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Morphological Characterization for Important Breeding Traits in Blackgram [*Vigna mungo* (L.) Hepper] Genotypes

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ABSTRACT: Characterization on morphological basis are very important for the identification of the important breeding traits in crop plants. An experiment was conducted on 40 blackgram genotypes to determine the important morphological traits using 18 DUS descriptors as per PPV & FRA. The genotypes were planted in three replications by employing randomized block design and the observations were recorded at different plant growth developmental stages. Out of 18, the 10 characters *viz.* plant growth habit, plant habit, foliage colour, leaf vein colour, petiole colour, intensity of green colour of premature pods, pod pubescence, seed colour, seed lusture and seed shape exhibited more variation as compared to the characters *viz.* anthocyanin colouration, stem pubescence, leaf pubescence and pod length which exhibited no morphological variation. The frequency distribution of purple vein colour of leaf and greenish seed colour was 2.5% which was lowest among all the traits and hence they carry unique morphological identity which will facilitate their easy identification. These traits might be considered in the urd varietal development programme for the easy visibility of varietal linked traits during maintenance breeding programme.

Keywords: Morphological, variation, DUS, PPV & FRA.

INTRODUCTION

Blackgram [*Vigna mungo* (L.) Hepper] being autogamous in its floral morphology is positioned in family *Fabaceae* (sub family: Papilionaceae) with chromosome number 2n=2x=22 is one of the dominant Asiatic leguminous crop. It is commonly called as urd, urdbean or mash and its estimated genome size is 574Mbp (Jegadeesan *et al*., 2021). It is a pulse of tropical and sub-tropical areas and potentially grown in many countries (Girish *et al.,* 2012). In India, its cultivation is taken up in all the cropping seasons *i.e*. Rabi, Kharif and Zaid. One of the major factor that has given fame to this crop is its adaptability in crop rotation with various crops and its suitability in both rainfed and irrigated conditions (Singh *et al.*, 2020).

Regarding nutritional aspects of blackgram, it shows its richness in protein content *i.e*. (20-25%). It also contains other proteins such as albumin and globulin along with amino acids like lysine and tryptophan. It also has fat (1.4%), minerals (3.2%), fibre (0.9%) and carbohydrate (59.6%). Apart from this, its seeds are rich in vitamins like thiamine, riboflavin and niacin.

When the existing UPOV models for plant variety protection could not meet requirements of India, the Government of India had to enact its own legislation popularly known as "Protection of Plant Varieties and Farmers Right Act (PPV&FRA) in 2001 with an aim of providing protection to the plant varieties on the basis of their distinctiveness, uniformity and stability (DUS) examination. This act apart from novelty carries a uniqueness of maintaining equality between the breeders and the farmers treating them as partners in their attempts of food security. There are several steps that the process of varietal identification includes and they are identification a variety, confirmation of a variety, distinctness of a variety from all other, purity of the variety and characterization of a variety as per their descriptors (Rao *et al.*, 2013). The DUS testing either in field or glasshouse is generally employed for two successive seasons as per the protocols given by PPV&FRA.

Morphological markers are inexpensive in nature, quick to score and have high heritability and therefore they are employed in morphological characterization (Kumawat *et al.*, 2020). Morphological characterization groups the germplasm/genotypes/varieties possessing specific traits that brings out a clear differentiation from one another. Piyada *et al*. (2010) also emphasized on morphological characterization in order to check variability and differentiate between the crop germplasm.

MATERIALS AND METHODS

The experimental material comprised 40 diverse blackgram genotypes received from the Department of Plant Breeding and Genetics, College of Agriculture,

Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India. The field trial was conducted during Summer-Kharif 2021 in randomized block design in 3 replications. The genotypes were planted in four rows of 2 meters each maintaining a row to row distance of 40 cm and plant to plant distance of 10 cm. The morphological observations under study were recorded at the stages as per the guidelines for the conduct of Test for Distinctiveness, Uniformity and Stability on Blackgram [*Vigna mungo* (L.) Hepper] by PPV&FRA. The anthocyanin colouration of hypocotyl was observed when the cotyledons were unfolded *i.e*. 5-6 days after sowing. The time of flowering was recorded when the 50% of the plants possessed at least one open flower. The plant growth habit, the plant habit, stem colour, stem pubescence, leaflet (terminal) shape, foliage colour, leaf vein colour, leaf pubescence were observed at 50% flowering stage. At the stage of fully developed green pods, the characters petiole colour, intensity of green colour of premature pods were noted. The pod length was taken up at harvest maturity while the seed colour, seed lusture, seed shape and seed size (weight of 100 seeds) were noted down in mature seeds *i.e*. after harvesting.

RESULTS AND DISCUSSIONS

Characterization forms a pre-requisite in varietal identification and the results of the same which includes grouping as well as frequency distribution of blackgram genotypes has been provided in the (Table 1&2) coupled with its discussion in this section.

Hypocotyl: Anthocyanin colouration. This trait acts as an important morphological marker and can be effectively employed for varietal identification prior to active seed multiplication. Anthocyanin colouration recorded at seedling stage was present in all the 40 blackgram genotypes under observation indicating no variation for this trait. Similar finding was reported by Singh *et al.* (2020).

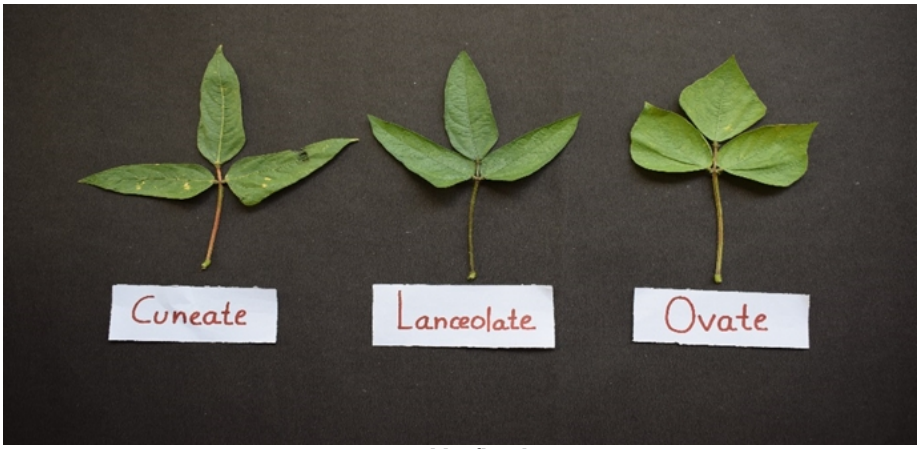
Anthocyanin colouration

Flower character. Time of flowering was examined when 50% of the plant had at least one open flower bud. It was grouped in three categories *viz*. early (<40 days)**,** medium (40-50 days) and late (>50 days). 32 genotypes were early in their time of flowering and 8 were medium while of the genotypes were late in their time of flowering (Table 1). The early the genotypes are the more is the tendency in them to mitigate the abiotic stresses during their reproductive stage (Pratap *et al*., 2013). Jain *et al.,* (2002) reported the usefulness of flower characteristics in characterization of greengram germplasm.

Plant characters. Plant growth habit and plant habit were studied at 50% flowering stage. Among 40 genotypes, 5 erect, 9 semi-erect and 26 spreading were in their growth habit while concerning plant habit, 8 determinate and 32 indeterminate genotypes were reported in the present investigation of characterization significant amount of variation these traits (Table 1). Erect types are prime importance as they receive good amount of sunlight which speeds up the assimilate production in the plant. Singh *et al.,* (2020) also reported significant variation in their findings in blackgram and Singh *et al.* (2014) in mungbean.

Stem characters. This character included two traits *viz*. stem colour and stem pubescence observed at 50% stage of flowering. The colour of stem out 40 genotypes were purple with green splashes for 31, green with green splashes for 5, purple for 4 genotypes and 0 for none of the genotypes respectively whereas stem pubescence was present in all the genotypes showing no variation (Table 1).

Leaf characters. These characters influence the yielding ability of genotypes because leaves directly participate in photosynthesis. Leaf characters included leaflet (terminal) shape, foliage colour, leaf vein colour and leaf pubescence which were noted at 50% stage of flowering. All the genotypes varied significantly for leaf morphology except for leaf pubescence because it was present in all the genotypes showing no variation (Table 1). The purple leaf vein colour was present in one genotype *i.e*. IPU 2-43 with a frequency distribution of 2.5% (Table 2).



Terminal leaflet shape

Petiole colour. Petiole colour was observed at the stage when green pods were full developed. The extent of frequency distribution for petiole colour was (35%) for green and (26%) for green with purple splashes colour respectively (Table 2). (Singh *et al.* 2020) also showed significant variation for petiole colour in blackgram genotypes.

Pod characters. Pod characters are one of the important attributes in blackgram as well as greengram and play a chief role in the identification of genotypes. In this present study, the pod characters *viz*. intensity of green colour of premature pods, pod pubescence and pod length was observes at fully developed green pod stage. These traits varied in their morphology and were grouped into different categories. Out of 40 genotypes, 23 possessed greenish yellow pods, 15 were with green while 2 had dark green pods respectively (Table 1). In case of pod pubescence, there was no significant variation because pubescence was present in the pods of all the 40 genotypes (Table 1). Similar results were reported by Kaur *et al*. (2017) in mungbean.


Light green pods


Dark green pods

Seed characters. The traits under seed characters included seed colour, seed lusture and seed shape respectively which were observed at seed maturity *i.e*. after harvesting. All these characters were assigned into different groups (Table 1). The mottled seed colour was present in 28 genotypes while it was black in 8 and greenish in 1 genotype respectively. The seed colour in Uradi was greenish and its frequency distribution was 2.5% (Table 2). The seed shape for 27 genotypes was globose and oval for 11 and drum-shaped for 2 genotypes respectively (Table 1).

The seed size was grouped into three categories *i.e*. 3 genotypes fell under large category, while 37 under medium category and none of the genotypes had small seeds (Table 1). Seed characterization is of prime importance because it enables a breeder to identify and differentiate one genotype from another while undertaking a seed production programme. Venkateswarlu *et al*. (2001) & Sabatina *et al.* (2021) discussed the importance of seed characterization in mungbean.

Table 1: Morphological Characterization of 40 Blackgram Genotypes.

Characters	Stage of Observation	Genotypes									
		PDU 1	TJU 339	TJU-1-30	TJU 328	TJU 103	T9	TJU 18	PU 35	TJU 111	TJU 67
Hypocotyl: Anthocyanin colouration	Cotyledons unfolded	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Time of flowering	50% plants with at least one open flower bud	Early	Early	Early	Early	Early	Early	Early	Early	Medium	Medium
Plant: Growth habit	50% flowering	Erect	Semi-erect	Spreading	Erect	Spreading	Erect	Erect	Semi-erect	Semi-erect	Spreading
Plant: Habit	50% flowering	Determinate	Determinate	Indeterminate	Indeterminate	Indeterminate	Determinate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Stem: Colour	50% flowering	Purple with green splashes	Purple with green splashes	Purple with green splashes	Green with purple splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes	Green w ith purple splashes	Purple	Purple with green splashes
Stem: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Leaflet (Terminal): Shape	50% flowering	Cuneate	Lanceolate	Lanceolate	Ovate	Lanceolate	Cuneate	Lanceolate	Lanceolate	Cuneate	Lanceolate
Foliage: Colour	50% flowering	Green	Dark green	Dark green	Green	Dark green	Green	Green	Green	Green	Dark green
Leaf: Vein colour	50% flowering	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Leaf: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Petiole: Colour	Fully developed green pods	Green	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green	Green with purple splashes	Green
Pod: Intensity of green colour of premature pods	Fully developed green pods	Yellowish green	Green	Green	Yellowish green	Yellowish green	Green	Green	Green	Yellowish green	Yellowish green
Pod: Pubescence	Fully developed green pods	Present	Present	Present	Present	Present	Absent	Present	Present	Present	Present
Pod: Length	Harvest maturity	Small	Small	Small	Small	Small	Small	Small	Small	Small	Small
Seed: Colour	Mature seeds	Mottled	Black	Mottled	Mottled	Mottled	Black	Mottled	Mottled	Mottled	Mottled
Seed: Lusture	Mature seeds	Dull	Dull	Dull	Dull	Dull	Dull	Dull	Dull	Dull	Dull
Seed: Shape	Mature seeds	Globose	Globose	Globose	Globose	Globose	Oval	Oval	Globose	Globose	Globose
Seed: Size (weight of 100 seeds)	Mature seeds	Large	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Characters	Stage of Observation	Genotypes									
		TJU 84	TJU 139	IPU-2-43	TJU 22	TJU 48	TJU 55	TJU 62	TJU 24	TJU 42	TJU 231
Hypocotyl: Anthocyanin colouration	Cotyledons unfolded	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Time of flowering	50% plants with at least one open flower bud	Early	Medium	Early	Early	Medium	Early	Early	Early	Early	Early
Plant: Growth habit	50% flowering	Spreading	Spreading	Spreading	Semi-erect	Semi-erect	Spreading	Spreading	Semi-erect	Semi-erect	Spreading
Plant: Habit	50% flowering	Determinate	Indeterminate	Determinate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Stem: Colour	50% flowering	Purple with green splashes	Green with purple splashes	Purple	Purple with green splashes	Purple	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes
Stem:	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present

Pubescence											
Leaflet (Terminal): Shape	50% flowering	Ovate	Lanceolate	Ovate	Ovate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate
Foliage: Colour	50% flowering	Green	Green	Dark green	Green	Green	Green	Dark green	Green	Green	Green
Leaf: Vein colour	50% flowering	Green	Green	Purple	Green	Green	Green	Green	Green	Green	Green
Leaf: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Petiole: Colour	Fully developed green pods	Green	Green with purple splashes	Green with purple splashes	Green	Green with purple splashes	Green	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green
Pod: Intensity of green colour of premature pods	Fully developed green pods	Yellowish green	Yellowish green	Dark green	Yellowish green	Yellowish green	Yellowish green	Yellowish green	Green	Green	Green
Pod: Pubescence	Fully developed green pods	Present	Present	Absent	Present	Present	Absent	Present	Present	Present	Present
Pod: Length	Harvest maturity	Small	Small	Small	Small	Small	Small	Small	Small	Small	Small
Seed: Colour	Mature seeds	Mottled	Mottled	Mottled	Mottled	Black	Mottled	Mottled	Black	Mottled	Mottled
Seed: Lusture	Mature seeds	Shiny	Dull	Dull	Dull	Dull	Dull	Dull	Shiny	Shiny	Dull
Seed: Shape	Mature seeds	Oval	Globose	Globose	Globose	Oval	Oval	Drum shaped	Oval	Globose	Globose
Seed: Size (weight of 100 seeds)	Mature seeds	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Characters	**Stage of Observation**	**Genotypes**									
		JU 3	**TU-98-14**	**LBG 20**	**JU 30**	**Indira Urad 1**	**TAU 2**	**TU-94-2**	**TJU-48-3**	**TJU-45-1**	**TJU 389**
Hypocotyl: Anthocyanin colouration	Cotyledons unfolded	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Time of flowering	50% plants with at least one open flower bud	Early	Early	Early	Early	Early	Early	Early	Medium	Early	Early
Plant: Growth habit	50% flowering	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading
Plant: Habit	50% flowering	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Determinate	Indeterminate	Indeterminate	Determinate	Indeterminate
Stem: Colour	50% flowering	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes
Stem: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Leaflet (Terminal): Shape	50% flowering	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Ovate	Lanceolate	Lanceolate	Cuneate	Lanceolate	Lanceolate
Foliage: Colour	50% flowering	Green	Green	Green	Green	Dark green	Green	Green	Green	Green	Dark green
Leaf: Vein colour	50% flowering	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Leaf: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Petiole: Colour	Fully developed green pods	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green	Green with purple splashes	Green	Green with purple splashes	Green with purple splashes	Green	Green
Pod: Intensity of green colour of	Fully developed	Green	Green	Green	Yellowish green	Dark green	Yellowish green	Yellowish green	Yellowish green	Yellowish green	Green

premature pods	green pods										
Pod: Pubescence	Fully developed green pods	Present	Absent	Absent	Present	Present	Absent	Present	Present	Present	Present
Pod: Length	Harvest maturity	Small	Small	Small	Small	Small	Small	Small	Small	Small	Small
Seed: Colour	Mature seeds	Greenish brown	Mottled	Greenish brown	Black	Mottled	Mottled	Mottled	Mottled	Mottled	Mottled
Seed: Lusture	Mature seeds	Dull	Dull	Shiny	Dull	Dull	Dull	Dull	Shiny	Dull	Dull
Seed: Shape	Mature seeds	Globose	Oval	Oval	Oval	Globose	Globose	Globose	Globose	Globose	Globose
Seed: Size (weight of 100 seeds)	Mature seeds	Medium	Medium	Large	Large	Medium	Medium	Medium	Medium	Medium	Medium

Characters	**Stage of Observation**	**Genotypes**									
		PU 19	**TJU 134**	**TJU 4**	**TJU-41-1**	**TJU-41-2**	**TJU-24-10**	**TJU 213**	**Uradi**	**TJU 262**	**TJU 273**
Hypocotyl: Anthocyanin colouration	Cotyledons unfolded	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Time of flowering	50% plants with at least one open flower bud	Early	Medium	Early	Medium	Early	Early	Early	Early	Early	Medium
Plant: Growth habit	50% flowering	Spreading	Spreading	Spreading	Spreading	Semi-erect	Erect	Semi-erect	Spreading	Spreading	Spreading
Plant: Habit	50% flowering	Indeterminate	Determinate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Stem: Colour	50% flowering	Purple with green splashes	Purple with green splashes	Green with purple splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes	Purple with green splashes	Green with purple splashes	Purple with green splashes	Purple with green splashes
Stem: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Leaflet (Terminal): Shape	50% flowering	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Cuneate	Lanceolate
Foliage: Colour	50% flowering	Green	Green	Green	Green	Green	Dark green	Green	Green	Green	Green
Leaf: Vein colour	50% flowering	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Leaf: Pubescence	50% flowering	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Petiole: Colour	Fully developed green pods	Green with purple splashes	Green	Green	Green with purple splashes	Green with purple splashes	Green with purple splashes	Green	Green with purple splashes	Green with purple splashes	Green with purple splashes
Pod: Intensity of green colour of premature pods	Fully developed green pods	Yellowish green	Yellowish green	Green	Yellowish green	Yellowish green	Yellowish green	Yellowish green	Yellowish green	Green	Green
Pod: Pubescence	Fully developed green pods	Present	Present	Present	Present	Absent	Present	Present	Present	Present	Present
Pod: Length	Harvest maturity	Small	Small	Small	Small	Small	Small	Small	Small	Small	Small
Seed: Colour	Mature seeds	Mottled	Mottled	Mottled	Black	Black	Black	Mottled	Greenish	Greenish brown	Mottled
Seed: Lusture	Mature seeds	Dull	Shiny	Dull	Shiny	Dull	Dull	Shiny	Shiny	Dull	Dull
Seed: Shape	Mature seeds	Oval	Oval	Globose	Globose	Globose	Globose	Drum shaped	Globose	Globose	Globose
Seed: Size (weight of 100 seeds)	Mature seeds	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Table 2: Frequency Distribution of Morphological Traits in 40 Blackgram Genotypes.

Characters	Classes	Number of genotypes	Percentage of genotypes (%)
Hypocotyl: Anthocyanin Coloration	Present	40	100.0
	Absent	00	0.0
Time of flowering	Early (<40 days)	32	80.0
	Medium (40-50 days)	08	20.0
	Late (More the 50 days)	00	0.0
Plant: Growth habit	Erect	05	12.5
	Semi-erect	09	22.5
	Spreading	26	65.0
Plant: Habit	Determinate	08	20.0
	Indeterminate	32	80.0
Stem: Colour	Green	00	0.0
	Purple with green splashes	31	77.5
	Green with purple splashes	05	12.5
	Purple	04	10.0
Stem: Pubescence	Absent	00	0.0
	Present	40	100.0
Leaf: Shape (Terminal)	Deltoid	00	0.0
	Ovate	05	12.5
	Lanceolate	30	75.0
	Cuneate	05	12.5
Foliage: Colour	Green	31	77.5
	Dark green	09	22.5
Leaf: Vein colour	Green	39	97.5
	Purple	01	2.5
Leaf: Pubescence	Present	40	100.0
	Absent	00	0.0
Petiole: Colour	Green	14	35.0
	Green with purple splashes	26	65.0
Pod: Intensity of green colour of premature pods	Yellowish green	23	57.5
	Green	15	37.5
	Dark green	02	5.0
Pod: Pubescence	Absent	07	17.5
	Present	33	82.5
Pod: Length	Small	40	100.0
	Medium	00	0.0
	Large	00	0.0
Seed: Colour	Greenish	01	2.5
	Greenish brown	03	7.5
	Mottled	28	70.0
	Black	08	20.0
Seed: Lusture	Shiny	09	22.5
	Dull	31	77.5
Seed: Shape	Oval	11	27.5
	Drum shaped	02	5.0
	Globose	27	67.5
Seed: Size (weight of 100 seeds)	Small	00	0.0
	Medium	37	92.5
	Large	03	7.5

CONCLUSION

Out of 18 morphological DUS characters, one character (seed colour) exhibited tetramorphic variation, five characters (plant growth habit, stem colour, leaf (terminal) shape, intensity of green colour of premature pods and seed shape) exhibited trimorphic variation, eight characters (time of flowering, plant habit, foliage colour, leaf vein colour, petiole colour, pod pubescence, seed lusture and seed size) exhibited dimorphic variation and four characters (anthocyanin colouration, stem pubescence, leaf pubescence and pod length) exhibited monomorphic variation.

As per the present investigation, the characters hypocotyl: anthocyanin colouration, stem pubescence, leaf pubescence and pod length showed no variation. Therefore they are of not much use in the exploitation of variability between the genotypes in terms of varietal identification when compared to the other traits studied possessing large variation and hence can be utilized in identification of elite lines. This finding might be useful for the researcher educational aspect and to the farmers as a unique identity of the varietal marker.

FUTURE SCOPE

The specific traits will be of great importance in breeding programme of the crop for addition of new traits in some of the important cultivars in seed production chain. Majority of the varieties go through a long journey in seed production chain only for good adaptability and unique morphological traits linked makes the identification easy in between different varieties of the same crop.

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Conflict of Interest. None.

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