

**RESEARCH PAPER**

Study of principal component analyses for pod traits in soybean

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Abstract : Yield being a complex entity influenced by several components and environments. PCA is a well-known method of dimension reduction that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set (Massay, 1965 and Jolliffe, 1986). In present study, PCA performed for pod and yield traits revealed that out of fourteen, only five principal components (PCs) exhibited more than 1.0 eigen value and showed about 70.44% total variability among the traits. PC1 showed 23.83% variability with eigen value 3.33 indicating the maximum variation in comparison to other four PCs. The PC1 was more related to traits viz., days to 50% flowering, total number of pods per plant, number of seeds per plant, biological yield per plant and seed yield per plant. Thus, PC1 allowed for simultaneous selection of yield related traits and it can be regarded as yield factor. PC2 exhibited positive effect for days to maturity, number of primary branches per plant and number of nodes per plant, The PC3 was more related to number of two seeded pods per plant, 100 seed weight and harvest index traits, whereas PC4 was more loaded with three seeded pods per plant. PC5 was more related to plant height and number of one seeded pods per plant. A high value of PC score of a particular advanced line in a particular PC denotes high value for those variables. Genotypes namely KS 103, JS 20-15, PS 1423, Cat 1957, Cat 1958, JS 20-06 and JS 20-66 can be considered an ideotype breeding material for selection and for further utilization in precise breeding programme.

Key Words : Eigen values, Principal component analysis, Soybean

View Point Article : Uikey, Shivani, Sharma, Stuti, Shrivastava, M.K. and Amrate, Pawan K. (2021). Study of principal component analyses for pod traits in soybean. *Internat. J. agric. Sci.*, 17 (2) : 341-349, DOI:10.15740/HAS/IJAS/17.2/341-349. Copyright@2021: Hind Agri-Horticultural Society.

Article History : Received : 25.02.2021; Revised : 27.02.2021; Accepted : 16.03.2021

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is a wonderful crop gifted by the nature to mankind which is one of richest sources of oil as well as protein. It belongs to the family Leguminosae and is a self-pollinated crop having chromosome number of $2n=40$. Its seed contains about 40 to 42% protein and 18 to 22% oil. The oil contains 85% unsaturated fatty acids which is free from

cholesterol, along with ample mineral elements, thus it is highly desirable for human diet. It occupies largest area among oilseed crops in India and World. In 2019-20, soybean occupied an area of 11.34 m ha with production of 13.63 m tonnes, and productivity of 1227 kg/ha in India. In M.P., the cultivation of soybean engross 5.51 m ha area with 6.73 m tonnes production and productivity of 1285 kg/ha (SOPA, 2020).

The yield level in soybean, at present, is hovering

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around 1.2 tonnes per ha, which is quite low. Yield is a complex entity influenced by several phenological, physiological, yield traits and environment in soybean as true in other crops also. At Jawaharlal Nehru Krishi Vishwa Vidyalaya several advanced generation fixed genotypes have been developed of different crosses with concerted efforts mounting appropriate selection pressure (Badkul *et al.*, 2014). Owing to lack of knowledge regarding relative importance and usefulness of variables, the investigator tries to include all the possible variables and makes the data matrix perceivably large, complicated and beyond comprehension. Therefore, the investigator requires a technique for systematic reduction and summarization of data sets. Principal component analysis, basically a well known data reduction technique identifies the minimum number of components, which can explain maximum variability out of the total variability (Anderson, 1972 and Morrison, 1982) and also to rank genotypes on the basis of PC scores.

MATERIAL AND METHODS

The present investigation was carried out at the Seed Breeding Farm, J.N.K.V.V. Jabalpur during the *Kharif* 2019. The experimental material comprised of 154 genotypes of soybean including four checks *viz.*, JS 20-34, JS 20-98, JS 335 and NRC 86 grown in Augmented block design (Federer, 1956). Design with plot size 0.5m × 3.0 m² having 3m row length and 40 cm row to row distance. Observations were recorded randomly on five competitive plants selected from each line. Observations

were recorded on the basis of five random competitive plants for the evaluation of 14 traits including two phenological traits. The mean data of 5 plants were subjected to Principal component analysis (PCA), a simple, non-parametric method for extracting relevant information from confusing data sets. It was calculated using Ingebriston and Lyon (1985) method.

RESULTS AND DISCUSSION

PCA preformed for pod and yield traits in 154 soybean genotypes revealed that out of fourteen, only five principal components (PCs) exhibited more than one eigen value, and showed about 70.44 % total variability among the traits studied. So, these five PCs were given due importance for further explanation (Table 1).

Screen plot explained the percentage of variance associated with each principal component obtained by drawing a graph between eigen values and principal component numbers. PC1 showed 23.83% variability

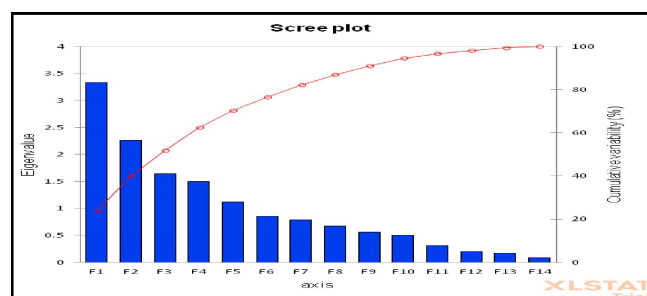


Fig. 1: Screen plot of principal component analysis of soybean genotypes between eigen values and principal components

Table 1: Eigen values, variability and cumulative percentage of soybean genotypes

Traits	Principal component (PC)	Eigen value	Variability (%)	Cumulative %
Days to 50 % flowering (Days)	PC 1	3.33	23.83	23.83
Days to maturity (Days)	PC 2	2.26	16.17	40.00
Plant height (cm)	PC 3	1.64	11.75	51.76
No. of primary branches/plant	PC 4	1.50	10.71	62.47
No. of nodes/plant	PC 5	1.11	7.98	70.45
1 seeded pods/plant	PC 6	0.85	6.12	76.58
2 seeded pods/plant	PC 7	0.78	5.61	82.19
3 seeded pods/plant	PC 8	0.67	4.83	87.03
Total pods/plant	PC 9	0.55	3.97	91.00
No. of seeds/plant	PC 10	0.50	3.58	94.58
100 seed weight (g)	PC 11	0.30	2.19	96.77
Biological yield (g)	PC 12	0.19	1.41	98.18
Harvest index (%)	PC 13	0.17	1.12	99.42
Seed yield (g)	PC 14	0.08	0.57	100.00

with eigen value 3.33 which then declined gradually. Semi curve line is obtained which after fifth PC tended to straight with little variance observed in each PC. From the graph, it is clear that the maximum variation was observed in PC1 in comparison to other four PCs, which is selected for explain here. So, selection of lines from this PC will be useful (Fig. 1).

Rotated component matrix revealed that each principal component separately loaded with various pod and yield attributing traits under study. The PC1 was more related to the days to 50% flowering, total number of pods per plant, number of seeds per plant, biological yield per plant and seed yield per plant. Thus, PC1 allowed for simultaneous selection of yield related traits and it can be regarded as yield factor. PC2 exhibited positive effect for days to maturity, number of primary branches per plant and number of nodes per plant. The third principal component was more related to yield traits *i.e.*, number of two seeded pods per plant, 100 seed

weight and harvest index, whereas PC4 was loaded with three seeded pods per plant. The fifth PC was more related to plant height and number of one seeded pods per plant (Table 2 and 3).

Similar results were obtained by Agrawal and Bhawasar (2013) for 100 seed weight and seed yield per plant, Birla and Ramgiri (2015) for seed yield and plant height, Dubey *et al.* (2018) for days to 50% flowering, plant height, number of branches per plant, number of nodes per plant, number of pods per plant, number of seeds per plant, biological yield per plant and seed yield per plant, and Fuzy *et al.* (2019) for biological yield. From this study, it was clear that PC1 and PC3 were found mostly related to yield attributing traits whereas PC2 was related to phenological traits. As PC1 and PC3 were constituted by most of the yield attributing traits, an intensive selection procedure can be designed to bring about rapid improvement of dependent traits *i.e.*, three seeded pods per plant, yield, 100 seed weight by

Table 2: Principal components for 14 yield contributing traits of soybean genotypes

Traits	Principal components				
	PC1	PC2	PC3	PC4	PC5
Days to 50% flowering (Days)	0.61	0.60	0.20	-0.02	-0.18
Days to maturity (Days)	0.61	0.62	0.17	0.04	-0.21
Plant height (cm)	0.45	0.41	0.07	0.21	0.47
No. of primary branches per plant	0.27	0.33	0.04	-0.06	-0.47
No. of nodes per plant	0.39	0.52	0.05	0.10	0.42
1 seeded pods per plant	0.33	-0.26	0.01	-0.06	0.61
2 seeded pods per plant	0.41	0.02	-0.62	-0.56	0.01
3 seeded pods per plant	0.03	-0.29	0.57	0.67	-0.07
Total no. of pods per plant	0.78	-0.23	-0.06	0.02	-0.07
No. of seeds per plant	0.70	-0.48	0.10	0.03	0.00
100 seed weight (g)	0.06	-0.06	0.64	-0.56	0.02
Biological yield (g)	0.58	-0.48	-0.08	0.08	-0.16
Harvest index (%)	-0.40	0.14	0.58	-0.52	0.11
Seed yield (g)	0.55	-0.52	0.30	-0.28	-0.04

Table 3: Interpretation of rotated component matrix for the traits having values >1.0 in each PCs

	PC 1	PC 2	PC 3	PC 4	PC5
	Days to 50% flowering	Days to maturity	Number of 2 seeded pods per plant	Number of 3 seeded pods per plant	Plant height (cm)
TRAITS	Total number of pods per plant	Number of primary branches per plant	100 seed weight (g)		Number of 1 seeded pods per plant
	Number of seeds per plant	Number of nodes per plant	Harvest index (%)		
	Biological yield (g)				
	Seed yield (g)				

Table 4 : PC scores of soybean genotypes

Sr. No.	Genotypes	PC1	PC2	PC3	PC4	PC5
1.	AGS 80	1.17	-0.22	-1.41	0.60	-1.78
2.	AGS 112	-0.51	-0.10	1.18	1.28	-0.85
3.	AMS 243	-0.82	0.97	0.11	-0.92	-0.52
4.	B 327	-0.72	0.42	0.07	2.06	-0.60
5.	BAUS 102	-0.14	1.93	-0.85	-0.40	-0.30
6.	Cat 156	1.05	2.60	-0.02	-0.23	0.99
7.	Cat 330	2.00	2.25	0.55	-0.02	0.09
8.	Cat 418	-0.55	-0.94	1.67	0.86	-0.64
9.	Cat 473B	1.51	0.57	1.93	2.23	-0.59
10.	Cat 488	0.40	1.22	0.84	-0.25	1.20
11.	Cat 60	0.89	2.61	-0.27	-0.34	-0.59
12.	Cat 642	-1.57	0.31	-0.85	-0.24	0.75
13.	Cat 1328	0.74	2.90	-1.12	0.45	-0.92
14.	Cat 1843B	0.50	2.80	-1.15	-0.42	0.57
15.	Cat 1957	1.75	1.14	0.63	-0.62	1.35
16.	Cat 1958	1.03	2.59	1.32	-1.70	0.02
17.	Cat 2059	-0.86	1.73	-0.04	-1.38	1.24
18.	Cat 2086A	1.26	2.01	0.86	-0.10	-0.58
19.	Cat 2090	0.52	2.49	0.76	-0.58	-1.64
20.	Cat 2127B	0.90	2.68	-1.20	0.59	-0.87
21.	DSB 1	1.76	3.65	-0.30	0.71	0.09
22.	DSB 25	3.41	1.25	-1.01	0.86	-0.56
23.	Eagle 81	-0.05	-1.33	-1.23	-0.97	-1.63
24.	ERS 9045	-1.98	-0.58	-0.25	-1.33	-1.03
25.	ERS 1344	-0.15	-0.82	1.78	0.15	-0.32
26.	EC 456647	-1.06	-0.12	2.62	-0.66	0.51
27.	GP 448	3.41	-0.58	2.59	-3.00	-1.03
28.	GP 465	0.16	1.45	-1.40	0.19	-1.53
29.	G 225	4.41	0.98	-1.52	-0.10	-0.56
30.	Himso 1681	-2.02	-0.61	-1.62	-0.39	0.09
31.	Hara soya Eagle	-0.57	0.60	-1.73	0.90	0.67
32.	IC 313230	-0.43	1.43	-0.68	0.06	-0.57
33.	JS 71-05	-0.20	0.69	-1.46	0.42	0.14
34.	JS 72-44	-0.91	1.39	1.34	0.48	-1.20
35.	JS 75-30	1.84	2.48	0.12	0.13	1.29
36.	JS 75-46	0.57	2.55	-0.92	0.72	0.97
37.	JS 97-57	-0.75	1.59	1.65	0.85	0.18
38.	JS 98-66	-1.34	-0.06	0.11	-1.89	0.67
39.	JS 99-77	-0.80	1.32	-0.11	-1.04	-0.75
40.	JS 99-88	-2.14	-0.57	-1.64	0.34	1.31
41.	JS 20- 06	0.72	-0.07	0.03	-1.22	0.18
42.	JS 20-15	0.06	1.28	1.10	1.67	-0.85
43.	JS 20-16	2.18	-0.01	-0.74	-0.46	1.37
44.	JS 20-25	-1.21	0.77	-1.25	-0.18	-0.33

Table 4: Contd.....

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45.	JS 20-32	0.79	0.97	0.94	2.69	2.16
46.	JS 20-55	-0.74	-0.45	-1.13	-0.08	0.59
47.	JS 20-63	-1.88	-0.38	1.95	0.76	-0.35
48.	JS 20- 66	-1.77	-1.01	1.01	1.96	-0.83
49.	JS 20-68	-1.59	-0.40	0.03	-1.45	-0.19
50.	JS 20-72	-1.75	-0.30	-1.05	-0.13	-0.36
51.	JS 20- 74	0.64	-2.52	0.14	2.52	0.51
52.	JS 20-77	-1.58	-0.11	-0.44	-1.24	0.59
53.	JS 20-81	-1.67	0.22	0.63	1.72	-0.64
54.	JS 20- 86	-1.24	1.45	-0.32	-0.26	-1.44
55.	JS 20-89	0.80	-1.74	2.62	1.46	-1.46
56.	JS 20-91	-1.99	-1.43	1.61	-0.60	-1.80
57.	JS 20- 96	1.17	-0.85	2.76	1.00	-0.25
58.	JS 20-97	-1.27	-1.26	-0.22	-1.16	-0.93
59.	JS 20-100	-1.73	0.01	0.55	1.44	-0.37
60.	JS 20- 104	0.07	1.01	0.05	-0.51	-0.50
61.	JS 20-108	1.04	-1.75	-0.21	-1.75	-1.43
62.	JS 20-109	-0.59	1.66	-0.73	-0.53	-1.26
63.	JS 20-110	-1.62	-0.11	0.27	1.08	-0.60
64.	JS 20- 113	-1.00	1.15	1.87	-2.85	0.09
65.	JS 20-03	-3.39	0.27	2.29	-0.82	-1.42
66.	JS 20-09	-2.10	0.08	0.66	0.95	-0.48
67.	JS 20-76	-0.98	0.67	-0.71	-1.12	-0.46
68.	JSM 3	-1.11	-0.19	0.74	0.95	1.39
69.	JSM 7	-3.37	-0.66	1.18	0.43	-0.92
70.	JSM 17	-3.60	0.01	1.73	-0.68	-0.95
71.	JSM 122	0.96	-2.44	-0.14	-1.20	0.04
72.	JSM 126A	3.06	-2.01	-1.29	-0.21	-1.79
73.	JSM 126B	-1.27	-0.38	-0.95	-0.72	-0.25
74.	JSM 127	2.37	0.33	0.96	-0.63	-0.31
75.	JSM 139	1.62	-1.64	-2.02	1.13	1.11
76.	JSM 155	-2.30	-0.54	1.29	0.57	-0.12
77.	JSM 170	-2.14	-0.29	-2.09	-0.38	-0.53
78.	JSM 188	-0.19	-0.58	-2.12	0.23	1.35
79.	JSM 202	0.32	1.44	-1.14	0.38	1.14
80.	JSM 203	3.42	-3.90	-0.69	-0.36	1.24
81.	JSM 224	-2.00	-0.12	1.01	0.77	1.61
82.	JSM 226	-1.05	-1.54	-0.19	2.49	2.97
83.	JSM 227	3.45	-0.60	-0.61	0.06	1.49
84.	JSM 228	0.11	0.22	-0.08	-1.07	0.49
85.	JSM 230	0.44	0.22	1.35	0.92	-0.77
86.	JSM 232	0.35	-0.51	-0.59	2.43	0.07
87.	JSM 236	2.80	-3.17	-0.02	-0.53	1.33
88.	JSM 259	1.14	-0.58	-0.06	-0.16	-0.24
89.	JSM 265	0.12	-0.91	-1.08	0.51	-0.68

Table 4 : Contd.....

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90.	JSM 276	-1.92	-1.23	0.25	2.25	-0.45
91.	JSM 284	1.35	-0.60	1.72	1.85	-0.02
92.	JSM 285	1.67	0.67	4.73	-1.28	0.62
93.	JSM 287	3.81	-1.68	1.05	4.24	-0.62
94.	JSM 288	2.46	-0.10	0.00	-1.08	-1.34
95.	JSM 298	-0.60	0.24	-0.96	0.46	1.38
96.	JSM 301	0.29	-0.57	0.04	-1.84	2.43
97.	JSM 302	-0.64	0.04	-1.39	-0.77	-0.58
98.	JSM 310	-0.50	-1.33	-0.40	-1.11	0.44
99.	JS 335×G.Soja2	0.35	2.12	0.49	2.77	1.09
100.	KS 103	2.94	1.56	1.17	-0.72	-0.48
101.	KBS 701	5.19	-1.86	3.28	-2.59	2.85
102.	MACS 453	3.06	-0.91	-0.51	0.13	1.23
103.	MACS 1442	-0.61	0.50	1.40	0.75	0.29
104.	MAUS 71	-1.73	0.36	1.26	1.21	-0.26
105.	MAUS 162	0.88	1.79	0.64	2.16	1.16
106.	MAUS 706	-1.47	-0.60	1.78	0.21	-0.63
107.	MAUS 1460	0.91	-0.74	-0.45	-0.82	2.44
108.	Nagaland 2	2.21	1.94	-0.66	-0.04	-1.25
109.	NRC 2	-1.83	-1.00	-1.96	-0.02	0.53
110.	NRC 7	0.23	0.67	-0.64	-1.38	0.83
111.	NRC 29	-0.91	-0.13	-1.78	-0.40	-0.14
112.	NRC 37	0.43	-1.19	-0.43	-0.26	-0.20
113.	NRC 67	-1.24	0.08	0.08	1.87	1.07
114.	NRC 76	-2.33	-0.39	-1.73	-0.05	0.60
115.	NRC 84	0.27	0.17	-0.47	-0.53	-1.71
116.	NRC 99	-0.84	1.95	-0.39	0.12	1.64
117.	NRC 116	-0.71	-0.78	-0.86	-0.55	-0.21
118.	NRC 124	3.91	-2.21	0.93	-1.05	-0.95
119.	NRC 2324	-1.78	-0.55	1.55	-2.93	1.68
120.	PI 204336	-0.49	-0.34	-1.23	-0.22	-0.43
121.	PS 7	-1.66	0.86	-0.78	-0.76	1.42
122.	PS 1423	1.05	0.24	-1.04	1.58	1.58
123.	PS 1569	-2.39	-0.49	-1.24	-0.49	0.70
124.	PK 462	2.33	-1.31	-1.94	0.18	-1.49
125.	PK 618	4.12	-0.12	-1.01	-0.21	-1.46
126.	PK 1092	-2.46	-0.81	0.47	-2.55	-0.08
127.	PK 1171	-2.50	-0.21	-1.13	-0.59	-0.39
128.	RKS 18	-0.87	0.12	1.05	1.05	-0.37
129.	RKS 24	3.13	-0.18	-2.25	0.14	-1.37
130.	RKS 39	-0.69	0.58	0.06	1.88	0.88
131.	RKS 47	0.27	2.56	-0.18	-0.39	0.03
132.	RKS 66	2.72	2.19	-0.35	0.00	0.20
133.	RSC 10-70	0.62	1.72	-0.45	-0.31	0.73
134.	RSC 10-71	2.29	1.55	-0.13	0.31	-0.84

Table 4: Contd.....

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135.	RVS 2007-6	1.26	0.03	-1.45	0.24	2.30
136.	RVS 2009-9	0.12	-1.69	1.70	0.75	-1.54
137.	RVS 2010-2	-0.14	-0.40	1.32	-2.11	-0.57
138.	RVS 2011-4	0.30	-2.39	-1.98	0.45	-1.30
139.	SL 742	-2.08	0.48	1.62	0.35	0.86
140.	SL 1028	-1.68	-1.17	0.42	-0.29	-1.33
141.	SL 1104	0.15	-0.75	-2.34	-2.74	1.44
142.	SKFSPC 11	-2.92	-0.47	1.93	-0.41	0.87
143.	SQL 31	-2.12	-1.90	-0.14	-2.29	0.19
144.	SQL 32	-0.08	1.71	-0.95	-0.08	-1.19
145.	SQL 89	-0.40	0.39	-0.08	-1.68	0.49
146.	TS 37	-3.01	-0.52	2.03	0.03	1.68
147.	VLS 58	4.82	-3.13	0.72	-0.16	-0.71
148.	VLS 69	-2.77	-1.04	-3.19	1.32	-1.75
149.	VLS 89	-2.85	-0.72	-0.71	-1.10	0.27
150.	WT 88	-0.34	0.45	-0.82	-0.90	-1.64
151.	JS 20-98	-1.65	-2.80	-0.74	1.44	0.80
152.	JS 20-34	-2.27	-2.96	-1.22	1.48	0.83
153.	JS335	1.78	-3.14	0.19	0.37	-0.41
154.	NRC-86	1.36	-6.54	-0.14	0.00	-0.11

selecting the lines from PC1 and PC3.

High PC score for a particular genotype in a particular component denotes high values for the variables in that particular genotype. KBS 701 had the highest PC score followed by VLS 58, G 225, PK 618, NRC 124, JSM 287, JSM 227, JSM 203, DSB 25, GP 448, RKS 24, JSM 126A, MACS 453, KS 103, JSM 236, RKS 66, JSM 288, JSM 288, JSM 127, PK 462, RSC10-71, KVS 701, Nagaland 2, JS 20-16, Cat 330, JS 75-30, DBS 1, Cat 1957, JSM 285, JSM 139, Cat 473B, NRC 86, JSM 284, Cat 2086A, RVS 2007-6, JS 20-96, PS 1423, Cat 156, JS 20-108, and Cat 1958 in PC1 indicated that these genotypes possesses high values of traits *viz.*, days to 50% flowering, total number of pods per plant, number of seeds per plant, biological yield per plant and seed yield per plant, which are mainly yield attributing traits. The highest PC score of DSB1 followed by Cat 1328, Cat 1843B, Cat 2127B, Cat 60, Cat 156, Cat 1958, RKS 47, JS 75-46, Cat 2090, JS 75-30, Cat 330, RKS 66, JS335×G. Soja2, Cat 2086A, NRC 99, Nagaland 2, BAUS 102, MAUS 162, Cat 2059, RSC10-70, SQL 32, JS20-109, JS 97-57, KS 103, RSC 10-71, GP465, JS 20-86, JSM 202, IC 313230, JS 72-44, JS 99-77, JS 20-15, DSB 25, Cat 488, JS 20-113, Cat 1957 and JS 20-104 in PC2 was mainly related with days to maturity, number of

primary branches per plant and number of nodes per plant.

The highest PC score was obtained by JSM 285 followed by KBS 701, JS 20-96, JS20-89, EC 456647, GP 448, JS 20-03, TS 37, JS 20-63, Cat 473B, SKFSPC 11, JS 20-113, ERS 1344, MAUS 706, JSM17, JSM 284, RVS 2009-9, Cat 418, JS 97-57, SL 742, JS 20-91, NRC 2324, MACS 1442, JSM 230, RVS 2010-2, Cat 1958, JSM 155, MAUS 71, AGS 112, JSM 7, KS 103, JSM 287, JS 20-15, RKS 18, JSM 224 and JS 20-66 in PC3 for traits namely number of two seeded pods per plant, 100 seed weight and harvest index. PC scores in PC4 were recorded the highest value for traits *viz.*, number of three seeded pods per plant by the genotypes JSM 287, JS 20-32, JS 20-74, JSM 226, JSM 232, JSM 276, Cat 473B, MAUS 162, JS 20-66, RKS 39, NRC 67, JSM 284, JS 20-81, JS 20-15, PS 1423, JS 20-34, JS 20-89, JS 20-98, JS 20-100, VLS 69, AGS 112, MAUS 71, JSM 139, JS 20-110, and RKS 18. However, JSM 226, KVS 701, MAUS 1460, JSM 301, RVS 2007-6, JS 20-32, NRC 2324, TS 37, NRC 99, JSM 224, PS 1423, JSM 227, SL 1104, PS 7, JSM 3, JSM 298, JS 20-16, Cat 1957, JSM 188, JSM 236, JS 99-88, JS 75-30, JSM 203, Cat 2059, MACS453, Cat 488, MAUS 162, JSM 202, JSM 139, JS 335×G. Soja 2 and NRC 67 had the highest PC scores in

PC5 plant height and number of one seeded pods per plant. Based on top PC scores genotypes were categorized in the Table 4 and 5.

PC scores were calculated for all the 154 genotypes in 5 principal components and utilized in finding superior one, superior for different combination of phenotypic

Table 5: List of selected genotypes in each principal component

Sr. No	PC1	PC2	PC3	PC4	PC5
1.	KBS 701	DSB 1	JSM 285	JSM 287	JSM 226
2.	VLS 58	Cat 1328	KBS 701	JS 20-32	KBS 701
3.	G 225	Cat 1843B	JS 20- 96	JS 20- 74	MAUS 1460
4.	PK 618	Cat 2127B	JS 20-89	JSM 226	JSM 301
5.	NRC 124	Cat 60	EC 456647	JSM 232	RVS 2007-6
6.	JSM 287	Cat 156	GP 448	JSM 276	JS 20-32
7.	JSM 227	Cat 1958	JS 20-03	Cat 473B	NRC 2324
8.	JSM 203	RKS 47	TS 37	MAUS 162	TS 37
9.	DSB 25	JS 75-46	JS 20-63	JS 20- 66	NRC 99
10.	GP 448	Cat 2090	Cat 473B	RKS 39	JSM 224
11.	RKS 24	JS 75-30	SKFSPC 11	NRC 67	PS 1423
12.	JSM 126A	Cat 330	JS 20- 113	JSM 284	JSM 227
13.	MACS 453	RKS 66	ERS 1344	JS 20-81	SL 1104
14.	KS 103	JS 335×G.Soja2	MAUS 706	JS 20-15	PS 7
15.	JSM 236	Cat 2086A	JSM 17	PS 1423	JSM 3
16.	RKS 66	NRC 99	JSM 284	JS 20-34	JSM 298
17.	JSM 288	Nagaland 2	RVS 2009-9	JS 20-89	JS 20-16
18.	JSM 127	BAUS 102	Cat 418	JS 20-98	Cat 1957
19.	PK 462	MAUS 162	JS 97-57	JS 20-100	JSM 188
20.	RSC 10-71	Cat 2059	SL 742	VLS 69	JSM 236
21.	Nagaland 2	RSC 10-70	JS 20-91	AGS 112	JS 99-88
22.	JS 20-16	SQL 32	NRC 2324	MAUS 71	JS 75-30
23.	Cat 330	JS 20-109	MACS 1442	JSM 139	JSM 203
24.	JS 75-30	JS 97-57	JSM 230	JS 20-110	Cat 2059
25.	JS 335	KS 103	RVS 2010-2	RKS 18	MACS 453
26.	DSB 1	RSC 10-71	Cat 1958		Cat 488
27.	Cat 1957	GP 465	JSM 155		MAUS 162
28.	JSM 285	JS 20- 86	MAUS 71		JSM 202
29.	JSM 139	JSM 202	AGS 112		JSM 139
30.	Cat 473B	IC 313230	JSM 7		JS 335×G.Soja2
31.	NRC-86	JS 72-44	KS 103		NRC 67
32.	JSM 284	JS 99-77	JSM 287		
33.	Cat 2086A	JS 20-15	JS 20-15		
34.	RVS 2007-6	DSB 25	RKS 18		
35.	JS 20- 96	Cat 488	JSM 224		
36.	JSM 259	JS 20- 113	JS 20- 66		
37.	PS 1423	Cat 1957			
38.	Cat 156	JS 20- 104			
39.	JS 20-108				
40.	Cat 1958				

traits. A high value of PC score of a particular genotype in a particular PC denotes high value for those variables, in that genotype which the component is representing. Thus, these score can be utilized to propose precise selection indices, whose intensity can be decided by variability explained by each of the PC.

Conclusion:

On the basis of PCA analysis, soybean genotypes namely KS 103, JS 20-15, PS 1423, Cat 1957, Cat 1958, JS 20-06, JS 20-66, JSM 202, JS 20-09, TS 37, NRC 76, G 225, PK 618 and JS 75-30 had been selected for yield and its contributing traits over different environments. This helps in the further improvement of genotypes in the breeding programme to achieve the desirable future varieties of soybean with wider adaptability.

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