

Research Article**Development of Isogenic Restorer Line in Extra Long Staple Cotton Variety Suvin**

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Abstract

Cotton is the most important commercial crop of India and heterosis in cotton is well documented with 7 to 50 per cent heterosis in interspecific (*G. hirsutum* x *G. barbadense*) hybrids, 10 to 138 per cent in intra-hirsutum hybrids and upto 220 per cent in *desi* (*G. herbaceum* x *G. arboreum*) hybrids. Currently hybrid cotton, especially Bt cotton hybrids, occupies more than 80 per cent of cultivated area under cotton in India. Male sterility system offers tremendous advantage to produce quality hybrid seeds at affordable price so that even marginal farmers can take up hybrid cultivation. In cotton both GMS and CGMS systems are available. In cotton, two types of male sterility *viz.*, Genic (GMS) and Cytoplasmic-Genic (CGMS) systems have been identified. Both the systems have been utilized for the commercial hybrid seed production in India and other countries. In CGMS system, the male parent of the hybrid needs to be converted into Restorer line. In cotton, Suvin is the only extra long staple *G. barbadense* variety available which is capable of spinning to 120^s count yarn. This variety has been successfully converted into Restorer line through back cross breeding utilizing Pima Restorer as the donor parent. Suvin Restorer is found to stably restore fertility in different CMS lines of *G. hirsutum*. The interspecific hybrids developed using Suvin Restorer was found to combine both high yield and superior fibre quality capable of spinning upto 80^s count and are comparable with conventional check hybrids.

Keywords:

Cotton, extra long staple cotton, male sterile lines, restores

Introduction

Cotton is the most important commercial crop of our country contributing upto 75% of total raw material needs of textile industry and provides employment to about 60 million people. Further, the export of raw cotton, yarn, textile, garments, cotton seed cake, oil and other by-products earn valuable foreign exchange to the extent of Rs.50,000 crores. India has achieved significant breakthrough in cotton yarn exports besides increasing its global market share in cotton textiles and apparels.

India has the largest area under cotton cultivation with relatively low productivity primarily due to the large area under rainfed cultivation with inadequate supply of inputs. Area wise, India ranks first in world, whereas, it ranks second in production next to China (Anonymous, 2010). Only in India, all the four spinnable fibre yielding species of *Gossypium*

viz., *Gossypium hirsutum*, *G. barbadense*, *G. arboreum* and *G. herbaceum* are cultivated commercially. In India, about 10.1 m ha is cultivated with cotton, of which around 66 % is grown as rainfed crop. Hybrid cotton cultivation in about 85% of total cotton area contributing 95% of production is a significant milestone achievement in Indian Cotton scenario. Cotton is the most important commercial crop of India and heterosis in cotton is well documented with 7 to 50 per cent heterosis in interspecific (*G. hirsutum* x *G. barbadense*) hybrids, 10 to 138 per cent in intra-hirsutum hybrids and upto 220 per cent in *desi* (*G. herbaceum* x *G. arboreum*) hybrids.

Currently hybrid cotton, especially Bt cotton hybrids, occupies more than 85 per cent of cultivated area under cotton in India. Male sterility system offers tremendous advantage to produce quality hybrid seeds at affordable price so that even marginal farmers can take up hybrid cultivation. In cotton, two types of male sterility *viz.*, Genic (GMS) and Cytoplasmic-Genic (CGMS) systems have been

identified. Both the systems have been utilized for the commercial hybrid seed production in India and other countries.

Male sterility was reported for the first time in cotton by Justus and Leinweber in 1960. Later several workers reported male sterility (Richmond and Kohel, 1961; Justus *et al.*, 1963; Allison and Fisher, 1964; Weaver, 1968; Weaver and Ashley, 1971; Rhyne, 1971; Turcotte and Feaster, 1979, 1985; Bowman and Weaver, 1979; Zhang *et al.*, 1992) in USA and China. In India, male sterility in arboreum cotton has been reported (Singh and Kumar, 1993; Meshram *et al.*, 1994).

In cotton, CGMS system is developed by introgressing cytoplasm of one species into the nuclear background of another species. From 1970 onwards, Meyer in USA introgressed several cytoplasm *viz.*, *G. barbadense*, *G. tomentosum*, *G. arboreum*, *G. herbaceum*, *G. anomalum*, *G. longicalyx* and *G. harknessii* into *G. hirsutum* and developed a CMS system with cytoplasm of D_{2-2} *G. harknessii* and its fertility restorer dominant 'F'. This system was developed by repeated backcrossing, testing and selection in *G. hirsutum* genome. Genetic analysis proved that its fertility can be restored by one or two dominant genes. One RAPD marker linked with this fertility-restoring gene has been identified. However, the system suffers due to yield suppression, low ginning and fibre fineness, induction of female sterility in certain interspecific crosses due to deleterious effects of *harknessii* cytoplasm. Hence, search is on to use more wild species cytoplasm to develop new CMS sources with better restorers. Considerable success has been achieved using *G. aridum* cytoplasm with better restorers, which are under evaluation.

In CGMS system, the male parent of the hybrid needs to be converted into Restorer line. In cotton, Suvin is the only extra long staple *G. barbadense* variety available which is capable of spinning to 120^s count yarn. This variety has been successfully converted into Restorer line through back cross breeding utilizing Pima Restorer as the donor parent as discussed below.

Material and Methods

The present study was conducted at Central Institute for Cotton Research, Regional Station, Coimbatore over a period of the past one decade. The Pima Restorer was used as the donor for restorer 'R' gene

and it has been used to convert the super fine extra long staple *G. barbadense* cultivar Suvin into restorer line. Suvin was used as female parent and it was crossed with Pima Restorer and the resultant progeny was heterozygous for the restorer gene. The hybrid was back crossed with Suvin for six generations and every time selection was made to fix the characteristics of the Suvin cultivar. In the BC6 generation, single plants were selected which are in conformity with the characteristics of Suvin and their progenies were raised separately. Simultaneously, the selected plants were also crossed with CMS LRA 5166 line maintained at station and the crossed seeds were sown for confirmation of restoration. Only those progenies which showed 100 per cent fertility restoration and showed homogeneity in the progeny rows were selected and bulked.

To test the usefulness of the so developed restorer line (SR), it was crossed with various CMS line *viz.*, Laxmi, MCU 5 VT 70 E, 70 G, IRH 1-6, IRH 1-10, 22-29 HS, Aabadhita, Suman, Anjali and LRA 5166. The resultant hybrids were evaluated in a randomized block design along with conventional check hybrids *viz.*, TCHB 213 and Sruthi in a three row replicated trial. Data were recorded on boll weight (g), lint index (g), seed index (g), ginning outturn (%), 2.5 % span length (mm), uniformity ratio, micronaire, bundle strength (g/tex) and elongation percentage following standard procedure. Data were analyzed to find out whether any difference is there between various hybrids.

Results and discussion:

In general, the intra-hirsutum hybrids are characterized by high yield and wide adaptability and spinnability upto 60^s count yarn. The interspecific (*G. hirsutum* x *G. barbadense*) hybrids are characterized by high yield, superior quality and spinnability upto 80^s count. The *desi* hybrids (*G. arboreum* x *G. arboreum* and *G. herbaceum* x *G. arboreum*) have high yield, resistance to biotic and abiotic factors but are spinnable upto 20^s count yarn only (Manickam *et al.*, 2004).

In India, two new male sterility source each in upland and *arboreum* cottons have been identified since 1993. In upland cotton, wild species *G. aridum* has been identified as new source of cytoplasmic genic male sterility at Akola Centre through interspecific hybridization. In upland cotton, new GMS has been identified through induced mutation

from the cultivar Abadhita (10 kR gamma rays + 0.2% EMS combination). In *G. arboreum*, two male sterility loci (ams1 – as spontaneous mutant of cultivar DS 5 and ar.ms from *G. anomalum*) have been identified (Manickam *et al.*, 2004).

Though male sterility system has been successfully exploited in cotton by releasing both GMS and CGMS based hybrids, no interspecific (*hirsutum* x *barbadense*) hybrids have been developed and released so far on commercial scale in India. This is mainly because of the lack of suitable combination of parents in CMS and restorer background. Though several *hirsutum* lines are available in CMS background, no superior restorer line is available in *G. barbadense*. We have successfully converted Suvin into a restorer line, which was found to restore most of the CMS lines stably over the years and has been found to combine with them to produce high yielding ELS hybrids. Several such hybrids have been developed and evaluated in the present study.

Analysis of data on characters like boll weight, lint index, seed index, ginning outturn and seed cotton yield indicated significant difference among these hybrids (Table 1). The highest seed cotton yield was recorded in the cross CMS Anjali x SR (1709 kg/ha) which is significantly higher than that recorded in conventional check hybrids viz., DCH 32 (1197 kg/ha) and Sruthi (884 kg/ha). Against TCHB 213(1395 kg/ha), the best conventional check hybrid, the test hybrid registered numerical superiority. This test hybrid also registered highest seed index of 13.9 g. For fibre quality traits like 2.5 % span length (38.1 mm), uniformity ratio (49.0) and micronaire (3.9) also CMS Anjali x SR was found to be the best hybrid (Table 2).

Apart from this hybrid, several other CMS based hybrids developed out of Suvin Restorer showed their superiority in terms of other characters like IRH 1-4 X SR for ginning outturn (34.5 %), 70 G x SR for maturity percentage (0.68) and 70 E x SR for bundle strength (29.0 g/tex).

It can be concluded from the above study that Suvin Restorer is found to stably restore fertility in different CMS lines of *G. hirsutum*. The interspecific hybrids developed using Suvin Restorer was found to combine both high yield and superior fibre quality capable of spinning upto 80^s count and are comparable with conventional check hybrids.

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**Table 1. Per se performance of hybrids for yield and other characters**

HYBRID	Boll weight (g)	L.I. (g)	S.I. (g)	GOT (%)	Seed Cotton Yield (Kg/ha)
Anjali x SR	4.0	5.5	13.9	28.4	1709
LRA 5166 X SR	3.8	4.8	12.4	28.3	1549
TCHB 213 [C]	4.0	4.5	10.1	30.9	1395
DCH 32 [C]	4.3	6.0	12.9	31.9	1197
70 G X SR	3.8	5.0	10.4	32.6	1229
IRH 1-10 X SR	3.5	4.5	10.2	30.6	1044
IRH 1-6 X SR	3.6	4.7	9.4	33.4	970
Sruthi [C]	3.7	4.3	9.5	31.5	884
Laxmi X SR	3.2	4.3	9.2	31.7	866
IRH 1-4 X SR	3.2	4.6	8.6	34.5	776
MCU 5-VT X SR	3.7	4.4	9.6	31.5	727
22-29 HS X SR	3.5	4.3	8.9	32.4	707
Abadhita X SR	3.2	4.1	8.5	32.3	681
Suman X SR	3.3	3.8	9.1	29.7	553
70 E X SR	3.2	4.1	9.1	31.3	532
70 E X PR	3.3	5.2	9.9	34.4	512
CD @ 5%	0.3	0.4	0.6	0.9	454
CV %	8.2	9.4	10.3	12.0	13.1

Bold figures indicate the maximum value recorded

L.I. and S.I. are Lint and Seed index

Table 2. Per se performance of hybrids for fibre quality characters

HYBRID	2.5 % Span Length (mm)	Maturity (%)	Uniformity Ratio	Micronaire	Bundle Strength (g/tex)	Elongation (%)
Anjali x SR	38.1	0.65	49.0	3.9	26.5	5.5
LRA 5166 X SR	37.2	0.66	48.0	3.5	26.8	5.6
TCHB 213-[C]	32.7	0.65	42.2	3.0	25.6	5.4
DCH 32 [C]	36.8	0.65	49.0	3.7	25.7	7.7
70 G X SR	32.5	0.68	44.3	3.5	25.6	5.1
IRH 1-10 X SR	31.8	0.64	45.5	3.0	24.0	5.4
IRH 1-6 X SR	31.2	0.64	45.1	3.0	25.4	5.4
Sruthi-[C]	32.7	0.66	42.9	3.1	26.3	5.4
Laxmi X SR	32.5	0.66	44.9	2.9	26.9	5.3
IRH 1-4 X SR	31.1	0.66	44.3	3.0	27.1	5.0
MCU 5-VT X SR	31.9	0.63	44.9	2.9	28.0	5.2
22-29 HS X SR	31.9	0.64	45.0	3.0	27.6	5.1
Abadhita X SR	30.1	0.62	44.4	2.7	27.6	5.0
Suman X SR	31.7	0.65	45.0	2.8	28.0	5.3
70 E X SR	35.6	0.62	44.3	2.7	28.6	5.2
70 E X PR	33.9	0.64	41.7	2.9	29.0	5.3

Bold figures indicate the maximum value recorded