
ROSE BREEDING
TEXAS A&M UNIVERSITY
http://www.facebook.com/tamuroses

Two Creative Rose Breeders

Robert Basye

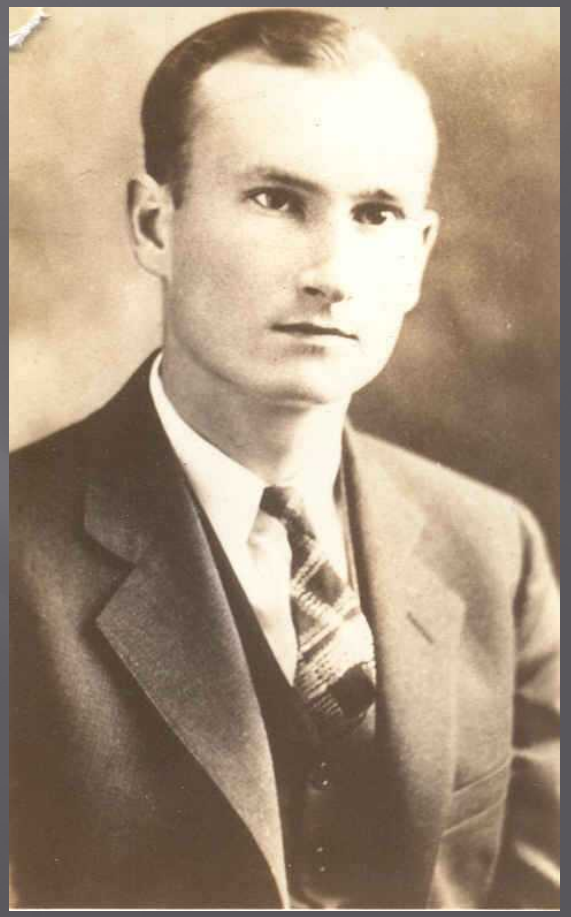
2000

Ralph Moore

2009

Late 1930s

- Robert Basye
  - TAMU mathematician
  - Rose breeding as hobby
  - Brazos Valley in Texas
  - Emphasis on disease resistance



Carefree Roses

"Develop the bush on which to hang those wonderful flowers"

Established Basye Endowed Chair in Rose Genetics in 1991

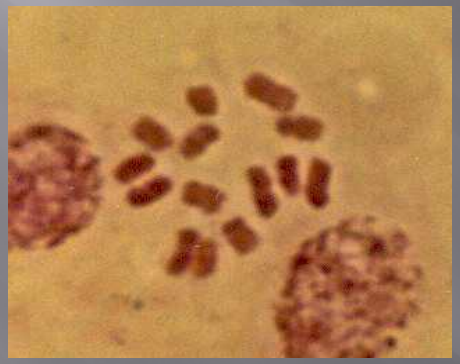
Created Amphidiploids

rugosa
rubra

wichurana

Sterile diploid hybrid

Doubled the Chromosome Number



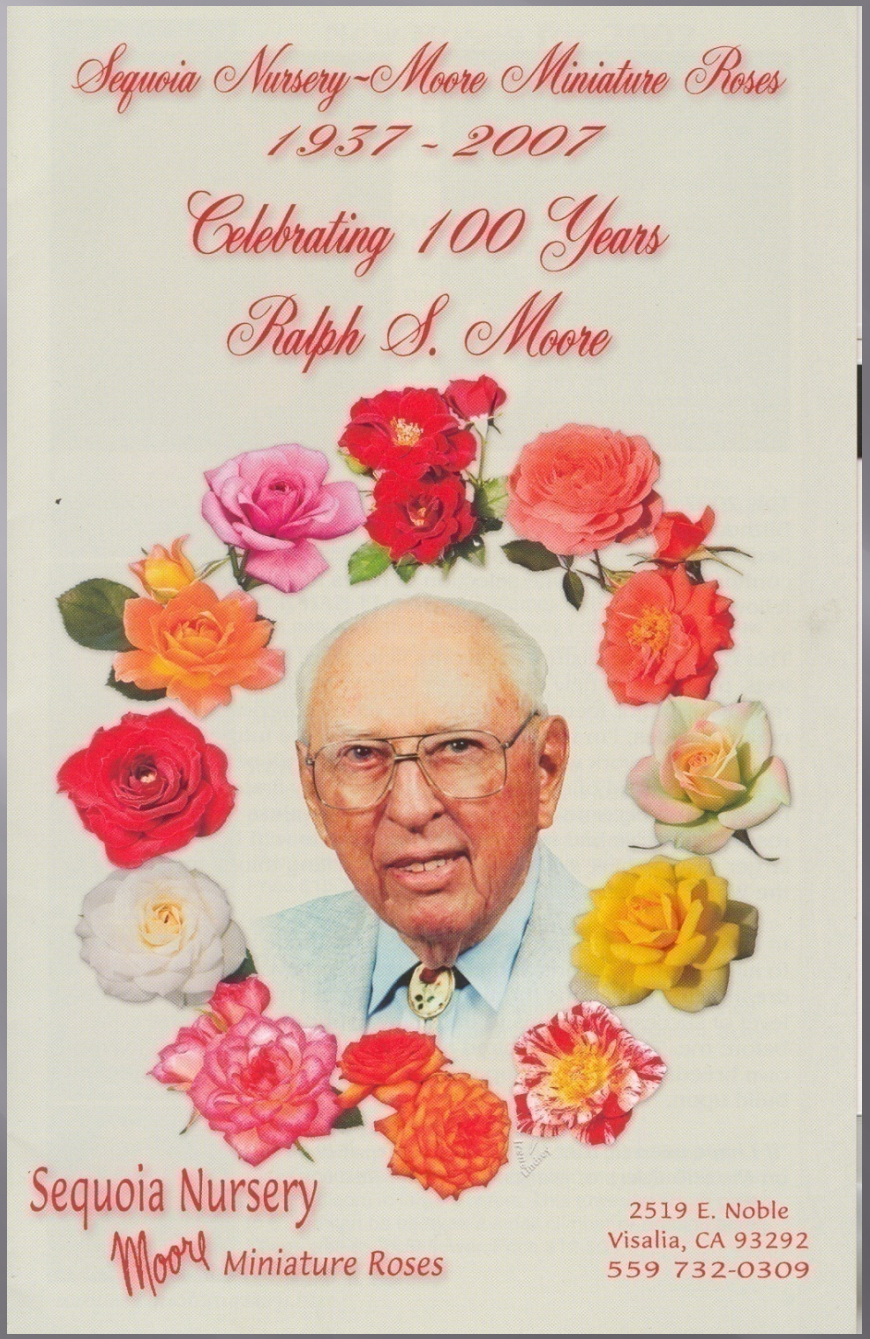
Basye's Purple
Belinda's Dream
Basye's Blueberry
Basye's Legacy
Basye's Myrrh Scented

Late 1930s

- Ralph Moore
  - Sequoia Nursery, 1937
  - Breeder and nurseryman
  - San Joaquin Valley in California
  - Unique plant and flowering traits

Sequoia Nursery

Met in 1991



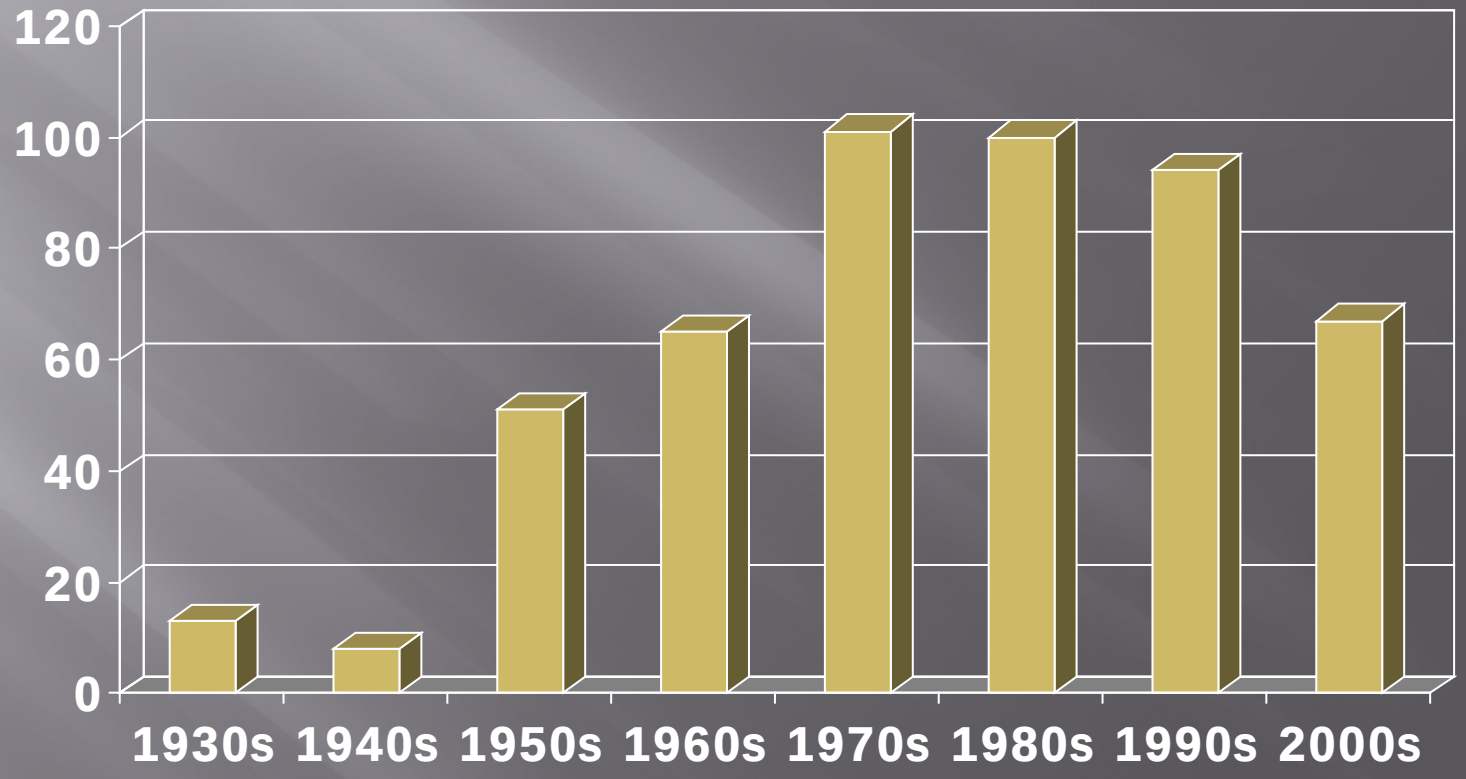
October 2007 Donation

Education

Research

Sustainability

Roses by Ralph Moore
Father of the Miniature Rose



Miniature Roses

Joycie
Rennie
Little Buckaroo
Ring of Fire
Rise N Shine

Stripes

Stars N Stripes
Earthquake
Charlie Brown
Love and Peace
Twister
Striped Rugosa

Halo Roses

Halo Sunrise
Halo Fire
Halo Star

Hulthemia Hybrids

Persian Flame
Persian Light
Persian Peach
Persian Sunset
Persian Yellow

Moss Roses

Fairy Moss
Goldmoss
Kara
Dresden Doll

Crested Roses

Crested Jewell
Crested Sweetheart
Queencrest
Robin Red Crest

Bracteata Hybrids

Rugosa Hybrids

Linda Campbell
Topaz Jewell
Moore’s Striped Rugosa

Species Used

Moore

Hulthemia persica
Rosa wichurana
Rosa bracteata
Rosa soulieana
Rosa rugosa
Rosa nutkana
Rosa chinensis
European species

Basye

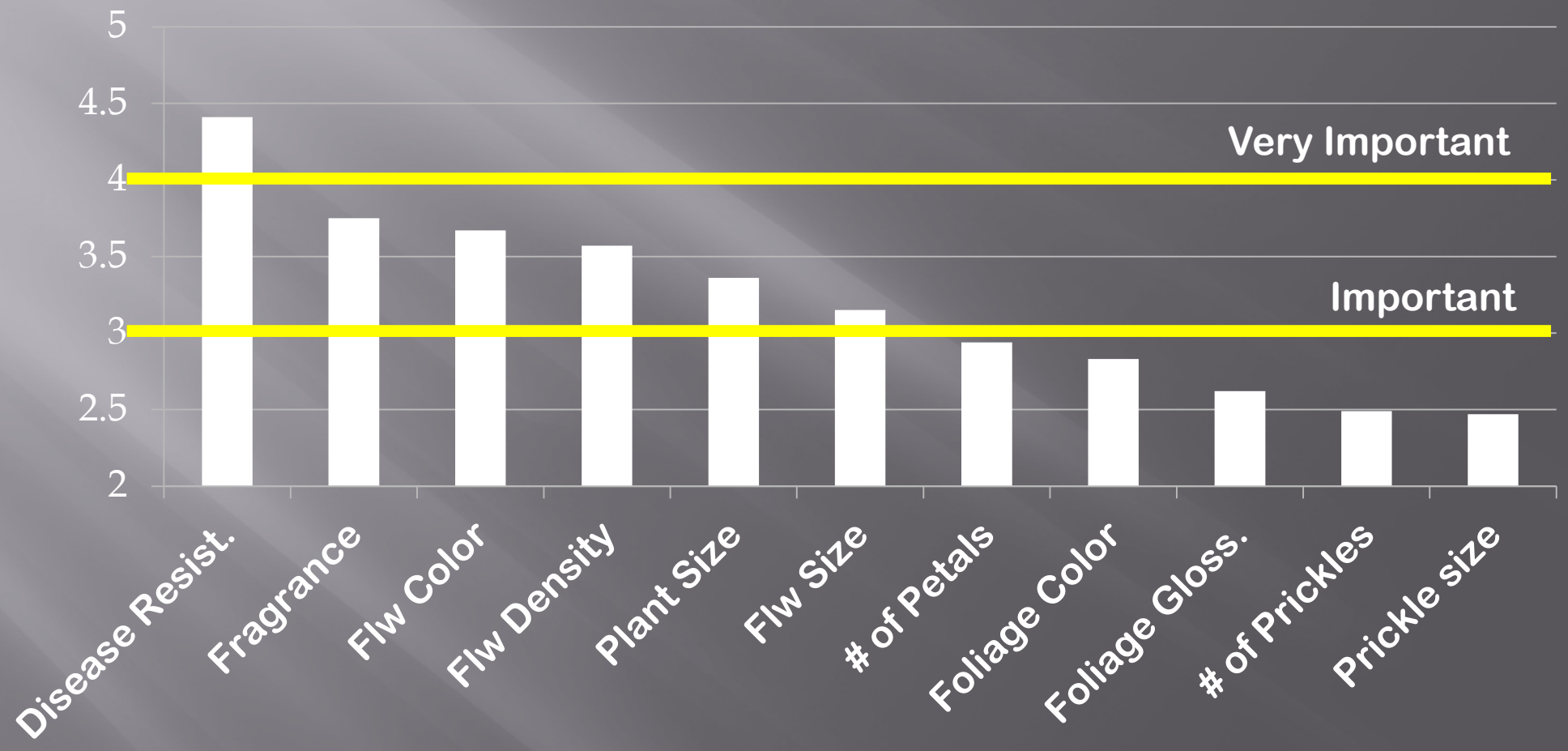
Rosa wichurana
Rosa bracteata
Rosa roxburghii
Rosa rugosa
Rosa moschata
Rosa chinensis
Rosa carolina
Rosa virginiana
European species

Overall Goal

- **Well Adapted Landscape Roses**
  - **Disease Resistant**
  - **Heat Tolerant**
  - **High Number of Flowers**
  - **Horticultural Traits**

Importance of Rose Traits

5= most important, 4= very important, 3= important, 2= not very important, 1= not important at all



Rose Hybridizer Association and Texas A&M University online survey. 1,439 responses.
October 15 - December 12, 2012.

Rose Diseases

(Photos courtesy of Mark Windham and David Byrne)

Rose Diseases

(Photos courtesy of Mark Windham and David Byrne)

Healthy Compact
Floriferous
No Prickles

Black spot

- Disease resistance
  - Black spot resistance
    - Race specific
    - Partial resistance

Partial Resistance to Black Spot

Resistance Genes Limit Growth of Fungus

Acervuli

Lesion Length

Field Evaluation of Rose Seedlings

Rose Variety Evaluation

Cercospora

Greenhouse Evaluation
Culturing the fungus

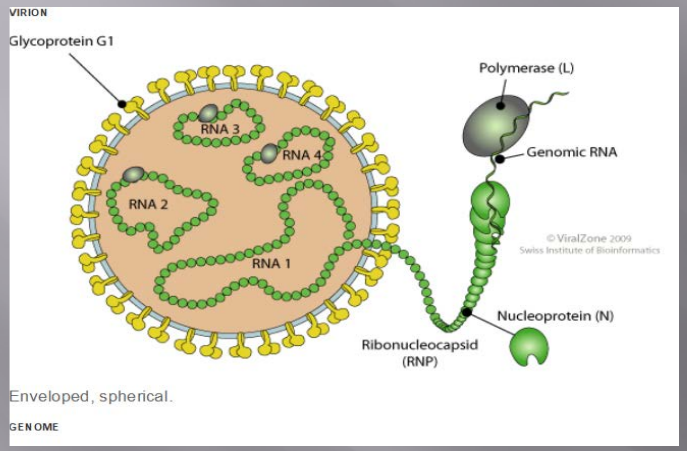
Rose Rosette Disease

Viral disease
Mite transmitted
Epidemic in midwest to eastern USA
Little is known about management or resistance

(Photos courtesy of Mark Windham)

Three Players in Disease Development

Pathogen: Virus



Rose Rosette Virus

Vector: Mite

Phyllocoptes fructiphilus

Reservoir: Wild rose

Rosa multiflora

Rose Rosette Research Plots
Three year trials

Tennessee
Mark Windham

Delaware
Tom Evans

Also field trials in
Oklahoma with Jen Olson
Texas with Kevin Ong and Maddi Shires

Photos courtesy of Mark Windham, University of Tennessee and Tom Evans, University of Delaware

RRD Augmentation

Photos courtesy of Mark Windham, University of Tennessee and Tom Evans, University of Delaware

RRD Augmentation

RRD symptoms after 3 months on very susceptible rose

Can take 2 years for symptoms to appear

Photos courtesy of Tom Evans, University of Delaware

Trial Data

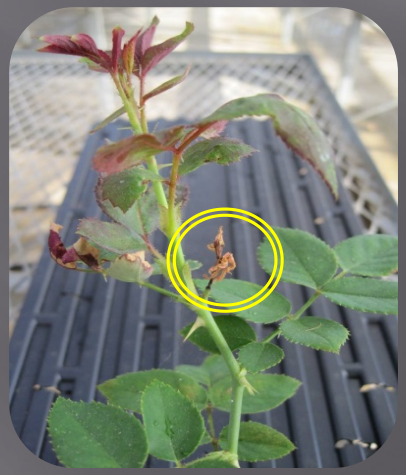
Augmented and Natural Infection

Rose accessions	Susceptible	No- Mild symptoms Virus	No symptoms No virus
1207	1,168	22	17
	96.7%	1.8%	1.4%

Data from
Oklahoma (Jen Olson),
Tennessee (Mark Windham, Alan Windham),
Texas (Kevin Ong, Maddi Shires)
Delaware (Tom Evans)

Heat Tolerance

- Heat affects
  - Plant growth
  - Flower production/abortion
  - Flower size and color
  - Petal size and number



Summer Flowering of Roses

Flower intensity: 0= no flowers, 3 = 30% plant covered with flowers, 6 = 60% plant covered with flowers, 9 = 90% covered with flowers

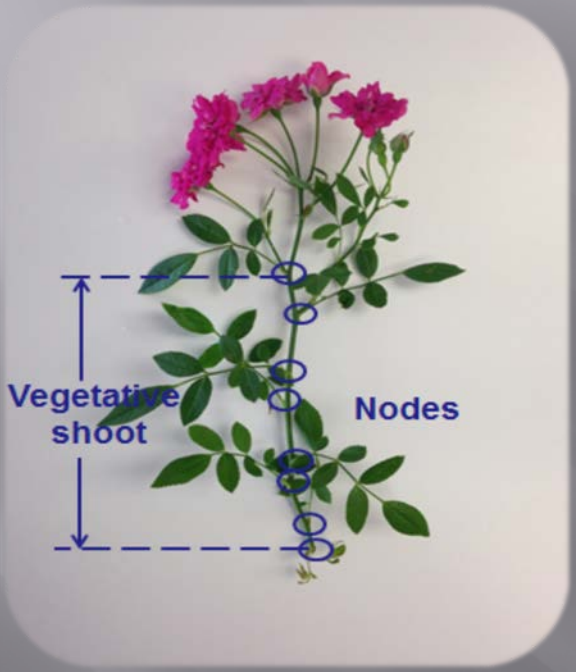
Flower Intensity

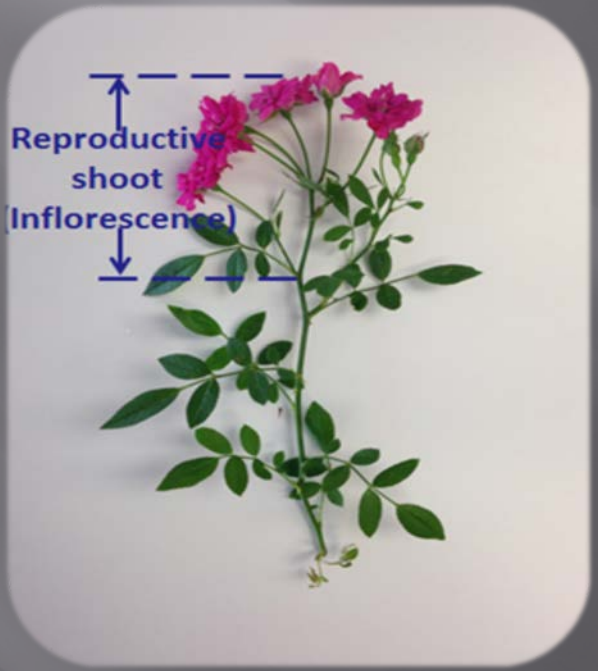
5-6

3-4

1-2

Plant Architecture





Breeding of Garden Roses

- Diploid breeding program
  - Species introgression
  - Rosa wichuraiana – resistance to black spot and heat tolerant
  - Rosa palustris and setigera – resistance to RRD
- Tetraploid breeding program
- Combine Basye/TAMU, Moore germplasm, other roses
- Major emphasis on genetics and marker assisted breeding

BETTER PHENOTYPING TOOLS

Fieldbook App

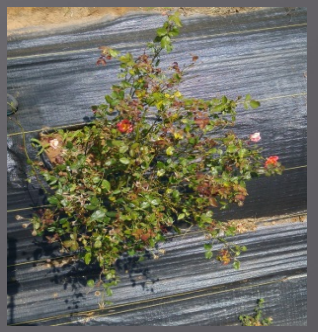
Digital Image Analysis

Same variety cycles differently

	May	June	July
Block 1			
Block 2			

Weekly Pictures

April

May




June




July



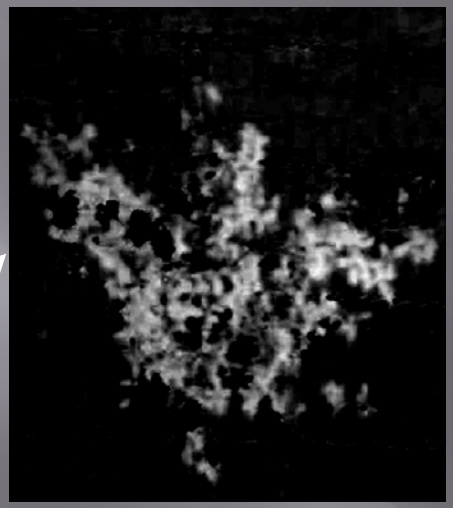
Data Analysis Workflow – Yeyin Shi

Original RGB

Green leaves

Flowers

Green – Red Channel



Otsu's Segmentation

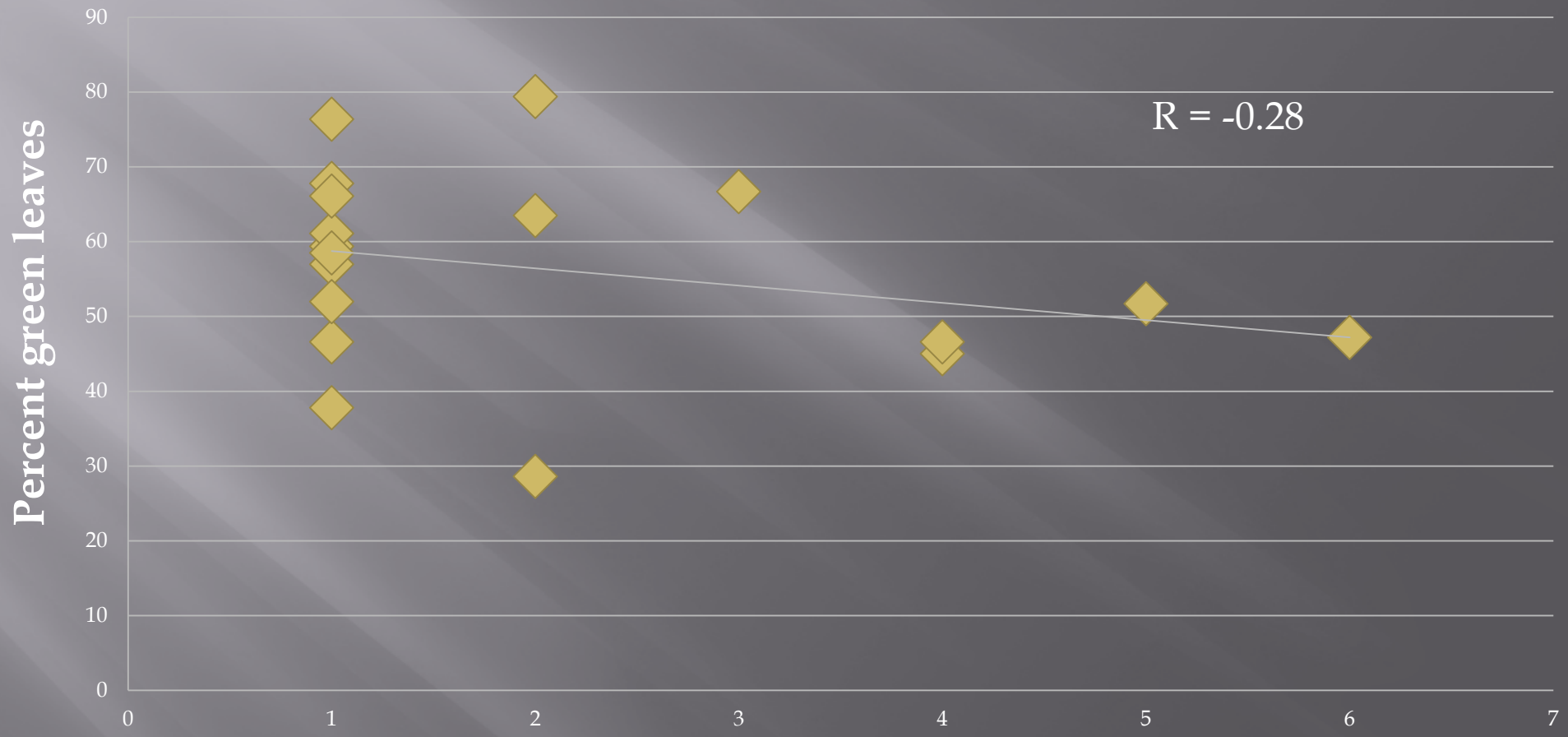
Hue and Value Channels

Otsu's Segmentation

Flower segmentation not based on color

Correlation between Flower Coverage as estimated by digital imagery and flower intensity ratings

Correlation between % Green Leaves as estimated by digital imagery and Defoliation ratings



Next step..drones?

- Time: 15 minutes
- Expense
  - Drone with camera
  - Inexpensive, $2-5K
- Challenges
  - Analysis
  - Regulations
    - License to fly
    - Permission to fly
    - Ground rig may be easier

April 6th to June 8th 2017

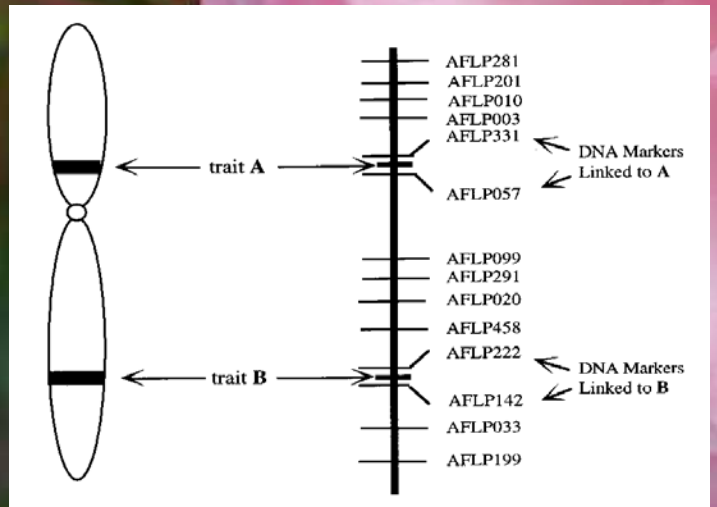


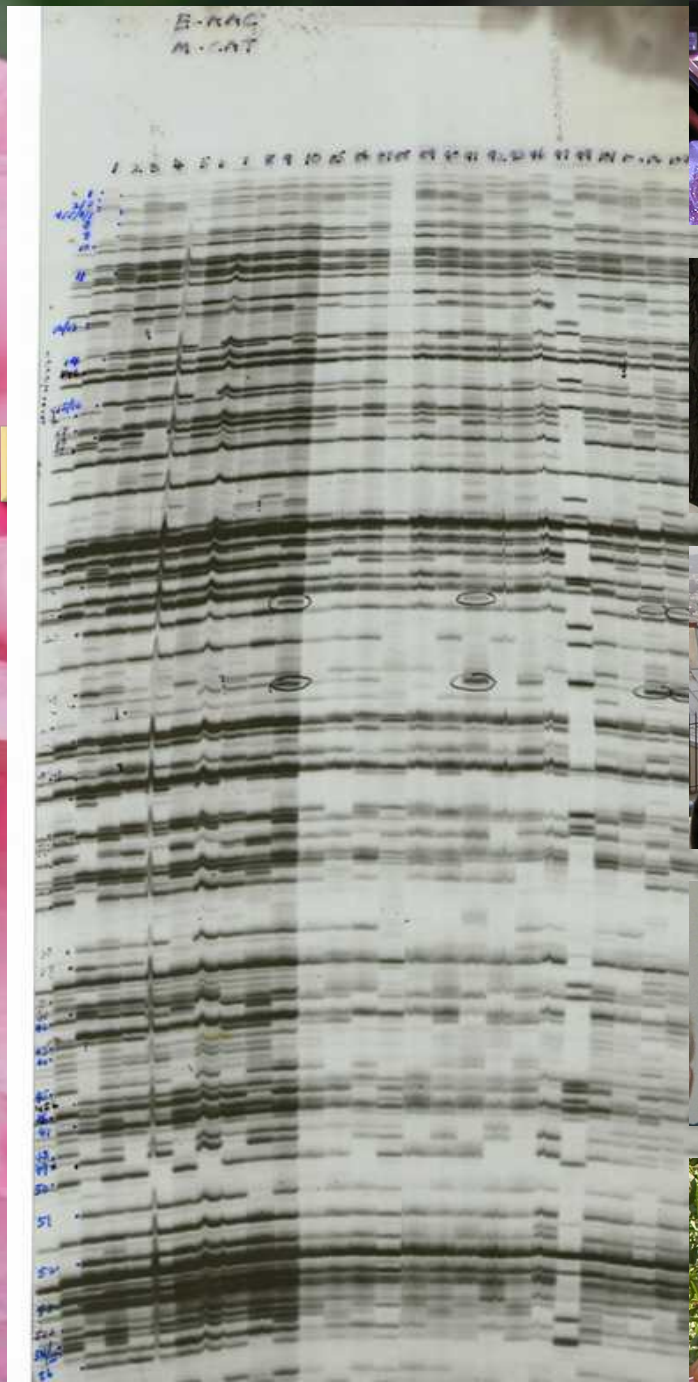






MOLECULAR MARKERS IN ROSE BREEDING AND GENETICS





Breeding of Commercial Roses
First Generation

Breeding Cycle	Commercial Trial Multiple Sites

Breeding with Species First Generation

Conversion from Once Blooming to Everblooming	Breeding Cycle	Commercial Trial Multiple Sites

Time Needed
Commercial Trial Endpoint

Generation	Cultivated		Generation	Resistant species
First	7		Conversion First	11
Second	11		Second	15
Third	15		Third	19
Fourth	19		Fourth	23

Two year greenhouse phase: produce, germinate, select seedlings
Two year seedling adaptation evaluation in field
Three year multiple site commercial evaluation

How Do We Make it Quicker?

DNA informed breeding

Marker assisted breeding

Accelerate Breeding Progress
MAB (Marker Assisted Breeding)

- Reduce breeding cycle time by 50%
  - Eliminate field screening
  - All initial RRD resistance screening done in greenhouse
- Reduce seedlings that need to go to field
- Improve parental selection
  - Knowledge of resistance genes

Seedlings : 15 year program

	Traditional	MAB	
Greenhouse	**21,000**	**31,000**	**148%**
Field	**11,105**	**1,561**	**14%**

If same field work – could screen 220,000 seedlings

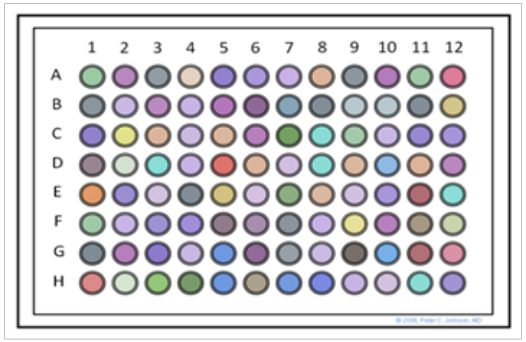
DNA-informed breeding
What do we need?

- Plentiful molecular markers
- Consensus map with these markers

Genotyping by Sequencing SNP markers

DNA is extracted from folded young leaves

1. Plate DNA



2. Digest DNA with RE

Methylation sensitive REs (FseI, NgoMIV and NheI) cut gene rich region and filter out repetitive genomic fraction

3. Ligate barcoded adapters

4. Pool DNAs

5. Shear DNA, select size, fill in 5' adapters sequence, blunt DNA, ligate 'A' and ligate T-tailed adapter

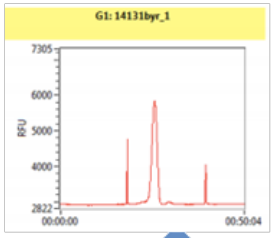
6. Biotinylated Primers

7. PCR

8.Clean up and purify single strand DNA

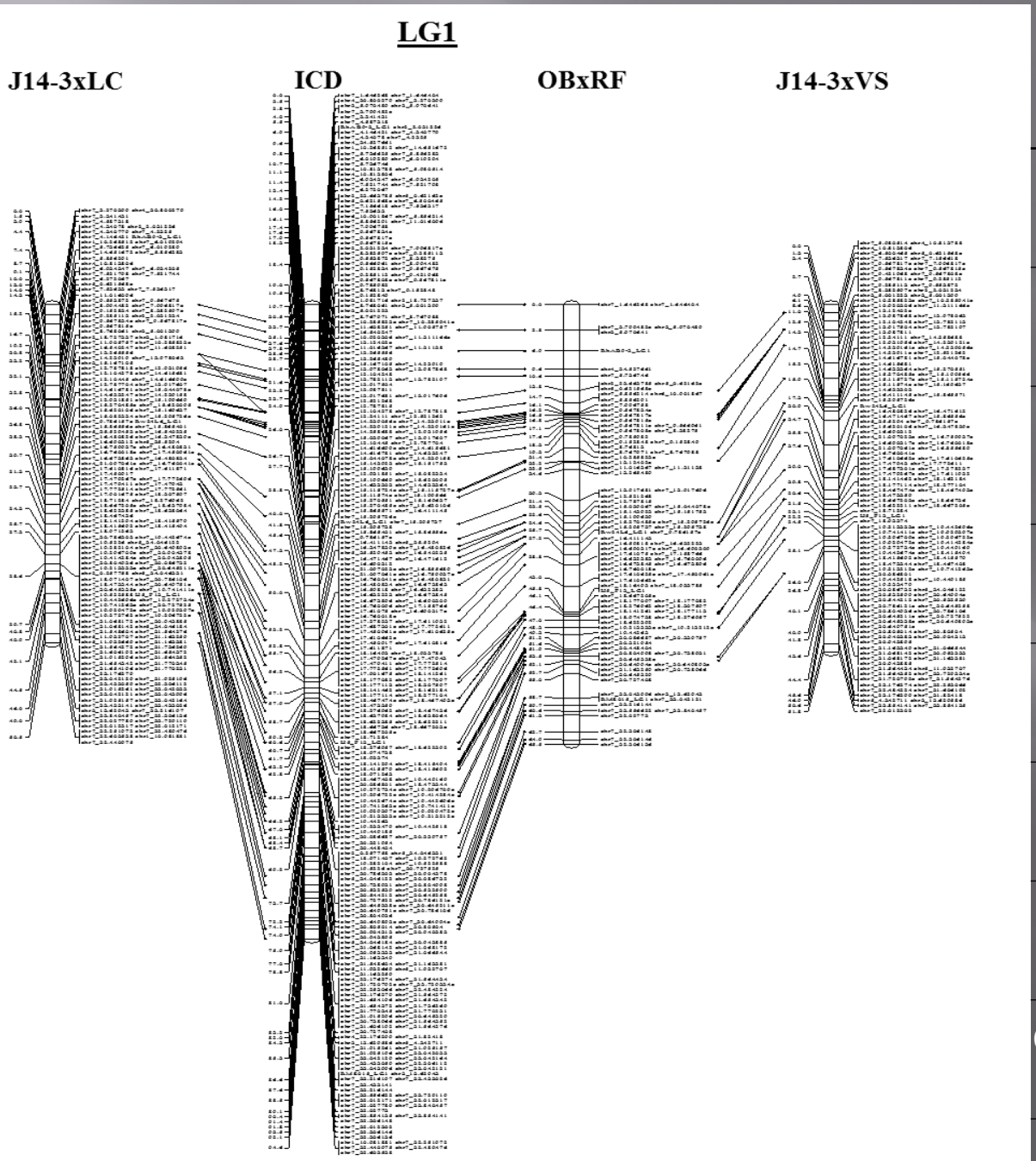
8. PCR

9. DNA quality evaluation



10. Sequence in Illumina HiSeq 2500

11. Data analysis



JoinMap 4.0

LGs	Marker statistics	J14-3 x LC	J14-3 x VS	OB x RF	ICD
LG1	Total	189	161	103	348
	Bin no.	38	39	48	93
LG2	Total	271	297	369	753
	Bin r no.	60	81	76	161
LG3	Total	196	123	84	340
	Bin no.	49	43	31	91
LG4	Total	199	224	221	520
	Bin no.	40	49	61	120
LG5	Total	275	226	303	564
	Bin no.	50	56	64	121
LG6	Total	220	140	225	472
	Bin no.	45	39	61	109
LG7	Total	231	263	246	530
	Bin no.	54	62	45	125
Overall	Total	1581	1434	1551	3527
	Bin no.	336	369	386	820

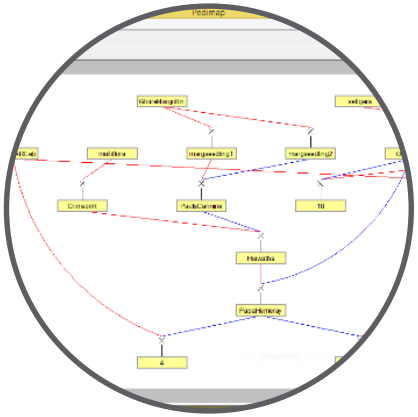
** In the order of J14-3xLC : J14-3xVS : OBxRF*

Phenotyping

- Measure the strength of resistance a rose has to the disease organism

Genotyping

- Genotyping by sequencing approach to produce thousands of tags of genetics tags/markers on rose chromosomes



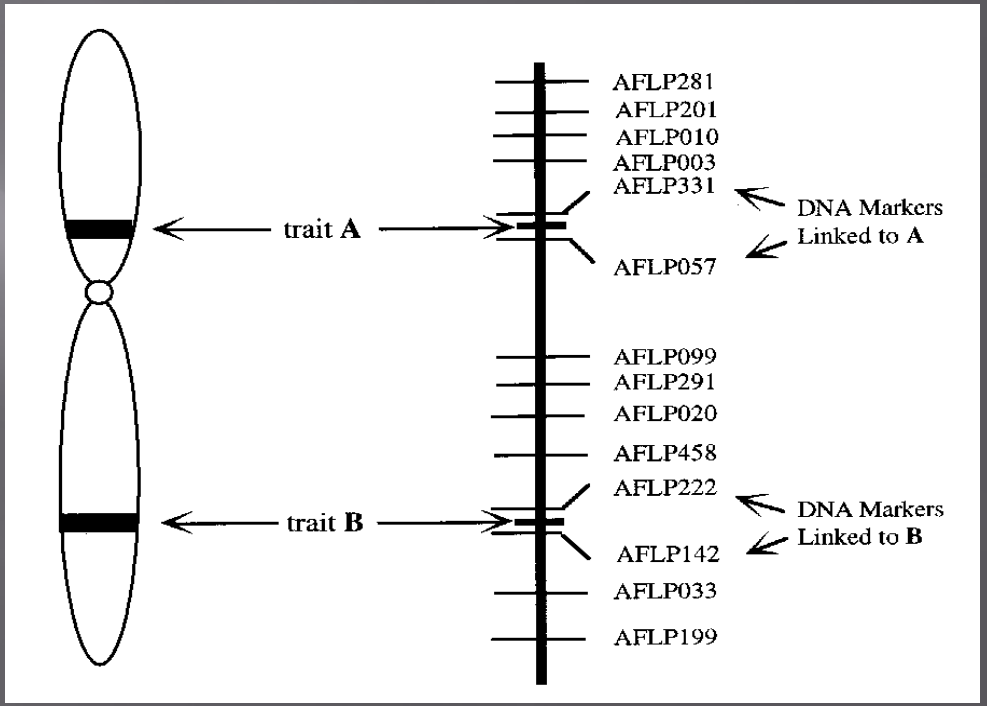
QTL Analysis

- Phenotype and marker data are combined in a database for identification of quantitative trait loci using Pedimap and FlexQTL software

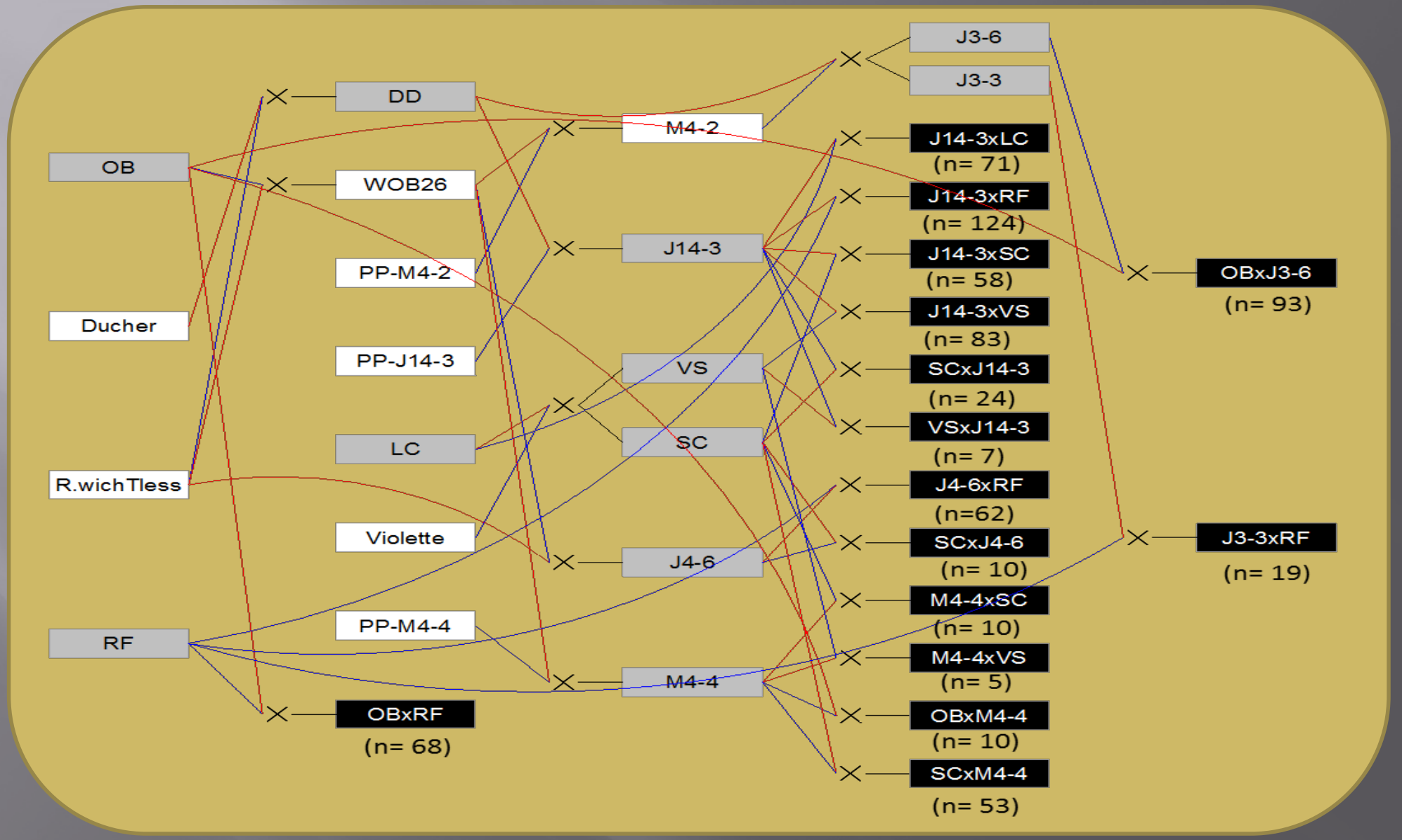
Markers for disease resistance, plant architecture, heat tolerance etc.

Accelerate Breeding Progress

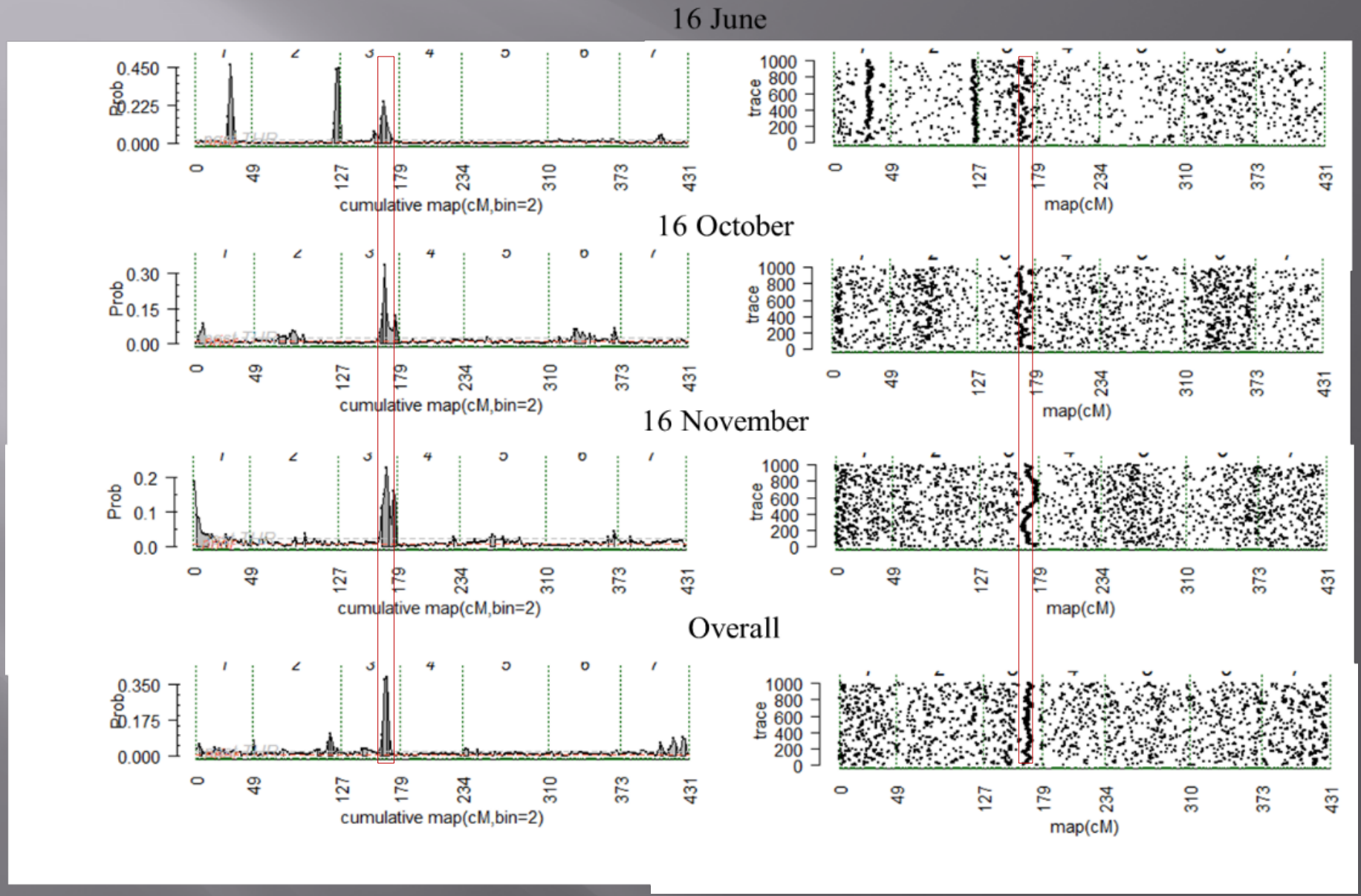
- Facilitate selection and parental selection
  - Adaptation
    - Black spot resistance
    - Cercospora resistance
    - Rose rosette resistance
    - Heat tolerance
  - Floral and plant traits
    - Flower type/color
    - Fragrance
    - Flower yield
    - Plant architecture



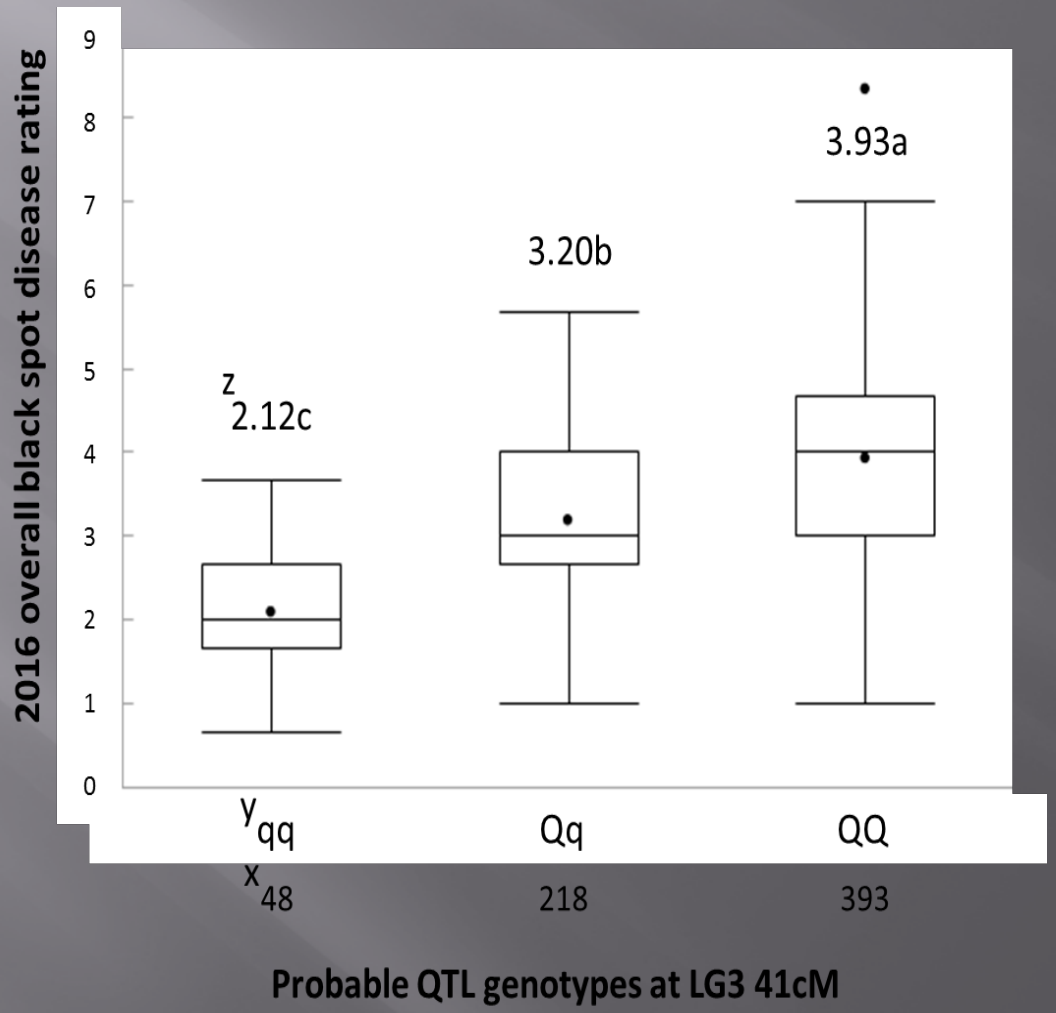
Diploid rose population: inter-related families



Black spot resistance QTL analysis: a large-effect on LG3



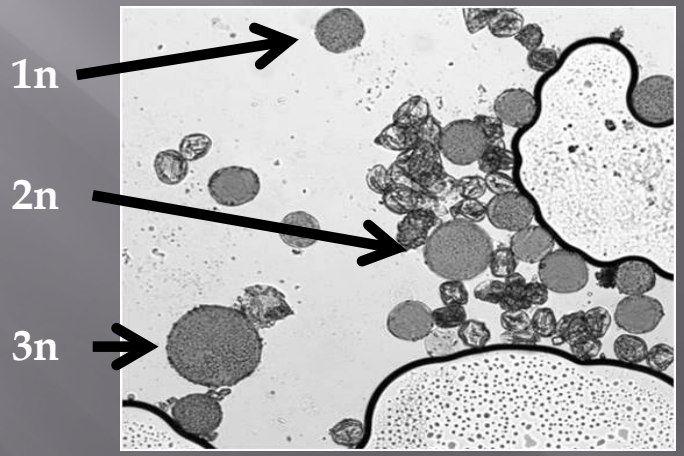
Mean values for three probable QTL genotypes at signal peak 41cM among all mapping materials



Commercial roses are diploid, triploid and tetraploid

Diploid
2x = 14

Tetraploid
4x = 28



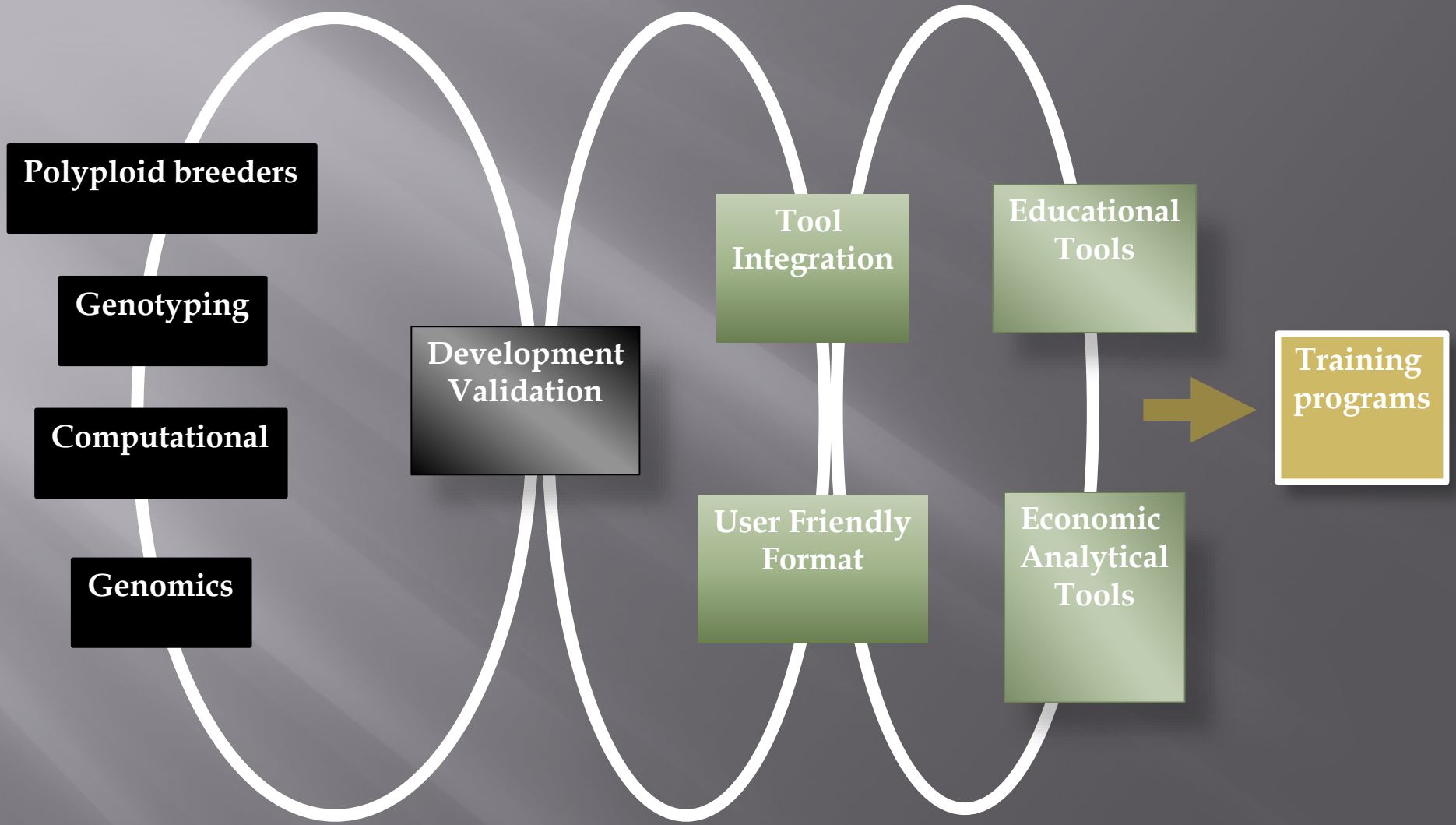
Triploid roses produce 1n, 2n and 3n pollen grains

Tools for Polyploid Group

San Diego Botanical Garden

January 11-12, 2018

Accelerate the breeding of polyploid crops


Polyploid breeders
Genotyping
Computational
Genomics
Development Validation
Tool Integration
User Friendly Format
Educational Tools
Economic Analytical Tools
Training programs


Rose Breeding at Texas A&M University
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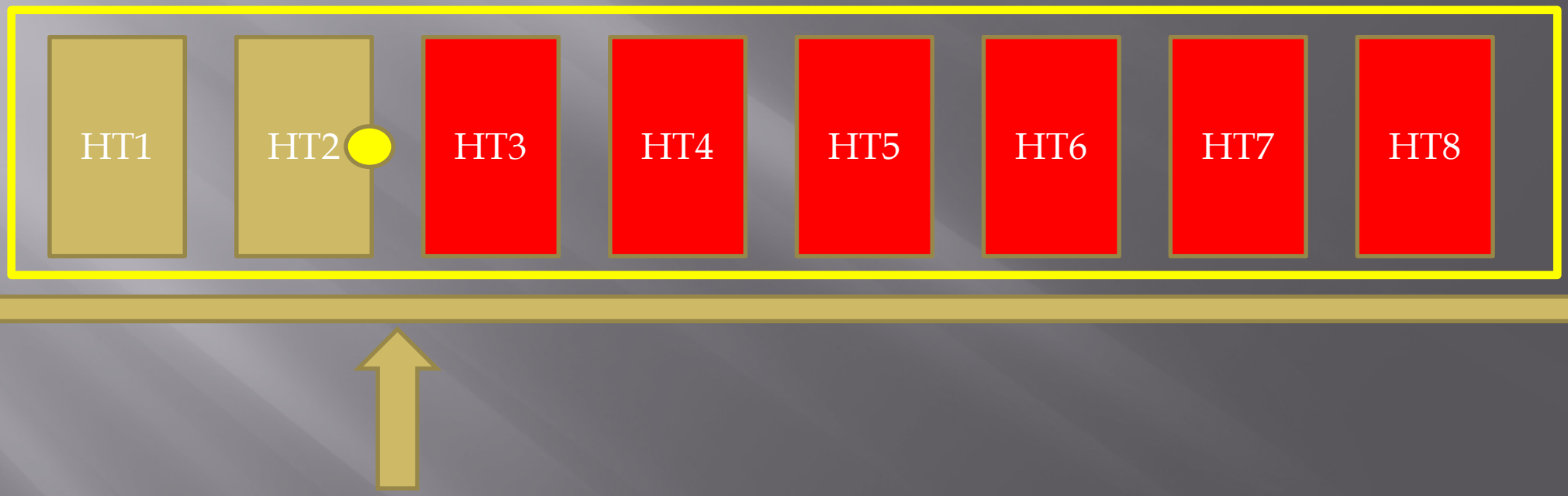
HortTREC Research Field

Pecan Orchard



Pasture

HT3 and HT4
Diploid population – Breeding blocks

- Star Roses hybrids
  - Rosa palustris
  - Rosa blanda
- Rosa palustris, Amrine
- Breeding plots – elimination
- Peach plots

- HT3 and HT4
  - Diploid population
  - Planted, 2 plots
    - Overton, Tennessee
  - Parents
    - TAMU, M4-4, 7-20, 7-30, J06-14-20-3
    - Srdce Europy, Papa Hemeray
    - Ole x palustris
    - Setigera x Ole

HT5
Cultivar Evalution
Advanced Selections

HT6
Species Collection
Diploid population

- Rows 1-4
  - Rosa species
  - Rootstocks
  - Interspecific hybrids
- A12/D14 population
  - Parents
    - J06-14-20-3, M4-4
    - Sweet Chariot, Vineyard Song, Red Fairy, Little Chief
    - Old Blush
  - Current data
    - GBS
    - Traits
      - Black spot, cercospora
      - Architectural traits
      - Flower, size, petal number

HT7
Breeding Plots
Tetraploid population

- Breeding plots - parents
  - Brite Eyes
  - Above and Beyond
  - Lafter
  - Honey Perfume
  - Stormy Weather
- Tetraploid population
  - Planted
    - College Station, Overton
    - Tennessee
  - Parents
    - Brite Eyes
    - My Girl
    - Stormy Weather
  - Data
    - SNP array
    - Disease, horticultural

HT8
Breeding Plots – Eliminating Diploid Collection Miscellaneous Roses

- Breeding Plots
- Hybrids with
  - Basye's Purple
  - R. palustris EB ARE
  - R. palustris OB ARE

- Diploid Collection
  - Planted
    - College Station, Overton
    - Oklahoma
    - Tennessee
  - Data
    - Disease resistance
    - Architectural traits
    - SNP array

Texas A&M University
Rose Breeding and Genetics

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http://www.facebook.com/tamuroses

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