Covered topics,
Distance Learning course Plant Breeding M1-M5

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The five main modules consist of the following content:

Module 1 Principles of plant breeding

1. Modes of reproduction

- Introduction
- Reproduction modes
- Autogamous crops
- Consequences of self-fertilisation
- Crops with Clonal Reproduction
- Allogamous Crops
- Genotype and allele frequencies of allogamous crops
- Genotype and allele frequencies continued
- Breeding in allogamous crops

2. Phenotype and genotype

- Phenotype and genotype
- The relationship between phenotype and genotype
- Determining the genotypic variation
- Quantification of the non-genetic variation on the basis of a pure line
- Quantification of non-genetic variation using experimental blocks
- Parent-offspring regression
- Heritability
- Calculating heritability
- Using heritability in breeding
- Quantifying the genotypic variation in the progeny of a cross
- Narrow and wide sense heritability
- High heritability implies good opportunities for selection
- Closing remarks

3. Selection methods

- Selection methods
- Selection methods for autogamous crops
- Mass selection
- Bulk breeding
- Pure line selection
- Pedigree selection
- Single-seed descent
- Dihaploid lines and single-seed descent
- Backcross breeding
- Extra explanation on linkage drag
- Backcross breeding continued
- Recurrent selection

Module 2 Marker-assisted selection

1. Introduction

2. Markers

- What is a genetic marker?
- Types of genetic markers
- Polymorphic versus monomorphic DNA markers
- DNA markers
- Extra explanation: DNA markers: polymorphic or monomorphic; dominant or codominant
- Types of DNA markers
- SNPs
- Extra explanation SNP
- SCAR
- SSRs or 'microsatellites'
- Extra explanation SSRs
- Characteristics of some types of DNA marker
- Running the markers

3. Linkage mapping

- Background: Genotype, phenotype and traits
- Extra explanation: genotype and phenotype
- Linkage
- Extra explanation: independent assortment
- Linkage, recombination and map distance
- Extra explanation: linkage, recombination and map distance
- Why use linkage maps?
- Extra explanation: linkage maps
- How to make a linkage map
- Step 1. Development of a mapping population
- Extra explanation: development of a mapping population
- Development of a mapping population in autogamous species
- Development of a mapping population in allogamous species
- Development of a mapping population in polyploid plant species
- Step 2. Genotyping: identification of polymorphism
- Extra information: identification of polymorphism
- Step 3. Linkage analysis of markers
- Extra questions: linkage analysis of markers
- Linkage analysis in practice
- Example of linkage between a marker and a resistance gene
- Map distances and markers
- Extra explanation: linkage analysis in practice
- Genetic map vs. physical map
- Genetic mapping functions
- Genetic mapping functions (continued)
- Errors in genotype scoring
- Steps to perform - an example
- Final remarks - not a fixed solution

4. QTL analysis

- Step 4: Phenotyping: from linkage map to QTL analysis
- Step 5: QTL Analysis
- Extra explanation on QTL analysis
- Likelihood of QTLs: LOD score
- Extra explanation on LODs
- Methods to detect QTLs
- QTL methods: single-marker analysis
- Extra explanation on single-marker analysis
- QTL detection methods: simple-interval mapping
- Extra explanation on simple-interval mapping
- QTL detection methods: composite-interval mapping
- About finding QTLs
- Marker numbers and spacing
- Making comparisons between maps
- QTLs among populations
- Extra explanation QTLs among populations
- Shortcuts for gene tagging
- Bulked segregant analysis
- Selective genotyping
- Extra explanation BSA and selective genotyping
- What's next?

5. MAS in breeding

- Marker-assisted selection in breeding programs
- From markers to breeding
- High-resolution mapping
- High-resolution mapping II
- High-resolution mapping of specific chromosomal regions
- Extra questions
- Marker validation
- Extra explanation on marker validation
- Haplotype
- Marker conversion
- Extra explanation on marker conversion
- Selection of QTLs
- Early generation selection
- Extra: saving time and money
- Marker-assisted backcrossing (MAB)
- Extra explanation on marker-assisted backcrossing
- Marker-assisted gene pyramiding
- Simultaneous selection for multiple traits
- Cost/benefit analysis of MAS

Module 3 Resistance to biotic factors

1. **Introduction**
2. **Part I Barley leaf rust (4 pages)**
3. **Part II Partial resistance (3 pages)**

Module 4 F1 hybrids

- F1 hybrid breeding: what and why
- Procedure
- Advantages
- F1 breeding in autogamous crops
- F1 breeding in allogamous crops
- Weak plants and poor seed production
- Double-cross hybrids
- What is heterosis? Hypotheses
- How to identify heterotic pools
- General and specific combining ability
- Top crosses to test GCA
- The F1 hybrid breeding programme
- Procedural bottlenecks
- Tomato: preventing outcrossing and selfing
- Maize: preventing outcrossing and selfing
- Application of male-sterility
- Cytoplasmic male sterility
- Maintainer line
- Genetic vulnerability
- Comparing open pollinated varieties with F1 hybrid cultivars

Module 5 Mutation Breeding

A: changes at the genome and chromosome level

- Levels of DNA alterations and their effects
- Ploidy changes
- Autoploids and allopoids
- Effect of ploidy changes on phenotypes of plants
- Use of ploidy changes in breeding
- Synthetic alloploids
- Doubling of chromosome number in somatic cells and gametes
- Consequences of FDR and SDR
- Halving the ploidy level
- Aneuploidy
- Structural differences in chromosomes
- Effects of structural chromosome rearrangements

B: changes at the DNA level

- Types and frequency of DNA sequence differences
- Allele mining and haplotype
- Accumulation of mutations
- Phenotypic effects of mutations
- Altered gene function
- Induction of mutations in conventional breeding
- Factors determining the success of the mutagenic treatment
- Loss and gain of function
- Redundancy of the gene-to-be-mutated
- Pleiotropic effects
- Type, dose and duration of mutagenic treatment
- Mutation induction using insertion of transposons or T-DNA constructs
- Type of tissue treated
- Creating novel variation in seed propagated plants
- Independent mutations

- The tunica-corpus theory in vegetatively propagated plants