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Characterization of American cotton (*Gossypium hirsutum* L.) genotypes based on morphological characters

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Abstract

Fifty genotypes were characterized based on their morphological characters as per DUS guidelines of American cotton *viz.*, hypocotyl pigmentation, leaf shape, leaf colour, leaf pubescence, leaf petiole pigmentation, flower petal colour, flower stigma position, pollen colour, anther filament colouration, plant stem hairiness, plant stem pigmentation, growth habit, plant height, boll colour, boll shape, boll surface, prominence of tip in boll, boll opening and seed fuzz. The genotypes has shown great extent of morphological variability for all the traits observed.

Keywords: DUS, morphological characters, American cotton

Introduction

Cotton (*Gossypium* sp.), being the “King” of fibers in preparing human apparel has played a key role in the development of civilization. Due to its importance in agriculture as well as industrial economy, it is also known as “white gold”. Simpson (1954) classified cotton as predominantly self-pollinated and often cross-pollinated crop. The genus *Gossypium* comprises around 50 species making it the largest in species number in the tribe *Gossypieae*. There are four cultivated species of cotton *viz.*, *Gossypium arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense*. The first two species are diploid ($2n=2x=26$) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid ($2n=4x=52$) and are also referred to as New World Cottons. *G. hirsutum* is also known as American cotton or upland cotton and *G. barbadense* as Egyptian cotton or Sea Island cotton or Peruvian Cotton or Tanguish Cotton or quality cotton. In India, out of four cultivated species of cotton, *Gossypium hirsutum* L. has lion’s share in total cotton growing area due to its quality and quantity with superiority.

Descriptors of varieties of crop species are required for characterization of varietal identity, determine varietal purity and establish the distinctiveness of new variety from existing varieties and documentation of genetic resources. With the introduction of high yielding varieties and new technologies become a great threat to the security of the age-old practice of growing traditional varieties and landraces which may have immense potential for different important traits, a variety is eligible for registration and release if it possesses novelty, distinctiveness, uniformity and stability (DUS) characteristics. DUS testing of cultivars is one of the requirements for granting Plant Breeders Rights (PBR) and it is conducted according to national guidelines prepared on the basis of UPOV guidelines. Varieties within plant species have specific characters, which are suitable for distinguishing of varieties differences. This fact has important place for DUS testing and variety identification and verification (Keefe, 1999) [5]. A strict maintenance breeding for genetic purity of all the example varieties is warranted for a valid DUS testing for proper implementation of PPV & FR Act (Chakrabarty *et al.* 2012) [6]. Therefore, the present study was undertaken to characterize American cotton genotypes based on morphological traits.

Materials and Methods

The main objective of the investigation was to characterize the American cotton genotypes to assess their potential to contribute to future crop improvement programmes. The fifty American cotton genotypes were evaluated at Cotton Research Station, Junagadh Agricultural University, Junagadh in Randomized Block Design in three replications with each genotype was planted in row to row spacing of 120 cm. The seeds were dibbled in rows at a distance of 45 cm and plot size 6.3 × 1.2 m. Need based agronomic and plant protection measures were taken up for good crop growth. Data was collected at various growth stages of American cotton plant.

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Results and Discussion

The results obtained in the present investigation have been presented in the Table 1. Hypocotyl pigmentation was recorded as present or absent in the 50 cotton genotypes, 9 genotypes (GP Hir.-48, GP Hir.-58, GP Hir.-70, GP Hir.-71, GP Hir.-85, GP Hir.-88, GP Hir.-92, GP Hir.-94 and GJ. Cot101) were grouped under absent and remaining 41 genotypes were grouped under present of hypocotyl pigmentation. Similar classification was studied by (Rai *et al.*, 2016) [10]. Fifty genotypes under study leaf shape was palmate (normal), similar categorization was also studied by (Rajeev *et al.*, 2005, Kaur *et al.*, 2016 and Anjani *et al.*, 2018) [11, 4, 1]. Twenty seven genotypes studied were having light green leaves and 23 were having green leaves (Reddy *et al.*, 2007 and Nimbal *et al.*, 2019) [12, 8]. Pubescence on the leaves is very common cotton characteristic. 27 genotypes were having sparse, 15 genotypes under medium and remaining 8 genotypes (GP Hir.-49, GP Hir.-50, GP Hir.-52, GP Hir.-53, GP Hir.-68, GP Hir.-73, GP Hir.-93 and GP Hir.-94) were having dense (Kaur *et al.*, 2016, Nimbal *et al.*, 2019) [4, 8]. Twenty six genotypes had leaf petiole pigmentation and remaining 24 genotypes were without leaf petiole pigmentation (Rai *et al.*, 2016 and Anjani *et al.*, 2018) [10, 1]. The photographs of all the qualitative characters have been shown in the figure 1-6.

Flower petal colour is one of the important character for characterization and was classified as white, cream and yellow. Three genotypes (GP Hir.-48, GP Hir.-49 and GP

Hir.-82) had white petal colour, 33 with cream and 15 genotypes had yellow petal colour (Reddy *et al.*, 2007 and Kaur *et al.*, 2016) [12, 4]. Flower stigma position was exerted in 40 genotypes and 10 genotypes (GP Hir.-54, GP Hir.-66, GP Hir.-78, GP Hir.-79, GP Hir.-80, GP Hir.-81, GP Hir.-82, GP Hir.-89, GP Hir.-91 and GP Hir.-93) had embedded stigma (Rai *et al.*, 2016 and Anjani *et al.*, 2018) [10, 1]. Majority of the genotypes 27 had cream pollen colour and rest 23 had yellow pollen colour (Anjani *et al.*, 2018 and Nimbal *et al.*, 2019) [1, 8]. In majority of genotypes 42 anther filament colouration was present while absent in 8 genotype (GP Hir.-48, GP Hir.-49, GP Hir.-54, GP Hir.-55, GP Hir.-56, GP Hir.-57, GP Hir.-77 and GP Hir.-82) (Rai *et al.*, 2016) [10]. Thirteen genotypes were found to have sparse stem hairiness, 13 genotypes medium stem hairiness and 24 genotypes fall in dense hairiness category (Nimbal *et al.*, 2019 and Patel *et al.*, 2020) [8, 9]. Seventeen genotypes had stem pigmentation and in remaining 33 genotypes plant stem pigmentation was absent (Rajeev *et al.*, 2005 and Rai *et al.*, 2016) [11, 10]. The plant growth habit was erect strong in 16 genotypes, stout bushy type in 9 genotypes (GP Hir.-59, GP Hir.-60, GP Hir.-69, GP Hir.-71, GP Hir.-73, GP Hir.-76, GP Hir.-87, GP Hir.-90, GP Hir.-93) and erect open type was found in 25 genotypes (Sangwan *et al.*, 2016 and Balakrishnan *et al.*, 2020) [13, 2]. The plant height showed variation among genotypes. Twenty seven genotype was medium tall and 23 genotypes were tall plant height. Same classification was studied earlier by (Eshiet and Brisibe 2015 and Balakrishnan *et al.*, 2020) [3, 2].

Table 1: Characterization of different morphology characters of American cotton

Genotypes	Hypocotyl pigmentation	Leaf shape	Leaf colour	Leaf pubescence	Leaf petiole pigmentation	Flower petal colour	Flower stigma position
GP Hir.-48	Absent	Palmate	Green	Medium	Absent	White	Exerted
GP Hir.-49	Present	Palmate	Green	Dense	Present	White	Exerted
GP Hir.-50	Present	Palmate	Light green	Dense	Present	Cream	Exerted
GP Hir.-51	Present	Palmate	Green	Medium	Absent	Yellow	Exerted
GP Hir.-52	Present	Palmate	Light green	Dense	Present	Cream	Exerted
GP Hir.-53	Present	Palmate	Light green	Dense	Absent	Yellow	Exerted
GP Hir.-54	Present	Palmate	Green	Medium	Absent	Cream	Embedded
GP Hir.-55	Present	Palmate	Green	Medium	Absent	Yellow	Exerted
GP Hir.-56	Present	Palmate	Light green	Sparse	Present	Cream	Exerted
GP Hir.-57	Present	Palmate	Light green	Sparse	Present	Cream	Exerted
GP Hir.-58	Absent	Palmate	Light green	Sparse	Absent	Yellow	Exerted
GP Hir.-59	Present	Palmate	Green	Sparse	Absent	Cream	Exerted
GP Hir.-60	Present	Palmate	Light green	Sparse	Present	Yellow	Exerted
GP Hir.-61	Present	Palmate	Green	Sparse	Present	Yellow	Exerted
GP Hir.-62	Present	Palmate	Light green	Medium	Present	Yellow	Exerted
GP Hir.-63	Present	Palmate	Light green	Medium	Present	Cream	Exerted
GP Hir.-64	Present	Palmate	Light green	Sparse	Absent	Yellow	Exerted
GP Hir.-65	Present	Palmate	Light green	Sparse	Present	Cream	Exerted
GP Hir.-66	Present	Palmate	Green	Sparse	Absent	Cream	Embedded
GP Hir.-67	Present	Palmate	Light green	Sparse	Absent	Cream	Exerted
GP Hir.-68	Present	Palmate	Green	Dense	Present	Cream	Exerted
GP Hir.-69	Present	Palmate	Light green	Sparse	Present	Cream	Exerted
GP Hir.-70	Absent	Palmate	Green	Medium	Absent	Cream	Exerted
GP Hir.-71	Absent	Palmate	Light green	Medium	Absent	Cream	Exerted
GP Hir.-72	Present	Palmate	Light green	Medium	Present	Cream	Exerted
GP Hir.-73	Present	Palmate	Green	Dense	Absent	Cream	Exerted
GP Hir.-74	Present	Palmate	Green	Sparse	Present	Yellow	Exerted
GP Hir.-75	Present	Palmate	Green	Sparse	Absent	Cream	Exerted
GP Hir.-76	Present	Palmate	Light green	Sparse	Absent	Cream	Exerted
GP Hir.-77	Present	Palmate	Light green	Medium	Absent	Cream	Exerted
GP Hir.-78	Present	Palmate	Green	Sparse	Absent	Cream	Embedded
GP Hir.-79	Present	Palmate	Light green	Sparse	Present	Cream	Embedded
GP Hir.-80	Present	Palmate	Light green	Sparse	Absent	Cream	Embedded
GP Hir.-81	Present	Palmate	Light green	Sparse	Absent	Cream	Embedded
GP Hir.-82	Present	Palmate	Light green	Sparse	Present	White	Embedded

GP Hir.-83	Present	Palmate	Green	Medium	Absent	Cream	Exerted
GP Hir.-84	Present	Palmate	Green	Medium	Absent	Cream	Exerted
GP Hir.-85	Absent	Palmate	Light green	Sparse	Present	Cream	Exerted
GP Hir.-86	Present	Palmate	Green	Sparse	Present	Yellow	Exerted
GP Hir.-87	Present	Palmate	Light green	Medium	Absent	Cream	Exerted
GP Hir.-88	Absent	Palmate	Green	Medium	Present	Yellow	Exerted
GP Hir.-89	Present	Palmate	Light green	Sparse	Present	Yellow	Embedded
GP Hir.-90	Present	Palmate	Green	Sparse	Absent	Yellow	Exerted
GP Hir.-91	Present	Palmate	Green	Sparse	Present	Cream	Embedded
GP Hir.-92	Absent	Palmate	Light green	Sparse	Present	Cream	Exerted
GP Hir.-93	Present	Palmate	Light green	Dense	Absent	Cream	Embedded
GP Hir.-94	Absent	Palmate	Green	Dense	Present	Cream	Exerted
GJ. Cot101	Absent	Palmate	Green	Sparse	Present	Cream	Exerted
GJ. Cot102	Present	Palmate	Light green	Sparse	Present	Yellow	Exerted
GJ. Cot38	Present	Palmate	Green	Medium	Present	Yellow	Exerted

Table 1: Contd....

Genotypes	Pollen colour	Anther filament colouration	Plant stem hairiness	Plant stem pigmentation	Boll colour	Boll shape	Boll surface
GP Hir.-48	Cream	Absent	Dense	Absent	Green	Ovate	Smooth
GP Hir.-49	Cream	Absent	Medium	Absent	Green	Round	Smooth
GP Hir.-50	Yellow	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-51	Yellow	Present	Medium	Present	Green	Round	Smooth
GP Hir.-52	Cream	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-53	Yellow	Present	Medium	Absent	Green	Round	Smooth
GP Hir.-54	Yellow	Absent	Dense	Absent	Green	Ovate	Smooth
GP Hir.-55	Cream	Absent	Medium	Absent	Green	Elliptic	Smooth
GP Hir.-56	Yellow	Absent	Sparse	Present	Green	Ovate	Smooth
GP Hir.-57	Cream	Absent	Medium	Present	Green	Ovate	Smooth
GP Hir.-58	Yellow	Present	Dense	Absent	Green	Elliptic	Smooth
GP Hir.-59	Cream	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-60	Cream	Present	Dense	Absent	Green	Elliptic	Smooth
GP Hir.-61	Yellow	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-62	Cream	Present	Dense	Present	Green	Ovate	Smooth
GP Hir.-63	Cream	Present	Dense	Present	Green	Ovate	Smooth
GP Hir.-64	Yellow	Present	Dense	Present	Green	Elliptic	Smooth
GP Hir.-65	Cream	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-66	Cream	Present	Medium	Absent	Green	Ovate	Smooth
GP Hir.-67	Yellow	Present	Medium	Absent	Green	Ovate	Smooth
GP Hir.-68	Yellow	Present	Sparse	Absent	Green	Elliptic	Smooth
GP Hir.-69	Yellow	Present	Medium	Absent	Green	Round	Smooth
GP Hir.-70	Yellow	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-71	Yellow	Present	Dense	Present	Green	Elliptic	Smooth
GP Hir.-72	Yellow	Present	Medium	Present	Green	Elliptic	Smooth
GP Hir.-73	Cream	Present	Sparse	Present	Green	Elliptic	Smooth
GP Hir.-74	Yellow	Present	Sparse	Absent	Green	Ovate	Smooth
GP Hir.-75	Cream	Present	Sparse	Absent	Green	Ovate	Smooth
GP Hir.-76	Cream	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-77	Cream	Absent	Dense	Absent	Green	Ovate	Smooth
GP Hir.-78	Cream	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-79	Yellow	Present	Dense	Absent	Green	Ovate	Smooth
GP Hir.-80	Yellow	Present	Sparse	Present	Green	Ovate	Smooth
GP Hir.-81	Yellow	Present	Medium	Absent	Green	Ovate	Smooth
GP Hir.-82	Cream	Absent	Dense	Present	Green	Round	Smooth
GP Hir.-83	Cream	Present	Sparse	Absent	Green	Ovate	Smooth
GP Hir.-84	Cream	Present	Sparse	Absent	Green	Ovate	Smooth
GP Hir.-85	Cream	Present	Medium	Present	Green	Ovate	Smooth
GP Hir.-86	Yellow	Present	Dense	Present	Green	Ovate	Smooth
GP Hir.-87	Cream	Present	Dense	Present	Green	Elliptic	Smooth
GP Hir.-88	Yellow	Present	Dense	Present	Green	Ovate	Smooth
GP Hir.-89	Cream	Present	Medium	Absent	Green	Elliptic	Smooth
GP Hir.-90	Cream	Present	Dense	Present	Green	Elliptic	Smooth
GP Hir.-91	Yellow	Present	Dense	Present	Green	Ovate	Smooth
GP Hir.-92	Cream	Present	Sparse	Absent	Green	Round	Smooth
GP Hir.-93	Cream	Present	Sparse	Absent	Green	Ovate	Smooth
GP Hir.-94	Yellow	Present	Sparse	Absent	Green	Elliptic	Smooth
GJ. Cot101	Cream	Present	Sparse	Absent	Green	Elliptic	Smooth
GJ. Cot102	Yellow	Present	Medium	Absent	Green	Ovate	Smooth
GJ. Cot38	Cream	Present	Sparse	Absent	Green	Ovate	Smooth

Table 1: Contd....

Genotypes	Prominence of tip in boll	Boll opening	Seed fuzz	Growth habit	Plant height (cm)
GP Hir.-48	Blunt	Semi open	Sparse	Erect open	Tall
GP Hir.-49	Blunt	Open	Sparse	Erect open	Medium tall
GP Hir.-50	Blunt	Open	Sparse	Erect strong	Tall
GP Hir.-51	Blunt	Open	Medium	Erect open	Medium tall
GP Hir.-52	Blunt	Semi open	Sparse	Erect open	Medium tall
GP Hir.-53	Blunt	Open	Medium	Erect open	Tall
GP Hir.-54	Blunt	Semi open	Sparse	Erect strong	Medium tall
GP Hir.-55	Pointed	Semi open	Sparse	Erect open	Tall
GP Hir.-56	Blunt	Open	Sparse	Erect strong	Medium tall
GP Hir.-57	Blunt	Semi open	Dense	Erect open	Tall
GP Hir.-58	Pointed	Semi open	Naked	Erect open	Tall
GP Hir.-59	Blunt	Semi open	Sparse	Stout bushy	Medium tall
GP Hir.-60	Pointed	Semi open	Naked	Stout bushy	Medium tall
GP Hir.-61	Blunt	Semi open	Naked	Erect open	Tall
GP Hir.-62	Blunt	Semi open	Sparse	Erect open	Tall
GP Hir.-63	Blunt	Open	Medium	Erect open	Tall
GP Hir.-64	Blunt	Semi open	Sparse	Erect open	Medium tall
GP Hir.-65	Blunt	Semi open	Medium	Erect strong	Medium tall
GP Hir.-66	Blunt	Open	Medium	Erect strong	Tall
GP Hir.-67	Blunt	Open	Sparse	Erect open	Medium tall
GP Hir.-68	Pointed	Open	Sparse	Erect strong	Tall
GP Hir.-69	Blunt	Semi open	Dense	Stout bushy	Tall
GP Hir.-70	Pointed	Open	Medium	Erect open	Medium tall
GP Hir.-71	Pointed	Semi open	Naked	Stout bushy	Tall
GP Hir.-72	Pointed	Semi open	Naked	Erect open	Tall
GP Hir.-73	Pointed	Semi open	Medium	Stout bushy	Tall
GP Hir.-74	Blunt	Open	Sparse	Erect open	Medium tall
GP Hir.-75	Pointed	Semi open	Sparse	Erect open	Medium tall
GP Hir.-76	Blunt	Semi open	Dense	Stout bushy	Medium tall
GP Hir.-77	Blunt	Open	Naked	Erect strong	Medium tall
GP Hir.-78	Pointed	Semi open	Medium	Erect open	Medium tall
GP Hir.-79	Pointed	Open	Naked	Erect strong	Medium tall
GP Hir.-80	Blunt	Open	Medium	Erect strong	Medium tall
GP Hir.-81	Blunt	Open	Naked	Erect strong	Tall
GP Hir.-82	Blunt	Open	Dense	Erect strong	Tall
GP Hir.-83	Blunt	Open	Sparse	Erect open	Tall
GP Hir.-84	Blunt	Open	Naked	Erect open	Medium tall
GP Hir.-85	Blunt	Open	Sparse	Erect open	Medium tall
GP Hir.-86	Blunt	Semi open	Naked	Erect strong	Medium tall
GP Hir.-87	Blunt	Semi open	Medium	Stout bushy	Medium tall
GP Hir.-88	Blunt	Semi open	Medium	Erect strong	Tall
GP Hir.-89	Blunt	Semi open	Sparse	Erect strong	Medium tall
GP Hir.-90	Blunt	Open	Sparse	Stout bushy	Medium tall
GP Hir.-91	Blunt	Semi open	Sparse	Erect open	Medium tall
GP Hir.-92	Blunt	Open	Sparse	Erect strong	Tall
GP Hir.-93	Blunt	Open	Medium	Stout bushy	Medium tall
GP Hir.-94	Pointed	Open	Medium	Erect strong	Medium tall
GJ. Cot101	Pointed	Open	Sparse	Erect open	Tall
GJ. Cot102	Blunt	Open	Sparse	Erect open	Tall
GJ. Cot38	Blunt	Open	Sparse	Erect open	Tall

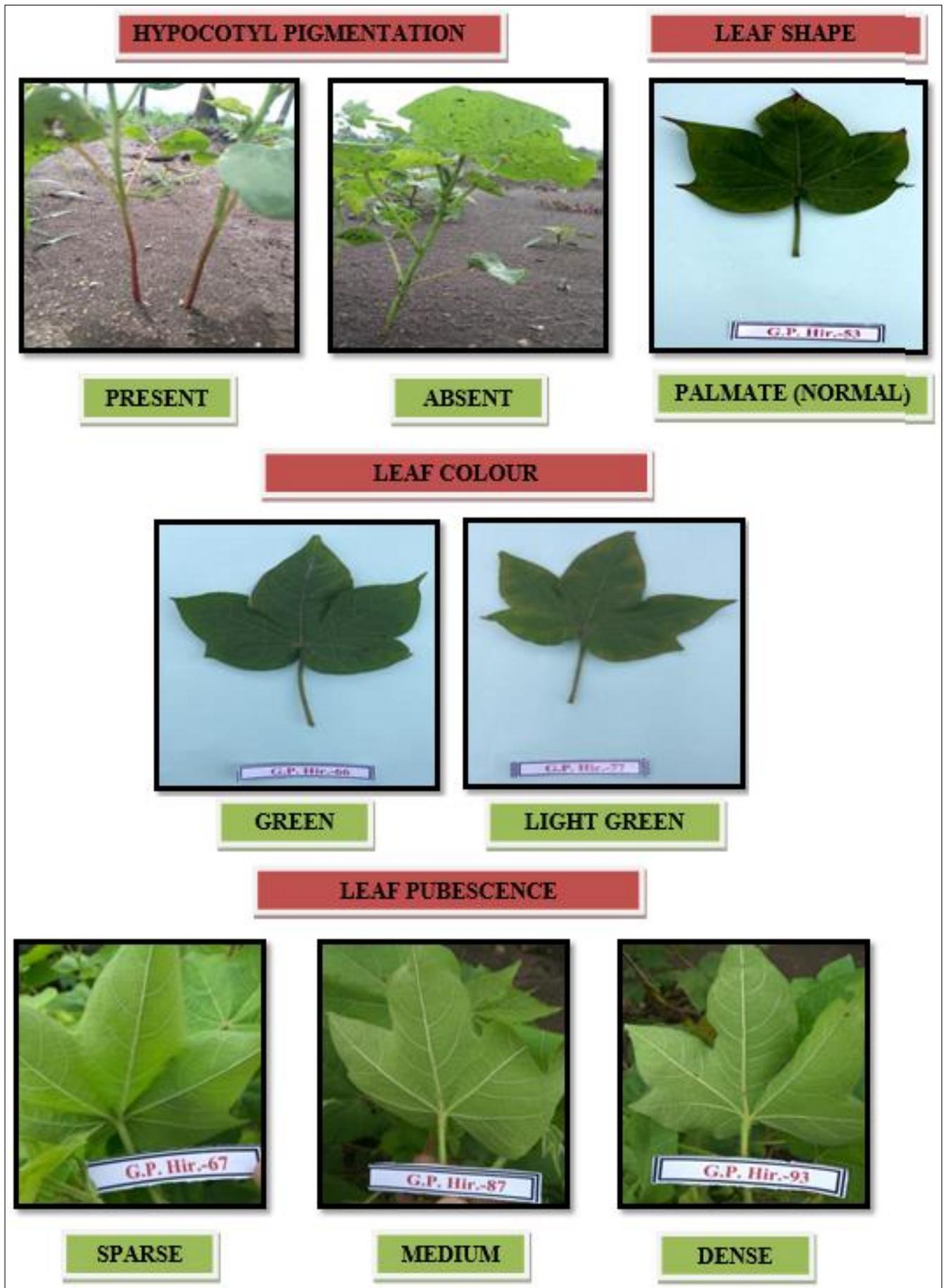


Fig 1: Different qualitative characters of American cotton

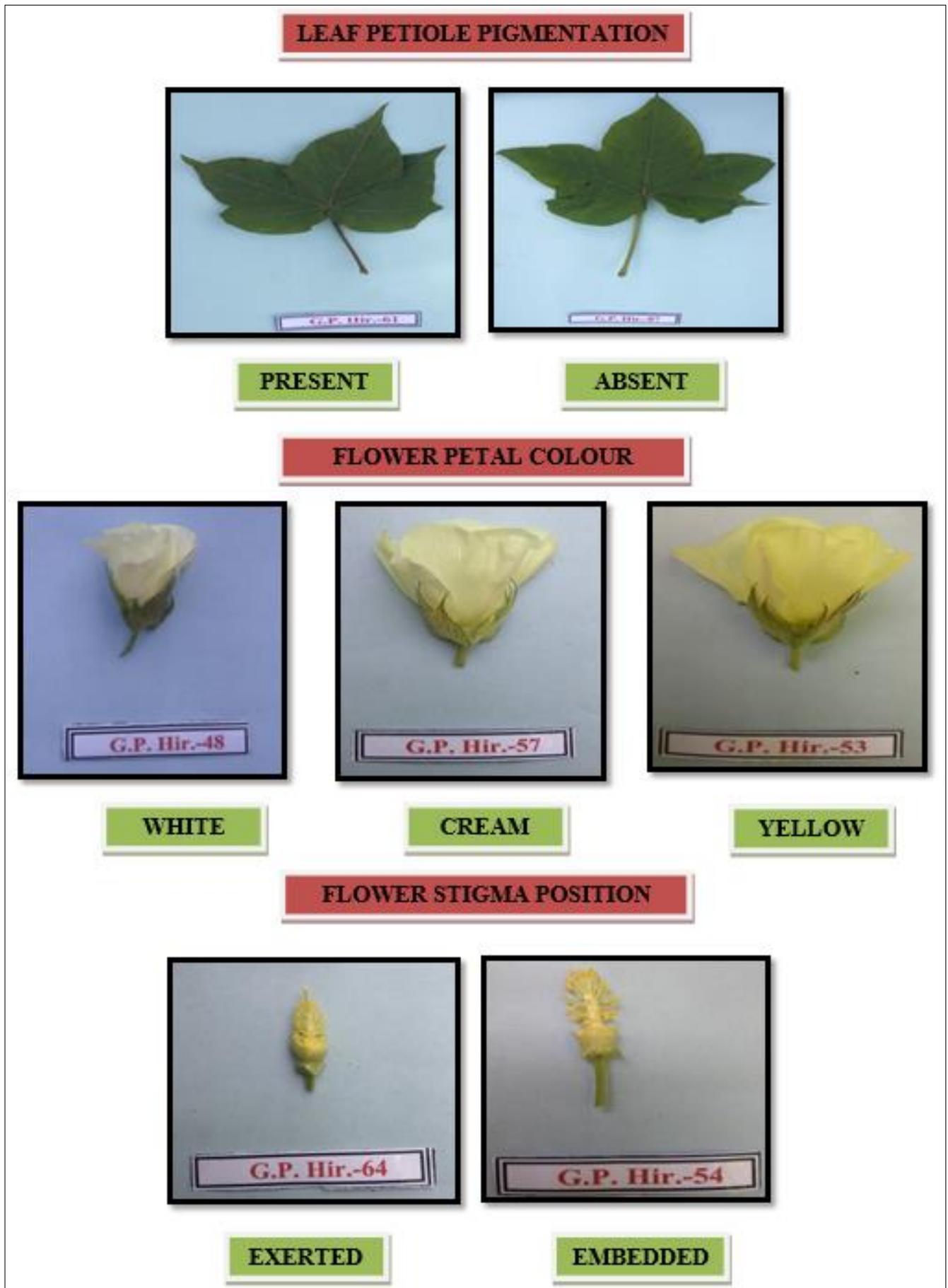


Fig 2: Different morphology characters of American cotton

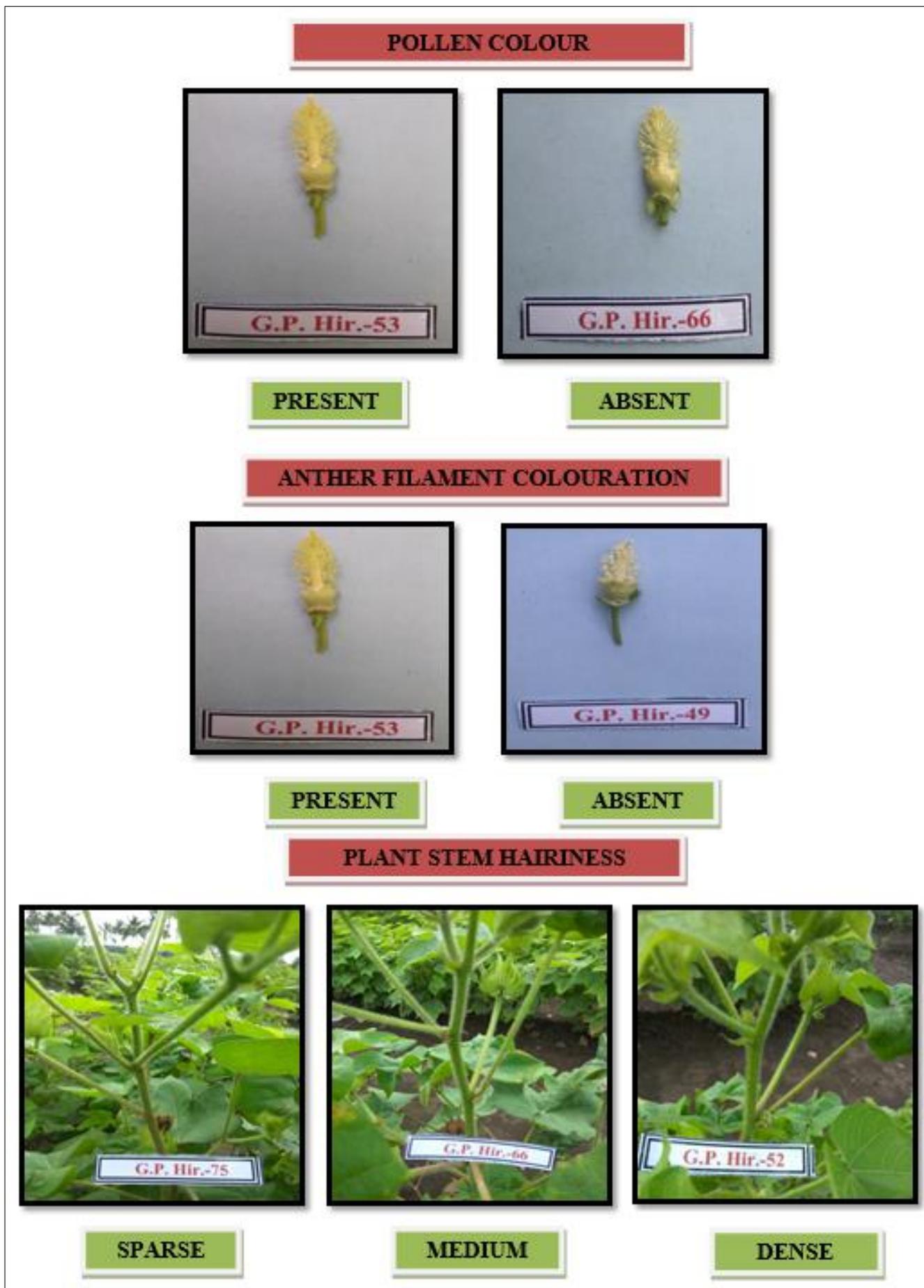


Fig 3: Different morphology characters of American cotton

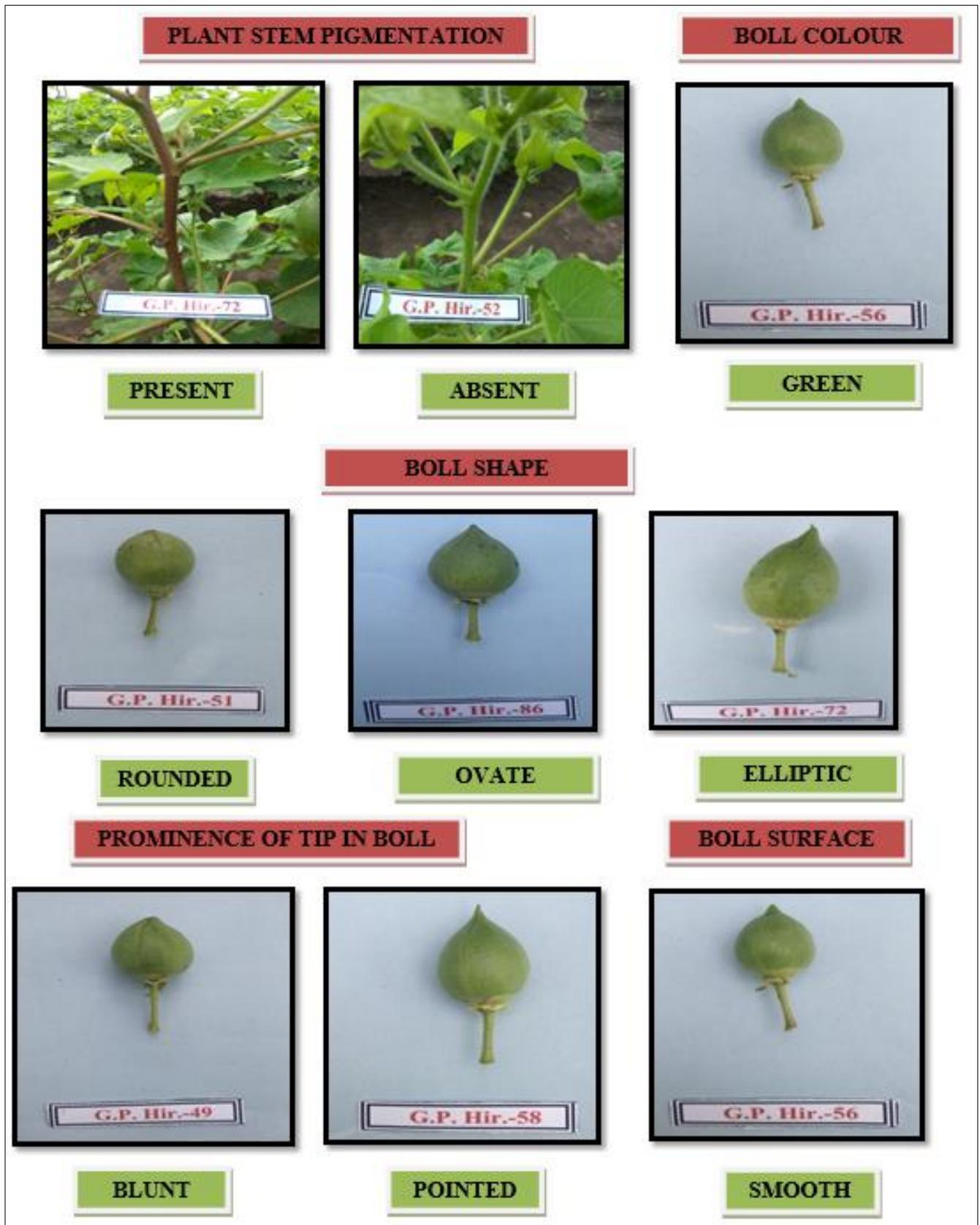


Fig 4: Different morphology characters of American cotton

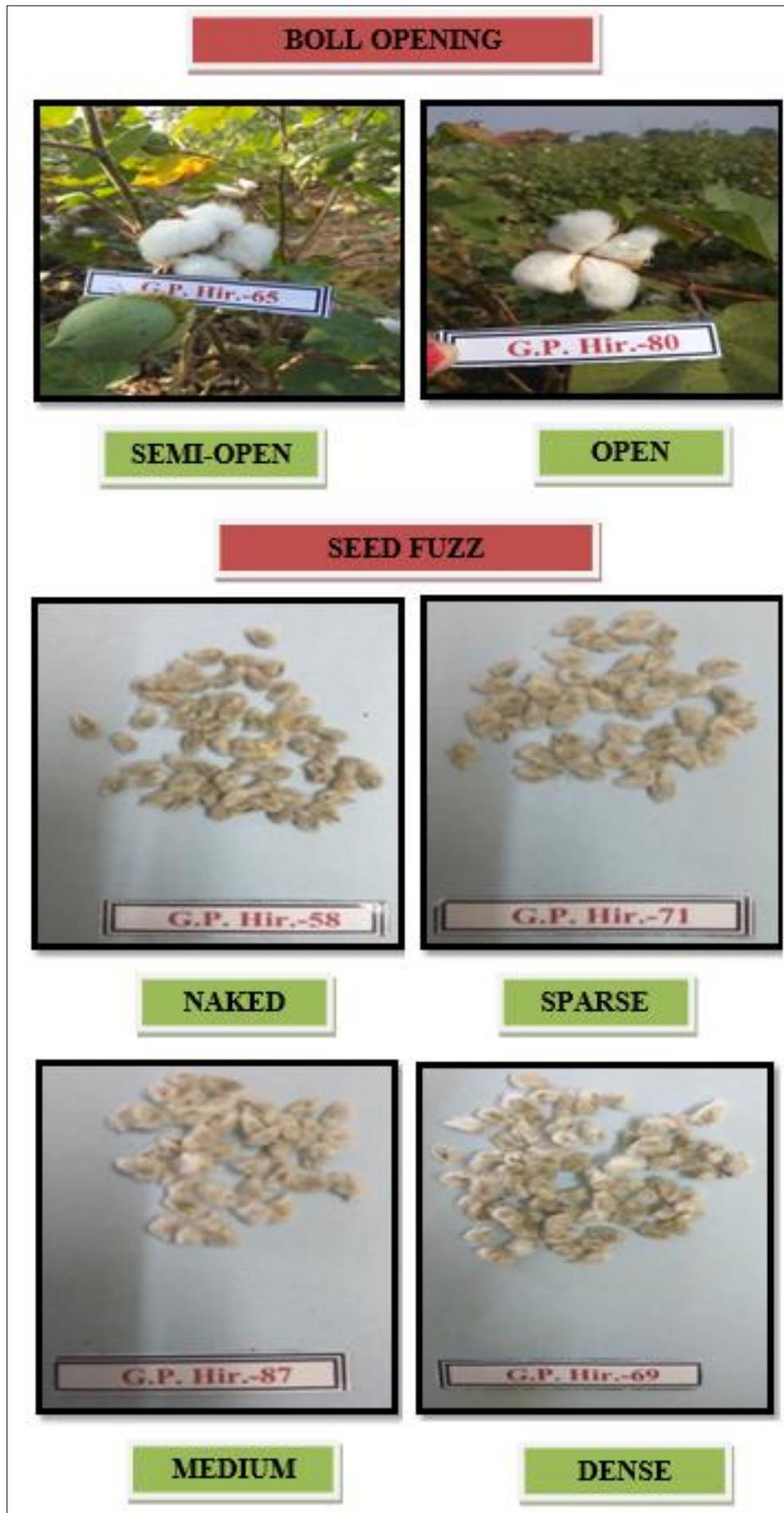


Fig 5: Different morphology characters of American cotton



Fig 6: Different morphology characters of American cotton

Fifty genotypes under study boll colour was green (Rai *et al.*, 2016 and Anjani *et al.*, 2018) ^[10, 11]. Boll shape (longitudinal section) categorized as round, ovate and elliptic, six genotypes (GP Hir.-49, GP Hir.-51, GP Hir.-53, GP Hir.-69, GP Hir.-82 and GP Hir.-92) had rounded boll shape, 31 genotypes with ovate boll shape and 13 genotypes had elliptic boll shape (Manivannan *et al.*, 2018 and Nimbal *et al.*, 2019) ^[7, 8]. Fifty genotypes under study boll surface was smooth (Rai *et al.*, 2016 and Anjani *et al.*, 2018) ^[10, 11]. Thirty seven genotypes had blunt boll tip and rest 13 genotypes had pointed boll tip (Anjani *et al.*, 2018 and Nimbal *et al.*, 2019) ^[1, 8]. Twenty six genotypes had open type of boll opening and remaining 24 genotypes were in semi-open category (Shakeel *et al.*, 2008 and Rai *et al.*, 2016) ^[14, 10]. The quantum of the fuzzy nature of the seed was used as criteria to distinguish the cotton genotypes and the genotypes were categorized as naked, sparse, medium and dense. Ten genotypes had seed fuzz naked, 23 genotypes with sparse seed fuzz, 13 genotypes with medium seed fuzz and 4 genotypes (GP Hir.-57, GP Hir.-69, GP Hir.-76 and GP Hir.-82) with dense seed fuzz (Rai *et al.*, 2016) ^[10].

Conclusion

In conclusion, morphological characters *viz.*, hypocotyl pigmentation, leaf shape, leaf colour, leaf pubescence, leaf

petiole pigmentation, flower petal colour, flower stigma position, pollen colour, anther filament colouration, plant stem hairiness, plant stem pigmentation, growth habit, plant height, boll colour, boll shape, boll surface, prominence of tip in boll, boll opening and seed fuzz are important markers to varietal identification and genuineness of variety in American cotton. They are very important during the development, maintenance and multiplication of new varieties, parental lines and hybrids. Hence, from of breeder point of view, study of qualitative characters is very useful to differentiate to various hybrids and their parental lines.

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