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A Novel Study of Apomixis and Mode of Reproduction in Plant Breeding

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SUMMARY

Inventive study of Apomixis and asexual reproduction through seed, has several potential applications in plant breeding since it allows favourable genotypes to be maintained over generations. Because most major crops lack natural apomixis, it's important to understand how apomixis develops and persists in natural plant systems. The current state of knowledge on the origin, establishment, and maintenance of natural apomixis is reviewed here. Hybridization, whether on diploid or polyploid cytotypes, appears to be a primary trigger for the generation of unreduced female gametophytes, which is the first step toward apomixis, and must be paired with parthenogenesis, the development of an unfertilized egg cell, according to many studies. Despite this, most apomictic plants still require endosperm fertilisation.

INTRODUCTION

A plant breeder must consider the mode of reproduction and pollination since these factors influence the breeding processes that will be utilised to improve the genetics of a crop species. The manner of reproduction and pollination of a crop species influence the breeding procedure chosen. Reproduction is the process through which living organisms produce children of the same species (species). There are two types of reproduction in agricultural plants: sexual reproduction and asexual reproduction.

I. Sexual reproduction

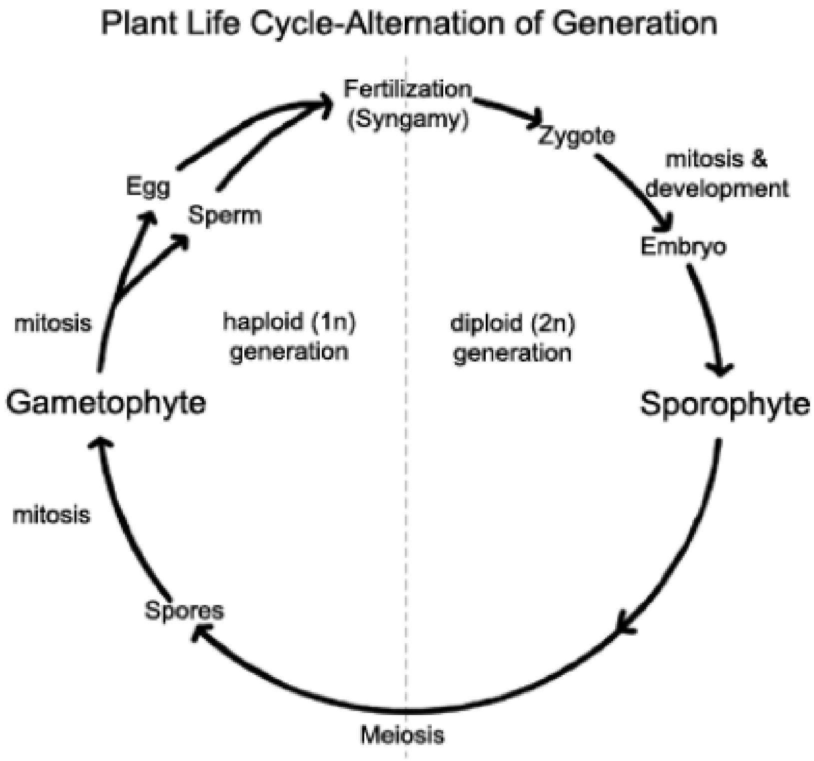
Sexual reproduction is the process of multiplying plants through embryos that have grown from the union of male and female gametes. This category includes all seed-propagating species.

Sporogenesis: Sporogenesis is the process of producing microspores and megaspores. Microspores are formed in anthers through microsporogensis, and megaspores are formed in ovules through megasporogenesis. Microspore (MMC) or pollen mother cell (PMC) are sporophytic cells in the pollen sacs of anther that undergo meiotic division to generate haploid microspores. Microsporogenesis is the process of sporophytic cells in the pollen sacs of anther undergoing meiotic division to form haploid microspores. Each PMC produces four microspores, each of which converts into pollen grain after the wall thickens.

Megasporogenesis: Megaspore mother cell (MMC) is a single sporophytic cell inside the ovule that undergoes meiotic division to create haploid megaspores, and the process is known as megasporogenesis. Each MMC creates four megaspores, three of which degenerate into one functioning megaspore.

Microgametogenesis: The generation of male gametes, or sperm, is what this is all about. The microspore nucleus divides mitotically after pollen maturation to create a generative and a vegetative or tube nucleus. In this binucleate stage, pollen is usually discharged. Pollination is the process of pollen reaching the stigma. Pollen germinates once it has been pollinated. The pollen tube moves down the style after entering the stigma. During this phase, the generative nucleus divides again to produce two male gametes or sperm nuclei. Microgametophyte refers to pollen and the pollen tube that contains a pair of sperm nuclei. Through the micropyle, the pollen tube penetrates the embryo sac and discharges the two sperm nuclei.

Fertilization: Fertilization is the process of one of the two sperms fusing with an egg cell to produce a diploid zygote. Triple fusion occurs when the remaining sperm fuse with the secondary nucleus, resulting in the development of a triploid primary endosperm nucleus. After multiple mitotic divisions, the main endosperm nucleus matures into mature endosperm, which feeds the developing embryo (Daurelio *et al.*,2004: Horandl *et al.*,2018)



II. Asexual reproduction: Asexual reproduction is the process of multiplying plants without the union of male and female gametes. Vegetative plant parts or vegetative embryos that develop without sexual fusion can both reproduce asexually (apomixis). As a result, there are two types of asexual reproduction: vegetative reproduction and apomixis. Plant multiplication by use of numerous vegetative plant parts is referred to as vegetative reproduction. Natural vegetative reproduction and artificial vegetative reproduction are the two types of vegetative reproduction.

Natural vegetative reproduction: Underground stems, sub aerial stems, roots, and bulbils are all used in nature to multiply specific plants. Underground stems (a modified clump of stems) give rise to new plants in several crop species. Rhizome, tuber, corm, and bulb are the four forms of underground stems. The following are some instances of plants that reproduce by means of underground stems:


Rhizome: Turmeric


Tuber: Potato


Bulb: Onion

Artificial vegetative reproduction Artificial multiplication of plants using vegetative elements. Cuttings of stems and roots, as well as layering and grafting, are used to reproduce.

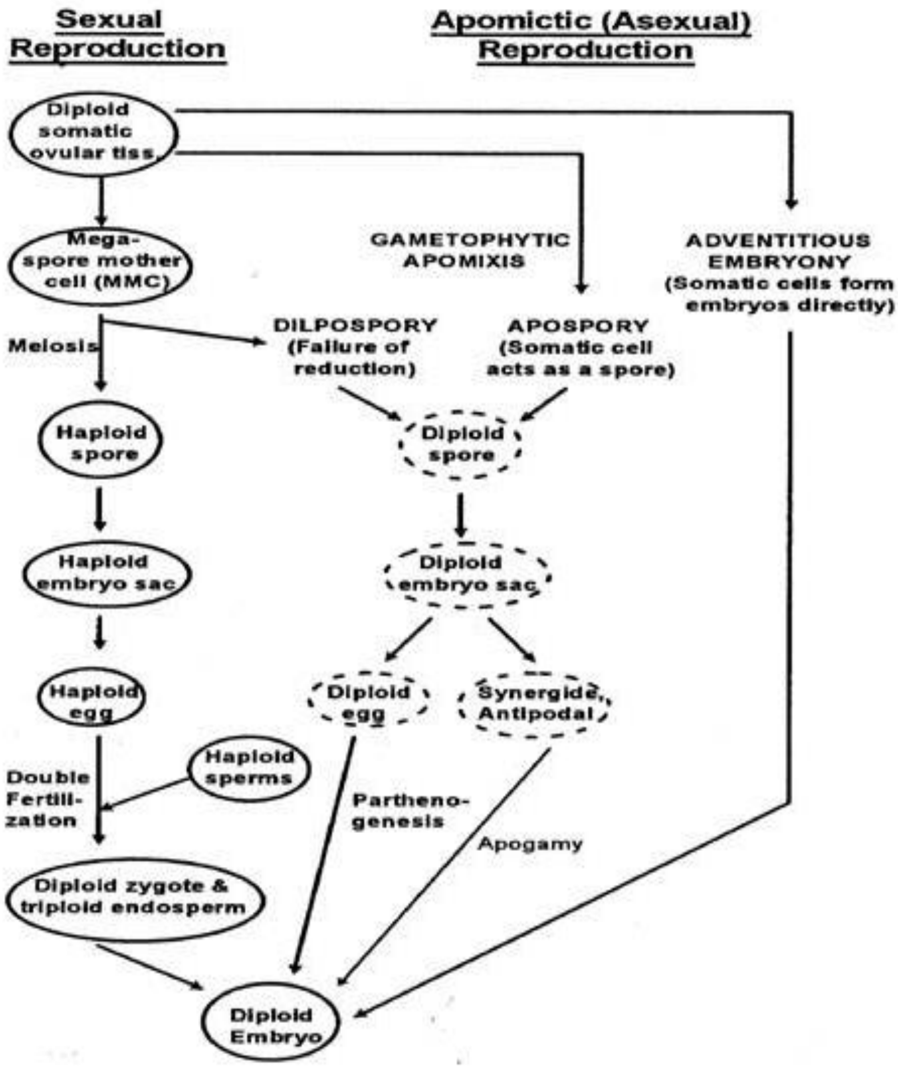
Apomixis: Apomixis is the term for seed development that occurs without sexual fusion (fertilization). Apomixis is a condition in which an embryo develops without being fertilised. As a result, apomixis is asexual reproduction.

Apomixis can be seen in a variety of crop species. Apomixis is the sole way for some animals to reproduce. Obligate apomixis is the name given to this type of apomixis. However, in other species, sexual reproduction occurs alongside apomixes (Barke *et al.*, 2018).

There are four types of apomixis: viz.

1) Parthenogenesis, 2) Apogamy, 3) Apospory and 4) Adventive Embryony.

Parthenogenesis is the process of a woman becoming a mother. The creation of an embryo from an egg cell without fertilisation is referred to as parthenogenesis. Apogamy is the term for when two people are married. Apogamy is the formation of an embryo from synergids or antipodal cells of the embryosac. Apospory is the third type of spore. The initial diploid cell of the ovule outside the embryosac develops into another embryosac without reduction in apospory. Without fertilisation, the embryo develops directly from the diploid egg cell. Embryony with a sense of adventure. Adventive embryony is the development of an embryo directly from the diploid cells of an ovule that are outside the embryosac and belong to either the nucellus or the integuments (Krahulcova *et al.*, 2011: Schmidt *et al.*, 2014).



Apomixis – classification and significance in plant breeding

Apomixis is a Greek word that combines the words "APO" (away from) and "mixis" (process of mixing or mingling). It occurs when a sexual reproductive process occurs instead of the regular sexual processes of reduced division and fertilisation. In other words, apomixes is a sort of reproduction in which homologous structures' sexual organs participate, but seeds are generated without gametes being united. The seeds produced in this manner are vegetative in nature. Obligate apomixis occurs when apomixis is a plant species' only means of reproduction (Burgess *et al.*, 2012).

Facultative apomixis, on the other hand, happens when gametic and apomictic reproduction occur in the same plant. Leuwenhock is credited with being the first to notice this occurrence as early as 1719 in *Citrus* seeds.

Apomixis is widely distributed among higher plants. More than 300 species belonging to 35 families are apomictic. It is most common in Gramineae, Compositae, Rosaceae and Rutaceae. Among the major cereals maize, wheat and pearl millet have apomictic relatives.

Types of Apomixis

1. **Recurrent Apomixis**

When meiosis is disrupted (sporogenesis fails), an embryo sac develops from the MMC or megaspore mother cell (archesporial cell) or from a neighbouring cell (in that case MMC disintegrates). As a result, the egg cell is diploic. Without fertilisation, the embryo develops directly from the diploid egg-cell. Recurrent apomixis includes somatic apospory, diploid parthenogenesis, and diploid apogamy. Diploid parthenogenesis and apogamy, on the other hand, occur solely in aposporic (somatic) embryo-sacs. As a result, recurring apomixis is caused by the somatic or diploid aposory. (Aliyu *et al.,* 2010).

2. Non -recurrent Apomixis

Without fertilisation, an embryo develops directly from a normal egg cell (n). Because an eggcell is haploid, the resultant embryo is haploid as well. This includes haploid parthenogenesis, haploid apogamy, and androgamy. Apomixis of this nature is quite uncommon. They do not reproduce and, like com, are solely of genetic importance.

3. Adventive Embryony

In oranges and roses, for example, embryos develop from a single cell or a group of cells in the nucellus or in the integuments. It is not classified as recurrent apomixis since it occurs outside the embryo sac, yet it is regenerated with the same accuracy.

Conclusion and advantages

The genetic content of plants reproduced through amphimixis is altered by the two sexual processes of self- and cross,fertilization, followed by segregation. In such plants, inbreeding and uncontrolled outbreeding also tend to disrupt heterozygote superiority. Apmicts, on the other hand, prefer to preserve their carriers' genetic structure. They can also pass down heterozygote benefits from generation to generation. As a result, such a process could be very useful in plant breeding, where maintaining genetic consistency across generations for both homozygozity (in seIfer varieties) and heterozygozity (in hybrids of both seIfers and outbreeders) is the most important goal. Furthermore, because apomixis prevents fertilisation, it may disrupt the efficient exploitation of maternal influence, if any, as reflected in the progenies, whether early or late, because it causes the perpetuation of only maternal individuals and maternal traits. Horticultural crops, particularly fruit trees and ornamental plants, are the most susceptible to maternal impacts.

CONCLUSION

Apomixis is a complex developmental characteristic that, if introduced into major crops, is projected to have a huge impact on plant breeding, decreasing the time it takes to generate a new variety and increasing profitability. Currently, apomixis is used to create forage cultivars, although there are no studies demonstrating lack of genetic homogeneity or genetic degradation in those cultivars. The mechanisms underlying the emergence and dynamics of apomixis in natural plant populations, as well as the potential results of apomixis in natural systems and its role in plant evolution, have been obscured for a long time. Knowledge of the genetic and ecological factors governing developmental interactions between meiotic and apomictic pathways, as well as population dynamics at local and regional scales, can help us not only decipher the strategies plants use to respond and adapt to the environment, but it can also be used to improve apomictic crop management and production practises.

REFERENCES

Aliyu, O. M., Schranz, M. E., and Sharbel, T. F. (2010). Quantitative variation for apomictic reproduction in the genus *Boechera* (Brassicaceae). *Am. J. Bot.* 97: 1719–1731.

Barke, H., Daubert, M., and Hörandl, E. (2018). Establishment of apomixis in diploid F2 hybrids and inheritance of apospory from F1 to F2 hybrids of the *Ranunculus auricomus* complex. *Front. Plant Sci.* 9:1111.

Burgess, M. B., Cushman, K. R., Doucette, E. T., Talent, N., Frye, C. T., and Campbell, C. S. (2014). Effects of apomixis and polyploidy on diversification and geographic distribution in *Amelanchier* (Rosaceae). *Am. J. Bot.* 101, 1375–1387.

Daurelio, L. D., Espinoza, F., Quarin, C. L., and Pessino, S. C. (2004). Genetic diversity in sexual diploid and apomictic tetraploid populations of *Paspalum notatum* situated in sympatry or allopatry. *Plant Syst. Evol.* 244, 189–199.

Hörandl, E. (2010). The evolution of self-fertility in apomictic plants. *Sex. Plant Reprod.* 23, 73–86.

Krahulcova, A., Krahulec, F., and Rosenbaumova, R. (2011). Expressivity of apomixis in 2n+n hybrids from an apomictic and a sexual parent: insights into variation detected in *Pilosella* (Asteraceae: Lactuceae). *Sex. Plant Reprod.* 24, 63–74.

Schmidt, A., Schmid, M. W., Klostermeier, U. C., Qi, W. H., Guthorl, D., Sailer, C., et al. (2014). Apomictic and sexual germline development differ with respect to cell cycle, transcriptional, hormonal and epigenetic regulation. *PLoS Genet.* 10:e1004476.