

UNUSUAL FORM OF MALE-STERILITY IN THE SUNFLOWER VARIETY, SUF-2

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Summary

The sunflower variety SUF-2, also known as Coimbatore-1 (Co-1), is a selection from 'Cernianka' of USSR and is cultivated extensively in South India, because of its shorter life span (65 days) and adaptation to semi-arid conditions. An unusual form of male-sterility is recorded in this variety not observed in any other variety of sunflower so far investigated. In each disc floret there are five epipetalous stamens whose connectives are extended beyond the anthers as hoods. Sterile stamens are randomly distributed and are found often in the same floret along with fertile ones. Anther development in fertile and sterile stamens are identical until the initiation of meiosis in the microspore mother cells. In fertile anthers, meiosis leads to the development of spinous pollen grains which are released after normal anther dehiscence. In sterile anthers, however, the tapetal cells and their nuclei enlarge enormously and the sporangia become undulated in transectional outline. Although meiosis is normal, cytokinesis fails to take place so that coenocytic structures are resulted. The four haploid nuclei of such cells further divide mitotically and result in 32- to 64-nucleate structures. Concomitantly these cells also enlarge enormously. Very often only one or two such coenocytic cells develop in each anther locule, the others degenerating at various developmental stages. The coenocytic cells do not develop exine and intine. Microsporangia containing these cells do not develop endothelial layer and consequently there is no anther dehiscence. The anthers degenerate subsequently.

Introduction

Although the anatomy and cytology of male-sterile lines of many angiospermous taxa have been studied in detail in the past (Laser and Lersten, 1972), detailed developmental studies on the male-sterile forms of sunflower are meagre. Nakashima and Hosokawa (1974) studied a genic male-sterile line and Horner (1977) investigated a cytoplasmic male-sterile form of sunflower. They reported that the anther tapetal cells, without forming a periplasmodium, enlarged abnormally and caused sterility which sets in at the microspore tetrad stage. Since our studies on the partially male-sterile SUF-2 sunflower variety were at variance from the above two investigations, the present contribution is made.

Materials and Methods

The sunflower variety, SUF-2, also known as Coimbatore-1 or Co-1, is a selection from 'Cernianka' of USSR and cultivated extensively in the semi-arid localities of South India, because of its short life-span (65 days). Developing tube florets were fixed in the field itself in Formalin-70% ethyl alcohol-glacial acetic acid

mixture (1:18:1) and were processed through customary methods of dehydration and embedding (Johansen, 1940). Microtome sections were taken at a thickness of 8-10 μ m and were stained with haematoxylin-erythrosin.

Results

In each tube floret, there are five epipetalous stamens whose connectives are protruded beyond the anthers as hoods. Sterile stamens are often found in the same floret along with normal stamens. The tetrasporangiate anthers of individual stamens are free from one another and are not syngeneicous.

Anther development in fertile and sterile stamens is identical until the microspore tetrads are formed. The anther wall, which develops according to the Dicot Type of Davis (1966), consists of hypodermis, a middle layer and a tapetum. In transverse sections of anthers, there are about 2-6 sporogenous cells in each locule. In fertile anthers, all the tapetal cells become binucleate, before becoming a periplasmodial mass by about the tetrad stage. The viable pollen grains are spinous and are released after normal anther dehiscence.

In sterile anthers, the tapetal cells begin to enlarge during the initiation of meiotic division in the microspore mother cells. The nucleus of the tapetal cell does not undergo mitotic division, contrary to the condition in normal anthers, but instead enlarges enormously. The tapetal cells also do not become periplasmodial and degenerate in situ in the cellular state.

Meiotic division in the microspore mother cells of sterile anthers takes place normally but cytokinesis is prevented, thus resulting in 4-nucleate structures, which, for convenience, are designated here as multinucleate microspores (MMs). All the MMs begin to enlarge, but many of them begin to degenerate at various stages of enlargement. Only one or a few of them persist in each locule. The MMs attain a final size of about 8 to 10 times that of their original size. The four haploid nuclei undergo repeated mitotic divisions to result in 8- to 64-nucleate MMs. The MMs do not develop exine and intine but retain their callosic wall which was formed during the onset of meiotic division. In the microsporangia containing the MMs, the cells of the hypodermal layer do not develop the characteristic fibrous thickenings; the microsporangia also become undulated in outline and finally degenerate along with their contents, if any.

Discussion

Depending upon the plant, male-sterility may be expressed by one or more of the following: degeneration of sporogenous cells, abnormal behaviour of the tapetum, failure of cytokinesis in the microspore mother cells after meiosis, failure of the release of microspores from the tetrads, abnormalities in pollen grain development and lack of anther dehiscence (Laser and Lersten, 1972). In the two male-sterile lines of sunflower so far studied (Nakashima and Hosokawa, 1974; Horner, 1977), male-sterility was attributed to the abnormal development of the tapetum and to its

failure to form a periplasmodial mass. In both studies, anther degeneration was reported to occur at the tetrad stage itself. In the sterile anthers investigated here, the behaviour of the anther tapetum is similar to the above two instances. But, in addition, sterility is manifest by the failure of cytokinesis after meiosis in the microspore mother cells and the subsequent increase in the nuclear number of the coenocytic 4-nucleate structures thus formed.

Failure of cytokinesis to result in 4-nucleate structures has so far been reported in three apomictic compositae, Arnica alpina (Afzelius, 1936); Leontodon hispidus (Bergman, 1935) and Minuria integerrima (Davis, 1964), in irradiated Arachis hypogaea (Bora et al., 1961) and Ricinus communis (Singh and Gunckel, 1965) and in male-sterile Melilotus alba (Castetter, 1925), Glycine max (Brim and Young, 1971; Albertson and Palmer, 1979) and Pisum sativum (Gottschalk and Kaul, 1974). Excepting in the two irradiated plants mentioned above where a maximum of six nuclei have been recorded (two or three of which are micronuclei), in the rest, more than four nuclei were never found. In other words, the multinucleate microspores recorded by us in the sterile anthers of SUF-2 variety of sunflower are unique among the angiosperms.

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