Bulletin of Pure and Applied Sciences.
Botany, Vol.44 B, No.1.
January-June 2025: P.65-68
Short Communications

Print version ISSN 0970 4612
Online version ISSN 2320 3196
Available online at www.bpasjournals.com

Embryogenesis & Gametogenesis in Plants: With a Sharp Focus on Venezuela

Rishan Singh*

Author's Affiliation
Research Media SR (Pvt BRD), Durban, 4001, South Africa & School of Life Sciences, University of KwaZulu-Natal, Westville campus, Durban 4041, South Africa

***Corresponding Author:**
Rishan Singh
Research Media SR (Pvt BRD), Durban, 4001, South Africa & School of Life Sciences,
University of KwaZulu-Natal, Westville campus,
Durban 4041, South Africa
E-mail: rishansingh18@gmail.com,
rshnsingh1@yahoo.com

Keywords:
Embryo,
Genetic Drift,
Testa,
Sporophyte,
Spores,
Heliconia rostrata,
Copaifera langsdorffii,
Eryngium foetidum

Received on 24.08.2024
Revised on 24.04.2025
Received on 14.05.2024

Abstract

Fruit and flower plant species woudn't exist if it hadn't been for the processes of embryogenesis and gametogenesis. In nuts, the process by which an embryo is formed, is identical to that in sugar bean and maize plants. One of the essential requirements that ensure that embryogenesis and gametogenesis occurs properly is the formation of a mature and immature sporophyte. Furthermore, soil nutrient uptake and compost constituents also are essential requirements for the formation of well-developed plant propagules. In this paper, plant embryogenesis and gametogenesis will be discussed with a sharp focus on Venezuelan plants.

How to cite this article: Singh R. (2025). Embryogenesis & Gametogenesis in Plants: With a Sharp Focus on Venezuela. *Bulletin of Pure and Applied Sciences-Botany,* 44B(1), 65-68.

THE INTRODUCTORY PREMISE

Plants, just like seeds, need an adequate amount of moisture and nutrients to grow. This means that the growth of seed embryos and ordinary plants need the same requirements to be able to thrive optimally in their respective habitats (Goldberg *et al.,* 1994). With this, sometimes, plants and seed embryos may need exogenous or endogenous substances to assist in their growth. At the beginning of the lifecycle of a seed, the embryo begins by imbibing water (San Pedro *et al.,* 2017). Thereafter, there is an influx of nutrients that are supplied to the embryo from the seed cotyledons (Singh, 2024). However, the during taken for seed and plant propagation differs between species and genera (Oridate *et al.*, 1992). A good example where this is applicable is the seeds of ***Phaseolus vulgaris*** and the monocotyledon, ***Zea mays*** (Fahey *et al.*, 1986). Between these 2 seeds, primary seed structures start appearing quicker in ***Phaseolus vulgaris*** in comparison to ***Zea mays*** inspite of ***Phaseolus vulgaris*** being a dicotyledon. It is a known fact that seed sprouting depends on seed topology and the constituency of the soil. In chestnut seeds, i.e. ***Castanea sativa***, it's probably that its propagation is country-specific, but this does not mean that it cannot be propagated outside its providence (Singh, 2024).

In my opinion, it is through genetic drift that different plant species are found in different regions of the world. This could be attributed to natural and artificial selection, as well as, the different soil types mixing during evolution. It could have also been that this genetic drift created an imbalance in plants colonizing different habitats. However, ferns, moses and fungi have pre-existed since evolution, particularly since evolution has enabled them to adapt to their ecological niches. In ferns, aloe and water lilly, seeds are produced through pollination. This is also the situation in the fruit-bearers, the gynnosperms. However, in the fruit-bearers, seed encapsulation is mandatory, but not in all cases - as is the typical case in pineapple and strawberry plants where the seeds become active in their natural state. In rose plants, although they produce vitamin-c-rich fruits, they are still termed as angiosperms because the seeds or fruits are hard and don't germinate in the environment.

In order to understand embryogenesis more clearly, we must first envisage that seed germination occurs from the seed coat, or testa. This is the first line of entry into the endosperm of the seed. The endosperm undergoes a variety of biochemical changes to produce a zygote, which is essential for sporophyll production (Brown, 1988). However, without water, embryogenesis is halted because the sporophyll is forced to remain intact. Furthermore, cotyledons don't develop without the endosperm undergoing chemical changes (Sudhersan *et al*., 2011). Once water enters, the embryo gives rise to the cotyledons, and thereafter, the angio- or gymnosperm plant (Lafon-Placette & Köhler, 2014).

EMBRYOGENESIS IN NON-ANGIOSPERM AND ANGIOSPERM PLANTS

There are many underlying genetical and morphological implications of embryogenesis in plants. Firstly, we would understand the situation in non-angiosperms and thereafter look into what prevails in the angiosperms.

a. Non-angiosperm plants

In **ferns**, Polypodium, the sporophyte contains two sets of chromosomes. This means that the sporophyte is diploid (2n). In this plant, genetic variation occurs when the diploid sporocytes that are present in the sporangia become haploid (n). This haploid state happens due to independent assortment and crossing over. Therefore, it is said that the gametophyte is haploid and this is the result of the mentioned events occurring within the sporophyte. Regarding the male gametes, genetic diversity occurs among the sperm due to genetic recombination (Singh, 2024). The sperm is produced by the antheridia, and each of them has a haploid set of chromosomes. Similarly, the egg cell produced is haploid, however, it is produced by the archegonia. In this way, the male and female gametes are genetically diverse. The diploid number is restored when the egg and sperm cell forms the zygote, which contains genetic material from both parents. This zygote grows into a new sporophyte and is responsible for continuing the genetic lineage.

With respect to the above, it is imperative to understand that genetic regulation occurs by the ***SPO11*** gene initiating meiosis, which leads to the production of haploid spores. In addition, the development of the male gametes, which influence pollen development and function, is regulated by ***MS1*** and ***MS2***. Regarding the female gametes, ***GAMYB*** is responsible for regulating the development of the archegonia and egg cells (Singh, 2024).

Unlike the ferns, in the **mosses**, Sphagnum, the diploid sporophytes produce spores that are haploid in the sporangia (Singh, 2019). Since meiosis occurs, genetic recombination causes the spores produced to be diverse. Therefore, the gametophyte produced is haploid. Similar to the ferns, the sperm cells are produced from the antheridia, while the egg cell is produced from the archegonia. Both the male and female gametes are genetically diverse. Once fertilization occurs, the new sporophyte formed inherits the traits of the male and female gametophytes, resulting in a diploid zygote.

With respect to the above, it is essential to understand that, just like in the ferns, ***SPO11*** is crucial for meiosis. However, sporophyte development involves the TALE homeobox gene, also called ***TDR***. ***MS1*** is required for male gamete development, while the Auxin Response Factor, also called ***ARF***, is needed for archegonium development.

b. Angiosperm plants

In **roses**, Rosa, each cell contains two sets of diploid chromosomes. In this plant, the microsporocytes are diploid. Once they undergo meiosis, haploid microspores are produced. Each microspore (of the anthers) develops into a pollen grain, which contains the sperm cells. During meiosis, genetic recombination causes the pollen grains to contain diverse genetic information. The structure of the pollen grain is such that it contains two sperm cells that are required for fertilisation to occur. In contrast to the above, the female gametes are housed within the ovules. The megasporocytes are diploid, and once meiosis occurs, a single functional haploid megaspore is produced. From this megaspore, the embryo sac emerges. The embryo sac contains the egg cell and other supportive cells. These cells are required for fertilisation to occur, and this contributes toward genetic diversity. In Rosa, fertilization occurs once a pollen grain lands on the stigma, and the sperm cells travel through the style to the ovule. Once the egg and sperm cell fuse, a diploid zygote is formed. This zygote contains a combination of new genetic material, which develops into a seed.

With respect to the above, flower development and the overall structure of the sporophyte is regulated by ***APETALA1*** and ***LEAFY***. Regarding the male gametes, ***TAPETUM* 1**, also called Tapetum Determinant 1, is required for pollen development. Pollen formation needs ***MS1*** and ***MS2*** genetic regulation. On the other hand, sperm cell development and function, need ***DUO POLLEN1***, and DUO1, genes during gametogenesis. Concerning the female gametes, the embryonic development stage is regulated by ***GASR***, also called the Gametophytic Asymmetric Selection Region, while ***SP/SCR***, also called the S-locus Receptor Kinase gene, regulates the interaction between the pollen and stigma. This causes fertilization to occur (Singh, 2019).

In **Zea mays**, corn, the sporophyte is diploid (Singh, 2019). This means that the sporophyte contains two sets of chromosomes. The male gametes are housed in tassels in the anthers. Within the anthers, the microspores produce haploid pollen grains. This occurs through meiosis. Due to recombination, each pollen grain contains diverse genetic material. The pollen grain structure in *Zea mays* is such that they contain two sperm cells. In contrast, the female gametes are housed in the ear. Within the ovary, the megasporocytes form once single haploid megaspore. This occurs due to meiosis. The haploid megaspore develops into the embryo sac, which contains an egg cell and other cells required for fertilisation. Just like in Rosa, fertilisation occurs once the pollen is transferred to the stigma and the sperm cells travel down the style to the egg cell. Once fertilization occurs in the ovule, a diploid zygote is formed. This zygote contains genetic contributions from both parents and it develops into a seed.

With respect to the above, gene control in the sporophyte stage is regulated by ***TEOSINTE BRANCHED***, also known as TB. This gene is involved in the development of corn plant structure. Pollen development requires ***MS1*** and ***MS2*** genes, while anther and pollen development also requires TDF1 genes. The ***Zea Expression Protein 1***, ZEP1, plays a role in pollen grain development. Concerning the female gametes, ***AGAMOUS-LIKE***, AGL, genes are involved in ovule and embryo sac development. On the other hand, ovule development is regulated by RNA-dependent RNA Polymerase6, ***RDR6***, expression.

In **Venezuela**, the country's rich biodiversity can be observed through native plant species and embryogenesis. In ***Heliconia rostrata***, also known as Lobster Claw plant, embryogenesis occurs within the vibrant tubular flowers. The development starts from the fertilised ovules within the ovary, leading to the formation of seeds that are suitable for a tropical environment. Similarly, in ***Copaifera langsdorffii***, also known as Copaiba tree, the seeds develop through embryogenesis in the large fruits. The embryo undergoes several stages of development, which eventually forms a mature viable seed. In Culantro, a plant found in Andean regions, known as ***Eryngium foetidum***, the seeds which are produced through embryogenesis are essential to propagate this culinary herb. Plant development in Venezuela's diverse ecosystem is an intricate process, and this is showcased by each of the plants above following a unique embryonic pathway that's adapted to their specific environmental conditions.

REFERENCES

Brown, D. C. (1988). Germplasm determination of in vitro somatic embryogenesis in alfalfa.

Fahey, J. W., Reed, J. N., Readdy, T. L., & Pace, G. M. (1986). Somatic embryogenesis from three commercially important inbreds of Zea mays. Plant cell reports, 5, 35-38.

Goldberg, R. B., De Paiva, G., & Yadegari, R. (1994). Plant embryogenesis: zygote to seed. Science, 266(5185), 605-614.

Lafon-Placette, C., & Köhler, C. (2014). Embryo and endosperm, partners in seed development. Current Opinion in Plant Biology, 17, 64-69.

Oridate, T., Atsumi, H., Ito, S., & Araki, H. (1992). Genetic difference in somatic embryogenesis from seeds in melon (Cucumis melo L.). Plant cell, tissue and organ culture, 29, 27-30.

San Pedro, T., Gammoudi, N., Peiró, R., Olmos, A., & Gisbert, C. (2017). Somatic embryogenesis from seeds in a broad range of Vitis vinifera L. varieties: rescue of true-to-type virus-free plants. BMC plant biology, 17, 1-12.

Singh R. 2019. Specialised features of the red speckle bean, Phaseolus vulgaris. Bio-Science Research Bulletin: Life Sciences 35 (2): 70-71.

Singh R. 2024. Report on genetic control of plant seeds undergoing gametogenesis. Research Media SR Archives.

Singh, R. (2019). Life Cycle Changes in the Ferns, Moss, Gymnosperms and Angiosperms. Voice of Intellectual Man-An International Journal, 9(1), 153-156.

Singh, R. (2024). Systematics, Biology, Economic Importance, Natural Enemies and Food Plants of Aphis (Aphis) Spiraecola Patch, 1914 (Aphididae: Hemiptera) In India. Munis Entomology & Zoology, 19(2), 771-802.

Sudhersan, C., Jibimanuel, S., & Ashkanani, J. (2011, September). Somatic embryogenesis and production of synthetic seeds in Ziziphus. In II International Jujube Symposium 993 (pp. 83-90).

****