Unit-II

▶ Cultivation of drugs :

- Production of crop containing medicinal value.
- It requires intensive care & management.
- Due to controlled environment, plants with maximum secondary metabolites produced.

• Methods of cultivation :

(I) Vegetative propogation (Asexual propogation)

(II) Seed propogation (Sexual propogation)

(I) Vegetative propogation :

- Also known as Asexual propogation.
- In this, the new plant is developed from the vegetative part of a plant such as root or stem by placing it at suitable environmental conditions.
- Example of drugs obtained from vegetative propogation :

Bulbs – Garlic, squill

Tubers – Potato, Aconite

Rhizomes – Ginger, Turmeric

• Advantages of vegetative propogation :

- It is an easy, cheap & rapid method of multiplication
- All the plants developed by these methods is similar to the parent plant.

- Seedless variety of plant can be propogated by this method.
  eg. Grapes, Turmeric, etc.

(II) Seed propogation:

- Also known as sexual propogation.
- The plants which are raised from seeds are called as seedlings.
- Before germination seeds can be treated with chemical like giberellins, cytokinins & ethylene to promote growth of seedling.

- **Properties of seeds:**
- Seeds must be of good quality.
- Should have high germination rate.
- Should be free from insects & microbes.

- **Types of seed propogation:**

Seed propogation can be done by two methods:-

(a) Broadcasting method

- In this methods, small seeds are scattered on the area of cultivation.
- eg. Isabgol, Linseed.

(b) Dibbling method

- In this method, average size seeds are sown in a hole.
- eg. Papaya seeds, Castor seeds, etc.

Collection of drugs :

→ After the sufficient growth of plant, the plant material should be collected at specific season & also at specific time period, to get best quality of product.

→ After collection, the raw material is subjected to preliminary processing including —

- Washing
- Removing of extraneous / undesirable materials,
- Cutting
- Drying
- Storing.

→ The collected materials should be protected from insects, rodents, birds, pests, etc.

→ After collection to prevent it from attacking of microbes, the plant materials are properly dried & stored in well closed container.

→ The plant materials can be dried in no. of ways :—

- Sunlight
- Drying in oven
- Vaccum drying
- In spray dryer.

▶ Factors influencing cultivation of medicinal plants :

(1) Light
(2) Temperature
(3) Humidity
(4) Rainfall
(5) Soil
(6) Pest & pest management
(7) Fertilizer
(8) Plant hormones
(9) Mutation
(10) Polyploidy
(11) Hybridization.

(1) **Light** – for the continuation of life of plant it is an important source of energy.
– It influences photosynthesis, opening & closing of stomata, flowering, etc.

(2) **Temperature** – It is a crucial factor for controlling the growth, metabolism & to get the yield of secondary metabolite.
→ Extremly high as well as low temperature disturbs the quality of medicinal plants.
→ **Examples** – Saffron grows in cold climate.
– Pyrethrum grows in dry weather.

(3) **Humidity** – It also affects the plant cultivation.
→ For the growth of plant optimum humidity is required.

(4) Rainfall - for the proper development of plant, rainfall is required in proper measurements.

→ The main source of water for the soil is rain water.

→ Minerals in the soil get dissolved in water & then absorbed by plants.

(5) Soil - It provides mechanical support, water & essential food/nutrients for the development of plants.

→ It consists of air, water, mineral matters & organic matters.

(6) Pests & pests control -

→ The pests are undesired plant & animal species that causes a great damage to the plants.
- eg. Insects, microbes.

→ To get the best quality of plant products, it is very necessary to control the pests.

→ Pest control methods :-

(a) Mechanical method -
- Hand picking
- Heat treatment
- Trapping of pests.

(b) Chemical control methods - Use of pesticides like -
- Insecticides
- Herbicides
- fungicides
- Rodenticides, etc.

(c) Agricultural methods –

→ These method involves advanced techniques of plant breeding by genetic manipulations.

(7) Fertilizers :

→ The fertilizers are added to the soil, to supply nutrients for the growth of plant.

→ Types of fertilizers –

- Chemical fertilizer – e.g. Urea, ammonium sulphate, ammonium chloride, etc.
- Bio fertilizers – e.g. Rhizobium, Azotobacter, Blue green algae, etc.
- Manures – e.g. animal feces, cowdung, powdered seaweed, etc.

Plant hormones & their applications :

Definition –

→ They are the chemical substances which are responsible for the growth of plant & controlling its physiological processes.

→ They are also called as "Plant growth regulators" or "Phytohormones"

Types –

→ The plant hormones are of various types :–

- Auxins
- Gibberellins
- Cytokinin
- Ethylene
- Abscisic acid.

(A) Auxins –

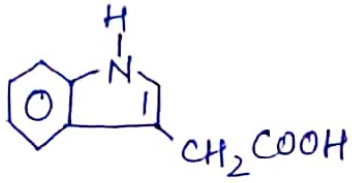
→ The term "auxin" is derived from the Greek word "auxein" which means to grow.

→ It was discovered by "Charles Darwin".

→ Type of Auxins –

(1) Natural auxin

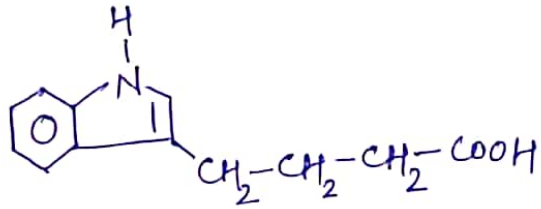
eg.



Indole-3-acetic acid (IAA)

(2) Synthetic auxins

eg.



Indole-3-butyric acid (IBA)

- **Functions of Auxin –**

→ Promotes cell elongation.
→ It stimulates differentiation in phloem & xylem.
→ It involves in different growth processes like –
  - leaf growth
  - fruit growth
  - initiation of vascular tissues, etc.

→ It promote cell division at root & shoot apex.

B) Gibberellins –

→ They are acidic in nature.
→ They are a class of endogenous plant growth regulator.
→ There are currently 136 GAs identified from plants, fungi & bacteria.
→ The gibberellins are named GA_1 ---- GAn in order of discovery.
→ They are present in different organs & tissues like – root, shoot, buds, leaves, fruits, etc.
→ Named as GA, GA_2, GA_3, ... GAn
→ 1st discovered from fungus "Gibberella fujikuroi"
→ GA_3 is called as Gibberellic acid.

- **Functions –**

→ They are able to produce morphological changes in plants.

→ They promote stem elongation.

→ They can cause parthenocarpic (seedless) fruit development.

(C) Cytokinin –

→ They are a class of purine type phytohormones.

→ They contains purine ring in its structure.

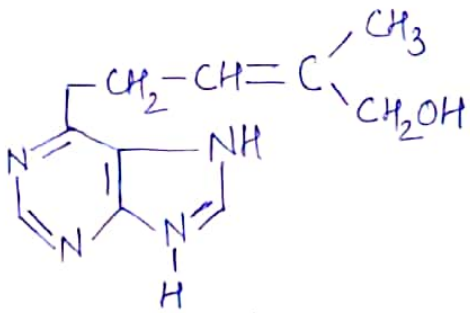
→ cytokinin breaks into –

- cyto (cell) + kinin (division)
- means cytokinin promotes cell division.

- **Types of cytokinin –**

(1) Natural

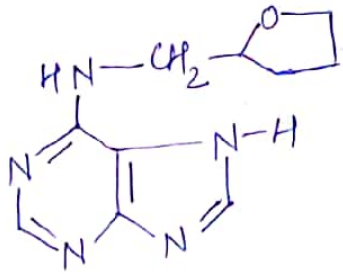
e.g. Zeatin



(Zeatin)

(2) Synthetic

e.g. kinetin



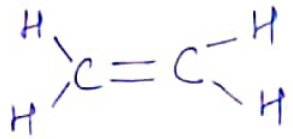
(kinetin)

- **Functions of cytokinin –**

→ They stimulates cell division.
→ Stimulates morphogenesis (shoot initiation / bud formation)
→ allows falling of plants & trees.
→ Stomatal opening.

(D) Ethylene –

→ They are the volatile hormones, simple organic molecules, present in the form of gas.
→ It is present in ripen fruits, flower, seed, stem, root, leaf, etc.
→ Structure of ethylene –



(ethylene)

→ In 1934, Gane reported that plants synthesize ethylene.
→ In 1935, Crocker propoled that ethylene is responsible for fruit ripening.

- **Functions –**

→ Fruit ripening.
→ ~~Initiation of stem elongation & bud development.~~
→ Growth inhibition.
→ Induction of flowering.

(5) Abscisic acid :

→ It is a natural plant growth inhibitor.

→ Also called as ABA.

→ It is a naturally occuring sesquiterpenoid (15- carbon) compound in plants, produced via mevalonic pathway.

→ It is called as "stress hormone". It increases the tolerance of plants toward various stresses. It induces the closure of stomata during water stress.

- **Functions** –

→ It stimulates the closure of stomata (water stress brings about an increase in ABA synthesis).

→ It promotes falling of leaves.

→ inhibits shoot growth.

→ seed & bud dormancy.

[Dormancy – the state in which a plant is alive but not actively growing.]

- One more point of ABA
  - In 1963, Fredrick Addicott & his associates, two compounds isolated named as Abscisin I & Abscisin II.
  - Abscisin II is called as Abscisic acid.

Polyploidy :

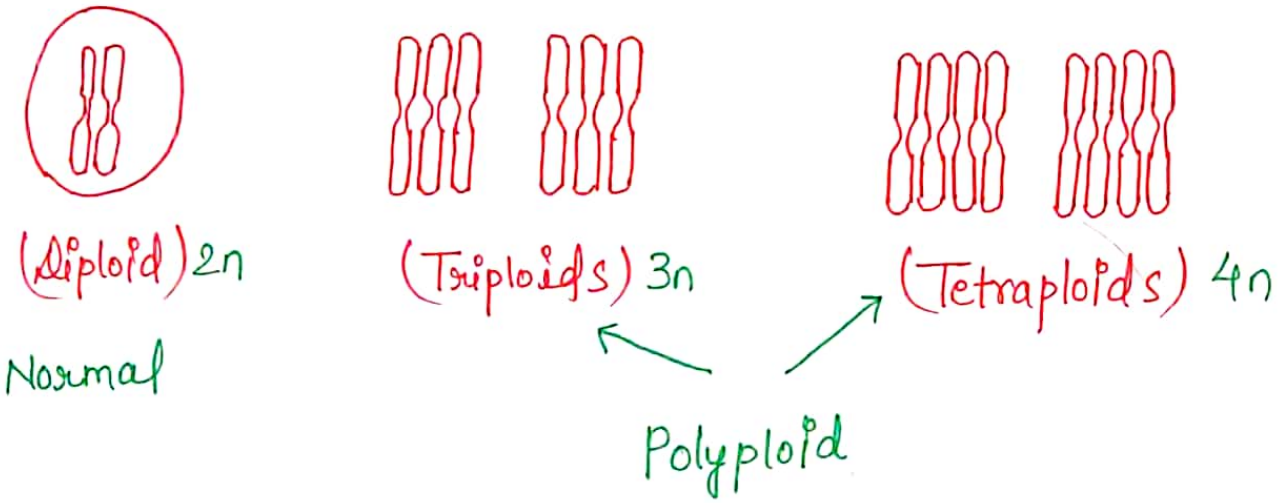
▶ definition- The state of a cell or organism having more than 2 sets of homologous chromosomes is known as polyploidy.

- poly + ploidy
  - poly → many
  - ploidy → pair of chromosomes.

- means Polyploids are organisms with multiple sets of chromosomes.

→ Most of the eukaryotes are diploid & have 2 pair of chromosome in which one set/pair is inherited from each parent.

But in case of polyploidy, a cell contains more than 2 sets/pair of chromosomes.



→ It may occur due to abnormal cell division.

▶ Classification of polyploids :

Based on the chromosomal composition, polyploids are classified on 2 classes :-

(1) Euploids —(a)→ Autopolyploidy
(1) Euploids —(b)→ Allopolyploidy
(2) Aneuploids

(1) Euploids -

→ It is a condition when a cell or an organism has one or more than one complete set of chromosomes.

(2) Aneuploids -

→ The abnormal condition in which one or more chromosomes of a normal set of chromosomes are missing or present in more than their usual no. of copies.

Points —

Euploids are further classified as -
(a) Autopolyploidy (self) - combination of genomes from single species.
(b) Allopolyploidy - combination of genomes from different species
(Auto - self, Allo - different)

- Approx 50 - 70 % of angiosperms undergone polyploidy during their evolutionary process.
- Polyploidy is important for plant evolution.
  ↓
  (means change in the characteristics of species.)

▶ Methods of induction of Polyploidy in plants :

(1) Physical agents –

e.g. X-rays, temperature (heat/cold treatments)

(2) Chemical agents –

e.g. Sulphanilamide, veratrine, hexachlorocyclohexane, colchicin, nitrous oxide, etc.

▶ Applications of polyploidy :

→ Creation of new crop species.

→ To increase the yield/content of secondary metabolite in plant.

– eg. Chemically induced polyploidy (by the help of colchicin)

↓

variation in composition of constituents in plant.

eg. – ↑ce in tropane alkaloid in belladonna; Cinchona, Lobelia, etc.

– in digitalis increase in content of Lanatoside A & B.

– in opium, increase in content of morphine concentration.

Mutation :

▶ **Definition** - A mutation is a permanent alteration / changes in the genetic material or character of an organism.

→ A Dutch botanist "Hugo De vries" coined the term "mutation".

→ It causes changes in the characteristics of a species.

→ It could be beneficial to improve the yields of phytoconstituents in plants.

→ The individuals showing these changes are known as "Mutants".

→ The agents / factors causing mutation are known as "Mutagens".

▶ **Types of mutation** -

(1) Spontaneous mutation

(2) Point mutation -
- (a) → Silent mutation
- (b) → Missence mutation
- (c) → Nonsense mutation

(3) Frame-shift mutation.

(1) Spontaneous mutation :

→ It occurs naturally without any cause.

(2) Point mutation :

→ Also called as base substitution.

→ It occurs when a single nucleotide is replaced with a different nucleotide. They are of 3 types –

(a) Silent mutation –

- In this, the mutation in DNA do not have an observable effect on the organism.

(b) Missense mutation –

- In this, single amino acid is change in the protein.
- It changes the activity of the protein.
- It may be harmful or beneficial.

(c) Non-sense mutation –

- It occurs when the sequence of nucleotides in DNA is changed in such a way that stops the normal sequence of amino acid in final protein.

(3) Frameshift mutation :

→ It is caused by the deletion or insertion of a base pair in a DNA sequence.

(4) Induced mutation :

→ The mutation can be artificially produced by the agents called mutagens.

▶ Mutagens :

The mutagens are of 2 types. They are –

(a) Physical mutagens.

(b) Chemical mutagens.

(a) Physical mutagens –

(i) Ionizing radiations – eg. X-ray, γ-ray & cosmic rays

(ii) Non-Ionizing radiations – eg. U.V. rays.

(b) Chemical mutagens –

(i) Alkylating agents – Nitrogen & Sulphur mustard, ethylsulphonate, ethylethane sulphonates.

(ii) Nitrous acid

(iii) Acridines.

▶ Applications of mutation in medicinal plants :

→ High content of solasodine is produced by applying radiation & chemical mutagens to Solanum khasianum.

→ High yield of morphine is obtained by applying chemical mutagens in Opium (Papaver somniferum).

→ Ionizing radiation is widely used to treat the seeds for crop improvement.

→ Capsaicin content is increased in capsicum using chemical mutagens.

→ Applying radiation in dioscorea in diosgenin content can be increased.

Conservation of medicinal plants :-

→ Medicinal plants are also called medicinal herbs & are used in traditional system of medicine since prehistoric times.

→ Plants synthesize hundreds of chemical compounds for functioning like -

Defence against - insects
- fungi
- diseases, etc.

→ The medicinal plants are globally valuable sources of herbal products & they are disappearing at a high speed. So, it is very necessary to conserve the plant species which are medicinally important.

→ The conservation of medicinal plants involves -

collection
↓
Propagation
↓
characterization
↓
evaluation
↓
disease elimination
↓
storage
↓
distribution.

- **Methods of conservation :-**

(1) In-situ conservation.
(2) Ex-situ conservation.

(1) In-situ conservation -

→ It is the process of protecting an endangered plant or species in its natural habitat or environment by biosphere reserves (national parks or gene sanctuary).

→ It is applied to conservation of agricultural biodiversity by using farming practices.

→ The maintainance cost of it is very high.

(2) Ex-situ conservation -

→ It is the process of protecting an endangered species of plant outside its natural habitat / environment by removing the part of plant & placing it in a new location within the care of humans.

→ In this, the genetic materials obtained from seeds or from invitro cultures (plant cells, tissues or organs) can be preserved under gene banks under optimum condition.

There are several methods ~~which are~~ for the Ex-situ conservation of plants are —

(a) Cryopreservation
(b) Cold-preservation
(c) Low-pressure & low oxygen storage.
(d) Tissue culture technique.
(e) Gene bank
(f) Seed bank.

(a) Cryopreservation:

→ It is also called as freeze preservation.

→ It involves the use of liquid nitrogen having −196°C temperature at which zero metabolism or non-dividing state occurs of plant cells & tissue under it.

→ In this, seeds, pollen, tissue or embryos are stored in liquid nitrogen.

(b) Cold preservation:

→ Cold storage refers to the conservation of germplasm or genetic materials of plant at temperature between 1-9°C.

→ This method is simple, economical & having better survival rate of plant cells or tissues.

→ In vitro developed shoots or & fruits of plant have been stored by this method.

(c) Low pressure & low oxygen storage :

→ It is an alternative method to cryopreservation & cold storage.

→ In low pressure storage (LPS), surrounding atmospheric pressure is lowered & this system is suitable for storing plant materials for short & long term.

→ In low oxygen storage (LOS), the oxygen level is reduced & the atmospheric pressure is maintained at 260 mm Hg by adding inert gas like nitrogen.

(d) Tissue culture Technique :-

→ Plant tissue culture is a quick & very efficient invitro technique for propagating plant species under aseptic environment.

→ Mainly used to conserve endangered species & production of disease free clones of plant.

(e) Gene banks & seed banks :-

→ This Technique is used for the storage of seeds, tissue culture, ~~embryos~~, embryos, cells, DNA, etc.. in a temperature & moisture controlled environment.

HYBRIDIZATION

❖ Definition:

- The combining or crossing of two genetically dissimilar plants to create a hybrid is called as Hybridization.
- It is a process through which hybrids are obtained.

❖ Types: Hybridization may be of following types:

(i) Intra-varietal hybridization:

The crosses are made between the plants of the same variety.

(ii) Inter-varietal hybridization:

The crosses are made between the plants belonging to two different varieties.

(iv) Intra-generic hybridization:

The crosses are made between two different species of the same genus.

❖ Procedure of Hybridization: It involves the following steps:

1. Selection of parents
2. Emasculation
3. Bagging
4. Tagging
5. Crossing
6. Harvesting and storing the F, seeds
7. Raising the F_1 generation.

1. Selection of parents:

- Two parents should be selected.
- One should be well adopted the nature of other variety.
- Other variety should have the characters which is absent in 1^{st} variety.

2. Emasculation:

- It can be defined as the removal of stamens or anthers or the killing of the pollen grains of a flower without affecting the female reproductive organs.

3. Bagging:

- The emasculated flower is immediately bagged to avoid pollination by any foreign pollen.
- The bags may be made of paper, butter paper, glassine or fine cloth.
- The bags are tied to the base of the stalk of the flower with the help of thread, wire or pins.
- Both male and female flowers are bagged separately to prevent contamination in male flowers and cross-pollination in female flowers.

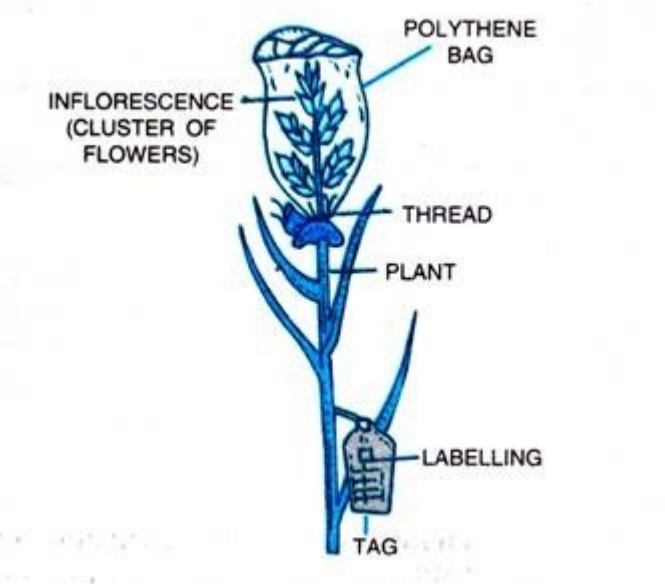


Fig: Bagging and Tagging

4. **Tagging:**
   - The emasculated flowers are tagged just after bagging.
   - Generally circular tags of about 3 cm are used.
   - The tags are attached to the base of flower with the help of thread.
   - The information given on tag must be as brief as possible.

5. **Crossing or Pollination:**

- In this method, pollens from the male parent are placed on the receptive stigma of emasculated flowers to bring about fertilization.

6. **Harvesting and Storing the F_1 Seeds:**

- Crossed heads or pods of desirable plants are harvested. Its seeds are stored properly with tags.

7. **Raising the F_1 generation:**

- In the coming season, the stored seeds are sown separately to raise the F_1 generation hybrids.

❖ Applications of Hybridization:

- For crop improvement.
- To get good quality of plant.
- To produce disease resistance, herbicide resistance and many other quality character.
- To enhance the yield of phyto-constituent in medicinal plants.
  Examples-
  - Increase in the solasodine content by the hybridization of Solanum incanum and Solanum melongena.
  - Hybridization of Cinchona succirubra and Cinchona ledgeriana, yields more amount of quinine.
