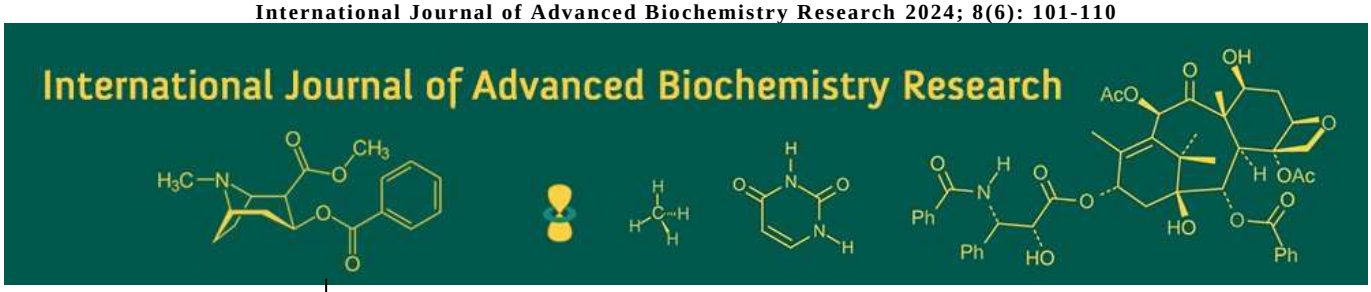

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Morphological characterization and assessment of genetic variability in black gram (*Vigna mungo* L.) germplasm at Bastar plateau

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Abstract
Black Gram (*Vigna mungo* L. Hepper) is most prevalent types out of pluses crops Eighty two genotypes of Black gram collected from Bastar Region (Dantewad, Sukma, Bijapur, Kondagoan, Narayanpur, Kanker districts). The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications comprising two check varieties *viz.* Indira Urd Pratham and T.U. 94-2. The observations were taken at various stages of the plant's development. Determine the important morphological traits using PPV&FRA descriptors. *viz.* Seedling vigour, Hypocotyl colour, Growth pattern, Growth habit colour, Twining Tendency, Leaf colour, Leafiness, Stem colour, Leaf pubescence, Petiole colour, Branching pattern, Nodulation, Raceme Position, Calyx colour, Corolla colour, Pod pubescence, Immature pod colour, mature pod colour, pod sheltering in the field, terminal leaflet shape, pod shape and Seed size exhibited more variation. The lowest frequency distribution of all the traits was found in the 1% range for the mottled seed color, ovate terminal leaf shape, with abundant leaf pubescence. As a result, these traits have a distinct morphological identity that will make identification easier. For simple visibility of varietal associated traits during maintenance and resistance breeding programs, this attributes might be taken into consideration in the development of the black gram variety.

Keywords: Descriptor, morphological, randomization & variation

Introduction
Grain legumes, typically referred to as pulses, are a wonderful natural gift that add a substantial element to a diet heavy in cereal. Black gram is a widely used pulse in India with high phosphoric acid content. It is one of the most valued pulses, due to its culinary values. They serve as Asia's primary protein source. In Indian agriculture, they are very important "*Vigna mungo* L. Hepper, commonly known as black gram, is a member of the Asian *Vigna* crop species". Black gram is classified in two groups *Vigna mungo var. niger* and *Vigna mungo var. Virdis*, in *niger* includes varieties which mature early and have black coloured seeds and in *virdis* includes varieties which mature late and their seeds are smaller and green in colour. In India, blackgram, also called Mash, is a grain legume that is domesticated from *V. mungo var. silvestris*. It belongs to the family Fabaceae with their chromosome number of black gram is 2n=2x=22. The center of genetic diversity for black gram is in India.
Most of the black grams that are produced are used to make curries, soups, dals, snacks, vada and desserts. Its seeds contain roughly 24–26% protein, 60% carbohydrates, 1.5% fat, 3.5–4.5% fiber, 4.5–5.5% ash, and a number of minerals, vitamins, and amino acids. That's why it's called "poor man's meat" in general. It is the most abundant source of phosphoric acid, five to ten times more abundant than other pulse crops. India is the biggest producer and consumer of black gram worldwide. Cultivated area 3211 hectares of land, it production roughly 2055metric tonnes of black gram annually; in 2023-24, the average productivity per hectare was 640 kg/hectare. Myanmar and Pakistan come after India. Top ten producers of black gram in india is Madhya pradesh (884.60 Tonne) Andhra Pradesh (424.68 Tonne), Uttar Pradesh (291.50 Tonne), Tamil Nadu (268.72 Tonne) Maharashtra (211.20 Tonne) Rajasthan (155.50 Tonne), Gujarat (130.01 Tonne), Jharkhand (120.39 Tonne), Telangana (66.55 Tonne) and West Bengal (50.17 Tonne).

The productivity of this crop is relatively low, despite its importance. The black gram is primarily grown in Sri Lanka, Pakistan, and India Burma as well as a few countries in Southeast Asia. In the Indian subcontinent, black gram is grown mainly as an intercrop with other crops like pigeon pea and cereals during the rainy season. It is also grown as a pure crop on residual moisture in the winter (in rice fallows) and in the spring and summer (as an irrigated crop) between two main crops. It's most commonly found in tropical and subtropical areas.

The creation of novel types primarily depends on the accessibility of genetic

variations in the foundational material and the degree of adaptability to achieve the intended character. The growth of domesticated species and reproduction of new varieties usually depends on what is genetic diversity found in current genotypes". Black grams are used for a variety of purposes, including fuel, food for humans, and soil fertility maintenance. A plant breeder must estimate various genetic parameters, such as components of variances, genotypic and phenotypic coefficients of variability, heritability, and genetic advance, in order to conduct an effective breeding program that produces qualitative traits. In this regard, one such estimate that offers a precise notion about a particular trait that should receive more attention during selection is variability.

Materials and Methods

The experiment was conducted at "Research cum Instructional Farm, Shaheed Gundadhoor College of Agriculture and Research Station, Kumhrawand, (Jagdalpur), Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chhattisgarh)" Eighty-two genotypes of black gram (genotypes acquired from Chhattisgarh's Bastar district) plus the check varieties Indira Urd Pratham and T.U. 94-2. Every genotype was planted during *kharif* in two rows that were 30×10 cm apart and 3 m long by 1 m wide. Five randomly selected subjects received the observations. The anthocyanin coloration of genotypes was noticed after the cotyledons were unfolded, or 5 to 6 days after sowing, according to the days to emergence observation recorded from sowing to 50% seedling emergences. The time of flowering was recorded when the 50% of the plants possessed at least one open flower. The plant growth habit, growth pattern, twining tendency, leaf colour, leafiness, leaf pubescences, , stem colour, stem pubescence, calyx colour, corolla colour, raceme position, leaflet (terminal) shape, leaf vein colour, leaf pubescence were observed at 50% flowering stage. At the stage of fully developed green pods, the characters branching pattern, nodulation, pod pubescence, petiole colour, intensity of green colour of premature pods were noted the pod length and pod mature colour was taken at maturity and pod sheltering in the field was taken after maturity while the seed colour, seed lusture, seed shape and seed size were noted down in mature seeds *i.e.* after harvesting.

Details of Experimental materials in below

SGBG 1, SGBG 2, SGBG 3, SGBG 4, SGBG 5, SGBG 6, SGBG 7, SGBG 8, SGBG 9, SGBG 10, SGBG 11, SGBG 12, SGBG 13, SGBG 14, SGBG 15, SGBG 16, SGBG 17, SGBG 18, SGBG 19, SGBG 20, SGBG 21, SGBG 22, SGBG 23, SGBG 24, SGBG 25, SGBG 26, SGBG 27, SGBG 28, SGBG 29, SGBG 30, SGBG 31, SGBG 32, SGBG 33, SGBG 34, SGBG 35, SGBG 36, SGBG 37, SGBG 38, SGBG 39, SGBG 40, SGBG 41, SGBG 42, SGBG 43, SGBG 44, SGBG 45, SGBG 46, SGBG 47, SGBG 48, SGBG 49, SGBG 50, SGBG 51, SGBG 52, SGBG 53, SGBG 54, SGBG 55, SGBG 56, SGBG 57, SGBG 58, SGBG 59, SGBG 60, SGBG 61, SGBG 62, SGBG 63, SGBG 64, SGBG 65, SGBG 66, SGBG 67, SGBG 68, SGBG 69, SGBG 70, SGBG 71, SGBG 72, SGBG 73, SGBG 74, SGBG 75, SGBG 76, SGBG 77, SGBG 78, SGBG 79, SGBG 80 and two cheek variety Indira Urd Pratham and T.U. 94-2 collected from IGKV, Raipur (C.G.)

Results and Discussion

Characterization is a prerequisite for varietal identification, and the outcomes of this have been supplied in the (Table 1) along with its commentary, which covers grouping as well as frequency distribution of black gram genotypes.

Seedling vigor: Germinated seeds were placed on vertical plates with 0.8% agar-medium without NaCl (non-stress) or with 50 mm NaCl (salt stress) to determine the seedling vigor. A laminar flow-cabinet was used to pour 80 to 90 cc of the agar medium into square plates (12 12 1.7 cm). Three categories—poor, moderate, and vigorous—will be used to classify seedling vigor. Of the 82 genotypes, 22 fell into the vigorous category.

Hypocotyls: Anthocyanin colouration. Prior to active seed multiplication, this characteristic can be used to accurately identify varietals since it serves as a key morphological marker. All 82 of the black gram genotypes under observation had anthocyanin coloration documented at the seedling stage, demonstrating no variance for this characteristic. Singh *et al*. (2020) [16] reported a similar discovery.

Leaf characters: Due to leaves' direct involvement in photosynthesis, these traits have an impact on genotypes' producing capacity. At the halfway point of the flowering cycle, leaf characteristics such as the form of the primery leaf, the shape of the terminal leaflet, leafiness, leaf color, and leaf pubescences were observed. Except for leaf pubescence, which was present in every genotype displaying no variation, all the genotypes showed significant diversity in leaf morphology. (Table 1).

Fig 1: Variation in terminal leaflet shape (SGBG43- Lanceolate, SGBG 20-Ovate)

Flower characters: When 50% of the plant's head had at least one open flower bud, flowering time was assessed. It was divided into three categories: early (40 days or less), medium (41-50 days), and late (50 days or more). A total of 59 genotypes had early blooming times, 19 had medium times, and 4 had late flowering times. (Table 1). The greater the genotypes' propensity to reduce abiotic stressors during the reproductive stage, the earlier they are (Pratap *et al*., 2013) [3]. When describing the green gram germplasm, Jain *et al*. (2002) [4] reported the value of flower features. Corolla and raceme colors, as well as calyx color.

Fig 2: Flower colour

Plant characters: Plant growth habit, out of 82 genotypes, 17 genotypes are erect, 45 semi erect genotypes, 20genotypes are spreading types. The most important forms are that are upright because they get plenty of sunshine, which accelerates the creation of plant assimilates. (Singh *et al.*, 2020) [16]. Also reported significant variation in their findings in black gram by Singh *et al.*, (2014) [17] in moonbeam. In growth pattern traits 64 genotypes show determinate growth and 18 are indeterminate type growth, 45 genotypes dose note showing twining tendency, 26 genotypes are slightly twined, intermediated type twining tendencies showed in 8 genotypes and 3 genotypes (SGBG 78, SGBG 79, SGBG 80). In nodulation character 25 genotypes slightly or poor nodulation, intermediated types nodulation seen in 45 genotypes and 12 genotypes visualized heavy nodulation. Basal branching pattern show 42 genotypes, 27 genotypes show central branching pattern, 4 genotypes *viz*. SGBG 55 SGBG 56 SGBG 66 SGBG 69 top branching pattern and 9 genotypes over all branching pattern show. All plant characteristic were studied at 50% flowering stage. More pod setting in over all branching pattern genotypes as compared to other.

Table 1: Frequency distribution of qualitative traits in black gram

Traits	Group	Codes	Plants (n= 82)	Frequency (%) of genotypes
Days to emergences	Early (<4)	1	14	17
	Medium (5)	3	34	42
	Late (>5)	7	34	41
Seedling vigour	Poor	3	20	24
	Intermediate	5	52	64
	Vigorous	7	10	12
Hypocotyls colour	Green	1	29	36
	Green purple	2	19	23
	Purple	3	19	23
	Dark purple	4	15	
Growth pattern	Determinate	1	64	78
	Indeterminate	2	18	22
Growth habit	Erect	1	17	21
	Semi-erect	2	45	55
	Spreading	3	20	24

Twining Tendency	None	0	45	55
	Slight	3	26	32
	Intermediate	5	8	10
	Pronounced	7	3	3
Leaf colour	Light green	3	33	40
	Intermediate green	5	28	34
	Dark green	7	21	26
Leafiness	Sparse	3	35	43
	Intermediate	5	23	28
	Abundant	7	24	29
Raceme position	Mostly above canopy	1	21	26
	Intermediate	2	50	63
	No pod visible above canopy	3	9	11
Stem colour	Light green	1	5	6
	Dark green	2	4	5
	Light purple	3	52	63
	Dark purple	4	21	26
Stem pubescences	Absent	0	0	0
	Present	1	82	100
Leaf pubescence	Glabrous	0	1	1
	Very sparsely pubescent	1	52	64
	Puberulent	3	15	18
	Moderately Puberulent	5	13	16
	Densely Puberulent	7	1	1
Petiole colour	Green	1	5	6
	Greenish purple	3	32	40
	Purple	4	36	45
	Dark purple	5	7	9
Branching pattern	Basel	1	42	51
	Central	2	27	33
	Top	3	4	5
	All over	4	9	11
Nodulation	Slight (poor)	3	25	30
	Intermediate	5	45	55
	Heavy	7	12	15
Days to 50 flowering (flowering time)	Early (<40)	1	59	50
	Medium (40-50)	2	19	33
	Late (>50)	3	4	17
Calyx colour	Green	1	61	74
	Purplish green	2	9	11
	Greenish purple	3	12	15
Corolla colour	Yellow	1	40	49
	Greenish yellow	2	15	18
	Yellowish greenish	3	24	29
	Greenish purple yellow	4	3	4
Pod pubescence	Glabrous	0	2	3
	Puberulent	3	33	40
	Moderately	5	37	45
	Densely pubescent	7	10	12
Immature pod colour	Light green	1	44	54
	Dark green	2	38	46
Mature pod colour	Straw	1	9	11
	Tan	2	6	7
	Broun	3	16	20
	Broun and black	4	20	25
	Black	5	30	37
Pod sheltering in the field	Absent	0	79	96
	Present	+	3	4
Pod shape	Cylindrical	2	82	100
Pod attachment to peduncle	Pendant	1	42	50
	Sub erect	2	26	33
	Erect	3	12	17
Terminal leaflet shape	Deltate	1	32	39
	Ovate	2	30	37
	Ovate-lanceolate	3	11	13
	Lanceolate	4	3	4
	Rhombic	5	5	6
	Obovate	6	1	1

Growth habit	Erect	1	31	38
	Semi-erect	2	31	38
	Spreading	3	20	24
Seed colour	Light green	1	2	3
	Brown	3	27	35
	Chocolate	4	21	28
	Black	5	25	33
	Mottled	6	1	1
Seed size	Small	1	18	22
	Medium	2	28	34
	Bolded	3	36	44
Seed shape	Globose	1	28	34
	Ovoid	2	33	40
	Drum	3	21	26
Seed lusture	Absent	0	33	40
	Present	+	49	60

Stem characters. Two characteristics stem color and stem pubescence, were present at the 50% stage of blooming. Out of 82 genotypes, light green stem color comprised 5, dark green stem color comprised 4, and light purple stem color was visualized in 52 genotypes. 21genotypes show dark purple colour, whereas stem pubescence was present in all the genotypes showing no variation (Table 1).

Petiole and peduncle character: The color of the petiole was seen when the green pods were fully formed. The frequency distribution's range for the color of the petiole was (35%) green and (26%) green with purple splashes, respectively. (Table 1). (Singh *et al.* 2020) [16] also showed a substantial difference in petiole color in genotypes of black gram.

Fig 3: Petiole colour variation

Pod characters: One of the crucial characteristics of both black and green gram is its pod features, which are crucial for genotype identification they are essential for determining genotypes and directly influencing yield. In this present study, the pod characters *viz.* premature (immature) pods colour, pod pubescence, pod length and pod attachment to peduncle was observes at fully developed green pod stage (when pods are full grown). These characteristics, which varied in their morphology and were categorized, are crucial for identifying a variety or piece of germplasm. Of the 82 genotypes, 27 had light green pods and 55 had dark green pods. (Table 1). Pod attachment to peduncle categorized in three type 13 genotypes are erect, 26 sub erect types and 43 pendant genotypesBecause pubescence was present in the pods of all 82 genotypes, there was no discernible variation in pod pubescence, despite modest variations in pubescence density. I was seen in my research experiment pod they posed densely pubescences no damaged by insect (Table 1). Kaur *et al.* (2017) [7] reported comparable outcomes in mungbean.

Fig 4: Variation in pod shape

Seed characters: Seed color, seed lustre, and seed shape, which were noticed at seed maturity, or after harvesting, were examples of features under the heading of seed characters. These characters were sorted into various groups in Table 1 (see below). In 36 genotypes, the seed color was black; in 26 genotypes, it was brown; in 17 genotypes, it was chocolate; in 2 genotypes (SGBG 11 and SGBG 12); and in genotype SGBG 13, it was greenish brown (Fig. 3). Light green, Brown, Chocolate, and Black Mottled are the seed colors. Brown seeds with a 35% frequency distribution made up the Urd population (Table 1). For a total of 27 genotypes, the seed form was globose for 11, oval for 11, and drum-shaped for 2 genotypes (Table 1). The 30 genotypes of the seed size were divided into three categories. (Table 1).

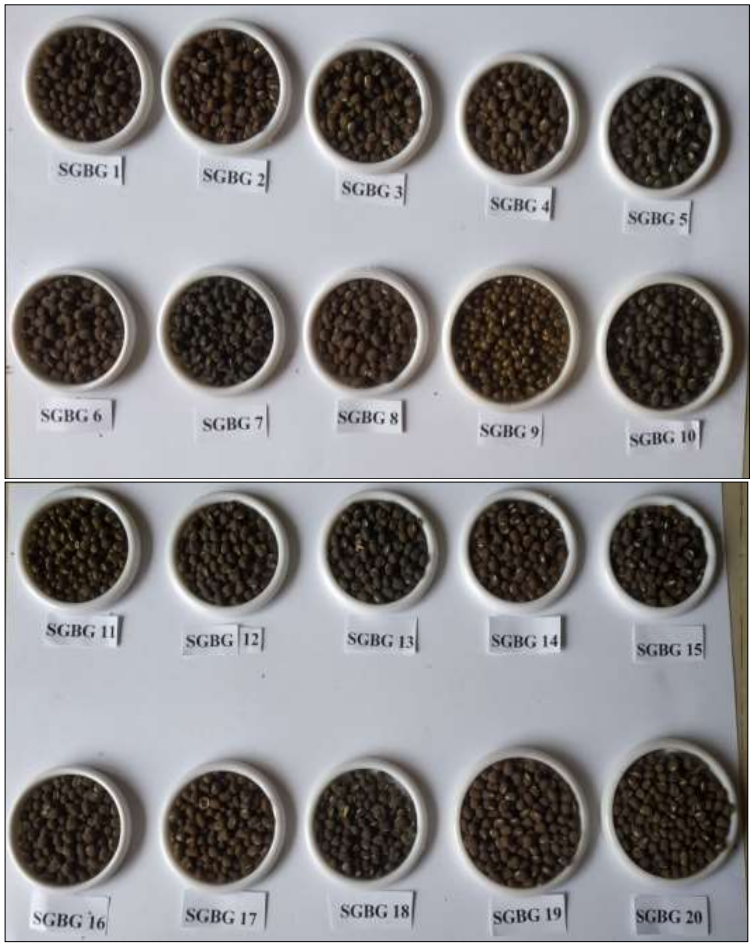

Fig 5: Seed colour

In 33 genotypes, seed lustre is present; it is lacking in 49 genotypes. Seed characterization is crucial because it enables a breeder to recognize and distinguish between different genotypes while implementing a seed production program. The significance of seed characterisation in mungbean was explored by Sabatina *et al*. in 2021.

Table 2: Morphological characterization of 82 black grams Germplasm

Characters	Stage of observation	Genotypes/Germplasm										
		SGBG 1	SGBG 2	SGBG 3	SGBG 4	SGBG 5	SGBG 6	SGBG 7	SGBG 8	SGBG 9	SGBG 10	SGBG 11
Seedling vigour	After emergences	7	5	5	7	5	5	5	3	3	5	3
Days to emergences	After emergences	5	5	5	6	5	5	6	6	6	6	6
Hypocotyls colour	Cotyledons unfolded	1	4	2	4	2	4	1	1	2	4	2
Time of flowering	50% plants have at least one open flower bud	1	1	2	1	1	2	`1	1	1	1	1
Twining Tendency	50% flowering	0	0	3	0	3	0	0	0	0	0	3
Leaf colour	50% flowering	3	5	5	7	7	7	7	3	3	7	5
Leafiness	50% flowering	7	5	3	3	5	7	3	5	5	7	3
Terminal leaflet shape	50% flowering	2	1	2	3	2	1	3	2	1	2	5
Growth habit	After pod setting	3	3	2	1	2	3	1	2	2	1	2
Raceme position	50% flowering	1	2	3	1	2	3	1	2	2	2	2
Stem colour	50% flowering	3	3	3	4	3	3	3	4	3	1	4
Leaf pubescence	50% flowering	0	0	3	0	0	0	0	5	0	0	1
Petiole colour	50% flowering	4	5	4	5	3	4	1	4	4	1	5
Branching pattern	During pod setting	2	1	1	2	1	2	1	2	1	1	1
Nodulation	50% flowering	5	5	3	5	5	7	5	7	5	5	5
Calyx colour	50% flowering	1	1	1	2	3	1	1	1	1	1	1
Corolla colour	50% flowering	1	1	2	3	2	1	1	2	1	3	1

Pod shape	Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod pubescence	Fully developed green pods	3	5	3	7	5	5	3	5	0	5	3
Pod attachment to peduncle	After pod setting	1	2	1	1	1	1	2	3	1	3	1
Immature pod colour	During pod setting	1	1	1	2	2	1	2	2	1	1	1
Mature pod colour	After maturation of pod	5	3	5	2	3	4	5	1	3	1	2
Pod sheltering in the field	After maturity	0	0	0	0	0	0	+	0	0	0	0
Seed colour	After harvesting	3	3	3	4	5	4	5	5	1	5	1
Seed size	Mature seeds	3	3	3	1	3	3	2	1	2	2	2
Seed shape	Mature seeds	1	3	2	2	1	3	1	3	2	2	2
Seed luster	Mature seeds	0	+	0	0	0	+	+	+	+	0	+

Characters	**Stage of observation**	**Genotypes/Germplasm**										
		SGBG 12	**SGBG 13**	**SGBG 14**	**SGBG 15**	**SGBG 16**	**SGBG 17**	**SGBG 18**	**SGBG 19**	**SGBG 20**	**SGBG 21**	**SGBG 22**
Seedling vigour	After emergences	3	5	3	3	3	3	3	5	5	5	7
Days to emergences	After emergences	4	5	6	5	5	5	6	5	6	5	4
Hypocotyls colour	Cotyledons unfolded	3	2	2	1	3	4	2	3	4	3	4
Time of flowering	50% flowering	1	2	2	1	2	1	1	1	1	1	2
Twining Tendency	50% flowering	3	0	0	3	0	0	0	3	5	3	3
Leaf colour	50% flowering	3	7	3	5	3	5	3	5	7	5	3
Leafiness	50% flowering	5	7	3	5	7	3	5	7	7	7	7
Terminal leaflet shape	50% flowering	2	2	6	2	1	3	2	1	2	1	2
Raceme position	50% flowering	3	2	2	2	3	1	2	1	3	2	3
Stem colour	50% flowering	4	2	3	4	2	3	3	2	1	3	3
Leaf pubescence	50% flowering	0	0	0	0	0	0	0	3	0	0	3
Petiole colour	50% flowering	3	4	3	4	3	4	3	3	3	4	3
Branching pattern	During pod setting	1	1	1	1	1	2	1	1	1	1	2
Nodulation	50% flowering	3	3	5	5	5	5	5	7	3	3	5
Calyx colour	50% flowering	3	1	1	1	1	2	1	1	1	1	1
Corolla colour	50% flowering	3	2	1	3	1	2	3	2	1	1	2
Pod shape	Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod pubescence	Fully developed green pods	3	3	5	5	3	7	3	5	3	5	1
Pod attachment to peduncle	After pod setting	2	1	3	2	1	1	2	1	1	2	1
Immature pod colour	During pod setting	1	2	2	2	2	2	1	1	1	2	1
Mature pod colour	Fully developed green pods	4	5	3	4	2	5	4	4	4	3	4
Pod sheltering in the field	After maturity	0	0	0	0	0	0	0	+	0	0	0
Terminal leaflet shape	50% flowering	2	2	6	2	1	3	2	1	2	1	2
Growth habit	After pod setting	3	1	1	2	1	1	1	2	3	2	2
Seed colour	After harvesting	3	2	4	5	5	5	5	4	3	4	5
Seed size	Mature seeds	3	2	2	3	2	1	1	3	2	3	1
Seed shape	Mature seeds	1	2	3	2	2	2	2	3	2	2	1
Seed luster	Mature seeds	0	0	+	0	0	+	0	+	+	+	0

Characters	**Stage of observation**	**Genotypes/Germplasm**										
		SGBG 23	**SGBG 24**	**SGBG 25**	**SGBG 26**	**SGBG 27**	**SGBG 28**	**SGBG 29**	**SGBG 30**	**SGBG 31**	**SGBG 32**	**SGBG 33**
Seedling vigour	After emergences	7	5	3	3	3	7	7	5	5	5	5
Days to emergences	After emergences	5	6	5	6	4	5	6	5	6	5	6
Hypocotyls colour	Cotyledons unfolded	2	4	1	2	3	2	3	1	3	1	1
Time of flowering	50% flowering	1	1	2	1	1	1	1	2	1	1	2
Twining Tendency	50% flowering	0	0	5	0	0	0	0	3	3	3	5
Leaf colour	50% flowering	7	5	3	3	5	3	7	3	3	5	5
Leafiness	50% flowering	5	3	5	3	3	3	5	3	3	5	7
Terminal leaflet shape	50% flowering	1	5	1	4	4	4	3	2	1	2	1
Raceme position	50% flowering	2	2	2	1	1	1	1	2	2	2	3
Stem colour	50% flowering	4	3	3	2	4	3	3	3	3	3	3
Leaf pubescence	50% flowering	3	5	1	3	0	0	0	0	0	7	1
Petiole colour	50% flowering	4	4	4	1	3	3	3	4	4	5	3
Branching pattern	During pod setting	1	2	1	2	2	2	3	1	1	1	1
Nodulation	50% flowering	3	3	3	7	5	5	7	5	3	5	5
Calyx colour	50% flowering	1	1	1	3	2	3	2	2	3	1	1
Corolla colour	50% flowering	3	1	1	1	3	3	1	1	1	3	3
Pod pubescence	Fully developed green pods	5	7	3	7	5	3	7	3	5	3	3
Pod shape	Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod attachment to peduncle	After pod setting	1	2	1	3	3	1	1	3	2	2	1
Immature pod colour	During pod setting	1	1	1	2	2	1	2	1	2	2	1
Mature pod colour	Fully developed green pods	2	1	1	5	4	5	4	4	3	5	3
Pod sheltering in the field	After maturity	0	0	0	0	0	0	0	0	0	0	0
Terminal leaflet shape	50% flowering	1	5	1	4	4	4	3	2	1	2	1
Growth habit	After pod setting	3	1	2	1	1	1	1	2	1	2	3
Seed colour	After harvesting	4	3	3	3	3	5	5	3	5	5	5
Seed size	Mature seeds	2	3	2	2	1	1	1	1	1	1	1
Seed shape	Mature seeds	3	2	1	1	2	2	2	3	1	2	2
Seed luster	Mature seeds	+	0	0	0	+	0	0	+	0	0	0

Characters	Stage of observation	Genotypes/Germplasm										
		SGBG 34	SGBG 35	SGBG 36	SGBG 37	SGBG 38	SGBG 39	SGBG 40	SGBG 41	SGBG 42	SGBG 43	SGBG 44
Seedling vigour	After emergences	5	5	3	3	3	3	5	5	5	7	5
Days to emergences	After emergences	5	4	6	4	6	6	4	6	56	6	6
Hypocotyls colour	Cotyledons unfolded	1	2	1	4	1	2	1	2	3	4	3
Time of flowering	50% flowering	1	1	1	2	2	1	2	1	1	1	1
Twining Tendency	50% flowering	0	3	0	0	0	0	0	0	0	3	0
Leaf colour	50% flowering	3	5	3	3	3	5	7	7	7	5	3
Leafiness	50% flowering	3	5	5	3	3	5	3	3	7	7	5
Terminal leaflet shape	50% flowering	1	5	1	2	1	2	4	2	2	2	2
Raceme position	50% flowering	2	2	2	1	2	2	1	1	2	2	2
Stem colour	50% flowering	4	3	4	4	4	3	4	3	3	3	3
Leaf pubescence	50% flowering	0	3	0	0	0	5	5	1	3	5	0
Petiole colour	50% flowering	5	4	4	4	3	4	4	4	5	4	4
Branching pattern	During pod setting	2	1	1	1	1	1	1	1	2	1	2
Nodulation	50% flowering	5	3	5	3	3	5	5	5	3	3	3
Calyx colour	50% flowering	1	2	2	1	1	1	1	3	1	2	1
Corolla colour	50% flowering	2	1	2	2	1	1	3	3	1	1	1
Pod shape	Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod pubescence	Fully developed green pods	7	5	7	5	3	3	5	3	5	7	5
Pod attachment to peduncle	After pod setting	1	1	2	2	2	3	3	2	3	1	1
Immature pod colour	During pod setting	2	2	1	1	1	2	2	2	2	2	1
Mature pod colour	Fully developed green pods	5	4	1	5	5	5	5	4	2	5	5
Pod sheltering in the field	After maturity	0	0	0	0	0	0	0	0	0	0	0
Terminal leaflet shape	50% flowering	1	5	1	2	1	2	1	2	2	2	2
Growth habit	After pod setting	3	2	2	1	1	3	2	1	2	2	2
Seed colour	Mature seeds	5	3	3	5	5	4	3	4	3	5	4
Seed size	Mature seeds	3	2	3	2	3	2	3	3	3	3	2
Seed shape	Mature seeds	3	1	1	1	2	2	1	2	1	2	1
Seed lusture	Mature seeds	+	0	0	0	+	+	0	0	0	0	0

Characters	Stage of observation	Genotypes/Germplasm										
		SGBG 45	SGBG 46	SGBG 47	SGBG 48	SGBG 49	SGBG 50	SGBG 51	SGBG 52	SGBG 53	SGBG 54	SGBG 55
Seedling vigour	After emergences	5	5	5	3	3	7	3	3	3	5	5
Days to emergences	After emergences	6	6	6	5	5	6	5	5	6	6	6
Hypocotyls colour	Cotyledons unfolded	1	3	1	2	3	2	3	4	3	3	2
Flowering time	50% flowering	1	1	1	1	1	1	1	2	2	2	1
Twining Tendency	50% flowering	0	0	3	0	3	3	0	0	0	0	0
Leaf colour	50% flowering	5	5	3	3	5	7	3	3	5		5
Leafiness	50% flowering	3	3	3	5	7	5	3	5	5	7	3
Terminal leaflet shape	50% flowering	1	1	1	3	1	2	1	2	2	1	3
Raceme position	50% flowering	1	1	1	1	2	2	2	2	2	1	2
Stem colour	50% flowering	3	4	4	3	3	4	3	3	3	3	3
Leaf pubescence	50% flowering	0	0	0	3	1	1	3	5	5	5	5
Petiole colour	50% flowering	4	4	4	3	4	3	4	3	4	4	3
Branching pattern	During pod setting	1	2	1	2	1	2	1	2	2	1	3
Nodulation	50% flowering	5	5	5	5	3	5	3	3	5	5	7
Calyx colour	50% flowering	1	1	1	1	1	3	1	1	1	2	1
Corolla colour	50% flowering	3	1	1	2	3	3	1	1	1	4	3
Pod shape	Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod pubescence	Fully developed green pods	3	5	3	3	5	3	3	5	3	5	5
Pod attachment to peduncle	After pod setting	1	1	1	2	3	1	1	1	2	2	1
Immature pod colour	During pod setting	1	2	1	2	1	2	1	2	1	1	1
Mature pod colour	Fully developed green pods	5	3	5	3	1	1	3	4	4	4	5
Pod sheltering in the field	After maturity	0	0	0	0	0	0	0	0	0	0	0
Terminal leaflet shape	50% flowering	1	1	1	3	1	2	1	2	2	1	3
Growth habit	After pod setting	2	1	1	1	2	3	2	1	1	2	1
Seed colour	Mature seeds	3	3	3	5	3	3	5	3	3	3	5
Seed size	Mature seeds	3	2	3	1	2	3	1	3	2	2	1
Seed shape	Mature seeds	1	3	3	2	1	2	2	3	3	2	1
Seed luster	Mature seeds	0	0	+	0	+	+	0	+	+	+	0

Characters	Stage of observation	Genotypes/Germplasm										
		SGBG 56	SGBG 57	SGBG 58	SGBG 59	SGBG 60	SGBG 61	SGBG 62	SGBG 63	SGBG 64	SGBG 65	SGBG 66
Seedling vigour	After emergences	5	7	3	7	7	7	5	5	7	7	5
Days to emergences	After emergences	5	5	6	6	5	4	4	5	6	5	6
Hypocotyls colour	Cotyledons unfolded	4	1	1	2	1	1	1	1	3	1	3
Flowering time	50% flowering	1	1	1	2	2	1	1	1	2	1	1
Twining Tendency	50% flowering	0	0	0	3	5	3	3	3	5	0	0
Leaf colour	50% flowering	7	3	7	3	5	3	5	5	3	7	5
Leafiness	50% flowering	3	3	7	3	7	3	5	3	7	3	3
Terminal leaflet shape	50% flowering	2	2	1	1	1	2	3	2	1	2	1
Raceme position	50% flowering	1	2	2	1	3	2	2	3	3	1	2
Stem colour	50% flowering	4	1	3	3	3	4	3	4	3	3	3
Leaf pubescence	50% flowering	0	0	0	0	0	3	0	0	0	5	1
Petiole colour	50% flowering	4	3	4	4	1	4	3	3	3	3	4
Branching pattern	During pod setting	3	2	4	4	1	1	4	4	1	2	3
Nodulation	50% flowering	3	7	5	3	3	5	3	5	3	7	5
Calyx colour	50% flowering	1	1	1	1	1	3	1	2	1	2	1
Corolla colour	50% flowering	1	3	1	3	3	3	1	1	2	2	1
Pod shape	After Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod pubescence	Fully developed green pods	3	5	5	5	3	5	3	5	3	5	5
Pod attachment to peduncle	After pod setting	2	2	2	1	1	1	1	3	1	2	1
Immature pod colour	During pod setting	1	2	1	2	1	1	2	1	1	2	2
Mature pod colour	Fully developed green pods	5	5	2	3	2	3	1	5	1	4	5
Pod sheltering in the field	After maturity	0	0	0	0	0	0	0	0	0	0	0
Terminal leaflet shape	50% flowering	2	2	1	1	1	2	3	2	1	2	1
Growth habit	After pod setting	1	2	3	3	3	2	2	3	3	1	1
Seed colour	Mature seeds	3	5	5	5	5	4	4	4	5	5	5
Seed size	Mature seeds	3	2	2	3	1	3	2	1	1	2	1
Seed shape	Mature seeds	3	2	1	1	1	2	3	3	1	1	3
Seed luster	Mature seeds	+	0	0	0	0	0	+	+	0	0	+

Characters	Stage of observation	Genotypes/Germplasm										
		SGBG 67	SGBG 68	SGBG 69	SGBG 70	SGBG 71	SGBG 72	SGBG 73	SGBG 74	SGBG 75	SGBG 76	SGBG 77
Seedling vigour	After emergences	5	7	7	7	3	5	5	5	5	7	7
Days to emergences	After emergences	5	5	6	4	7	4	4	4	5	6	5
Hypocotyls colour	Cotyledons unfolded	2	1	1	4	1	2	1	3	1	3	4
Flowering time	50% flowering	1	1	1	1	2	1	1	1	1	1	1
Growth pattern	50% flowering											
Twining Tendency	50% flowering	0	0	3	0	3	5	5	3	3	5	0
Leaf colour	50% flowering	5	7	7	3		7	3	3	3	5	5
Terminal leaflet shape	50% flowering	1	3	3	3	2	1	1	2	1	1	3
Leafiness	50% flowering	5	3	7	3	3	7	7	7	5	3	3
Raceme position	50% flowering	1	2	2	1	3	3	3	3	1	1	1
Stem colour	50% flowering	3	31	3	3	4	3	3	3	3	3	3
Leaf pubescence	50% flowering	1	5	0	5	0	5	0	0	0	3	5
Petiole colour	50% flowering	5	3	1	4	3	3	3	4	3	3	4
Branching pattern	During pod setting	4	2	3	4	2	4	4	1	2	4	2
Nodulation	50% flowering	5	5	5	7	3	3	5	5	5	5	5
Calyx colour	50% flowering	1	1	2	1	2	1	1	1	1	1	1
Corolla colour	50% flowering	1	3	1	2	1	1	3	1	1	3	1
Pod shape	After Pod setting	2	2	2	2	2	2	2	2	2	2	2
Pod pubescence	Fully developed green pods	5	7	5	5	3	5	3	5	3	3	7
Pod attachment to peduncle	After pod setting	1	1	1	1	2	2	2	1	2	2	1
Immature pod colour	During pod setting	2	2	2	2	2	1	1	1	2	1	2
Mature pod colour	Fully developed green pods	5	5	5	5	4	5	3	3	5	5	3
Pod sheltering in the field	After maturity	0	+	0	0	0	0	0	0	0	0	0
Terminal leaflet shape	50% flowering	1	3	3	3	2	1	1	2	1	1	3
Growth habit	After pod setting	1	1	1	1	2	3	3	2	2	2	1
Seed colour	Mature seeds	5	3	4	5	5	5	4	4	3	3	5
Seed size	Mature seeds	3	3	2	1	3	3	2	2	3	3	1
Seed shape	Mature seeds	2	3	3	2	1	1	3	2	3	2	1
Seed luster	Mature seeds	0	+	+	0	0	0	+	+	+	0	0

Characters	Stage of observation	Genotypes/Germplasm				
		SGBG 78	SGBG79	SGBG80	Indira Urad Pratham	TU 94-2
Seedling vigour	After emergences	7	7	7	7	5
Days to emergences	After emergences	4	5	5	4	5
Hypocotyls colour	Cotyledons unfolded	2	1	3	1	4
Flowering time	50% flowering	1	1	1	2	2
Twining Tendency	50% flowering	7	7	7	0	0
Leaf colour	50% flowering	5	7	7	3	3
Leafiness	50% flowering	7	7	7	3	3
Terminal leaflet shape	50% flowering	5	2	1	1	5
Raceme position	50% flowering	2	3	3	1	1

Stem colour	50% flowering	1	4	3	3	3
Leaf pubescence	50% flowering	3	0	5	1	1
Petiole colour	50% flowering	3	4	3	3	3
Branching pattern	During pod setting	1	1	1	2	2
Nodulation	50% flowering	5	7	7	7	7
Calyx colour	50% flowering	2	1	1	1	2
Corolla colour	50% flowering	2	3	1	1	5
Pod shape	After Pod setting	2	2	2	2	2
Pod pubescence	Fully developed green pods	3	3	5	5	7
Pod attachment to peduncle	After pod setting	2	1	3	1	1
Immature pod colour	During pod setting	1	1	1	1	1
Mature pod colour	Fully developed green pods	3	5	4	4	4
Pod sheltering in the field	After maturity	0	0	0	0	0
Terminal leaflet shape	50% flowering	5	2	1	1	5
Growth habit	After pod setting	3	3	3	2	2
Seed colour	Mature seeds	5	5	4	5	5
Seed size	Mature seeds	2	2	2	1	1
Seed shape	Mature seeds	1	2	3	1	1
Seed luster	Mature seeds	0	0	+	0	0

Note: - SGBG= Shaheed Gundadhur Black Gram

Conclusion

In conclusion, the meticulous characterization of black gram genotypes has yielded crucial insights essential for varietal identification and breeding programs. Through a thorough examination of various morphological and physiological traits, including seedling vigor, leaf and flower characteristics, plant and stem attributes, pod features, and seed traits, a comprehensive understanding of genotype diversity has been achieved. These findings not only enhance our knowledge of black gram but also provide a basis for targeted breeding efforts aimed at improving yield and stress tolerance. Moreover, the significance of seed characterization underscores its pivotal role in seed production and germplasm management, contributing to agricultural sustainability and global food security.

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