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Research Article

Principal component analysis for grain quality characters in rice germplasm

K.R.V. Sathya Sheela[1], S. Robin[2] and S. Manonmani[3]

[1]Assistant Professor, Maize Research Station, Vagarai TNAU, Coimbatore, Tamil Nadu, India.
[2]Former Dean, SPGS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
[3]Professor and Head, Dept of Plant Genetic Resources, CPBG, Tamil Nadu Agricultural University Coimbatore, Tamil Nadu, India.
E-Mail: sathyakrv@yahoo.co.in

Abstract

Rice is the dietary staple for more than one third of the world's population and it is a model cereal species serving as the genetic platform to study the functions of the genes. In the present study, twenty four genotypes were studied for the thirteen grain quality traits. Principal Component Analysis was utilized to estimate the relative contribution of various traits for total variability. Four components were found to possess Eigen value more than 1. The PC1, PC2, PC3 and PC4 contributed 27.73, 19.12, 15.27 and 10.12 per cent of variability. Together, they accounted for 72.24 per cent of the variability of the genotypes used in the study has revealed the traits contributing for the variation.

Keywords

Rice, genotypes, variability

INTRODUCTION

Rice is the world's most important food crop, the dietary staple for more than one-third of the world's population. Rice is the holder of two important titles, *i.e*., the most important food crop in the world catering to the calorific needs of majority of the global population and a model cereal species serving as the genetic platform to study the functions of the genes. Due to self sufficiency in production, rice quality is of great importance to people involved in producing, processing and consuming rice and the most important quality components includes appearance, milling, cooking and processing quality, and nutritional quality (Koutroubas*et al.,* 2004). Rice has one of the largest germplasm collections in the world. This accessible collection of diverse cultivated and wild rice germplasm has made great contributions to rice breeding. Sufficient knowledge about genetic diversity in the gene pool is a prerequisite to adapt an efficient and valuable breeding approach. Characterization of this existing variability and realignment of characters in them through selective breeding might go a long way in meeting the existing and emerging challenges that threaten the world food security (Vanaja and Babu, 2006). Principal Component Analysis is one of the important tools used for identifying the plant characters that categorize the distinctiveness among the promising genotypes. PCA helps to eradicate redundancy in data sets due to regular variation occurring regularly in the crop species (Majiand Saibu, 2012) and (Ramakrishnan*et al.,* 2016). Hence, the importance of PCA is considered and the investigation was carried out in the rice germplasm.

MATERIALS AND METHODS

Twenty four genotypes of rice were used to reveal the genetic relationship between the different accessions. The experiment was conducted at Paddy Breeding Station, Coimbatore, Tamil Nadu Agricultural University, Coimbatore. The grain quality traits *viz*., hulling and milling out turn, head rice recovery, grain length, grain breadth, L/B ratio and cooked rice quality characterized by grain length after cooking, grain breadth after cooking, LER, BER, gelatinization test, gel consistency and amylose content were estimated (Juliano, 1979) and the list of twenty four genotypes represented in **table 1.**The Principal Component Analysis was carried out to identify plant traits that contribute most of the observed variations among the genotypes. Mean values of 24 genotypes for thirteen quantitative traits were used. Principal Components are generally estimated from correlation matrix or covariance matrix. The analysis was conducted using STAR software.

Table 1. Genotypes used in the study

1.	BPT 5204	13.	JGL 3844
2.	IET 19555	14.	JalaharaPonni
3.	MTU-1561-4-1-1-1	15.	KDML 105
4.	KJTG MS -4B	16.	Sonamasuri
5.	KJTG MS -5B	17.	RTN 10B
6.	BG 304	18.	KJTG MS-1B
7.	IET 19577	19.	CBO2 - 595
8.	CN 1081-3-18	20.	JGL 3855
9.	AT 362	21.	early Samba
10.	JGL 1798	22.	CB04-110
11.	BPT 5204	23.	CO 47
12.	IET 19555	24.	ADT 45

RESULTS AND DISCUSSION

The purpose of the PCA is to obtain a small number of factors which account for maximum variability out of the total variability. Eigen vector values, percentage of variance and the cumulative percentage are presented in **table 2**. In this case, 4 components had Eigen values greater than 1.0. PCA 1, 2, 3 and 4 had Eigen values of 3.605, 2.485, 1.985, and 1.316 respectively. Percentage of variance for the four factors was 27.73, 19.12, 15.27 and 10.12 per cent. Together they accounted for 72.24 % of the variability of the genotypes used for the diversity analysis. The contributions of the quality characters for the principal component are presented in **table 3**. Water absorption by weight(0.2829), amylose (0.1823,) showed positive loadings in PC 1 and the remaining parameters showed negative loadings. In PC2, Hulling%(0.4063), LER(0.3677) milling%(0.3574) and grain breadth(0.3108) showed positive loadings and the remaining factors showed negative loadings. The parameters *viz*., gel consistency(0.4813), HRR(0.3564), BER(0.2707), and milling%(0.1920) showed positive loadings on the PC3 whereas Breadth(-0.5387), amylose(-0.2804) and grain breadth after cooking(BAC-0.1059) showed negative loadings. These traits have the largest participation in the divergence and carry the largest portion of its variability. Similar studies were done by Nachimuthu*et al*. (2014) and Gour*et al*. (2017)

Table 2. Eigen values, proportion of variance and cumulative proportion of rice germplasm

Principal Components	EigenValues	Proportion of Variance	Cumulative Proportion
PC1	3.6045	0.2773	0.2773
PC2	2.4851	0.1912	0.4684
PC3	1.9853	0.1527	0.6211
PC4	1.3160	0.1012	0.7224
PC5	0.9794	0.0753	0.7977
PC6	0.7327	0.0564	0.8541
PC7	0.6736	0.0518	0.9059
PC8	0.5238	0.0403	0.9462
PC9	0.4351	0.0335	0.9796
PC10	0.2571	0.0198	0.9994
PC11	0.0052	0.0004	0.9998
PC12	0.0020	0.0001	1.0000
PC13	0.0004	0.0000	1.0000

Scree plot explained the percentage of variation by a graph between Eigen Values and Principal Components (**Fig. 1**). It is clearly depicted in the graph that the maximum variation was observed in PC1, PC2, PC3 and PC4 (Gour *et al.,* 2017). The distribution of the scores for the thirteen quality traits in the Principal Component Analysis were broad showing the large diversity. The analysis explained the variance structure through a few linear combination of the variables, proportion of variability. Thus on the basis of factor loadings, an exact picture of the component traits that are contributing maximum variability is obtained. The information on genetic diversity are essential for shaping breeding strategies, heterotic grouping and to predict future hybrid performance (Acquaah, 2012). The biplot diagram (**Fig. 2**) between PC 1 and PC2 explained the distribution and the nature of diversity for both variables and the genotypes. The loading plot depicted that almost all the genotypes and variables showed high degree of variation. Similar reports were observed by Ravi *et al.,* 2018.

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Table 3. Contribution of first four principal components to variation in rice varieties

Parameters	PC1	PC2	PC3	PC4
Hulling %	-0.2391	0.4063	0.1181	0.1246
Milling %	-0.0577	0.3574	0.1920	0.3966
HRR	-0.0645	0.0777	0.3564	0.4946
Length	-0.3664	-0.3635	-0.1207	0.0966
Breadth	-0.0940	0.3108	-0.5387	0.1994
L/B ratio	-0.2684	-0.4786	0.1956	0.0185
LAC	-0.4740	-0.0498	-0.0724	-0.1927
BAC	-0.4165	0.0559	-0.1059	0.1423
LER	-0.2860	0.3677	0.0262	-0.0304
BER	-0.3540	-0.1408	0.2707	0.0293
Water Absorption by weight	0.2829	-0.0211	0.2740	-0.2894
Gel consistency	0.0407	0.0606	0.4813	0.1330
Amylose	0.1823	-0.2804	-0.2804	0.4635

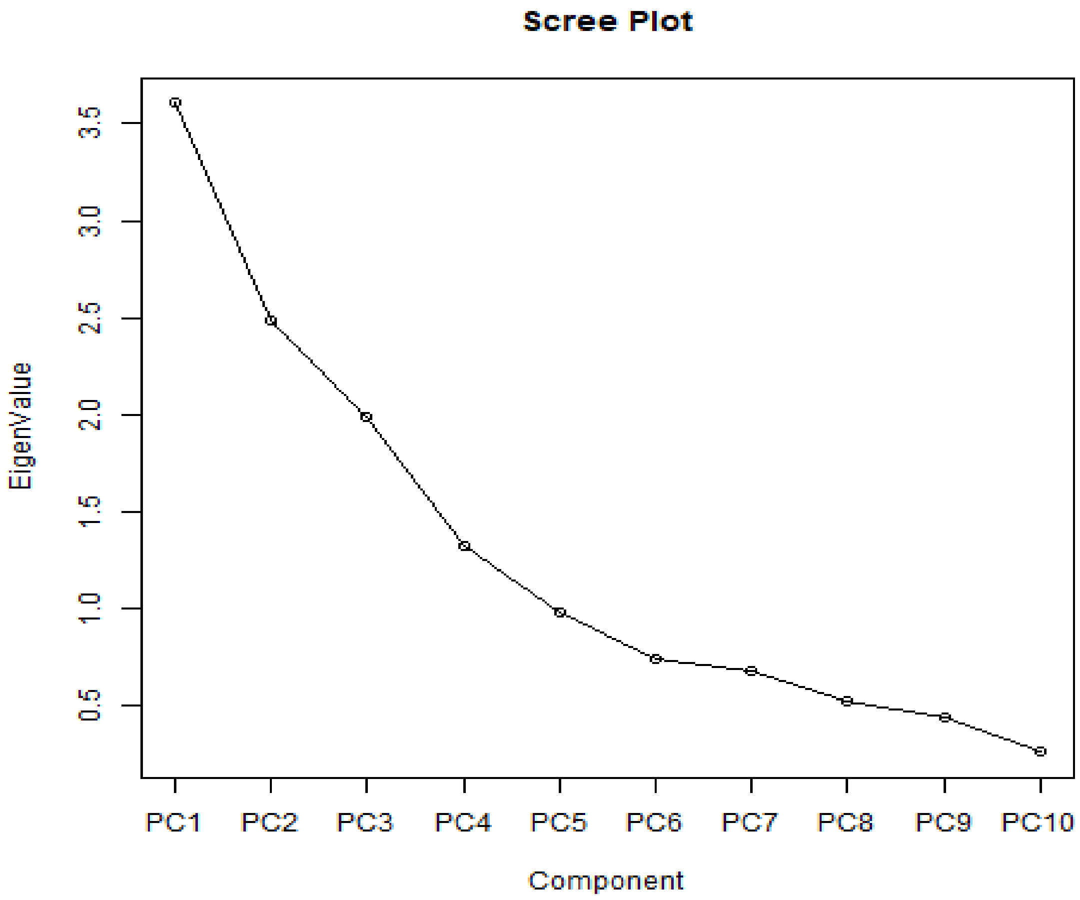

Fig. 1. Scree plot diagram constructed using thirteen principal components.

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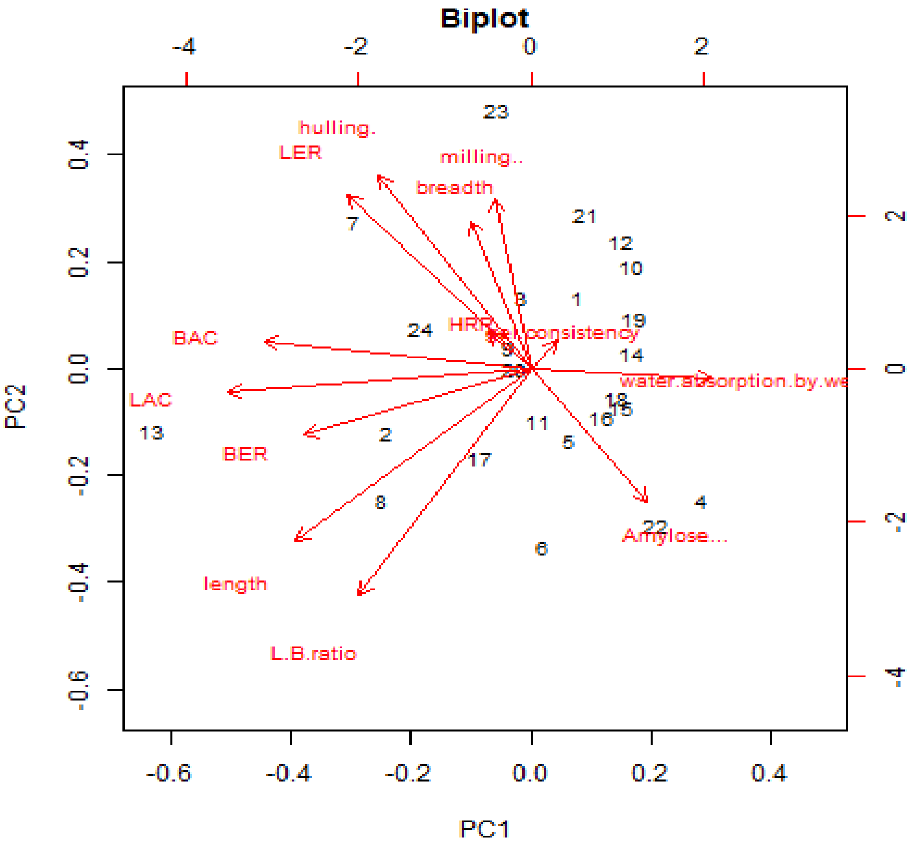

Fig. 2.Biplot diagram of principal components

Nowadays, in addition to yield, the grain quality characters are gaining much importance. Principal Component Analysis revealed the relative contribution of grain quality traits in creating the variability. Four principal components, PC1, PC2, PC3 and PC4 showed variability of 27.73, 19.12, 15.27 and 10.12 per cent respectively. The biplot diagram exhibited high variability among the genotypes and between the parameters. In this regard, the study will be helpful in identifying the variability contributing parameters and selection of suitable genotypes for breeding and utilization in crop improvement for grain quality traits.

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REFERENCES

Acquaah G. 2012. Principles of plant genetics and breeding.Second edition. Wiley-blackwellpublications.; 127- 129. [Cross Ref]

Juliano, B. O. 1979. A simplified assay for milled rice amylose.Cereal Sci. Today, **16**: 334-338.

Koutroubas S. D., F. Mazzini, B. Pons and Ntanos. 2004. Grain quality variation and relationships with morphological traits in rice (*Oryzasativa* L.) genetic resources in Europe. Field Crops Research, **86**:115-130. [Cross Ref]

LokeshGour, SB Maurya, GK Koutu, SK Singh, SS Shukla and DK Mishra. 2017. Characterization of rice (*Oryza sativa* L.) genotypes using principal component analysis including scree plot & rotated component matrix. International Journal of Chemical Studies. **5**(4): 975-983.

Maji AT, Shaibu AA. 2012. Application of principal component analysis for rice germplasm characterization and evaluation. Journal of Plant Breeding and Crop Science. 4(6):87-93. [Cross Ref]

Nachimuthu VV, Robin S, Sudhakar D, Raveendran M, Rajeswari S, Manonmani S. 2014. Evaluation of Rice Genetic Diversity and Variability in a Population Panel by Principal Component Analysis. Indian Journal of Science and Technology. **7**(10):1555-1562.

Ramakrishnan P, Babu C, Iyanar K and N. Manivannan. 2014. Principal component analysis for evaluation of Guinea grass (*Panicum maximum*jacq.) germplasm accessions. The Bioscan. **11**(4): 2859-2862.

Ravi Yugandhar P, SuneethaKota UshaKiran, B. and Sridhar, M. 2018. Principal component analysis for agro-morphological and quality characters in germplasm of rice (*Oryza sativa* L.). International Journal of Advanced Biological Research**, 8** (2): 268-273.

Vanaja, T. and L. C. Babu. 2006. Variability in grain quality attributes of high yielding rice varieties (*Oryza sativa L.*) of diverse origin. Journal of Tropical Agriculture, 44(1-2): 61-63.