



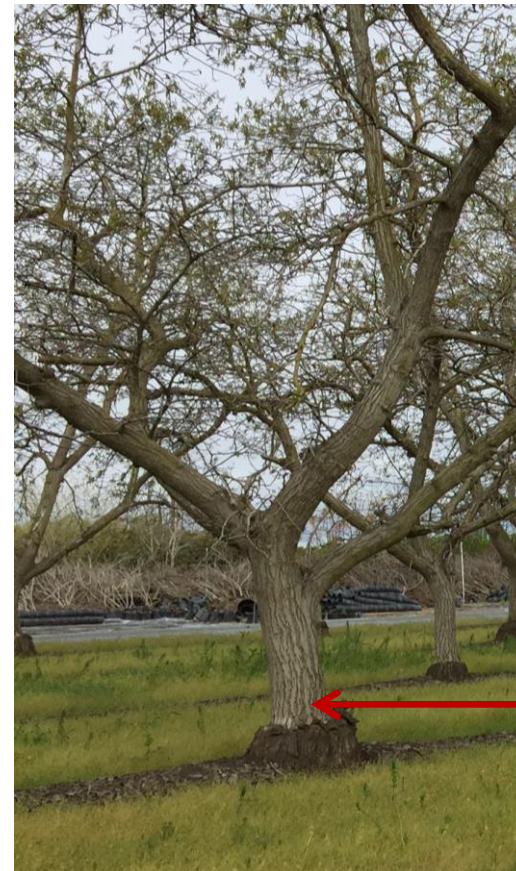
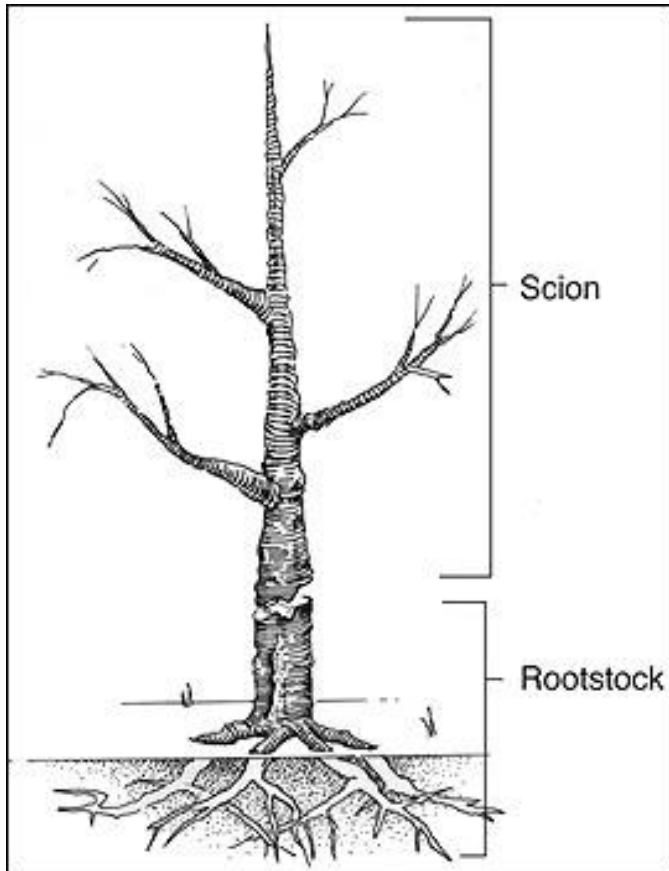
Rootstocks
Demystified




What is a rootstock?

The trunk or roots into which the scion material is inserted.

Juncture of rootstock and scion is called the graft union.



Why use a rootstock?

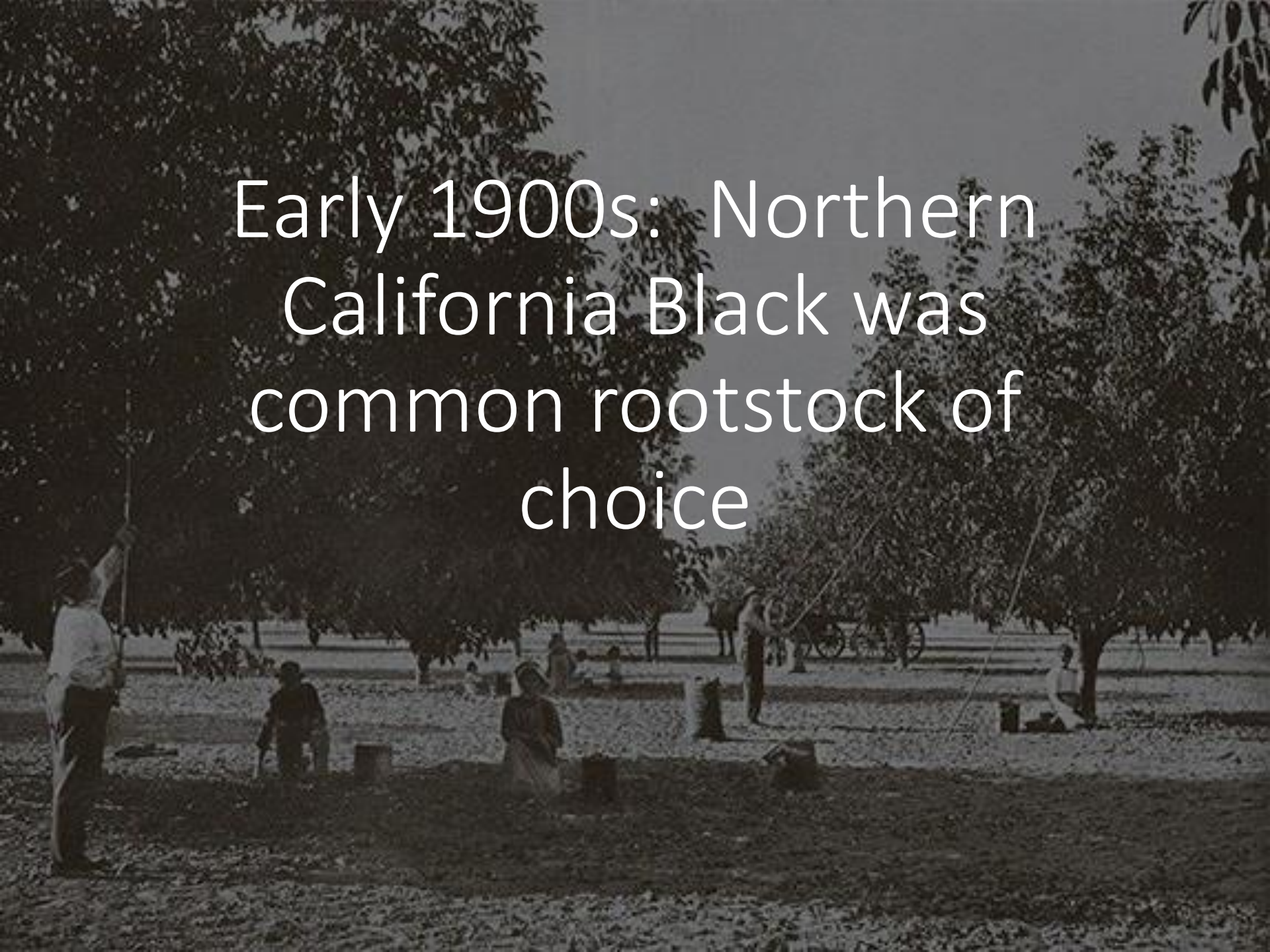
- 
- A photograph of a newly planted vineyard. The rows of young grapevines are spaced out across a field, with a dirt road running through the center. The background shows a range of mountains under a clear sky. The vines are supported by wooden stakes and have white protective sleeves around their trunks.
- Enhanced freeze tolerance
 - Disease or pest tolerance
 - Adapted for soil and water quality
 - Horticultural properties


Why use a rootstock on walnut?

- 1) Disease or pest tolerance.
- 2) Horticultural properties
- 3) Adapted to soil and water quality



Early 1900s: Northern
California Black was
common rootstock of
choice





Northern California Black Walnut (*Juglans hindsii*) rootstock chosen because:


- Considered resistant to oak root fungus.
- Considered tolerant of saline conditions
- Considered less susceptible to crown gall

Luther Burbank's home: Santa Rosa, CA
Luther heard of potential for interspecies crosses of Juglans in 1870s.



100 year old
'Paradox'

25 year old
'Paradox'



‘Paradox’ gained popularity in the 1950s because:

- More vigorous than black walnut rootstock
- tolerant of root lesion nematode
- more resistant to Phytophthora

**In 1950s, 'Paradox' became rootstock
of choice**

'Paradox'

Northern California Black

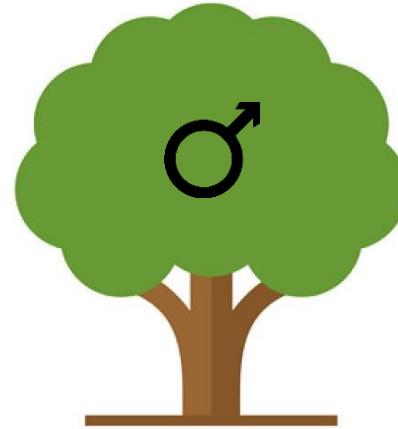
What is 'Paradox'?

- Interspecies hybrid
- Paradoxical because it is a fast-growing hardwood

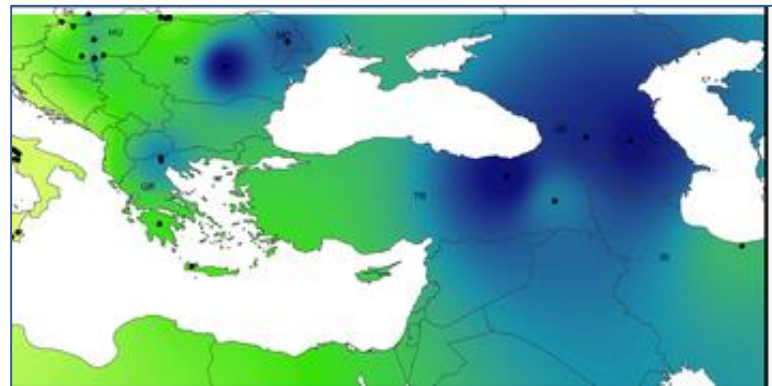
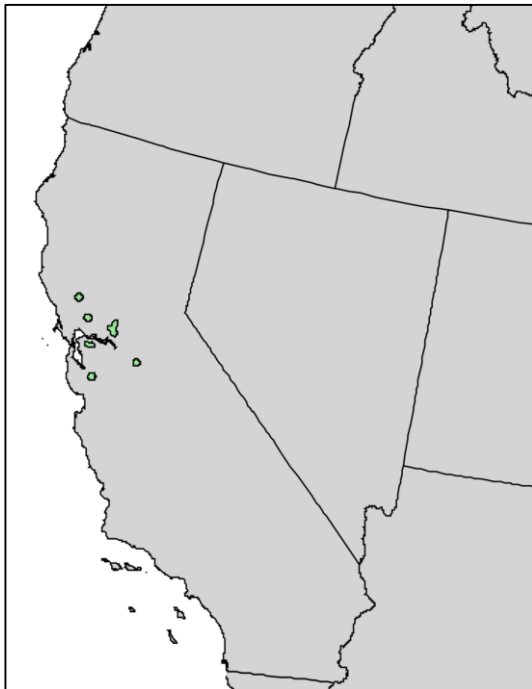
Northern California Black
(*Juglans hindsii*)



X

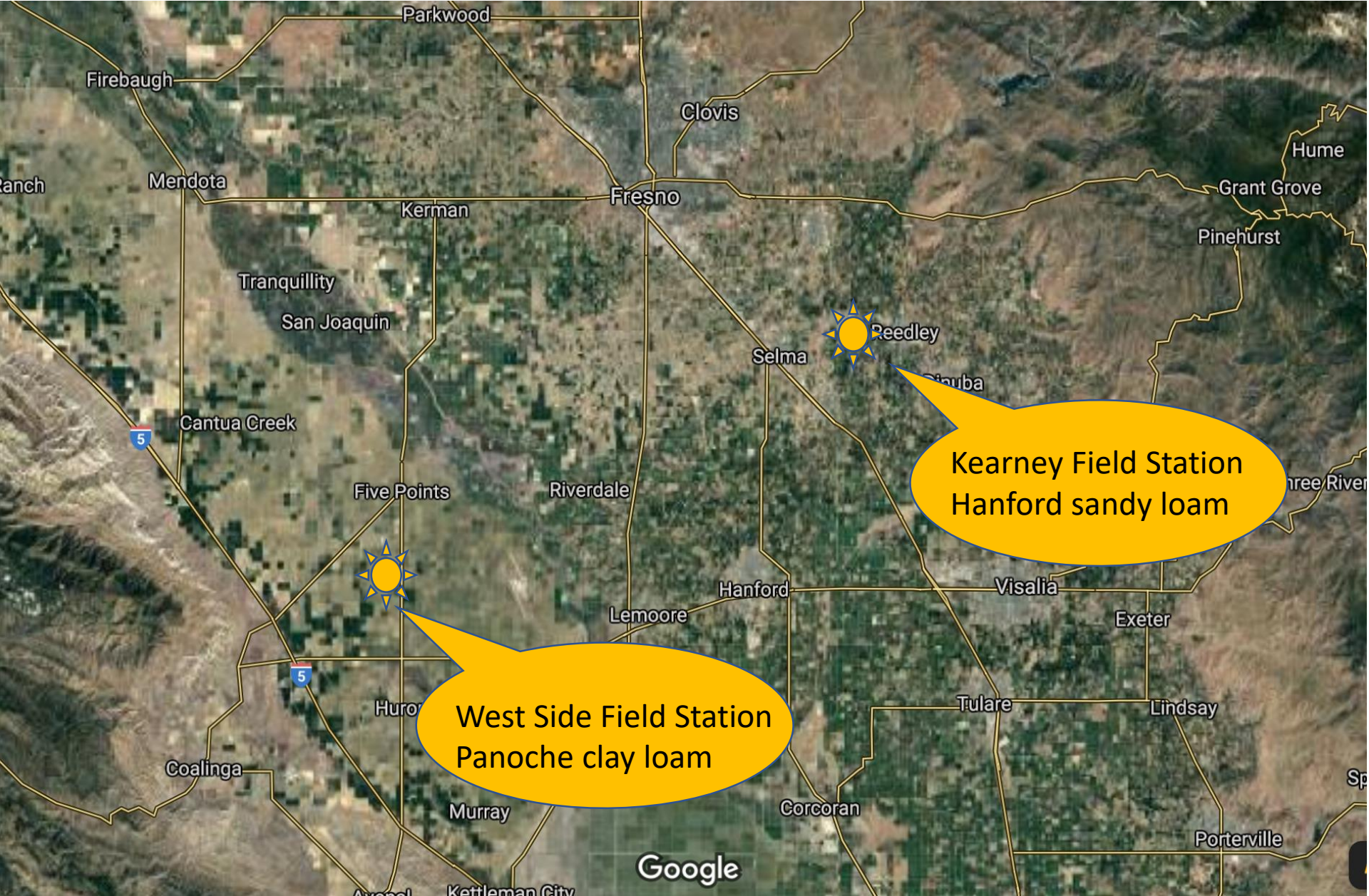


English walnut
(*Juglans regia*)



Centers of *J. regia* diversity: eastern
Anatolian Peninsula, into western
China

1960s Walnut Rootstock Research:



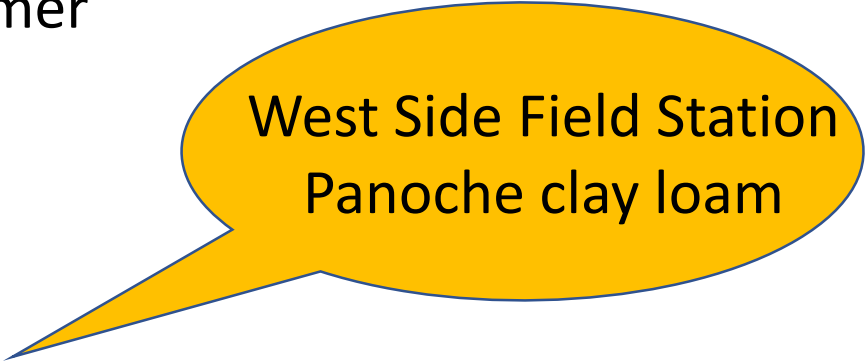
Kearney Field Station
Hanford sandy loam

West Side Field Station
Panoche clay loam



Kearney Field Station
Hanford sandy loam

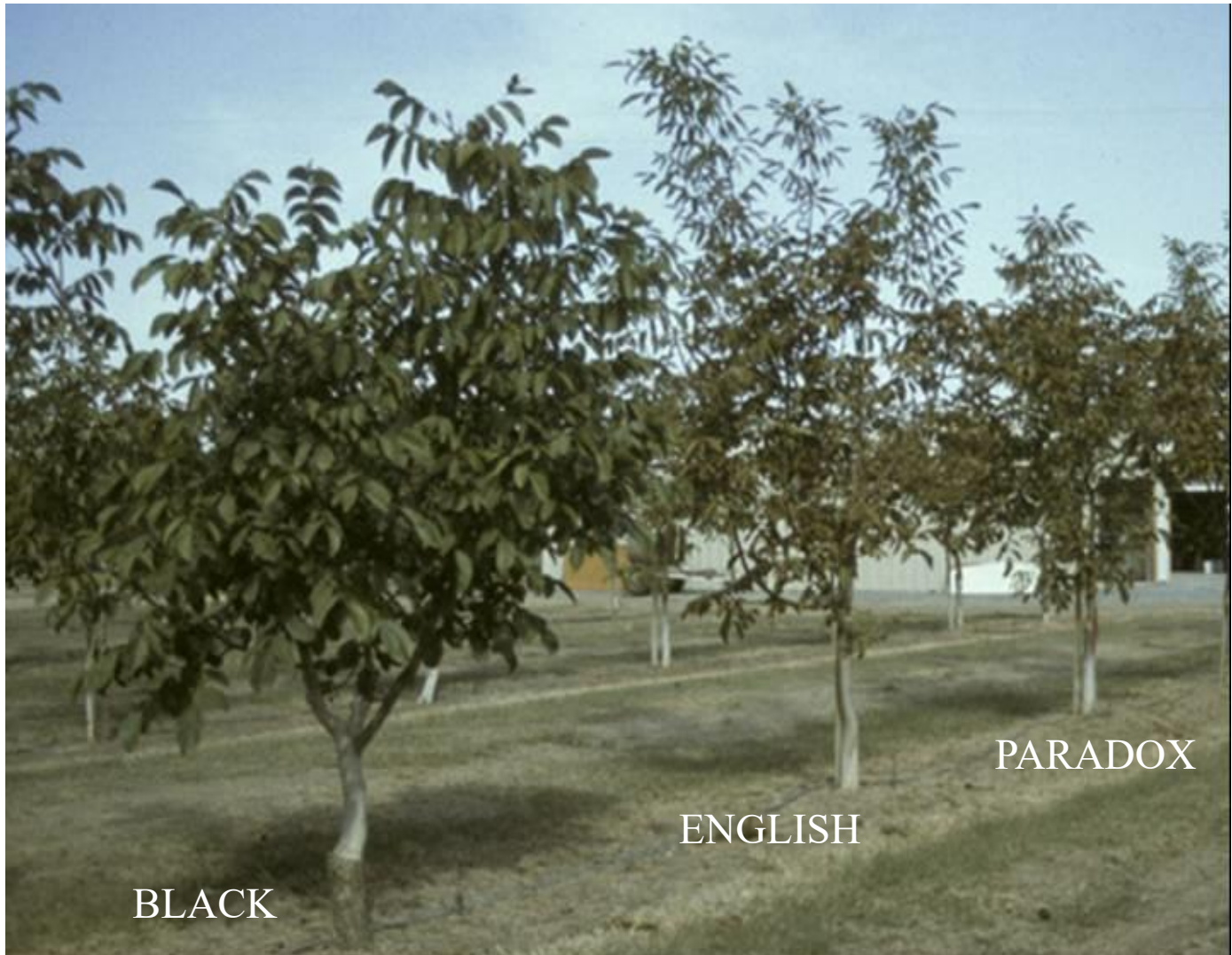
Paradox: An “outstanding performer”
High yield per tree



West Side Field Station
Panoche clay loam

Paradox performed “poorly” and had...
smaller trees,
lower yield,
and higher Cl accumulation... than Northern California Black.

Salt Tolerance of Walnut Rootstocks



BLACK

ENGLISH

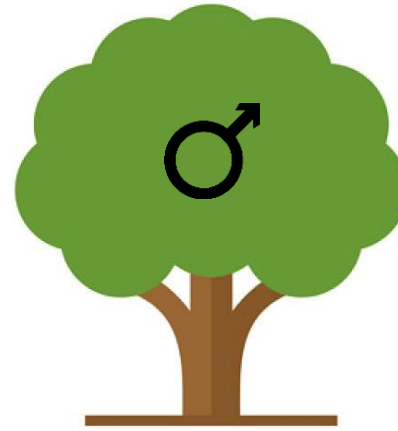
PARADOX

Chuck Leslie

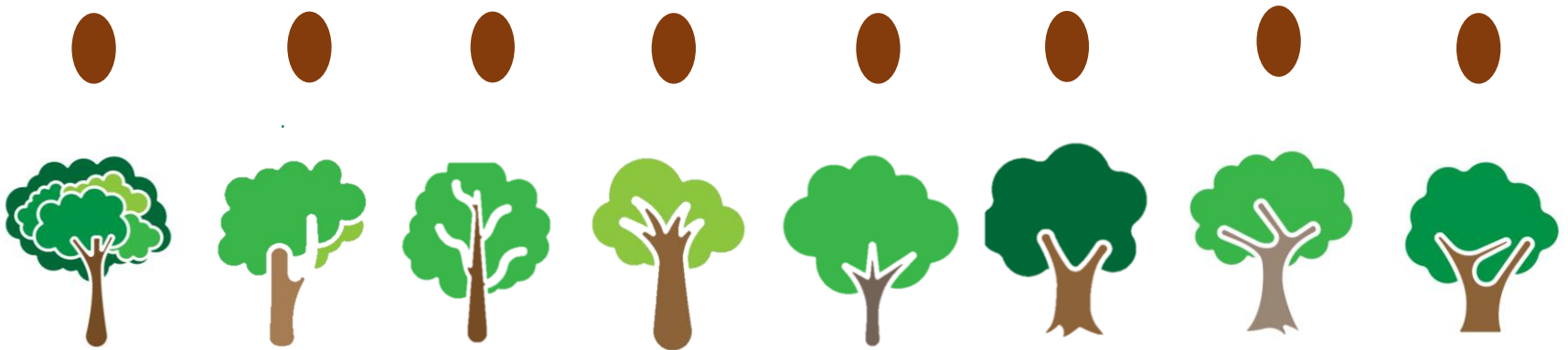
Northern California Black
(*Juglans hindsii*)



X



English walnut
(*Juglans regia*)



'Paradox' Seedling Rootstock

Heterogeneous seedling population of 'Paradox'

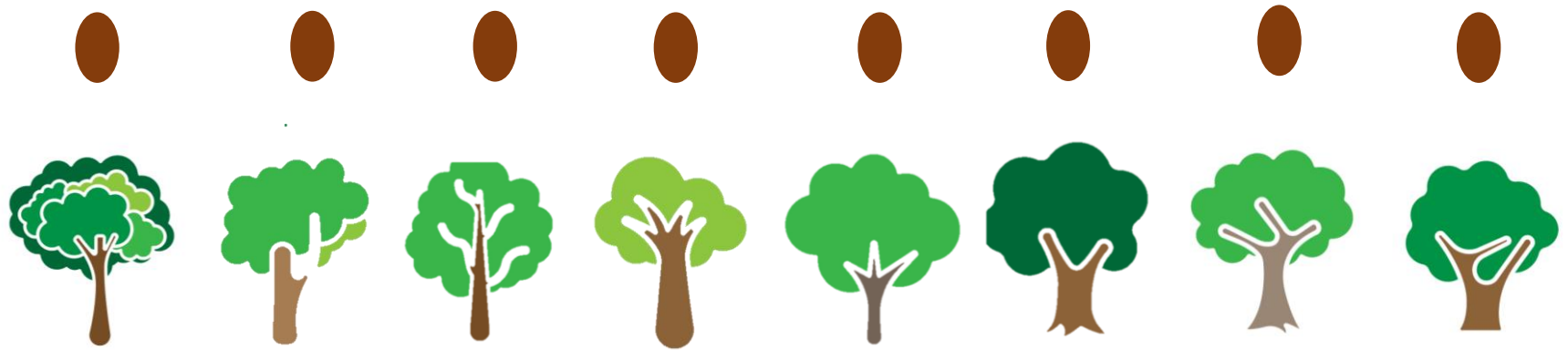




Homogeneous clones

Where do the clones come from?

'Paradox' Seedling Rootstock



'VX211'

'Vlach'

- 1) Select Phenotypes
- 2) Vegetatively propagate
- 3) Screen
- 4) Propagate commercially

Why do these clonal lines all have the same name (UCB-1)?



Nursery/Lab A
(UCB-1)



Nursery/Lab B
(UCB-1)



Nursery/Lab C
(UCB-1)



Northern CA Black
(*J. hindsii*) ♀

English Walnut
(*J. regia*) ♂

↓
'Paradox'



↓
'VX211'

↓
'Vlach'

What is micropropagation?

Micropropagation is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants, using plant tissue culture.

Proliferation of Axillary Buds:

- Meristematic-based proliferation system (adventitious systems = higher mutation risk)

- Approximately 5x proliferation per month (more possible, but increases risk of epigenetic variation).

G.C. Phillips and J.F. Hubstenberger, 2013. Micropropagation by Proliferation of Axillary Buds. In: Plant Cell Tissue and Organ Culture, Fundamental Methods, Eds. Gamborg and Phillips, Springer, 2013.

What is axillary bud proliferation?

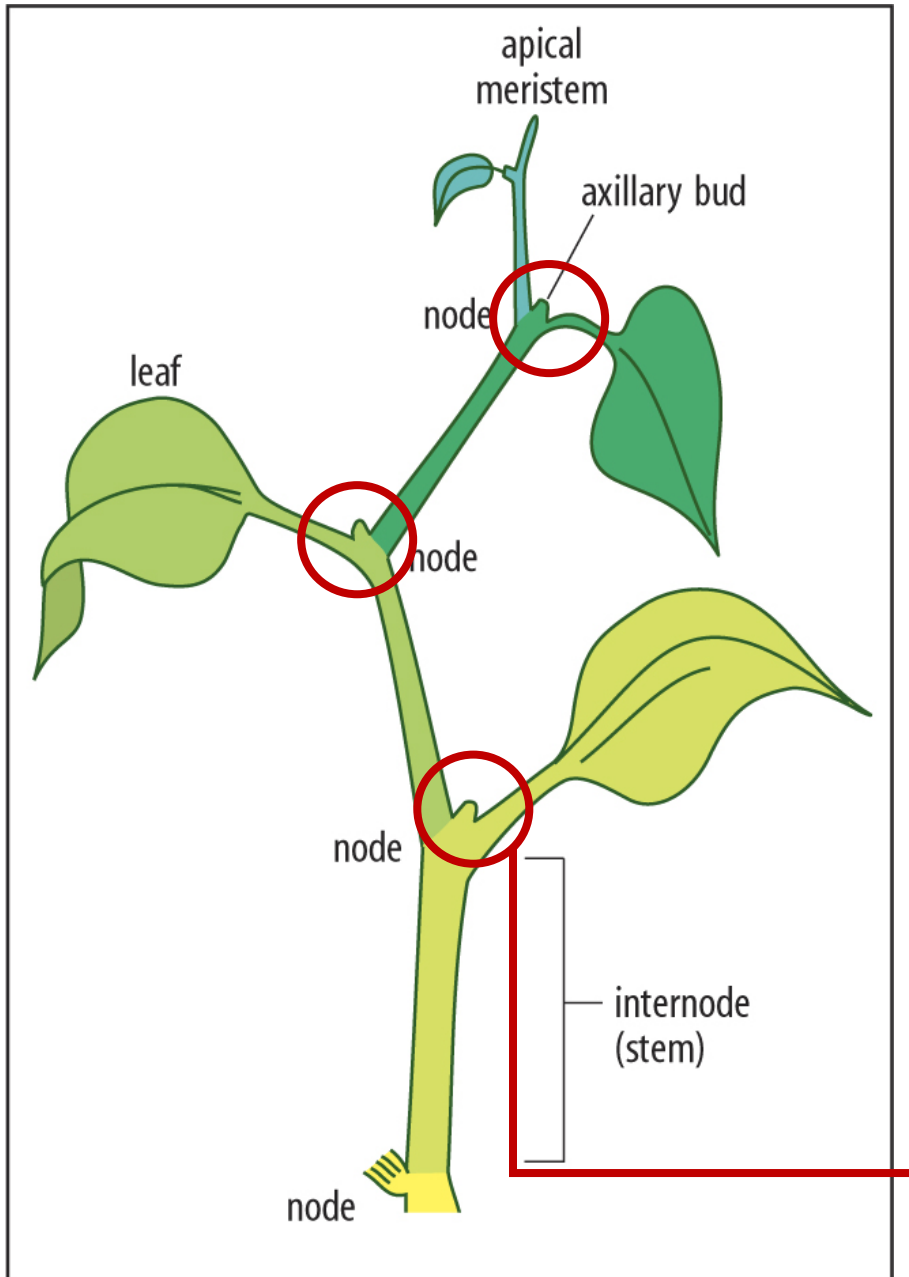


Photo: Chuck Leslie

Clones are genetically identical

- Vegetatively propagated
 - Micropropagated in tissue culture
 - Rooted cuttings



Clonal Population



Seedling Population



Clonal Rootstock Sold Three Ways

100% Clonal, No Seed!

RX 1 USPP #20649

- ✓ Phytophthora & Crown Gall Resistant
- ✓ Largest Tree & Highest Yield

VX 211 USPP #21179

- ✓ Great Vigor & Nematode Tolerant
- ✓ Survives Well in Field Tests

**OPTION
1**



ELLEPOT® CONTAINER

- ✓ Paradox Rootstock:
RX1, VX211, Vlach
- ✓ Great Defense Against
Crown Gall
- ✓ Readily Available,
Cost Effective

**OPTION
2**



STRAIGHT BAREROOT

- ✓ Paradox Rootstock:
RX1, VX211, Vlach
- ✓ One Season Growth
- ✓ Ready to Graft in
Your Orchard

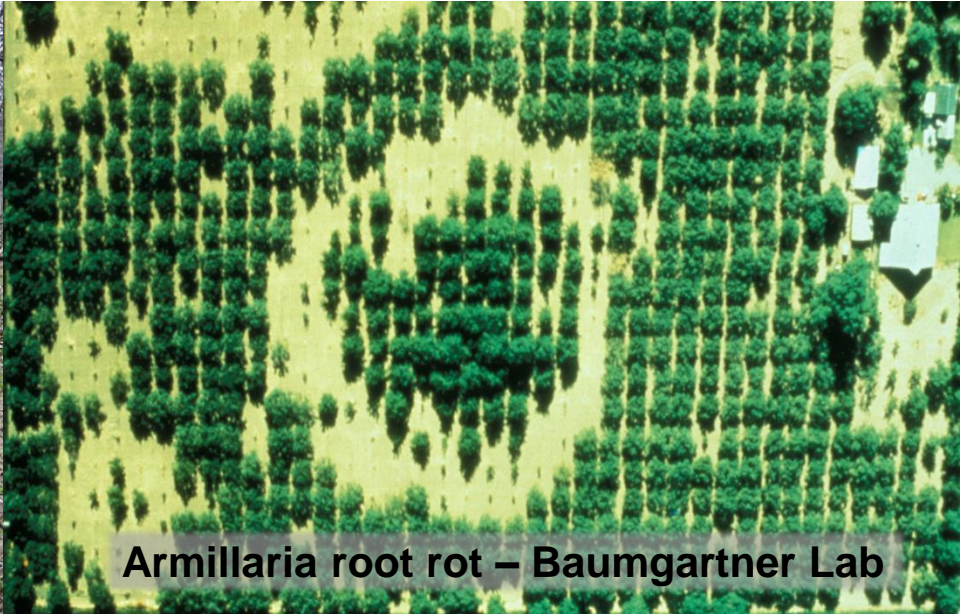
**OPTION
3**



FINISHED TREES

- ✓ Budded or grafted
- ✓ Bareroot Trees on Clonal
Paradox Rootstock
- ✓ No Field Budding or
Grafting Logistics

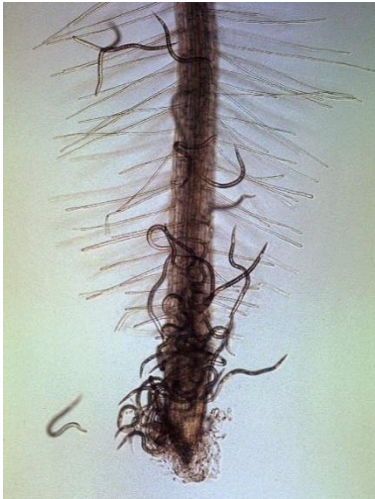
Pathogen Resistance Screening



➤ VX211

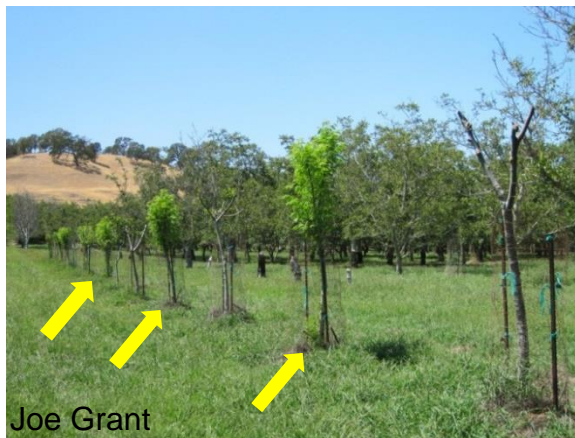
Paradox
(*J. hindsii* x *J. regia*)

- Exceptional vigor
- Nematode tolerance
- Replant sites

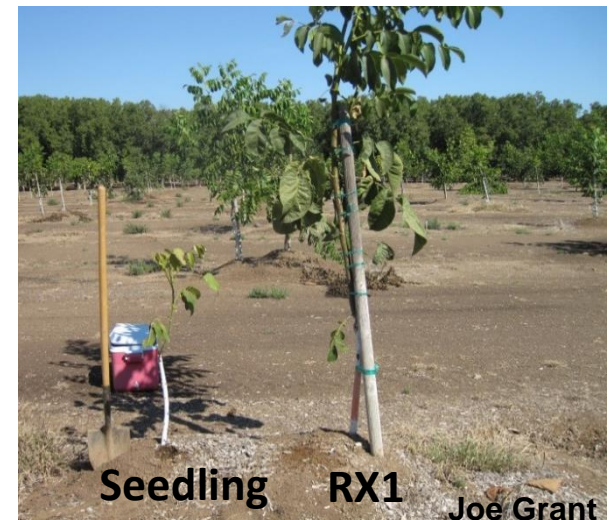


➤ RX1

(*J. microcarpa* x *J. regia*)



- Resistance to *Phytophthora*
- Excellent survival in wet location
- Consider for replant sites
- Possibly drought and salt tolerant



‘Vlach’

(*J. hindsii* x *J. regia*)

- Sourced from a big ‘Paradox’ seedling
- Put into tissue culture
- 1st commercially-available clonal walnut rootstock
- Vigorous

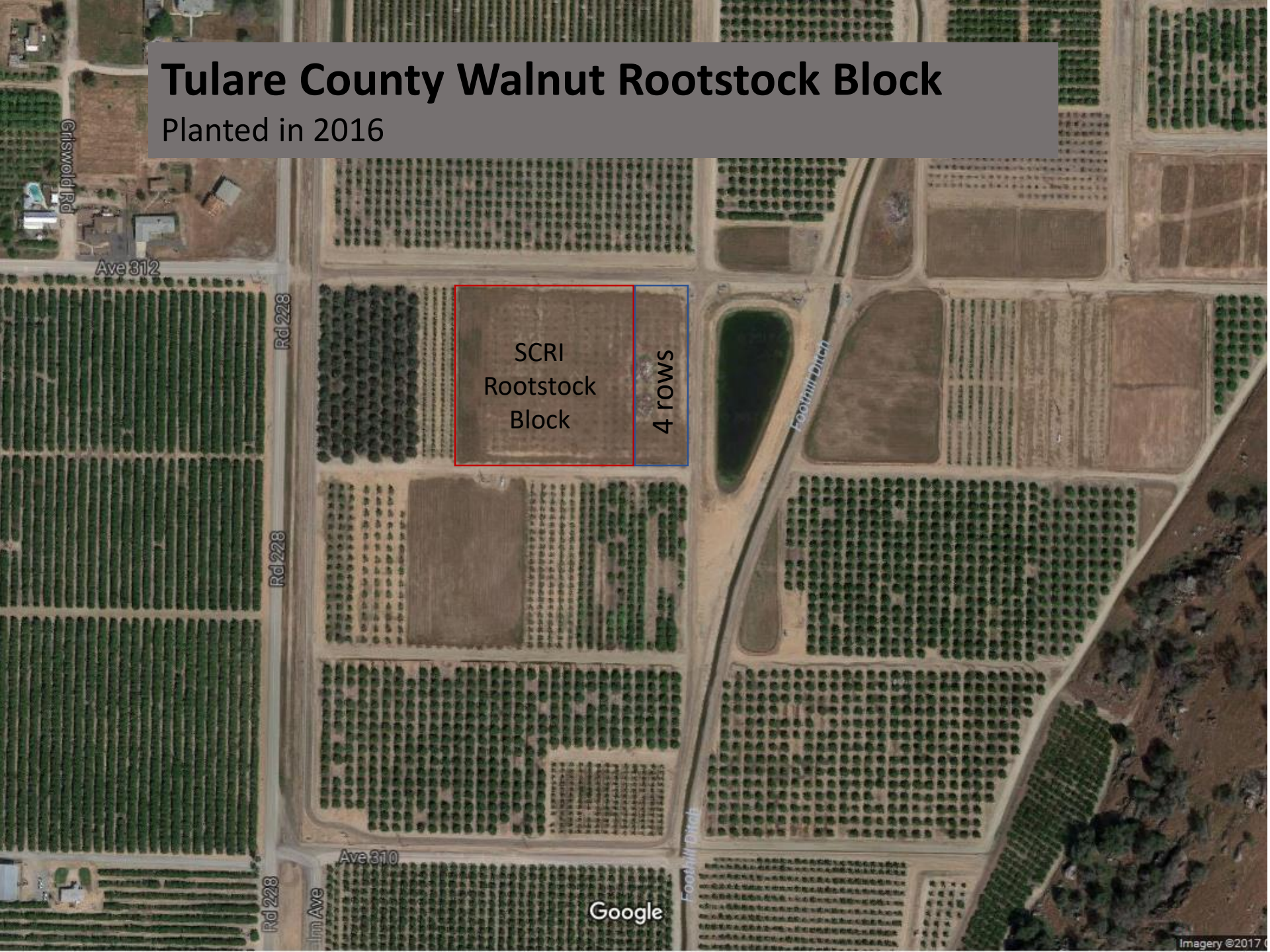


Current Generation Walnut Rootstock Trials

Rootstock	Genetics	Trials planted (location)	Reason we're interested
K3	J. microcarpa	Tulare Co., Lake Co., Glenn Co., Sutter Co., Solano Co.	Crown gall
STJM 4	J. microcarpa x J. regia	Tulare Co., Lake Co., Glenn Co., Sutter Co., Solano Co.	Phytophthora, crown gall
29 JM8	J. microcarpa x J. regia	Tulare Co., Lake Co., Glenn Co., Sutter Co., Solano Co.	Phytophthora, nematodes
CC	J. hindsii x J. regia	Lake Co., Sutter Co.	Nematodes
11-991	J. microcarpa x J. regia	Tulare Co., Sutter Co., Solano Co.	Crown gall
3S 17	J. cathayensis x J. regia	Sutter Co., Solano Co.	Phytophthora, nematodes

Tulare County Walnut Rootstock Block

Planted in 2016



SCRI
Rootstock
Block

4 rows

January 2019
Walnut Rootstock Block





Crown gall in rootstock plot

Seedling Paradox only



Clonal almond rootstock
(R. Duncan)

RX1-low/moderate resistance?

Yield Data Collected in 2019

VX211, RX1, Vlach performed statistically similarly to seedling Paradox





RX1



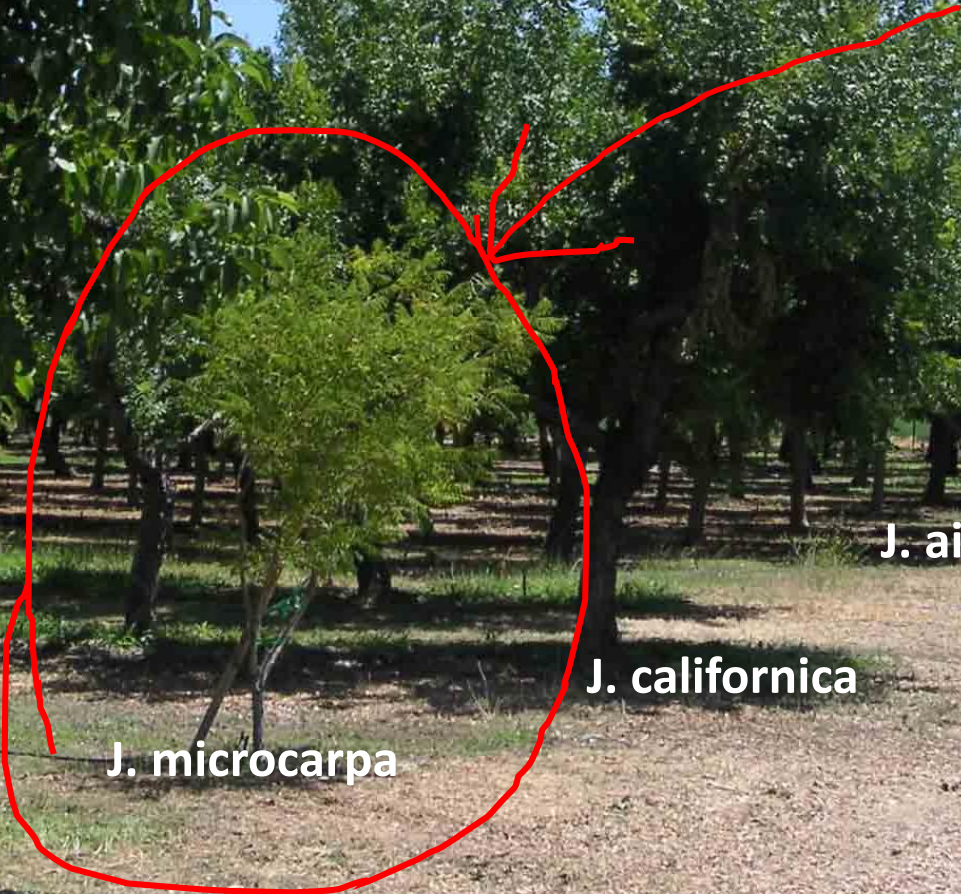
Vlach



VX211

**USDA Walnut
Germplasm Collection
Winters, CA**

holy grail?



J. regia

J. microcarpa

J. californica

J. ailantifolia

J. hindsii

J. major