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ORIGINAL ARTICLE

DEVELOPMENT OF FEMALE GAMETOPHYTE IN PEPEROMIA OBTUSIFOLIA. A. DIETR.

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Abstract:

The evolution of female gametophyte development in angiosperms provides an excellent system to investigate the developmental basis of morphological novelty. In the present study, in Peperomia obtusifolia the ovary is unilocular with single, basal, unitegmic, orthotropous and crassinucillate ovule. During developmental stages meiotic and mitotic division takes place resulting into the formation of tetrasporic, sixteen nucleate, peperomia type of mature female gametophyte.

KEYWORDS-

Female gametophyte, unitegmic, orthotropous, tetrasporic and peperomia.

INTRODUCTION-

The family piperaceae comprises of nine genera and more than thirteen hundred species (Hooker, 1885; Hutchinson, 1959 and Cronquist, 1968). The Piper and Peperomia are two large genera widely distributed in both the hemispheres. Members of the order piperales though have some advanced characters but it retained some primitive features. Plants are herbs, shrubs and rarely subarboreous. Flowers are minute, unisexual and are borne in axillary or terminal catkin. Male flower consist of two stamens and female flower consist of two or three free carpels which may be connate below. The fruit is small, one seeded and indehiscent.

The evolution of female gametophyte development in angiosperms provides an excellent system to investigate the developmental basis of morphological novelty. Development of female gametophyte includes monosporic, biosporic and tetrasporic patterns of megasporogenesis (Madrid and Friedman, 2008 and 2009). All members of piperaceae are tetrasporic and in Peperomia female gametophyte contains sixteen nuclei at maturity (Maheshwari, 1950; Davis, 1966). Dozens of researchers have investigated peperomia type female gametophyte development in the genus Peperomia (Campbell, 1899, a, b; Bannicova and Plyusch, 1984; Bannicova et al., 1987 and Smirnov and Grakhantseva, 1988). The constituent members belonging to the family piperaceae sharply differs from other angiosperms in development of embryo sac with respect to arrangement and behavior of nuclei produced at the end of meiosis. The embryo sac development in the family piperaceae with certain exceptions confirms to Peperomia type. In the present investigation the development of female gametophyte in Peperomia obtusifolia is tetrasporic, sixteen nucleate and peperomia type.

MATERIALS AND METHODS

Developing inflorescences of Peperomia obtusifolia were collected from plants growing in the garden of Department of Botany, Nagpur University, Nagpur in the month of April. Inflorescences were fixed between 9.30 a.m. to 12p.m. and 3.00p.m. to 5.00 p.m. in formalin acetic acid and stored in 70% ethyl alcohol. The spikes with buds and flowers at different stages of development were processed for

dehydration and clearing in alcohol-xylol series and embeded in paraffin wax. The sections were cut at a thickness of 10-12 microns by Cambridge Rocking Microtome, stained with Heidenhains iron-alum hematoxylin and destained in picric acid. Different stages of development were drawn by Camera Lucida.

RESULTS AND DISCUSSION

All different stages of development of female gametophyte of Peperomia obtusifolia are reported in Plate-I. The mature ovule is unitegmic, orthotropous and crassinucillate. The ovule primordium arises from the base of ovary as a straight nucellar protuberance. The initials for integument differentiate from nucellar epidermis (Fig. 1). It develops as annular outgrowths which gradually grows upwards (Fig. 2 and3) and soon encloses the nucellus leaving a narrow space at the apex constitute the micropyle (Fig. 4 and 5). Female gametophyte is developed from a large size prominent archesporial cell with dense protoplasm and conspicuous nucleus. It is hypodermal in origin (Fig. 1). Periclinal division in archesporial cell gives rise to a primary parietal cell on outer side and primary sporogenous cell on inner side (Fig. 2). Further divisions in primary parietal cell give rise to three layered parietal tissues (Fig. 5). Nucleus of functional megaspore mother cell undergoes first and second meiotic divisions. The first meiotic division gives rise to two nuclei embedded in common cytoplasm without cell plate formation (Fig. 6),

vacuoles are situated at micropylar end, between and around the two nuclei (Madrid and Friedman, 2010). Cell plate formation has been reported in some species of Peperomia results into the formation of separate cells (Madrid and Friedman, 2010) but formation of cell plate disappeared later in few species of Peperomia (Fisher, 1914; Murty, 1959 and Perisamy, 1965). The dyad nuclei undergoes second meiotic division results into the formation of four nuclei which are scattered in cytoplasm and enclosed by a common wall (Fig. 7-9). In the present work megaspore nuclei do not exhibit polarity depending upon plane of orientation of spindles. Initially nuclei are arranged in tetrahedral or isobilateral manner with small vacuoles around them (Fig. 7 and 8). Later on these four nuclei migrate towards periphery of developing embryo sac resulting into the formation of large vacuole in the centre (Fig. 9) but in different species of Peperomia cell plate is formed between each pair of megaspore (Madrid and Friedman, 2010).

After meiosis four megaspore nuclei of Peperomia obtusifolia divides mitotically produce eight nucleate female gametophyte where nuclei are arranged in tetrahedral configuration. By this time, central vacuole takes up the majority of cell volume (Fig. 10). Each daughter nuclei further divides mitotically produced sixteen nuclei without wall formation. These nuclei embedded in peripheral layer of cytoplasm. Thus development of female gametophyte in Peperomia obtusifolia confirms to be tetrasporic pattern (Murty, 1959; Perisamy, 1965; Arias and Williams, 2008; Madrid and Friedman, 2010).

In the present investigation, organization of sixteen nucleate mature female gametophyte contains egg apparatus, polars and antipodals (Fig. 11). Egg apparatus at micropylar end consist of an egg and a synergid. A nucleus from each pair migrate towards the centre of embryo sac constitute polars and remaining six nuclei for the time being lie in peripheral layer of cytoplasm at chalazal end constitute laterals or antipodals but variations observed in P. dolabriformis and P. jamensoniana. In this mature female gametophyte contains ten cells: an egg cell, two synergids, six accessory cells and a central cell (Campbell, 1899, a,b; Johnson, 1900) while in P. hispidula the mature female gametophyte contains three cells: an egg cell, one synergid cell and a central cell. In this species accessory cells are absent and secondary nucleus is the fusion product of fourteen polar nuclei (Johnson, 1914; Madrid and Friedman, 2010). Egg apparatus of P.obtusifolia and P. hispidula shows resemblance in having an egg and a synergid but differences occur in respect to polars and antipodals (Madrid and Friedman, 2010).

CONCLUSION

Thus, in the present work development of embryo sac in P. obtusifolia and other species of Peperomia (Campbell, 1899; Johnson, 1914; Murty, 1959; Perisamy, 1965; Gonzáìez and Rudaìì, 2003; Madrid and Friedman, 2009 and 2010) confirms to be tetrasporic, sixteen nucleate and peperomia type.

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