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INHERITANCE OF FREGO BRACT AND ITS LINKAGE WITH FIBRE AND SEED TRAITS IN COTTON

SAJID-UR-RAHMAN[1], TANWIR AHMAD MALIK[*2], M. ASHRAF[3] AND SAMINA MALIK[3]

[1]*Agricultural Biotechnology Research Institute, AARI, Faisalabad*
[2]*Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad*
[3]*Department of Botany, University of Agriculture, Faisalabad*

Abstract

Narrow and twisting flower bract exists in addition to normal broad bract in cotton germplasm which has been named as frego bract. In this bract type, bracteole is reduced; hence do not provide shelter to eggs/nymphs of insects and has been reported to provide resistance against some insect pests like bollworms and boll weevil. Inheritance of this trait was studied by crossing normal and frego bract genotypes. In the F_2 population normal bract and frego bract plants were in the ratio of 3:1 showing monogenic inheritance of the trait, frego bract being recessive. The test cross ratio of 1:1 confirmed the monogenic inheritance. The F_2 population was used to study linkage relationship of frego bract with fibre (staple length, fibre fineness, fibre strength) and seed traits (ginning out turn, seed index and seed volume). There was positive correlation of bract type with fibre strength (normal bract allele and alleles for strong fibre seemed to be on the same chromosome). The absence of correlation of the gene for frego bract with the other traits, shows that it segregates independently in relation to those traits. Hence frego bract type plants may be tailored with good combination of agronomic traits.

Introduction

Some morphological traits have been identified which confer resistance to insect pests in cotton. Incorporation of such traits in the cotton cultivars has been advocated for stable, economic and environment friendly insect resistance in cotton by many researchers (Maxwell & Jennings, 1980; Bhat & Basu, 1984; Bhat & Jaysawal, 1989). These traits include trichomes, okra leaf, nectariless, gossypol glands, frego bract etc. which make cotton plant unattractive to insects for feeding, oviposition, shelter etc. Kogan & Ortman (1978) proposed the term ‘antixenosis’ to describe the plant properties responsible for such non-preferences. Antixenosis signifies that the plant is considered unsuitable or a bad host.

Frego bract is narrow and twisted compared to normal broad bract. Due to less width and reduced bracteole surface, frego bract doesn’t provide shelter to insect’s eggs/nymphs. Frego bracts leave the boll exposed so the eggs/nymphs are vulnerable to environmental vagaries, pesticides and predators. Thomson *et al*. (1987), working on frego bract trait has reported the importance of this trait against *Helicoverpa* tolerance. A cultivar, Sicot-3 having frego bract was developed which yielded better than Deltapine 61 and farmers used one insecticide spray less on Sicot-3 than on Deltapine (Thomson *et al*.,

* Corresponding Author: tanwirm@hotmail.com; msajidrahman@yahoo.com

1987). The resistance conferred by frego-bract character was reported as effective in suppressing boll weevil population and comparison of the fibre properties of frego lines with commercial varieties showed that it would be a useful trait for the development of insect resistant cotton cultivars (Jenkins & Parrott, 1971). A study conducted by Weaver & Reddy (1977) also showed that cotton varieties with combination of frego bract and red plant color could be developed which would be competitive in yield and fibre quality with other commercial varieties.

The literature survey shows that the traits is controlled by single recessive gene (Green, 1955; Maxwell & Jenning, 1980) however, very limited studies are conducted about the trait especially, the effect of frego bract trait on yield and fibre quality so the incorporation of the trait in commercial cultivars has not been seriously undertaken by cotton breeders. The present work was conducted to study the inheritance of the traits and its effects on fibre and seed traits

Materials and Methods

Cotton genotypes, 3722LA-566 (frego bract) and HRVO1 (normal bract) were grown during the normal crop season (May-November) of 2004 in the field. Half of the F_1 seed harvested from the hybrid plants was planted in pots under glasshouse conditions in December, 2004 for making backcrosses and to produce seed of F_2 population. Parental, F_1, F_2 and backcross (BC_1 and BC_2) generations were planted in field during the year 2005. The experiment was sown in a triplicated randomized complete block design. A single row for parental and F_1 generations, 8 rows for each of the backcrosses and 15 for the F_2 generation were planted in a replication. The length of each row was 4 meter. Row to row and plant to plant distance was 75 and 30 cm, respectively. Normal agronomic practices were followed in the experiment. At maturity 5 guarded plants per replication for each of the F_1 and parents, 50 for each of the backcrosses and 100 for the F_2 generation were selected to record the data on individual plant basis.

Staple length, fibre strength and fibre fineness of each sample were measured by using Spinlab HVI-900 in the Department of Fibre Technology, University of Agriculture Faisalabad. Dry samples of seed cotton harvested from individual plants were weighed and ginned separately with a single roller electrical gin in the laboratory. Analytical balance was used to weigh the seed cotton and lint. Ginning out-turn (GOT) was calculated as %age of lint in seed cotton. Seed index for each genotype was obtained by weighing 100 delinted and oven dried (at 45°C) seeds in grams selected at random from the seed of each selected plant. Seed volume was measured by the displacement of water caused by 100 delinted seeds and recorded in ml. Narrow, twisting and long bracts (frego bract) in the bud/flower/boll were scored as 1 and the normal bracts (broad) were scored as 2 (Fig.1).

The segregating ratios of plants in F_2 and test cross generations for the trait were tested for their fitness to a theoretical ratio through chi-square test (Harris, 1912; Malik *et al*., 2007). Phenotypic and genotypic correlation coefficients between pairs of plant traits were also determined using the data of 300 F_2 plants. Phenotypic correlation coefficients were calculated by the formula as outlined by Dewey & Lu (1959) using Minitab computer programme. The genetic correlations (r_g) between two characters were calculated as given by Ehdaie *et al*. (1993).

Fig. 1: Frego bract and normal bract at flower bud stage and complete boll stage in cotton.

Results and Discussion

Inheritance studies: Data of F_2 and test/backcross populations of the cross (HRVO1 × 3722LA-566) was used to study the genetics of this trait. Chi-square test was used to test the difference of expected and observed phenotypic ratios. The results of Chi-Square test are given in the table-1.

Normal bract and frego bract plants were in a ratio of 3:1 in the F_2 population (Table-1) showing monogenic inheritance, frego bract being recessive trait. The test cross ratio of 1:1 confirmed the monogenic inheritance. These findings support the results of earlier work on the genetics of frego bract (Green, 1955, Maxwell & Jennings, 1980; Smith & Cothren, 1999). In the present studies it was observed that in frego bract phenotype there were differences in the size and shape in plants of segregating populations, which suggested that the phenotype might vary in different genetic backgrounds or some modifier genes affect the phenotype. The progenies of single plants selection may be further tested for their genetics. Simple monogeneic inheritance of the traits suggests it may be manipulated easily in a breeding programme.

Table 1: Chi-Squared values and probabilities of goodness of fit of F_2 and Backcross generation phenotypes for frego bract.

Generation	Expected ratio to be tested	Observed value		χ^2 value	P range
		Normal bract	Frego bract		
F_2	3:1	230	70	0.44*	0.75-0.50
Testcross	1:1	86	64	3.22*	0.10-0.05

Table 2: Phenotypic (Lower diagonal) and genetic correlation (Upper diagonal) matrix for the frego bract trait with fibre and seed traits

Parameter	FF*	FS	SL	GOT	SV	SI	Br
Fibre Fineness (FF)		-0.10	-0.24	0.14	0.08	0.09	-0.07
Fibre Strength (FS)	-0.09		0.26	0.09	0.10	0.05	0.16
Staple length (SL)	-0.21**	0.22**		-0.10	-0.03	0.12	0.09
GOT	0.16*	0.07	-0.10		-0.06	-0.15	0.12
Seed Volume (SV)	0.08	0.09	-0.03	-0.06		0.36	-0.01
Seed Index (SW)	0.09	0.05	-0.16*	-0.15*	0.34**		-0.00
Bract Type (Br)	-0.06	0.15*	0.08	0.11	-0.01	-0.00	

* Fibre fineness is measured in micronaire, higher the micronair lesser would be fineness and vice versa

Phenotypic and genetic correlations: The estimates of correlation among traits are useful for planning a breeding programme to synthesize a genotype with desirable traits. The objective of the present study was to find correlation among the frego bract trait and traits related to fibre in cotton. A very large F_2 segregating population (300) involving parents with contrasting traits was used. In F_2 population, alleles of parental traits are recombined so, the correlations among the traits reflect linkage relationships.

Pairwise phenotypic and genetic correlations between frego bract trait and the traits related to fibre and seed (fibre fineness, fibre strength, staple length, GOT, seed index and seed volume) were calculated using the data of F_2 populations. Genetic and phenotypic correlation are given in Table-2. In general, the magnitude of genetic correlations was higher than that of phenotypic correlations, which was expected (Tyagi, 1987). Fibre quality traits like fibre fineness, fibre strength and staple length are important in cotton industry. There are spinning problems if these fibre quality traits are not upto a certain standard (Malik *et al.*, 2006). So the effects of a new trait like frego bract on cotton fibre traits should be studied. Similarly the effect of the trait on seed characteristics should also be studied. Cotton fibre is produced on seeds so the size of seed is important. There is relationship of seed size and the surface area. Smaller seed would have more surface area and more number of seed may be produced in the locks of a boll if the seed size is smaller.

Bract type positively associated with fibre strength. This suggests that normal bract plants produce strong fibre than the frego bract plants. The absence of correlation of the gene for frego bract with the other traits, shows that it was not linked to the genes of those traits. Frego bract trait has been found on chromosome 3 (Endrizzi *et al*., 1984; Smith & Cothren, 1999). So QTLs for fibre strength have also been reported on chromosome 3 (Shen *et al*. 2005, Frelichowski *et al.* 2006) which support the results of present study However, Smith (2001), has been able to develop a frego bract line, which had strong fiber. This shows that negative linkage of frego bract with fibre strength can be broken, so promising frego bract cotton genotypes with improved insect resistance can be tailored.

The mutant frego bract trait has very narrow bracts, which are flared away from bud, flower and boll. It does not provide shelter to the eggs/larvae of bollworms and boll weevil (Bhat & Basu, 1984; Nyambo, 1985; Kadapa, 1988; Jones *et al*., 1989; Surulivelu & Sundaramurthy, 1992; Surulivelu, 1996; Neto *et al*., 2005) as well as help in escaping boll rot disease (Jones & Andries, 1969). However, Singh (2004) reported that frego bract phenotype associated with abnormal leaf shape, shy bearing and low photosynthesis.

Wilson, (1989) and Meredith *et al*. (1996) evaluated the effects of morphological traits on yield and quality and concluded that frego bract traits did not have major negative association and incorporation of the trait in a cultivar was practically feasible and beneficial. Similarly Thomson *et al.* (1987) studied the effect on yield and quality associated with glabrous leaf, frego bract, okra leaf and nectariless genes and concluded that these traits had minor effects on yield and lint quality. Earlier findings corroborate the results of present study, hence it may be suggested that morphological traits like frego bract should be incorporated in the commercial cultivars. The incorporation of morphological characters related to insect resistance would help reduce pesticide load without affecting the desirable genetic combinations.

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