Assessment of Exotic Sesame (*Sesamum indicum*) Accessions through Principal Component Analysis

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ABSTRACT

The present research conducted over 96 exotic sesame accessions with five checks, to identify the minimum number of components, which could explain maximum variability out of the total variability using Principal Component Analysis (PCA); The investigation was performed under Project Co-ordinating Unit (Sesame and Niger) Research Farm, JNKVV, Jabalpur (M.P.) during *kharif* 2018 using Augmented block design. Among the studied traits, Component 1 had the contribution from the traits *viz*., number of primary branches per plant, number of capsules per plant, number of seeds per capsule, oil content and seed yield/plant, which accounted 30.71% to the total variability. Days to flower initiation and days to 50% flowering had contributed 17.11% to the total variability in component 2. The remaining variabilities of 11.26%, 9.94%, 7.48% and 6.73% were consolidated in PC3, PC4, PC5 and PC6 respectievely by various traits like number of secondary branches/plant, capsule length, days to maturity, thousand seed weight and plant height . The cumulative variance of 83.23% of total variation among 12 characters was explained by the first six axes. On the basis of PC scores PC1, PC3 and PC5 accounting mainly to yield and quality traits containing accesions *viz*., EC-334998, ES-38, EC-346426, EC-334958, EC-340538, RT-351 and GT-10 might be further utilized in breeding programme.

Keywords: Principal component, Exotic sesame accession, Augmented block design, PC scores

1. INTRODUCTION

Sesame (*Sesamum indicum* L.) unremarkably known as til or benniseed from the family Pedaliaceae is a broadleaf, one of the most eminent annual oilseed crop in tropical and subtropical countries including India with chromosome number 2n =26. *S. indicum,* the cultivated type, originated in India is tolerant to dry spell conditions in high heat, with residual moisture in soil. It can grow well in many ecological regions of tropical and subtropical climate, and also grows in almost all kind of soils. Besides being drought tolerant and having acceptance of a range of different soils, sesame also stimulates a fauna of beneficial soil microbes and reduces the nematode populations.

It is an antediluvian oilseed, first noticed and recorded as a crop in Babylon and Assyria over 4,000 of years ago but naturalized well over 3000 years ago. Among *kharif* oilseed crops, sesame occupies an important place next to groundnut. It is one of the crops under cultivation from ancient times (Joshi, 1961and Bist *et al.,* 1998). Its production in India is boosting, as more than 30 % of world production is bestowed by India and India ranks top in total production (Pandey *et al*., 2015). India is a major producer of sesame in the world and inhabits about 36% of the total acreage and contributes about 25% of the total output.

In India, sesame is cultivated in 1544.9 thousand hectare with production of 715.7 thousand tonnes and productivity of 463.26 kg/ha (Anonymous, 2017- 18). Madhya Pradesh contributes 18.8% and 24.03% share of country's area (424 thousand ha) and production (180 thousand tonne), respectively and ranked third in area and second in production. In India, major sesame producing states are Rajasthan, U.P., M.P., A.P., Orissa, Gujarat, Tamil Nadu and Karnataka.

Sesame, which is entitled as “the queen of oilseed crops”, is best known for caliber edible oil. Its seed contains 48-55% oil, protein (20-28%), carbohydrate (23%), minerals, healthy polyunsaturated fatty acid and also few chemicals like lignans, pinoresinol and lariciresinol. Due the presence of potent antioxidants, sesame seeds are called as “the symbol of immortality” (Ayana. 2015). Sesame contributes in multifarious ways to human beings like culinary preparation, edible purposes, in industries like paints, cosmetics, insecticides, soap making, pharmaceuticals, *etc*. It is also used as a cattle supplement especially for milch cattle and as manure due to presence of 6-6.2% N. 2-2.2% P and 1-1.2% K in its cake (Singh *et al.*, 2009). Despite being largely self-sufficient in production, sesame productivity is declining mainly due to unavailability of high yielding varieties and it is a matter of great concern for scientists as well as the farmers’ community. Though *Sesamum indicum* genotypes in Indian landmass are reported to represent a good diversity however, still no systematic efforts are created to characterize and document the native and exotic collections to reveal the genetic diversity (Kim *et al*., 2002).

Principal component analysis measures the importance and contribution of each component to the total variance while each coefficient of proper vectors indicates the degree of contribution of every original variable with which each principal component is associated (Sanni *et al*., 2012). The presence of genetic diversity could be a fascinating demand for any breeding program. Both diversity analysis and PCA are useful for parent’s choice in hybridization to develop high yield potential cultivars and to meet the diversified goals of plant breeding. A thorough knowledge on Principal component analysis will provide basis for selecting systematic breeding strategy to improve yield potential of the genotypes.

2. MATERIAL AND METHODS

The present experiment was conducted under Project Coordinating Unit (Sesame and Niger) Research Farm, JNKVV, Jabalpur (M.P.) during *kharif* 2018. The experimental material consisted of 96 sesamum germplasm along with 5 checks with distance between rows 0.40 m and plant to plant 0.12 m. The crop was raised under recommended package of practices along with prophylactic protection measures. The analysis was done using method given by Massay, 1965 and Jolliffie, 1986.

3. RESULTS AND DISCUSSION

In PCA analysis, principal components (PCs) exhibited more than 0.5 Eigen value and showed the cumulative variance of 83.23% among the traits studied as shown in scree plot fig 1. Out of twelve, only six principal components were given due importance for further explanation. The PC1 had the highest variability (30.711 %) followed by PC2 (17.11%), PC3 (11.27%), PC4 (9.94%), PC5 (7.49%) and PC6 (6.73%) for all the traits under study as represented in Table 1.Almost similar findings were found by Baraki *et al*. (2015) and Shim *et al*. (2016) with total variance of 88.49% and 82.3%.

Table 1- Eigen values, % variance and cumulative eigen values of different traits in sesame genotypes

Characters	Principal component (PC)	Eigen value	Variability (%)	Cumulative %
DFI	PC1	3.685	30.711	30.711
DFF	PC2	2.054	17.114	47.824

NPB	PC3	1.352	11.267	59.091
NSB	PC4	1.193	9.943	69.035
PH	PC5	0.899	7.489	76.523
NCPP	PC6	0.808	6.733	83.257
CL	PC7	0.797	6.642	89.899
NSPC	PC8	0.563	4.693	94.591
DM	PC9	0.456	3.802	98.394
TSW	PC10	0.089	0.743	99.136
OC	PC11	0.066	0.551	99.687
SYPP	PC12	0.038	0.313	100.000

**Moisture content on oven dry weight basis*

Results displayed in Table 2 and 3 revealed that the first principal component (PC1) was mostly related with yield traits such as number of primary branches per plant, number of capsules per plant, number of seeds per capsule, oil content (%) and seed yield per plant. The second principal component (PC2) was dominated by traits number of days to 50% flowering and days to flower initiation and PC3 with number of secondary branches per plant and capsule length. On the basis of PCA, most of the important yield attributing and quality traits were present in PC1, PC2 and PC3. Similar results were reported by Saha *et al.* (2012) for days to 50% flowering, days to maturity and number of capsules per plant, Ismaila and Usman (2014), Jahan *et al*. (2021) for number of capsules per plant and number of branches per plant, Shim *et al*. (2016) for capsule length and number of capsules per plant, days to maturity and plant height; Baraki and Berhe (2019), Sravanthi *et al.* (2021) for seed yield, number of primary and secondary branches, number of capsule per plant and number of seeds per capsule. In contradiction Singh *et al*. (2018) reported that PC1 was mostly related with phonological traits *viz*., days to flower initiation, days to 50% flowering and days to maturity.

Table 2 Rotated component matrix for different traits of sesame genotypes

Traits	Principal Components					
	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**
DFI	0.321	0.919	-0.039	-0.166	0.080	0.163
DFF	0.281	0.910	-0.021	-0.175	0.099	0.168
NPB	0.557	-0.172	0.214	-0.220	0.319	-0.126
NSB	0.459	-0.053	0.658	0.048	-0.297	0.005
PH	0.305	-0.378	0.289	-0.283	0.059	0.620
NCPP	0.943	-0.119	-0.048	0.046	0.023	-0.052
CL	-0.076	0.353	0.601	0.464	-0.353	-0.021
NSPC	0.899	-0.101	-0.135	0.013	0.030	-0.012
DM	0.063	-0.104	-0.381	0.626	-0.046	0.535
TSW	-0.139	0.055	0.371	0.496	0.740	-0.047
OC	0.542	0.166	-0.351	0.374	-0.113	-0.238
SYP	0.948	-0.123	-0.016	0.093	-0.018	-0.069

Table 3: Interpretation of rotated component matrix for the traits having maximum values in each PCs

	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**
Traits	Number of primary branches per plant	Days to flower initiation	Number of secondary branches per plant	Days to maturity	Thousand seed weight	Plant height

Number of capsules per plant	Days to 50% flowering	Capsule length	-	-	-
Number of seeds per capsule		-	-	-	-
Oil content (%)	-	-	-	-	-
Seed yield/plant	-	-	-	-	-

Germplasm lines showing maximum positive PC scores and common in PC1, PC3 and PC5 for number of primary branches per plant, number of capsules per plant, number of seeds per capsule, oil content, seed yield per plant, number of secondary branches per plant, capsule length and thousand seed weight are EC-118571; and genotypes common in PC 1 and PC 3 are EC-334998, EC-335015, EC-346424, EC-346599, EC-346633 and EC-346681; genotypes common in PC1 and PC5 are RT-351, ES-38, EC-34625, EC-334958 and EC-340538. Genotypes showing maximum positive PC scores in PC1 for number of primary branches per plant, number of capsules per plant, number of seeds per capsule, oil content, seed yield per plant and negative scores in PC2 for traits days to flower initiation and days to 50% flowering are RT-351, EC-346424, EC-346400, EC-334958 and EC-346599.The results presented in tables 4 and 5. Thus, selection of these lines could help in further development of new high yielding quality varieties.

4. CONCLUSION

Principal component analysis measures the importance and contribution of each component to the total variance while each coefficient of proper vectors indicates the degree of contribution of every original variable with which each principal component is associated (Sanni *et al*., 2012).These results could now be used by breeders to develop high yielding sesame varieties and develop new breeding protocols for sesame improvement.

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APPENDIX

FIG. 1: SCREE PLOT OF PRINCIPAL COMPONENT ANALYSIS OF SEASAMEGERMPLASM BETWEEN EIGEN VALUE AND PRINCIPAL COMPONENTS.

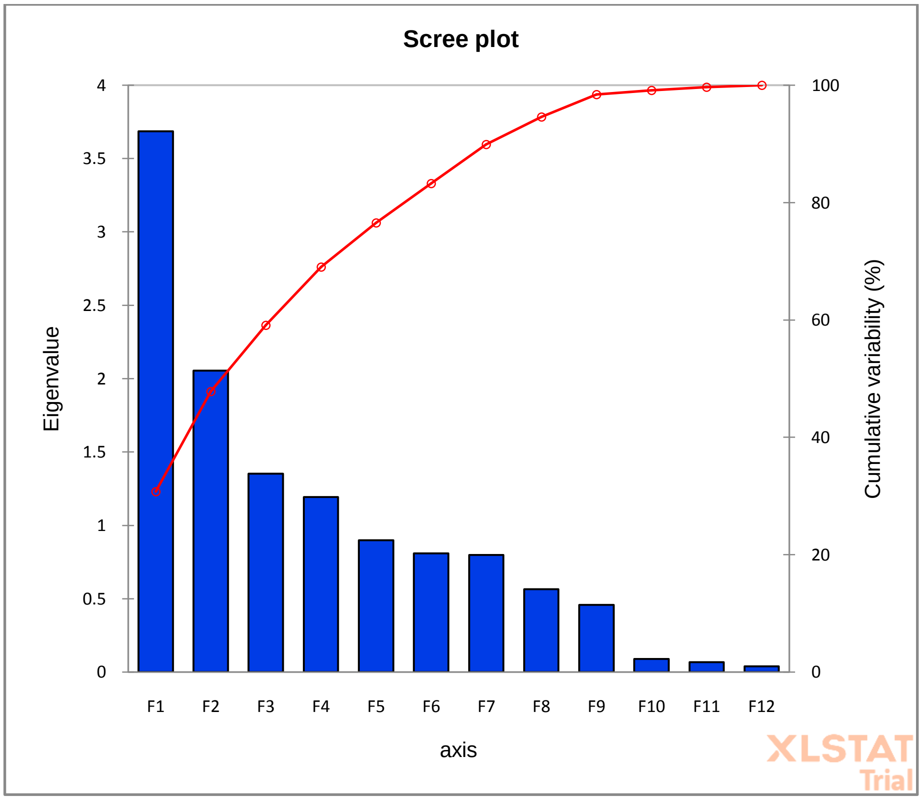

Table 4: PC scores of nigergermplasm having positive values >0.5 in each PCs.

S. No.	Genotypes	PC1 score	PC2 score	PC3 score	PC4 score	PC5 score	PC6 Score
1	TKG 22	1.235	2.668	-1.256	0.867	-0.184	0.36
2	GT 10	1.927	3.496	-2.099	1.033	0.079	-0.46
3	JTS 8	1.346	1.778	-1.235	0.787	0.172	-0.346
4	TKG 21	2.399	2.082	-0.347	0.243	-0.274	-1.743
5	RT-351	2.362	-1.537	-2.377	1.636	0.875	2.1
6	EC-38	1.269	0.862	-1.26	-0.906	0.579	-2.082
7	EC-177-A	-0.196	0.629	0.492	-0.112	-0.151	-0.047
8	EC-177-1	-0.885	-0.169	-0.107	-2.432	1.64	-0.535
9	EC-43708	-1.688	1.867	0.239	-0.264	-0.563	-0.274
10	EC-43760	-1.691	0.036	-0.627	-1.675	0.843	0.281
11	EC-89105	0.224	-0.059	-0.175	1.033	-0.525	-0.618
12	EC-89671	1.516	0.404	0.032	-0.928	0.146	0.063
13	EC-109693-A	-1.665	1.042	1.099	-0.091	-0.787	0.304

S. No.	Genotypes	PC1 score	PC2 score	PC3 score	PC4 score	PC5 score	PC6 Score
14	EC-118569	-2.134	1.077	0.753	-1.919	0.221	-0.611
15	EC-118571-B	-0.661	0.966	2.115	-0.773	-0.485	0.036
16	EC-118571	3.42	-1.146	0.927	-1.787	0.912	-0.995
17	EC-132827-1	0.278	0.39	-1.216	0.392	0.228	0.675
18	EC-34625	1.642	0.889	-0.196	-2.031	1.187	-0.935
19	EC-346347	-1.99	1.724	0.075	-0.646	0.048	0.955
20	EC-346377	0.906	0.653	-0.286	-1.49	0.445	0.474
21	EC346478	-2.039	0.918	-0.303	-0.177	-0.128	1.389
22	EC-346480	-0.41	2.933	2.338	-1.486	0.205	0.453
23	EC-346514	1.024	-1.096	0.049	-0.414	-0.192	0.989
24	EC-356526	0.776	-0.421	1.337	-0.919	0.005	0.465
25	EC-178365	2.054	0.412	0.757	-1.084	-0.082	-0.353
26	EC-133850-S	-2.116	-0.87	1.401	-0.868	-0.611	-0.211
27	EC-132828	0.715	2.912	1.36	-0.584	-0.196	0.822
28	EC-178374	4.048	2.432	0.3	-0.981	0.402	0.991
29	EC-334962	3.28	-0.922	-0.334	-0.039	0.595	-0.78
30	EC-334974	-2.548	-0.454	-0.516	-1.264	0.35	-1.337
31	EC-334982	-1.641	-2.529	-1.05	0.236	0.834	-0.039
32	EC-334993	-2.716	0.893	1.131	-0.805	0.129	0.148
33	EC-335005	1.51	-0.227	-1.025	-0.636	0.541	-0.258
34	EC-334998	3.607	1.274	2.605	-0.929	0.134	1.045
35	EC-335015	1.978	-0.082	1.027	0.095	-0.137	0.957
36	EC-334999	1.562	0.437	-0.4	-0.379	0.078	0.615
37	EC-335017	-1.758	0.914	0.408	1.006	-1.014	1.575
38	EC-342782	-1.794	0.086	1.073	0.95	-0.994	0.597
39	EC-346165	-3.428	0.868	1.191	-0.471	-0.111	0.469
40	EC-346192	-2.457	-1.59	-0.398	-1.555	0.378	-0.08
41	EC-346224	-1.791	-0.405	-0.436	0.196	-0.334	-0.396
42	EC-346300	-2.309	-0.836	0.564	-1.523	0.422	0.252
43	EC-346358	-2.152	-0.533	0.828	-0.217	-0.622	0.347
44	EC-346374	-2.442	-1.247	-0.674	-0.07	-0.273	-0.018
45	EC-346391	-1.834	-3.246	1.131	-0.537	-0.334	2.415
46	EC-346395	-2.59	0.287	-0.052	-1.564	-0.073	0.49
47	EC-346424	3.535	-3.247	3.619	-0.514	-0.459	0.273
48	EC-346448	-2.035	-2.813	-0.548	-1.442	0.751	0.03
49	EC-346453	2.054	0.412	0.757	-1.084	-0.082	-0.353
50	EC-346471	-2.944	0.632	3.781	5.196	7.189	-0.406
51	EC-346599	2.2	-1.22	0.846	1.135	-0.897	0.375
52	EC-346620	-1.461	0.037	0.494	-0.09	0.126	0.737
53	EC-346633	1.164	0.625	1.145	0.586	-0.659	0.973
54	EC-346698	-1.203	0.512	-0.054	-0.511	0.028	0.753
55	EC-346779	-0.009	-1.602	-0.11	0.946	-0.386	-0.094
56	EC-346926	2.409	-1.667	-0.104	0.904	-0.216	-0.684
57	EC-346999	-1.006	-1.288	0.033	1.102	-0.782	0.784
58	EC-347070	-2.12	-1.881	0.466	1.28	-0.827	-1.199
59	EC-347128	-0.719	0.274	0.169	0.746	-0.215	-0.891
60	EC-347142	0.091	0.932	1.069	-0.208	-0.623	-0.727
61	EC-347166	-0.89	-1.194	-0.622	0.949	-0.521	0.426
62	EC-350647	-0.341	-2.706	-0.027	0.604	-0.527	-0.057

S. No.	Genotypes	PC1 score	PC2 score	PC3 score	PC4 score	PC5 score	PC6 Score
63	EC-351826	0.872	0.403	-1.534	-0.236	0.479	-0.792
64	EC-351882	-0.512	-0.092	-1.132	1.633	-0.826	-0.025
65	EC-351887	-1.944	-2.218	-0.754	0.728	-0.707	-1.372
66	EC-351901	0.102	-1.194	-2.59	-0.59	0.929	0.971
67	EC-351904	0.49	-1.596	-1.309	-0.157	0.405	0.791
68	EC-355653	1.674	-1.549	-0.595	-0.02	0.14	-0.777
69	EC-355674	4.28	-1.253	0.278	1.159	0.154	1.162
70	EC-357021	1.089	-1.361	0.118	-0.409	0.249	0.543
71	EC-357313	-1.145	-0.38	0.428	0.651	-0.907	-0.645
72	EC-357327	-0.091	-1.876	-1.807	-0.443	0.522	0.11
73	EC-350401	-2.46	1.372	-0.146	1.323	-0.546	0.053
74	EC-376977	-2.944	0.632	3.781	5.196	7.189	-0.406
75	EC-346144	-0.825	0.345	-1.989	0.003	0.214	0.683
76	EC-346400	1.821	-0.817	0.804	1.703	-1.192	-0.23
77	EC-346411	2.638	0.218	0.487	1.209	-0.957	0.023
78	EC-346440	3.257	-0.439	0.04	-0.091	0.251	0.541
79	EC-346681	4.499	-1.338	2.046	0.037	-0.224	0.053
80	EC-346750	-0.991	-1.351	-1.044	-0.655	0.542	-0.343
81	EC-351880	0.833	0.458	0.132	-1.035	0.399	-0.024
82	EC-351888	-2.131	2.839	-0.539	0.079	-0.195	-1.984
83	EC-351903	-1.366	1.026	0.162	0.67	-0.588	0.072
84	EC-355670	-0.523	-0.677	-1.607	-0.281	1.379	0.251
85	EC-361719	-1.331	2.29	-0.998	-0.126	-0.122	1.003
86	EC-377321	2.661	0.733	-0.47	1.372	-0.796	-1.155
87	EC-377351	0.919	-0.799	0.143	-0.945	0.617	0.195
88	EC-0346210	0.437	0.531	-2.406	0.308	0.243	0.506
89	EC-0346341	1.297	2.638	0.436	0.271	-0.253	-0.053
90	EC-334956	-2.96	2.321	-0.743	1.428	-0.712	1.403
91	EC-334958	0.761	-0.803	-1.199	1.013	0.523	1.1
92	EC-340538	1.647	1.403	-1.092	-0.609	1.416	-0.835
93	EC-346173	-1.657	0.063	0.364	-1.095	-0.219	-1.121
94	EC-346174	2.343	0.788	-0.203	0.307	0.159	-2.447
95	EC-346175	0.743	0.295	-0.319	-1.155	0.368	1.301
96	EC-346186	-2.384	-0.742	1.188	0.925	-0.834	-1.137
97	EC-346197	0.042	0.2	-0.998	2.211	-0.858	0.4
98	EC-346226	0.135	-2.041	-1.504	0.011	0.215	-1.792
99	EC-346229	-0.825	0.345	-1.989	0.003	0.214	0.683
100	EC-346265	1.082	1.513	0.152	1.5	-1.722	-0.231
101	EC-346275	-1.931	-0.644	1.634	0.563	-0.934	-2.088

Table 5: List of selected genotypes in each principal component having positive values

PC1	PC2	PC3	PC4	PC5	PC6
TKG 22	TKG 22	EC-109693-A	GT 10	EC-177-1	RT-351
GT 10	GT 10	EC-118571-B	RT-351	EC-34625	EC346478
JTS 8	JTS 8	EC-346480	EC-89105	EC-346471	EC-334998
TKG 21	TKG 21	EC-356526	EC-335017	EC-355670	EC-335017
RT-351	EC-43708	EC-133850-S	EC-346471	EC-340538	EC-346391
EC-38	EC-109693-A	EC-132828	EC-346599	EC-355674	
EC-89671	EC-118569	EC-334993	EC-346999	EC-361719	
EC-118571	EC-346347	EC-334998	EC-347070	EC-334956	
EC-34625	EC-346480	EC-335015	EC-351882	EC-334958	
EC-346514	EC-132828	EC-342782	EC-355674	EC-346175	
EC-178365	EC-178374	EC-346165	EC-350401		
EC-178374	EC-334998	EC-346391	EC-346400		
EC-334962	EC-350401	EC-346424	EC-346411		
EC-335005	EC-376977	EC-346471	EC-377321		
EC-334998	EC-351888	EC-346633	EC-334956		
EC-335015	EC-351903	EC-347142	EC-334958		
EC-334999	EC-361719	EC-346681	EC-346197		
EC-346424	EC-0346341	EC-346186	EC-346265		
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EC-346633	EC-340538				
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