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Research Article

Principal component analysis of yield and yield related traits in rice (*Oryza sativa* L.) landraces

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Abstract

A total of 49 rice landraces were investigated for eight traits using principal component analysis (PCA) for the determination of variation pattern, the relationship among genotypes and its traits. Out of eight principal components (PC), three PC's exhibited Eigenvalue more than one with 72.9 per cent of total variability among the characters. The highest positive Eigenvalue observed for the number of productive tillers per plant (0.148) and flag leaf length (0.148) in PC1 indicated their pronounced effect in the overall variation of the genotypes. The study revealed the traits that are contributing maximum for the variation. Hence, selective rice landraces can be utilized for improving these traits in high yielding cultivars through suitable breeding programmes.

Key words: principal component analysis, rice landraces, genetic diversity

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal crop cultivated all over the world and serves as the major staple food for one-third of the global population. Among the rice producing countries, India covers the area of 44 million hectares under rice cultivation in the world with the production of 121.46 million tonnes (Ministry of Agriculture and Farmers Welfare, Government of India, 2020-21). Considering the increase in human population and decline in natural resources, the development of new high yielding rice varieties has become essential.

The landraces are the valuable treasure of genetic material which possesses potential traits for future crop development and improvement programs (Sinha and Mishra, 2012). The green revolution has significantly increased the production of food grains and achieved the status of self-sufficiency in our country (Maji and Shaibu, 2012). But on the other side, high yielding varieties have stimulated the erosion of landraces and wild varieties

of rice (Sajid *et al.*, 2015). The importance of landraces can never be denied in the agricultural system, because improvement in existing variety depends upon desirable genes present in landraces and wild varieties only. Assessment of genetic diversity is very important in rice breeding from the viewpoint of selection, conservation of different rice landraces and proper utilization (Jayasudha and Sharma, 2010). Principal Component Analysis (PCA) is a powerful and well-known multivariate statistical tool in data analysis, used to identify the minimum number of components, which can elucidate maximum variability out of the total variability (Anderson, 1972) and also to rank genotypes on the basis of PC scores. Principal components are generally estimated either from the correlation matrix or covariance matrix. Considering the importance of PCA, this study was conducted on 49 rice landraces with an objective to identify the quantitative traits responsible for the variations among the rice genotypes.

MATERIALS AND METHODS

The experiment was carried out using forty nine rice landraces (**Table 1**) at the research fields of the Department of Plant Breeding and Genetics, Anbil Dharmalingam Agricultural College and Research Institute, Trichy. The experiment was laid in randomized block design with three replications during the late *samba* season of the year 2020. All the genotypes were sown in raised bed nursery and 25 days old seedlings were transplanted to the main field with the spacing of 20 x 20 cm. Recommended agronomic practices were followed for good crop maintenance. Observations on eight yield contributing traits viz., Days to 50% flowering, plant height (cm), flag leaf length (cm), the number of productive tillers per plant, panicle length (cm), the number of grains per panicle, hundred grain weight (g) and single plant yield (g) were recorded on five randomly selected plants in each replication. The principal component analysis was used to identify the traits with a maximum contribution to the variation among forty nine genotypes. From the mean values of 49 genotypes for eight quantitative traits, principal components were estimated using STAR software.

RESULTS AND DISCUSSION

Principal component analysis (PCA) is used to transform large data set into smaller principal components without any loss of details, by considering the interdependence among the characters. Eigenvector value, percentage of variation and cumulative percentage are given in **Table 2**. In the present study, out of eight components studied, three components showed Eigenvalue greater than 1. The principal components having more than one Eigenvalue showed more variation among the rice genotypes for the selection of diverse parents. Percentage of variation for three components (PC1, PC2, PC3) together accounted for 72.9 per cent of variability among the genotypes studied and the remaining five components accounted for only 27 per cent variability. The contribution of eight quantitative traits to the principal components is presented in **Table 3**. The number of productive tillers (0.1482) and flag leaf length (0.1482) showed positive loading in PC1 while other traits showed negative loadings. In PC2, the parameters viz., panicle length (0.0519), hundred seed weight (0.5644) and single plant yield (0.4951) showed positive loading and remaining factors showed negative loadings. In PC3, traits

Table 1. List of rice landraces used in this study

S.No.	RG No.	Genotypes	S.No.	RG No.	Genotypes
1	RG3	Senkar	26	RG201	Poombalai
2	RG4	Murugankar	27	RG202	Ottadam
3	RG12	Vellaichithiraikar	28	RG204	Poongar
4	RG15	Palkachakha	29	RG205	Kaatu samba
5	RG25	Soma kuruvai	30	RG206	Kulivedichan
6	RG37	Shenmolgi	31	RG207	Karuppu kavuni
7	RG48	Kalarkar	32	RG208	Ilupaipoo samba
8	RG66	Seevana samba	33	RG209	Signikar
9	RG76	Matta kuruvai	34	RG215	Kuruvai samba
10	RG77	Karuthakar	35	RG219	Kichadi samba
11	RG82	Thooyamalli	36	RG220	Samba mosanam
12	RG95	Jeeraga samba	37	RG221	Swarna mughi
13	RG103	Mattaikar	38	RG225	Garudansamba
14	RG106	Katta samba	39	RG227	Kothamalli samba
15	RG110	Norungan	40	RG230	Ramakali
16	RG126	Kallimadayan	41	RG231	Kalanamak
17	RG164	Thillainayagam	42	RG233	Salem samba
18	RG193	Kavuni sigappu	43	RG237	Rathasali
19	RG194	Poovan samba	44	RG240	Kaatu vanibam
20	RG196	Perungar	45	RG241	Vaadan samba
21	RG197	Iravai pandi	46	RG244	Koombalai
22	RG198	Vasaramundan	47	RG245	Swarna kichadi
23	RG199	Kallundai	48	RG247	Katarni
24	RG200	Karunguruvai	49	AC39389	Chettivirippu
25	RG222	Navaran			

Table 2. Eigen values, Percentage of variation and Cumulative percentage for principal components

Principal components	Eigen values	Percentage of variation	Cumulative percentage
PC1	3.0977	38.72	38.72
PC2	1.5273	19.09	57.81
PC3	1.2117	15.15	72.96
PC4	0.7352	09.19	82.15
PC5	0.5548	06.93	89.08
PC6	0.4100	05.12	94.21
PC7	0.3089	03.86	98.07
PC8	0.1544	01.93	100.00

Table 3. Contribution of first three principal components to variation in rice landraces

Parameters	PC1	PC2	PC3
Days to 50% flowering	-0.3365	-0.4069	0.1968
Plant height	-0.4045	-0.1249	0.2403
Number of productive tillers	0.1482	-0.0630	0.7210
Flag leaf length	0.1482	-0.0630	0.7210
Panicle length	-0.4289	0.0519	-0.2030
Number of grains per panicle	-0.3469	-0.1844	-0.4768
Hundred seed weight	-0.3575	0.5644	0.0699
Single plant yield	-0.3734	0.4951	0.2651

like panicle length (-0.2030) and the number of grains per panicle (-0.4768) showed negative loading whereas, further traits showed positive loadings. These traits are largely engaged in the divergence and they also carry most of the variability. Kumari *et al.* (2021) based on their study in 119 rice breeding lines along with two checks reported that the first three PCs together contributed 68.69 per cent to the total variability and that the number of productive tillers per plant showed positive loading in PC1. Hence, the selection of traits with high variability will be rewarding for future breeding programs.

Scree plot elucidated the variation percentage between Eigenvalues and the Principal components (**Fig 1.**). In this study, PC1 showed 38.7 per cent variability with Eigenvalue of 3.09. From the graph, it is clear that the maximum variation was observed in PC1 in comparison to other PCs. Rahangdale *et al.* (2021) reported maximum variation of 20.82 per cent in PC1 in their study on 67 rice lines. Hence, the genotypes selected from PC1 would be useful in future breeding programmes for the improvement of the traits contributing maximum variability viz., the number of productive tillers per plant and flag leaf length.

The biplot diagram gives the picture of interaction among the characters and also the genotypes performing better for the traits. The vector length of each trait depicts its

contribution to total divergence, longer the vector length, more is the contribution of concerned traits. In this study, the distribution and nature of diversity for genotypes and quantitative traits are described in the biplot diagram (**Fig. 2.**) between PC1 and PC2. The trait hundred grain weight showed maximum vector length indicating its contribution to the total divergence followed by flag leaf length, panicle length and plant height. The angle between the trait vectors indicates the direction of association between the traits. An acute angle (<90°) between vectors indicates a positive correlation, whereas an obtuse angle (>90°) indicates a negative correlation and a right angle (90°) indicates no correlation. Out of eight traits studied, the traits viz., days to 50% flowering, plant height, flag leaf length, panicle length, the number of grains per panicle, hundred grain weight showed a positive correlation with grain yield per plant. The genotypes that are present close to the trait vector of the same quadrant would be the best performing for those traits. The genotypes viz., Senkar, Kallundai, Kichadi samba, Navaran along with other genotypes in the particular quadrant perform better for the traits like plant height, days to fifty per cent flowering, flag leaf length and the number of grains per panicle. The genotypes like Murugankar, Kallimadayan, and Kaatuvaanibam along with others are the best performing genotypes for the traits hundred seed weight, panicle length and single plant yield. Shenmolgi, Mattaikar, Ramakali are some of the poor performing genotypes for

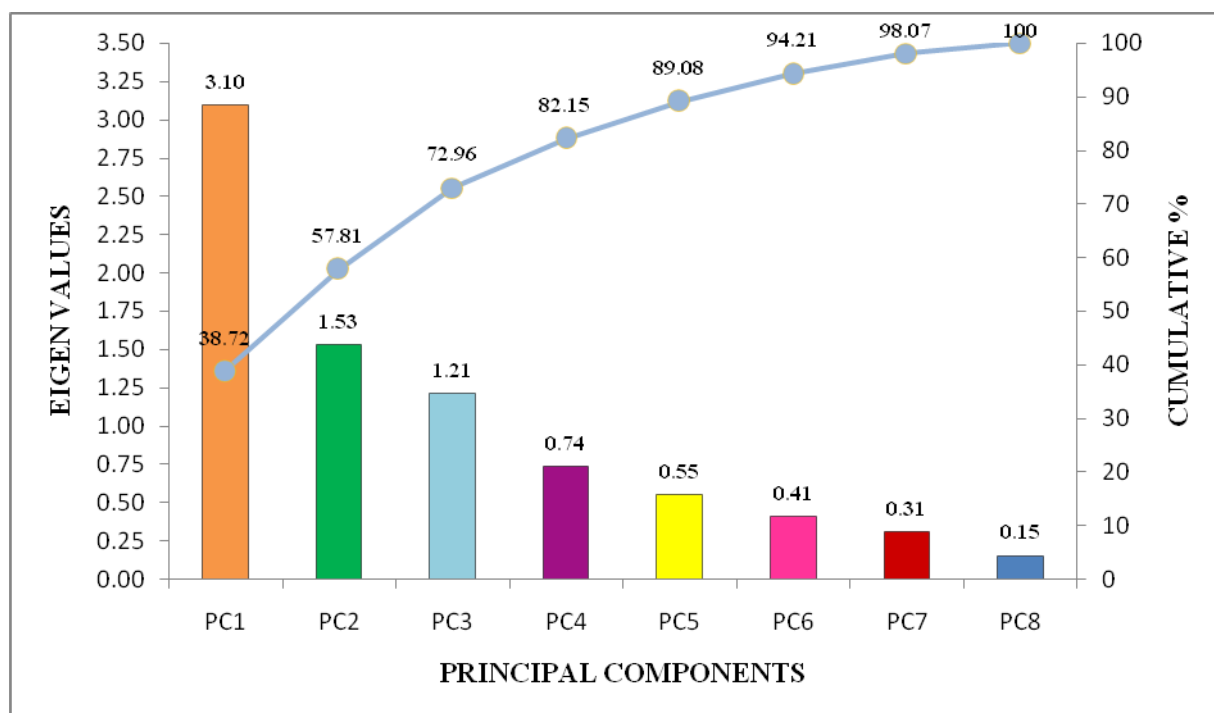


Fig. 1. Scree plot diagram using principal components of rice landraces

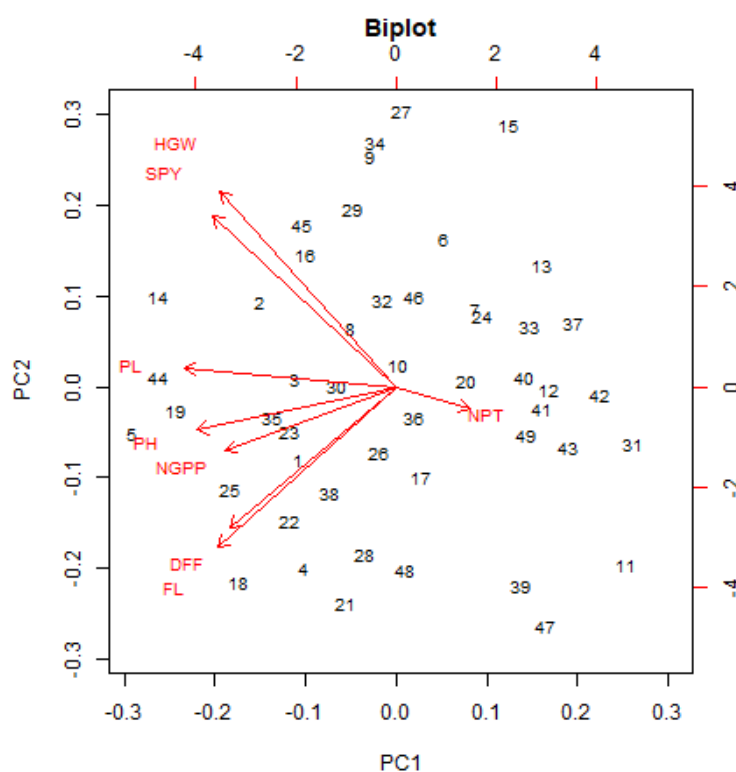


Fig. 2. Biplot diagram of principal components 1 and 2

Note : The corresponding landraces for the serial numbers mentioned in the figure are furnished in Table 1.

the traits under consideration as they are present in the opposite direction to the trait vector.

Thus, the present study can be utilized to identify the variability contributing parameters and to select the landraces to utilize them as donors for the improvement of traits in future breeding programs.

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