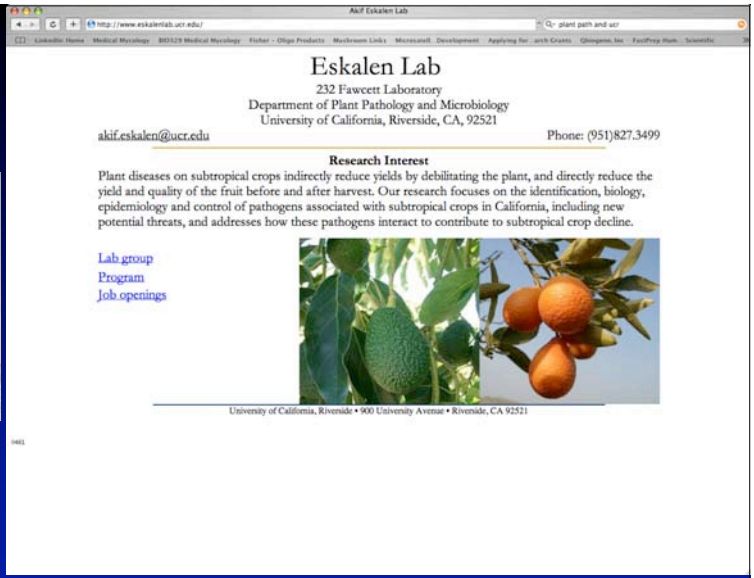
Avocado Rootstock Breeding at UC Riverside

Greg W. Douhan
Department of Plant Pathology and Microbiology



Akif Eskalen

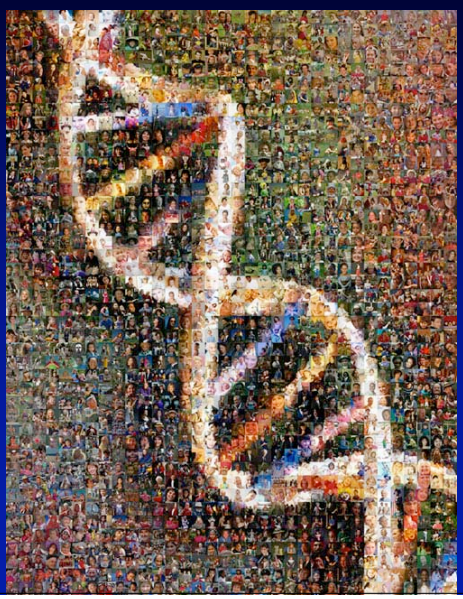
CE Subtropical Pathologist

www.eskalenlab.ucr.edu/

Grower Survey

County	Location	Root Rot Rating	Chemical Control	Application	Application Time of Year	Buffered	Application Method
San Diego	South	7	Phosacid	1 to 3	Feb, Aug	yes	injection
San Diego	South	3	Phosacid	Bimonthly		yes	irrigation
San Diego	South	3	Phosacid	2	Spr, Fall	yes	injection
San Diego	South	8	Phosacid	1	June	yes	irrig/spray
Riverside	South	7	Fertilizer 0-28-25	3 to 4	Spr, Fall	both	chemigated injection drench
Santa B.	North	7	Phosacid	1 (mature) 4 (young)	Spring Spr - Fall	both both	injection drench
Santa B.	North	0	gypsum	3	Spr - Fall	no	irrigation
Ventura	North	6.5	Phosphite	2	Srp, Fall	no	chemigation
Ventura	North	7	Phosacid	4	all year	yes	irrigation
Ventura	North	1	None	0			
Los Angeles	North	5.5	None	0			

Molecular Biology 101



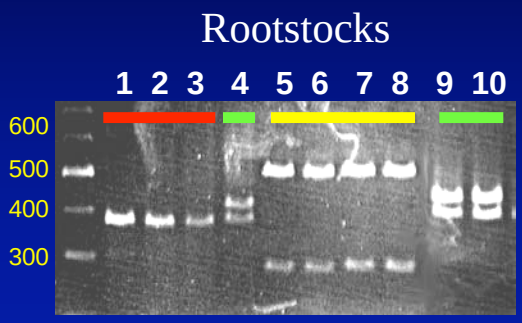
Molecular Biology 101

DNA sequence data

Rootstock	DNA sequence
Duke 7	AGGGCTCTTCCAGAGAGGGCTCTTCCAGAG
Dusa	AGGGCTCTTTCAGAGAGGGCTCTTCCAGAG
Uzi	AGGGCTCTTCCAGAGAGGTCTCTTCCAGAG

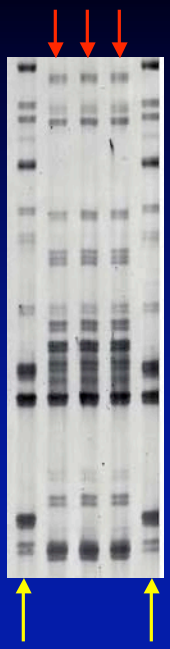
Molecular Biology 101

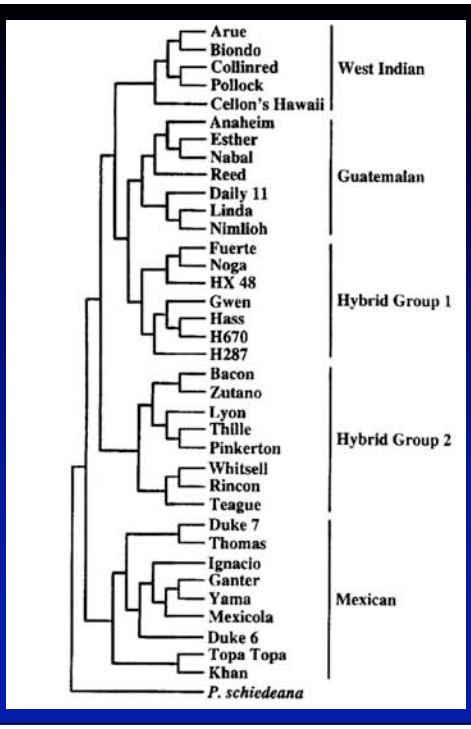
Molecular Markers



Molecular Biology 101

Molecular Markers





Davis *et al.* 1998
Heredity 89:319-323

Overview

Pathogen

Control

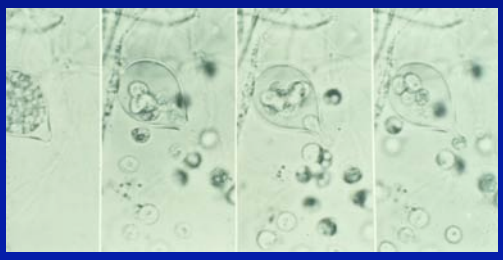
Breeding Program

Avocado Root Rot

- **“Avocado tree decline” noted in the 1920’s**

Avocado Root Rot

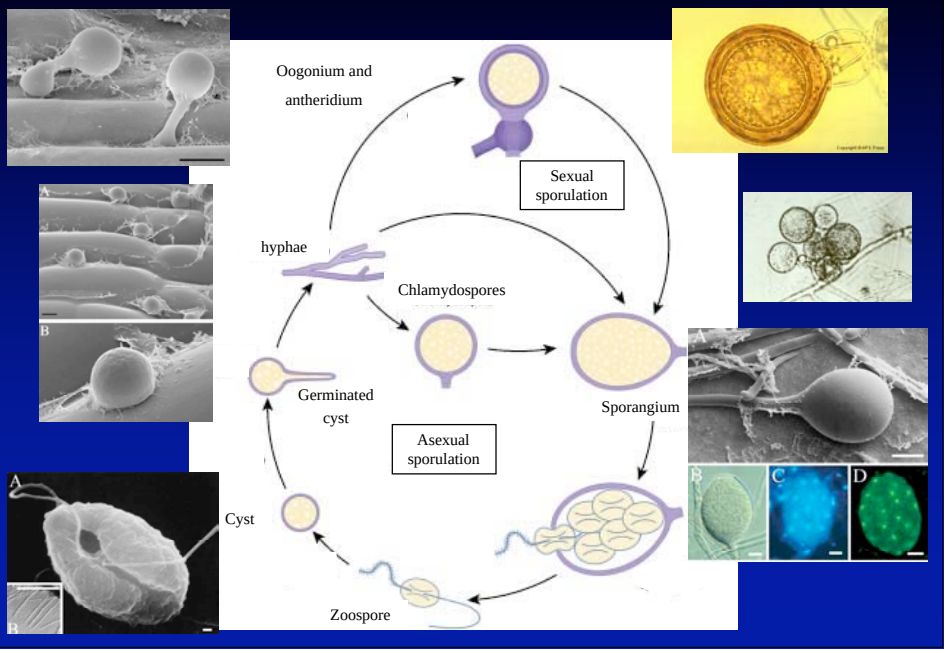
- **“Avocado tree decline” noted in the 1920’s**
- ***P. cinnamomi* identified in the early 1040’s as the causal agent**



Avocado Root Rot

- **“Avocado tree decline” noted in the 1920’s**
- ***P. cinnamomi* identified in the early 1040’s as the causal agent**
- **100s of hosts**

Life cycle of *Phytophthora cinnamomi*



Control

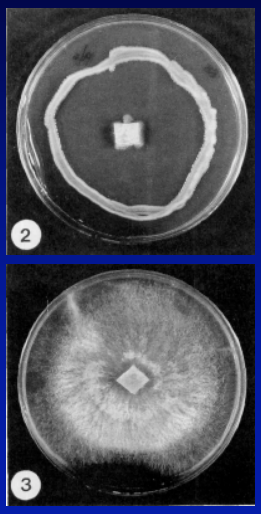
- Nursery practices

Control

- Nursery practices
- Cultural practices

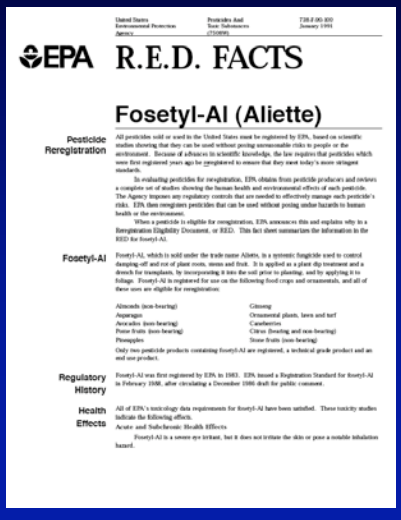
Control

- Nursery practices
- Cultural practices
- Biological control



Control

- Nursery practices
- Cultural practices
- Biological control
- Chemical control



EPA R.E.D. FACTS

Fosetyl-Al (Aliette)

Pesticide Reregistration

Fosetyl-Al

Regulatory History

Health Effects

Control

- Nursery practices
- Cultural practices
- Biological control
- Chemical control
- Clonal rootstocks

Control

- Nursery practices
- Cultural practices
- Biological control
- Chemical control
- Clonal rootstocks

No one magic bullet yet!

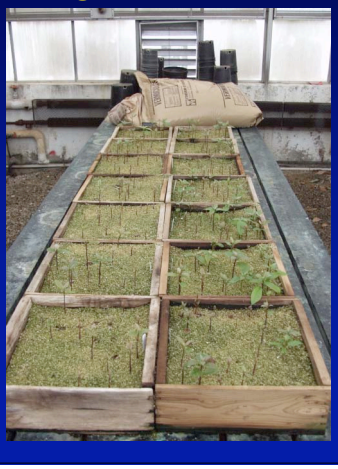
Rootstock Breeding at UCR

Rootstock Breeding at UCR

- George Zentmyer (1944-1983)
- Michael Coffey (1980's)
- John Menge (1990's - 2005)

Rootstock Breeding at UCR

- Since 1989, over 50,000 seedlings screened



Rootstock Breeding at UCR

- Since 1989, over 50,000 seedlings screened
- Approximately 30 varieties (PP#'s) are being tested under field conditions from this project

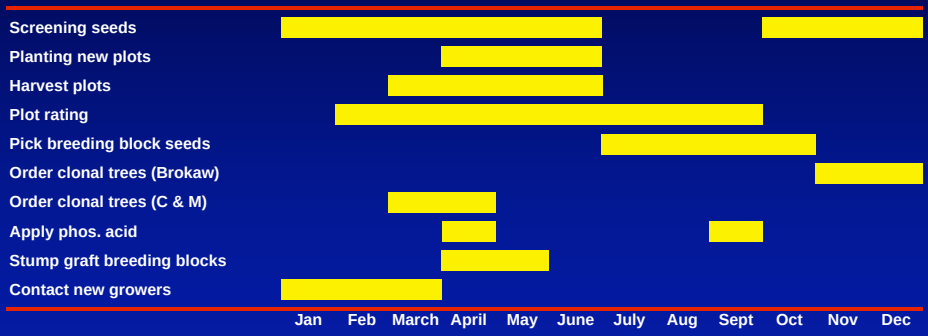
Rootstock Breeding at UCR

- Since 1989, over 50,000 seedlings screened
- Approximately 30 varieties(PP#'s) are being tested under field conditions from this project
- ~ 26 active field plots

Rootstock Breeding at UCR

- Since 1989, over 50,000 seedlings screened
- ~30 varieties are currently being tested under field conditions
- ~26 active field plots
- 42 plots dropped since the inception of Menge's original research project proposal

General timeline for avocado field work

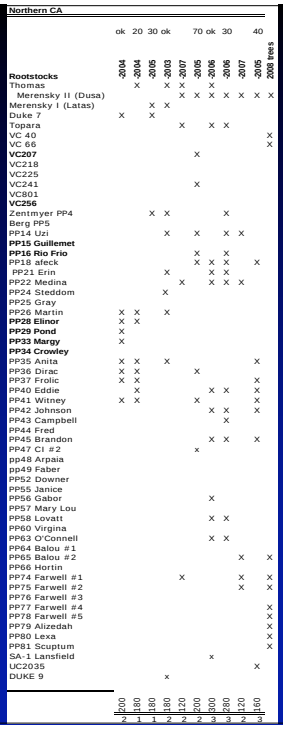


Southern CA

% freeze damaged	10%	ok	ok	20	ok	10			
Rootstocks	-2005	-2005	-2005	-2000	-2002	-2002	2007	-2007	2008 trees
Thomas			x	x	x	x		x	x
Merensky II (Dusa)	x	x		x			x	x	x
Merensky I (Latas)				x					
Duke 7				x					
Topara									
VC 40									
VC 66									
VC207		x							
VC218	x								
VC225		x				x			
VC241		x		x				x	
VC801	x	x	x			x			
VC256			x			x			
Zentmyer PP4				x	x		x		
Berg PP5	x	x							
PP14 Uzi		x		x		x	x		
PP15 Guillemet				x					
PP16 Rio Frio	x	x		x					
PP18 afeck		x				x			x
PP21 Erin							x		
PP22 Medina									
PP24 Steddom				x			x		
PP25 Gray								x	
PP26 Martin									x
PP28 Elinor									
PP29 Pond					x				
PP33 Margy					x				
PP34 Crowley					x				
PP35 Anita					x		x		
PP36 Dirac	x	x							
PP37 Frolic					x				
PP40 Eddie			x					x	
PP41 Witney	x	x	x		x				
PP42 Johnson									
PP43 Campbell								x	
PP44 Fred					x				
PP45 Brandon								x	
PP47 Cl #2									
pp48 Arpaia									
pp49 Faber									
PP52 Downer	x	x							
PP55 janice									x
PP56 Gabor	x	x	x						
PP57 Mary Lou									x
PP58 Lovatt									
PP60 Virgina									x
PP63 O'Connell									
PP64 Balou #1									x
PP65 Balou #2								x	x
PP66 Hortin								x	
PP74 Farwell #1									
PP75 Farwell #2								x	x
PP76 Farwell #3								x	
PP77 Farwell #4									x
PP78 Farwell #5									
PP79 Alizedah									
PP80 Lexa									
PP81 Scuptam									
SA-1 Lansfield									
UC2035									
DUKE 9					x				
Number of trees	180	260	120	300	200	100	120	220	
Disease Pressure	2	1	2	3	1	2	1	2	

1 = low
2 = medium
3 = high

Southern California growing region



Northern California growing region

Low Disease Pressure

Fallbrook, harvest April 2006

Rootstock	Total fruit weight (kg)	Individual fruit weight (kg)
Witney	36.62a	0.229a
Crowley	35.43ab	0.221a
Anita	34.51ab	0.231a
Thomas	30.66abc	0.232a
Pond	30.48abc	0.234a
Zentmyer	29.74abc	0.223a
Margy	29.05abc	0.237a
Duke 9	28.45bc	0.241a
Fred	27.79bc	0.233a
Frolic	23.28c	0.237a

Moderate Disease Pressure

Escondido CA, Harvest, April 2006

Rootstock	Total fruit weight per tree (kg)	Individual fruit weight (kg)
Latas	26.34a	0.233a
Steddom	23.76ab	0.233a
Toro Canyon	22.90ab	0.241a
VC207	20.95ab	0.232a
Uzi	18.86b	0.229a
VC225	12.93c	0.234a
Afek	9.52cd	0.229a
VC241	6.33de	0.224a
Thomas	4.33de	0.242a
VC44	2.85e	0.242a

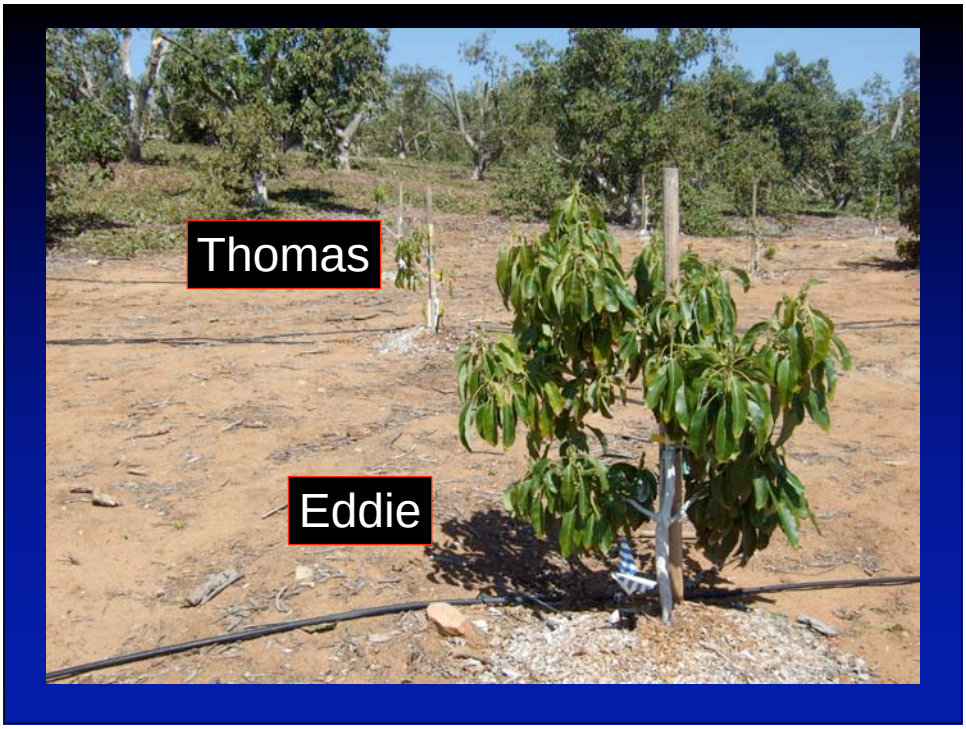
Heavy Disease Pressure

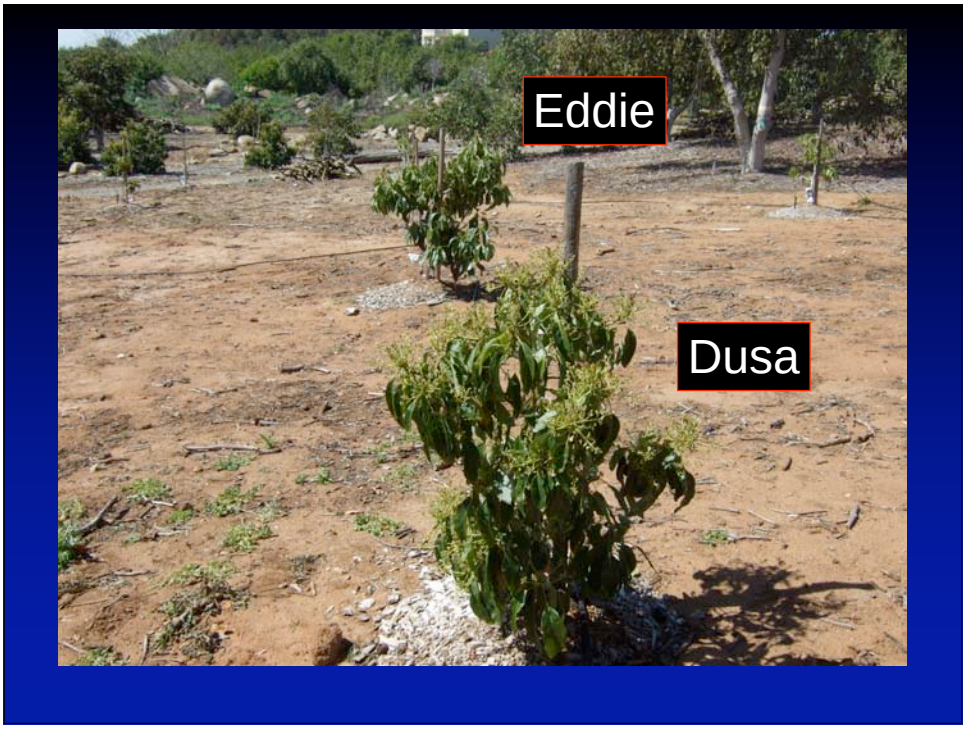
Escondido, CA, May 2006

Rootstock	Fruit weight per tree (kg)	Individual fruit weight (kg)
Merensky II (Dusa)	53.24 a	0.18 a
Zentmyer	51.75 a	0.22 a
Merensky I (Latas)	50.46 a	0.23 a
Uzi	43.66 a	0.19 a
Steddom	41.00 a	0.20 a
VC241	27.96 a	0.20 a

One year old plot-Rancho Ca

Rootstock	Tree rating (0-5; 5=dead)	Canopy vol (cu ft)	Trunk diam (cm)	Salt damage (0-5; 5=heavy)	Dead trees (%)[1]
Brandon	0.763g	27.40a	2.537a	2.026a	0
Eddie	0.947fg	24.03ab	2.390a	1.263bcd	0
Dusa	1.175efg	18.93bc	2.510a	1.175cd	0
Farwell 1	1.417def	19.70bc	2.383a	1.189ab	0
Campbell	1.658cde	16.21c	2.184ab	1.868ab	0
Farwell 2	1.833 cd	13.42cde	2.350a	2.139a	0
VC241	1.868cd	17.91bc	2.179ab	1.553abc	0
Gray	2.028cd	7.57e	1.917b	1.878d	0
Thomas	2.075bc	15.23cd	2.190ab	2.105a	5
Balou 1	2.700ab	7.36e	1.960b	0.778d	10
Balou 2	2.763a	8.84de	1.821b	1.625abc	16


Thomas
Eddie


Eddie
Dusa

Breeding Blocks

- Block #1 (f16a) planted in 2001; Dusa, Duke 9, Duke7, Latas, PP4, UC 2001
- Block #2 (f16b) planted in 1999; PP4, Toro Cayon, Thomas, Spencer
- Block #3 (f16c) planted in 2000; Regrafted in 2005 with Zentmyer, Uzi, Steddom, Anita
- Block #4 (f16d) planted in 2001; PP#'s 1, 2, 3, 4, 5, 15, 16,19, 21, 26, 29, 36, 40, 41, 42, 50, 52, 54, 55, 56, 57, 58, 59, 60, 62,63
- Block #5 (dwarf) planted in 2005; Wilg, VC 241, PP21 Erin, PP37, Frolic, PP41, Witney
- Block #6 (vc's) planted in 2005; 7,15, 26, 28, 40, 51,65, 66, 802, 803, 804
- Block #7 (f15g) planted in 1991; Regrafted in 2005 with Zentmyer, Uzi, Steddom, Anita
- Block #8 (salt) planted in 2003; Toro Canyon, Dusa, Latas, VC207, VC218, VC801
- Block #9 (salt) planted in 2003; Dusa, Latas, Toro Canyon, VC218, VC207

Greenhouse study testing two types of materials

Changes in the program

- **Molecular methods**
  - **Parentage analysis**

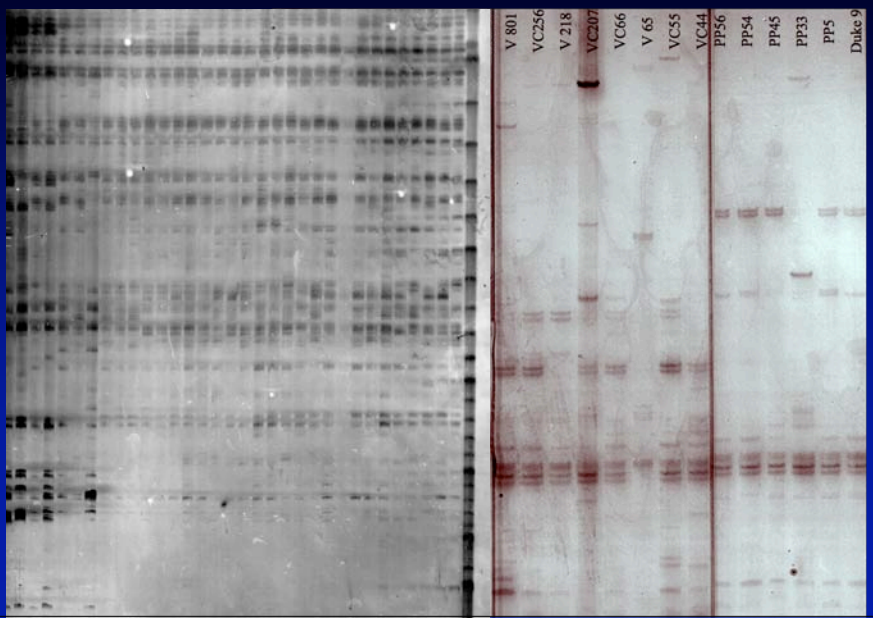
Changes in the program

- **Molecular methods**
  - **Parentage analysis**
  - **Decide which varieties to field test**

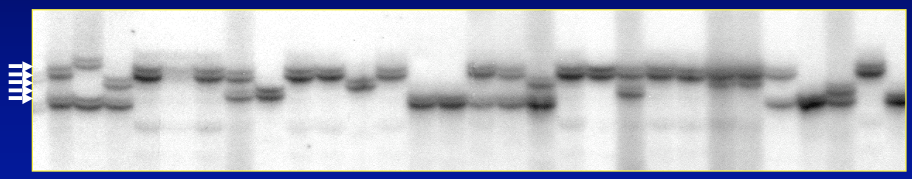
Changes in the program

- **Molecular methods**
  - **Parentage analysis**
  - **Decide which varieties to field test**
  - **Marker based breeding ?**

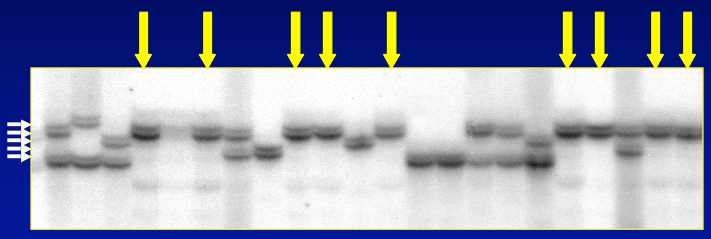
Molecular Markers: AFLP



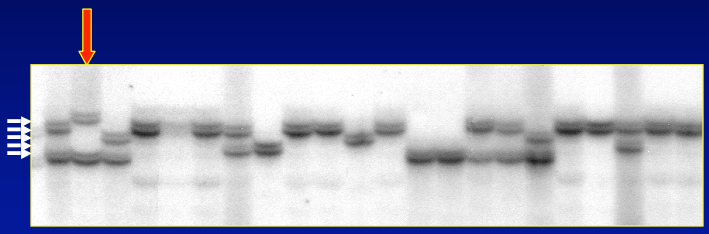
Molecular Markers: microsatellites



Molecular Markers: microsatellites



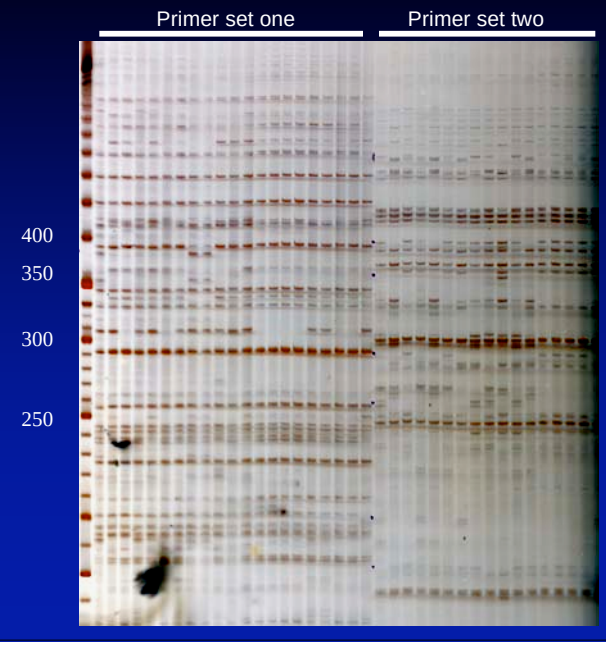
Molecular Markers: microsatellites



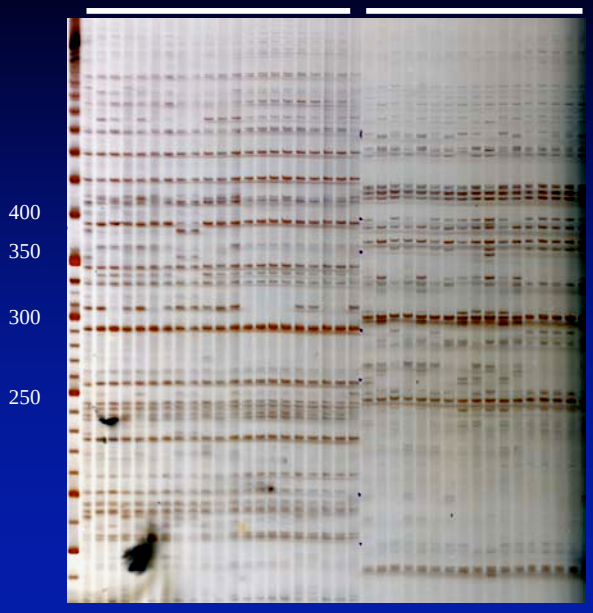
Changes in the program

- **Pathogen: Molecular methods**
  - **Population biology; pathogen diversity**
  - **PCR based assay**
- **Avocado: Molecular methods**
  - **Parentage analysis**
  - **For making field testing decisions**
  - **Marker based breeding ?**

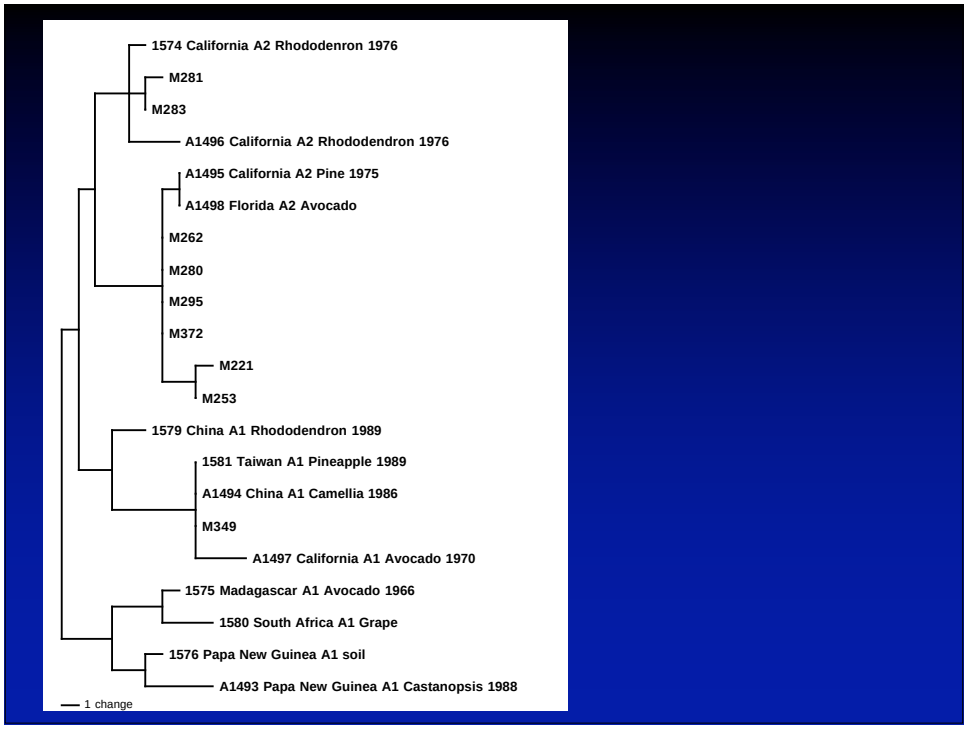
P. cinn: Amplified Fragment Length Polymorphism

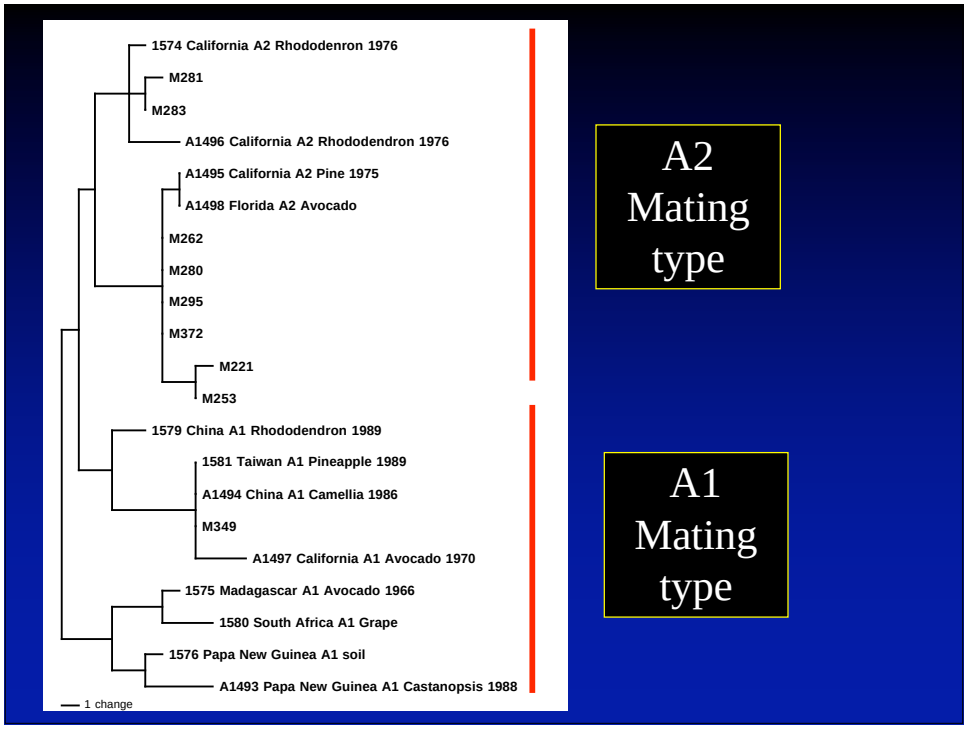


Amplified Fragment Length Polymorphism

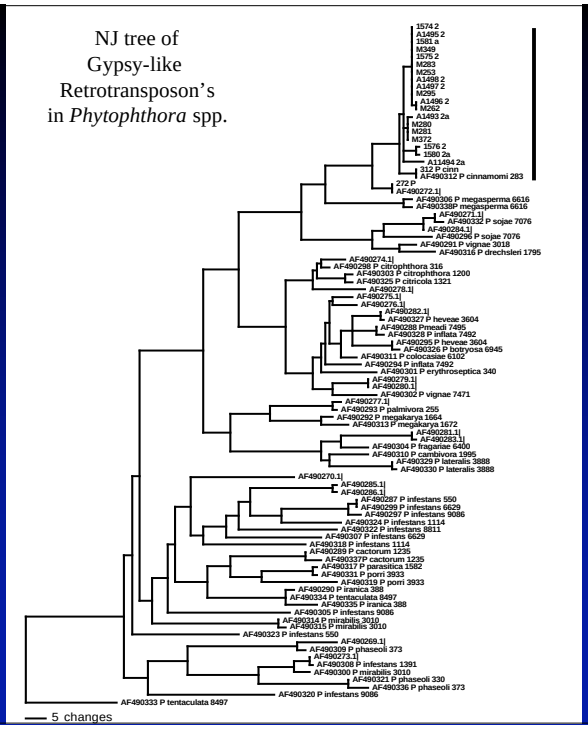


1000110110110000
0111111011110110
0000011010001100


1574 California A2 Rhododenron 1976
M281
M283
A1496 California A2 Rhododendron 1976
A1495 California A2 Pine 1975
A1498 Florida A2 Avocado
M262
M280
M295
M372
M221
M253
1579 China A1 Rhododendron 1989
1581 Taiwan A1 Pineapple 1989
A1494 China A1 Camellia 1986
M349
A1497 California A1 Avocado 1970
1575 Madagascar A1 Avocado 1966
1580 South Africa A1 Grape
1576 Papa New Guinea A1 soil
A1493 Papa New Guinea A1 Castanopsis 1988
1 change


1574 California A2 Rhododenron 1976
M281
M283
A1496 California A2 Rhododendron 1976
A1495 California A2 Pine 1975
A1498 Florida A2 Avocado
M262
M280
M295
M372
M221
M253
1579 China A1 Rhododendron 1989
1581 Taiwan A1 Pineapple 1989
A1494 China A1 Camellia 1986
M349
A1497 California A1 Avocado 1970
1575 Madagascar A1 Avocado 1966
1580 South Africa A1 Grape
1576 Papa New Guinea A1 soil
A1493 Papa New Guinea A1 Castanopsis 1988
1 change
A2 Mating type
A1 Mating type

NJ tree of Gypsy-like Retrotransposon's in *Phytophthora* spp.



P. cinnamomi clade

Rootstock breeding program

Breeding blocks; recently replanted with the newest UC varieties and also include Dusa, are now sizing up and producing.

The rootstock collection at south coast is creating one big breeding block. Every year our number of seeds screened will increase.

Rootstock breeding program

We are now implementing "molecular methods" for the rootstock research.

We now remove the seed from the screening plants and subject them to root rot conditions longer before making selections.

Rootstock breeding program

The rootstock test plots have Thomas and Dusa. One new plot has a treatment of Thomas with fungicide and without out for further evaluation.

Focusing on more challenging plots with strong p.c. pressure. Dropping plots with low to no p.c. pressure quicker.

Rootstock breeding program

Getting closer to releasing the PP #4 Zentmyer,PP # 14 Uzi, and PP # 24 Steddom. This will give growers more rootstock options.

Setting up plots with 200/to 220 trees resulting in 10 or 11 varieties in test. Focusing on getting more material out to the field faster to screen out the week and problem selections faster. Dropped the component analysis because in wasn't effective.

Rootstock breeding program

Brandon is now keeping better records including using spreadsheets to track all varieties progress, and using e-mail to connect with growers better.

Acknowledgements

- California Avocado Commission & Avocado growers
- Brokaw & C&M Nurseries
- Root rot crew: Brandon McKee, Elinor Pond, & Erin Fuller
- Mary Lu Arpaia
- Gary Bender
- Ben Faber