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Robert H. Smith Faculty of Agriculture, Food and Environment
הפקולטה לחקלאות, מזון וסביבה ע"ש רוברט ה. סמית
The Robert H. Smith Institute of Plant Sciences and Genetics in Agriculture

Mapping and Characterizing of Simple and Complex Traits in Autotetraploid Roses (*Rosa hybrida* L.)

Yaniv Semel – EPPN summer school

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The Hebrew University of Jerusalem

Introduction

- Family: **Rosaceae** (*Prunus, Malus, Pyrus….*); Subfamily: **Rosoideae** (*Fragaria, Rubus, …);* Genus: ***Rosa*** (over 100 species)
- Chromosome numbers in the genus ***Rosa*** are based on multiples of seven and range from $2n=2x=14$ to $2n=8x=56$
- Species: ***R. hybrida* L.** - The cultivated roses, perennial shrubs, highly hetrozygosity, mostly autotetraploids ($2n=4x=28$), with a small genome estimated at about 550 Mb (0.57 pg/1C)
- Roses have been admired for their beauty and fragrance since the dawn of civilization and there are evidences that roses were cultivated 5000 years ago by the ancient civilization of China.
- The rose accounts for two-thirds of the international cut floral industry which exceeds 40 billion dollars per year.
- Surprisingly, **little is known about the rose genetics** because of **technical factors that make the rose difficult model for genetic analysis:** high hetrozygosity, difficulties in sexual reproduction from pollination to seed germination and high ploidy levels.

Objectives

- Constructing genetic linkage maps of autotetraploid roses.

- Characterizing and mapping of simple and complex traits in autotetraploid roses.

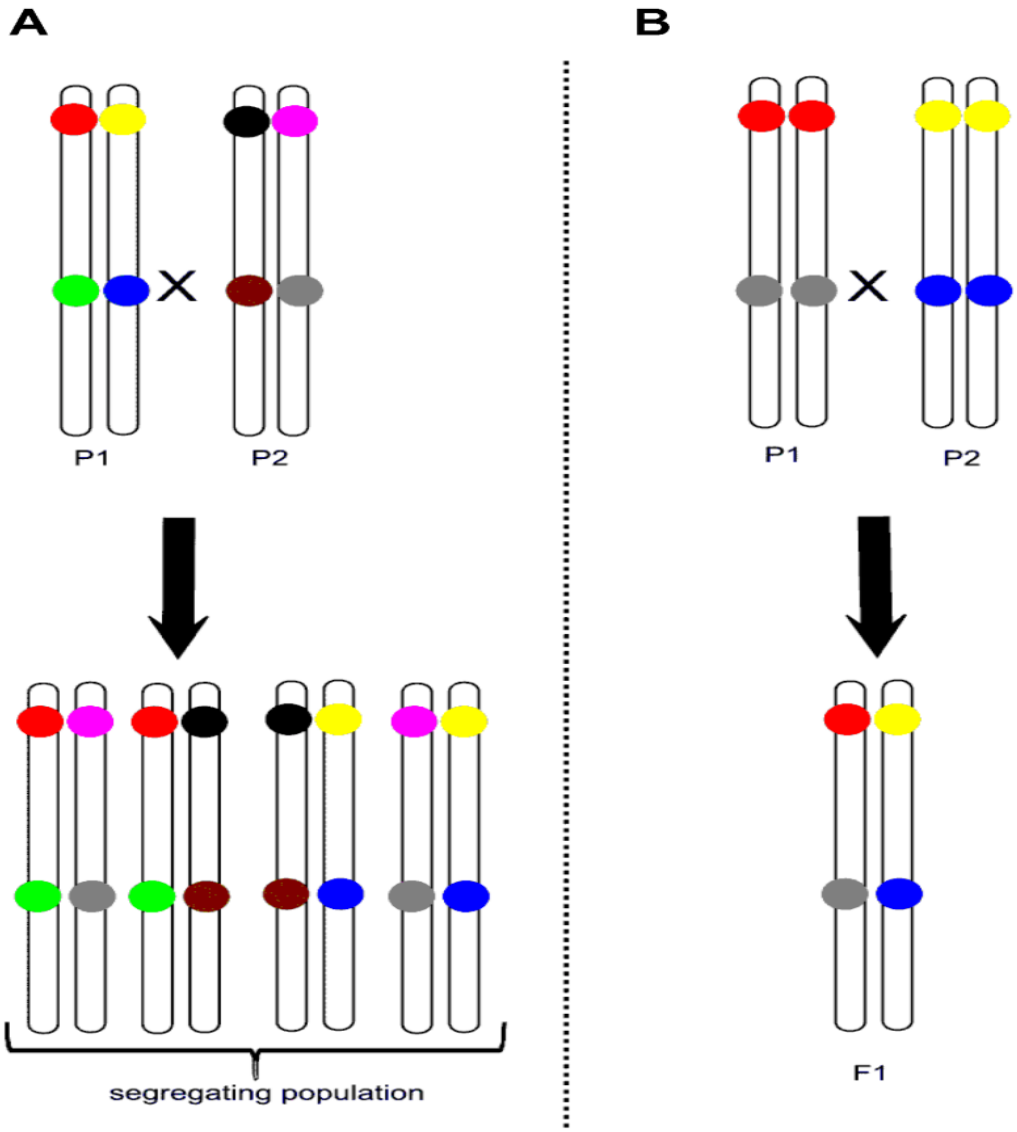
Autotetraploid Linkage maps

- **Golden Gate**®(GG) - Kordes
- Cutting variety
- Yellow- Carotenoids
- Sensitive to pests and disease
- Barely prickled
- Small-medium bud
- Lack a distinct odor
- Vase life – 12-14 days

- **Fragrant Cloud**®(FC)- Tantau
- Garden variety
- Red peach- Flavonoids
- Resistant to pests and disease
- Highly prickled
- Large bud
- Strong fruity scent
- Vase life - 5 days

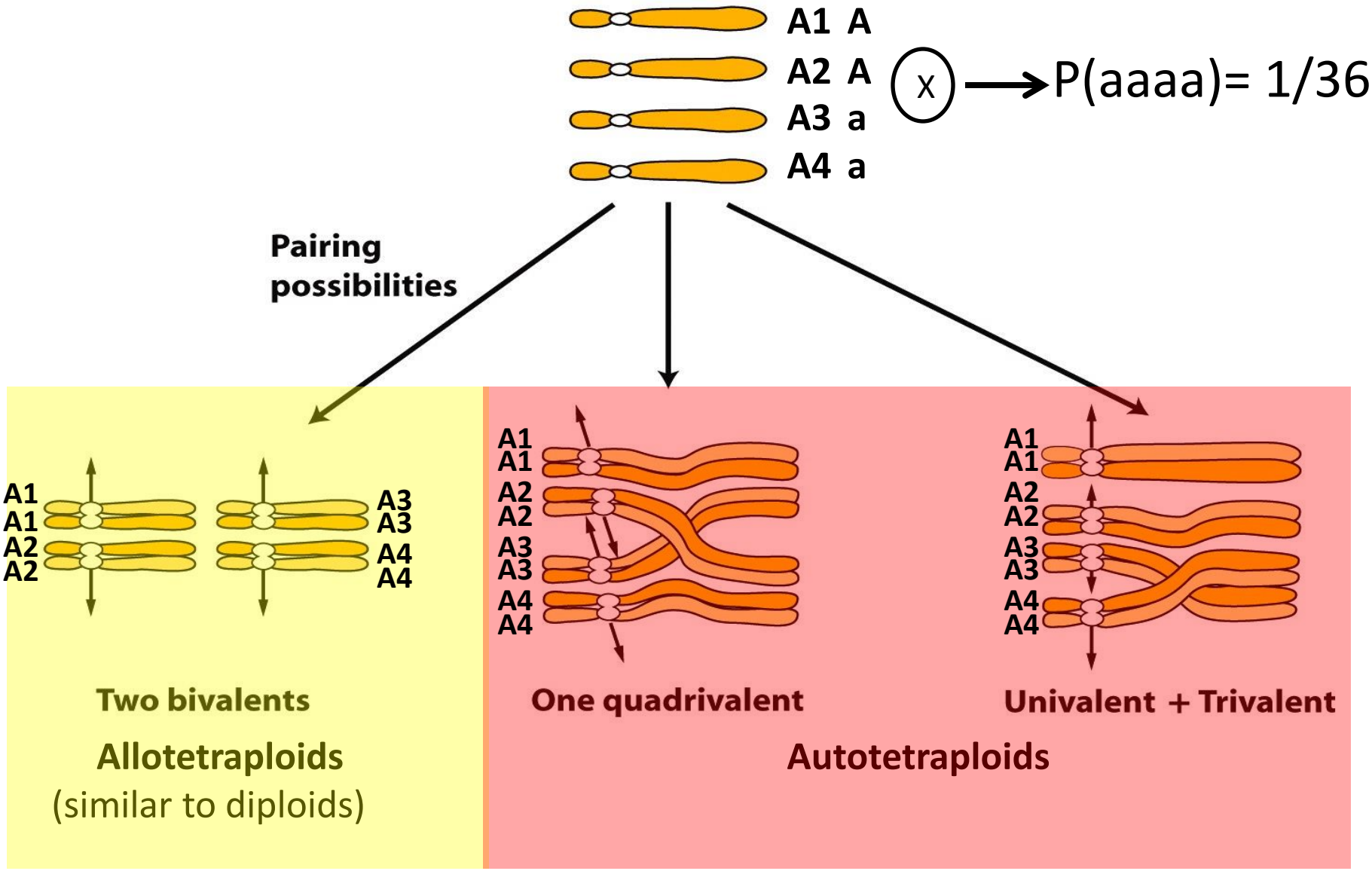
Mapping population of 132 siblings- “GGFC”

Autotetraploid Mapping- **Double pseudo testcross strategy**

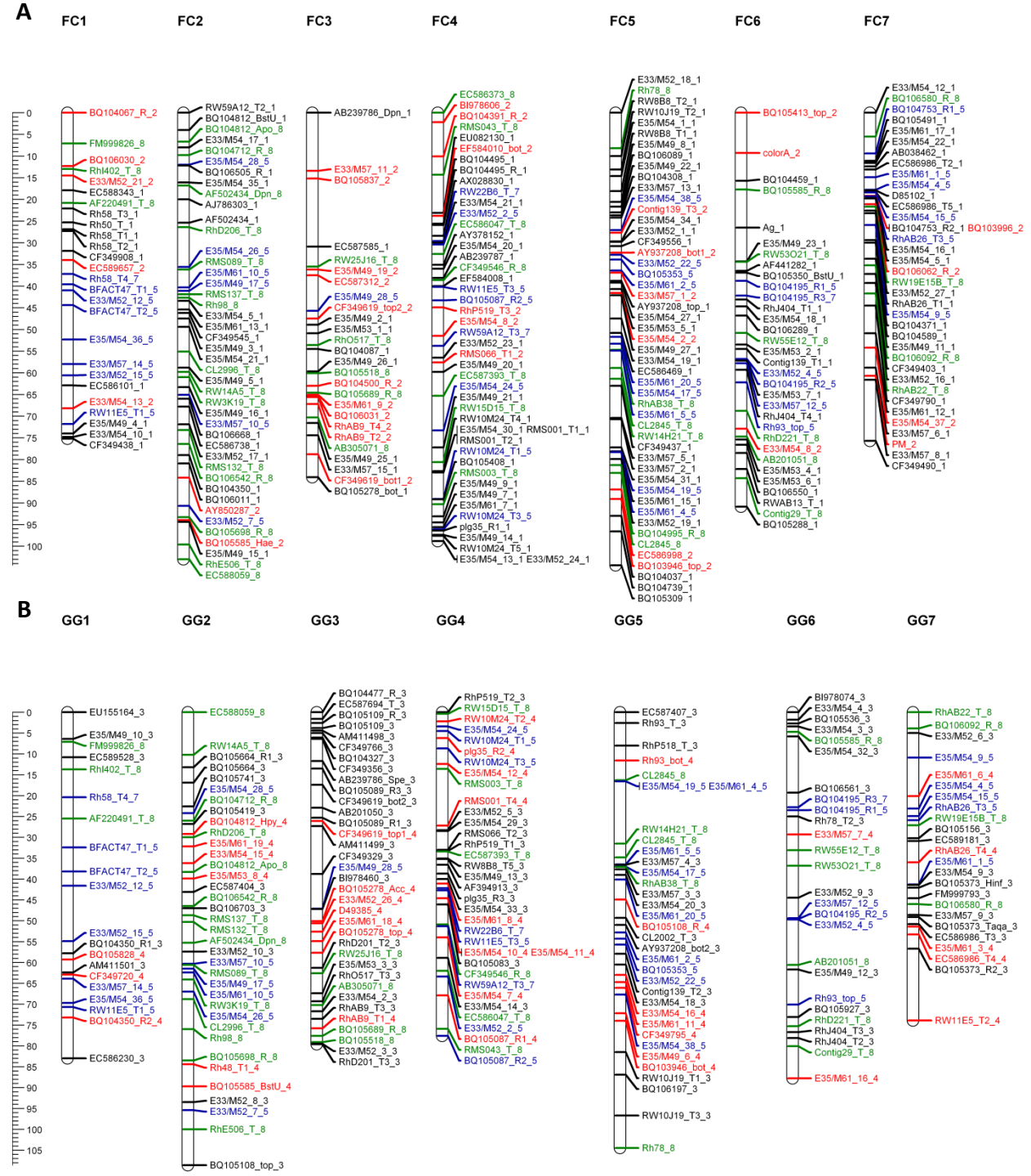


Gar et al. (2011)


GGFC population



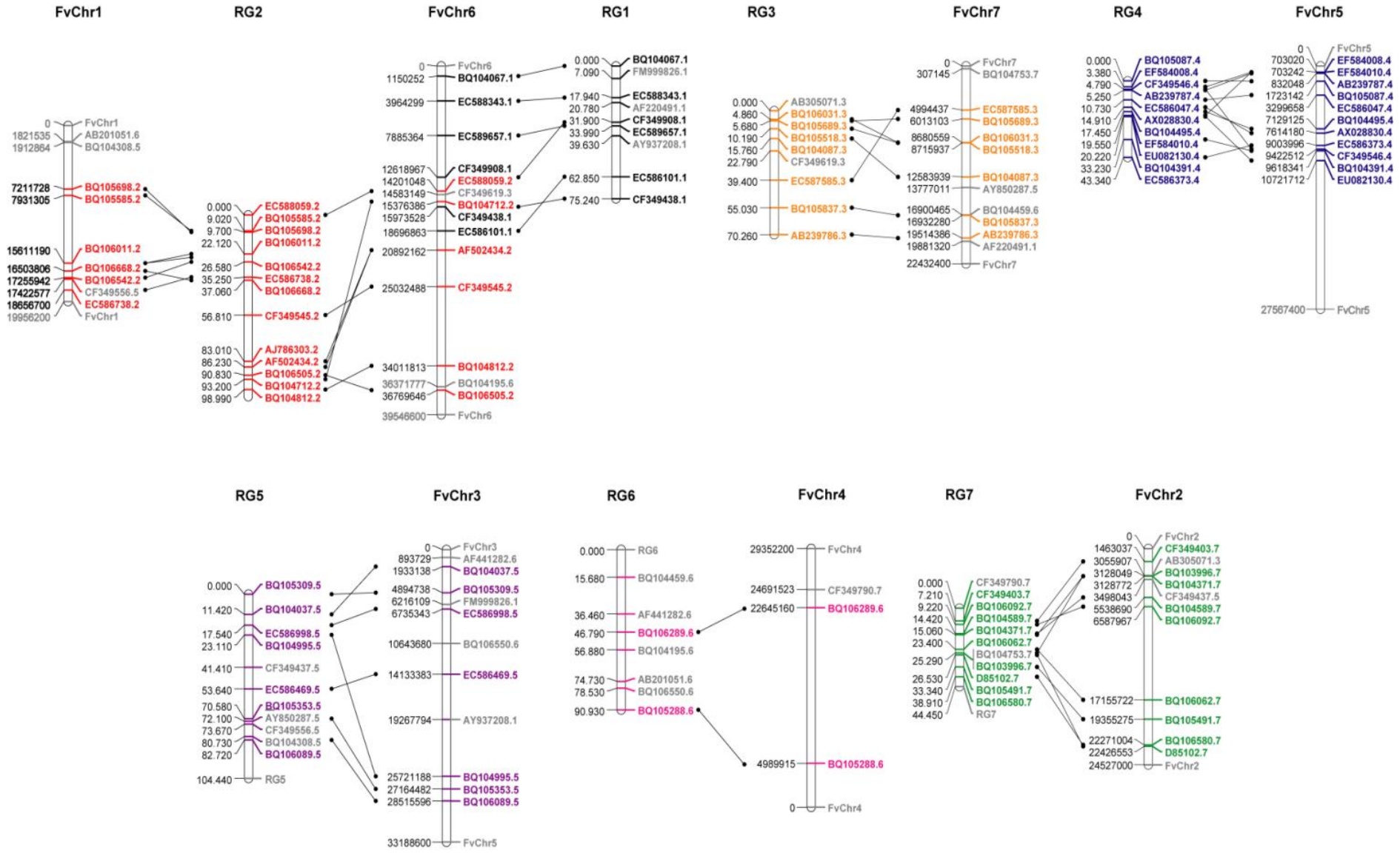
- Simple genetic traits segregate up to 35:1 ratio compared to 3:1 in diploids models



- FC- 259 markers covering 632 cM (A)
- GG- 210 markers covering 616 cM (B)
- 111 common markers.
- 128 sequence-based markers.

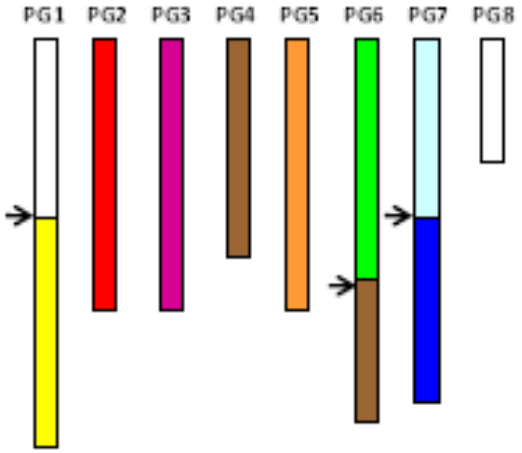
Gar et al. (2011)

Map validation- The synteny between *Rosa* and *Fragaria*

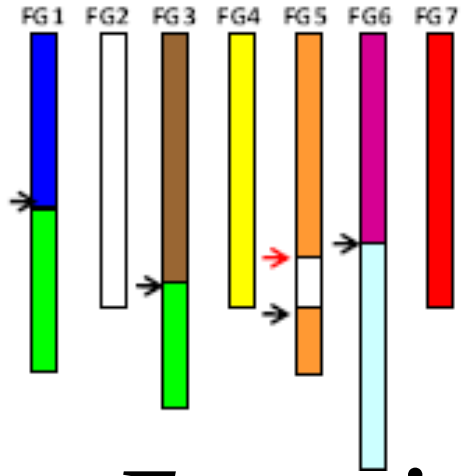


Gar et al. (2011)

Macro-synteny

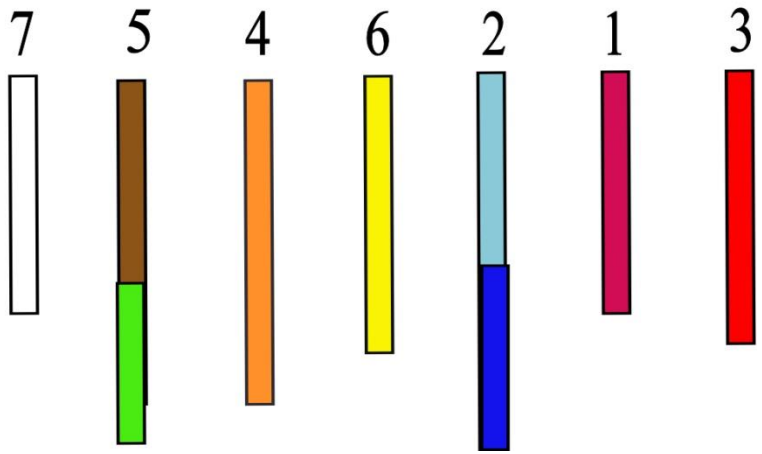


Prunus



Fragaria

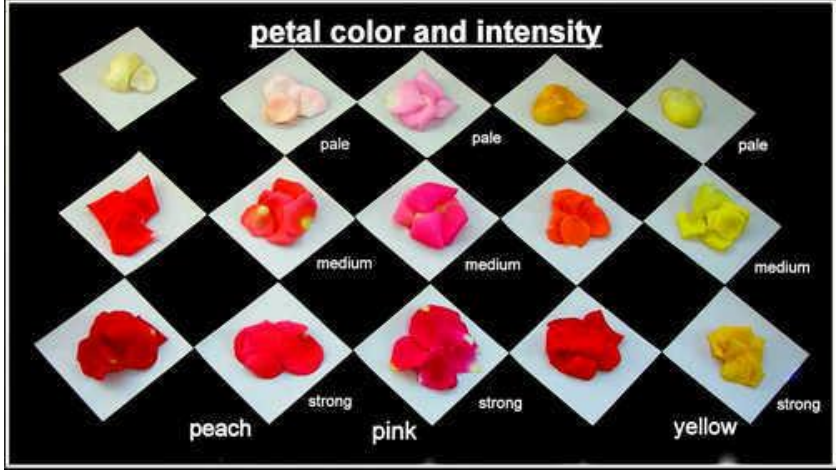
Jung et al. (2012)

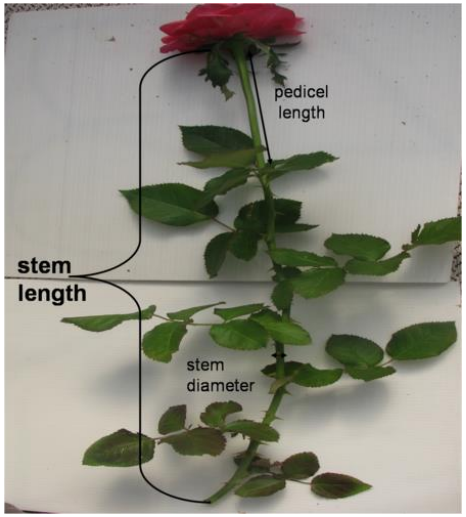


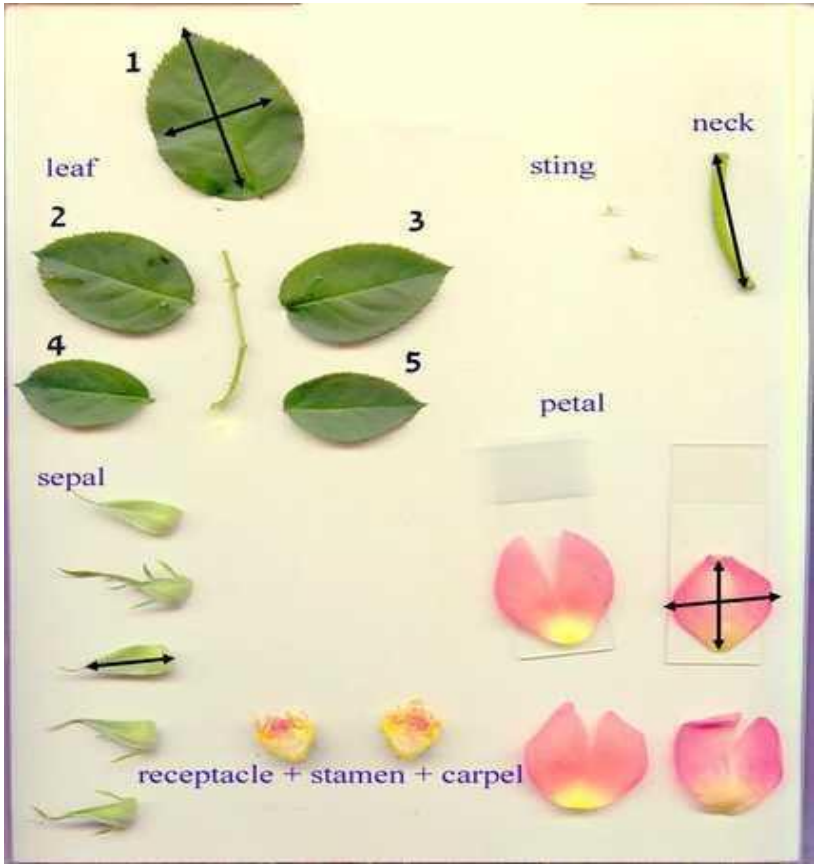
Rosa

Phenotyping

Vase life experiments


petal color and intensity
pale
pale
pale
medium
medium
medium
strong
strong
strong
peach
pink
yellow


pedicel length
stem length
stem diameter


1
leaf
2
3
4
5
neck
sting
petal
sepal
receptacle + stamen + carpel

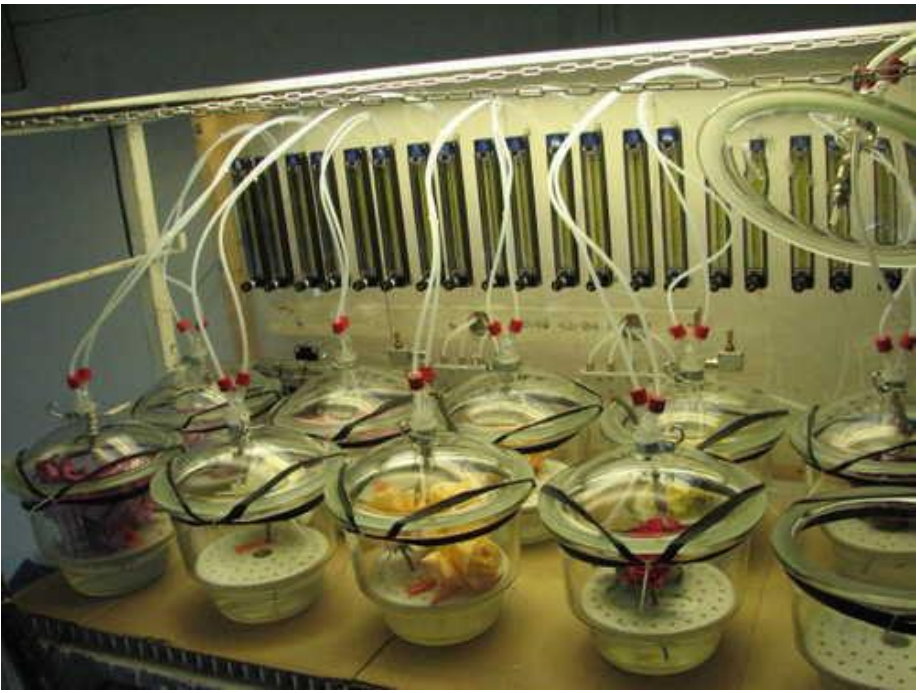
Bush growth and development

Number of prickles

Metabolic profiling of rose scent

- Flowers at developmental stage 4 were collected.
- Some of which were analyzed for volatiles content using a GC-MS headspace.
- From the remained flowers, samples of **Petal tissues** (stage 4) were collected and sent to primary and secondary metabolic profiling.

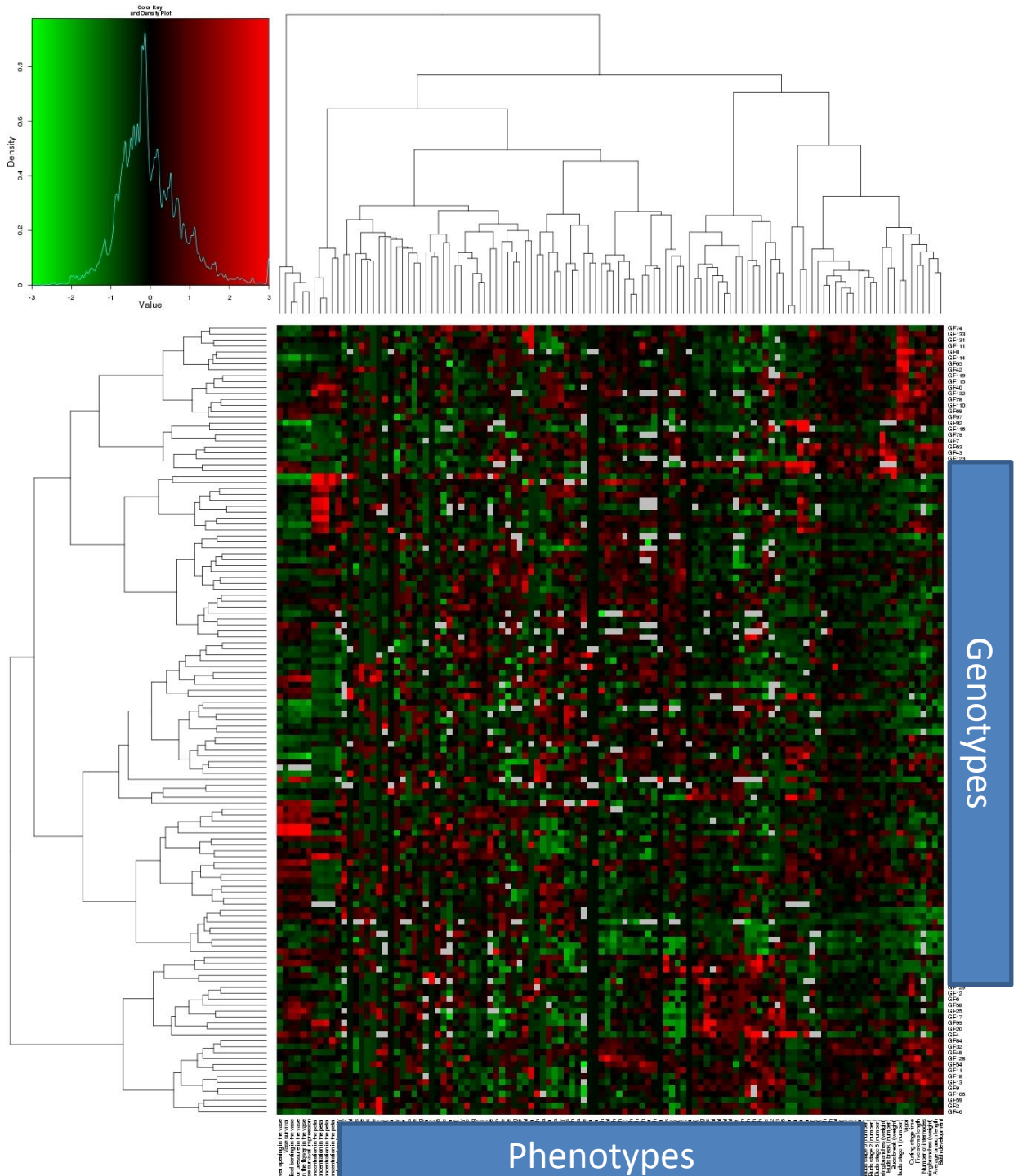
Volatiles measured by GCMS (gas chromatograph mass spectrometry)



Secondary metabolites measured by LCMS (liquid chromatograph mass spectrometry)

Large Scale Phenotyping in Tetraploid Roses as a Tool for Locating and Mapping Traits at the Whole Plant Level

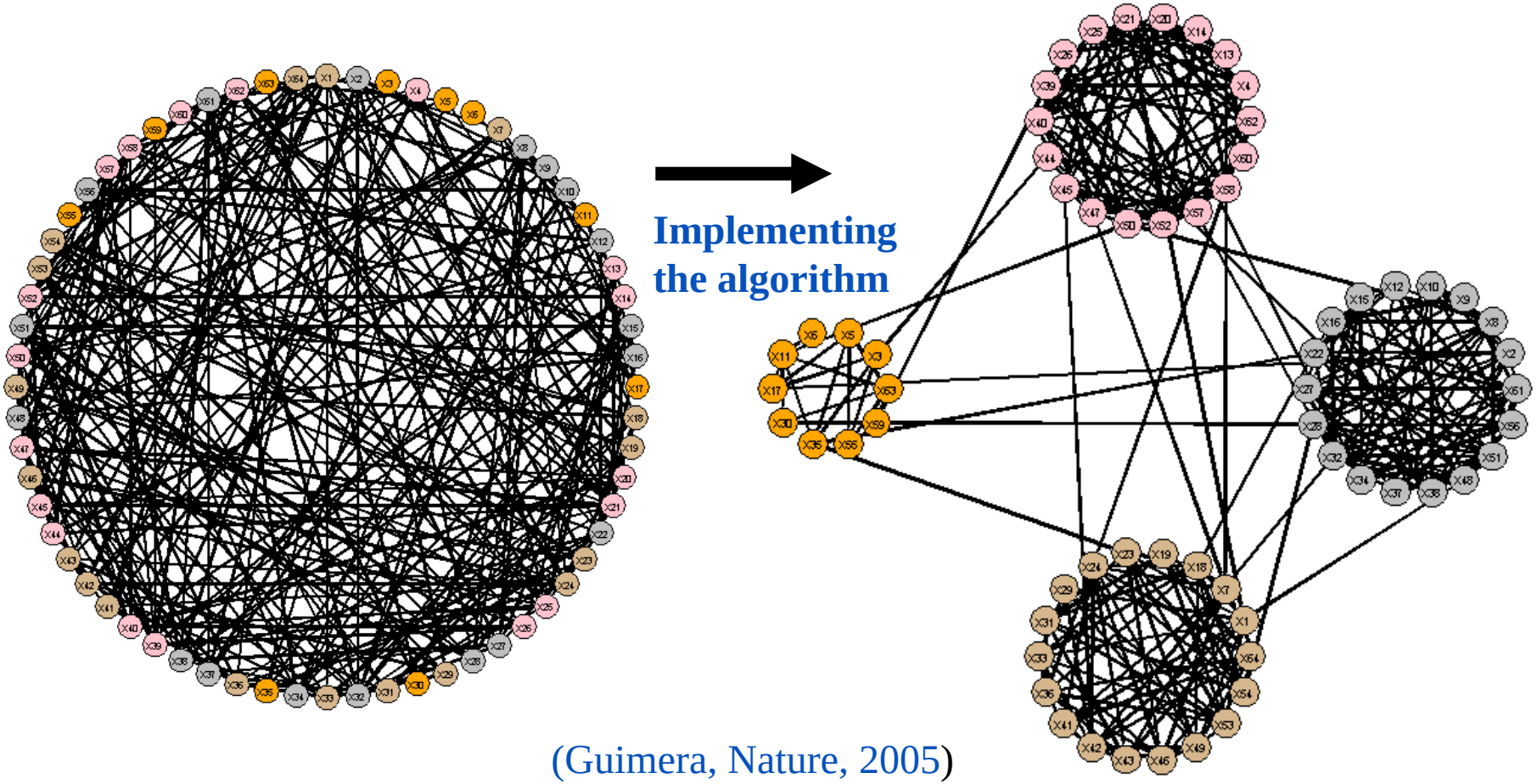
Character Groups	Number of characters	Collaboration	Measuring Tool
Flavonoids	8	Michal Oren-Shamir- Agricultural Research Organization	HPLC
Secondary Metabolites	116	Asaph Aharoni- Weizmann Institute	LCMS
Anatomy and Morphology	54		Manually
Fertility	4		Manually
Growth and Development	28		Manually
Quality	17		Manually
Yield	15		Manually
Primary Metabolites	85	Alisdair R Fernie- Max-Planck institute Aaron Fait- Ben Gurion University	GCMS GCMS
Carotenoids	12	Joseph Hirschberg- Hebrew University	HPLC
Volatiles	102	Eyal Fridman- Hebrew University	GCMS –Headspace
Total	**441**		



How can we interpret this data?

Cartography of complex networks

The algorithm finds modules in networks. Each module represents a subset of nodes that are connected to each other more than to nodes in other modules.



(Guimera, Nature, 2005)

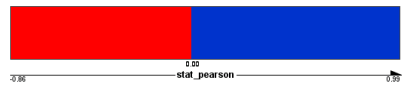
Visual Legend for default

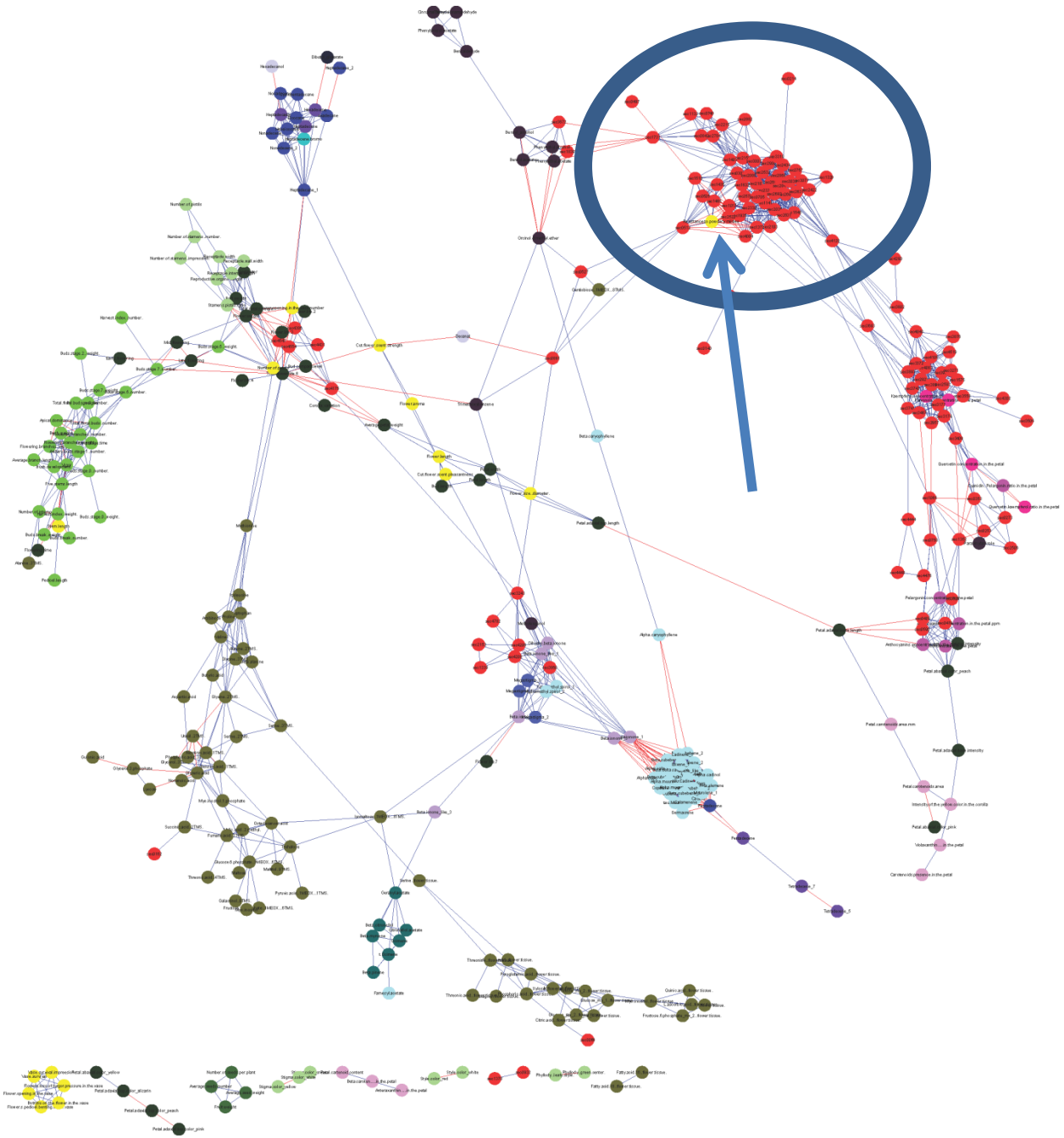
Node Label is displayed as ID

Node Color Mapping

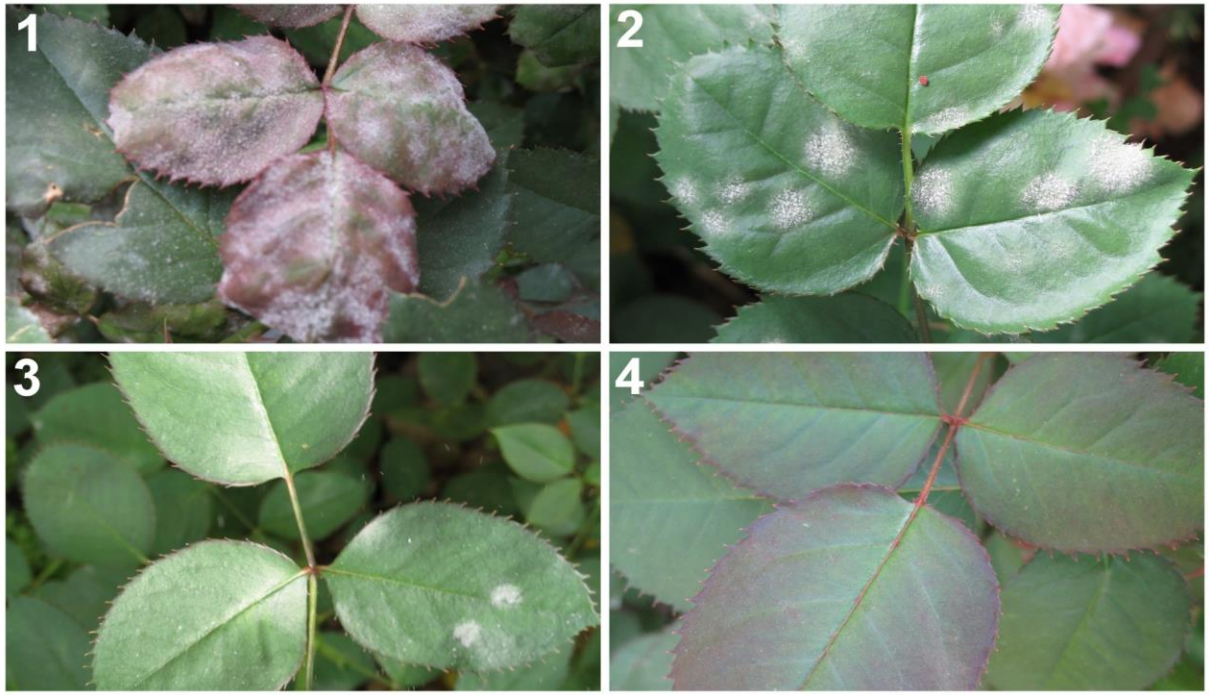
Node Color	Column 2
	Biochemistry- Anthocyanins
	Biochemistry- Carotenoids
	Biochemistry- Flavonols
	Fertility
	Growth and development- Bush
	Growth and development- Flower
	Metabolites- Primary (Fait A.)
	Metabolites- Primary (Zamir D.)
	Metabolites- Secondary (Aharoni A.)
	Quality- Breeding
	Quality- Cutting product
	Quality- Resistances
	Quality- Scent
	Quality- Vase life
	Volatiles- Alkane
	Volatiles- Apocarotenoid
	Volatiles- Fatty acid derivative
	Volatiles- Halocarbon
	Volatiles- Monoterpene
	Volatiles- Norisoprene
	Volatiles- Olefin
	Volatiles- Organic acid
	Volatiles- Phenolic derivative
	Volatiles- Sesquiterpene
	Anatomy and morphology- Flower
	Anatomy and morphology- Leaf
	Anatomy and morphology- Prickles
	Anatomy and morphology- Reproductive organs
	Yield

Edge Color Mapping





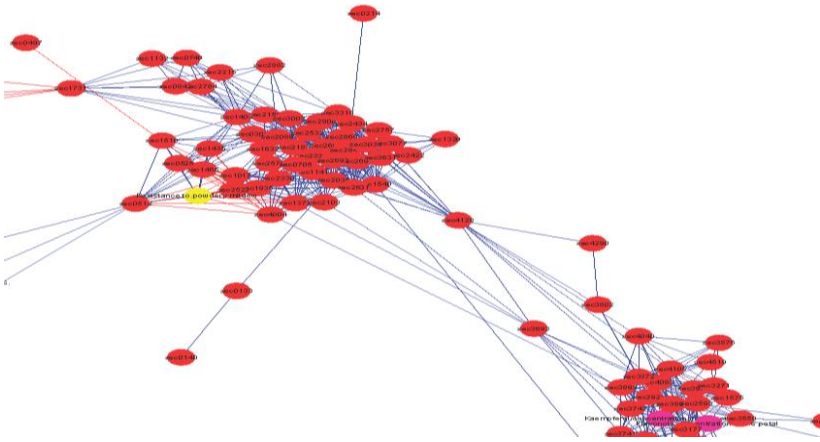
• **Powdery Mildew** disease in roses caused by the fungi *Sphaerotheca pannosa* (Wallr) Lev. var. *rosae* War. is one of the most common disease globally , damaging both greenhouse and open field roses.



Score	Disease Coverage (%)	Infected Tissues
1-	50-90	all plant tissues
2-	35-50	leaves, apices, sepals, receptacles, sometime stems pedicels and petals
3-	5-34	leaves, apexes, sometime sepals and receptacles
4-	0-4	only leaves

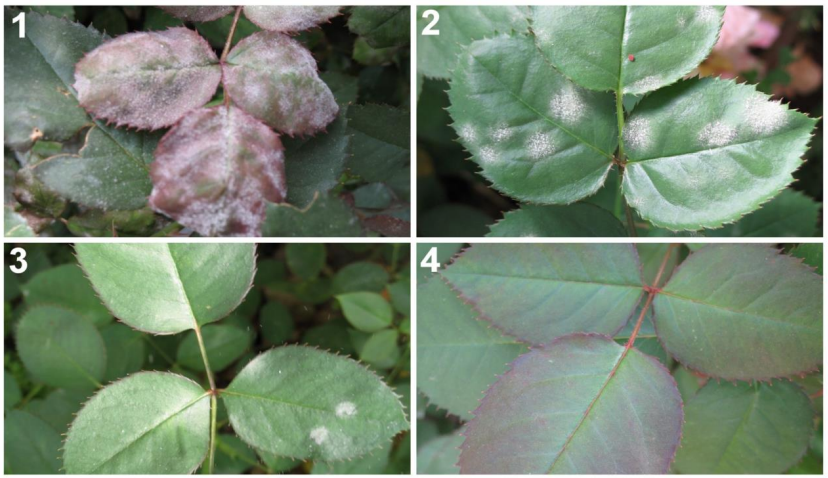
Correlation between some secondary metabolites and resistance to Powdery Mildew

- The LC-MS run yield 4807 fragments that were name secXXXX.
- By using statistical we were able to reduce it to 116 representative fragments.
- We detect seven fragments showing strong correlation with the level of the Powdery Mildew resistance.



Correlation between some secondary metabolites and resistance to Powdery Mildew

Powdery Mildew (leafs)

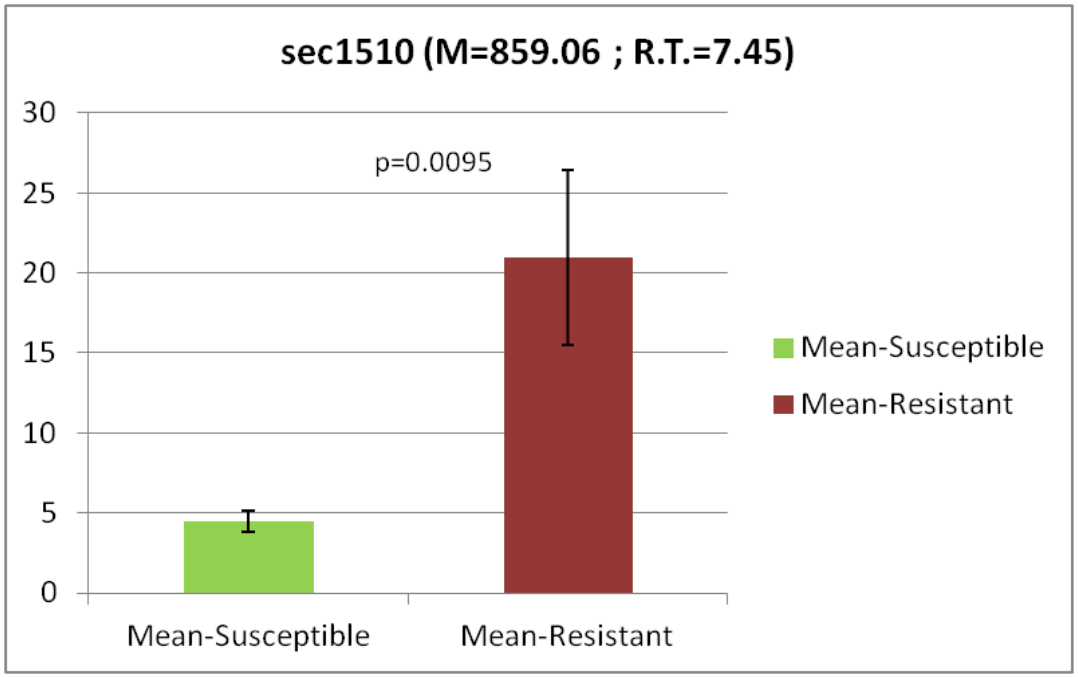


Secondary metabolite (flowers)

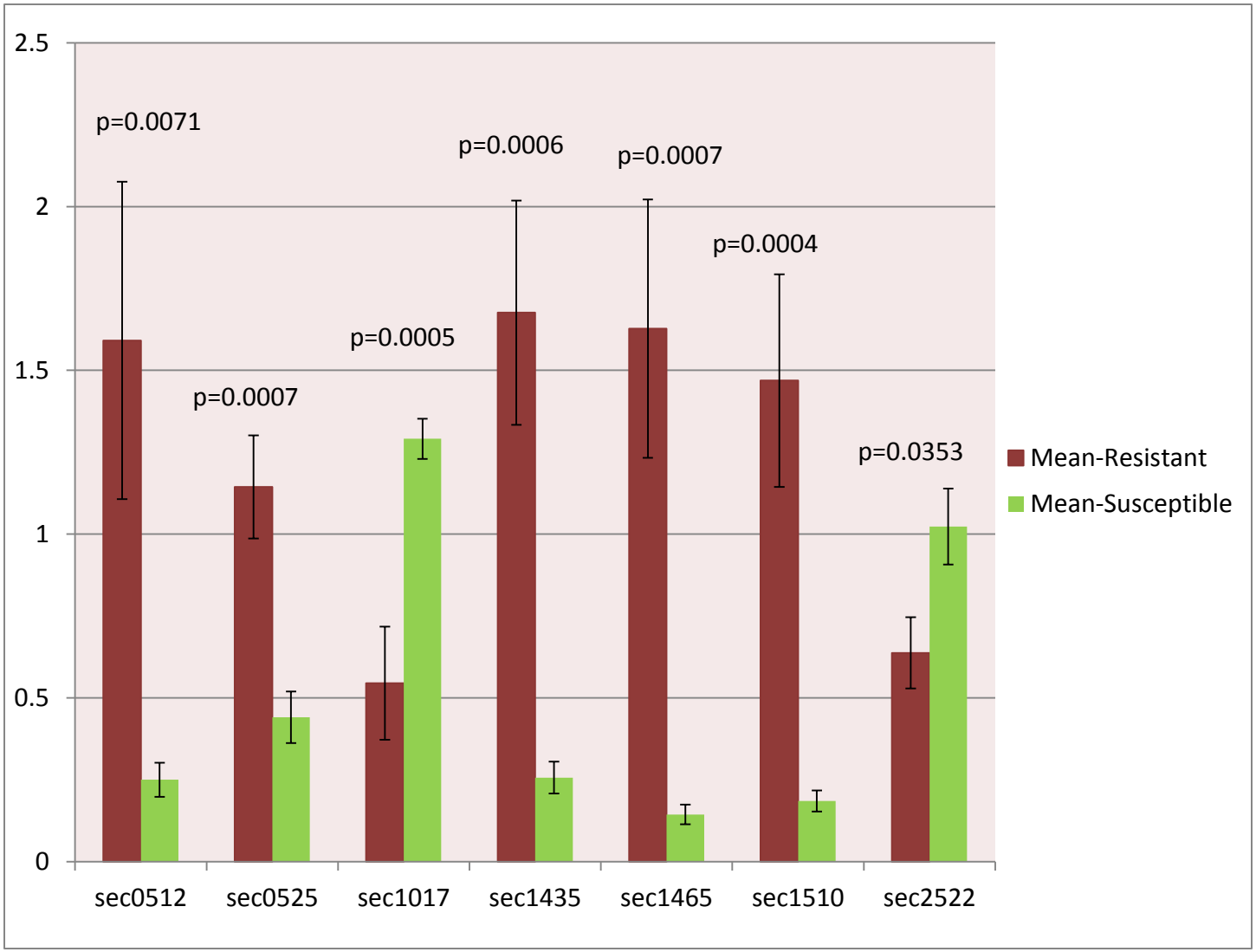
Second experiment

- To check the repeatability of the results in other rose varieties and to check the relationship with powdery mildew resistance.
- 15 resistant and 15 susceptible genotypes were selected.

Sec 1510


sec1510 (M=859.06 ; R.T.=7.45)
30
25
20
15
10
5
0
p=0.0095
Mean-Susceptible
Mean-Resistant
Mean-Susceptible
Mean-Resistant

Petals LCMS Analysis- First run results for the selected varieties



Fragment 6

Petals LCMS Analysis

Name: **sec1510**

Comment: RT=7.16 & MZ=859.06

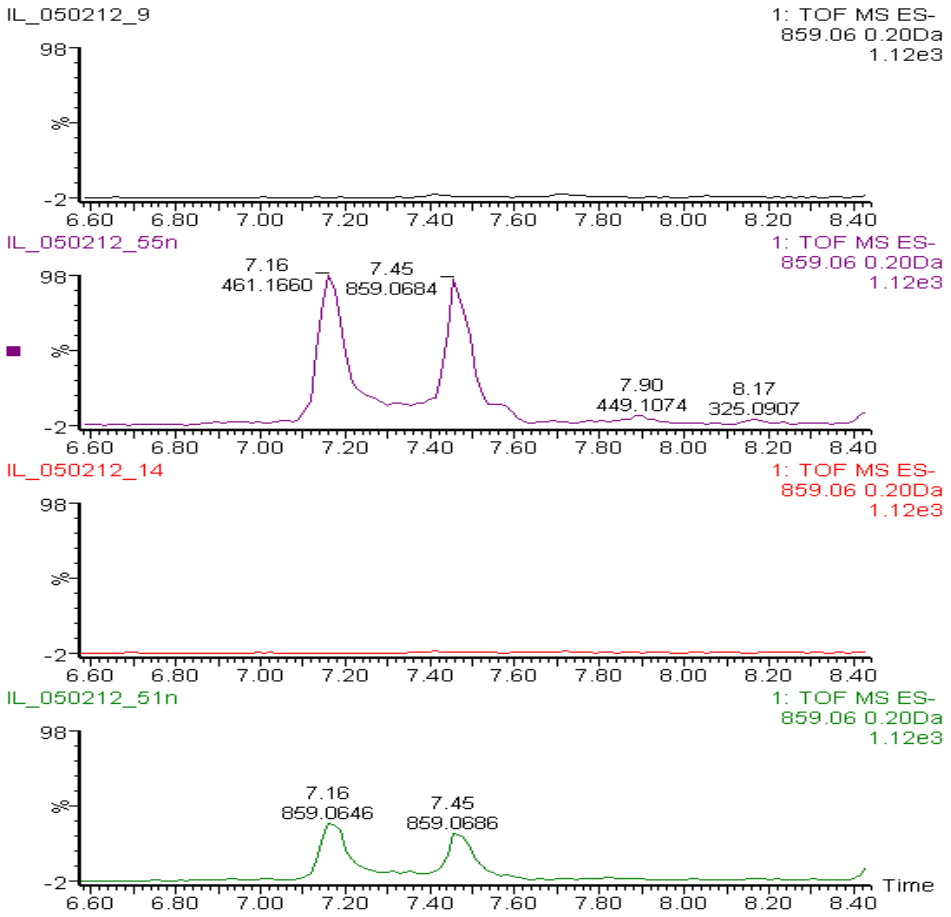
Formula: $C_{75}H_{52}O_{48}$

GF26-susceptible

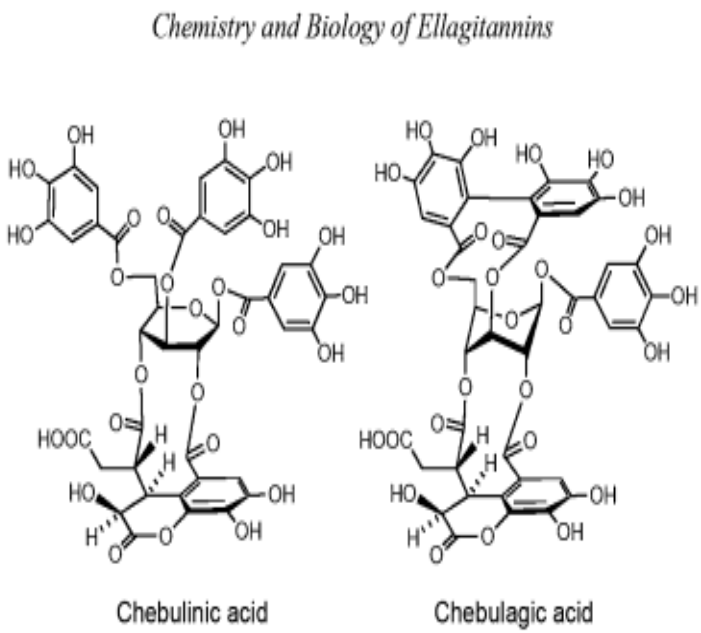
GF99-resistant

GF97-susceptible

GF98-resistant



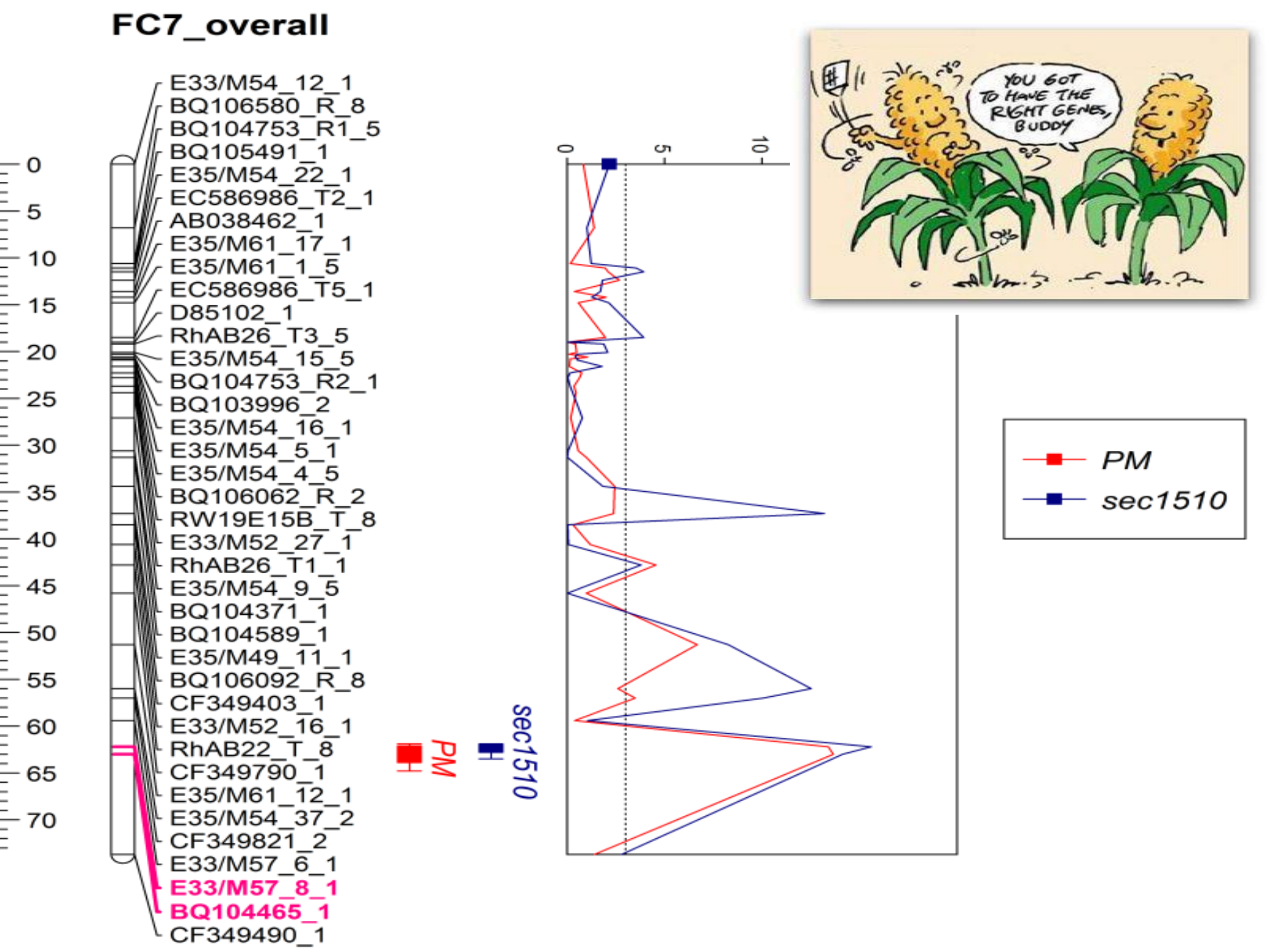
- Following further analysis of the seven fragments according to their mass and R.T and the data of the related mass we determined that all fragments are hydrosable tannins.
- To be more specific **Ellagitannins.**



Ellagitannins in Rosaceae and Resistance to Powdery Mildew

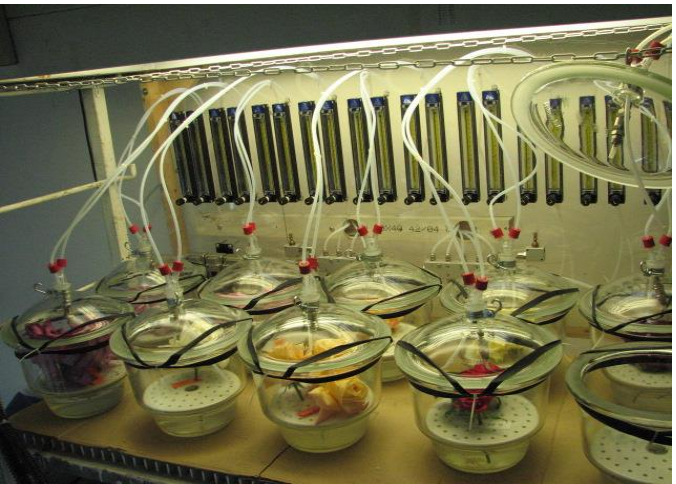
- Ellagitannins may be important for the resistance to powdery mildew in strawberries as their accumulation was strong and rapid enough to inhibit the initial phases of infection.
- No firm conclusions can be drawn yet concerning the functions of ellagitannins in plant defense against pathogens.
- However, antimicrobial, antioxidant and protein binding capacity of ellagitannins suggest a protective role in plants.

Hukkanen et al. (2007)


FC7_overall
E33/M54_12_1
BQ106580_R_8
BQ104753_R1_5
BQ105491_1
E35/M54_22_1
EC586986_T2_1
AB038462_1
E35/M61_17_1
E35/M61_1_5
EC586986_T5_1
D85102_1
RhAB26_T3_5
E35/M54_15_5
BQ104753_R2_1
BQ103996_2
E35/M54_16_1
E35/M54_5_1
E35/M54_4_5
BQ106062_R_2
RW19E15B_T_8
E33/M52_27_1
RhAB26_T1_1
E35/M54_9_5
BQ104371_1
BQ104589_1
E35/M49_11_1
BQ106092_R_8
CF349403_1
E33/M52_16_1
RhAB22_T_8
CF349790_1
E35/M61_12_1
E35/M54_37_2
CF349821_2
E33/M57_6_1
E33/M57_8_1
BQ104465_1
CF349490_1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
PM
sec1510
0
5
10
YOU GOT TO HAVE THE RIGHT GENES, BUDDY
PM
sec1510

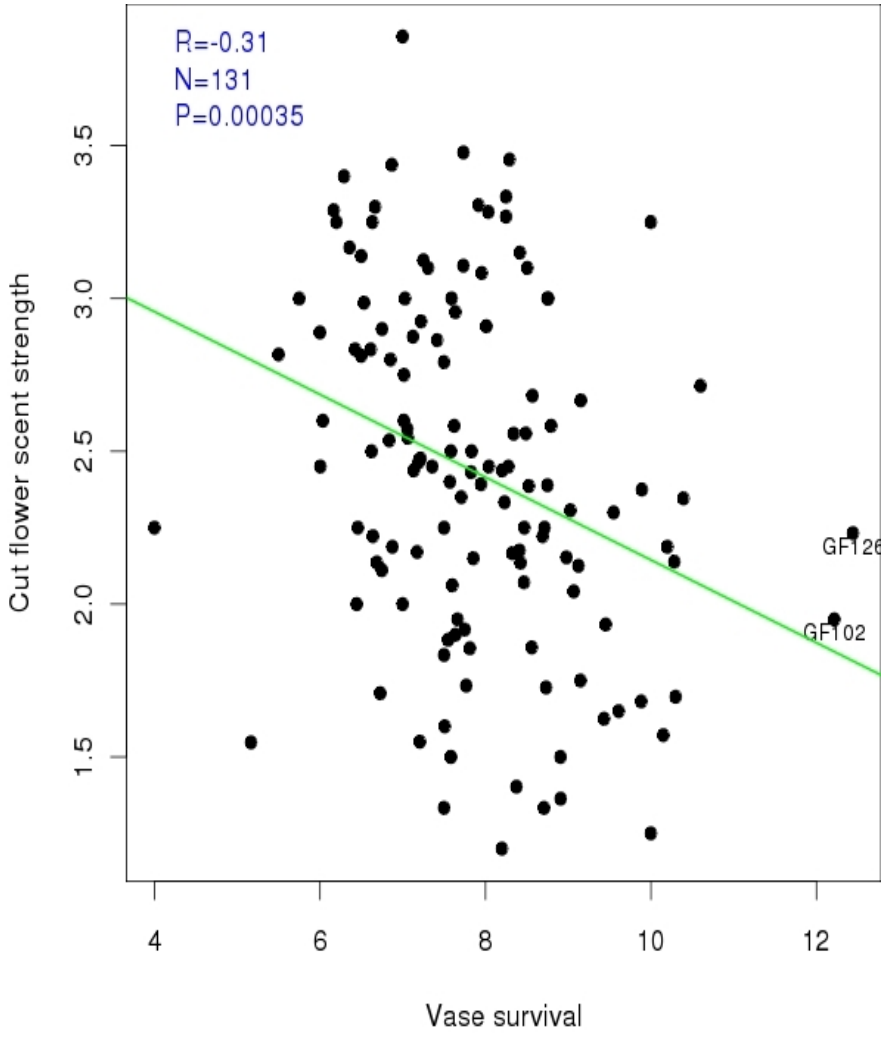
The recipe to rose scent

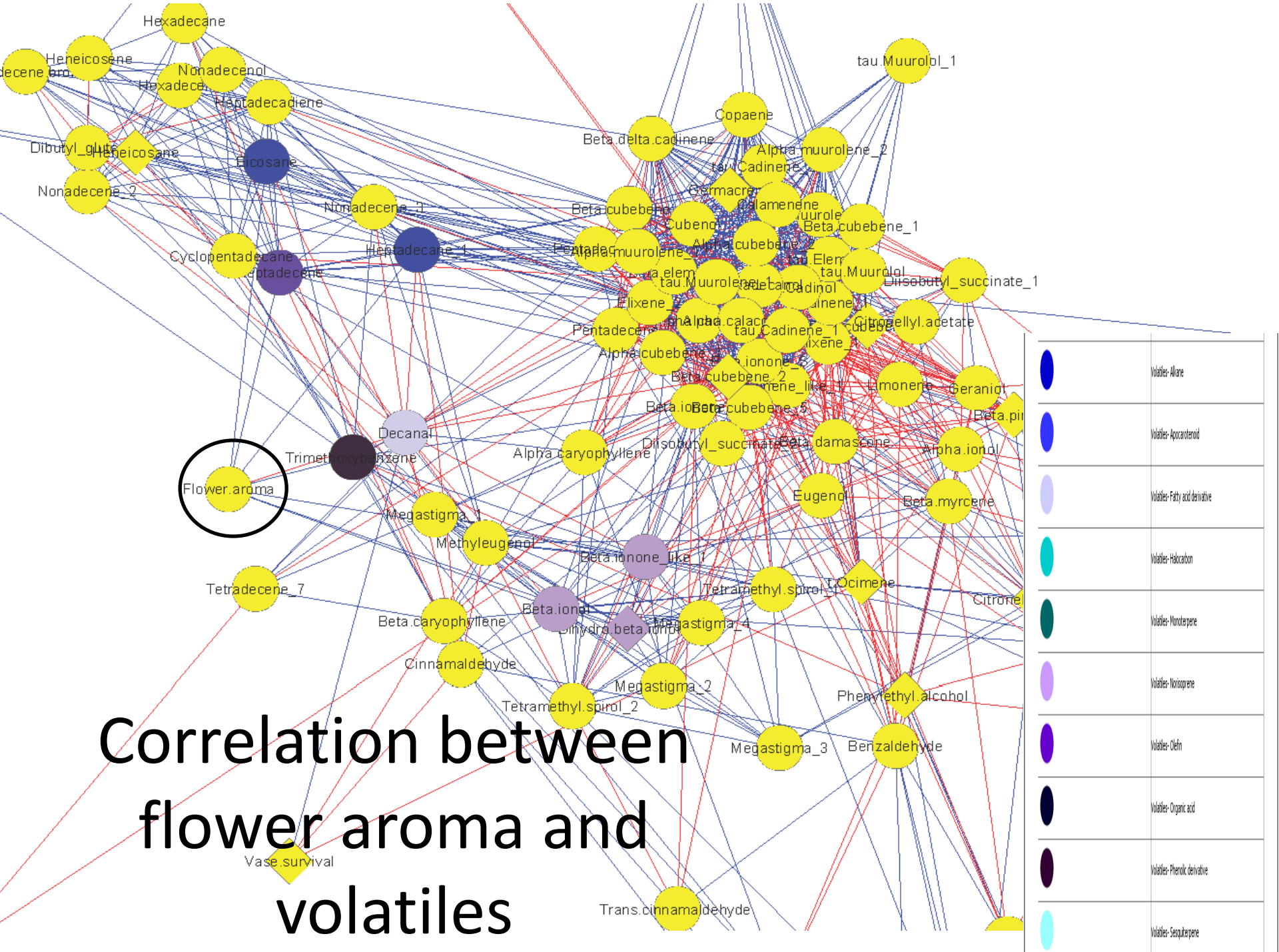
- Over a period of six years the roses segregating population was evaluated for smell strength by more than 50 students thus generating a reliable score for this trait.
- Using a GC-MS headspace technique we detect in the GGFC population 102 unique volatiles.



Reintroducing Fragrance to Cut Roses - Breeding Autotetraploids

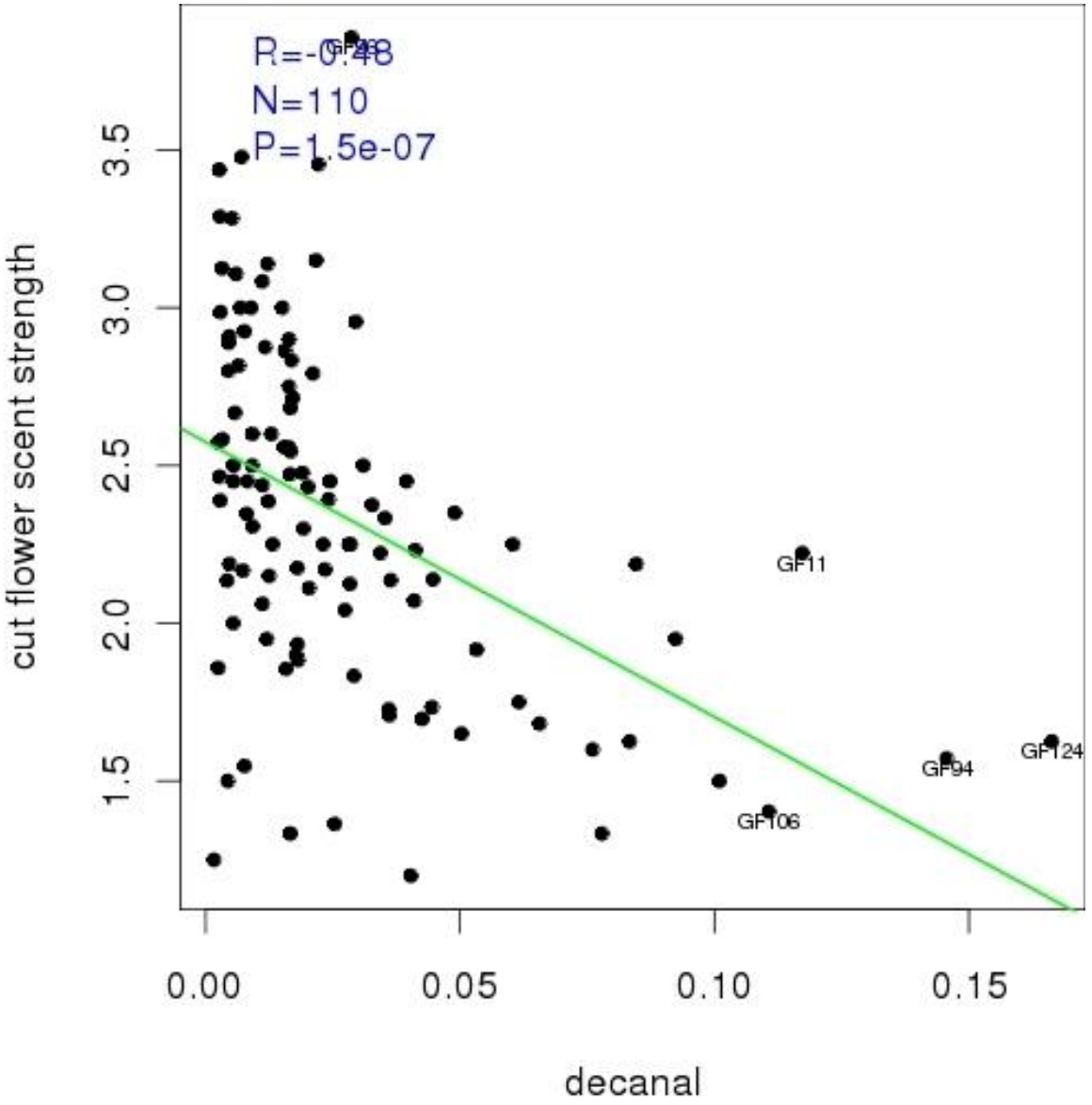
- The intensive breeding efforts for cut roses with long vase life considerably narrowed the genetic basis of the crop and eliminated the scent of the flower.
- Consequently, most of the modern cut flower rose varieties today are odorless.





Correlation between flower aroma and volatiles

Correlation between a volatile and scent strength (example)

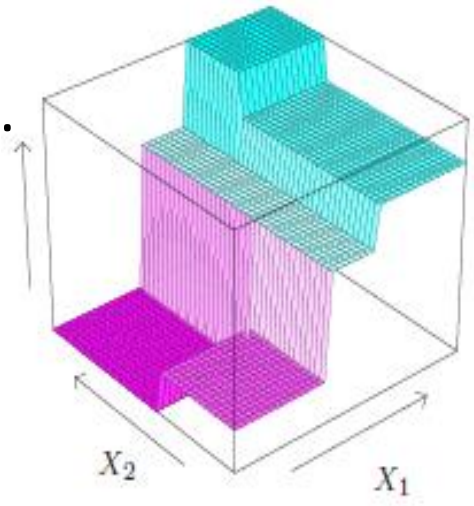


Eight components (volatiles) linearly correlative with flower aroma

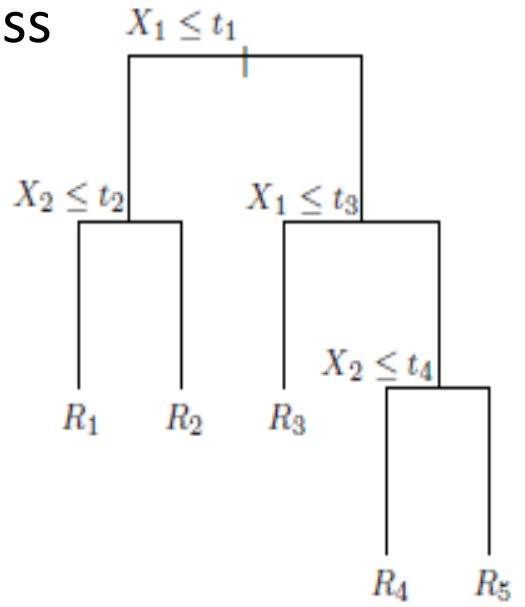
- Three **beta ionone** derivatives and **trimethoxybenzene.**
- **Eicosane** and **heptadecane** are odorless.
- **Heptadecene** has been reported from other perfume-flowered species but not in the Rosaceae family.
- **Decanal** is an important component of cumin and buckwheat odor. Moreover, **decanal** also differs from the other volatiles as it showed a negative correlation with scent strength.
- These findings may suggest that these volatiles contribute to the rose unique scent via different numerous mechanisms.

Classification and Regression Trees (CART)

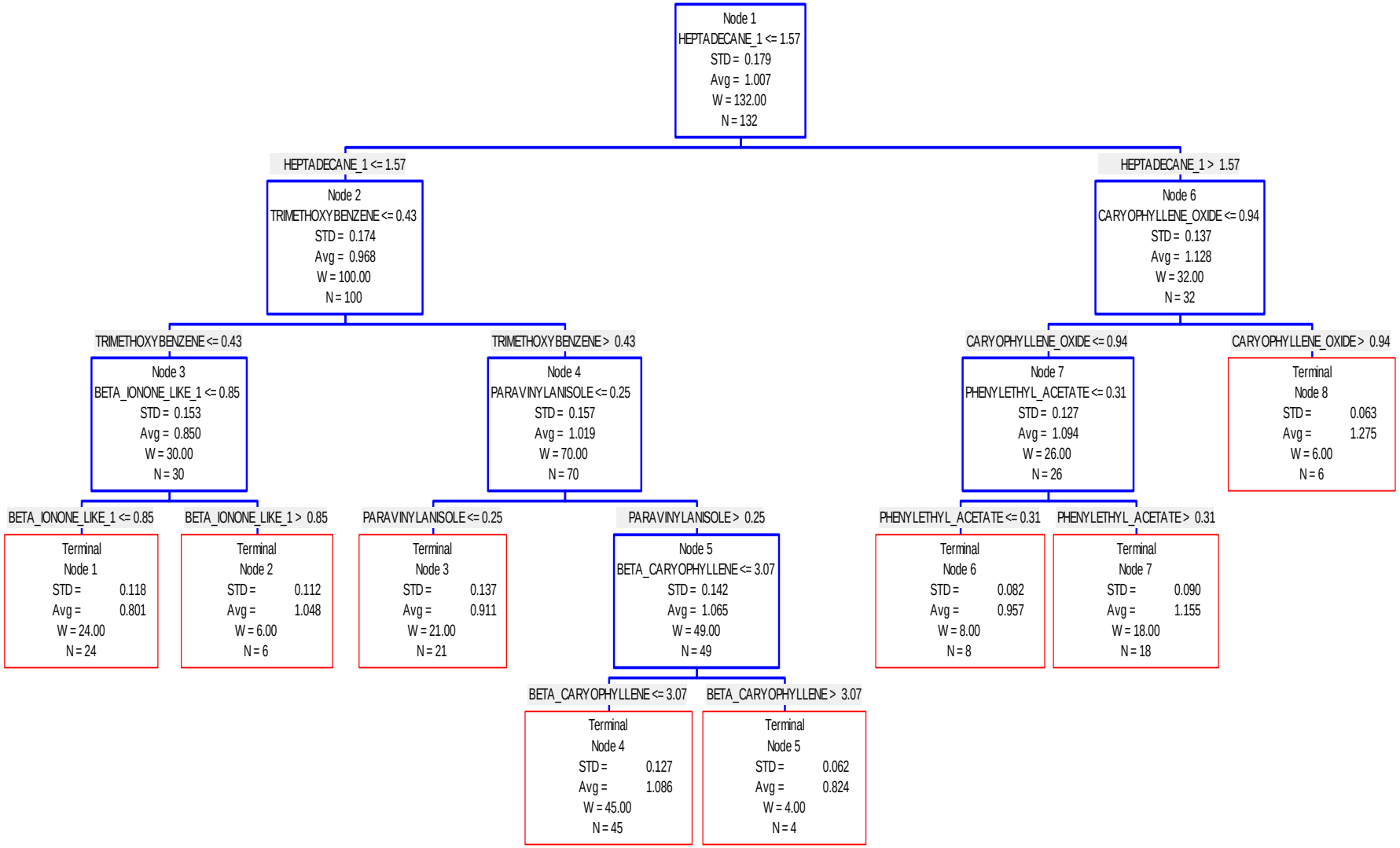
- CART tree is generated by repeated dynamic partitioning of data set which automatically determines which variables and regions to focus on.
- **Seek the splitting variable j and split point s that minimize the inner variance of the sub-groups.**
- Path through the tree governed by the answers to questions or rules (Yes= left; No= right)
- At some point a given path ends in a terminal node, all records in the node are assigned to a single class



- "Regression trees have not been used much in genetics, but the natural way in which complex interactions can be expressed through regression trees does make them intriguing" (Broman & Sen 2009).

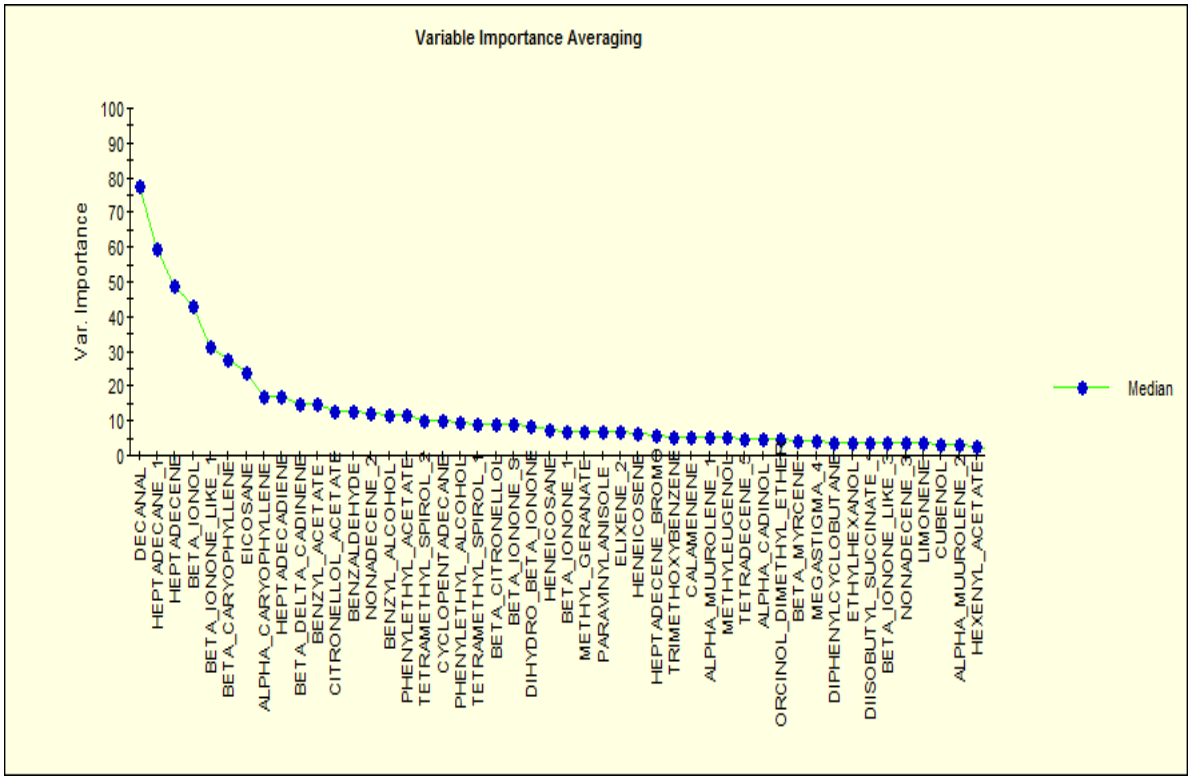


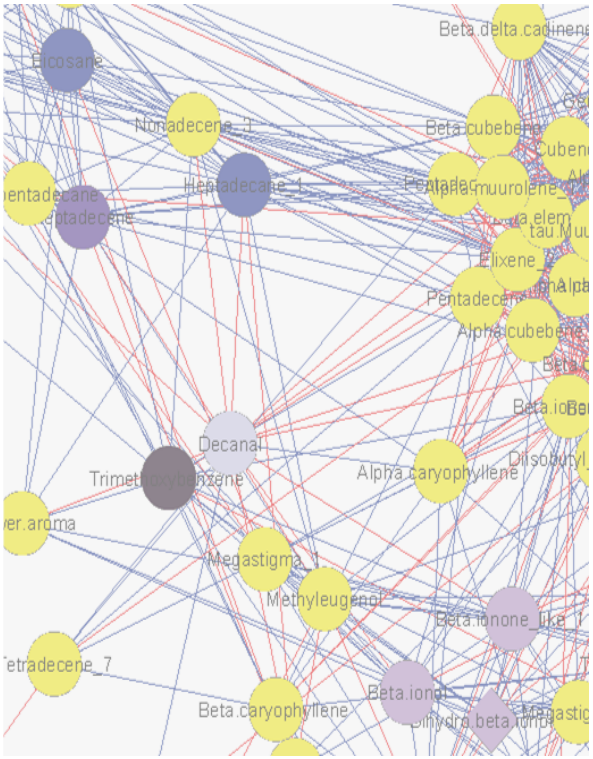
CART Analysis - Volatiles



CART Ensembles Analysis- Volatiles

- According to the CART ensembles analysis, the volatiles with the largest influence on the variance of fragrance in this population are: beta ionol, heptadecane, heptadecene and decanal.





Conclusion remarks

- Constructing autotetraploid maps.
- Comparative and evolutionary studies.
- PM resistance and Ellagitannins .
- Flower aroma and volatiles.
- CART as a tool for analyzing complex traits.
- “As we look ahead to developing new technologies, methodologies and training new minds, we must remember that no single technological advance or statistical method will unravel the genomic mystery. Instead, it will be the conglomeration of ideas, techniques and analyses that provide the end to this endeavor” Doerge (2002).

Rose database

Sign In

Select an organism from the right and then login

User Name:

Password:

Forgot your password?

Sign Up

Log As Guest | Login

Select an Organism

Tomato | Lisianthus | Rose

Rice | Arabidopsis | Barley

Maize | Melon | Mouse

Wheat

Tutorial

Demonstration videos

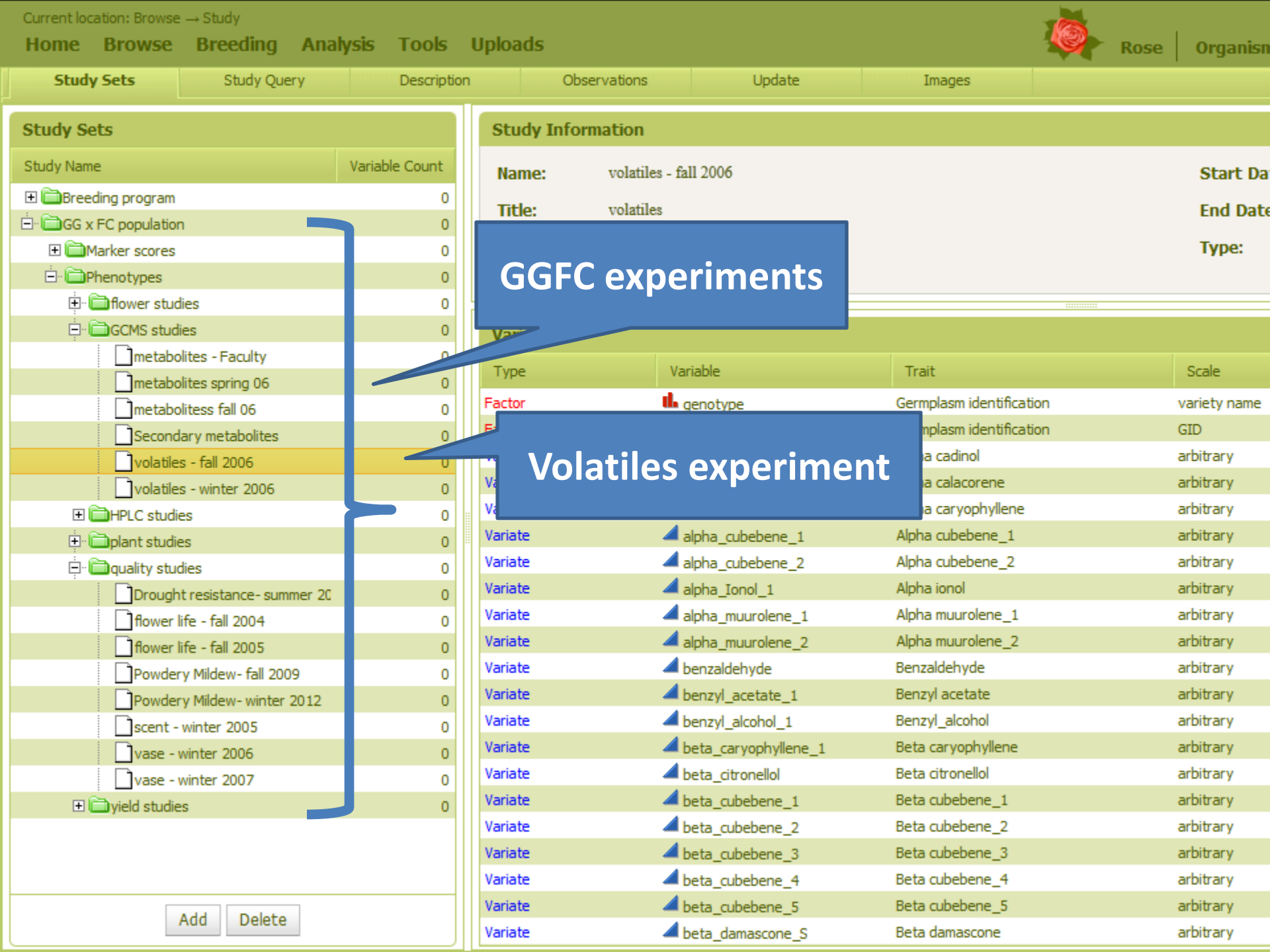
1. Overview
2. Main system
3. Upload wizards
4. Breeding management
5. Phenotype analysis
6. Genetic analysis

Phenom-Networks company website

Phenom-Networks

Gen…on how bree… data… has developed a web based platform into which scientists can import their raw data to enable analysis of simple and complex traits.

http://phnserver.phenome-networks.com/


Current location: Browse → Study
Home
Browse
Breeding
Analysis
Tools
Uploads
Rose
Organism
Study Sets
Study Query
Description
Observations
Update
Images
Study Sets
Study Name
Variable Count
Breeding program 0
GG x FC population 0
Marker scores 0
Phenotypes 0
flower studies 0
GCMS studies 0
metabolites - Faculty 0
metabolites spring 06 0
metabolitess fall 06 0
Secondary metabolites 0
volatiles - fall 2006 0
volatiles - winter 2006 0
HPLC studies 0
plant studies 0
quality studies 0
Drought resistance- summer 20 0
flower life - fall 2004 0
flower life - fall 2005 0
Powdery Mildew- fall 2009 0
Powdery Mildew- winter 2012 0
scent - winter 2005 0
vase - winter 2006 0
vase - winter 2007 0
yield studies 0
Add
Delete
GGFC experiments
Volatiles experiment
Study Information
Name: volatiles - fall 2006
Title: volatiles
Start Da
End Date
Type:
Type
Variable
Trait
Scale
Factor genotype Germplasm identification variety name
mplasm identification GID
a cadinol arbitrary
a calacorene arbitrary
a caryophyllene arbitrary
Variate alpha_cubebene_1 Alpha cubebene_1 arbitrary
Variate alpha_cubebene_2 Alpha cubebene_2 arbitrary
Variate alpha_Ionol_1 Alpha ionol arbitrary
Variate alpha_muurolene_1 Alpha muurolene_1 arbitrary
Variate alpha_muurolene_2 Alpha muurolene_2 arbitrary
Variate benzaldehyde Benzaldehyde arbitrary
Variate benzyl_acetate_1 Benzyl acetate arbitrary
Variate benzyl_alcohol_1 Benzyl_alcohol arbitrary
Variate beta_caryophyllene_1 Beta caryophyllene arbitrary
Variate beta_citronellol Beta citronellol arbitrary
Variate beta_cubebene_1 Beta cubebene_1 arbitrary
Variate beta_cubebene_2 Beta cubebene_2 arbitrary
Variate beta_cubebene_3 Beta cubebene_3 arbitrary
Variate beta_cubebene_4 Beta cubebene_4 arbitrary
Variate beta_cubebene_5 Beta cubebene_5 arbitrary
Variate beta_damascone_S Beta damascone arbitrary

Study: **flower - summer 2005**

Reload | Clear | Save | Filter | Columns | Split at: 2 | Do split | Display | Tools

Observations Rows per page **100**

#	GID	col_low_l	col_low_in	col_up_l	col_up_int	pet_l	pet_wid	pet_wei	pet_wei_a	carp_l	carp_rec_	flwr_rec_l	carp_wid	carp_wal	st_4num	co
1	222	5.9	2.3	27.8	3	33.6666667	29.3333333	3.6	0.09790909	1.2683333	0.8033333	9.3	0.8233333	0.2033333	4.7	
2	223	10.3	2	29.5	2	39.75	38.5	3.4	0.2	1.15	0.7475	9.5	0.8775	0.205	2.5	2
3	224	23.2	2	4.8	1.7	28	27.3333333	3.4	0.11064516	1.1266667	0.54	6.7	1.3183333	0.2033333	2.7	1.3
4	225	22.3	1.3	10	1	32.3333333	25.5833333	2.4	0.12327586	0.9983333	0.735	9.3	0.7016667	0.1541667	0.3	1
5	226	33.3	1	5.3	1	38.5	32.75	2.5	0.212	1.1	0.7866667	9.7	0.595	0.1908333	0.3	1.7
6	227	6.6	3	16.2	2						0.5916667	7	0.7333333	0.1483333	1	2
7	228	4.3	2	27.3	3						0.8466667	9.7	0.775	0.195	5.7	1.3
8	230	35.7	1	4.5	1						0.6816667	6.3	1.31		0.3	1.7
9	231	0		33	1						0.7283333	8	0.7616667	0.1633333	7	1
10	232	11.7	1.3	18.2	2						0.6775	6.5	0.6808333	0.1933333	1.3	2
11	233	6.5	1	25.8	2.3						0.8533333	9.7	0.8	0.2041667	3.3	2
12	234	7.9	2	25.8	1.3	33.6666667	30.5833333	4.5	0.07420765	1.17	0.605	7.7	1.0566667	0.2258333	3	2
13	235	10.3	2	25	3	35.25	36.125	4	0.14436364	0.85	0.42	6	0.8925	0.205	1	2
14	236	6.3	1	23.7	2	29.9583333	29.5416666	2.2	0.08666667	1.1241667	0.66	5.8	0.8291667	0.1558333	1.8	2
15	237	7.3	2.6	25.8	2	33.1	31.9	5.4	0.13038835	1.301	0.822	8.6	1.041	0.2125	6.6	1.8
16	238	6.1	1.5	31.1	2	37.25	32.125	4.2	0.15425926	1.125	0.6825	7.5	0.8525	0.20625	3	2
17	239	10.1	2	29	2	39.0833333	34.0833333	4.1	0.18560606	1.0733333	0.7866667	8	0.675	0.185	1.3	2
18	240	6.4	2.3	31.3	1.7	37.75	33.0833333	4.8	0.1452	1.175	0.5816667	5.3	1.1516667	0.215	1.3	2
19	241	6.5	1.5	4.2	1.5	35	34	2.6	0.14222222	1.07	0.395	5.7	0.6825	0.1925	3	2
20	242	7.2	2	26.9	3	34.0833333	30.8333333	3.3	0.16915254	1.0316667	0.5366667	5.3	0.9616667	0.2241667	1	2

Raw data of an experiment

List of all traits

Ontology column

Trait [Total Records 470] Save as Excel

#	Name	Abbr.	Description	Group	Ontology	Images?
1	Alanine (2TMS)		aliphatic amino acid	Metabolites- Primary (Fait A.)	TO:0002673	No
2	Alanine (3TMS)		aliphatic amino acid	Metabolites- Primary (Fait A.)	TO:0002673	No
3	Alpha cadinol		sesquiterpene alcohol	Volatiles- Sesquiterpene	TO:0000277	Yes
4	Alpha calacorene		sesquiterpene olefin	Volatiles- Sesquiterpene	TO:0000277	Yes
5	Alpha caryophyllene		sesquiterpene olefin	Volatiles- Sesquiterpene	TO:0000277	Yes
6	Alpha cubebene_1		sesquiterpene olefin	Volatiles- Sesquiterpene	TO:0000277	Yes
7	Alpha cubebene_2		sesquiterpene olefin	Volatiles- Sesquiterpene	TO:0000277	Yes
8	Alpha ionol		norisoprene alcohol	Volatiles- Norisoprene	TO:0000277	Yes
9	Alpha muurolene_1		sesquiterpene olefin	Volatiles- Sesquiterpene	TO:0000277	Yes
10	Alpha muurolene_2		sesquiterpene olefin	Volatiles- Sesquiterpene	TO:0000277	Yes
11	Amino acids in the petal		flower's primary metabolites content	Metabolites- Primary (Fait A.)	TO:0002673	No
12	Anteraxanthin (%) in the petal		petal's carotenoids content (% from the total amount of caroteno	Biochemistry- Carotenoids	TO:0000496	No
13	Anther color		main color of an anther	anatomy and morphology- Reproduct	TO:0000187	Yes
14	Anthocyanins concentration in the pe		petal's anthocyanins content	Biochemistry- Anthocyanins	TO:0000071	Yes
15	Apical dominance		shoot apical dominance	Growth and development- Bush	TO:0000660	Yes
16	Arabinose		cell wall component	Metabolites- Primary (Fait A.)	TO:0000291	No
17	Ascorbic acid		organic acid	Metabolites- Primary (Fait A.)	TO:0000281	No
18	Asparagine		neutral amino acid	Metabolites- Primary (Fait A.)	TO:0002673	No
19	Asparagine (flower tissue)		neutral amino acid	Metabolites- Primary (Zamir D.)	TO:0002673	No
20	Aspartic acid		acidic amino acid	Metabolites- Primary (Fait A.)	TO:0002673	No
21	Aspartic acid (flower tissue)		acidic amino acid	Metabolites- Primary (Zamir D.)	TO:0002673	No
22	Average branch length		average branches length per bush	Growth and development- Bush	TO:0000576	Yes
23	Average petal weight		total petals weight divided by total number of petals	anatomy and morphology- Flower	TO:0000275	No
24	Average seed weight		the average weight of the seed	Fertility	TO:0000181	Yes
25	Average seeds number		total number of seeds per plant divided by total number of fruit	Fertility	TO:0000445	Yes
26	Axillary buds stage 1 (number)		number of axillary buds in floral developmental stages 0-1	Growth and development- Bush	TO:0000646	Yes
27	Axillary buds stage 6 (number)		number of axillary buds in floral developmental stages 6-7	Growth and development- Bush	TO:0000646	Yes

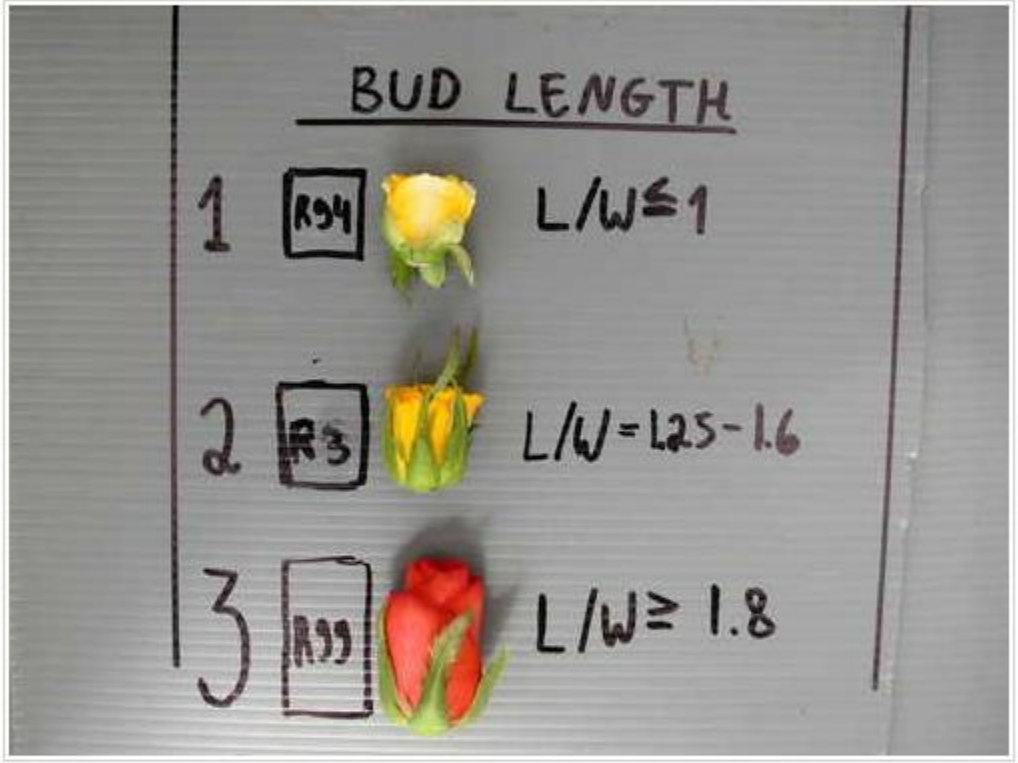
New Trait

Trait: **Bud length**



Description + Images for each trait

‹ Previous Next ›



Bud length 1

Download Original

null

Current location: Breeding → Fields

Home Browse Breeding Analysis Tools Uploads

Rose | Organism

Fields list | Lines | Traits | Groups | Nursery | Field map | Field plots | **Observations**

Field: **fall 2012 (BR12)**

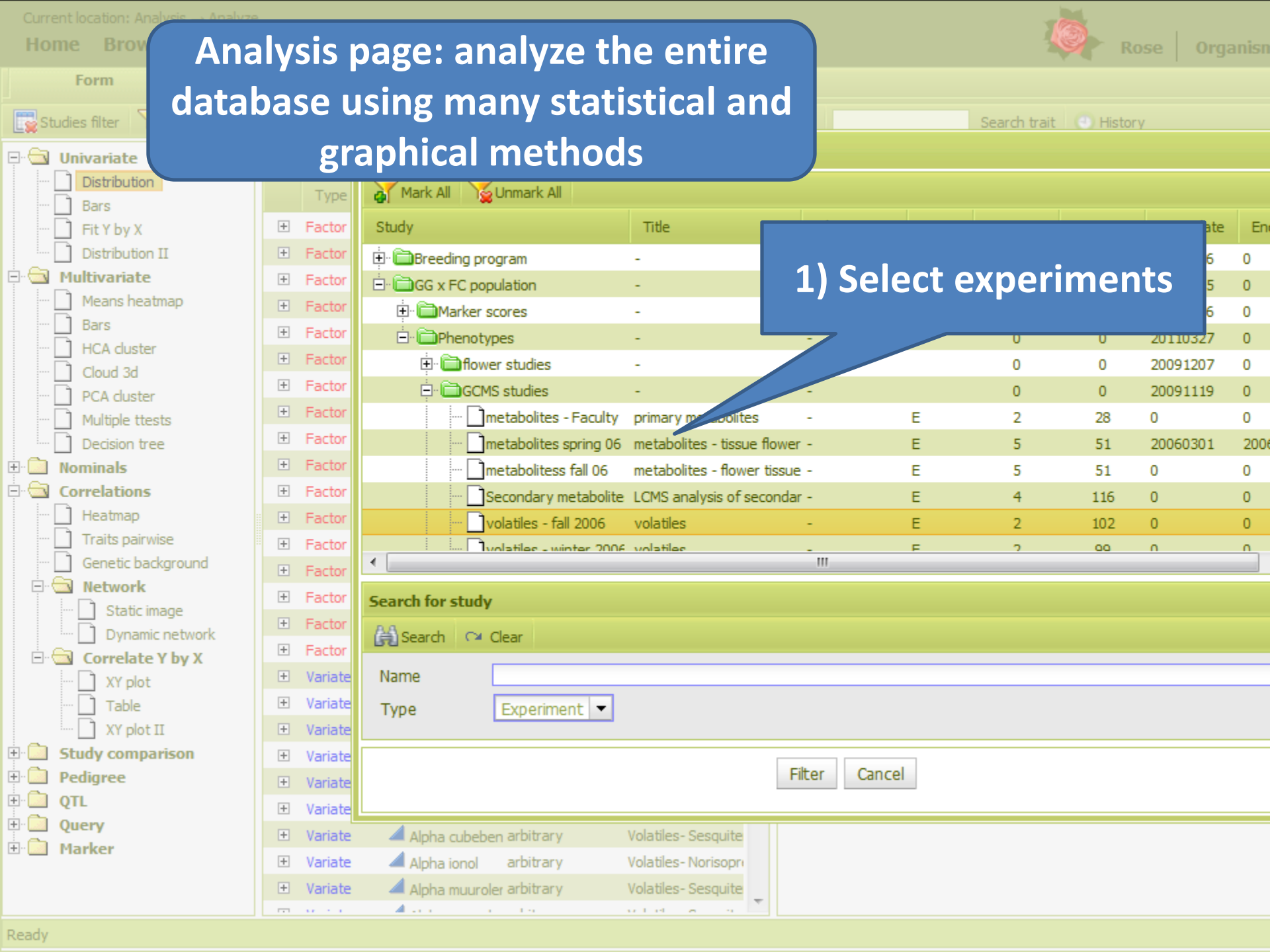
Refresh | Clear | Save | Filter | Split at: 2 | Do split | Display | Category | Edit | Tools | Reports

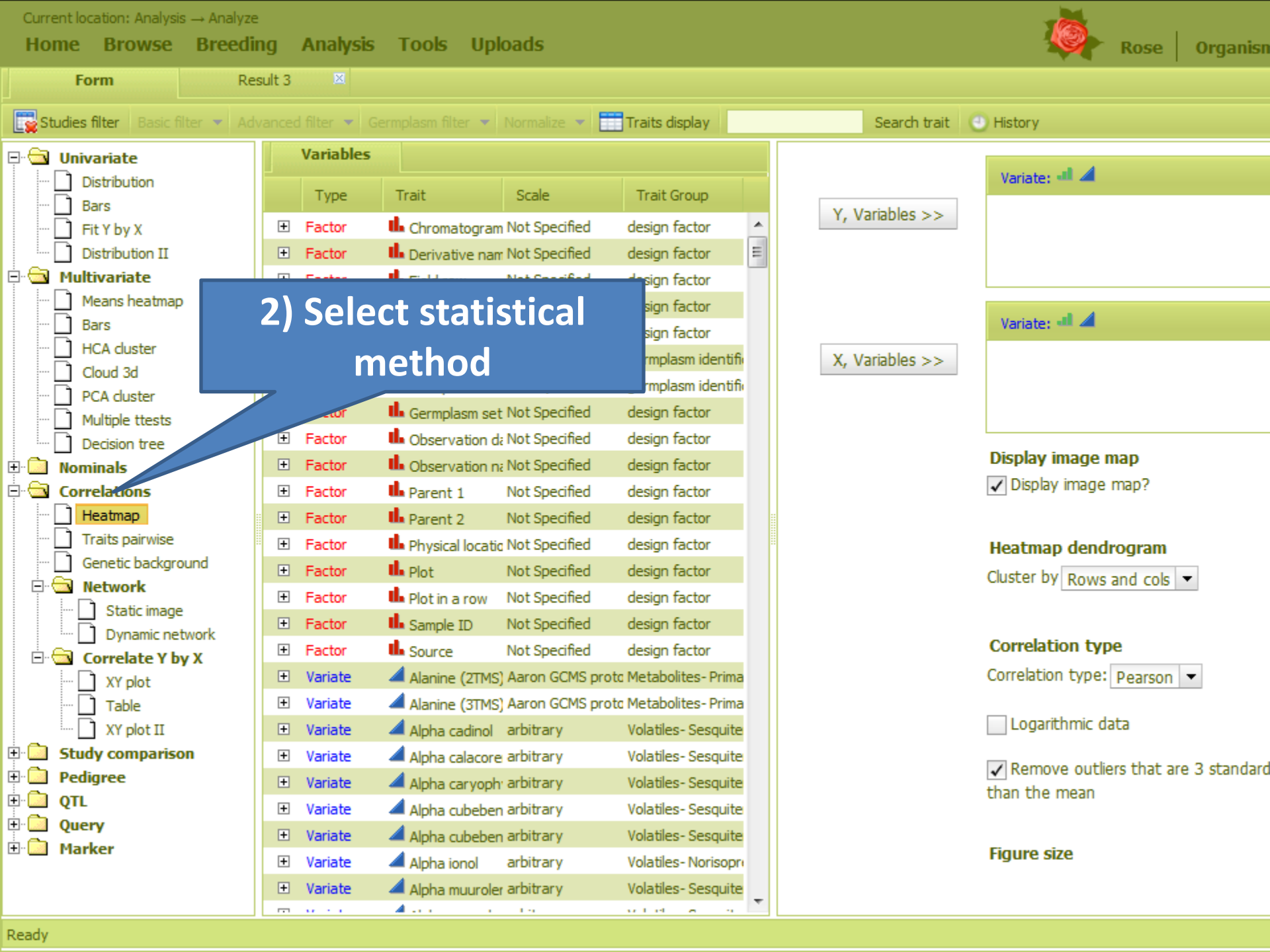
Selections and Observations Rows per page 30 Columns

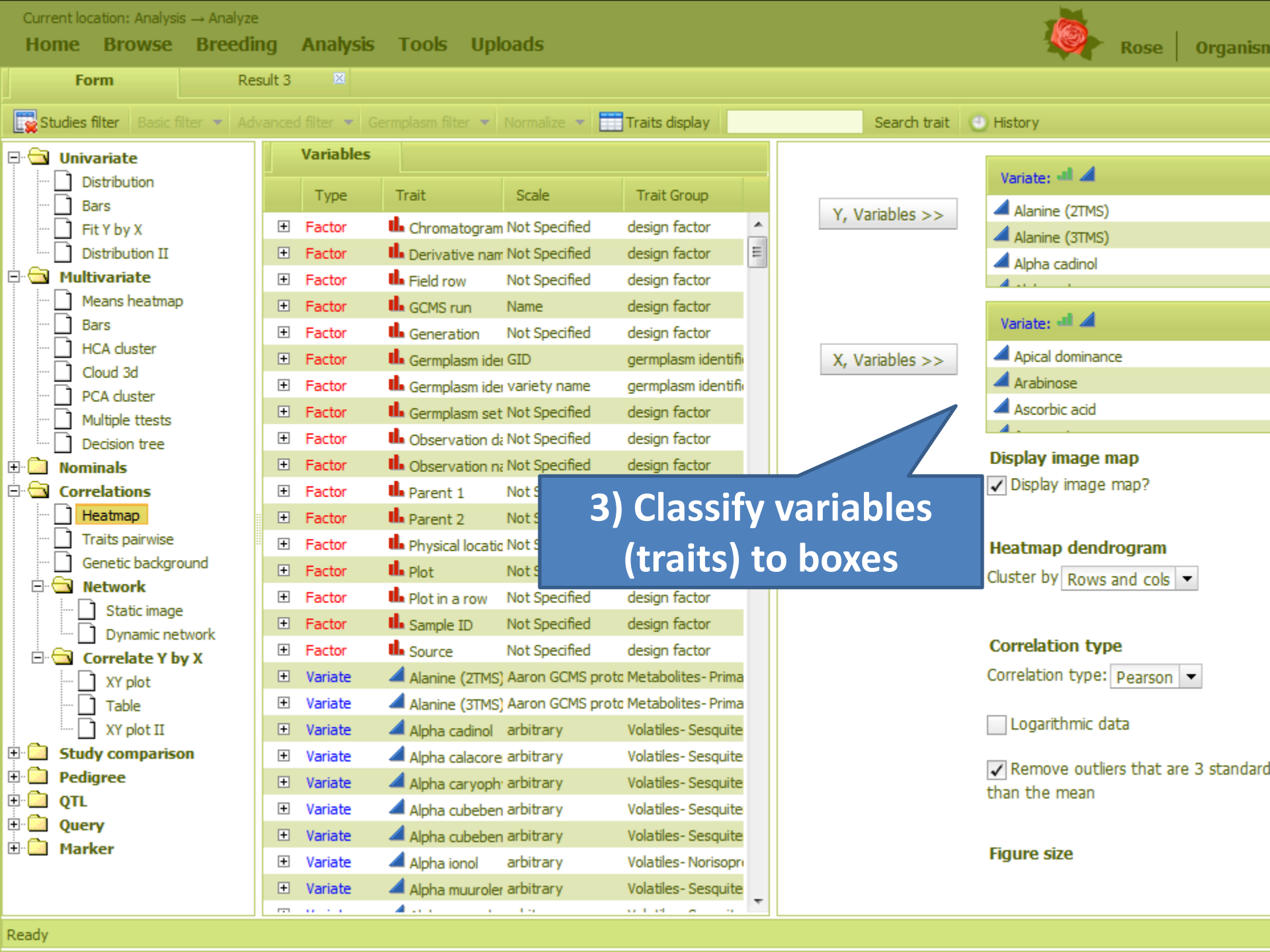
	#	GID	Line name	Source	Plot name	Fruit extracted	Seed extracted	Plant	Observatic date	Selected	Prickly pedicel	location	Cut flower scent pleasantne	Flower color-major	Flower color-minor	
	1	222	GF1	GG / FC	1	No	No		20121105	No	3			pink		3
⊞	2	270	GF2	GG / FC	2	No	No		20121105	No	3					
⊞	3	281	GF3	GG / FC	3	No	No		20121105	No	2		2	dark pink		2
⊟	4	292	GF4	GG / FC	4	No	No		20121105	No	3		1	cream		1
																
⊟	5	222	GF1	GG / FC	1	No	No		20121105	No	3		1	pink		1
																
⊞	6	303	GF5	GG / FC	5	No	No		20121106	No	3		1	light pink	peach	1
⊞	7	314	GF6	GG / FC						No	3		1	pink		1
⊞	8	325	GF7	GG / FC						No	3		3	peach	pink	2
⊞	9	336	GF8	GG / FC						No	3		1	pink		1

Phenotypes + Images for each genotype

1 2 3 → Records from 1 to 30 of 191


Analysis page: analyze the entire database using many statistical and graphical methods
1) Select experiments
Univariate
Distribution
Bars
Fit Y by X
Distribution II
Multivariate
Means heatmap
Bars
HCA cluster
Cloud 3d
PCA cluster
Multiple ttests
Decision tree
Nominals
Correlations
Heatmap
Traits pairwise
Genetic background
Network
Static image
Dynamic network
Correlate Y by X
XY plot
Table
XY plot II
Study comparison
Pedigree
QTL
Query
Marker
Mark All
Unmark All
Study
Title
Breeding program
GG x FC population
Marker scores
Phenotypes
flower studies
GCMS studies
metabolites - Faculty
metabolites spring 06
metabolites - tissue flower
metabolitess fall 06
metabolites - flower tissue
Secondary metabolite
LCMS analysis of secondar
volatiles - fall 2006
volatiles
Search for study
Search
Clear
Name
Type
Experiment
Filter
Cancel
Alpha cubeben arbitrary Volatiles- Sesquite
Alpha ionol arbitrary Volatiles- Norisopr
Alpha muuroler arbitrary Volatiles- Sesquite
Ready


Current location: Analysis → Analyze
Home
Browse
Breeding
Analysis
Tools
Uploads
Rose
Organism
Form
Result 3
Studies filter
Basic filter
Advanced filter
Germplasm filter
Normalize
Traits display
Search trait
History
Univariate
Distribution
Bars
Fit Y by X
Distribution II
Multivariate
Means heatmap
Bars
HCA cluster
Cloud 3d
PCA cluster
Multiple ttests
Decision tree
Nominals
Correlations
Heatmap
Traits pairwise
Genetic background
Network
Static image
Dynamic network
Correlate Y by X
XY plot
Table
XY plot II
Study comparison
Pedigree
QTL
Query
Marker
2) Select statistical method
Variables
Type
Trait
Scale
Trait Group
Factor Chromatogram Not Specified design factor
Factor Derivative nam Not Specified design factor
Germplasm set Not Specified design factor
Factor Observation da Not Specified design factor
Factor Observation na Not Specified design factor
Factor Parent 1 Not Specified design factor
Factor Parent 2 Not Specified design factor
Factor Physical locatic Not Specified design factor
Factor Plot Not Specified design factor
Factor Plot in a row Not Specified design factor
Factor Sample ID Not Specified design factor
Factor Source Not Specified design factor
Variate Alanine (2TMS) Aaron GCMS protc Metabolites- Prima
Variate Alanine (3TMS) Aaron GCMS protc Metabolites- Prima
Variate Alpha cadinol arbitrary Volatiles- Sesquite
Variate Alpha calacore arbitrary Volatiles- Sesquite
Variate Alpha caryoph arbitrary Volatiles- Sesquite
Variate Alpha cubeben arbitrary Volatiles- Sesquite
Variate Alpha cubeben arbitrary Volatiles- Sesquite
Variate Alpha ionol arbitrary Volatiles- Norisopr
Variate Alpha muuroler arbitrary Volatiles- Sesquite
Y, Variables >>
X, Variables >>
Variate:
Variate:
Display image map
Display image map?
Heatmap dendrogram
Cluster by Rows and cols
Correlation type
Correlation type: Pearson
Logarithmic data
Remove outliers that are 3 standard
than the mean
Figure size
Ready


Current location: Analysis → Analyze
Home Browse Breeding Analysis Tools Uploads
Rose
Form
Result 3
Studies filter
Basic filter
Advanced filter
Germplasm filter
Normalize
Traits display
Search trait
History
Univariate
Distribution
Bars
Fit Y by X
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Means heatmap
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QTL
Query
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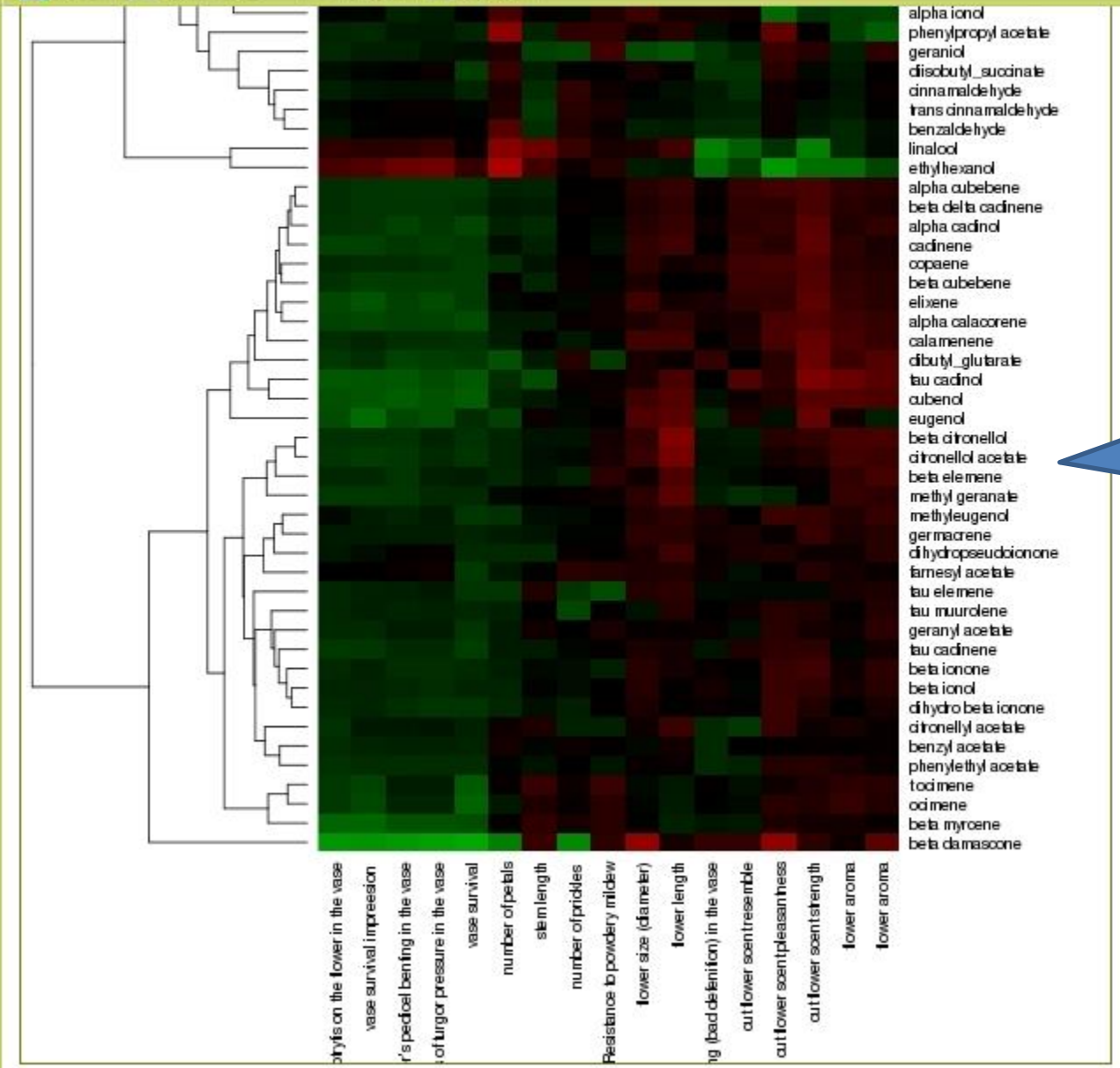
Variables
Type
Trait
Scale
Trait Group
Factor Chromatogram Not Specified design factor
Factor Derivative nam Not Specified design factor
Factor Field row Not Specified design factor
Factor GCMS run Name design factor
Factor Generation Not Specified design factor
Factor Germplasm ide GID germplasm identifi
Factor Germplasm ide variety name germplasm identifi
Factor Germplasm set Not Specified design factor
Factor Observation da Not Specified design factor
Factor Observation na Not Specified design factor
Factor Parent 1 Not S
Factor Parent 2 Not S
Factor Physical locatic Not S
Factor Plot Not S
Factor Plot in a row Not Specified design factor
Factor Sample ID Not Specified design factor
Factor Source Not Specified design factor
Variate Alanine (2TMS) Aaron GCMS proto Metabolites- Prima
Variate Alanine (3TMS) Aaron GCMS proto Metabolites- Prima
Variate Alpha cadinol arbitrary Volatiles- Sesquite
Variate Alpha calacore arbitrary Volatiles- Sesquite
Variate Alpha caryoph arbitrary Volatiles- Sesquite
Variate Alpha cubeben arbitrary Volatiles- Sesquite
Variate Alpha cubeben arbitrary Volatiles- Sesquite
Variate Alpha ionol arbitrary Volatiles- Norisopr
Variate Alpha muuroler arbitrary Volatiles- Sesquite
Y, Variables >>
X, Variables >>
Variate:
Alanine (2TMS)
Alanine (3TMS)
Alpha cadinol
Variate:
Apical dominance
Arabinose
Ascorbic acid
3) Classify variables (traits) to boxes
Display image map
Display image map?
Heatmap dendrogram
Cluster by Rows and cols
Correlation type
Correlation type: Pearson
Logarithmic data
Remove outliers that are 3 standard
than the mean
Figure size
Ready



Output example

Acknowledgments

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- Sagit Meir

Golden Gate (GG)
no scent
vase life-12 days

Fragrant Cloud (FC)
strong scent
vase life- 5 days

07-1130
strong scent
vase life- 15 days

07-655
strong scent
vase life- 19 days

07-296
strong scent
vase life- 13 days

07-2087
light scent
vase life- 18 days

07-1336
strong scent
vase life-14 days

07-1449
strong scent
vase life-12 days

07-1773
strong scent
vase life- 12 days

07-133
light scent
vase life- 14 days

07-1465
light scent
vase life- 11 days

07-2506
strong scent
vase life- 18 days

07-2811
light scent
vase life- 22 days

rosita vendela
no scent
vase life- 11 days

"Don't hurry.
Don't worry.
You're only here
for a short visit.
So don't forget to
stop and smell
the roses."

(*Walter Hagen*)


The Israeli president Mr. Shimon Peres
smelling our roses (June, 2011)