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Characterization of Accessions and Identification of Potential Markers for Yield in Cotton

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ABSTRACT: The present study was carried out to characterize 5882 accession of *Gossypium hirsutum* and 650 of *G. arboreum* under different evaluation programme on the basis of thirty three morphological characters and the accession for marker trait of the interest were screened. Ninety one accession of *G. hirsutum* with various marker characters such as red leaves, okra leave, red petal, spotted petal, cluster boll bearing habits, elliptic bolls, dwarf and compact height, khaki cotton, naked seed and fourteen accession of *G. arboreum* with character of spotted petal were identified. The superior accessions for yield among each group were also identified for utilization in cotton improvement programme.

Keywords: Cotton, *Gossypium hirsutum*, *Gossypium arboreum*, Germplasm, Accessions, Morphological characters, Yield markers

The cotton is the most important fibre crop playing a key role in the economic and social affairs of India. It provides raw material for textile manufacturing, surgical industry, edible oil, cattle feed, particle board, composting, and other uses. In North Zone, the traditional varieties are replaced by high yielding Bt cotton hybrids of reduced genetic base and leading to increased genetic vulnerability for various disease and pest and lost tolerance to abiotic factors. Several researchers confirmed narrowness among cultivars in India and Pakistan through molecular techniques [1, 2]. There is an urgent need to broaden the genetic base of cotton cultivars by introgression of genes from available diverse sources of germplasm. Establishing the identity of germplasm accessions is essential for this purpose under specific environmental conditions. The allelic variations among germplasm are important for use to develop new combinations [3]. Thus, the genetic variation based upon morphological attributes has been exploited in cotton germplasm and the lines with marker characters were identified for future breeding programme.

MATERIALS AND METHODS

The 5882 of *G. hirsutum* and 650 of G arboreum geographically and phenotypically diverse genotypes from gene pool were evaluated during the period from 2011-2014 under north zone condition. The large number of accessions were evaluated in parts during the period. These genotypes were raised in single row at 67.5 cm between the row and 30 cm between the plants at CICR Regional station Sirsa. The recommended agronomic and plant protection measures were followed to raise the crop. Data on important morphological characteristics were recorded under field condition at different stages of crop growth as per National DUS test guidelines descriptors for cotton. The data on presence of pigmentation, flower characters, bract characters and leaf characters were recorded at peak flowering stage. The data on the plant height, growth habit, fuzz characters, lint characters and seed characters were recorded at picking stage. The data on quantitative traits *i.e.* boll weight, boll number/plant, yield/plant were recorded in two replication of five plant each from the population and were analyzed statistically [4].

RESULTS AND DISCUSSION

Wide variations for each trait in the accessions included in the study were observed for each trait (Table 1 & Plate 1). The range for boll weight (1.36-3.6g), boll number (3.0-50) and yield per plant (4.0-185.3g) in *G hirsutum*. In the germplasm, some of the accessions were observed with unique characteristics which are of

Table 1. Cotton accessions with various morphological markers and their per plant yield

	Accessions	Petal Colour	Pollen Colour	Leaf Colour	Boll weight (g)	Boll number	Yield/ Plant (g)
Red leaves	IC – 356853	Cream	Cream	Green	3.0	19	57.0
	IC – 357214	Cream	Cream	Green	3.0	7	21.0
	IC – 357694 CC	Cream	Cream	Green	2.9	10	28.9
	IC – 357792	Cream	Cream	Green	2.0	21	39.0
	IC-358532	Cream	Yellow	Green	2.0	20	40.0
	EC-431889	Cream	Cream	Green	2.8	25	69.0
	EC-431853	Cream	Cream	Green	2.7	30	30.7
	IC-431167	Cream	Cream	Green	2.2	11	24.2
	IC-431168	Cream	Cream	Green	3.0	27	71.0
	IC-359745	Red	Cream	Green	2.7	17	53.0
	EC 431335	Red	Cream	Green	2.9	20	51.8
	EC-431939	Cream	Cream	Green	2.8	15	28.7
Okra leave	EC-343834	Cream	Cream	Green	3.1	26	72.2
	EC-343982	Cream	Cream	Green	3.1	25	78.1
	IC-431309	Cream	Cream	Green	2.8	41	117.7
	IC-431310	Yellow	Yellow	Green	3.0	39	118.2
	IC-431073	Yellow	Cream	Green	2.5	38	94.1
	IC-431287	Yellow	Cream	Green	2.9	20	60.3
	IC-431190	Cream	Cream	Green	2.4	32	76.5
Red Petal Pollen yellow	EC-343644	Red	Yellow	Red	2.3	5	8.0
	EC-344026	Red	Yellow	Red	2.1	11	22.0
	IC – 358997	Red	Yellow	Red	2.8	8	22.4
	EC-344511	Red	Yellow	Red	2.3	3	6.9
	IC – 358991	Red	Yellow	Red	2.9	4	11.7
	IC – 358998	Red	Yellow	Red	3.2	4	12.8
	IC 359393	Red	Yellow	Red	2.0	6	1.8
	IC – 356959	Red	Yellow	Red	2.2	12	24.6
	EC 431335	Red	cream	Red	2.9	16	51.8
	EC 431395	Red	Yellow	Red	3.1	20	64.6
	EC 431800	Red	cream	Red	2.7	10	25.0
	EC 431839	Red	cream	Red	2.6	16	41.0
	EC 431940	Red	cream	Red	2.9	25	63.0
Spotted petal	IC – 359690	Red	Cream	Green	2.4	8	19.2
	AKH -8649	Red	Cream	Green	3.1	63	185.3
	IC – 359952	Red	Yellow	Green	3.3	34	112.2
	ZGG- 7	Red	Cream	Green	2.7	29	77.7
	Br 02 -353	Red	Cream	Green	2.4	26	47.4
	SGNR – 24	Red	Cream	Green	2.4	35	44.3
	SA -170	Red	Cream	Green	2.4	9	21.6
	SA -497	Red	Cream	Green	3.0	8	23.7
	SA -17	Red	Cream	Green	2.4	15	36.0
	VC – 8	Red	Cream	Green	2.3	2	4.0
	VC – 9	Red	Cream	Green	2.3	4	6.0
	ICMF – 31	Red	Yellow	Green	2.7	17	46.4
	N-57	Cream	Cream	Green	3.6	15	2.4
Cluster boll bearing habits	IC – 359727	Yellow	Yellow	Green	3.2	11	2.9
	IC358249	Cream	Cream	Green	2.5	23	50.0
	IC 357011	Cream	Cream	Green	2.0	30	65.0
	EC 138340	Cream	Cream	Green	3.5	18	70.0
	EC 357540	Cream	Cream	Green	2.5	16	36.0

	Accessions	Petal Colour	Pollen Colour	Leaf Colour	Boll weight (g)	Boll number	Yield/ Plant (g)
	EC 359062	Yellow	Yellow	Green	3.2	10	45.0
	EC 358358	Cream	Cream	Green	1.6	19	34.0
	EC 356657	Yellow	Yellow	Green	3.4	22	80.0
	EC 357298	Yellow	Cream	Green	2.3	18	47.0
	EC 359098	Yellow	Cream	Green	2.9	20	45.0
	EC 142762	Cream	Cream	Green	3.4	10	45.0
	EC 152280	Cream	Cream	Green	2.5	16	50.0
	IC 358789	Cream	Yellow	Green	2.0	7	16.0
	AV-3670 LYCH	Yellow	Cream	Green	1.5	17	41.0
Accession with elliptic bolls	IC356900	Yellow	Yellow	Green	2.7	13	37.0
	IC358215	Yellow	Cream	Green	2.9	32	115.0
	EC128334	Cream	Cream	Green	1.8	22	45.0
	IC 357011	Cream	Cream	Green	2.0	30	65.0
	CAT 2803	Cream	Yellow	Green	2.6	15	35.0
	EC 137596	Cream	Yellow	Green	3.1	16	48.0
	EC 142770	Cream	Cream	Green	3.4	22	60.0
	EC 128334	Cream	Cream	Green	2.6	27	75.0
	EC 358371	Cream	Yellow	Green	2.3	23	55.0
	EC 359088	Yellow	Cream	Green	2.7	22	55.0
	EC 359098	Yellow	Cream	Green	2.9	20	45.0
	EC 357008	Yellow	Cream	Green	3.0	31	100.0
	EC 357554	Yellow	Cream	Green	2.5	16	36.0
	EC 358449	Cream	Cream	Green	2.9	18	40.0
Early maturity, dwarf & compact	IC – 356642	Cream	Cream	Green	3.5	27	94.5
	CPD -425	Cream	Cream	Green	3.1	30	93.6
	IC – 359371	Cream	Cream	Green	3.0	30	90.0
	EC-344656	Cream	Yellow	Green	3.0	8	24.0
	EC-344304	Cream	Cream	Green	3.2	31	115.6
	IC-356713	Cream	Cream	Green	2.5	10	28.0
	L-604	Cream	Cream	Green	2.5	6	18.0
	BMK-136	Cream	Cream	Green	2.5	6	18.0
Khaki Cotton	IC – 357091	Cream	Cream	Brown	3.0	14	41.4
	IC–357754	Cream	Cream	Brown	2.0	7	11.9
	IC-358405	Cream	Cream	Brown	1.5	5	7.3
	IC – 359501	Cream	Cream	Brown	2.0	27	48.6
Naked Seed	SA -13	Cream	Cream	Green	3.1	16	49.3
	SA - 1135	Cream	Cream	Green	2.5	27	67.5
	SA -68	Cream	Cream	Green	2.5	10	23.0
	SA -17	Cream	Cream	Green	2.4	15	36.0
	SA 12N	Cream	Cream	Green	2.9	24	69.8
	SA 303	Cream	Cream	Green	3.2	28	89.9
Range					1.36-3.6	3.0-50	4.0-185.3
Grand Mean					2.7	18.8	48.4
CD (p=0.05)					0.043	0.69	1.93

significant importance for breeding programme. The variation in leaf characters such as leaf shape, leaf colour was observed in germplasm accessions included in study. Most of the accessions were with normal green color leaf, however, only 12 accessions were observed with red colour leaf. These accessions noticed significantly superior for boll weight, boll number and yield per plant. However, for boll weight the accession IC 356853 (3.0 gm), IC 357214 (3.0 gm); for boll number per plant IC 431853 (30), IC 431168 (27) and for yield per

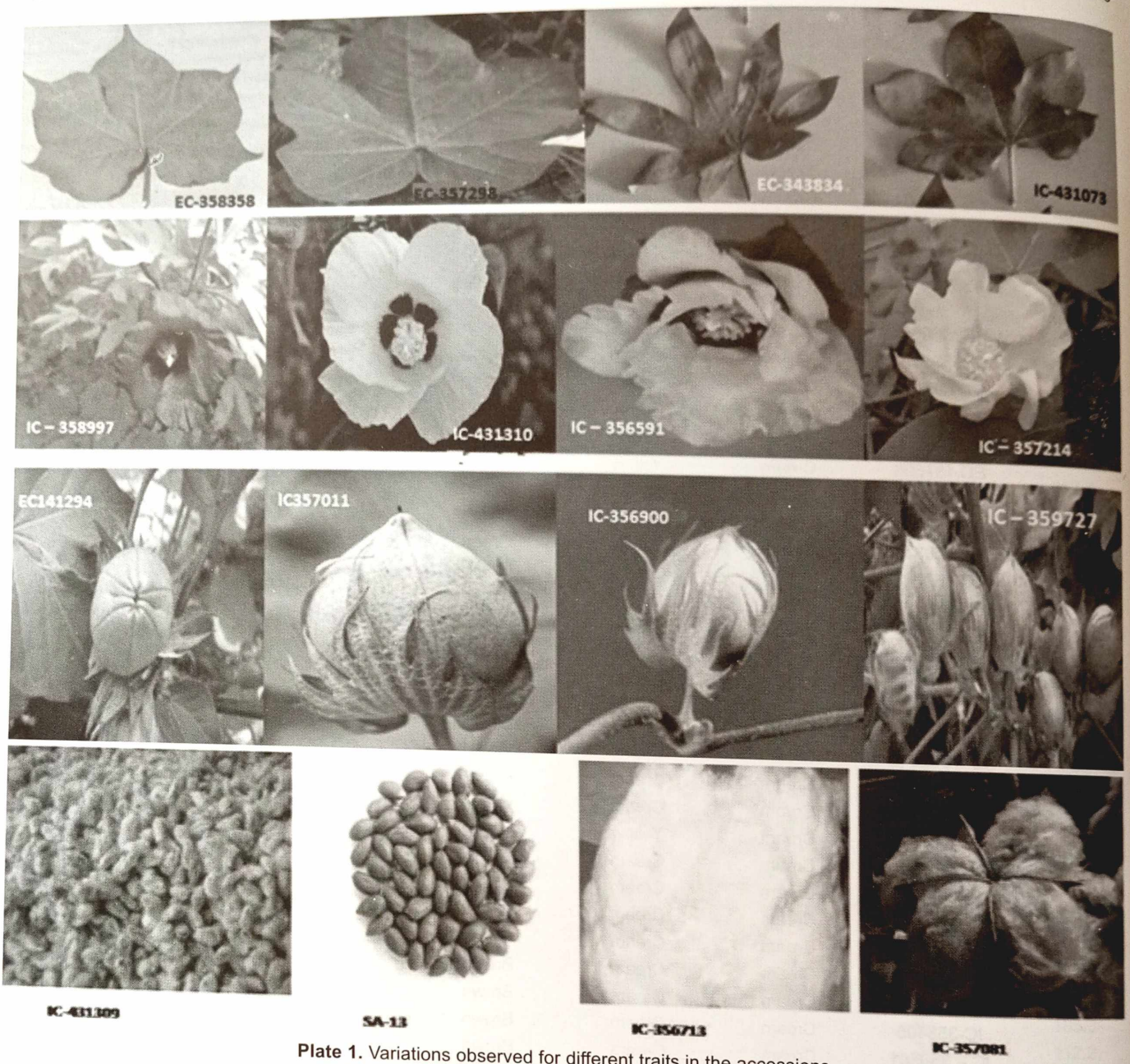

Plate 1. Variations observed for different traits in the accessions

plant IC-431168 (71 g), EC-431889 (69 g) were observed superior. These are useful accession for marker based research programme. The beneficial contribution of okra leaf cultivars is well established. In a study from Pakistan, the traits like okra leaf type, trichomes and gossypol glands confer significant resistance against some of the major insect pests including the sucking and chewing insect complex [5]. The presence of these traits make okra-leaf type cotton genotypes potentially tolerant to drought, resistance against insect pests and competitive to the normal-leaf types in yield and fibre quality. In the entire germplasm evaluated, 7 accessions were observed for this trait and possess the significantly superior boll weight, boll number per plant and yield per plant. Among these, the superior observed for boll weight were EC 343834 (3.1 gm), EC 343982 (3.1 g); for boll number per plant EC 431309(41), IC 431310 (39); for yield per plant EC 431310 (118.2g), IC 431309 (117.7 g). Among the 7 identified accessions, the accessions EC 431073, EC 431287, IC 431310 also possessed the yellow petal characteristics and are the useful source for breeding programme.

The diversity of flower color is one of the most beautiful gifts of nature which attract the pollinators and also an

important tool for the genetic and taxonomic study of cotton. The earlier studies indicated that the flower color is associated with the flavonoid synthesis which is a kind of biologically-active chemical showing insect resistance and antibacterial properties [6]. In the large number of germplasm evaluated under the study, wide variation for flower characters such as sepal pigmentation, flower petal colour, flower petal spotting, position of stigma, filament coloration, anther colour was observed. Most of the accessions were of cream petal and cream pollen however, thirteen accessions were observed with red petal and yellow pollen. The boll weight, boll number and yield per plant in these accessions were also observed significantly superior. The superior accessions among these were IC 358998 (3.2g), IC 431395 (3.1g) for boll weight; EC 431940 (25), EC 431395 (20) for boll number per plant; EC 431395 (64.6g), EC 431940 (63.0g) for yield per plant.

The spotted petal is a prominent and unique marker trait for breeding importance. The petals of most of the accession of the study were without any spot however the 13 accessions observed with unique marker trait of red spot on inner surface of the petals (Table 2). The boll weight, boll number and yield per plant in these accessions also observed significantly superior. Along the spotted petal, the accessions observed superior for boll weight, boll number and yield per plant were IC 359952 (3.3g, 34 and 112.3g), AKH 8649 (3.1g, 63,185.3g). The importance of the trait in marker based research programmes was also reported by several researchers [7].

The boll bearing habit is a genetic trait for genotype characterization. Most of the accessions observed with solitary boll bearing habit except 14 accessions which possess cluster boll bearing habit. Along with cluster bearing, IC 359727 accession also observed with unique characters of zero monopodia, short sympodia with 1-2 node and height more than 4.5 feet and are the useful as source for the trait to incorporate through breeding techniques to increase the yield of cultivars from vertical growth under high density plant population. The cultivars CNH CB 211 with similar properties also identified through earlier studies [8]. All the accessions identified for this trait were observed significantly superior for boll weight, boll number and yield per plant among the study material. The superior for boll weight EC 138340 (3.5g), EC 356657 (3.4g), EC 142762 (3.4g); for boll number per plant IC 357011 (30), IC 358249 (23); for yield per plant EC 356657 (80g), EC 138340 (70g). The boll shape is also an important trait for cultivar identification. In most of the accessions, the shape was round except elliptic boll character in 14 accessions (Table 1). Among these, for boll weight EC 142770 (3.4g), EC 137596 (3.1g); boll number IC 358215 (32), EC 357008 (31); yield per plant IC 358215 (115g), EC 357008 (100g) were observed superior.

Table 2. *G. arboreum* accessions with spotted petal and their yield

Accession Name	Plant Body	Pollen Colour	Boll Wt. (g)	Boll/ plant	Yield/ plant (g)
IC-432364	Red	Yellow	2.1	22.0	42.9
IC-432389	Red	Yellow	2.5	16.1	32.7
IC-432404	Red	Yellow	2.6	21.0	59.1
IC-432463	Red	Yellow	3.0	33.1	48.6
IC-432489	Red	Yellow	2.0	49.0	101.6
IC-432483	Red	Yellow	2.1	40.0	84.0
IC-422491	Red	Yellow	2.4	33.7	56.7
IC-432373	Green	Yellow	2.2	20.0	34.5
IC-432424	Green	Yellow	2.6	42.0	82.3
IC-432428	Green	Yellow	2.4	27.5	65.5
IC-432328	Green	Yellow	2.0	20.7	15.0
IC-432489	Green	Yellow	2.6	39.5	42.5
30816	Medium	Green	2.5	28.9	73.3
IC-432448	Medium	Green	2.5	21.5	53.8
Range			2.0-3.0	20.0-49.0	15.0-101.6
Grand Mean			2.3	30.1	57.1
CD (p=0.05)			0.043	6.86	11.0

The early crop maturity decreases the period of crop susceptibility to yield loss by insects, reduces insect control costs and lowers selection pressure for insecticide resistance development. The 25–30% increase in cotton yield by manipulation of plant density and crop geometry over recommended spacing on shallow to medium deep soils under rainfed conditions was also reported by [9]. Among the evaluated germplasm, eight accessions are observed with early maturity of 120 days and were dwarf in nature with height 1-1.5 ft. Among them the accession for boll weight IC 356642 (3.5g), EC 344304 (3.2g); for boll number IC 359371 (30), CPD 425 (30); for yield/ plant EC 344304 (115.6g) IC 356642 (94.5g), CPD 425 (93.6g) were observed superior (Table 1).

The natural trend among the consumers and environment conscious people created a demand of textile products manufactured from naturally colored cottons. Compared with white fibre cotton, the naturally colored cotton needs no dyeing steps during the fabric manufacturing process, hence dyeing costs can be saved. By elimination of dyeing process the water and soil pollution caused by disposal of toxic dye waste can be avoided. The presence of flavonoids in natural colored fibre also provides protection from ultraviolet light and microorganisms. Because of these properties it has become an environment friendly option [10, 11]. Among the 5882 germplasm line evaluated under the study, the lint of most of the accessions was white except four accessions; IC 357091, IC 357754 Brown, IC 358405, and IC 359501 in which brown lint property was observed. The accession observed superior for boll weight were IC 357091 (3g), IC 357754 (2g), IC 359501 (2g); for boll number IC 359501 (27), IC 357091 (14); for yield per plant IC 359501 (48.6g), IC 357091 (41.4 g) (Table 1). These accessions are useful source to utilize for improvement in yield of coloured cotton cultivars for increasing demand.

The commonly cultivated *G. hirsutum* cotton is characterized by dense fuzzy seed coat and requires acid delinting at the time of sowing for easy handling of seeds. However, the nakedness of seed appears useful tool in improving ginning efficiency and to eliminate the delinting process. It was also reported that the naked seed lowers cotton processing costs by reducing the formation of fuzz, reduced seed coat neps, improved yarn quality by reduced short fiber content, reduce the energy and time for cotton ginning and oil extraction and will eliminate the need to acid-delinting prior to planting [12]. The naked seed serve as a useful marker character also. In spite of useful characters, the geneticists and producers did not favour this trait because of lower lint percentages. Among the germplasm accessions evaluated, most of accessions are with fuzzy seed however six accessions i.e. SA 13, SA 1135, SA 68, SA 17, SA 12 N and SA 303 were observed with naked seed which can be use a source for incorporate the character in cultivars. The accessions SA 303 (3.2g), SA 13 (3.1g) for boll weight; SA 303 (28), SA 1135 (27) for boll number per plant; SA 303 (89g), SA 12N (69.8g) were observed superior.

The range for boll weight (2.0-3.0g), boll number (20-49) and yield per plant (15-101.6g) in *G. arboreum*. The desi cotton (*G. arboreum*) having very high yield potential along with resistance to biotic and abiotic stresses. In arboreum also most of they were without any spot on petal however the 14 accessions observed with unique marker trait of red spot on inner surface of the petals (Table 2). The boll weight, boll number and yield per plant in these accessions also observed significantly superior. The superior accession for boll weight IC 432463 (3.0g), IC 432424 (2.6g); for boll number per plant IC 432489 (49), IC 432424 (42); yield per plant IC 432489 (101.6g), IC 432483 (84g) were observed. In *G. arboreum* cotton, these accessions are useful for marker based studies.

REFERENCES

1. CHAUDHARY L, A SINDHU, M KUMAR, R KUMAR AND M SAINI (2010). Estimation of genetic divergence among some cotton varieties by RAPD analysis. *Journal of Plant Breeding and Crop Science*, **2**(3): 39-43.
2. DONGRE AB, MP RAUT, MR BHANDARKAR AND KJ MESHRAM (2011). Identification and genetic purity testing of cotton F_1 hybrid using molecular markers. *Indian Journal of Biotechnology*, **10**: 301-306.
3. MALIK WAQAS, ASIF ALI KHAN, HAFIZA MASOOMA NASEER CHEEMA, USMAN ASLAM, MUHAMMAD ZAFFER IQBAL, ABDUL QAYYUM, AZRA YASMEEN AND NOREEN BIBI (2015). Transcriptome Analysis of Pigment Related Genes in Colored Cotton. *International Journal of Agriculture and Biology*, **17**(1): 205-210.
4. SHEORAN OP, DS TONK, LS KAUSHIK, RC HASIJA AND RS PANNU (1998). Statistical Software Package for Agricultural Research Workers. In: Hooda, D.S., Hasija, R.C., (Eds.), Recent Advances in information theory, Statistics and Computer Applications. *Department of Mathematics Statistics, CCS HAU, Hisar, India*, pp: 139-143.
5. NAWAB NN, A MEHMOOD, G JEELANI, M FAROOQ AND TN KHAN (2014). Inheritance of okra leaf type, gossypol glands and trichomes in cotton. *The Journal of Animal and Plant Sciences*, **24**(2): 526-533.

6. TAN J, M WANG, L TU, Y NIE AND Y LIN (2013). The flavonoid pathway regulates the petal colors of cotton flower. *Plos One*, **8**(8): e72364.

7. SANGEETA I, NK BIRADARPATIL, RR HANCHINALR, R HANCHINAL, BS VYAKARANAHAL, BS JANAGOUDAR AND IS KATAGERI (2012). Characterization of cotton hybrid DCH-32 and its parental lines based on morphological characters. *Karnataka Journal of Agricultural Sciences*, **25**(4): 531-534.

8. PUNIT M, G VINITA, BR RODE, KR KRANTI, M SARAVANAN AND K ANJALI (2016). CNH CB 212 (IC0597398; INGR 14059), a Cotton (*Gossypium hirsutum*) Germplasm with Cluster Boll Bearing Habit, Zero Monopodia and Compact Habit. *Indian Journal of Plant Genetic Resources*, **28**(3): 370.

9. VENUGOPALAN MV, KR KRANTHI, D BLAISE, LAKDE SHUBHANG AND K SANKARANARAYANA (2014). High density planting system in cotton -The Brazil experience and Indian initiatives. *Cotton Research Journal*, **5**(2): 1-7.

10. HONGJIE FENG, LI YANJUN, WANG SHAOFANG, ZHANG LIANGLIANG, LIU YONGCHUANG, XUE FEI, SUN YUQIANG, WANG YONGMEI AND SUN JIE (2014). Molecular analysis of proanthocyanidins related to pigmentation in brown cotton fibre (*Gossypium hirsutum* L.). *Journal of Experimental Botany*, **65**(20): 5759-5769.

11. SEN-HE QIANA, HONGA LIANG, XUA MIAO, CAIA YONG-PING, LINA YI, GAOA JUN-SHAN (2015). Cellulose synthesis in coloured cotton. *Science Asia*, **41**: 180-186.

12. BECHERE E, BOYKIN CLIF J, AND WR MEREDITH (2011). Evaluation of cotton genotypes for ginning energy and ginning rate. *The Journal of Cotton Science*, **15**: 11-21.