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Somaclonal Variations

Somaclonal Variation

Genetic variations in plants that have been produced by plant tissue culture and can be detected as genetic or phenotypic traits.

Basic Features of Somaclonal Variations

- * Variations in number and structure of chromosomes are commonly observed.
- * Regenerated plants with altered chromosomal changes often show changes in leaf shape and colour, growth rate and habit, and sexual fertility.
- * It is generally heritable mutations and persist in plant population even after plantation into the field.

Mechanism of Somaclonal Variations

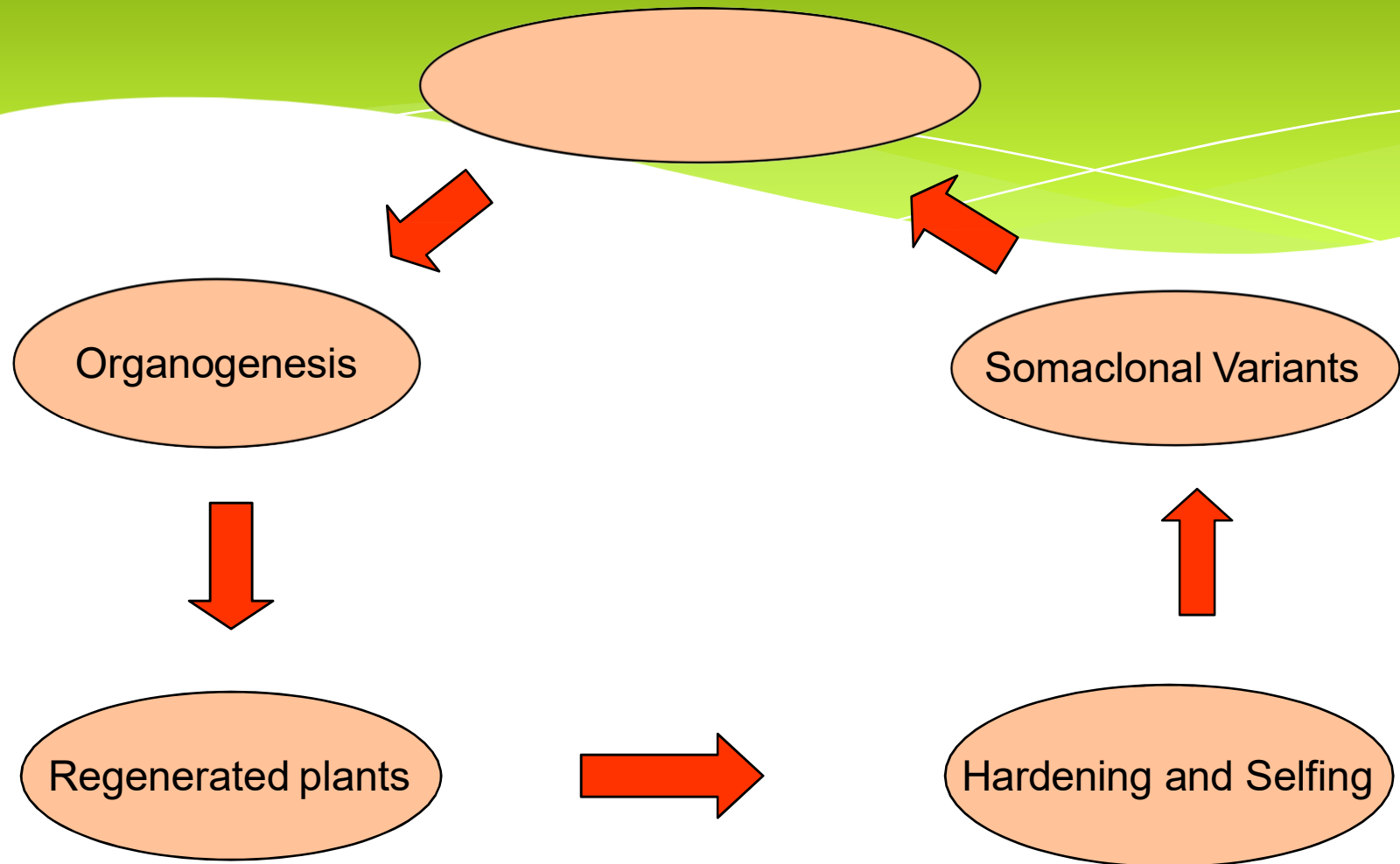
1. Genetic (Heritable Variations)

- Pre-existing variations in the somatic cells of explant
- Caused by mutations and other DNA changes
- Occur at high frequency

2. Epigenetic (Non-heritable Variations)

- Variations generated during tissue culture
- Caused by temporary phenotypic changes
- Occur at low frequency

Steps involved in induction and selection of Somaclonal Variations



Causes of Somaclonal Variations

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graph TD; A{{Causes of Somaclonal Variations}} --> B(Physiological Cause); A --> C(Genetic Cause); A --> D(Biochemical Cause);
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**Physiological
Cause**

Genetic Cause

**Biochemical
Cause**

Physiological Cause

- * **Exposure of culture to plant growth regulators.**
- * **Culture conditions**

Genetic Cause

1. Change in chromosome number

- * aneuploidy – gain or loss of 1 or more chromosomes
- * polyploidy – gain or loss of an entire genome
- * translocation – arms of chromosomes switched
- * inversion – piece of chromosome inverted

2. Change in chromosome structure

- * Deletion
- * Inversion
- * Duplication
- * Translocation

Genetic Cause

3. Gene Mutation

- * Transition
- * Transversion
- * Insertion
- * Deletion

4. Plasmagene Mutation

5. Transposable element activation

Genetic Cause

6. DNA sequence

- **Change in DNA**
 - **Detection of altered fragment size by using Restriction enzyme**

- **Change in Protein**
 - **Loss or gain in protein band**
 - **Alteration in level of specific protein**

- **Methylation of DNA**
 - **Methylation inactivates transcription process.**

Biochemical Cause

- * **Lack of photosynthetic ability due to alteration in carbon metabolism**
- * **Biosynthesis of starch via carotenoid pathway**
- * **Nitrogen metabolism**
- * **Antibiotic resistance.**

Detection and Isolation of Somaclonal Variants

1. Analysis of morphological characters

- * Qualitative characters: Plant height, maturity date, flowering date and leaf size
- * Quantitative characters: yield of flower, seeds and wax contents in different plant parts

2. Variant detection by cytological Studies

- * Staining of meristematic tissues like root tip, leaf tip with feulgen and acetocarmine provide the number and morphology of chromosomes.

3. Variant detection by DNA contents

- * Cytophotometer detection of feulgen stained nuclei can be used to measure the DNA contents

Detection and Isolation of Somaclonal Variants

4. Variant detection by gel electrophoresis

- * Change in concentration of enzymes, proteins and chemical products like pigments, alkaloids and amino acids can be detected by their electrophoretic pattern

5. Detection of disease resistance variant

- * Pathogen or toxin responsible for disease resistance can be used as selection agent during culture.

6. Detection of herbicide resistance variant

- * Plantlets generated by the addition of herbicide to the cell culture system can be used as herbicide resistance plant.

Detection and Isolation of Somaclonal Variants

7. Detection of environmental stress tolerant variant

- * Selection of high salt tolerant cell lines in tobacco
- * Selection of water-logging and drought resistance cell lines in tomato
- * Selection of temperature stress tolerant in cell lines in pear.
- * Selection of mineral toxicities tolerant in sorghum plant (mainly for aluminium toxicity)

Advantages of Somaclonal Variations

- * **Help in crop improvement**
- * **Creation of additional genetic variations**
- * **Increased and improved production of secondary metabolites**
- * **Selection of plants resistant to various toxins, herbicides, high salt concentration and mineral toxicity**
- * **Suitable for breeding of tree species**

Applications to crop improvement

- * **Improvement of existing clonal cultures**
 - * sugarcane – selections for higher yield & disease resistance
 - * potatoes – yield & disease resistance
 - * improved geraniums (esp. scented varieties)
 - * woody ornamentals (e.g., Paulownia – selection for leaf variegation)

Disadvantages of Somaclonal Variations

- * A serious disadvantage occurs in operations which require clonal uniformity, as in the horticulture and forestry industries where tissue culture is employed for rapid propagation of elite genotypes
- * Sometime leads to undesirable results
- * Selected variants are random and genetically unstable
- * Require extensive and extended field trials
- * Not suitable for complex agronomic traits like yield, quality etc.
- * May develop variants with pleiotropic effects which are not true.



THANK YOU