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Identification of Superior NPT Rice Genotypes Based on Result of Principal Component Analysis

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Abstract

Rice feeds more than half the world's population, and improving the productivity of this grain is necessary for food security. Rice is most important and staple food crop because more than half of the world's population (>3.5 billion) depends on it for their livelihood. The research workwas conducted at Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh during *kharif* season (2019). The experiment was performed on 80 NPT rice genotypes. These genotypes were planted in randomized complete block design. All the given eighty rice genotypes were studied for Principal Component Analysis for identification of the superior rice genotypes. The result shown PC-1 accounted for 20.90 % of total variability, whereas, PC-2, PC-3, PC-4, PC-5, PC-6, PC-7 and PC-8 exhibited 15.01, 13.09, 10.73, 8.59, 6.21, 5.40 and 3.70 respectively. Among the genotypes under the study; JNPT-809, JNPT(S)10-1-1B, JNPT-533, JNPT-521-1 and JNPT-526 shown their dominance in yield as well as quality attributing traits.

Key words : *Eigenvector, covariance, PCA, rotated component matrix, scree plot.*

Introduction

Rice (*Oryza sativa* L.) is the most important food crop and a primary food source for more than one third of the world's population. Rice feeds more than half the world's population, and improving the productivity of this grain is necessary for food security. Despite the major improvement in grain yield delivered by the exploitation of semi-dwarfism and heterosis (1,2). Rice is most important and staple food crop because more than half of the world's population (>3.5 billion) depends on it for their livelihood (3,4,5). It is cultivated in more than 100 countries worldwide. In an effort to overcome the yield ceiling of current rice varieties, the ideotype approach has been proposed and used in breeding programmes to improve rice yield potential (6).

Principal component analysis (PCA), also known as Karhunen-Loeve expansion, is a classical feature extraction and data representation technique widely used in the areas of pattern recognition and computer vision such as face recognition (7). Principal component analysis is one of the important statistical tool of diversity analysis. The Principal component analysis (PCA) is an Eigen vector based multivariate statistical technique which analyze and simplify the inter- relationship among a large set of variables in a small set of variables or components without losing any essential information of original data set, hence it reduces a large series of data into smaller number of components. Each component describes per cent variation to the total variability. PCA also is a tool to reduce multidimensional data to lower dimensions while retaining most of the information. It covers standard deviation, covariance, and eigenvectors. Theobjective of principal component analysis is to identify the minimum number of components, which can explain maximum variability out of the total variability (8,9) and also to rank genotypes on the basis of PC scores.

Materials and Methods

The research workwas conducted at Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh during *kharif* season (2019). The experimental material of this investigation was comprised of 80 NPT rice genotypes. These genotypes were planted in randomized complete block design. The observations were recorded by selecting 5 random plants for twenty-eight quantitativecharacters. All the given eighty rice genotypes were studied for Principal Component Analysis for estimating genetic diversity and identification of superior rice genotypes.

Results and Discussion

Among the 28 rice genotypes studied, only 8 principal components (PCs) exhibited more than 1.0 eigen value and showed about 83.63 % variability among the traits studied. (here only eighth PCs were considered possessing most variability in the proposed characters). The PC-1 accounted for 20.90 % of total variability, whereas, PC-2, PC-3, PC-4, PC-5, PC-6, PC-7 and PC-8 exhibited 15.01, 13.09, 10.73, 8.59, 6.21, 5.40 & 3.70

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Table-1 : Eigen values, % variance and cumulative % variance values of different traits in NPT lines of rice.

Characters	PC	Eigen value	Variability (%)	Cumulative %
DTPI	PC1	5.852	20.901	20.901
DTM	PC2	4.203	15.011	35.912
NOT	PC3	3.665	13.091	49.002
NOET	PC4	3.005	10.732	59.734
Plant height (cm.)	PC5	2.404	8.585	68.320
Stem length (cm.)	PC6	1.739	6.211	74.531
Stem thickness (cm.)	PC7	1.513	5.402	79.932
FLL (cm.)	PC8	1.036	3.701	83.634
FLW (cm.)	PC9	0.957	3.419	87.053
Panicle length (cm.)	PC10	0.759	2.710	89.763
Panicle Weight (g)	PC11	0.557	1.989	91.751
spikelets per panicle	PC12	0.497	1.775	93.526
fertile spikelet per panicle	PC13	0.386	1.378	94.904
SF%	PC14	0.339	1.209	96.113
SD	PC15	0.291	1.038	97.151
1000 GW.	PC16	0.213	0.759	97.910
GL (mm)	PC17	0.182	0.652	98.562
GB (mm)	PC18	0.149	0.532	99.094
DGL (mm)	PC19	0.112	0.399	99.493
DGB (mm)	PC20	0.062	0.220	99.713
L/B Ratio	PC21	0.044	0.158	99.871
H%	PC22	0.012	0.044	99.915
M%	PC23	0.012	0.042	99.957
HRR%	PC24	0.005	0.019	99.976
BYPP	PC25	0.005	0.018	99.994
PI%	PC26	0.001	0.003	99.997
HI%	PC27	0.001	0.003	100.000
GYPP(g)	PC28	0.000	0.000	100.000

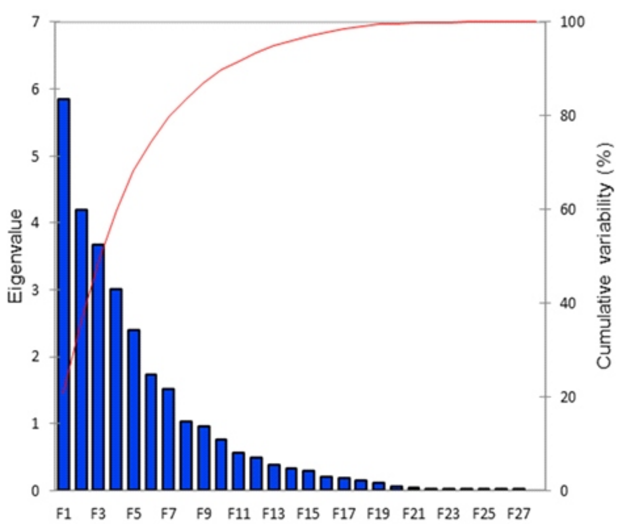

Fig.-1 : Scree plot of principal component analysis for NPT lines of rice between their Eigen value and the number of principal component.

respectively, among the genotypes for the traits under study. The table given below describes distribution of the PCs with their eigen values, variability and cumulative contribution respectively.

Scree plot : Scree plot graph depicted in figure above explains the percentage of variance associated with each principal component obtained by drawing a graph between Eigen values and principal component numbers. PC1 showed 20.901% variability with Eigen value 5.852, which then declined gradually.

Principal components like PC2, PC3, PC4and PC7 contributing both yield and quality traits. PC1, PC5 and PC8 accounts for yield related components, whereas PC6 contributed to quality related traits. The PC1 accounted for the quantitative traits like spikelets per panicle, fertile spikelets per panicle and spikelet density. PC2 accounted for traits like days to panicle initiation, days to maturity, stem thickness and L:B ratio. PC3 accounted for traits like thousand grain weight, panicle index, hulling index and grain yield per plant. PC4 accounted for yield and quality traits like plant height, stem length, flag leaf length, panicle length, grain length and decorticated grain length. PC5 accounted for the quantitative traits like tillers per plant and productive tillers per plant.PC6 accounted only the quality related traits like hulling %, milling % and head rice recovery. PC7 accounted for traits like panicle weight, grain breadth, decorticated grain breadth and biological

Table-2 : Principle component scores of rotated component of matrix.

Characters	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
DTPI	-0.076	0.339	-0.013	-0.013	-0.070	0.012	0.059	-0.117
DTM	-0.078	0.338	-0.013	-0.014	-0.069	0.014	0.061	-0.116
NOT	-0.006	-0.007	-0.059	0.007	0.368	0.092	0.108	0.094
NOET	-0.025	-0.030	-0.035	-0.008	0.373	0.039	0.129	0.051
PH	0.045	0.011	-0.016	0.224	-0.013	0.010	0.079	0.054
SL	0.040	0.027	-0.013	0.211	-0.025	0.003	0.095	0.057
ST	-0.089	0.140	-0.034	-0.017	-0.232	0.034	0.100	-0.147
FLL	0.048	0.055	-0.063	0.199	-0.021	0.008	0.047	0.057
FLW	-0.044	0.055	0.036	-0.038	-0.251	0.040	0.078	0.275
PL	0.052	-0.062	-0.023	0.201	0.043	0.033	-0.014	0.024
PW	-0.017	-0.009	0.132	-0.002	0.059	-0.094	0.291	0.091
TSPP	0.376	-0.096	0.007	0.066	0.025	-0.009	-0.030	-0.059
FSPP	0.377	-0.114	-0.003	0.073	0.033	-0.001	-0.019	0.105
SF%	0.016	-0.103	-0.036	0.033	0.052	0.030	0.052	0.749
SD	0.312	-0.055	0.008	-0.012	0.013	-0.024	-0.025	-0.061
1000 GW.	-0.055	-0.168	0.087	0.007	-0.046	0.014	0.036	0.040
GL	-0.076	0.339	-0.013	-0.013	-0.070	0.012	0.059	-0.117
GB	-0.078	0.338	-0.013	-0.014	-0.069	0.014	0.061	-0.116
DGL	-0.006	-0.007	-0.059	0.007	0.368	0.092	0.108	0.094
DGB	-0.025	-0.030	-0.035	-0.008	0.373	0.039	0.129	0.051
L/B Ratio	0.045	0.011	-0.016	0.224	-0.013	0.010	0.079	0.054
H%	0.040	0.027	-0.013	0.211	-0.025	0.003	0.095	0.057
M%	-0.089	0.140	-0.034	-0.017	-0.232	0.034	0.100	-0.147
HRR%	0.048	0.055	-0.063	0.199	-0.021	0.008	0.047	0.057
BYPP (g)	-0.044	0.055	0.036	-0.038	-0.251	0.040	0.078	0.275
PI%	0.052	-0.062	-0.023	0.201	0.043	0.033	-0.014	0.024
HI%	-0.017	-0.009	0.132	-0.002	0.059	-0.094	0.291	0.091
GYPP(g)	0.376	-0.096	0.007	0.066	0.025	-0.009	-0.030	-0.059

Table-3 : Interpretation of rotated component matrix for the traits having highest value in each PCs.

PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
SPP	DTPI	1000GW	PH	TPP	H%	PW	FLW
FSP	DTM	PI	SL	PTPP	M%	GB	SF
SD	ST	HI	FLL		HRR	DGB	
	LBR	GYPP	PL			BYPP	
			GL				
			DGL				

yield per plant. While PC8 accounted for quantitative traits like flag leaf width and spikelet fertility. These results were in partial conformation with (10,11,12,13).

It was recorded that number of productive tillers, grain yield per plant, days to maturity, stem thickness, panicle length, spikelet fertility, number of spikelets per panicle, fertile spikelet per panicle are comes under yield related traits**.** Many of the traits like hulling %, grain length, length elongation percentage, length breadth ratio of grain, cooked grain length, cooked grain breadth, decorticated grain length, decorticated grain breadth, thousand grain weight, head rice recovery and milling % are considered for quality traits during planning of such type of breeding research programs.

Conclusions

Based on the results of PCA, promising genotypes Identified were: JNPT-809 and JNPT(S)10-1-1B, JNPT-533, JNPT-521-1 and JNPT-526. Dominated by yield as well as quality associated traits, these lines had high value for yield as well as quality. Thus, these genotypes should be used for development of further promising genotypes.

Table-4 : PC scores of different rice genotypes possesses positive values (>1.0) in each PCs.

Genotypes	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
JNPT-802	-1.044	-1.275	0.962	0.349	-1.244	1.174	-0.828	0.168
JNPT-804	3.168	-1.589	1.068	0.598	-2.759	1.051	-0.355	0.321
JNPT-805	0.762	1.536	5.210	0.357	0.579	-0.179	-2.512	-0.115
JNPT-809	4.865	-1.926	2.465	-0.944	2.347	0.285	-1.574	-0.452
JNPT-811	1.107	-0.512	0.294	1.171	-1.126	-1.554	0.073	-2.661
JNPT 6-2A	2.113	0.527	0.926	-0.105	-2.192	2.388	-0.508	-1.333
JNPT 7-1B	-2.557	0.934	2.552	-1.359	0.405	0.468	-0.147	-2.857
JNPT 7-1B	-0.911	0.118	0.820	0.982	-0.906	-0.780	-1.121	0.391
JNPT 4-1-2	-2.866	-1.726	1.846	2.385	-1.011	-1.432	-1.224	-0.843
JNPT (s)4-1-2	-4.536	-0.262	-0.130	0.657	-1.164	-1.019	0.786	0.733
JNPT 23-1A	-1.237	-0.085	-0.584	1.445	-0.050	-1.239	1.595	-0.181
JNPT 6-2B	0.376	2.290	-1.197	1.344	1.974	2.896	0.510	-1.706
JNPT 7-10	-2.861	3.338	-1.595	-0.821	-2.748	-1.670	-0.645	-0.066
JNPT (s)10-1-1B	-4.377	3.909	-0.659	1.904	0.374	0.375	-0.161	-0.516
JNPT (s)10-1-1B	-4.545	0.925	4.046	2.272	1.942	0.207	0.401	0.975
JNPT-818	-0.918	-1.706	0.747	3.420	-0.983	-1.116	1.218	-1.149
JNPT-820	3.286	0.103	-0.803	1.557	-0.259	0.900	1.236	0.170
JNPT-821	3.451	0.607	-3.054	3.090	-0.900	-0.754	0.764	0.223
txty0JNPT-822	3.878	4.464	-0.395	-2.465	2.088	-0.810	1.431	-1.173
JNPT-823	3.756	-0.963	-0.105	0.775	-1.347	-1.075	1.061	-0.802
JNPT-824	4.167	-1.835	1.581	1.114	0.006	-0.027	0.955	-0.118
JNPT-825	3.367	2.344	0.366	-3.691	-0.608	-1.434	3.129	-0.693
JNPT-826	4.965	2.494	1.705	-2.069	-0.972	-0.882	0.843	-0.277
JNPT-827	4.174	0.255	-1.063	3.845	1.030	1.120	-0.501	-0.457
JNPT-828	5.371	3.656	0.597	-0.400	-0.779	-0.441	-0.528	0.766
JNPT-829	4.413	1.695	-0.130	0.917	0.490	2.002	-1.489	0.023
JNPT-831	4.544	2.701	0.452	-1.734	-0.560	-1.839	1.296	0.587
JNPT-832	5.090	0.471	0.599	-0.075	-0.507	-0.935	-2.276	1.860
JNPT-844	-1.262	1.408	1.521	-0.257	-1.567	2.356	1.882	-1.601
JNPT 35-2A	-2.680	1.366	3.679	-2.270	1.833	-0.054	-2.126	-0.887
JNPT 23-1	0.313	-0.390	-0.084	2.459	-0.513	0.609	-0.200	1.457
JNPT-852	-0.817	0.362	0.208	-1.504	1.867	0.546	1.288	1.014
JNPT-853	0.501	-0.843	0.649	1.115	0.126	-3.194	0.334	1.746
JNPT-856	0.280	-0.704	0.792	3.155	-4.173	-0.115	-0.398	1.409
NPT-1	-2.237	-2.792	-1.181	-2.534	0.027	0.512	0.220	-0.006
57K-65-61	0.601	-0.836	-2.895	-0.406	2.348	-1.501	-0.764	1.687
H-56	-1.139	-1.928	-1.668	-1.254	0.509	0.100	-1.283	-0.818
H-4	0.394	-6.053	-0.099	1.249	0.448	1.489	0.865	0.741
NPT-65	-0.444	-3.546	0.677	-1.066	-1.446	0.622	-1.622	-1.852
NPT-70	-0.272	-2.787	-1.245	-0.497	0.500	-1.382	0.228	1.498
NPT-7	-1.585	-0.519	-1.729	-2.814	-1.846	0.394	-0.115	-0.669
NPT-10	-1.972	-2.025	-3.194	-1.856	-0.968	0.714	0.273	0.304
NPT-17	-2.333	2.272	-4.474	-0.296	1.189	1.735	0.239	0.484
NPT-23	0.244	-0.874	-1.574	0.082	-0.732	3.068	-1.051	-0.123
NPT-24	-1.499	-1.720	-0.500	-2.097	-1.940	0.929	2.251	0.922
NPT-25	1.606	-1.162	0.266	-2.692	0.897	1.138	-1.245	-0.083
NPT-29	-0.348	-3.552	0.376	-2.453	0.335	-0.870	-0.984	-2.053
NPT 35-1	-0.492	-1.653	-1.240	-2.903	3.771	0.587	0.919	0.452
NPT 35-2	0.592	-3.056	-0.315	-1.637	0.318	2.382	-0.919	0.212
NPT 37	1.134	-2.589	-2.312	-1.673	0.698	-1.372	-0.389	-0.856
NPT 41	-3.015	-2.241	-0.180	3.453	1.014	-2.027	-0.318	-1.296
NPT 47	0.692	-1.431	-0.991	1.548	3.912	-1.854	0.048	-1.552
NPT 49	-3.924	3.027	-4.836	-1.689	-0.958	-0.160	-1.669	1.137

Table-4 : Contd....

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Genotypes	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
NPT 01	0.257	-1.901	0.208	-0.049	-1.617	1.643	1.515	0.251
NPT 13-01	1.439	1.007	-3.247	0.478	2.115	0.769	0.714	0.330
NPT 23-01	1.891	-0.602	-3.233	0.413	-1.420	-2.005	-2.098	-0.710
NPT 24-01	-1.478	1.839	-1.838	-1.636	-1.889	-1.672	-0.878	-0.643
NPT 25-01	-0.388	-5.630	-0.514	-0.188	1.322	-1.174	3.709	-0.346
NPT 27-01	2.566	0.037	-2.639	1.847	-0.323	1.750	0.152	0.515
NPT 32-01	-0.740	-1.459	-1.060	1.927	-0.252	0.054	-2.934	0.684
JNPT 521-1	-1.378	0.361	3.311	1.983	1.402	-2.005	1.534	0.325
JNPT 521-2	-1.350	0.184	2.610	-0.568	0.912	-0.864	-0.713	-0.133
JNPT 522	-0.375	-0.324	3.902	0.319	-1.620	2.172	0.349	0.027
JNPT 523	-3.196	4.995	-1.083	2.993	-0.472	0.255	1.322	-1.373
JNPT 524	-0.949	1.032	-1.185	0.531	2.105	-1.524	0.384	0.455
JNPT 525	0.989	0.194	1.563	-0.051	-0.815	-0.944	0.063	0.874
JNPT 526	-0.514	0.445	1.667	-1.688	2.851	-0.487	-2.234	1.330
JNPT 527-1	-0.483	1.112	-1.490	0.477	0.648	-0.421	-0.591	-1.180
JNPT 527-2	-0.068	1.114	2.091	0.685	2.033	0.072	0.501	0.186
JNPT 528-1	-0.379	1.366	1.730	-0.641	1.022	1.112	0.399	1.624
JNPT 528-2	0.099	1.764	-0.524	-2.214	-2.196	-0.606	-0.249	-0.058
JNPT 529	-0.246	1.013	-2.328	2.836	2.894	1.654	-0.717	0.339
JNPT 530	-1.555	-0.128	2.574	-0.203	-1.428	0.600	1.050	1.718
JNPT 531	-2.110	2.144	-0.488	0.111	-0.909	-0.685	-1.178	-0.014
JNPT 532	-0.973	0.866	0.765	0.389	-0.373	0.014	0.707	1.083
JNPT 533	-2.079	1.427	2.476	-1.158	1.193	0.585	0.174	1.070
JNPT 534	-2.421	0.281	0.617	-1.619	-1.657	0.219	0.648	0.629
JNPT 535	-2.633	-0.718	1.738	-1.967	-0.274	0.274	0.561	1.146
JNPT 536	-1.356	-0.563	-1.391	-1.323	-1.206	-1.279	-0.408	-0.040
JNPT 537	-1.913	1.925	-0.401	0.630	1.184	2.164	1.324	-0.175

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