



# THE CREATION OF GRAPE CLEAN STOCK AT FOUNDATION PLANT SERVICES UNIVERSITY OF CALIFORNIA AT DAVIS

DEBORAH GOLINO, DIRECTOR

**UCDAVIS FPS**



## Foundation Plant Services Mission



- Produce, test, maintain and distribute elite disease-tested plant propagation material.
- Provide plant importation and quarantine services, virus testing and virus elimination.
- Coordinate release of UC-patented varieties.
- Link researchers, nurseries, and producers.

# WINEGRAPES OF UC DAVIS

[HOME](#) - [TABLE OF CONTENTS](#) | [ABOUT](#) | [FPS GRAPE PROGRAM](#)

This book tells the story of a valuable grapevine collection housed at the University of California, Davis. Foundation Plant Services at UC Davis accumulated the diverse group of grapevines through long-term collaboration with university scientists and viticulturists and the wine industry in a mutual effort to identify, acquire and develop high quality wine and table grapes.



- The Origin of Foundation Plant Services
- Black Grapes of Bordeaux
- Malbec & Cot at FPS
- Sauvignon blanc and the Sauternes
- The Pinots
- Chardonnay
- The Origin of California's Zinfandel (Croatia)
- Barbera Finds a Second Home in California
- Riesling at FPS

## FPS Crop Programs



- **Grape**
- **Strawberry**
- **Fruit and Nut Trees**
- **Rose**
- **Sweet potato**

# California Dept. of Food and Agriculture (CDFA) Registration and Certification Programs



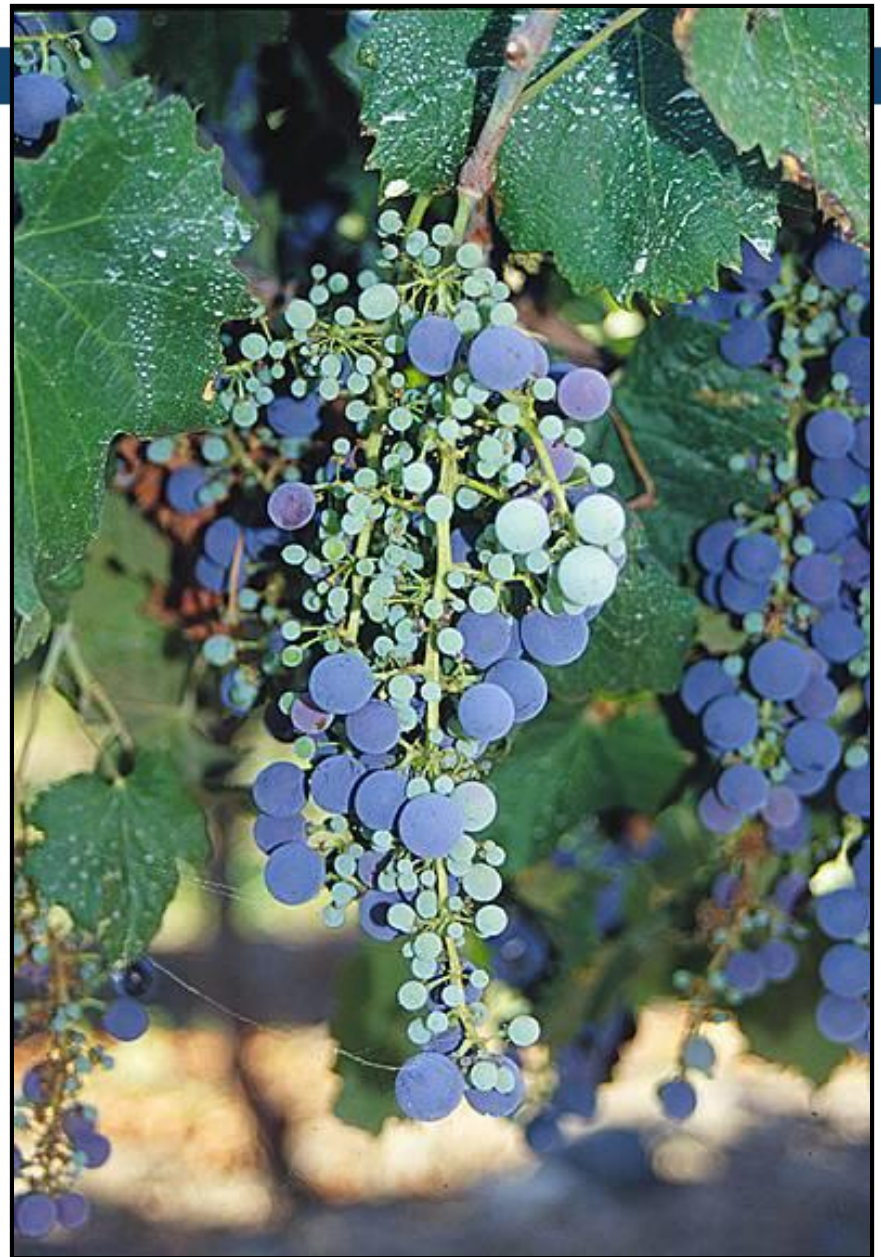
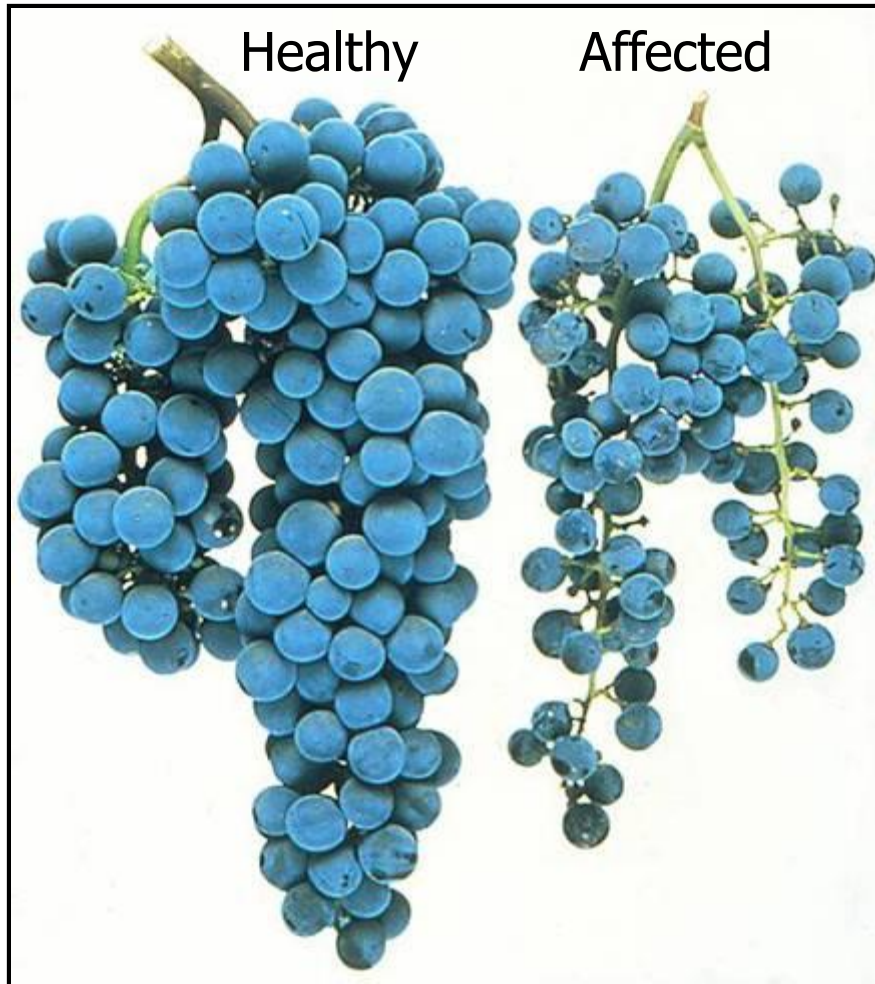
**Grapes**  
**Fruit and Nut Trees**  
**Strawberries**



# Grapevine Virus Diseases



## GFLV (Fanleaf) Fruit Symptoms



# Grapevine Leafroll Virus Effects



- Sugar reduced 1-4° Brix
- Color reduced
- Yield reduced
- Ripening delayed
- TA increased
- Graft incompatibility
- Disease severity depends on variety, clone, rootstock, site, year, leafroll type/strain

# Grapevine Red Blotch Virus 2012

- Cultivar: Early Burgundy
- Location: Sonoma
- Collector: H. Olmo
- Year of collection: 1940



### New Grape Selection

- Foreign imports
- Domestic selections
- New cultivars

### Disease Elimination Therapy

- Tissue culture
- Heat treatment

### Disease Testing

Retesting

Tests positive

Release time

all tests negative

## FOUNDATION **G1**

### Provisional Foundation Vines

### Professional Identification

ID not correct  
**REMOVE**

ID verified correct

## Registered Foundation Vines **G1**

### To Nurseries

Registered Stock **G2**

### To Growers

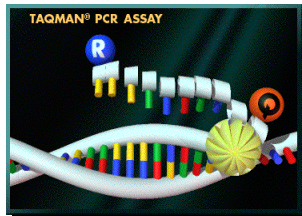
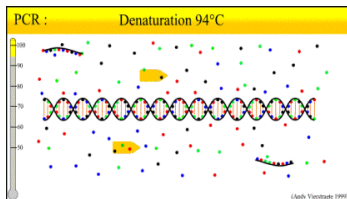
Certified Stock **G3**

2 - 6 years

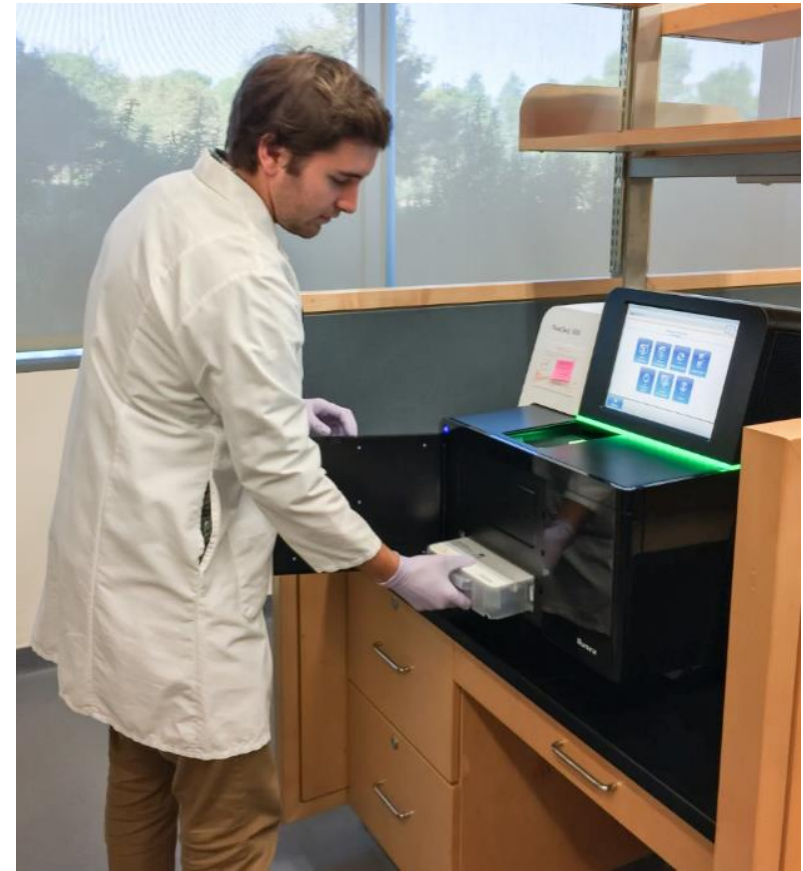
# Diagnostics tools

## Conventional tools

- **Biological Indexing**
  - Herbaceous indexing
  - Woody indexing
- **Serological techniques**
  - ELISA
- **Nucleic acid-based Assays**
  - RT-PCR
  - Real-time qPCR



## High-throughput sequencing (HTS)



**NextSeq 500**

# Virus Elimination Therapy

**Microshoot tip culture  
(or meristem shoot tip culture)**

**Eliminates viruses and other pathogens**



**Grapevine Fanleaf Virus**



**Grapevine Leafroll  
associated Viruses**



**Rugose wood Viruses**

# Virus Elimination Therapy

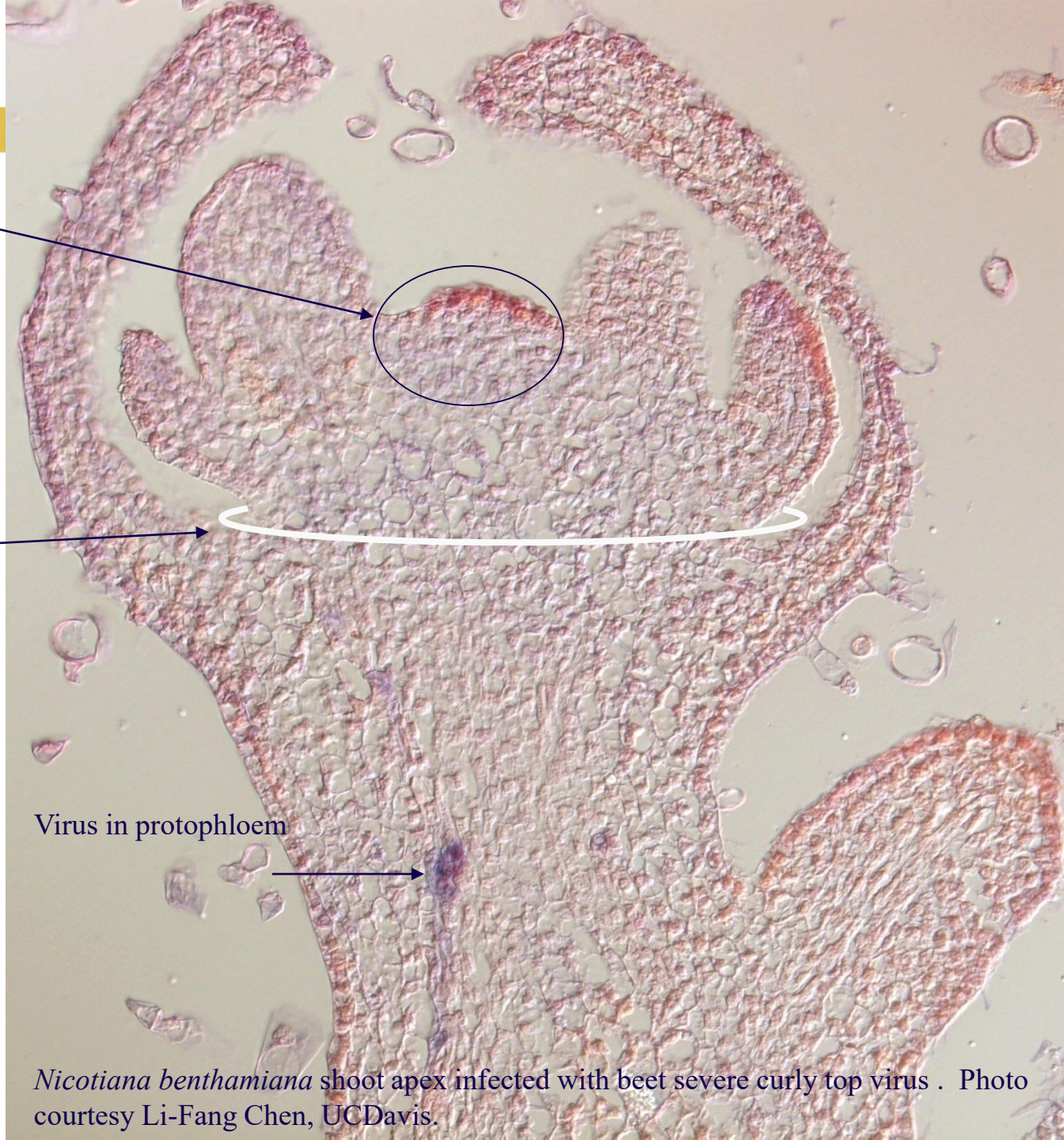
## Microshoot tip culture

- Used on many crops since 1950's
- Often combined with heat therapy (*in vivo or in vitro*)
- Viruses limited to vascular tissues are easier to eliminate.
- FPS performs microshoot tip virus elimination therapy for grapes, strawberries, roses, sweet potatoes, and *Prunus* trees.

Meristem dome

CUT

Virus in protophloem



# Grape Virus Elimination Therapy Procedure



**Collect apical  
shoot tips**



**Excise  
microshoot tip in  
sterile hood**



**Microshoot tip**

- meristem dome and 1-2 pairs of leaf primordia
- < 0.5 mm

# Grape Virus Elimination Therapy Procedure

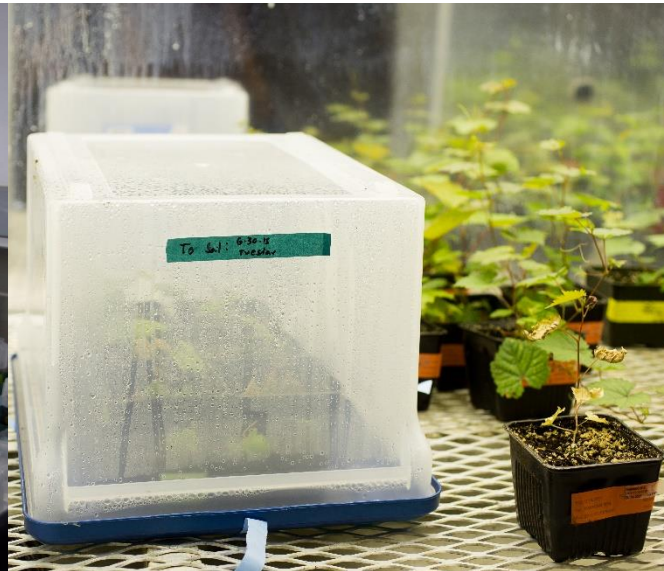


**Plants develop a shoot first, then root in 5 to 12 months**

# Grape Virus Elimination Therapy Procedure



**Transfer to potting mix**



**Acclimatize 2 weeks**



**Test plants**

# CLASSIC FPS FIELD – BLOCK C - 3



# Classic Foundation Vineyard

Established 1992, Davis, California

| # Vines | # Selections | Acreage |
|---------|--------------|---------|
| 4,088   | 1,920        | 25      |

## Classic Foundation Vineyard Testing

### 2017 maintenance testing

- 1/5 of the vineyard was tested for CDFA panel
- (1,524 vines)

### Additional testing

- All selections with orders in the last five years and all selections with a request for material prior to November 15, 2017 were tested (1,915 vines)

# RUSSELL RANCH MAP



# Russell Ranch Foundation Vineyard

Established 2010, Davis, California

| # Vines | # Selections | Acreage |
|---------|--------------|---------|
| 4,406   | 1,885        | 29.50   |

## Qualifications of Russell Ranch Foundation Vines:

1. Microshoot tip tissue culture therapy
2. Negative test results on Protocol 2010 panel



## Foundation Plant Services Available Tests for Protocol 2010

### 2010 Protocol Distribution

2010 Protocol  
Qualified grape  
material  
exclusively  
available to U.S.  
commercial  
grapevine nurseries.



| Group            | Pathogen  | Symbols   | ELISA | qPCR | PCR | Herb. Index | Woody Index |
|------------------|---|-----------|-------|------|-----|-------------|-------------|
| Nepoviruses      | Grapevine fanleaf virus   | GFLV      | X     | X    | X   | X           | St. George  |
|                  | Tomato ringspot virus   | ToRSV     | X     | X    | X   | X           |             |
|                  | Tobacco ringspot virus  | TRSV      |       | X    | X   | X           |             |
|                  | Arabis mosaic virus   | ArMV      | X     |      | X   | X           |             |
|                  | Strawberry latent ringspot virus                                | SLRSV     |       | X    | X   | X           |             |
|                  | Blueberry leaf mottle virus                                     | BLMV      |       | X    | X   | X           |             |
|                  | Raspberry ringspot virus  | RpRSV     |       | X    | X   | X           |             |
|                  | Tomato black ring virus   | TBRV      |       | X    | X   | X           |             |
|                  | Grapevine deformation virus                                     | GDeFV     |       | X    | X   | X           |             |
|                  | Artichoke Italian latent virus                                  | AILV      |       |      |     | X           |             |
| Closteroviruses  | Grapevine leafroll associated virus 1                           | GLRaV-1   | X     | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 2                           | GLRaV-2   | X     | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 2RG                         | GLRaV-2RG |       | X    | X   |             |             |
|                  | Grapevine leafroll associated virus 3                           | GLRaV-3   | X     | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 4                           | GLRaV-4   | X gen | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 5                           | GLRaV-5   | X gen | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 6                           | GLRaV-6   | X gen | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 7                           | GLRaV-7   |       | X    | X   |             |             |
|                  | Grapevine leafroll associated virus 9                           | GLRaV-9   | X gen | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 10                          | GLRaV-10  |       | X    | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus 11                          | GLRaV-11  | X     |      | X   |             | Cab. Franc  |
|                  | Grapevine leafroll associated virus Car.                        | GLRaCV    | X gen | X    | X   |             | Cab. Franc  |
| Vitiviruses      | Grapevine virus A   | GVA       |       | X    | X   |             | Kober 58B   |
|                  | Grapevine virus B   | GVB       |       | X    | X   |             | LN33        |
|                  | Grapevine virus D   | GVD       |       | X    | X   |             |             |
|                  | Grapevine virus E   | GVE       |       | X    |     |             |             |
|                  | Grapevine virus F   | GVE       |       | X    |     |             |             |
| Foveavirus       | Grapevine rupestris stem pitting associated virus (all strains) | GRSPaV    |       | X    | X   |             | St. George  |
| Maculavirus      | Grapevine fleck virus   | GFkV      | X     | X    | X   |             | St. George  |
|                  | Grapevine redglobe virus  | GRGV      |       | X    | X   |             |             |
| Marafiviruses    | Grapevine syrah virus-1   | GSyV-1    |       | X    | X   |             |             |
|                  | Grapevine vein feathering virus                                 | GVFV      |       | X    | X   |             |             |
|                  | Grapevine asteroid mosaic virus                                 | GAMV      |       | X    | X   |             |             |
| Trichovirus      | Grapevine Pinot gris virus                                      | GPGV      |       | X    | X   |             |             |
| DNA Viruses      | Grapevine red blotch associated virus                           | GRBaV     |       | X    | X   |             |             |
|                  | Grapevine vein clearing virus                                   | GVCV      |       | X    | X   |             |             |
| Phytoplasma      | Universal detection   | Phyto     |       | X    | X   |             |             |
| Pierce's Disease | <i>Xylella fastidiosa</i>                                       | PD        |       | X    | X   |             |             |

Key:

X Test performed at FPS.

X = test is available;

X gen.= ELISA using generic antibody which detects GLRaVs-4, 5, 6, 9 and Car in a single test;

qPCR= quantitative PCR= real time RT-PCR with TaqMan probe; PCR= will include RT-PCR for RNA viruses.

# History of GRBV Testing at Russell Ranch and Classic Foundation

## Russell Ranch Foundation

|  | # Vines Tested | Total Vines<br>in Field | Positive Results |
|--|----------------|-------------------------|------------------|
|--|----------------|-------------------------|------------------|

|      |       |       |   |
|------|-------|-------|---|
| 2013 | 1,106 | 1,142 | 0 |
|------|-------|-------|---|

|      |   |       |   |
|------|---|-------|---|
| 2014 | 2 | 1,807 | 0 |
|------|---|-------|---|

|      |       |       |   |
|------|-------|-------|---|
| 2015 | 1,002 | 2,616 | 0 |
|------|-------|-------|---|

|      |     |       |   |
|------|-----|-------|---|
| 2016 | 584 | 3,290 | 0 |
|------|-----|-------|---|

|      |        |       |   |
|------|--------|-------|---|
| 2017 | *6,761 | 4,132 | 5 |
|------|--------|-------|---|

\*Some vines tested multiple times

Planting dates: 2012-2017

## Classic Foundation

|  | # Vines Tested | Total Vines<br>in Field | Positive Results |
|--|----------------|-------------------------|------------------|
|--|----------------|-------------------------|------------------|

|       |       |   |
|-------|-------|---|
| 3,438 | 4,284 | 9 |
|-------|-------|---|

|       |       |   |
|-------|-------|---|
| 1,010 | 4,081 | 6 |
|-------|-------|---|

|     |       |   |
|-----|-------|---|
| 636 | 4,169 | 0 |
|-----|-------|---|

|       |       |   |
|-------|-------|---|
| 2,276 | 4,163 | 0 |
|-------|-------|---|

|       |       |   |
|-------|-------|---|
| 3,604 | 4,088 | 1 |
|-------|-------|---|

Planting dates: 1992-2017

### New Grape Selection

- Foreign imports
- Domestic selections
- New cultivars

Release time

2 - 6 years

Disease Testing

Retesting

Tests positive

Disease Elimination Therapy

- Tissue culture
- Heat treatment

all tests negative

**FOUNDATION** **G1**

Provisional Foundation Vines

Professional Identification

ID not correct  
**REMOVE**

ID verified correct

**Registered Foundation Vines** **G1**

To Nurseries

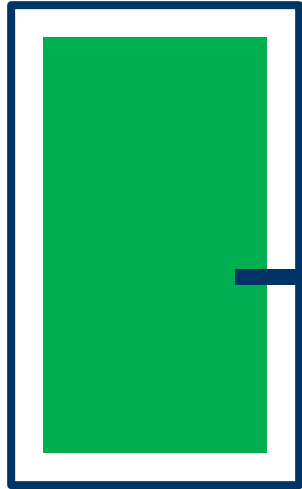
Registered Stock **G2**

To Growers

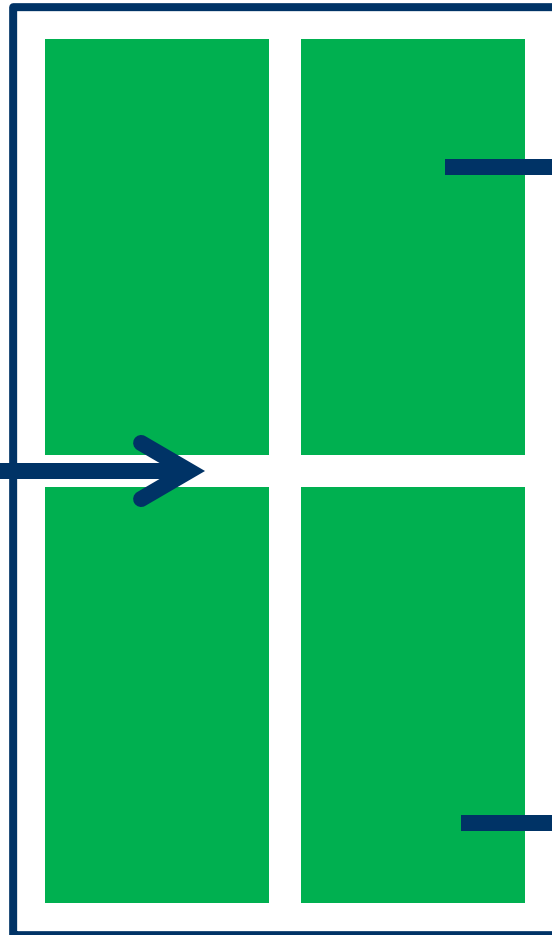
Certified Stock **G3**

Registered  
Increase Blocks

Foundation



Every  
vine  
tested



Sampled in order  
to detect anything  
>1%  
and delimitation



Dr. Kari Arnold, Post Doctoral Fellow

Quantitative Risk and Epidemiology Lab, UC Davis, Plant Pathology

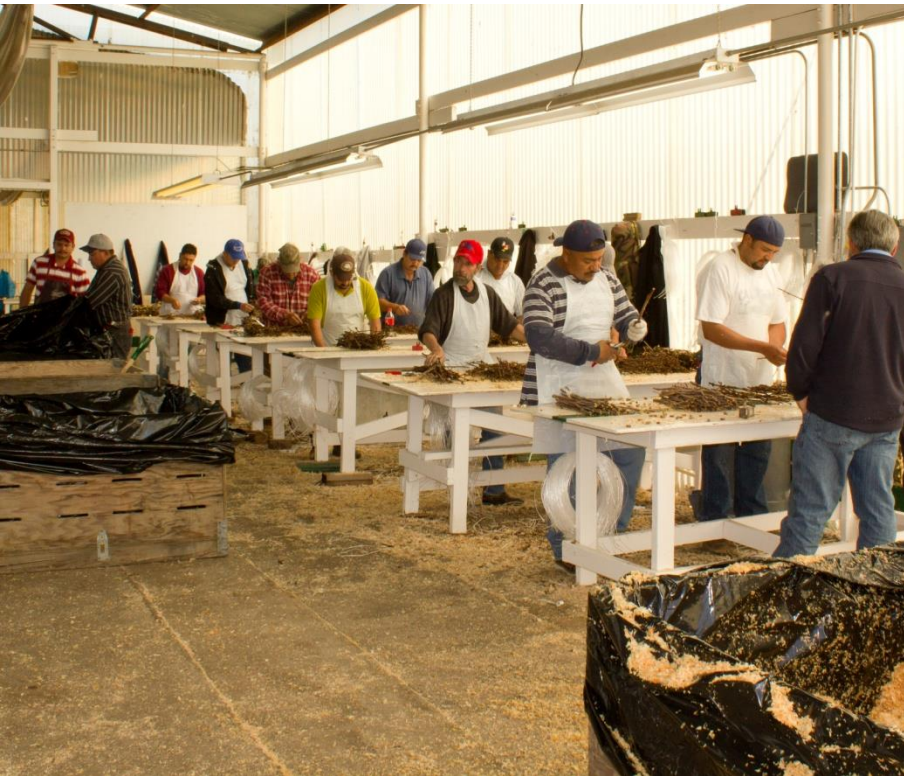
# FPS G1 Foundation Grape Planting Stock

- Disease-tested
- Professionally-identified
- True-to-variety
- \$5.00/cane



# FPS Impact

**20 – 70 million grapevine plants sold per year trace back to FPS**



Does this process make any difference?



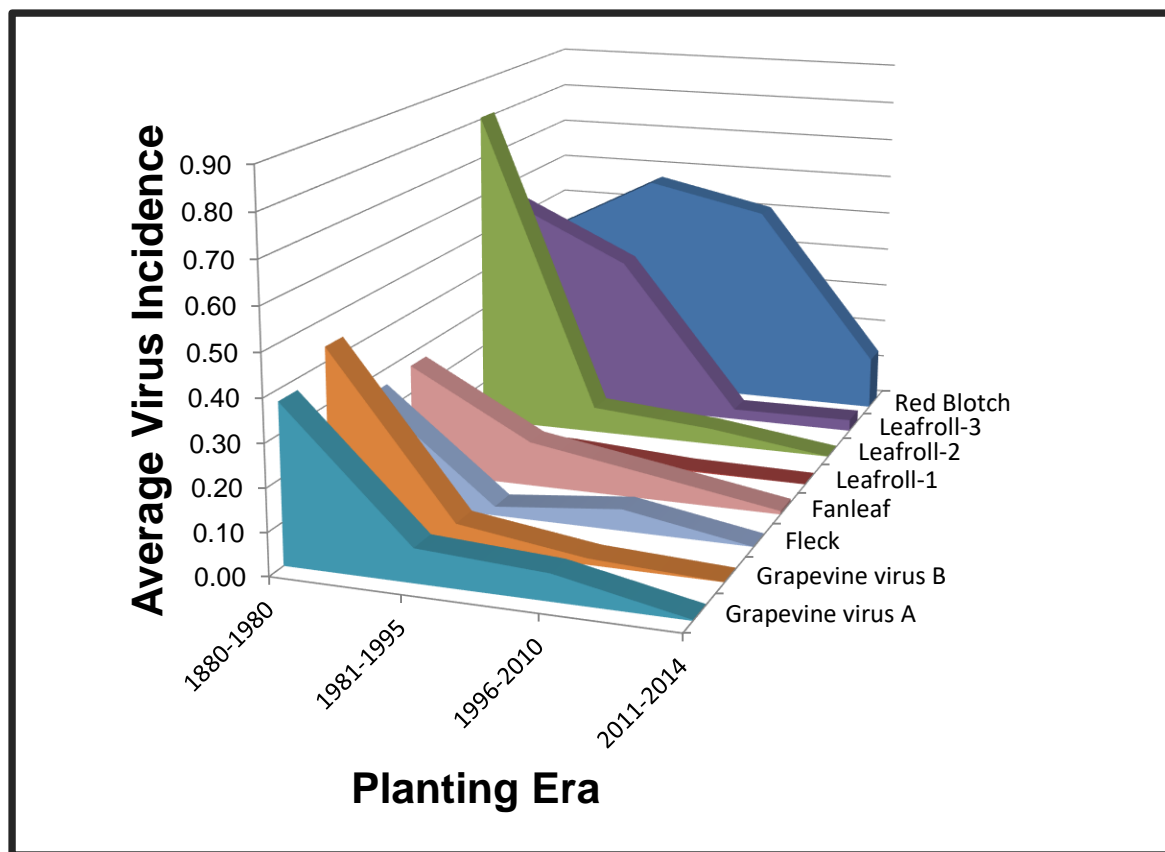
**Objective: Survey of grapevine material**

# Survey of vineyard viruses

- Surveyed viruses based on the vineyard block **AGE**
- Age ranges based on **“PLANTING BOOMS”**

- 1880-1980: Heritage material
- 1981-1995: AXR#1 rootstock failure
- 1996-2010: Alternative rootstocks failing to viruses previously masked in material by rootstocks AXR#1 and St. George
- 2011-2014: Post economic recession, “YOUNG” material, also encapsulates GRBaV crisis

## Survey of old vs. new, virus screened material



## An Historic Perspective

- Many different viruses
- Viruses are at high incidences
- Some vector borne, some only plant material borne
- Recent discoveries

Vector Borne  
.....GLRaV-3?

Recent Discovery  
.....GRBaV?

Old material

New material

**UCDAVIS**  
UNIVERSITY OF CALIFORNIA



Time (in plant material generations)

# Economic Benefits of Grapevine Certification Program

Estimated costs of red blotch disease were as high as \$1,100/acre/ year in 2015 dollars (or about \$68,548 per hectare over a 25-year lifespan of a vineyard) (Ricketts et al., 2017)

Estimated costs of leafroll disease with no disease control ranged from \$29,902 to \$226,405 per hectare over a 25-year lifespan of a vineyard in California (Ricketts et al., 2015)





**Thank you!**