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Course: Plant Propagation and Nursery Management

Lecture No. 12

Topic: Apomixis - Definition and types

- Apomixis, derived from two Greek word "***APO***" (away from) and "***MIXIS***" (act of mixing or mingling).
- The first discovery of this phenomenon is credited to Leuwen hock as early as 1719 in Citrus seeds.
- In apomixes, seeds are formed but the embryos develop without fertilization.
- The genotype of the embryo and resulting plant will be the same as the seed parent.

Definition:

"The process of development of diploid embryos without fertilization."

Or

"Apomixis is a form of asexual reproduction that occurs via seeds, in which embryos develop without fertilization."

Or

"Apomixis is a type of reproduction in which sexual organs of related structures take part but seeds are formed without union of gametes."

In some species of plants, an embryo develops from the diploid cells of the seed and not as a result of fertilization between ovule and pollen. This type of reproduction is known as **apomixis** and the seedlings produced in this manner are known as apomicts. Apomictic seedlings are identical to mother plant and similar to plants raised by other vegetative means, because such plants have the same genetic make-up as that of the mother plant. Such seedlings are completely free from viruses.

In apomictic species, sexual reproduction is either suppressed or absent. When sexual reproduction also occurs, the apomixes is termed as ***facultative apomixis***. But when sexual reproduction is absent, it is referred to as ***obligate apomixis***.

Apomixis was defined by Winkler as replacement of the normal sexual reproduction by asexual reproduction, without fertilization. This definition notable does not mention meiosis. Thus "normal asexual reproduction" of plants, such as propagation from cuttings or leaves, has never been considered apomixis but replacement of the seed by a plantlet, or replacement of the flower by bulbils are types of apomixis. Apomixis produces embryos or seed progeny that are exact genetic replicas of the mother plant. The main advantage of apomixis over sexual reproduction is the possibility to select individual plants with superior characteristics and propagate them clonally through seeds.

Types of Apomixis:

Maheshwari (1950) classified apomixis into four groups:

1. Recurrent Apomixis:

In this type of apomixis, the embryo sac develops from the diploid egg mother cell or from some other diploid cells of the embryo sac without fertilization. Consequently, the egg has the normal diploid number of chromosomes, the same as in the mother plant. The embryo subsequently develops from egg nucleus without fertilization. This series of events is known to occur in some species of *Crepis, Poa Taraxacum* and *Allium* without the stimulus of pollination, while in others, *like Parthenium, Rubus, Malus* (apple) the stimulus of pollination appears to be necessary for the development embryo or to produce a viable endosperm.

2. Non-Recurrent Apomixis:

In this type of apomixis, the embryo develops directly from the haploid egg cell (haploid parthenogenesis) or some other haploid cells of embryo sac (haploid apogamy) without fertilization, and as a result, the embryo developed is also haploid. This type of apomixis occurs very rarely and is primarily of genetic interest. The plants produced are haploid and sterile. It is common in *Solanum nigrum* and *Lilium species* etc.

3. Adventitious Embryony or Nucellar Embryony:

Adventitious embryony is also called as nucellar embryony or nucellar budding. In this type, the embryo does not develop from the cells of the embryo sac but it develops from a cell or a group of cells either of nucellus or integuments. The cells of integument or nucellus are diploid and hence the resultant embryo is also diploid. Such embryos usually develop outside the embryo sac in addition to the regular embryo. Adventitious embryony occurs in many plant species but is most prominent in tropical and sub-tropical tree species, like citrus and mango.

4. Vegetative apomixis or bulbils:

In this type, vegetative buds or bulbils are produced in the inflorescence in place of flowers. These buds or bulbils may sprout into new plants while they are still attached to the mother plants. This type of apomixis is quite common in *Allum, Agave, Poa* and *Diascorea* and in some grasses.

Advantages

- Assured reproduction in the absence of pollinators, such as in extreme environments
- Maternal energy not wasted in unfit offspring (cost of meiosis)
- Some apomictic plants (but not all) avoid the male energy cost of producing pollen

Disadvantages

- Can't control accumulation of deleterious genetic mutations
- Usually restricted to narrow ecological niches Lack ability to adapt to changing environments

MONOEMBRYONY:

"It is the phenomenon in which only one embryo produced in a seed."

POLYEMBRYONY

"It is the phenomenon in which two or more embryos are produced in a seed."

Polyembryony means that more than one embryo develops within a single seed. It is also known as adventitious embryony (Nucellar embryony or Nucellar budding). This condition may result from many reasons but one of the most common reasons being the nucellar embryony. Sometimes more than one nucleus develops within the embryo sac, which may lead to development of more than one embryo. Further, cleavage of pro-embryo during early stages of development may be other reason for development of multiple embryos as in case of conifers. Among fruit crops polyembryony is quite common in mango and citrus.

- Polyembryony can develop from several distinct causes. Specific cells in the nucellus or sometimes with integument have embryos. Genetically, these embryos have the same genotype as the parental plant and are apomictic.
- Adventitious embryony occurs in many plant species but is most common in citrus and mango. In these species, both zygotic and apomictic embryos are produced. In other species (e.g. *Opuntia*), no pollination or fertilization is needed.
- Polyembryony is common in mango and citrus. In trifoliate orange (*Poincirus trifoliata)* several seedlings arise from one seed. of these seedlings, one seedling, usually the weakest may be sexual, and the others arise apomictically from cells in the nucellus, which are diploid copies of the mother plant.

Horticultural significance of polyembryony:

Nucellar seedlings in citrus are completely free from viruses, because the embryo sac and adjoining tissues are impregnated at flowering time with some unknown powerful substances which kills all the viruses. For immediate requirement of planting material, development of nucellar lines is the quickest and easiest method. The major possible horticultural applications of polyembryony are:

- Nucellar seedlings are true-to-type seedlings
- Such seedlings are genetically uniform and can be used as virus free rootstocks
- More vigorous seedlings – continuous vegetative propagation leads to decline in vigour in citrus
- Development of virus free seedlings and bud wood
- Significance in breeding programme

Significance of polyembryony and apomixis

Polyembryony and apomixis occur in many plant species in nature. The ability of plants to reproduce apomictically has great significance in horticulture because of the following reasons:

- These provide an opportunity for producing genetically uniform population.
- Apomictic seedlings are useful for producing uniform rootstocks in apple (*Malus toringoides* and *M. sikkimensis*), citrus and Jamun etc.
- Polyembryony demonstrates that embryogenic potential is not limited to zygote but is possessed by various other somatic cells, which forms the base for in vitro somatic embryogenesis.
- Apomictic seedlings are highly uniform and quite healthy in contrast to sexually produced seedlings.
- Apomictic seedlings are helpful for identification during hybridization (e.g. trifoliate leaf character in citrus).
- Apomictic seedlings are suitable for screening viruses, which are not otherwise transmitted through seeds.

Source:

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