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Short Communication

Utilization of wild species for cotton improvement

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Abstract

The population based on complex crosses involving five diploid and two tetraploid species of *Gossypium*, was utilized following conventional breeding. The autotetraploids of diploid wild species and *G. barbadense* were crossed with *G. hirsutum*. The crosses were carried in bulk up to F_4 in isolated field and practiced onward selection for useful traits converged in the population thereafter for more than ten generations.

Key words: *Gossypium*, cotton, hybrid breeding, wide crosses

Cotton (*Gossypium hirsutum*) breeding had a landmark through Hybrid-4 (H-4) in 1970 (Patel 1981) after which hybrid cotton cultivation became popular in central India giving more than twice the yield compared to the parent varieties such as Gujarat-67 (Paroda 2004). To ease out commercial scale hybrid seed production, genetic male sterility (GMS) and cytoplasmic genetic male sterility (CGMS) played important role (Meshram 2002). Seed cotton yield is a complex trait genetically complemented by other component traits (Mukewar 1986). Long staple varieties have special importance in textile industry. Improvement in staple characters of *Hirsutum* cotton for advanced spinning and weaving industry, using wild relatives of cotton, was a major objective of present investigation. The work was initiated by author in his own field in the year 2001, after his superannuation from the services of Dr Panjabrao Deshmukh Krishi Vidypeeth.

The seed of diploid wild species (*Gossypium anomalum, G. thurberi,* G. *raimondii, G. arboreum and G. herbaceum*) presoaked for 24 hours in water was treated with 0.01 percent Colchicine ($C_{22}H_{25}NO_6$) solution for 12 hrs and sown in field at the spacing of 60x60 cm. The induced allotetraploids were confirmed cytologically. Pollen from the five allotetraploids mixed in a plate and used for pollination of hand emasculated cotton flowers of F_1 PKV Hybrid-3 (cmsAK32A X Dhy286-1R) under controlled conditions. Similarly, crosses were done successfully between F_1 PKV Hybrid 3 (tetraploid *G. hirsutum)* as female with *G. barbadense*. These crosses provided blend of nuclear genes of seven species including cultivated *G. hirsutum and G. barbadense* to form a base population with *G. harknessii* cytoplasm from cmsAK32 to converge useful traits. In each generation from F_2 to F_4, male sterile (ms) plants were identified and used as female parent and were allowed to have natural crossing in isolation with fertile plants of the population. It provided an array of genetic recombination with fertility restorer genes as well as male sterile genes and a blend of gene constellations from the wild species. F_3 to F_5 generations were advanced by 'Single Boll Descend Method'. After F_5, pedigree method of selection was practiced. Agronomic characters and occurrence of sucking pest in seedling stage were monitored in the population by visible observations. The plants absolutely free from the infestation were tagged. They were hardly less than 1 per cent of the initial F_4 population. The hand ginning of each selected plant was performed and ginning out turn was worked out in percentage. Fuzzy verses clean seeded trait was recorded against each plant. The quality characters were screened visibly with main emphasis on fiber length and strength. In F_{12} generation 'Top

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Cross Method' was used to test fertility restoration ability *vis-a-vis* sterility maintainer trait. Table 1

Table 1. Promising commercial characters of clean seeded and fuzzy lines

Line no.	GOT %	Test wt. (g)	Characteristic features
Clean seeded B lines			
CSB 3	32.37	7.50	Big bolls and long fiber with good strengthweight
CSB 4	32.36	9.25	Big bolls and early maturity
CSB 5	31.25	9.50	Big bolls and long fiber with good strength
Clean seeded FR lines			
CSR1	26.19	10.61	Felted leaf, big boll, fine, long and strong fiber
Fuzzy B lines			
FZB 15	40.06	9.00	Fine, long and strong staple
FZB 16	38.46	11.00	Fine, long and strong staple
FZB 17	38.29	6.75	Fine, long and strong staple
FZB 18	37.70	9.50	Fine, long and strong staple
FZB 19	37.50	11.00	Fine, long and strong staple
FZB 20	36.36	10.14	Fine, long and strong staple
FZB 21	36.00	9.03	Fine, long and strong staple
FZB 2	37.83	9.50	Big Bolls, early maturity
Fuzzy FR lines			
FZR 7	39.13	9.00	Felted leaf, early maturity
FZR 8	36.76	9.25	Felted leaf, early maturity
FZR 9	35.71	9.25	Felted leaf, early maturity
FZR10	34.60	8.00	Felted leaf, early maturity
FZR 20	39.13	8.00	Felted leaf
FZR 21	36.36	10.50	Felted leaf
FZR 17	34.90	6.25	Good fiber length and strength
FZR 27	36.36	8.75	Good fiber length and strength
FZR 28	35.29	11.00	Good fiber length and strength
FZR 38	47.50	9.00	Good fiber length and strength

presents the clean seeded as well as fuzzy derivatives with improved fiber quality in final selection in F_{14} generation.

Clean seeded lines

There were three clean seeded B lines (maintainer of *G. herknesii* based CMS) and one fertility restorer (FR) line. CSR-1 had 26.19 per cent ginning out turn and excelled in fiber qualities along with felted leaf providing better tolerance against sucking pests. One of the maintainer lines (CSB-4) was early to flower (<50 days). CSB-3 and 5 had fairly strong and long fiber. The genetic trait of clean seed (Fig. 1) helps to improve

Fig. 1. Seeds of clean seeded cotton genotype

ginning efficiency. The clean seed skips the process of delinting and avoid environmental pollution of 4% acid effluent and save environment from chemical hazard especially towards labor health in the industry. Additionally, the cost involved in acid/gas delinting can be saved.

Fuzzy seeded lines

Among fuzzy seeded lines having more than 35 per cent ginning percentage were selected. There are promising eight B lines and ten FR lines. Seven B lines (FZB-15, 16, 17, 18, 19, 20 and 21) were excellent in respect of fineness as well as length of fiber and its strength. FZB-2 was early type with big boll size having <50 days flowering and <100 days maturity and will be useful for breeding early hybrids. There were 4 FR lines (FZR 17, 27, 28 and 38) excellent in respect of fiber length as well as strength. FZR7, 8, 9, 10, 20 and 21 were characterized by felted leaf and had very good tolerance to sucking pests.

Table 2 presents the quality traits of few advanced promising material analyzed in F_{15} generation at Ginning Training Centre, CIRCOT, Nagpur

Table 2. Quality traits in some improved breeding lines compared with popular varieties

Line no.	*GOT %	#Test wt. (g/100 seed)	#UHML (mm)	#UI %	#MIC micro-g/inch	#Tenacity 3.2mm (g/tex)	#EL %	Remarks
B-lines								
CSB-SVPSPF (Clean seeded)	32.50	5.10	32.5	87	3.0	30.6	6.0	Big boll
Line-6 (Fuzzy)	34.11	8.75	30.3	88	4.7	31.8	5.0	Fine, Long, Strong fiber
R-lines								
R-8 (Clean seeded)	33.17	8.50	29.0	85	4.0	28.7	5.4	Fine, Long, Strong fiber
RL-49 (Fuzzy)	34.00	8.83	30.5	86	3.3	**32.5**	6.0	Fine, Long, very Strong fiber
L-51-1 (Fuzzy)	37.68	9.50	28.1	85	5.1	29.4	5.2	Fine, Long, Strong fiber
L-51-2 (Clean)	27.00	11.00	31.9	87	4.2	30.2	5.0	Fine, Long, Strong fiber
L-48 (Fuzzy)	37.50	9.00	30.4	87	3.9	27.9	5.5	Fine, Long, Strong fiber
L-63 (Fuzzy)	35.59	9.25	31.5	87	4.0	30.0	5.2	Fine, Long, Strong fiber
@Standard Varieties								
Pima (USA)			35.9		4.3	44.4		
Giza-70 (Egypt)			35.7		3.9	45.1		
Giza-88 (Egypt)			35.7		3.7	47.8		
Giza-92 (Egypt)			34.1		3.8	47.5		
Suvin (India- Tamilnadu, Karnataka)				35.8		2.8	33.8	
DCH32 (India- MP, Karnataka)				34.0		3.0	32.0	
MCU-5 (India- Andhra, Maharashtra)				32.0		3.5	29.0	
H-4/ H-6 (India: MP, Gujrat, Maharashtra)					29.0		4.0	27.5

*Ginned on Liliput Lab Gin Model; #Data on UHML(Fibre Length), UI = (Uniformity Index), MIC = (Micronaire value), Tenacity and EL (Elongation) recorded by Ginning training center, CIRCOT, Nagpur; @Standard varieties popular worldwide, their major producing countries/ states are given in parenthesis, Source: Ginning training centre CIRCOT, Nagpur

in comparison to the standard varieties available. One of the fertility restorer *viz*., FZR-2015-49 was found to have good combination of fiber length, uniformity, fiber strength and elongation. B line 'CSB-2015-8', was found to have good fiber length and high uniformity index. Ginning out turn was found to be as high as 37 per cent in two restorer lines.

The quality traits *viz.*, length like *G. barbadense,* fineness as in *G. anomalum* strength donated by *G. thurberi* and/or *G. raimondii* (Mukewar 2011) could be amlgameted in clean as well as fuzzy seeded lines. Clean seed was from *G. thurberi*, In laboratory trial, the clean seed genotypes gave 30% more ginning efficiency on Liliput laboratory Gin Model over fuzzy seed genotypes. Clean seed has added advantage over acid delinted seed to tolerate soil moisture stress during germination with less chances of failure.

New high-speed air-jet spinning method has advanced to the point that processing capacities have approached that of saw ginning (Armijo et al. 2013). To compete in export internationally, the preference lies in Egyptian cotton (*G. barbadense*) having staple length above 32.5 mm along with fineness and uniformity. The genotypes of *G. hirsutum* cotton derived under present investigations are very close to it in quality. The long staple raw material will be useful to spin 80S (count) thread, which has added advantage of about 4 meters running cloth per kilogram of lint [6]. The introgression of fiber quality to *G. hirsutum* lines will help in future hybrid development program and alleviating import of long staple cotton bales by Indian textile industry, saving national foreign exchange.

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