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Morphological Characterization of Recombinant Inbred Lines of Soybean [*Glycine max* (L.) Merrill]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Morphological characterization facilitates the seed production agencies to identify the varieties on phenotypic basis by their distinguished characters. The presence of sufficient variability for various agro-morphological traits, as well as the improvement of these traithrough selection and introduction of new alleles, lines, and accessions into breeding activity from both exotic and indigenous collections, aids in the identification of potential donors. In the present study, 100 genotypes including 96 RIL (recombinant inbred lines), two parental and two national checks were planted at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. Fourteen phenological trait viz. growth type, growth habit, flower colour, leaf size of lateral leaflet, leaf shape of lateral leaflet, leaf intensity of green colour, pod hairiness, pod: colour of hair, seed size, seed shape, seed coat colour of testa, seed coat lustre, hilum colour and hilum funicle were observed at different growth stages of plants. Among these traits, Semi- determinant growth type (97%), Semi erect growth habit (98%),

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white flower colour (99%), Pod colour of hair (100%) and hilum funicle same as testa (97%) were most dominating. Whereas Seed coat colour of testa [yellow (74%), yellow-green (24%) and Green (2 %)], Hilum colour [black (48%) and brown (43%) and imperfect black (9%)] and Seed shape [spherical (48%), spherical flattened (33%), flattened (16%) and elongated (3%)] were varied among genotypes.

Keywords: Heterogeneity; exotic collection; determinant growth.

1. INTRODUCTION

Soybean [*Glycine max (*L) Merrill] currently ranks first in the world and third in India among the major oilseed crops after groundnuts and rapeseed-mustard with an area of 12.5 million hectares and a production of 13.2 million tonnes and yield of 1.06 t/ha (Director's Report, IISR, 2021-22). Soybean is belonging to the family Leguminosae syn. Fabaceae, subfamily Faboidae, and tribe Phaseoleae. *Glycine* (Wild.) is further subdivided into two subgenera: *Glycine and Soja*. There are 26 wild perennial species in the *Glycine* subgenus [1,2]. The seed of soybean consist very high range of protein (36.1–41.2%) with considerable amount of edible oil (16.8 – 20.2%) and several nutritional properties [3,4]. The amount of oil, protein, or other favourable substances was shown to be connected to the size and shape of the seeds [4-7].

Crop genotype exploitation is mostly dependent on the presence of genetic variability within or between them and the crop genetic resources have been categorised in large part by qualitative traits [8]. On the other hand, morphological characterization facilitates the seed production agencies to identify the varieties on phenotypic basis by their distinguished characters. To a large part, the commercial value of soybean seeds is determined by their visual quality, which comprises seed size, shape, colour and texture. In addition to the direct effect of seed size on yield, many studies have found a link between the external appearance of soybean seeds and their inside quality. Morphological characterisation is an important stage in the description and classification of accessions or genotypes because a breeding programme is largely dependent on the amount of genetic variability.

Multiple superior genotypes should be managed simultaneously in the seed production and varietal development programme. Numerous opportunities exist for genetic duplication and admixture. The Protection of Plant Varieties and Farmers Rights Act (PPV&FRA), 2001, intends to safeguard plant varieties based on distinctiveness, uniformity, and stability (DUS). In soybean and other crops, varieties and genotypes are morphologically recognised using descriptors based on distinctiveness, uniformity, and stability (DUS) [9-11]. It shows to be a solid method to define genotypes since the qualitative traits demonstrate stability over a range of environment and generations. Looking to all these aspects, an investigation was carried out to characterise the recently developed RILs of soybean at IISR, Indore on the basis of phenotype and to draw important selection indices by estimating genetic variability, heritability and genetic advance with respect to the different yield attributing traits.

2. MATERIALS AND METHODS

This experiment was conducted at breeding field of J.N.K.V.V., Jabalpur, during Kharif 2021. Jabalpur is most prominent place of soybean cultivation in India and all the varieties or genotypes express their characters fully. Two blocks were used in the experiment's randomized complete block design (RCBD), which helped to minimize experimental error and field variation. Each block was planted with two replications of 96 genotype RIL lines, each of which had two parental and two national checks from the IISR in Indore and the JNKVV in Jabalpur. The List of RILs, along with their pedigree showed in Table 1. Individual plant observations as well as net plot observations for morphological features were kept track of fourteen phenological trait viz. growth type: determinate and semi-determinate, growth type, growth habit, flower colour, leaf size of lateral leaflet, leaf shape of lateral leaflet, leaf intensity of green colour, pod hairiness, pod: colour of hair, seed size, seed shape, seed coat colour of testa, seed coat lustre, hilum colour and hilum funicle were used to record the observations of the lines proposed for this investigation.

Table 1. List of genotypes and their parentage

S. No.	Name of RILs	Pedigree	S. No.	Name of RILs	Pedigree
1	RIL-107-1	JS 97-52 × NRC 37	51	RIL-107-95	JS 97-52 × NRC 37
2	RIL-107-3	JS 97-52 × NRC 37	52	RIL-107-96	JS 97-52 × NRC 37
3	RIL-107-5	JS 97-52 × NRC 37	53	RIL-107-97	JS 97-52 × NRC 37
4	RIL-107-6	JS 97-52 × NRC 37	54	RIL-107-98	JS 97-52 × NRC 37
5	RIL-107-7	JS 97-52 × NRC 37	55	RIL-107-100	JS 97-52 × NRC 37
6	RIL-107-8	JS 97-52 × NRC 37	56	RIL-107-101	JS 97-52 × NRC 37
7	RIL-107-9	JS 97-52 × NRC 37	57	RIL-107-102	JS 97-52 × NRC 37
8	RIL-107-11	JS 97-52 × NRC 37	58	RIL-107-103	JS 97-52 × NRC 37
9	RIL-107-12	JS 97-52 × NRC 37	59	RIL-107-105	JS 97-52 × NRC 37
10	RIL-107-18	JS 97-52 × NRC 37	60	RIL-107-106	JS 97-52 × NRC 37
11	RIL-107-19	JS 97-52 × NRC 37	61	RIL-107-109	JS 97-52 × NRC 37
12	RIL-107-21	JS 97-52 × NRC 37	62	RIL-107-110	JS 97-52 × NRC 37
13	RIL-107-23	JS 97-52 × NRC 37	63	RIL-107-111	JS 97-52 × NRC 37
14	RIL-107-24	JS 97-52 × NRC 37	64	RIL-107-114	JS 97-52 × NRC 37
15	RIL-107-27	JS 97-52 × NRC 37	65	RIL-107-115	JS 97-52 × NRC 37
16	RIL-107-28	JS 97-52 × NRC 37	66	RIL-107-116	JS 97-52 × NRC 37
17	RIL-107-29	JS 97-52 × NRC 37	67	RIL-107-118	JS 97-52 × NRC 37
18	RIL-107-31	JS 97-52 × NRC 37	68	RIL-107-121	JS 97-52 × NRC 37
19	RIL-107-32	JS 97-52 × NRC 37	69	RIL-107-123	JS 97-52 × NRC 37
20	RIL-107-35	JS 97-52 × NRC 37	70	RIL-107-124	JS 97-52 × NRC 37
21	RIL-107-36	JS 97-52 × NRC 37	71	RIL-107-125	JS 97-52 × NRC 37
22	RIL-107-41	JS 97-52 × NRC 37	72	RIL-107-126	JS 97-52 × NRC 37
23	RIL-107-46	JS 97-52 × NRC 37	73	RIL-107-127	JS 97-52 × NRC 37
24	RIL-107-48	JS 97-52 × NRC 37	74	RIL-107-131	JS 97-52 × NRC 37
25	RIL-107-49	JS 97-52 × NRC 37	75	RIL-107-132	JS 97-52 × NRC 37
26	RIL-107-51	JS 97-52 × NRC 37	76	RIL-107-133	JS 97-52 × NRC 37
27	RIL-107-52	JS 97-52 × NRC 37	77	RIL-107-134	JS 97-52 × NRC 37
28	RIL-107-55	JS 97-52 × NRC 37	78	RIL-107-135	JS 97-52 × NRC 37
29	RIL-107-56	JS 97-52 × NRC 37	79	RIL-107-136	JS 97-52 × NRC 37
30	RIL-107-57	JS 97-52 × NRC 37	80	RIL-107-137	JS 97-52 × NRC 37
31	RIL-107-58	JS 97-52 × NRC 37	81	RIL-107-138	JS 97-52 × NRC 37
32	RIL-107-59	JS 97-52 × NRC 37	82	RIL-107-140	JS 97-52 × NRC 37
33	RIL-107-60	JS 97-52 × NRC 37	83	RIL-107-141	JS 97-52 × NRC 37
34	RIL-107-62	JS 97-52 × NRC 37	84	RIL-107-143	JS 97-52 × NRC 37
35	RIL-107-64	JS 97-52 × NRC 37	85	RIL-107-151	JS 97-52 × NRC 37
36	RIL-107-65	JS 97-52 × NRC 37	86	RIL-107-154	JS 97-52 × NRC 37
37	RIL-107-67	JS 97-52 × NRC 37	87	RIL-107-157	JS 97-52 × NRC 37
38	RIL-107-68	JS 97-52 × NRC 37	88	RIL-107-159	JS 97-52 × NRC 37
39	RIL-107-70	JS 97-52 × NRC 37	89	RIL-107-161	JS 97-52 × NRC 37
40	RIL-107-71	JS 97-52 × NRC 37	90	RIL-107-168	JS 97-52 × NRC 37
41	RIL-107-73	JS 97-52 × NRC 37	91	RIL-107-172	JS 97-52 × NRC 37
42	RIL-107-76	JS 97-52 × NRC 37	92	RIL-107-173	JS 97-52 × NRC 37
43	RIL-107-79	JS 97-52 × NRC 37	93	RIL-107-174	JS 97-52 × NRC 37
44	RIL-107-80	JS 97-52 × NRC 37	94	RIL-107-177	JS 97-52 × NRC 37
45	RIL-107-83	JS 97-52 × NRC 37	95	RIL-107-178	JS 97-52 × NRC 37
46	RIL-107-84	JS 97-52 × NRC 37	96	RIL-107-181	JS 97-52 × NRC 37
47	RIL-107-85	JS 97-52 × NRC 37	97	JS-97-52	PK 327 X L129
48	RIL-107-88	JS 97-52 × NRC 37	98	NRC 37	Gaurav X Punjab 1
49	RIL-107-91	JS 97-52 × NRC 37	99	JS 335	JS 78-77 X JS 71-05
50	RIL-107-92	JS 97-52 × NRC 37	100	JS 2029	JS 97-52 X JS 95-56

Table 2. Morphological characterization of soybean RILs

Trait	Classes	Frequency	Note
Growth type	Determinant	3	1
	Semi- determinant	97	2
Growth habit	Erect	2	1
	Semi erect	98	3
Flower colour	White	99	1
	Violet	1	2
Leaf size of	Small	4	3
lateral leaflet	Medium	88	5
	Large	8	7
Leaf shape of lateral leaflet	Pointed ovate	77	3
	Round ovate	23	4
Leaf intensity of green colour	Dark green	3	7
	Green	97	5
Pod hairiness	Pubescent	99	1
	Glabrous	1	0
Pod: colour of hair	Tawny brown	100	2
Seed size	Medium	44	5
	Small	45	3
	Large	11	7
Seed shape	Spherical	48	1
	Spherical-flattened	33	2
	Flattened	16	4
	Elongated	3	3
Seed coat colour of testa	Yellow	74	1
	Green	2	3
	yellow-green	24	2
Seed coat lustre	Intermediate	81	5
	Shiny	10	3
	Dull	9	7
Hilum colour	Black	48	6
	Brown	43	3
	Imperfect Black	9	5
Hilum funicle	Same as testa	97	1
	Different as testa	3	2

3. RESULTS AND DISCUSSION

There were 98 genotypes that were show semi-erect, and 2 genotypes erect type growth habit. Out of 100 genotypes only one genotype was violet, while the ninety-nine genotypes were white. Small leaves were found in 4 genotypes, medium leaves in 8 genotypes, and large leaves in 88 genotypes.

The RILs were classified into two groups based on the shape of the lateral leaflet: Round ovate, pointed ovate. 23 genotypes were round ovate and 77 genotypes were pointed ovate leaves. 97 genotype expressed green colour and 3 genotypes expressed dark green colour. RILs were classified depending on the presence or absence of hair on the pod: pubescent (hairs present) and glabrous (hairs absent). Ninety-nine genotypes had pubescence (either grey or tawny), while the one was glabrous. At the advanced pod filling stage, the pod colour was observed to be tawny brown. One hundred genotypes indicated tawny pubescence. Genotypes are divided into three groups based on seed size: small (less than 10 g), medium (10-13 g), and bold/large (more than 13 g). Forty-five genotypes had small seeds, forty-four had medium seeds, and the remaining eleven had bold/large seeds.

Out of 100 genotype, 48 genotypes had spherical seeds, 33 had spherical flattened seeds, 3 had elongated seeds, and the remaining 16 genotypes had flattened seeds. The colour of testa excluding hilum were shown as yellow, yellow green, green. 74 genotypes had yellow seed coats, 2 genotypes had yellow-

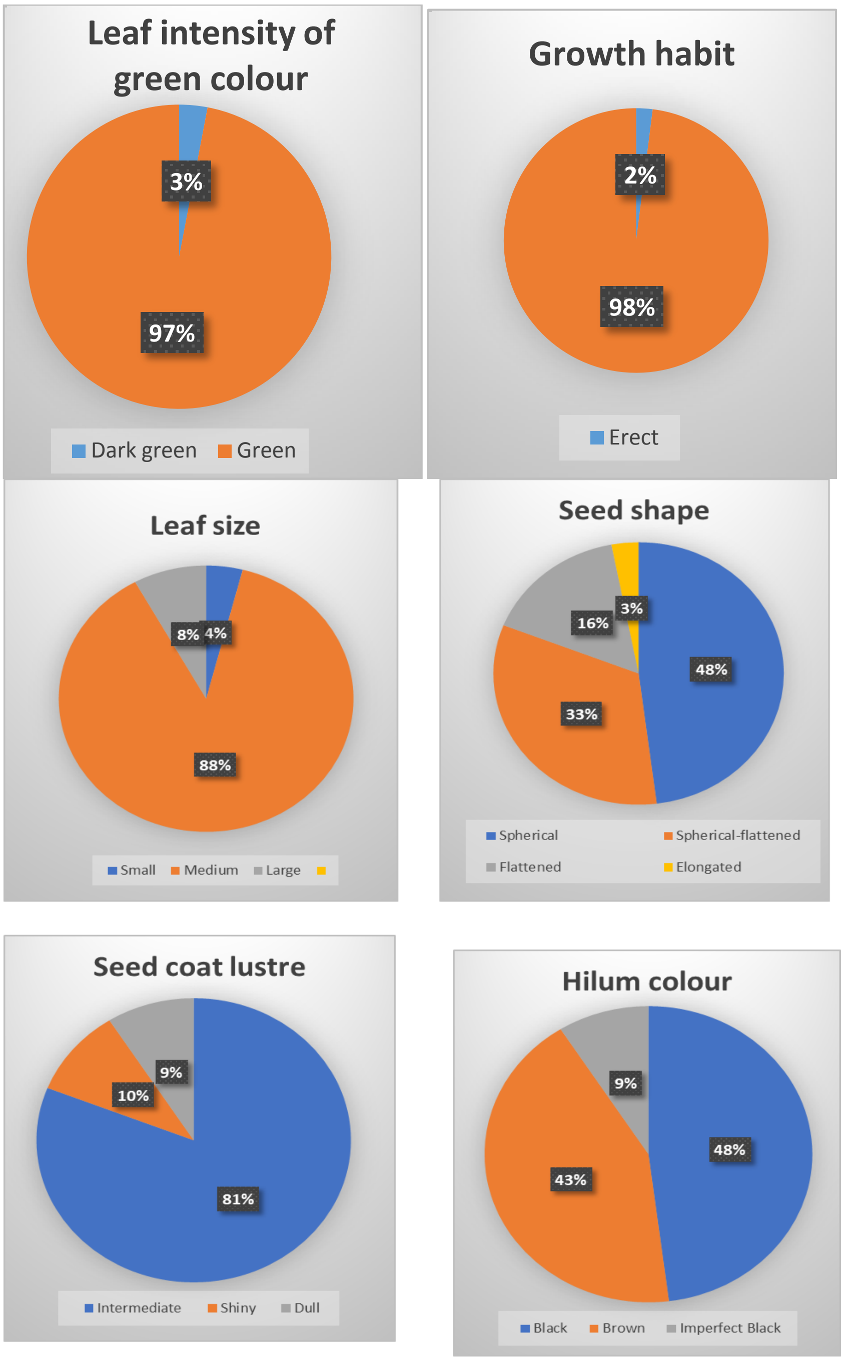

Fig. 1. Graphical representation of particular frequency of different traits

green seed coats, and the remaining 2 genotypes had green seed coats. Seed coat lustre of ten genotypes was shining, 81 genotypes were intermediate, and the other nine genotypes had dull seed coat lustre. Barela et al. [12], Soni et al. [13] Banerjee et al. [11] and Rahangdale et al. [14] revealed that there was a lot of variation in the soybean genotypes for DUS characters and qualitative traits provide stability over changing environments and generations.

Hilum colour were classified into four categories: brown, imperfect black, and black. 43 genotypes had brown hilums, 9 had imperfect black hilums, and 48 had black hilums. Hilum funicle colour was found to be either the same as testa or different from testa. Ninety-seven genotypes had hilum funicle colour that was the same as the testa, while the remaining three genotypes had hilum funicle colour that was different from the testa.

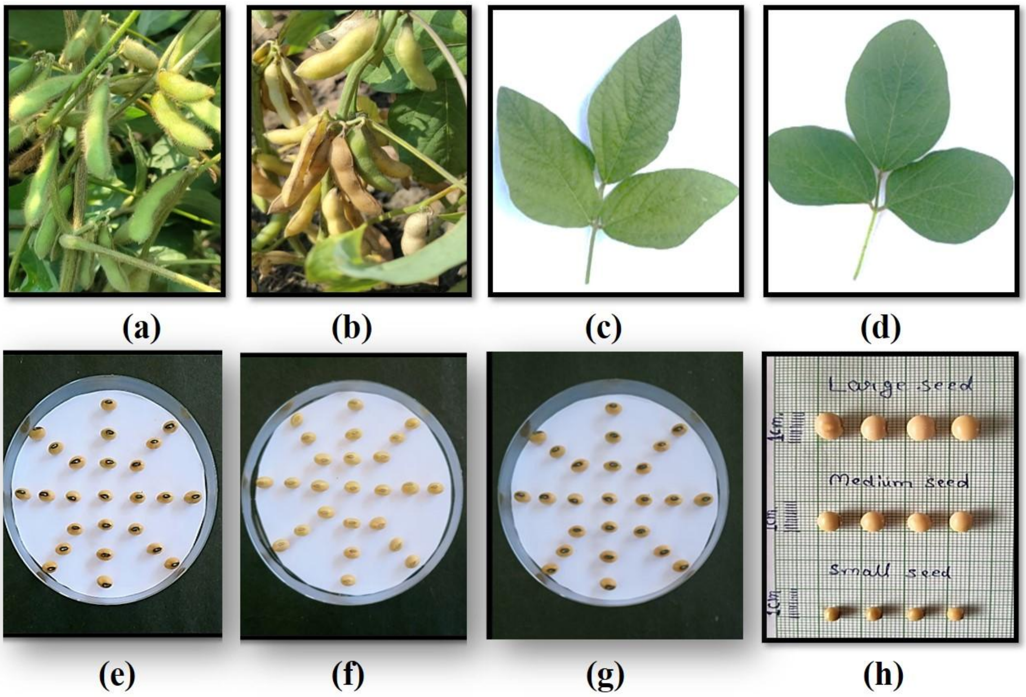

Fig. 1. Different destructive features of soybean (a) Pubescent (b) Glabrous, Leaf shape of lateral leaflet (c) Pointed leaf (d) Ovate leaf, Hilum colour (e) Black Helium (f) Brown helium (g) Imperfect black helium (h) Seed size

To establish phenotypic distinctiveness among soybean genotypes, morphological features must be used to classify them, making genotype identification easier in the future seed production programme. Since the DUS recommendations provided under the Protection of Plant Varieties and Farmers' Rights Act 2001 (PPVFRA) have become mandatory for the provision of protection to varieties and germplasm, etc. As a result, morphological features must be used to characterise the RILs. These distinct characteristics can assist breeders and seed producers in identifying genotypes on phenotypic basis. For morphological features, Barela et al. [15], Soni et al. [13], Painkra et al. [16], Uikey [4] and Mehra [17] used a similar characterisation study [18,19].

4. CONCLUSION

To meet the growing global demand for food security, genetic resources offer the basis for breeding selection and enhancement. The material in the soybean development programme is used more effectively when it is systematically characterized. The wide variety of seed hilum colors present in the RILs accounts for the high market price and profitability for farmers. Genotypes with this morphology can be chosen as a donor in the crossing operation after the stability and heritability of the traits have been determined.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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