RESEARCH NOTE

Comparative characteristics and gene action in three petal-spotted mutants of *Gossypium hirsutum*

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Introduction

Of the four *Gossypium* species under commercial cultivation in India, *G. hirsutum* (upland cotton) occupies around 70% of the area as straight varieties and intra-*hirsutum* hybrids. Even if a variety was developed through hybridization between cultivars having a narrow genetic base, identification becomes difficult unless the new genotype has a marker gene. Marker genes with prominent morphological differences are not easily available and often have undesirable effects. Breeding for induction of a prominent morphological character, or to avoid the undesirable effect of a marker gene, is not recommended because of the time involved in this process. Nevertheless, for purposes of maintaining purity of a new variety in the seed production process, prominent morphological differences among varieties have to be found. Morphological features are indicative of the genetic makeup of the plant, and it is usually not difficult for breeders to identify their own varieties even with minor differences from other varieties. Seed production systems all over the world are still based on visual differences. Off types — deviations from the variety norm — are eliminated, and it is assumed that the rest of the population is pure (ICAC 1996). Morphological mutants of *G. hirsutum* have been extensively used in genetic mapping studies and varietal identification, and in several instances have proven useful in agronomic improvement efforts. For developing high-yielding, high fibre quality varieties with marker characteristics of *G. hirsutum* cotton, it is also essential to study the gene action of these traits.

G. hirsutum typically lacks a petal spot. Petal-spotted spontaneous mutants of the species were identified from the populations of three genotypes, CSH-2501, AKH-0308 and AKH-9618. These mutants resemble the respective parent genotypes for majority of the morphological traits but possess, in addition to the marker character, some desirable morphological and fibre technological characters. Therefore, it is possible that the mutant strains have developed as a result of mutations in the gene or genes that control not only formation of pigmentation but also some other traits. Here we report on preliminary genetic characterization of these petal-spot mutants in *G. hirsutum*.

Materials and methods

Cultivated upland cotton lacks a petal spot but such spots are not uncommon in the so-called primitive cottons or race stocks (Fryxell 1984). The five petals of *G. hirsutum* have an area of anthocyanin pigmentation at the base, called a petal spot, like Asiatic cotton, *G. arboreum*. This character is an identified marker and can be used by breeders and seed producers. Germplasm lines of CSH-2501, AKH-0308 and AKH-9618 were grown at Central Institute for Cotton Research (CICR), Regional Station, Sirsa, India, in the kharif season of 2003. Populations of 45, 58 and 63 plants, respectively, of these strains were raised. One plant in each of the strains was found with slightly round red spots on the inner side of the petals of their flowers, while the other plants did not have any such spots. These variants have been denoted CSH-2501Pet, AKH-0308Pet and AKH-9618Pet. The variants were selfed, and the seeds were sown in off-season in glass house at CICR. No segregation of the petal spot was noticed. The trait therefore propagated true to type and was not influenced by environment. The three variants CSH-2501Pet, AKH-0308Pet and AKH-9618Pet were crossed in 2004 crop season with cultivar RS-2013 which has no petal spot. Observations on presence or absence of petal spot were recorded in F_1 population of three crosses. Dominance or recessiveness for petal spot colour in the F_1 population of each cross was recorded in 2005 crop season at full blooming stage. The crop was raised in four rows in a randomized block design with two replications of each F_1 population.

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Results and discussion

Intensity of anthocyanin pigmentation of the petal-spot mutants increased with growth/age of the flower. The other dissimilar and desirable features of the mutant/variant from the normal parents are that they had higher boll number per plant and boll weight, and comparatively dwarf habit. These traits are responsible for their higher yield. These mutants have higher fibre strength, longer fibre, and many features similar to those of the parent strains (table 1). Since the plants grown were from seeds collected from normal plants, and since petal-spotted plants had more than one character different from normal non-petal-spotted plants, the variants may be considered as spontaneous pleiotropic mutants. Possibly the mutation occurred in the gene or genes that affect not only formation of the pigmented spot on the inner side of the petals but also a few other traits. All F_1 plants in the three crosses were petal-spotted (table 2), indicating complete dominance of the petal-spot trait. Similar information in reciprocal crosses ruled out involvement of cytoplasmic inheritance. To observe the effect of environment on the gene producing pigmented spots, a population of 20 plants from the seeds harvested from the petal-spotted mutant/variant was raised at CICR Regional Station, Coimbatore, India, a location very different from Sirsa. It was observed that none of the plants was dissimilar to its parent. This indicated that the mutant/variant identified is not a resultant of outcrossings or a mixture.

Table 1. Mean (± SE) mrophological and agronomic characteristics of progeny of petal-spotted mutant plants and their parents in *G. hirsutum.*

Character	Parent CSH-2501	Petal-spot mutant of CSH-2501	Parent AKH-0308	Petal-spot mutant of AKH-0308	Parent AKH-9618	Petal-spot mutant of AKH-9618
Plant type	Lanky	Robust	Robust	Bushy	Robust	Bushy
Plant height (cm)	165.7	86.5	113.7	108.3	128.7	142.8
SE	10.85	9.8	10.3	10.3	11.7	21.3
Number of sympodial branches	23	19	23	9	13	18
SE	4.5	3.8	4.2	2.8	1.9	2.6
Number of monopodial branches	2.3	2.3	3.0	6.0	9.0	13.0
SE	0.1	0.1	0.3	1.0	1.3	1.8
Stem hairiness	Hairy	Hairy	Hairy	Hairy	Hairy	Hairy
Stem colour	Purple	Purple	Purple	Purple	Purple	Purple
Internode length (cm)	6.2	6.3	9.2	9.4	9.1	8.7
SE	0.8	0.7	1.0	1.1	1.1	1.3
Leaf size	Medium	Medium	Medium	Medium	Medium	Medium
Leaf shape	Palmate	Palmate	Palmate	Palmate	Palmate	Palmate
Leaf lobing	3-lobed	3-lobed	3-lobed	5-lobed	5-lobed	5-lobed
Nectaries per leaf	1	1	1	1–3	1–3	1–3
Bolls per plant	35.0	65.0	43.0	47.0	88.0	93.0
SE	1.5	1.7	1.8	1.7	2.8	2.3
Boll weight	3.2	3.2	3.4	3.5	3.2	3.4
SE	0.09	0.08	0.05	0.06	0.06	0.05
Boll shape	Round	Round oval	Pointed tip	Round oval	Round	Round pointed tip
Locules per boll	4-5	4-5	4-5	4-5	4-5	4-5
Seeds per locule	6-8	6-7	5-7	5-7	7-8	7-8

Seed cotton yield per plant (g)	105.0	185.0	148.0	164.0	224.0	280.0
SE	10.5	16.3	16.8	18.3	22.1	24.3
Number of sepals	3	3	3	3	3	3
Petal colour	Yellow	Creamy	Creamy	Creamy	Yellow	Yellow
Pollen colour	Creamy	Yellow	Yellow	Yellow	Creamy	Creamy
Petal spot	Absent	Present	Absent	Present	Absent	Present
Fuzz color	White	White	White	White	White	White
2.5% span length (mm)	24.3	25.7	26.7	27.2	27.1	28.2
SE	0.08	0.08	0.05	0.06	0.03	0.05
Fibre strength (g/tex)	19.9	22.9	21.7	23.0	20.0	21.6
SE	0.03	0.02	0.04	0.01	0.01	0.01
Micronaire value (MV)	5.5	5.4	4.2	3.4	4.6	4.4
Uniformity ratio	48	49	44	47	44	46

Table 2. Mean (±SE) agronomic characteristics of petal-spotted mutant plants from different sources and their F_1 progeny in *G. hirsutum*.

Character	Petal-spot mutant of CSH-2501	F_1 of RS-2013 × petal-spot mutant of CSH-2501	Petal-spot mutant of AKH-0308	F_1 of RS-2013 × petal-spot mutant of AKH-0308	Petal-spot mutant of AKH-9618	F_1 of RS-2013 × petal-spot mutant of AKH-9618	RS-2013 (commercial cultivar)
Plant height (cm)	108.3	149.7	66.7	133.8	113.3	123.3	122.7
SE	7.3	11.4	6.8	7.5	10.6	10.9	11.6
Number of sympodial branches	20.3	22.7	7.0	11.6	8.3	14.7	19.0
SE	2.3	2.6	0.9	1.3	0.9	1.2	1.2
Number of monopodial branches	1.3	4.0	0.7	2.8	3.0	9.7	8.3
SE	0.06	0.08	0.03	0.05	0.03	1.3	1.2
No.of bolls per plant	34.0	61.3	23.0	69.4	32.7	48.7	45.0
SE	1.5	1.8	1.2	2.1	2.3	3.5	3.8
Boll weight (g)	3.2	3.4	3.4	3.6	3.5	3.7	2.6
SE	0.06	0.03	0.02	0.03	0.02	0.04	0.02
Seed cotton yield per plant (g)	78.1	108.1	100.1	150.0	49.9	95.8	70.8
SE	10.3	11.3	9.8	15.6	7.2	8.6	6.5
Petal spot	Present	Present	Present	Present	Present	Present	Absent

Multiple, and desirable, phenotypic effects of morphological mutants have also been reported earlier in *G. hirsutum*. For example, a spontaneous fuzzless–lintless mutant of cotton variety MCU-5 was used as tester line with 15 other genotypes. The mutant had significantly favourable GCA (general combining ability) effects for seed index, uniformity ratio and maturity of fibres, indicating that the mutation not only affected the major gene for presence of fuzz or lint, but also influenced other yield and fibre characters through pleiotropism (Nadarajan and Rangasamy 1997). Mohod *et al*. (1992) demonstrated the importance of yellow petal / yellow anther length, bundle strength and fibre thickness. Wang and Zhao (1993) bred a new cotton line, Y1-4, with four different genetic marker characters. The line, despite its weak growth, showed profuse boll production and was resistant to *Fusarium* wilt. Mehetre *et al*. (1998) identified a modified branching habit mutant in the M_2 generation of *G. hirsutum* variety RHr-003 after treatment with 15 kR of γ-rays. The mutant plant produced more than one branch at each internode and a large number of bolls which were bigger than in the parent type. Peifu *et al*. (1998) identified a very early upland cotton mutant by γ radiation in M_5 generation. The mutant had average growth period of about 132–147 days, 13 to 18 days shorter than that of the parents. Four plants were selected for outstanding traits. Their fibre length was similar to that of control variety. Boll size was 5.4 g and lint content 37%. Overall, morphological mutants of cotton have been used extensively in genetic mapping studies and in several instances have proven useful in agronomic improvement efforts (Percy 1999; Kohel and Bird 2002). Further studies on the petal-spot mutants/variants reported here should address the genetic basis of this and associated characters to use these genes in breeding programmes.

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