Online course Plant Breeding

Covered topics

The complete online course Plant Breeding provides you with a concise overview of basic principles of plant selection and principles associated with genetic markers, linkage mapping, QTL-analysis, resistance against pathogens, F1 hybrids and mutation breeding. In this document the chapters and paragraphs per module are addressed.

Wageningen Academy
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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. **Marker Assisted Selection 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
- Autopoloids and allopoloids
- Effect of ploidy changes on phenotypes of plants
- Use of ploidy changes in breeding
- Synthetic allopoloids
- 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