yield was highly significant, its direct contribution (0.08) of tillers per plant was not high but direct contribution (0.24) of panicles per plant was high and it was also supplemented indirectly via the tillers per plant with correlation coefficient (0.35). The direct effect of flag leaf length was negative and low in spite of positive correlation coefficient (0.01).

Table.1 List of the genotypes used in the present investigation

S.no	Designation of genotypes	Grain type	Seed color
1.	IR11A257	Medium slender	Light brown
2.	IR11A293	Medium slender	Light brown
3.	IR11A534	Short slender	Light yellow
4.	IR11N169	Medium slender	White
5.	IR11N187	Short slender	Light brown
6.	IR11N304	Medium slender	Light brown
7.	IR11N400	Medium slender	White
8.	IR12L125	Medium slender	Light yellow
9.	IR12L159	Medium slender	Light brown
10.	OM6600	Short slender	White
11.	PR113	Medium slender	Light brown
12.	IRRI123	Medium slender	Light Yellow
13.	IR50	Long slender	white
14.	IR64	Long slender	White
15.	IR72	Long slender	Light Brown
16.	NDR359(LC)	Long slender	Light yellow

Table.2 Estimation of Phenotypic correlation coefficient between yield and its related traits in 16 rice genotypes

Sl. No	Characters	Plant height	Flag leaf length	Lag leaf width	Tillers/ plant	Panicles / plant	Panicle length	No. of spikelets /panicle	Days to maturit y	Biological yield /plant	Harvest index	Test weight	Seed yield /plant
1	Plant height	1.00	0.07	-0.05	0.13	-0.21	-0.01	0.36*	0.20	-0.29*	-0.41**	-0.26	-0.43
2	Flag leaf length		1.00	-0.28	0.24	-0.02	-0.04	-0.30*	0.54**	-0.27	0.25	-0.61**	0.01
3	Flag leaf width			1.00	-0.43**	-0.29	0.13	0.55 **	-0.35*	0.26	0.29	-0.01	0.37
4	Tillers /plant				1.00	0.56**	0.18	-0.10	0.06	-0.07	-0.39**	0.07	0.35
5	Panicles/plant					1.00	0.02	-2.5	0.10	-0.54**	-0.31*	0.006	0.35
6	Panicle length						1.00	0.006	0.22	0.28	0.18	0.29*	0.27
7	No. of spikelets /plant							1.00	-0.38**	0.07	-0.35*	-0.07	0.20
8	Days to maturity								1.00	-0.40**	0.13	-0.38*	-0.07
9	Biological yield /plant									1.00	0.33*	0.47**	0.56
10	Harvest index										1.00	0.009	0.93
11	Test weight											1.00	0.20

Table.3 Estimation of direct and indirect effects of yield related traits on seed yield in 16 rice genotypes at phenotypic level

Sl. No	Characters	Plant height	Flag leaf length	Lag leaf width	Tillers/plant	Panicles/ plant	Panicle length	No. of spikelets /panicle	Days to maturity	Biological yield /plant	Harvest index	Test weight	Seed yield /plant
1	Plant Height (cm)	**0.1106**	0.0088	-0.0065	0.0146	-0.0235	-0.0020	0.0399	0.0231	-0.0330	-0.0463	-0.0288	-0.4331
2	Flag Leaf length (cm)	-0.0081	**-0.1017**	0.0285	-0.0253	0.0030	0.0042	0.0308	-0.0558	0.0280	-0.0262	0.0629	0.0133
3	Flag Leaf width (cm)	0.0074	0.0350	**-0.1246**	0.0546	0.0363	-0.0164	-0.0693	0.0439	-0.0335	-0.0365	0.0013	0.3754
4	Tillers/ plant	-0.0115	-0.0216	0.0380	**0.0867**	-0.0487	-0.0160	0.0092	-0.0054	0.0065	0.0343	-0.0068	0.3592
5	Panicle/ plant	-0.0514	-0.0070	-0.0705	0.1360	**0.2419**	0.0059	-0.0611	0.0255	-0.1311	-0.0752	0.0015	0.3565
6	Panicle length (cm)	-0.0003	-0.0006	0.0019	0.0027	0.0004	**0.0148**	0.0001	0.0033	0.0043	0.0028	0.0044	0.2786
7	Spikelets/ panicle	0.0626	-0.0525	0.0966	-0.0185	-0.0439	0.0011	**0.1735**	-0.0672	0.0122	-0.0618	-0.0135	0.2019
8	Days to Maturity	-0.0074	-0.0194	0.0125	-0.0022	-0.0037	-0.0080	0.0137	**-0.0354**	0.0145	-0.0048	0.0134	-0.0741
9	Biological Yield (gm)	-0.1094	-0.1011	0.0988	-0.0275	-0.1990	0.1054	0.0259	-0.1501	**0.3671**	0.1214	0.1750	0.5673
10	Harvest Index (%)	-0.4295	0.2642	0.3005	-0.4058	-0.3190	0.1938	-0.3657	0.1383	0.3395	**1.0266**	0.0095	0.9343
11	Test Weight (gm)	0.0039	0.0092	0.0002	-0.0012	-0.0001	-0.0044	0.0012	0.0057	-0.0071	-0.0001	**-0.0149**	0.2042

Table.4 Estimation of components of variance and genetic parameters for 13 characters in rice germplasm

Characters	Vg	V_p	Coefficient of variation		h^2 (bs) (%)	GA	GA as (%)
			PCV (%)	GCV (%)			
Days to 50% flowering	26.22	27.29	5.26	5.16	96.10	10.33	10.41
Plant height	55.77	56.74	8.77	8.70	98.30	15.25	17.76
Flag leaf length	98.82	99.49	26.58	26.49	99.30	20.40	54.40
Flag leaf width	0.084	0.116	23.53	20.00	72.30	0.72	35.03
Numbers of tillers per plant	4.20	4.89	23.38	21.68	86.00	3.91	41.41
Number of panicles per plant	2.78	3.08	28.079	26.88	90.30	3.26	52.22
Panicle length	1.82	2.10	6.47	6.02	86.50	2.58	11.53
Number of spikelets per panicle	1220.32	1228.67	25.46	25.46	99.30	71.71	52.09
Days to maturity	21.776	25.81	3.91	3.91	84.40	8.82	6.80
Biological yield per plant	6.26	6.29	7.73	7.73	99.60	5.14	15.85
Harvest index	157.932	157.938	26.45	26.45	100.00	25.88	54.50
Test weight	36.87	36.98	24.348	24.317	99.70	12.49	50.02
Seed yield per plant	16.692	16.70	28.13	28.13	99.90	8.41	57.93

This was mainly because of negative indirect effect of the tillers per plant and plant height while very small contribution via flag leaf width, number of spikelets per plant and biological yield were revealed by this character. The flag leaf width was another character which had negative direct effect on yield. It showed positive indirect effect via tillers per plant, panicles per plant, days to maturity and flag leaf length while the negative forces of this characters were panicle length and biological yield and harvest index. The direct influence of number of spikelets per panicle was negative and its negative indirect effect were mainly days to maturity (-0.06) and harvest index (-0.06).

The organization of 13 traits into first, second, and third order variables in the path analysis provided more information than if all traits were treated only as first-order variables.

The yield components (plant height, flag leaf width, flag leaf length, tillers per plant, panicles per plant, panicle length, number of spikelets per panicles, days to maturity, biological yield, harvest index, test weight and seed yield) had a direct effect on yield if other components kept constant. But the magnitude of direct effect of harvest index was maximum. An overall analysis of path coefficient suggested that panicles per plant, tillers per plant, number of spikelets per plant, biological yield and plan height should be given the maximum consideration for yield improvement and appropriate selection indices should be formulated using these traits.

Estimates of genotypic and phenotypic coefficient of variation and genetic advance due to selection are presented in table 3. The success of plant breeding operations relies heavily on extent of genetic variability present in crop species for a particular trait. In fact plant breeding uses selection for improving the architecture of a crop by management of available genetic variability (Gravois and McNew, 1993; Mehetre *et al.*, 1994). In the present study, the genotypic coefficient of variation (GCV) was less than its corresponding estimates of phenotypic coefficient of variation (PCV) for all traits indication significant role of environment in the expression of these traits. Relatively higher estimates of GCV for the tillers per plant, panicles per plant, number of spikelets per panicle, flag leaf length, flag leaf width, harvest index and test weight suggest that the selection can be effective for these traits. Lines or genotypes with high number of spikelets per panicle and high number of panicles per plant will have high grain yield (Kumar, 1992). Therefore, these traits are good criteria for selection of genotypes with high yield.

In summary, our results suggest that a plant type for increasing grain yield should have high number of spikelets per panicle, high number of panicles per plant and high number of tillers per plant. Among these traits, number of spikelets per panicle and number of panicles per plant may be used for the indirect selection of grain yield.

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