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Anomalous stomatal features in great millet

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Abstract. The abnormalities in morphology, number, size and position of subsidiary cells, stomatal complexes and guard cells in the leaf epidermis of *Sorghum vulgare* Pers. have been reported. The subsidiary cells per stomatal complex range from two to four. Normally, subsidiary cells do not arch over the poles of a stoma, but in some cases they cap the poles. Nuclear degradation has also been described in the guard cells.

Keywords. Guard cell; stoma; stomatal complex; subsidiary cell.

1. Introduction

Stomatal complex in members of Gramineae is unique in possessing typical dumb-bell shaped guard cells and their morphology and development have been studied (Stebbins and Shah 1960; Inamdar 1970 ; Fryns-Claessens and Van Cotthem 1973). The study of anomalous stomatal features is, however, limited to a few species like wheat (Haber 1962; Foard and Haber 1961), *Hordeum* (Shah and Stebbins 1962) and *Stipa* (Arrillaga-Maffei 1966). The purpose of the present paper is to bring out the major abnormalities observed in the guard cells, subsidiary cells and stomatal complexes and to study the nuclear behaviour in the guard cells ir the leaf epidermis of *Sorghum vulgare* Pers.

2. Materials and methods

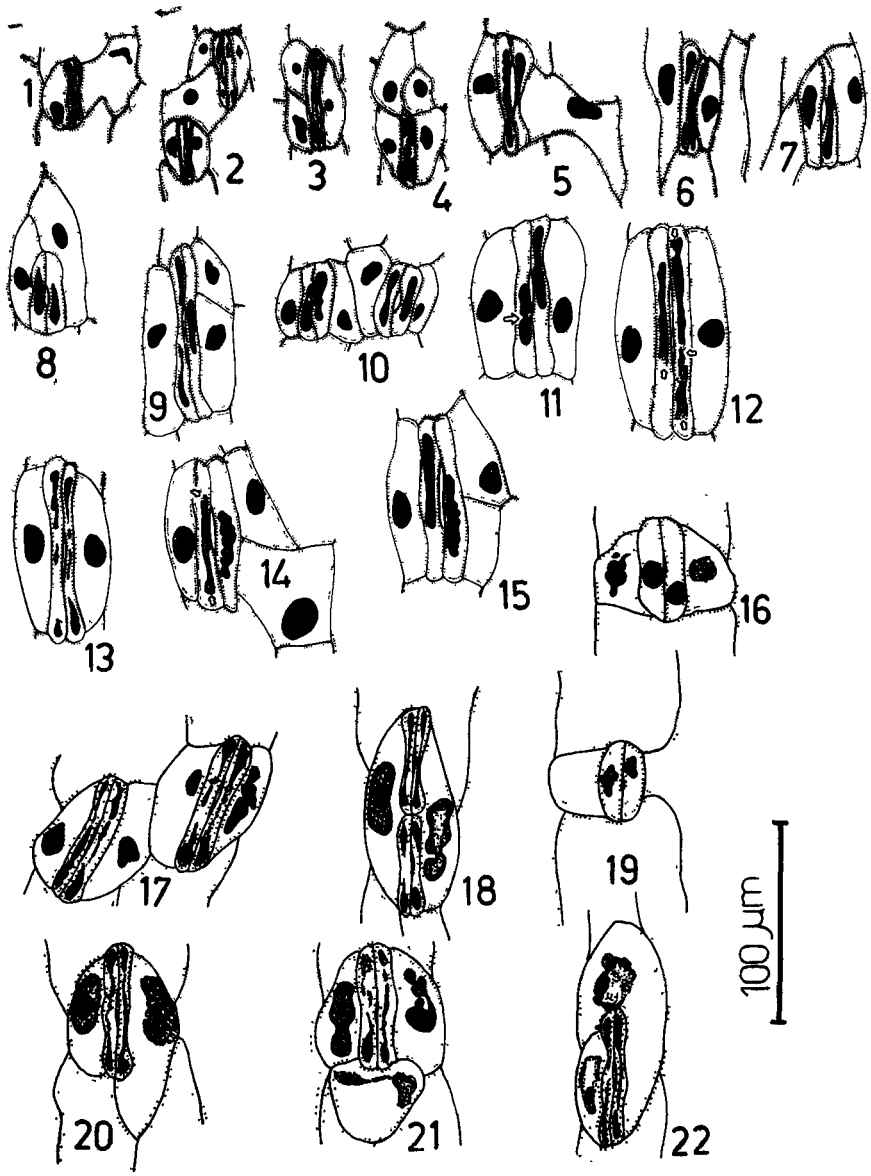
The epidermal peels from both adaxial and abaxial surfaces of the leaf of the great millet, *S. vulgare* (cultivar CHS_1 obtained from Agricultural Research Station, Surat) were stained with toluidine blue-O and mounted in glycerine jelly. The open sides of the cover-glass were sealed with DPX mountant.

3. Observations

The normal stomatal complex of *S. vulgare* is peracytic comprising a pair of dumb-bell shaped guard cells and two subsidiary cells contiguous along the lateral sides of guard cells. These subsidiary cells are usually shorter than the guard cells and

do not arch over the polar regions of the stoma. As the ontogeny and normal structure of stomata in grass family are well-known, we have not described that part here. However, we have noticed the following abnormal stomatal features in jowar.

The length of the stomatal complexes, from one pole to the other, varies from 30 to 110 μm (figures 1–22), the majority being between 60–80 μm. Those above 80 μm length have been considered here as giant ones. The shape of fully differentiated guard cell is usually dumb-bell like (figure 1). In some they may also be bean-shaped (figures 10, 16, 19). The length of one of the two guard cells may be more than the other one (figure 6). Similarly there may be variation of width of guard



Figures 1–22. Stomatal features in the leaf epidermis of *S. vulgare*.

cells also (figure 7). The stomatal complexes are usually arranged in vertical files and generally they are not contiguous. Rarely, two stomatal complexes of the neighbouring files of epidermal cells are contiguous along the entire or partial lateral sides of the subsidiary cells (figures 10, 17). Superimposed stomata are rarely found. We have noted that in some instances the entire superimposed twin of stomata is contiguous with a single pair of subsidiary cells (figure 18).

Normally, two bean-shaped subsidiary cells contiguous on two lateral sides of a stoma are slightly shorter than the length of the guard cells (figures 1, 3, 6, 10–19). In some stomatal complexes one of the subsidiary cells is larger than the other and covers a part of the polar region of a stoma (figure 20). Sometimes one of the subsidiary cells extends over the opposite subsidiary cell and forms a hook-like structure (figure 22). Both the subsidiary cells may be larger than the contiguous guard cells covering one of the poles of a stoma (figure 8). Three subsidiary cells may also occur due to the division of any one subsidiary cell (figures 3, 9, 15). In some instances, an additional polar subsidiary cell may also be found (figure 21). Rarely, four subsidiary cells, two laterals and two on any one polar side, are also observed in a stomatal complex (figure 4). The degree and mode of distension of such subsidiaries at maturity vary in different stomatal complexes as well as in two subsidiary cells of a single stomatal complex (figures 1, 5, 7, 16). Two nearby stomatal complexes may have a common subsidiary cell (figure 2). Sometimes the subsidiary cell may simulate other epidermal cells due to distension and subsequent vacuolation (figures 7, 14, 19).

The nucleus of the young guard cell is spherical or ovoid (figure 16). During the elongation of guard cells, however, it exhibits many structural changes leading to its autolysis. Nucleus elongates wherein the central part becomes comparatively thinner than the polar regions (figures 1, 7, 8). Later, it is fragmented at the central part (figure 3). Subsequently, the central part is lost and two nuclear fragments are seen in the polar regions (figures 2, 4, 6). Rarely, the elongated nucleus appears beaded (figures 5, 10). Sometimes, a notch is formed in the nucleus (figure 11, at arrow) during its elongation. The nucleus gets fragmented at this point. During that process the nuclear envelope autolyses at certain points (figures 12, 14, at arrows) preceding the autolysis of nuclear material (figure 13).

4. Discussion

The epidermal pattern in the leaf has been increasingly used in taxonomic purposes in grass family (Stebbins 1956; Jauhar 1967 ; Jauhar and Joshi 1967, Pattanath and Ramesh Rao 1969). Stebbins and Khush (1961) studied the variation of stomatal complexes in 49 monocot families for phylogenic investigation. While these aspects are not studied here, we show the abnormal features of stomatal complexes in jowar. Inamdar (1970) in his study on stomatal structure and development in 42 species of grass family recorded the only abnormality in the form of superimposed contiguous stomata in wheat. Foard and Haber (1961) and Haber (1962) reported the abnormalities in the stomatal complexes of wheat induced by the gamma irradiation. Such abnormalities resulted due to the absence of cell division in epidermis. Shah and Stebbins (1962) brought about the abnormalities in the stomatal complexes by chemical treatment in *Hordeum*

vulgare. But, Arrillaga-Maffei (1966) reported a number of natural abnormalities in the stomatal structure of *Stipa neesiana*. The presence of three or four subsidiary cells in various positions in relation to guard cell orientation in jowar is similar to that in *Stipa*. We have shown here that abnormality both in the number and morphology of subsidiary cells is rather common in jowar. Common pair of subsidiary cells for superimposed stomata (figure 18) is interesting. Arrillaga-Maffei (1966) also observed a similar situation in *Stipa*. But, instead of considering the stomates to be superimposed contiguous, the situation has been described as a variation of guard cells, i.e. in place of two guard cells such complexes have four guard cells with two flanking subsidiary cells. We do not agree to this interpretation. In some cases increase in basic number of subsidiary cells in stomatal complexes in *S. vulgare* occurs due to cell division as in ginger, mango-ginger and turmeric (Raju and Shah 1975), *Aganosma* (Patel *et al* 1972). The nuclear degradation of guard cell may occur in variety of ways as reported in earlier cases (Patel *et al* 1972; Raju and Shah 1975). Elongation, lobbing and fragmentation of nucleus in guard cells of grass species are unique.

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