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PRINCIPAL COMPONENT ANALYSIS IN SOYBEAN [*Glycine max* (L.) Merrill]

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Abstract: In present study, PCA was performed for seed yield and its contributing traits in soybean. Out of fourteen principal components, five components (PC_1 to PC_5) contributed 83.43% of total variation among different traits under experimental genotypes. Among these five components the days to maturity, seed yield per plant, number of seeds per pod, 100-seed weight and protein content was contributed greater towards variation in first, second, third, fourth and fifth principal component, respectively. According to the first principal component, genotype CSB 10112 had the highest score followed by CSB 10084, BAUS 102, G. Soybean 2 and G. Soybean 1, indicated that they were more related to days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, biological yield per plant and fodder yield per plant. The high PC score was observed in genotypes DSb 34, NCR 86, GJS 3, NRCSL 1 and PS 1613 for PC_2 which was closely related to number of pods per plant, pod length, number of seeds per pod, harvest index, biological yield per plant and seed yield per plant. In PC_3 high PC score was recorded by genotypes MACS 1575, KDS 109, NRC 128, JS 20-69 and MAUS 731 which exhibited high value for pod length, number of seeds per pod and fodder yield per plant. In PC_4 high PC score was found in genotypes NRC 129, SL 1123, Shalimar Soybean-1, RVS 2011-1and NRC 131 which indicated that they had high value of 100-seed weight and biological yield per plant. In PC_5 high PC score was recorded by genotypes JS 21-15, DS 3108, BAUS 102, SL 1068 and RVS 2011-1 which revealed that they had a high value for protein content. Thus breeder can select genotypes having the high PC score with desirable combination of characters for further breeding programme.

Introduction

Soybean [*Glycine max* (L.) Merrill] is considered a miracle crop because of its dual qualities *viz.*, protein and oil content in seed. These two parameters in one crop have thus, gained considerable importance in the agricultural economy of the World. It is considered as a wonder crop due to its dual qualities *viz.*, high protein (40-44%) and oil content (20%). The principal component analysis (PCA) is one of the multivariate analysis technique among set of the traits which ones are decisive in genotypic differentiation (Kovacic, 1994). PCA enables easier understanding of impacts and connections among different traits by identifying them and explaining their roles. This method is a powerful multiple method to apply for evaluating yield component (Guertin and Bailey, 1982), identify biological relationships

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among traits (Acquaah *et al*., 1992), decrease associated traits to few factors (Johnson and Wichern, 1996) and description of the correlations among variable.

Materials and Methods

The present investigation was conducted at Agricultural Research Station, Junagadh Agricultural University, Amreli. The experiment consisted of 50 genotypes, which were evaluated in randomized block design with three replications. The recommended package of practices was followed for raising a healthy crop. The data were recorded on five randomly selected competitive plants in each replication and each genotype for 12 characters *viz.*, plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, 100-seed weight (g), biological yield per plant (g), harvest index (%), protein content (%), oil content (%), seed yield per plant (g) and fodder yield per plant. Observations of days to 50 per cent flowering and days to maturity were recorded on plot basis. The analysis of principal component was carried out by computerized software XLSTAT.

Results and discussion

In present study, PCA was performed for seed yield and its contributing traits in soybean. Out of fourteen, only five principal components (PCs) exhibited more than 1.00 Eigen value and showed about 83.43 % variability among the traits studied. First principal component recorded the highest variation 30.05% followed by 23.16% (PC_2), 14.45 % (PC_3), 11.25% (PC_4) and 7.52% (PC_5). PCA for the first principal components of these data are given in Table 1.1.

Eigen value and variance associated with each principal component decreased gradually and cumulative variability increase gradually which is shown as screen plot in Fig. 1.1. The result or principal components is depicted as a factor loading score. This score given in Table 1.2. Accordingly, the first principal component (PC_1) had high positive component loading from days to maturity (0.798) followed by days to 50 per cent flowering (0.770), number of branches per plant (0.756), plant height (0.731), fodder yield per plant (0.686) and biological yield per plant (0.567). The major contributing characters for variation in the second principal component (PC_2) were seed yield per plant (0.935), pod length (0.655), number of seeds per pod (0.631), biological yield per plant (0.625), number of pods per plant (0.577) and harvest index (0.483). Likewise, the important traits *viz.*, number of seeds per pod (0.530), pod length (0.511) and fodder yield per plant (0.403) contribute more variation for PC_3. Similarly, 100-seed weight (0.478) and biological yield per plant (0.451) had more variation in PC_4 and only

protein content for PC_5. A principal component loading plot in Fig. 1.2 showed the distance of each variable with respect to PC_1 and PC_2 which contribute maximum variation (53.21%) to total variation showed in 50 soybean genotypes used. One character should be selected from each principal component which contribute much greater variation. days to maturity, seed yield per plant, number of seeds per pod, 100-seed weight and protein content is best choice for first, second, third, fourth and fifth principal component, respectively. Selection promising genotypes with these five components would be effective to increase seed yield per plant in soybean.

Hashash (2016) was earlier reported PC_1 and PC_2 having eigen values more than unity exhibited 82.55% of total variability among soybean genotypes. Manav *et al.* (2017) was also reported PC_1 contributed 52.85% of the total variation and dominated by number of days to maturity, number of branches per plant and plant height. The days to 50 per cent flowering, days to maturity, plant height, number of branches per plant and biological yield per plant contributed maximum variation for PC_1 was found in accordance with Dubey *et al.* (2018).

According to the first PC score Table 1.3, genotype CSB 10112 had highest score followed by CSB 10084, BAUS 102, G. Soybean 2 and G. Soybean 1, indicated that they were more related to days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, biological yield per plant and fodder yield per plant. The high PC scores in genotypes DSb 34, NCR 86, GJS 3, NRCSL 1 and PS 1613 in PC_2 was closely related to number of pods per plant, pod length, number of seeds per pod, harvest index, biological yield per plant and seed yield per plant. In PC_3 high PC score was exhibited by genotypes MACS 1575, KDS 109, NRC 128, JS 20-69 and MAUS 731 for pod length, number of seeds per pod and fodder yield per plant. In PC_4 high PC score was exhibited by genotypes NRC 129, SL 1123, Shalimar Soybean-1, RVS 2011-1and NRC 131 related to 100-seed weight and biological yield per plant. PC_5 exhibited protein content characteristics in DS 3108, BAUS 102, RVS 2011-1, MACS 1575 and PS 1611. Thus breeder can select genotypes having the high PC score with desirable combination of characters for further breeding programme.

Conclusion

Principal components analysis revealed that out of 14 principal components only five components exhibited more than 1.0 eigen value and showed about 83.43% total variability. One character should be selected from each principal component which contribute much greater variation. days to maturity, seed yield per plant, number of seeds per pod, 100-seed weight and protein content is best choice for first, second, third, fourth and fifth principal

component, respectively. Selection promising genotypes with these five components would be effective to increase seed yield per plant in soybean. Based on per se performance and PC score, genotypes DSb 34, NRC 86, GJS 3, NRCSL 1, PS 1613 and RVS 2011-1 were identified as elite genotypes.

References

Acquaah, G.; Adams, M. W. and Kelly, J. D. (1992). A factor analysis of plant variables association with architecture and seed size in dry bean. *Euphytica*, **60**: 171-177.

Dubey, N.; Avinashe, H. A. and Shrivasthava, A. N. (2018). Principal component analysis in advanced genotypes of soybean [*Glycine max* (L.) Merrill]. *Plant Archives*, **18**(1): 501-506.

Guertin, W. H. and Bailey J. P. (1982). Introduction to modern factor analysis. Edwards Brother (ed). *Inc Michigan*, USA.

Hashash, E. F. E. (2016). Genetic diversity of soybean yield based on cluster and principal component analysis. *Journal of Advances in Biology & Biotechnology*, **10**(3): 1-9.

Johson, R. A. and Wichern, D. W. (1996). Applied multivariate statistical analysis. Sterling Book House, New Delhi.

Kovacic, Z. (1994). Multivariate Analysis. Faculty of Economics, University of Belgrade, Serbia.

Manav; Arora, R. N. and Kumar, K. (2017). Principal component analysis of nine morphological traits in forty five accessions of soybean [*Glycine max* (L.) Merrill]. *International Journal of Pure Applied Bioscience*, **5**(6): 938-941.

Table 1.1: Principal components (PCs) analysis for metric traits in soybean genotypes

Principal component	Eigen values	Variability (%)	Cumulative (%)
PC_1	4.21	30.05	30.05
PC_2	3.24	23.16	53.21
PC_3	1.60	11.45	64.66
PC_4	1.58	11.25	75.91
PC_5	1.05	7.52	83.43
PC_6	0.79	5.65	89.08
PC_7	0.64	4.54	93.63
PC_8	0.38	2.69	96.31
PC_9	0.26	1.87	98.19
PC_{10}	0.12	0.84	99.03
PC_{11}	0.10	0.74	99.77
PC_{12}	0.02	0.13	99.91
PC_{13}	0.01	0.09	99.99
PC_{14}	0.00	0.01	100.00

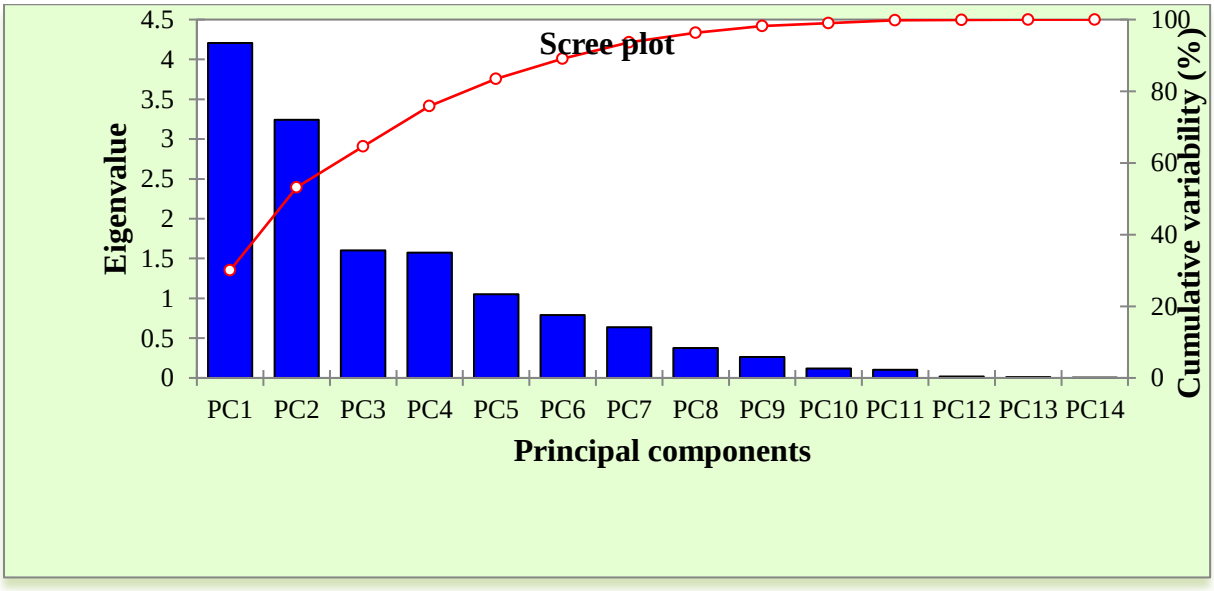

Fig. 1.1: Relationship between eigenvalue and cumulative variability as scree plot in soybean

Table 1.2: Factor loadings of principal components for 14 characters in 50 soybean genotypes

Sr. No.	Characters	PC_1	PC_2	PC_3	PC_4	PC_5
1	Days to 50 per cent flowering	0.770	-0.018	-0.098	-0.445	-0.171
2	Days to maturity	0.798	0.050	-0.052	-0.327	-0.125
3	Plant height	0.731	-0.310	0.021	0.022	-0.194
4	Number of branches per plant	0.756	0.176	-0.388	0.049	0.043
5	Number of pods per plant	0.492	0.577	-0.497	-0.067	0.203
6	Pod length	-0.176	0.655	0.511	-0.412	-0.168
7	Number of seeds per pod	-0.090	0.631	0.530	-0.450	-0.130
8	100-seed weight	-0.586	0.425	0.011	0.478	0.029
9	Biological yield per plant	0.567	0.625	0.259	0.451	0.084
10	Harvest index	-0.621	0.483	-0.477	-0.338	0.080
11	Protein content	0.259	-0.059	0.167	-0.196	0.731
12	Oil content	-0.033	0.412	-0.327	0.232	-0.548
13	Seed yield per plant	-0.041	0.935	-0.243	0.011	0.178
14	Fodder yield per plant	0.686	0.317	0.403	0.402	0.028

Loading plot of days to 50% flowering…… seed yield per plant

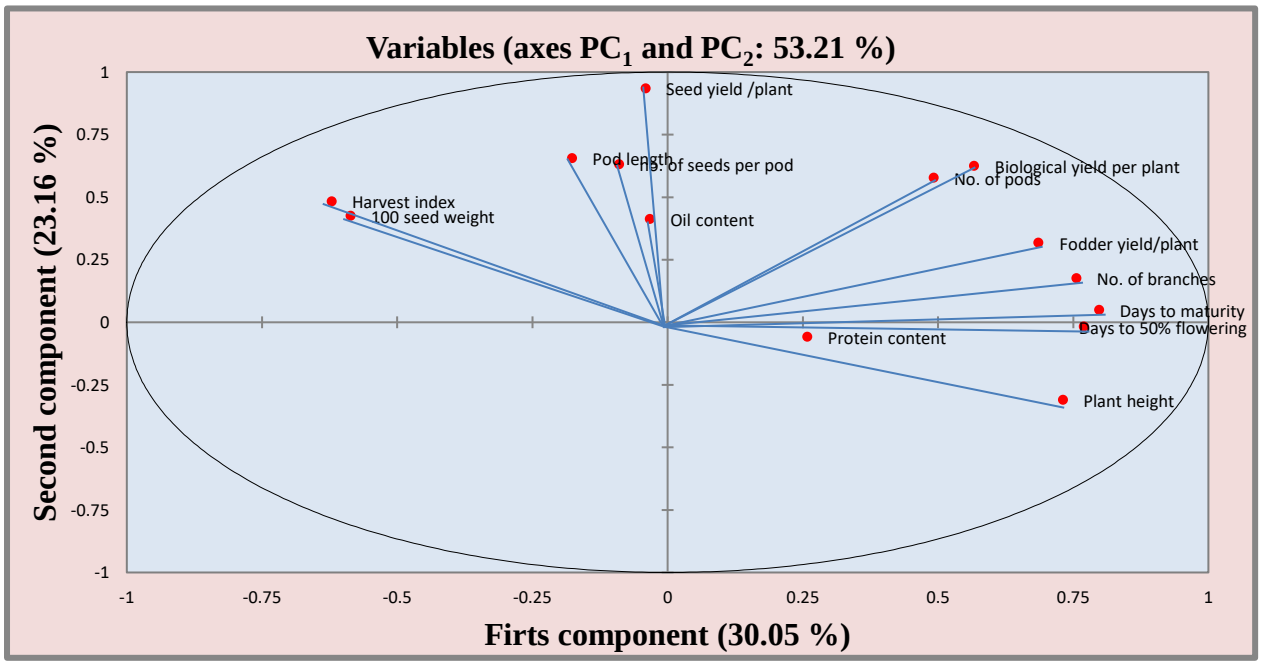

Table 1.3: Genotypes are selected on the basis of PC score in decreasing order in each component and presented below:

PC1	PC2	PC3	PC4	PC5
CSB 10112	DSb 34	MACS 1575	NRC 129	JS 21-15
CSB 10084	NCR 86	KDS 1095	SL 1123	DS 3108
BAUS 102	GJS	NRC 128	Shalimar Soybean-1	BAUS 102
G. Soybean 2	NRCSL 1	JS 20-69	RVS 2011-1	SL 1068
G. Soybean 1	PS 1613	MAUS 731	NRC 131	RVS 2011-1

Table 1.4: PC scores for soybean genotypes

Sr. No.	Genotypes	PC_1	PC_2	PC_3	PC_4	PC_5
1	NRC 128	1.560	1.221	**2.179**	0.052	-1.901
2	RVS 2011-3	-2.985	2.086	0.935	-0.913	-1.893
3	Dsb 34	-0.147	**3.815**	-1.977	0.482	-0.414
4	MAUS 725	-0.634	-0.094	-0.370	0.025	0.977
5	SL 1068	2.028	1.257	-0.063	-0.042	**1.515**
6	JS 21-15	2.094	-0.473	-0.464	-0.241	**1.767**
7	AUKS 174	-0.220	-3.428	-1.156	-1.786	1.299
8	NRC 137	1.046	-3.181	0.612	-0.716	0.310
9	VLS 95	-0.676	-0.259	-0.111	1.480	0.223
10	CSB 10084	**3.655**	-2.235	-1.911	1.139	-2.446
11	MACS 1493	1.672	-1.781	0.758	-0.058	-0.512
12	JA 20-17	-1.060	1.434	0.116	-0.208	0.422
13	NRC 130	-3.346	-1.656	-0.039	0.083	0.008
14	TS 53	1.657	-2.606	0.684	-0.261	0.606
15	JS 20-69	1.635	1.088	**2.107**	-0.906	-0.330
16	SL 1123	1.201	0.260	0.095	**3.520**	0.310
17	BAUS 102	**3.138**	-1.002	1.628	-0.051	1.521
18	MACS 1575	-2.869	-1.165	**2.988**	-1.070	1.305
19	MAUS 731	-0.677	1.376	**2.066**	0.159	1.182
20	NCR 132	-0.494	-3.161	-1.444	-0.262	-0.559
21	VLS 94	-2.181	1.142	-1.416	-0.251	0.016
22	AMS 2014-1	0.053	-4.143	0.266	0.302	0.031
23	KDS 1095	-2.336	-0.917	**2.283**	-1.397	-0.969
24	NRC 133	2.069	-0.404	0.373	0.649	0.783
25	DS 3108	-1.188	-1.087	-1.918	-0.023	**1.597**

26	AMS 100-39	-0.663	-0.323	-1.196	-1.650	-0.113
27	NRC 136	2.190	-1.409	-0.460	-0.415	-0.697
28	RVS 2011-1	-0.380	1.604	-0.748	**1.994**	**1.402**
29	CSB 10112	**4.524**	0.729	-0.371	1.324	0.359
30	PS 1613	0.783	**2.414**	0.884	1.072	-0.602
31	NRC 131	-1.116	-1.138	-0.183	**1.937**	-1.167
32	KDS 992	-0.682	0.051	1.483	-1.294	-0.493
33	RSC 11-07	1.016	0.664	-0.901	-0.437	-0.629

Table 1.4 (continue……)

Sr. No.	Genotypes	PC_1	PC_2	PC_3	PC_4	PC_5
34	NRCL 1	0.289	**2.555**	1.954	0.559	0.666
35	PS 1611	-1.867	-1.380	-2.048	0.681	1.290
36	RSC 11-03	0.338	-0.220	-1.481	-2.132	-0.922
37	NRC 134	1.903	0.199	1.875	0.050	-1.164
38	NRC 129	-3.067	0.622	0.640	**4.157**	-0.721
39	RVS 2011-2	-2.764	0.528	-1.266	-0.751	-1.534
40	SKF-SPS-11	-2.311	1.068	0.482	-1.727	1.239
41	SKF 1050	-1.838	1.713	-0.215	-0.308	1.099
42	Shalimar Soybean-1	-2.422	-0.972	0.536	**2.160**	0.035
43	NRC 86	1.104	**3.359**	-2.352	-0.137	0.687
44	JS 20-34	-5.530	-1.954	-0.530	0.545	-0.982
45	JS 97-52	1.855	2.058	-0.093	-1.328	-0.091
46	JS 335	-0.492	1.282	-0.404	-1.388	-0.578
47	JS 20-29	0.792	2.089	-1.174	-1.195	-0.773
48	G. Soybean 1	**2.468**	-1.621	0.258	0.174	0.152
49	G. Soybean 2	**2.855**	-0.604	-0.366	-0.414	-1.681
50	GJS 3	0.022	**2.602**	-0.547	-1.185	0.370