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Morphological Characterization of Exotic Lines of Soybean (*Glycine Max* (L.) Merrill) for Developing Ideotype

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ABSTRACT: During *Kharif* 2019, at the Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur, forty-eight exotic genotypes of soybean, including two national checks, were characterized using the DUS (Distinctness, Uniformity, and Stability) traits as prescribed by National DUS test guidelines. At various phases, observations were made on the leaves, stems, flowers, seeds, and pods of plants. For the most part, there was a lot of variation in the qualities evaluated. The findings demonstrated that soybean germplasm has a wide range of features and that the genotypes gathered had a lot of morphological variation, which may assist a breeder to improve the plant's genetic foundation. This will be extremely helpful in identifying and conserving genotypes for identification on the basis of distinguishing morphological characters and help to develop ideal plant type.

Keywords: Morphological Characterization, DUS test, Exotic Lines, soybean.

INTRODUCTION

The soybean [*Glycine max* (L.) Merrill] has long been regarded as the most important seed legume on the planet. It is known as the "Wonder crop" of the twentieth century due to its high oil and protein content. After peanuts and rapeseed-mustard, soybean now ranks first in the world and third in India among the major oilseed crops (Anonymous, 2008). Characterization with distinct morphological markers is essential for identification of genotypes and Intellectual property protection. India has enacted legislation for the Protection of Plant Varieties and Farmer's Right Act in 2001, in order to provide incentives for development and fulfil obligations under Trade Related Intellectual Property Right (TRIPs). Novelty, Distinctiveness, Uniformity and Stability are the essential requirements for grant of protection to distinct varieties/germplasm variation either Alpna *et al.* (2015). Attributes such as pod intensity of brown colour at maturity, pod pubescence, seed coat colour, seed shape, hilum colour, and seed size were shown to be more beneficial in efficiently differentiating the genotypes when using DUS descriptors. Breeders and researchers may find this study valuable in identifying these soybean genotypes and then using them in breeding programmes to produce superior varieties. Soybean that is cultivated has a wide range of genotypes. Germplasm is the basic material for every crop improvement programme and plays a critical role in crop development Sawarkar *et al.* (2010). Keeping the foregoing in mind, the primary goal of this experiment is to define soybean genotypes based on the morphological characteristics. The extra early genotypes are in high demand in the Malwa area of Madhya Pradesh to accommodate the following harvest. Soybean, like any other crop, is heavily influenced by climate change. Characters such as pod intensity of brown colour at maturity, pod pubescence, seed coat colour, seed shape, hilum colour, and seed size were shown to be more beneficial in efficiently differentiating the genotypes when using DUS descriptors. Breeders and researchers may find this study valuable in identifying these soybean genotypes and then using them in breeding programmes to produce superior varieties.

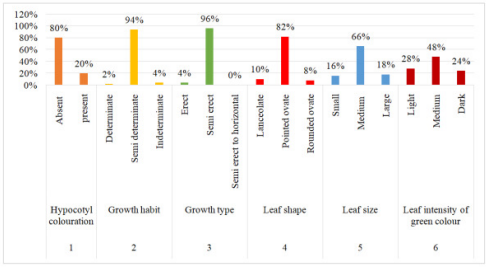
MATERIALS AND METHODS

Fifty exotic soybean lines, including two controls (JS 20-34 and JS 20-98), were received from the All India Coordinated Research Project (AICRP) on Soybean, Department of Plant Breeding and Genetics, JNKVV, Jabalpur, and the Indian Institute of Soybean Research, Indore (M.P.). In a Randomised Complete Block Design (RCBD), each genotype was accommodated in three rows of three metres in length in each replication, with a row to row spacing of 40 cm and a plant-to-plant distance of 7 cm after thinning. On five plants from each genotype, observations on seventeen traits were recorded at random.

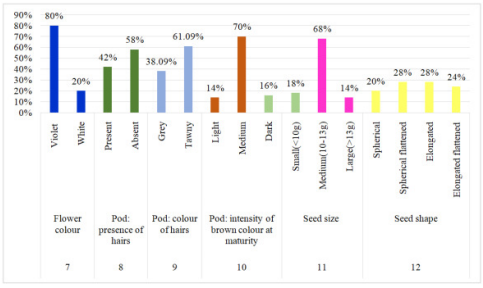
RESULT AND DISCUSSION

All the fifty genotypes were classified based on of morphological characteristics described in the DUS guidelines (PPV&FRA, 2018) i.e., hypocotyl

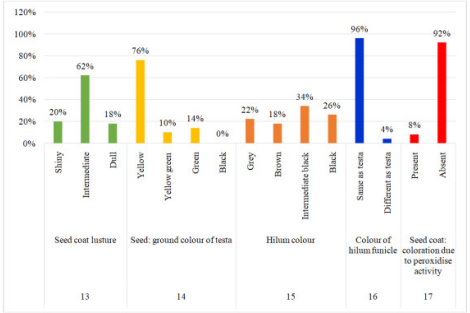
colouration, growth habit, growth type, leaf shape, leaf size, leaf intensity of green colour, flower colour, presence of pod hairs, colour of pod hairs, intensity of brown colour at pod maturity, seed colour, seed size, seed shape, seed coat lustre, hilum colour, hilum funicle colour and seed coat activity due to peroxidase. From the study of these characters, we can easily identify different genotypes of soybean. Hypocotyl coloration was found in ten genotypes, but not in the rest of the genotypes. At 50% flowering, a key characteristic, growth habit, was noted. Only one genotype had a determinate growth habit, two had indeterminate growth habits, and the rest 47 had semi-determinate growth habits. Only two genotypes showed erect growth habits, whereas 48 had semi-erect growth habits. Leaf shape was pointed ovate, leaf size was medium, and leaf colour intensity was medium in 41, 33, and 24 genotypes, respectively. The flowers of ten genotypes were white, whereas the flowers of the other genotypes were violet. Insect resistance is influenced by the presence of hair on the pod. There is a lot of evidence that thick trichomes prevent herbivorous insect damage to plants (Hare and Elle, 2002). The presence of pod hair was found in 21 genotypes, whereas the absence of pod hair was found in 29 genotypes. Both of these characteristics enable resistance to a variety of insects. At maturity, the maximum genotypes had medium pod intensity of brown colour. In seven genotypes, large seed (>13g) was found. Seed shape has a lot of variation. Ten genotypes had spherical seed shapes, 14 had spherical flattened seed shapes, 14 had elongated seed shapes, and 12 had elongated flattened seed shapes. The seed coat lustre was shiny in 10 genotypes, dull in 9 genotypes, and intermediate in 31 genotypes. The ground colour of the testa was mostly yellow and none had black appearance. Hilum colour was found to be grey in 11 genotypes, brown in 9 genotypes, intermediate black in 17 genotypes, and black in 13 genotypes. The colour of the hilum matches that of the testa in 48 genotypes, but the colour of the hilum differs in two genotypes. Seed coat: colour due to peroxide activity was seen in just four genotypes, with the remaining 46 genotypes being colourless.So, we can use these characters as an identification key. Similar, characterization pattern was adopted by, Ramteke *et al.* (2012); Malek *et al.* (2014); Ramteke *et al.* (2015); Dubey (2015); Talla *et al.* (2016); Bellaloui *et al.* (2017); Vandana *et al.* (2017); Bhakuni *et al.* (2017); Pawale *et al.* (2019); Dhaliwal *et al.*(2020); Singh *et al.* (2021); Thakur *et al.* (2022) taking distinguished morphological traits.



(a)



(b)



(c)

Fig. 1. Bar graphs (a.) (b.) and (c.) depicting variation in percentage contribution of various morphological traits.

Table 1: Frequency distribution for various morphological traits of soybean genotypes.

Sr. No.	Descriptors	States	Score	Genotypes frequency	Percentage contribution (%)
1.	Hypocotyl colouration	Absent	1	40	80
		present	9	10	20
2.	Growth habit	Determinate	1	1	2
		Semi determinate	2	47	94
		Indeterminate	3	2	4
3.	Growth type	Erect	1	2	4
		Semi erect	2	48	96
		Semi erect to horizontal	3	0	0
4.	Leaf shape	Lanceolate	1	5	10
		Pointed ovate	2	41	82
		Rounded ovate	3	4	8
5.	Leaf size	Small	1	8	16
		Medium	2	33	66
		Large	3	9	18
6.	Leaf intensity of green colour	Light	1	14	28
		Medium	2	24	48
		Dark	3	12	24
7.	Flower colour	Violet	2	40	80
		White	1	10	20
8.	Pod: presence of hairs	Present	1	21	42
		Absent	2	29	58
9.	Pod: colour of hairs	Grey	1	8	38.09
		Tawny	2	13	61.09
10.	Pod: intensity of brown colour at maturity	Light	1	7	14
		Medium	2	35	70
		Dark	3	8	16
11.	Seed size	Small(<10g)	1	9	18
		Medium(10-13g)	2	34	68
		Large(>13g)	3	7	14
12.	Seed shape	Spherical	1	10	20
		Spherical flattened	2	14	28
		Elongated	3	14	28
		Elongated flattened	4	12	24
13.	Seed coat lusture	Shiny	1	10	20
		Intermediate	2	31	62
		Dull	3	9	18
14.	Seed: ground colour of testa	Yellow	1	38	76
		Yellow green	2	5	10
		Green	3	7	14
		Black	4	0	0
15.	Hilum colour	Grey	1	11	22
		Brown	2	9	18
		Intermediate black	3	17	34
		Black	4	13	26
16.	Colour of hilum funicle	Same as testa	1	48	96
		Different as testa	2	2	4
17.	Seed coat: coloration due to peroxidise activity	Present	1	4	8
		Absent	2	46	92

Table 2: Morphological characterization of soybean genotypes.

Character	Classes	Genotypes
Hypocotyl colouration	**Present**	EC 393228, EC 456610, EC 113778, EC 241708, EC 34396, EC 46859, EC 114572, EC 10740, EC 333929, EC 350604, EC 393224, EC 528675, EC 34117, EC 389153, EC 335721, EC 389748, EC 250619, EC 1008, EC 456615, EC 377883, EC 393222, EC 389170, EC 396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 250608, EC 251358, EC 572160, EC 390981A, AGS 32, AGS 12, AGS 2, AGS 16, AGS 31, AGS 205, AGS 48, AGAS 125
	Absent	EC 250348, HARDER, EC 25352, EC 200149, EC 54464, EC 23001B, AGS 59, AGS 76, JS 20-98, JS 20-34
Growth habit	**Determinate**	JS 20-34
	Indeterminate	YOUNG, EC 34117
	Semi-determinate	EC 393228, EC 456610, EC 113778, EC 241708, EC 34396, EC 46859, EC 114572, EC 10740, EC 333929, EC 350604, EC 393224, EC 528675, EC 389153, EC 335721, EC 389748, EC 250619, EC 1008, EC 456615, EC 377883, EC 393222, EC 389170, EC 396055, EC 280129, EC 39220, EC

		391181, EC 38828, EC 250608, EC 251358, EC 572160, EC 390981A, AGS 32, AGS 12, AGS 2, AGS 16, AGS 31, AGS 205, AGS 48, AGAS 125, EC 250348, EC 25352, EC 200149, EC 54464, EC 23001B, AGS 59, AGS 76, JS 20-98, EC 250348, HARDER, EC 25352, EC 200149, EC 54464, EC 23001B, AGS 59, AGS 76, JS 20-98
Growth type	**Erect**	EC 335721, EC 389170,
	Semi- erect	EC 393228, EC 456610, EC 113778, EC 241708, EC 34396, EC 468597, EC 114572, EC 250348, EC 107407, EC 333929, EC 350664, EC 393224, HARDER, EC 528675, EC 34117, EC 389153, EC 389748, EC 257352, EC 250619, EC 110778, EC 456615, EC 337883, EC 393222, EC 396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 200149, EC 547464, EC 250608, EC 251358, EC 393228, EC 390981A, EC 23001B, AGS 32, AGS 12, AGS 59, AGS 2, AGS 16, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125, JS 20-98, JS 20-34
	Semi erect to horizontal	None
Leaf shape	**Lanceolate**	EC 389748, EC 250608, EC 251358, AGS 2, AGS 16
	Pointed ovate	EC 393228, EC 456610, EC 113778, EC 241708, EC 468597, EC 114572, EC 250348, EC 107407, EC 333929, EC 350664, EC 393224, HARDER, EC 528675, EC 34117, EC 389153, EC 335721, EC 257352, EC 250619, EC 110778, EC 456615, EC 337883, EC 393222, EC 396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 200149, EC 547464, EC 393228, EC 390981A, EC 23001B, AGS 32, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125, JS 20-98
	Rounded ovate	EC 34396, EC 389170, AGS 12, AGS 59, JS 20-34
Flower colour	**Violet**	EC 393228, EC 456610, EC 113778, EC 241708, EC 34396, EC 46859, EC 114572, EC 10740, EC 333929, EC 350604, EC 393224, EC 528675, EC 34117, EC 389153, EC 335721, EC 389748, EC 250619, EC 1008, EC 456615, EC 377883, EC 393222, EC 389170, EC 396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 250608, EC 251358, EC 393228, EC 390981A, AGS 32, AGS 12, AGS 2, AGS 16, AGS 31, AGS 205, AGS 48, AGAS 125
	White	EC 250348, HARDER, EC 25352, EC 200149, EC 54464, EC 23001B, AGS 59, AGS 76, JS 20-98, JS 20-34
Leaf size	**Small**	EC 335721, EC 250619, EC 389170, EC 250608, EC 251358, AGS 32, AGS 12, AGS 2
	Medium	EC 393228, EC 456610, EC 113778, EC 241708, EC 468597, EC 114572, EC 250348, EC 107407, EC 333929, EC 350664, EC 393224, HARDER, EC 528675, EC 34117, EC 389153, EC 389748, EC 257352, EC 377883, EC 396055, EC 280129, YOUNG, EC 39220, EC 200149, EC 547464, EC 393228, EC 390981A, AGS 16, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125, JS 20-98,
	Large	EC 34396, EC 110778, EC 456615, EC 393222, EC 391181, EC 38828, EC 23001B, AGS 59, JS 20-34
Leaf intensity of green colour	**Light**	EC 113778, EC 241708, EC 34396, EC 107407, EC 333929, EC 393224, EC 528675, EC 34117, EC 335721, EC 257352, EC 110778, EC 39220, EC 391181,
	Medium	EC 393228, EC 456610, EC 468597, EC 114572, EC 389153, EC 389748, EC 250619, EC 337883, EC 393222, EC 389170, EC 280129, YOUNG, EC 393228, EC 390981A, AGS 32, AGS 59, AGS 2, AGS 16, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125
	Dark	EC 250348, EC 350664, HARDER, EC 456615, EC 396055, EC 38828, EC 200149, EC 547464, EC 250608, EC 251358, EC 23001B, AGS 12, , JS 20-98, JS 20-34
Pod: presence of hairs	**Present**	EC 393228, EC 113778, EC 34117, EC 389748, EC 250619, EC 391181, EC 547464, EC 250608, EC 251358, AGS 32, AGS 2, AGS 16, AGS 48, EC 107407, HARDER, EC 257352, EC 110778, EC 456615, EC 377883, EC 389170, EC 280129
	Absent	EC 456610, EC 241708, EC 34396, EC 468597, EC 114572, EC 250348, EC 333929, EC 350664, EC 393224, EC 528675, EC 389153, EC 335721, EC 393222, EC 396055, YOUNG, EC 39220, EC 38828, EC 200149, EC 393228, EC 390981A, EC 23001B, AGS 12, AGS 59, AGS 76, AGS 31, AGS 205, AGS 125, JS 20-98, JS 20-34
Pod: Colour of hairs	**Tawny**	EC 393228, EC 113778, EC 34117, EC 389748, EC 250619, EC 391181, EC 547464, EC 250608, EC 251358, AGS 32, AGS 2, AGS 16, AGS 48
	Grey	EC 107407, HARDER, EC 257352, EC 110778, EC 456615, EC 377883, EC 389170, EC 280129
Pod: Intensity of brown colour at maturity	**Light**	EC 241708, EC 114572, EC 34117, EC 391181 EC 547464, EC 250608, AGS 32
	Medium	EC 393228, EC 456610, EC 113778, EC 34396, EC 468597, EC 250348, EC 107407, EC 333929, EC 350664, EC 393224, EC 528675, EC 389153, EC 335721, EC 110778, EC 456615, EC 337883, EC 393222, EC 389170, EC 396055, YOUNG, EC 38828, EC 251358, EC 393228, EC 390981A, EC 23001B, AGS 59, AGS 2, AGS 16, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125, JS 20-98, JS 20-34
	Dark	AGS 12, EC 200149, EC 280129, EC 257352, HARDER, EC 39920, EC 389748, EC 250619
Seed: ground colour of testa	**Yellow**	EC 393228, EC 456610, EC 113778, EC 241708, EC 34396, EC 468597, EC 250348, EC 107407, EC 333929, EC 350664, EC 393224, HARDER, EC 528675, EC 34117, EC 335721, EC 389748, EC 250619, EC 110778, EC 456615, EC 337883, EC 393222, EC 389170, EC 280129, YOUNG, EC 39220, EC 391181, EC 200149, EC 547464, EC 393228, EC 23001B, AGS 32, AGS 59, AGS 2, AGS 16, AGS 76, AGS 48, AGS 125, JS 20-34
	Yellow- green	EC 389153, EC 257352, EC 396055, EC 38828, AGS 31,
	Green	EC 114572, JS 20-98, AGS 12, EC 251358, EC 390981A, AGS 205, EC 250608
	Black	None
Seed size	**Small**	EC 241708, EC 34396, EC 114572, EC 250348, EC 389153, EC 335721, AGS 31, AGS 205, JS 20-98
	Medium	EC 393228, EC 456610, EC 113778, EC 468597, EC 107407, EC 333929, EC 350664, EC 393224, HARDER, EC 528675, EC 34117, EC 389748, EC 257352, EC 337883, EC 393222, EC 389170, EC

		396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 200149, EC 547464, EC 250608, EC 337883, EC 393222, EC 389170, EC 396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 200149, EC 547464, EC 250608, AGS 48, AGS 125,
	Bold	EC 250619, EC 110778, EC 456615, EC 393228, JS 20-34, EC 251358, EC 390981A
Seed shape	**Spherical**	EC 393228, EC 113778, EC 107407, HARDER, EC 528675, YOUNG, EC 23001B, AGS 12, AGS 76
	Spherical flattened	EC 456610, EC 241708, EC 34396, EC 114572, EC 250348, EC 393224, EC 34117, EC 389748, EC 456615, EC 389170, EC 396055, EC 38828, EC 547464, EC 393228, AGS 59, JS 20-98
	Elongated	EC 468597, EC 333929, EC 350664, EC 389153, EC 335721, EC 250619, EC 110778, EC 337883, EC 393222, EC 39220, AGS 2, AGS 48, JS 20-34
	Elongated flattened	EC 393224, EC 34117, EC 389748, EC 280129, EC 391181, EC 200149, EC 250608, EC 251358, EC 390981A, AGS 32, AGS 16, AGS 205
Seed coat lustre	**Shiny**	EC 333929, EC 350664, EC 257352, EC 337883, EC 393222, EC 280129, EC 391181, AGS 32, AGS 2, AGS 16,
	Intermediate	EC 393228, EC 456610, EC 241708, EC 34396, EC 468597, EC 114572, EC 107407, EC 393224, HARDER, EC 34117, EC 389153, EC 335721, EC 389748, EC 110778, EC 456615, EC 389170, EC 396055, YOUNG, EC 39220, EC 250608, AGS 12, AGS 59, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125, JS 20-98,
	Dull	EC 113778, EC 250348, EC 528675, EC 250619, EC 38828, EC 200149, EC 547464, EC 251358, EC 393228, EC 390981A, EC 23001B, JS 20-34
	Grey	EC 333929, EC 350664, EC 389748, EC 257352, EC 337883, EC 393222, EC 280129, EC 200149, AGS 32, AGS 2, AGS 16, AGS 76, AGS 31
	Brown	EC 107407, EC 528675, EC 34117, EC 456615, YOUNG, EC 391181, EC 547464, EC 250608, EC 251358, AGS 48,
Hilum colour	**Intermediate black**	EC 113778, EC 241708, EC 468597, EC 250348, HARDER, EC 389153, EC 250619, EC 110778, EC 38828, EC 393228, AGS 12, AGS 59, AGS 125, JS 20-98, JS 20-34
	Black	EC 393228, EC 456610, EC 34396, EC 114572, EC 114572, EC 393224, EC 335721, EC 389170, EC 396055, EC 39220, EC 390981A, EC 23001B, AGS 205
Colour of hilum funicle	**Same as testa**	EC 393228, EC 456610, EC 113778, EC 241708, EC 34396, EC 468597, EC 114572, EC 250348, EC 107407, EC 333929, EC 350664, EC 393224, HARDER, EC 528675, EC 34117, EC 389153, EC 335721, EC 389748, EC 257352, EC 250619, EC 110778, EC 456615, EC 337883, EC 393222, EC 389170, EC 396055, EC 280129, YOUNG, EC 39220, EC 391181, EC 38828, EC 200149, EC 547464, EC 250608, EC 393228, EC 23001B, AGS 32, AGS 12, AGS 59, AGS 2, AGS 16, AGS 76, AGS 31, AGS 205, AGS 48, AGS 125, JS 20-98, JS 20-34
	Different to testa	EC 251358, EC 390981A
Seed coat: Coloration due to peroxidase activity	**0**	EC 34396, EC 468597, EC 37783, EC 396055
	1	EC 113778, EC 335721, EC 200149, EC 393228, AGS 76, EC 114572
	2	EC 241708, EC 547464, EC 456610, EC 528675, JS 20-98, YOUNG, EC 257352, EC 350664, EC 333929, EC 280129, EC 250348, EC 107407, AGS 2, JS 20-34
	3	HARDER, EC 23001B. AGS 2, AGS 48, EC 389748, EC 39220, EC 393222, EC 389153, EC 34117, EC 38828, EC 393224, EC 110778, AGS 12
	4	JS 20-34, AGS 31, AGS 205, AGS 16, EC 391181, EC 250608, AGS 32, EC 456615, EC 389170
	5	EC 393228, EC 250619, EC 251358, EC 390981A

CONCLUSIONS

Genetic resources offer the foundation for selection and development via breeding to meet the world's constantly growing population's food security demands. Systematic characterization, on the other hand, leads to more efficient use of the material in the soybean improvement programme. Large variation in seed colour present in the germplasm has a high market price and high profitability to farmers. After determining the stability and heritability of the features, genotypes with this morphology can be chosen as a donor in the crossing procedure.

FUTURE SCOPE

Estimation of heritability and other genetic factors for traits like plant height and seed size may be used to determine the impact of the environment on the traits and their future application in crop improvement programmes.

The morphological characterisation can aid in the development of core collections at gene banks, hence increasing the availability of germplasm for breeders for various trait-specific lines.

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Conflict of Interest. None.

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