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Studies on microsporogenesis in genetic male sterile and fertile lines of *desi* cotton (*Gossypium arboreum* L.)

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Abstract

A comparative histological study of GAKA-423 male sterile and fertile anthers of *desi* cotton (*Gossypium arboreum* L.) revealed shriveling of microspores leading to deformed microspores without the complete development of pollen wall. The Genetically Male Sterile (GMS) anther sacs were completely appressed towards center enclosing the deformed microspores, which appeared as thick black undifferentiated band. The tapetum persisted during premeiotic and meiotic stages and disintegrated after release of microspores.

Key words : Cotton, *Gossypium arboreum*, genetic male sterility, microsporogenesis, histology

Introduction

The practical potential of male sterility system in hybrid seed production depends mainly on the stability of male sterile source. Although several cytoplasmic and genetic male sterile genotypes of *G. hirsutum* cotton ranging from partial to complete sterility have been observed [1-3], no information is available on the exact stage of microsporogenesis at which sterility occurs. Recently, a male sterile plant was reported [4] in BC_1 F_1 generation of cross, (*G. anomalum* × *G. arboreum*) × *G. arboreum* and male sterility was found to be controlled by a single recessive gene (*arms*). The present work was carried out to characterize the nature of irregularities during microsporogenesis and pollen development.

Materials and methods

Flower buds of both GAKA-423 genetic male sterile and fertile lines grown during summer 1995 at ARS, Dharwad were fixed in Carnoy's A solution for 48 hours and histological studies were carried out by standard methods of microtechnique [5-6]. The tissues were stained using Heidenhain's Iron Haematoxylin (0.5%) and observed under light microscope.

Results and discussion

Microsporogenesis in anthers of GMS line (GAKA- 423) was indistinguishable from its fertile counterpart until the release of microspores from tetrads. Arches- porial cells in each anther lobe gave rise to an outer layer of primary parietal cells and inner layer of primary sporogenous cells. The primary parietal cells further differentiated into an outer endothecium, a middle wall layer and a layer of sporogenous cells (Fig. 1). The primary sporogenous tissue by further mitotic divisions gave rise to a number of pollen mother cells (Fig. 2). The pollen mother cells through normal meiosis resulted in formation of diads and trihedral and tetrahedral tetrads in both GMS (Fig. 3) and male sterile anthers (Fig. 4). The tapeturn which appeared at premeiotic stage persisted during meiosis, till the formation of microspores and began to disintegrate soon after the release of microspores from tetrads (Fig. 5).

Pollen development in male fertile line: The microspores after release from tetrads had dense cytoplasm (Fig. 6) and enlarged considerably in size but later they started moving towards one side of the microspores (Fig. 7). Each microspore then developed a thin intine and a thick exine wall with a characteristic spiny pattern of cotton (Fig. 8). The pollen grains were released after breakdown of endothecium layer. Each pollen grain at this stage showed prominent nucleus either in center or little away from the center (Fig. 9) with intact walls.

Pollen abortion in GMS line: After the release of microspores from tetrads (Fig. 10), microspores started degenerating following slight initial enlargement (Fig. 11) Microspores, however appeared shrivelled due to the shrinkage of cytoplasm (Fig. 12 and 13) and incomplete development of pollen wall. Similar observations were made by Murthi and Weaver [1] in dominant genetic male sterile (MS7) cotton line, in which pollen abortion occurred at the time of pollen wall differentiation. The deformed microspores appeared as rod like structures (Fig. 14) which aligned at the periphery of anther locules. (Fig. 15). The anther sacs were completely collapsed and appressed towards inner side enclosing deformed microspores which formed thick undifferentiated band along the anther cavity. (Fig. 16). Similar observation was also made by Mehetre and Thombre [7] in cotton. The tapetum behaviour in both

GMS and fertile anther was found to be normal during microsporogenesis. There are several reports of degeneration of microspores without the involvement of tapetal cells either during or after the pollen wall differentiation in wheat [8], rice [9] and cotton [3].

The developing microspores require large amount of nutrients for growth and differentiation [10 and 11]. Failure of microspores to absorb the nutrients or lack of supply of nutrients might be the cause for pollen abortion in this particular male sterile line. The results of the present work, reveal that male sterility in GMS line can be attributed to unusual shrivelling and shrinkage of cytoplasm resulting in degeneration of microspores without the complete development of pollen wall. In the present investigation, the male sterility in GAKA-423 (*arms*) is due to post meiotic abnormality. Therefore, care should be taken to avoid the problem of resurgence of fertility during hybrid seed production.

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