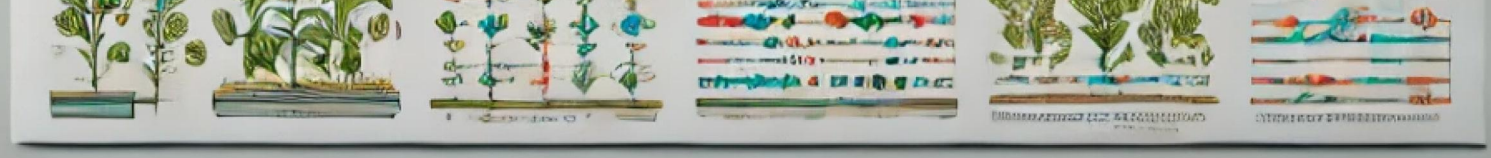


Plant Breeding

Plant Breeding

- History of convential Method of plant breeding is very old (9000 to 11000 year).
- To develop a new plant variety two methods are useful.

(i) **Conventional Methods** selection and hybridisation.

(ii) **New techniques** Mutation breeding and tissue culture.

Selection

This is oldest and simplest Method for crop improvement.

Selection is of three types:-

(a.) **Pure line selection:→** It is useful for self pollinated plant and it requires selection for 4 to 5 generation and around 10 years time.

(b.) **Mass selection:→** It is useful for self pollinated and cross pollinated plants but more useful for cross polinated plants.

It takes 5 to 6 generations and around 8 years to develop neco-variety.

(c). **clonal selection:-** This selection is for vegetatively reproducing plants.

- from this selection no new variety can be developed.

HYBRIDISATION

- It is most common method for crop Improvement.
- In this Method desired characters are brought together in a particular Variety.
- Hybridisation take place in following steps:-

Step 1 Collection of germoplasm (Variations):-

All possible Varieties of a crop are collected so all genetic combinations are brought at one place.

(a.) collection of wide Variety.
(b.) local of Desi Variety collection.
(c.) Improved Varieties but not cultivate collection.
(d). Improved varieties and cultivable.
(e). Varieties with plant breeders → These Varieties were not distributed for cultivation.

Step 2 Evaluation and selection of parents.

This step is carefully done and only those plants are selected as parents which has desirable character.

Step 3 cross hybridisation among selected parents.

This step is very time consuming and tedious/ troublesome process.

Step-4 Testing and selection of Superior Recombinatio

- This step requires carefull scientific Evoluation only those recombinants are selected which are superior to both parents (hybrid vigour).
- These recombinants are used for increasing desirable characters in future generations.

Step-5 Testing, Release and commersialisation of Newly developed Variety.

- These objectives are checked.
  - (a.) High yielding variety.
  - (b.) Resistance for local disease.
  - (c). Suitable for particular Environment and soil.
- These new varieties are checked for at least three successive seasons before they are commercialised.
- ICAR (Indian council for Agricultural Research) perform all these function.

Mutational Breeding

- With the help of Induced mutation new crop varieties can be developed but there are few limitations.

Limitations :-

- Most of the mutations are lethal.
- Most of the mutation are necessive in nature.
- Mutations are rare.
- Some Mutations show tendancy to revert back.

Example :-

Wheat → (i) Sharbati Sonara
(ii). Pusa lerma.

Rice → (i) Romai
(ii) Atomita.

Mung:- Development of resistance for Yellow Mosaic Virus (YMU) and Powdery Milden.

Applications of Plant Breeding :-

(i). To Increase yield productivity:

(a) Wheat:→ Norman E. Barlaug is known as the father of Green Revolution, got Nobel prize for peace in 1970.

M.S Swaminathan :→ father of Indian Green Revolution.

Norman E. Barlaug used Norin-10 dwarfing gene from Japan and developed sonara-64 and lerma rojo-64.

Sonara-64 $\xrightarrow{\gamma\text{-radiations}}$ Sharbati Sonara.

Lerma rojo-64 $\xrightarrow{\gamma\text{-Radiation}}$ Pusa lerma.

- In 1963, Sonalika and Kalyan Sona Varieties were developed.
- In 1960, 11 million tonnens wheat production.
- In 2000, Increased to 75 million tones.

B. Rice

- Dwarfing gene 'dee-geo-woo-gen' from Taiwan.
- From this Taichung-native 1 variety was developed.
- International Rice Research Institute, Manila, pillipines developed IR-8 and IR-24 Variety.
- Gurdev S. Khush crossed Oryza nivara (wild variety) from 13 Varieties belonging to 6 countries and developed IR-36.
- Jaya and Ratna variety of Rice were developed.
- In 1960, 35 Million tonnes rice production was there; in 2000 89.5 million tones rice production.

(c) Sugar Cane

- Saccharum barberi is a North Indian Variety it has thin stem and low sugar content.
- South Indian variety Saccharum officinarum has thick stem and high sugar but could not grow in North India. So these two Varieties were closed and new varieties were developed which has high yield, thick stem and high sugar.

2.) To develop disease Resistant Plant

Fungi → Red Rot → sugarcane
Late blight → Potato
Brown Rust → wheat

Bacteria → Black Rot → Crucifers. B.B.C

Virus → TMV, Turnip Mosaic Virus.

CROP	VARIETY	RESISTANCE TO DISEASE
Wheat	Himgiri	Leaf and stripe rust, hill bunt
Brassica	Pusa. Swarnica (Karen Rai)	white rust.
cauliflower	Pusa Shubha Pusa Snowball K-1	Block rot and curd blight black rot
Cowpea	Pusa Komal	Bacterial Blight.
Chilli	Pusa Sadabahar	chilly mosaic virus, Tobacco mosaic virus and Leaf curl.

3.) Development of crop which is resistant to insect and pest:-

Hairy leaves → cotton → Jassids
→ Wheat → Beetles.

Solid stem → wheat → stem sawfly

Smooth leaves, Nectar less → cotton → Bollworms not Attracted.

High Aspartic acid
Low N_2, low sugar
} Maize → stem borer.

CROP	VARIETY	INSECT PESTS
Brassica (Rapeceed Mustard)	Pusa Gaurav	Aphids
flat beam	Pusa Sem 2 Pusa Sem 3	Jassids Aphids and fruit, borer.
Okra (Bhindi)	Pusa Sawami Pusa A-4	Shoot and fruit borer

Abelmoscus Esculents (Bhindi) was damaged by Yellow Mosaic Virus so resistance gene was derived from wild variety and new variety developed named Prabhani Kranti.

Biofortification

840 million people are suffering from non-availability of adequate food.

3 billion people are suffering from deficiency of micronutrients, Vitamins etc (hidden hunges)

Definition: Improvement in:-

- Quality and content of protein.
- Quality and content of oil,
- Vitamin content
- Micronutrient content - is biofortification.

In 2000 hybrid Variety of Maize was developed having double amount of lysine and tryptophen.

Atlas 65 is a wheat variety rich in proteins.

- Vitamin A → Spinach, carrot, pumpkin.
- Vitamin C → Bittergound, tomato, Bathva, Mustard
- Fe and Ca → Spinach, Bathva
- Protein → Lablab, french-beans.

Plant tissue Culture

- This is latest and most promising Method for crop improvement.
- Totipotent cell's are used in this Method.

Explant → Plant part that is excited from its original location and it has ability to grow as whole plant.

Example → Shoot tip, root tip, Anther, Ovule, Embryo.

Culture Medium :→ the most common culture Medium used is Murashigice and SKoog's culture Medium.

Plantlets :→ When plant tissue culture is performed initially the growth is undifferentiated mass which is known as callus later on when growth regulators like NAA (Napthaline Acetic Acid) and BAP (benzyl aminopurine), 2-4D these are used.

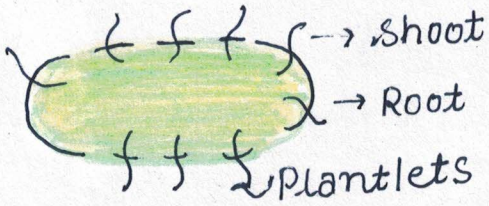
2-4-Dichlorodiphenoxy Acetic Acid.

Auxins ⟶ Root formation → NAA

cytokinitms → Shoot formation → BAP.

BAP cytokinins से shoot कर देता है।

Due to Effect of these growth regulators there is a formation of shoot and root in the culture medium These small plants are known as Plantlets.



These plantlets are transferred to green house for hardening process. Here low light and high humidity atmosphere is kept.

Types of Plant tissue Culture

(i) Meristem culture :→

- Meristem is actively dividing part at shoot tip and root tip.
- These cells are totipotent cells.

Uses of Meristem Culture

- To produce virus free culture.
- To conserve germ plasm.
- For rapid clonal multiplication.
- To produce transgenic plants.

(ii). Embryo culture :→

Embryo culture is performed in case of interspecific hybrid in such cases seeds are Exercised and Embryo is removed and cultured seperately It is known as Embryo rescue.

Uses/Applications of Embryo Rescue

- In some cases, of Interspecific hybrid Endosperm degenerates very Early. In such cases Embryo culture is performed.
- In case of orchid, seed do not have food storage for Embryo in such cases also it is helpful.
- When seed undergoes dominant state for longer duration in such cases also it is helpful.

3.) Anther culture / Haploid production:-

- Anther culture is also known as pollen grain culture or Androgenic haploid culture.
- Anther culture is haploid in nature but some time diploid plants are also formed then source of these plants will be Anther wall.
- Guha and Maheshwari introduced another culture for Datura Innoxia for the first time in India.

Uses of Anther Culture

- Haploid cultures can show Even a small mutation.
- To produces a pure line plant colchicine treatment can be used.
- For development of New pure line variety this Method take less time in comparision to Selection.

4. Somatic Hybridisation

Protoplast It is a plant cell without cell wall

When protoplast of two somatic cell is fused this process is somatic hybridisation.

Step 1 Removal of cell wall.

(a.) Removal of cell wall by Mechanical Method:-

In this method pectinases and cellulases are used.

Step-2 Fusion of protoplast.

(a.) Spontaneous fusion

- When some variety of protoplast are placed together they can fuse spontaneously.
- Not very useful.

Induced fusion

- By use of high Voltage shock.
- By treatment of polyethylene glycol (PEG).
- By treatment of calcium at high PH.
- By treatment of sodium nitrate → Interspecific hybrids are used by this Method.

Step3 culture of fused protoplast.

After somatic hybridisation these heterokaryons are grown in a culture medium to give plantlets.

Example (1)

(i) Rice and carrot fusion can be done by this Method.

(ii) Pomato → Potato + tomato.

(iii). Bomato → Brinjal + tomato.

Uses of Somatic Hybridisation.

(i) for Gene transfer.

(ii) Transfer of Cytoplasm.

(iii) Production of Allopolyploidy.

- It is also known as parasexual hybridisation.
- First Somatic hybrid between tobacco → Nicotiana glauca and Nicotiana longsdorfit.

CYBRID

When only cytoplasmic gene of one parent (Enucleated protoplast) is fused with Nucleated protoplast in such case only cytoplasm genes are hybridised so this is known as cybrid.

USES OF CYBRID

Streptomycin resistant regene Of Nicotiana tobacco is transferred to Nicotiana Siluestris. Male Sterlity gene can be transferred between Nicotiana, Brassia and petunia.

Micropropagation :-

Multiplication of genetically identical copies of a new variety by asexual reproduction is called as clonal propagation or micropropagation.

Soma Clonal Variations:

The only mode of Variations among soma clones is Mutation.

By Soma clonal Variations useful Varieties are developed:-

Wheat → Rust Resistant.

Potato → late blight Resistant

Rice → Tungro Virus Resistant
↳ Leaf hopper.