SEED ORCHARD CONFERENCE

A New Generation of Clonal Seed Orchards of Wild Cherry

Selection of Clones and Spatial Design

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About picky trees and stubborn bumble bees

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Clonal Seed Orchard of Wild Cherry – Constitution and Design

- Why wild cherry ?
- Why selection and breeding ?
- Why seed orchards ?
- and …. how ?

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Why wild cherry ?**
  - **High-grade timber**
    - **Prices standing timber**
      - **DBH ~ 50 cm : 200 € / m³**
      - **DBH ~ 80 cm : 500 € / m³**
  - **Silvicultural importance**
    - Valuable component of mixed hardwood stands
  - **Potential alternative for poplar for afforestation of set-aside or abandoned farmland**
  - **and… "*doing a bit of everything is the best excuse for doing something pretty close to nothing*"**

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Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Why selection and breeding ?**
  - **Annual demand for FRM ~ 30 kg of seeds**
  - **Before the Council Directive 1999/105/EC**
    - **Certification of FRM non-compulsory**
    - **Demand for FRM amply met by supply**
    - **Quality of FRM often unknown and mostly very bad**
  - **October 23th, 2003: implementation of Council Directive in Flemish forest law**
    - **Certification of FRM becomes compulsory**
    - **Genetic quality of FRM has to be warranted**
    - **Additional subvention for (re)forestation is confined to "recommended" (= indigenous) basic material**

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Why selection and breeding ?**
  - **Demand Supply**
  - **Indigenous basic material**
    - **FRM of category "source identified" not allowed for forestry purposes**
    - **Two seed stands**
    - **One seed orchard**
  - **Seed stands** (1/2)
    - **"*Vrebos*" (0.28 ha) & "*Rattenberg*" (0.37 ha)**
    - **Low yield ~ 10 kg in good crop years**
    - **Harvest is not cost-effective: cost price = 4 x selling price**

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- **Why selection and breeding ?**
  - **Seed stands** (2/2)
    - **"*Vrebos*" is likely to be deleted from the National Register**
    - **Low genetic diversity (16 SSR's)**
      - root suckering: 402 individuals → 71 genotypes

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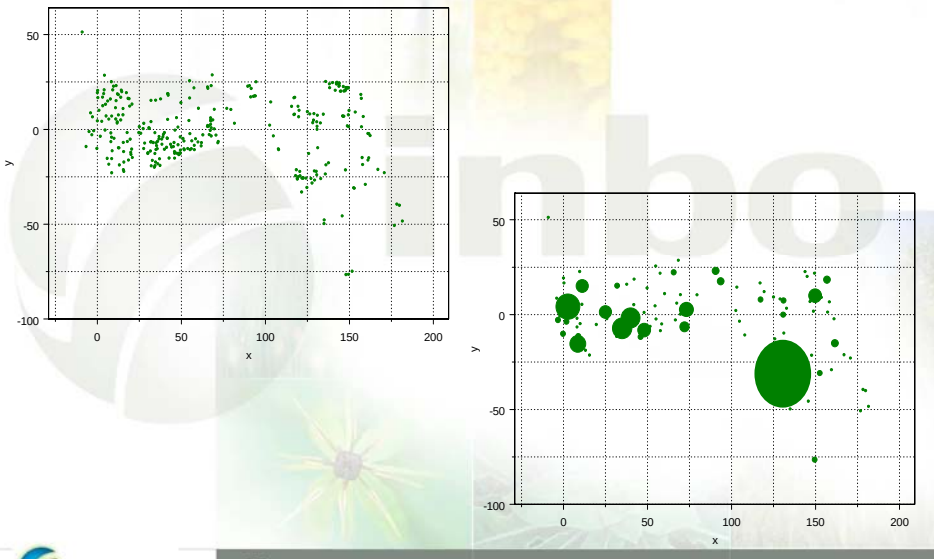

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Why selection and breeding ?**
  - **Seed stands** (2/2)
    - **"*Vrebos*" is likely to be deleted from the National Register**
    - **Low genetic diversity (13 SSR's)**
      - root suckering: 402 individuals → 64 genotypes
      - genetic distance < 0.23
    - **Cross-compatibility**
      - Gametophytically: 20 different *S*-genotypes
      - Phenologically: flowering period of clusters to be assessed
    - **Indication of introgression of sweet cherry varieties** (to be confirmed)

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Why selection and breeding ?**
  - **Seed orchard**
    - **"*Mommedeel*" (° 1988 - 0.82 ha)**
    - **65 genotypes selected in two populations**
    - **Moderate yield ~ 20 kg in good crop years**
    - **Recent severe dieback**
      - unsuitable site
      - rejection of grafts

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- Why wild cherry ?
- Why selection and breeding ?
- Why seed orchards ?
- and …. how ?

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- Why seed orchards ?
  - No perspectives for selection of additional seed stands
  - Seed orchards
    - enhanced yield and ditto genetic quality of offspring (IF well conceived)
    - possibility for intensive management
    - harvest less labour-intensive (i.e. low-cost)

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- and …. how ?
  - Selection of constituents
  - Spatial design
  - Spatial isolation
  - Management

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- **Selection of clones**
  - **Source = basic collection of 157 plus trees selected in 27 populations in the early 80's**
  - **Vegetative replica of plus trees planted in 6 multiclonal plantations**
  - **Seed harvest in multiclonal plantations**
  - **Establishment of 13 half-sib progeny tests (Σ = 15.3 ha)**
  - **Assessment of h^2_A & General Combining Ability**
  - **Construction of selection index**

$$I_S = \sum_{i=1}^{n} (h^2_A * GCA)_i$$

with n = number of traits assessed

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Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Selection of clones**
  - **Selection criteria**
    - **Vigour (height growth)**
    - **Morphology**
      - stem straightness
      - branching habit (number, tickness, angle of branches)
      - apical dominance
    - **Phenology**
      - flushing
      - bud set
      - St. Johns sprouts
    - **Disease resistance**

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Selection of clones**
  - **Selection criteria**
    - **Disease resistance**
      - anthracnosis *Blumeriella jaapii* (observation of natural infections)
      - bacterial canker *Pseudomonas syringae* pv. *syringae / morsprunorum / avii* (artificial infections)

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- **and …. how ?**
  - Selection of constituents
  - **Spatial design**
  - Spatial isolation
  - Management

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Spatial design**
  - **Wild cherry is entomophilous**
  - **Pollen vectors = mainly bumble bees**
    - **Leave a scent mark on flowers they visit**
    - **Tend to forage on small groups of trees**
  - **Patch-like pollination pattern is suspected**
    - **Test case: multiclonal plantation (105 genotypes)**
    - **Parenthood analysis**
      - selection of 16 equally distributed mother trees
      - ad random selection of 60 seedlings in the half-sib offspring of each mother tree
      - identification of fathers using
        16 SSR's (DP 0.76 → 0.95)
        SI-genotype (DP=0.98)

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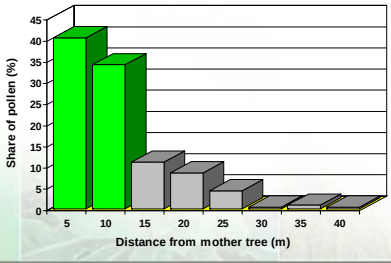
- **Spatial design**
  - **Parenthood analysis**
    - **21 % of the fathers are located outside the plantation**
    - **Internal pollen flux: 75% of the pollen donors within a distance of 10 m from the mother tree (= 2 x planting distance)**
    - **Paternal contribution was influenced by flowering period and *S*-(in)compatibility but <u>not</u> by flowering abundancy**
    - **Exclusion method**
    - **SSR's: Parent exlusion probability > 0.99**



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- **Spatial design**
  - **Neighbouring trees in future seed orchards should be cross-compatible**
    - **phenologically: overlap of flowering period**
    - **gametophytically: different SI-genotype**

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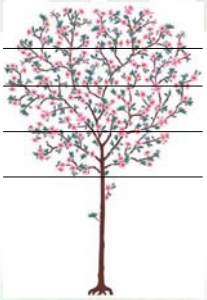
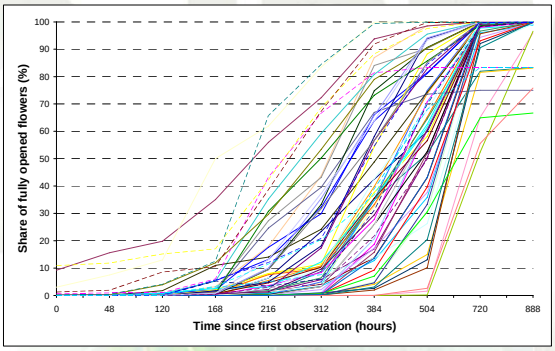
- **Spatial design**
  - **Phenological compatibility**
    - **Observation of flowering period**
      - crown divided into 4 strata
      - per stratum : observation of share of fully opened flowers every 48 hours for more then one month
    - **Observation in 4 plantations**
    - **Observation in 2002 and 2004**



Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Spatial design**
  - **Phenological compatibility**
    - **Observation of flowering period**



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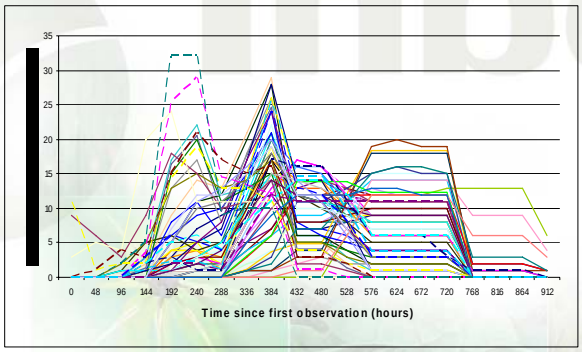
- **Spatial design**
  - **Phenological compatibility**
    - **however…**

- fully opened flowers only receptive for 38 hours
- viability of pollen in pollen bags of bumble bees = 12 hours



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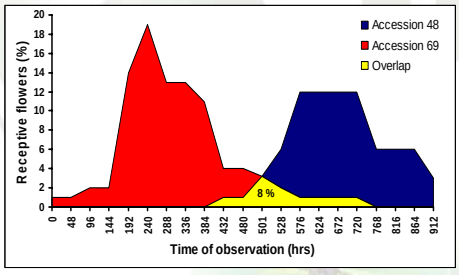

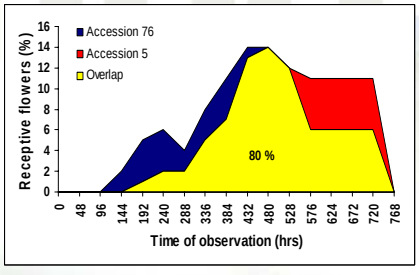

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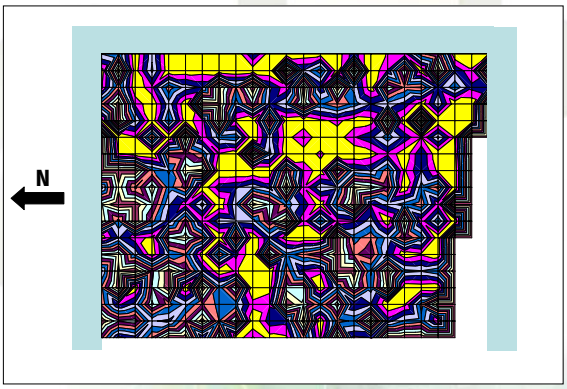
- **Spatial design**
  - **Phenological compatibility**
    - **furthermore…**

      - no influence of exposure or location within the plantation



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- **Spatial design**
  - **Phenological compatibility**
    - **furthermore…**

      - no influence of exposure or location within the plantation
      - no significant intra-clonal variation
      - no significant differences between sites
      - observations of 2002 & 2004 are concordant
      - and…btw…~ 51,000 observations

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- **Spatial design**
  - **Gametophytic compatibility**
    - **Governed by a multiallelic & highly polymorhic *S*-locus** (13 *S*-alleles in sweet cherry cv's + 11 *S*-alleles in wild cherry)
    - **Individuals with the same *S*-genotype are cross-incompatible**
    - **Molecular identification of *S*-alleles**

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- **Spatial design**
  - **Gametophytic compatibility – Molecular assessment**
    - **sizing of introns**

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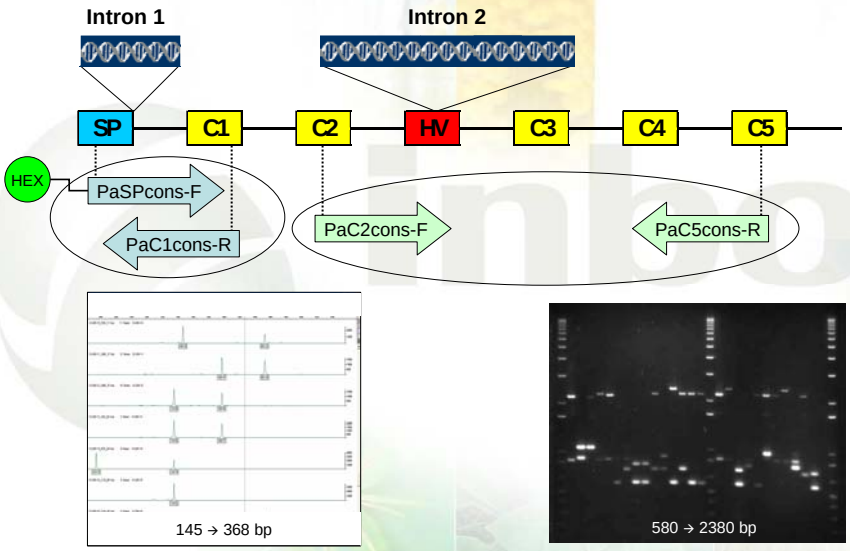

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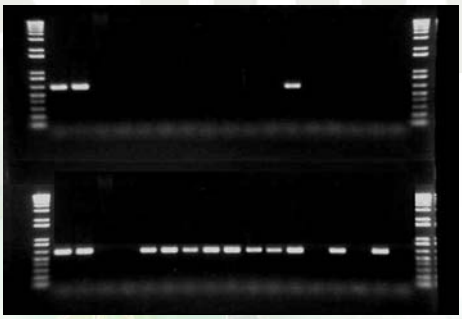
- **Spatial design**
  - **Gametophytic compatibility – Molecular assessment**
    - sizing of introns
    - allele-specific PCR



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- **Spatial design**
  - **Gametophytic compatibility – Confirmation**
    - **controlled crosses**

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- **Spatial design**
  - **Major spin-off**
    - **parenthood analysis → ~ incomplete diallel cross**
    - **determination of SCA for 51 combinations of clones**
    - **neighbouring trees should not only be cross-compatible but also have high SCA-values**

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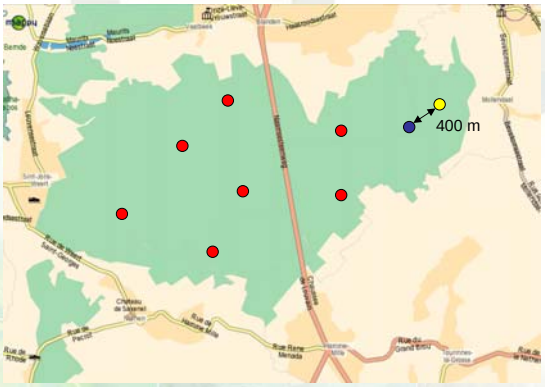
- **and …. how ?**
  - Selection of constituents
  - Spatial design
  - **Spatial isolation**
  - Management

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Spatial isolation**
  - **Minimizing genetic pollution**
  - **21 % of the pollen is coming from outside the plantation**

	79%
	17%
	4%



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  - Spatial design
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  - **Management**

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- **Establishment & Management**
  - **Vegetative propagation of mother trees**
    - **grafting on dwarfing rootstock**
    - **“Gisela 5” : compromis between dwarfing / compatibility**
  - **Planting in espalier**
  - **Bird nets**
  - **Bumble bee nests**
  - **Induce early and abundant flowering**
    - **pruning**
    - **tearing and bending of branches**
    - **use of herbicides**
    - **cutting of roots**

Clonal Seed Orchard of Wild Cherry – Constitution and Design

- **Staff**
  - **Breeding**
    - Bart De Cuyper – Senior researcher
    - An Van Breusegem – Lab assistant
    - Wim Stevens – Field technician
    - Steven Haelterman – Field technician
  - **Pathology**
    - Marijke Steenackers – Senior researcher
    - Sabrina Neyrinck – Lab assistant
    - Kurt Schamp - Field technician