

Lecture: - 2

2. Modes of Reproduction:

Reproduction refers to the process by which living organisms give rise to the offspring of similar kind (species).

In crop plants, the mode of reproduction is of two types: viz.

I) Asexual Reproduction.

II) Sexual Reproduction.

2.1 Asexual Reproduction: - Multiplication of plants without the fusion of male and female gametes is known as asexual reproduction.

➤ Asexual reproduction can occur either by vegetative plant parts or by vegetative embryos which develop without sexual fusion (apomixis).

➤ **Thus asexual reproduction is of two types:-**

1. Vegetative reproduction:-Vegetative reproduction refers to multiplication of plants by means of various vegetative plant parts. Vegetative reproduction is again of two types:-

a) Natural vegetative reproduction:-In nature, a new plant develops from a portion of the plant body. This may occur through modified underground and sub-aerial stems, and through bulbils.

➤ **Underground stems** are the underground modifications of stem generally serve as storage organs and contain many buds. These buds develop into shoots and produce plants after rooting. These are of four types: viz. rhizome, tuber, corm and bulb.

- **Rhizome:** Turmeric (*Curcuma domestica*), Ginger (*Zingiber officinale*)
- **Tuber:** Potato (*Solanum tuberosum*)
- **Corm:** Arvi (*Colocasia esculenta*), Bunda (*C. antiquorum*)
- **Bulb:** Garlic (*Allium sativum*), onion (*A. cepa*)

➤ **Sub aerial stems** are the modifications include runner, stolon, sucker etc., Sub-aerial stems are used for the propagation of mint, date palm etc.

➤ **Bulbils** are the modified flowers that develop into plants directly without formation of seeds.
Eg; Garlic.

b) Artificial vegetative reproduction: - Multiplication of plants by vegetative parts through artificial method is known as artificial vegetative reproduction. Such reproduction occurs by cuttings of stem and roots, and by layering and grafting. Examples of such reproduction are given below:

- **Stem cuttings:** Sugarcane (*Saccharum* sp.), grapes (*Vitis vinifera*), roses, etc.
- **Root cuttings:** Sweet potato, citrus, lemon, etc. Layering and grafting are used in fruit and ornamental crops.

2) Apomixis: - It refers to the development of seed without sexual fusion (fertilization). In apomixis embryo develops without fertilization. Thus apomixis is an asexual means of reproduction. Apomixis is found in many crop species.

a) Obligate apomixis:-Reproduction in some species occurs only by apomixis.

b) Facultative apomixis: - In some species sexual reproduction also occurs in addition to apomixis.

There are 4 types of apomixis :-

- Parthenogenesis:** - Parthenogenesis refers to development of embryo from the egg cell without fertilization.
- Apogamy:** - The origin of embryo from either synergids or antipodal cells of the embryo sac is called as apogamy.
- Apospory:** - In apospory, first diploid cell of ovule lying outside the embryo sac develops into another embryo sac without reduction. The embryo then develops directly from the diploid egg cell without fertilization. E.g.: Hieraceum, Malus, Crepis, Ranunculus, etc.
- Adventive embryony:**-The development of embryo directly from the diploid cells of ovule lying outside the embryo sac belonging to either nucellus or integuments is referred to as adventive embryony. E.g.; Mango, Citrus.

Significance of Apomixis:-

- It is of great help when the breeder desires to maintain varieties.
- Maintenance of superior genotypes.
- Rapid production of pure lines.
- Asexually reproducing crop species are highly heterozygous.
- Conservation of heterosis.

2.2 Sexual Reproduction:-Multiplication of plants through embryos which have developed by fusion of male and female gametes is known as sexual reproduction.

- All the seed propagating species belong to this group.
- Sexually reproducing crop plants produce a special structure, called flower which bears the essential whorls like androecium and gynoecium.
- Androecium consists of stamen and gynoecium consists of carpel.
- The male and female gametes are produced in microspores and megaspores respectively.

The steps involved in sexual reproduction are:

a) **Sporogenesis:** - Production of microspores and megaspores is known as sporogenesis.

- i) **Micro-Sporogenesis:**-In another lobe there are pollen sacs which contain numerous PMC (Pollen mother cell) undergoing meiosis, produces microspores or pollen, c/a micro-sporogenesis.
- ii) **Mega-Sporogenesis:**-Inside the ovary the ovules are present in which the MMC (Megaspore mother cell) undergoes meiosis and produces 4 megaspores out of which 3 degenerate and one survives, this process is called as mega-sporogenesis.

b) **Gametogenesis:** - During maturation of pollen, the microspore nucleus divides mitotically to produce generative and vegetative nucleus. The generative nucleus then divides to form male gametes or sperms.

- i) **Micro-gametogenesis:**- The pollen along with pollen tube and sperms is called micro-gametophyte and the production of sperms is known as micro-gametogenesis. The nucleus of functional megaspore divides mitotically three consecutive times to produce eight nuclei, which get arranged in the embryo sac.
- ii) **Mega-gametogenesis:**- The embryo sac contains generally one egg cell, two synergids, two central nuclei and three antipodals. All these cells are haploid and this process is called as mega-gametogenesis.

C) Fertilisation:-Fusion of one of the two sperms with the egg cell, to produce a diploid zygote, is known as fertilisation and the fusion of the remaining sperm with the secondary nucleus leading to the formation of primary endosperm nucleus known as double fertilisation or triple fusion.

➤ The zygote divides mitotically to produce diploid embryo. The primary endosperm nucleus produces endosperm by mitotic division; it may be absorbed completely in legumes or may form endospermous seed in cereals.

Modes of Pollination:

Pollination: - Pollination refers to the transfer of pollen grains from anthers to stigmas.

Types of Pollination: - I) Self pollination and II) Cross pollination.

Self Pollination:-It is the transfer pollen grain from the anther of a flower to the stigma of either the same or genetically similar flower. Its of two types – autogamy and geitonogamy.

a) **Autogamy** :-It is a type of pollination in which an intersexual or perfect flower is pollinated by its own pollen. It occurs by two method – homogamy and cleistogamy.

➤ **Homogamy** - The anthers and stigma of chasmogamous or open flower are brought together by growth, bending or folding.

➤ **Cleistogamy** - In this case, flowers do not open at all. This ensures complete self- pollination since foreign pollen cannot reach the stigma of a closed flower. Cleistogamy example - wheat, oats, barley and in a number of other grasses.

b) **Geitonogamy:**-It is a type of pollination in which pollen grains of one flower are transferred to stigmas of another flower belonging to either the same plant or genetically similar plants.

Cross Pollination: - It is the transfer pollen grain from the anther of one flower to the stigma of genetically different flower.It is performed with the help of an external agency.

c) **Dicliny:**- Dicliny or unisexuality is a condition in which the flowers are either staminate (male) or pistillate (female).

➤ **Monoecy:**- Staminate and pistillate flowers occur in the same plant, either in the same inflorescence, e.g., Castor, mango and coconut, or in separate inflorescences, chestnut, strawberries, rubber, grapes and cassava.

- **Dioecy**:- The male and female flowers are present on different plants, i.e., the plants in such species are either male or female, e.g., papaya, date, hemp, asparagus, and spinach. In general, the sex is governed by a single gene, e.g., asparagus and papaya. In some cases, there are hermaphrodite plants in addition to males and females, and a number of intermediate forms may also occur.
- d) Stamens and pistils of hermaphrodite flowers may mature at different times facilitating cross-pollination.
 - **Protogyny**:- In crop species like bajra, pistils mature before stamens.
 - **Protandry**:- In crops like Maize and sugar beets, stamens mature before pistils.
- e) In Lucerne or alfalfa, stigmas are covered with a waxy film. The stigma does not become receptive until this waxy film is broken. The waxy membrane is broken by the visit of honey bees which also effect cross-pollination.
- f) A combination of two or more of the above mechanisms may occur in some specie. This improves the efficiency of the system in promoting cross-pollination. For example, Maize exhibits both monoecy and protandry.
- g) **Herkogamy**- in some bisexual flowers the structure of male and female sex organs itself prove a barrier to self pollination.
- h) **Self incompatibility** – pollen grain of a flower do not germinate on there stigma of the same flower due to presence of similar self sterile gene.
- i) **Male sterility**- Male sterility refers to the absence of functional pollen grains in otherwise hermaphrodite flowers.

Often Cross Pollination: - In many crop plants, cross -pollination often exceeds 5 per cent and may reach 30 per cent. Such species are generally known as often cross-pollinated species, e.g., Jowar, Cotton, Arhar, Safflower etc.

- The genetic architecture of such crops is intermediate between self-pollinated and cross- pollinated species.

Consequently, in such species breeding methods suitable for both of them may be profitably applied. But often hybrid varieties are superior to others.