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Short Communication

Development of TGMS system in diploid cotton (*Gossypium arboreum* L.)

B. M. Khadi[1], A. M. Badigannavar, V. N. Kulkarni and I. S. Katageri

Agricultural Research Station, UAS Dharwad Farm, Dharwad 580 007

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Cotton, known as king of fibers, assumes place of pride in the Indian economy. Among the cultivated species, diploid cottons have wide adaptability and are relatively tolerant to biotic and abiotic stresses. Deliberate attempts have been taken up in the recent past on the heterosis breeding in diploid cottons for its strong competitiveness against upland varieties in rainfed cotton ecology. Using genetic male sterility system, few diploid hybrids have been developed and released for commercial cultivation. But area under these hybrids is not significant due to uneconomic hybrid seed production. Male sterility system developed by crossing *G. anomalum* × *G. arboreum* and a natural mutant has considerably reduced the cost of hybrid seed production by 30 per cent which was otherwise required for intensive emasculation [1]. This economy may help the poor farmers to adopt desi hybrid cultivation under rainfed conditions to achieve higher production of short to medium staple cottons.

The male sterility influenced by the environmental factors, mainly the temperature is being identified as Thermosensitive Genic Male Sterility System (TGMS) in rice and barley. Most of the TGMS lines as in rice, shows sterility behaviour at high temperature (>25°C) and found fertile at lower temperature. Thus TGMS lines can be used as a male sterile lines and also as a maintainer lines, providing the opportunity to produce hybrid seeds by the two line system. By this, the potential genetic vulnerability due to the restricted sterile cytoplasmic base is greatly reduced. Such a sterility behavior influenced by the temperature was also been found in *G. arboreum* GMS lines. The exploitation of different TGMS genes in cotton will not only broaden the genetic basis of the hybrids but also provide hybrid cotton breeders with more choice to develop two line diploid cotton hybrids with desirable traits. The present investigation reports the TGMS behavior of the *G. arboreum* GMS lines isolated under natural rainfed ecology.

Two genetic male sterile lines, *viz*., DS-5 (belongs to *G. arboreum* GMS governed by single recessive gene-ams_1) [2] and GAKA-423 (GMS with *G. anomalum* cytoplasm governed by monogenic recessive allele-*arms*) [3] were used as base material to study the sterility behavior in accordance with the temperature. On an average, a large flock of 1493 (DS-5) and 440 (GAKA-423) plants were raised as space planted at ARS, Dharwad during July, 2000. At flowering stage, pollen sterility was recorded for bagged and unbagged flower buds 'in all the plants and those plants which showed pollen fertility were selected and intensively studied under natural high temperature conditions during summer. The observations on sterility-fertility of these lines simulated with temperature were recorded and analyzed, cytologically by using acetocarmine stain. Deeply stained round pollen grains were taken as fertile and non-stained ones as sterile. The day when pollen is completely sterile/fertile in a plant kept under natural temperature regime was taken as critical temperature.

Results on the behavior of GMS lines at high temperatures under field conditions during *Kharif* from June-October were unique and all the plants bloomed and found sterile completely. The average temperature of 28.01°C (max.) and 20.51°C (min.) found to be best suited for both the GMS lines to bloom sterile flowers. Based on the results, there has been a sterility breakdown in both GMS lines as there were 47 (DS-5) and 12 (GAKA-423) fertile plants converted from 478 and 31 sterile plants under low natural temperature. During November 2000, there has been a sharp decline in the night temperature (16.9°C min), which was reflected in the sterility breakdown as evidenced by 10 and 4 fertile plants in DS-5 and GAKA-423 respectively. Further, the night temperature dropped much down to 13.4°C and highest number of fertiles (26 and 6) were recorded and confirmed by acetocarmine stain test. During these months, the sterility breakdown was unaffected by the maximum day temperature. The

Table 1. Temperature induced sterility breakdown in DS-5 and GAKA423 GMS lines during 00-01

Months	Temperature		No. of partial steriles		Rainfall (mm)	Rainy days
	max.	min.	DS-5	GAKA-423		
June 2000	28.69	21.24	0	0	0	0
July 2000	26.72	20.48	0	0	44.4	3
August 2000	26.43	20.25	0	0	37.6	5
September 2000	29.00	20.37	0	0	0.2	12
October 2000	29.25	20.18	0	0	187.7	15
November 2000	31.40	16.90	10	4	107.8	15
December 2000	29.30	13.40	26	6	252.0	12
January 2001	30.49	14.94	6	2	155.8	9
February 2001	31.83	15.94	5	0	-	-
March 2001	34.97	18.50	0	0	-	-
April 2001	36.99	21.32	0	0	0	0
May 2001	33.21	21.07	0	0	0	0
Mean	30.69	18.72			855.5	71
No. of fertile/total sterile plants			47/478	12/31		
% fertiles			9.83%	38.70%		

sharp fall in the night temperature with cold breeze, accompanied by 15-17°C as diurnal variation 'influenced much on the production of fertile flowers from among the sterile once. During March 2001, the maximum and minimum temperature was 34.97°C and 18.5°C respectively and all the plants which had fertile flowers (sterile converted into fertile ones) became again sterile. Similarly, barley GMS lines showed high fertility at lower temperature (20-24°C) and vice versa at higher temperature (27.7°C) [4].

The GMS plants were irrigated and observations continued in the summer 2001. The close observation on the flower morphology indicated that there has been a stable maintenance of the male sterility system throughout the summer (March, April and May 2001). Thus, the behavior of GMS lines throughout the *Kharif* and *Rabi* season clearly indicated the presence of specific temperature of day length sensitive nuclear genes in recessive state. The present findings as well as earlier reports on temperature discriminated expression of sterility/fertility in rice and barley suggests indirectly the possibility of environment sensitive gene(s) being either loosely linked or non-linked to the nuclear sterility gene, but located on the same chromosome [5]. Thorough investigations in this direction under different temperature regime chambers will enlighten the genetics of this behavior.

Looking to the huge cost of production towards inter/intra specific tetraploid hybrids, diploid hybrids, are found to be remunerative for the marginal farmers with minimum insecticidal spray and management practices. In this context, the TGMS system would be of considerable commercial value for hybrid seed production when it remains completely sterile at specific temperature regime. Then there would be a wide choice of using elite genotypes with fertility restorer genes for the production of highly heterotic hybrids. On the other hand, when there is a sterility breakdown at another temperature regime, it would facilitate maintenance of GMS line without the aid of maintainer line [4]. This advantage makes hybrid seed production considerably economical, especially in often cross-pollinated crop like cotton. India being a tropical country, TGMS lines so identified can be exploited for two-line hybrid cotton breeding after extensive studies under controlled environmental chambers.

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