

# Using and Breeding Drought Tolerant Grape Rootstocks

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# Acknowledgements

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- CDFA NT, FT, GV Improvement Advisory Board
- California Table Grape Commission
- American Vineyard Foundation
- E&J Gallo Winery
- Louis P. Martini Endowed Chair in Viticulture



# Thanks!

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Kevin Fort – Post-doc

Claire Heinitz, Jake Uretzky, Inez Hugalde, Cassie Bullock –  
PhD students

Andrew McElrone, USDA-ARS



# Rootstock Origin

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- First developed to address grape phylloxera in the late 1800s
- French scientists came to the US to collect *Vitis* species resistant to phylloxera
- Took back cuttings of many, but only *V. riparia* and *V. rupestris* rooted well from dormant cuttings
- Later added *V. berlandieri* for lime tolerance



# *V. riparia*

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Missouri River



# *V. rupestris*

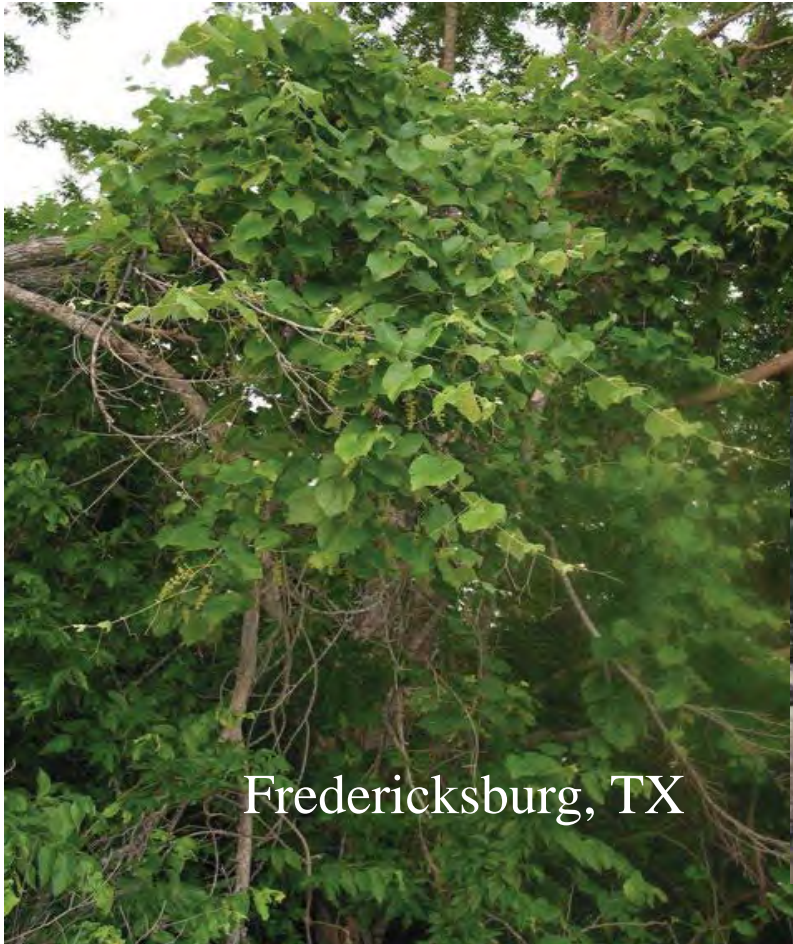
Jack Fork River, MO



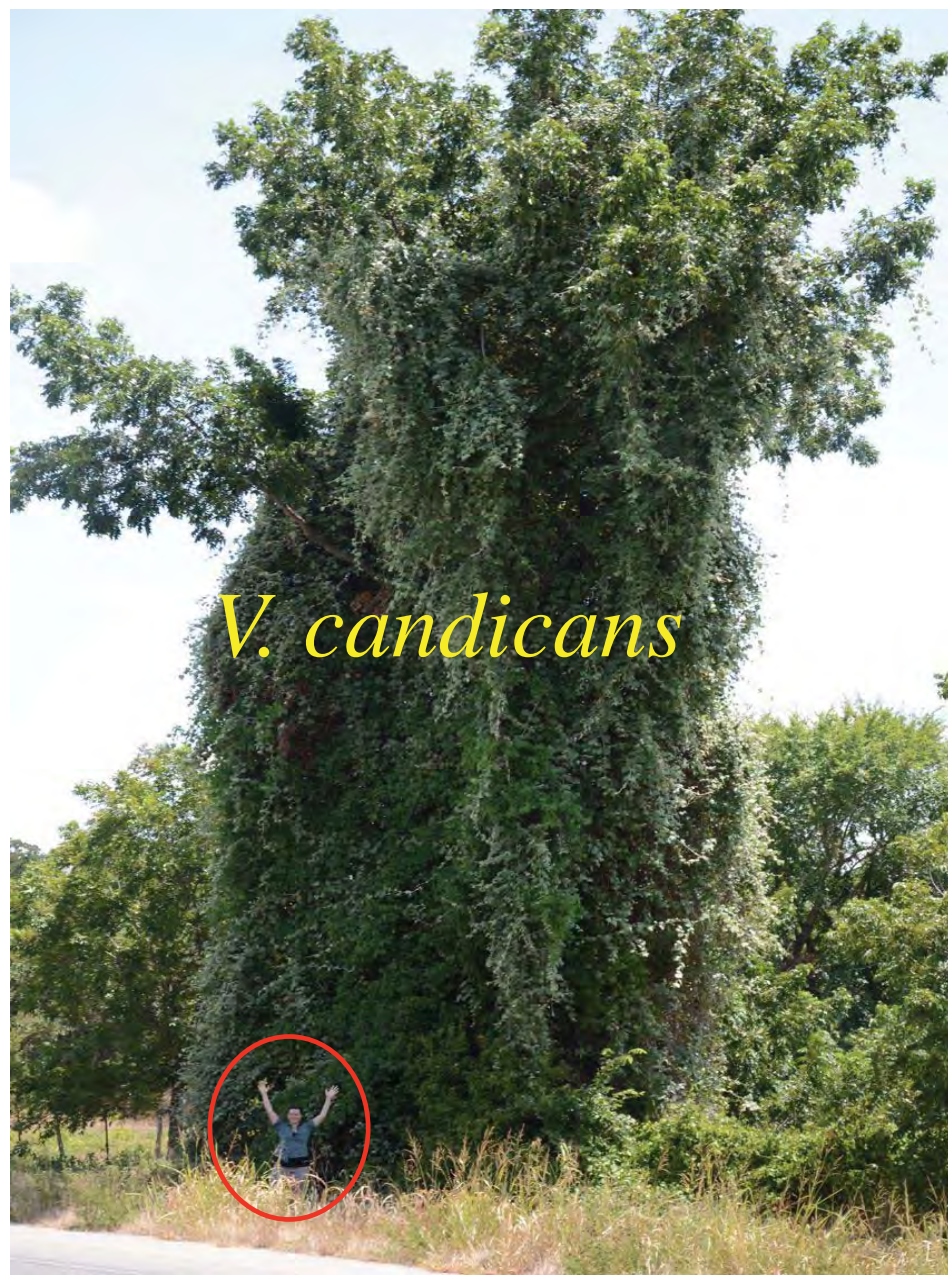
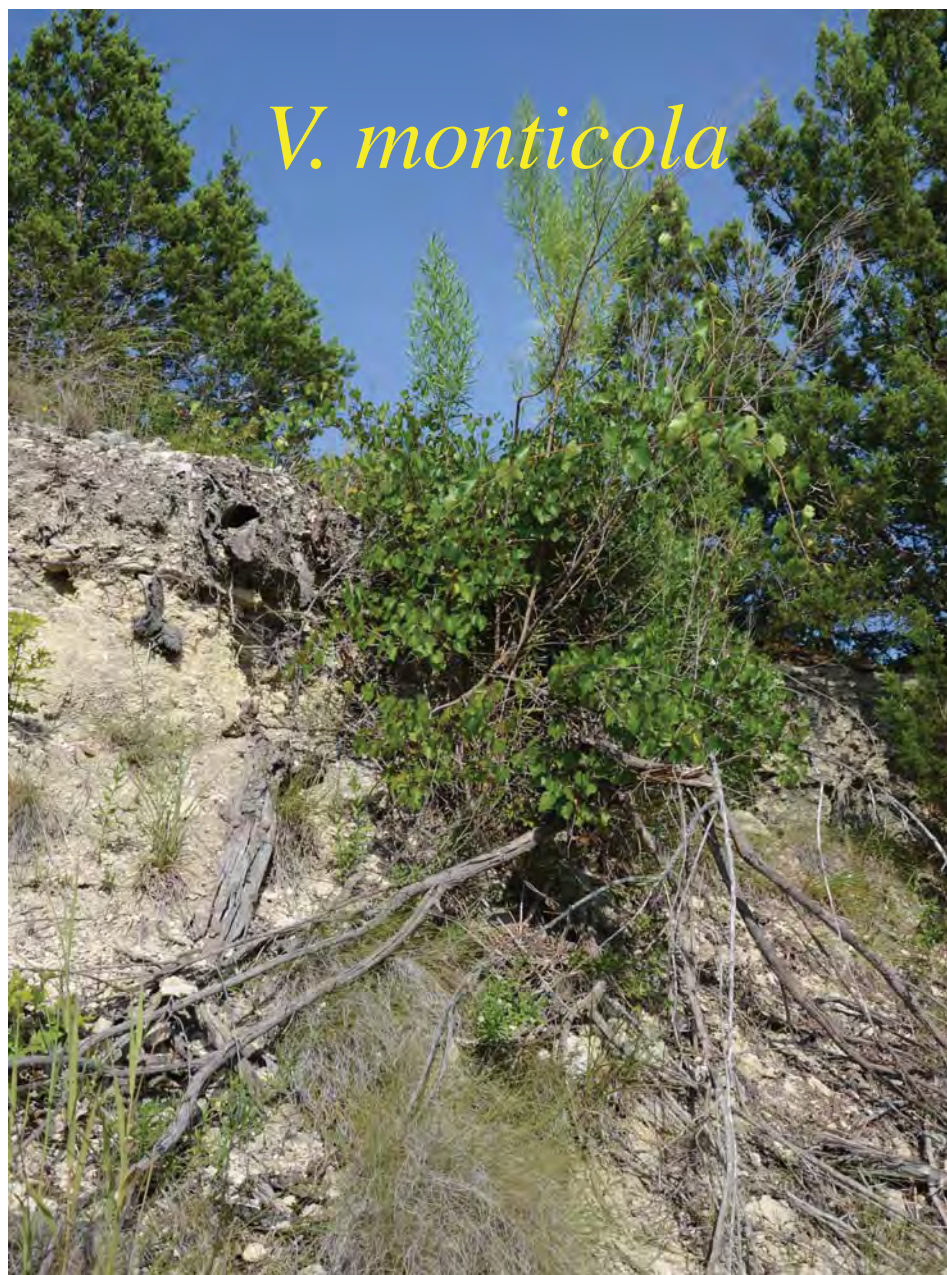


# *V. berlandieri*

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**“Isn’t there a cactus  
gene out there that  
might help?”**



# Breeding Rootstocks to Tolerate Drought

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- The ability to continue growth when exposed to water stress
- The ability to maintain crop yield with less water
- Adaptation vs. resistance
- Root architecture – shallow to deep rooting angles
- Root density – two tiered to even distributions
- Fine root recovery after drought
- Structural roots – which persist?
- Hydraulic lift
- Water uptake and permeability of structural roots
- In collaboration with Andrew McElrone



## Grape roots

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- Many perennial root systems mimic top growth – grape roots are vine-like
- Grape roots are sparsely scattered in the soil profile without drip or with adequate rainfall

## Grape roots

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- Grape roots are poor sinks – shoot tips; fruit; trunk; and then roots
- Species and rootstocks vary in their ability to produce/regenerate feeder roots



## Grape roots

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- Some species/rootstocks produce abundant fine roots, others do not – 110R, 1103P vs 101-14
- Some species/rootstocks produce more structural roots

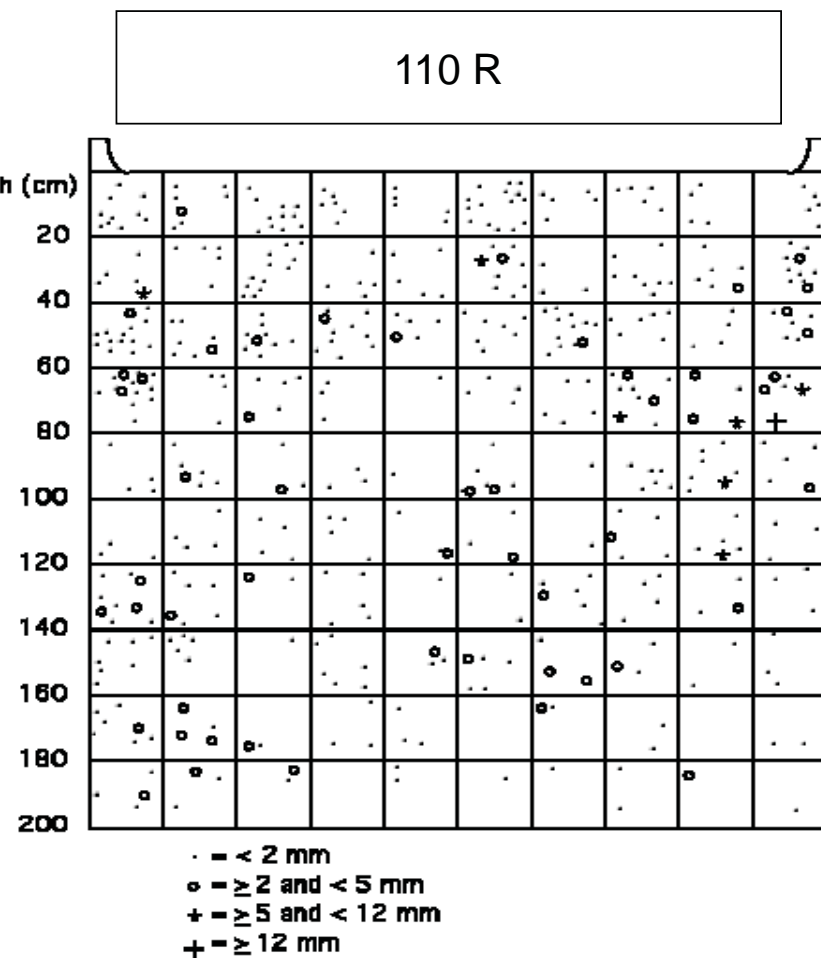
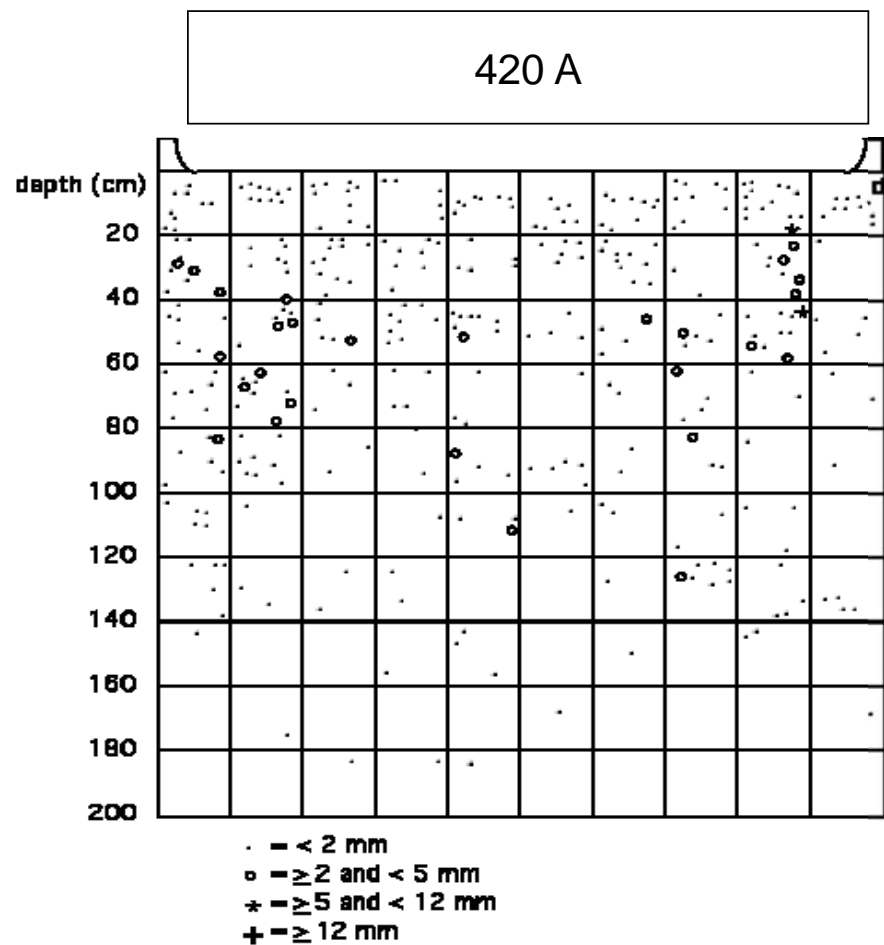
# Root architecture

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- The root system of rootstocks can be deeply penetrating or shallow – reflects its water needs and utilization
- The density of roots in the soil profile also varies
  - Evenly distributed
  - Primarily deep
  - Primarily shallow







Lisa Morano -- root profiles from the Oakville Station



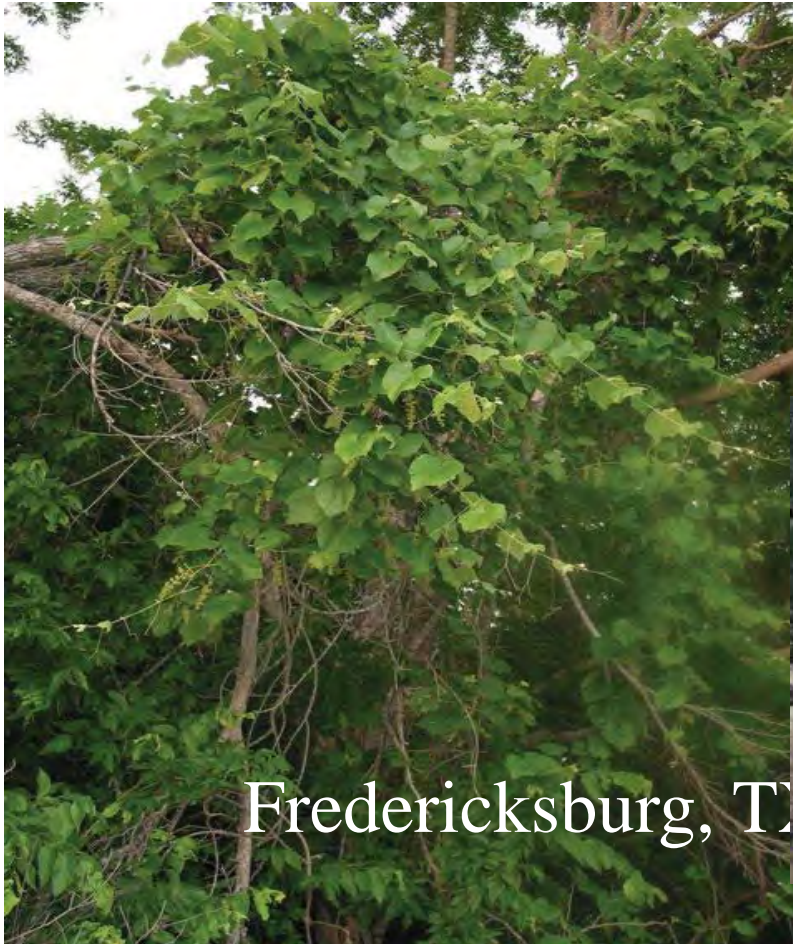
## Grape roots

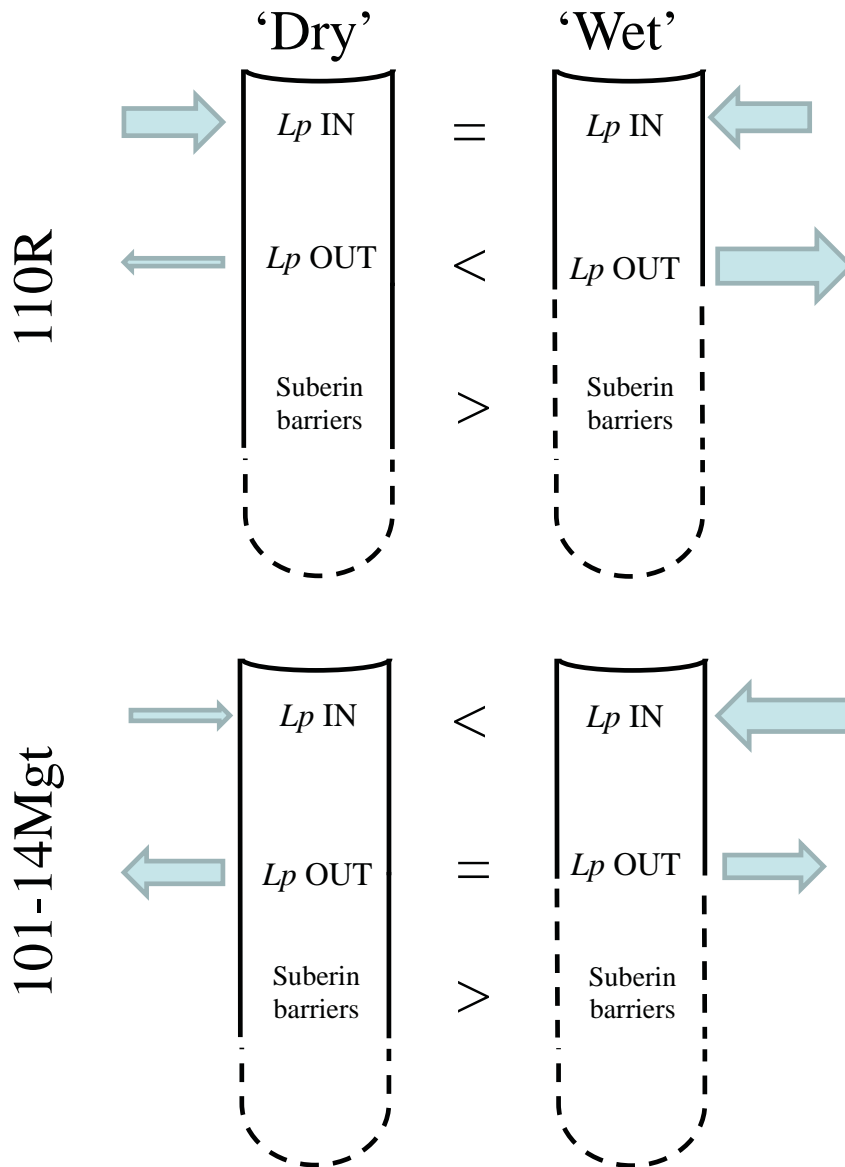
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- Some hydraulically lift water – redistribute it within the root system
- Root behavior/structure will have an impact on downwardly mobile insecticides

# *V. berlandieri*

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## McElrone Collaboration

**110R maintains water permeability into roots, but limits leakiness under drought**

**101-14 water permeability decreases into roots, but maintains leakiness under drought**



## Which rootstock to choose?

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- *riparia* based – shallow roots, water sensitive, low vigor, early maturity:
  - 5C, 101-14, 16161C (3309C)
- *rupestris* based – broadly distributed roots, relatively drought tolerant, moderate to high vigor, midseason maturity:
  - St. George, 1103P, AXR#1 (3309C)

## Which rootstock to choose?

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- *berlandieri* based – deeper roots, drought tolerant, higher vigor, delayed maturity:
  - 110R, 140Ru (420A, 5BB)
- *champinii* based – deeper roots, drought tolerant, salt tolerance, but variable in hybrids
  - Dog Ridge, Ramsey (Salt Creek)
  - Freedom, Harmony, GRNs
- Site trumps all... soil depth, rainfall, soil texture, water table

# Drought Resistance: What is needed?

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- Understanding drought adaption vs drought resistance
- Can we un-couple rooting depth from drought adaptation/resistance?
- What is the relationship of seasonality to rooting depth and rootstock parentage?
- Kevin Fort, Jake Uretsky, Jean Dodson, Joaquin Fraga, Cecilia Osorio
- Andrew McElrone



# Grape roots

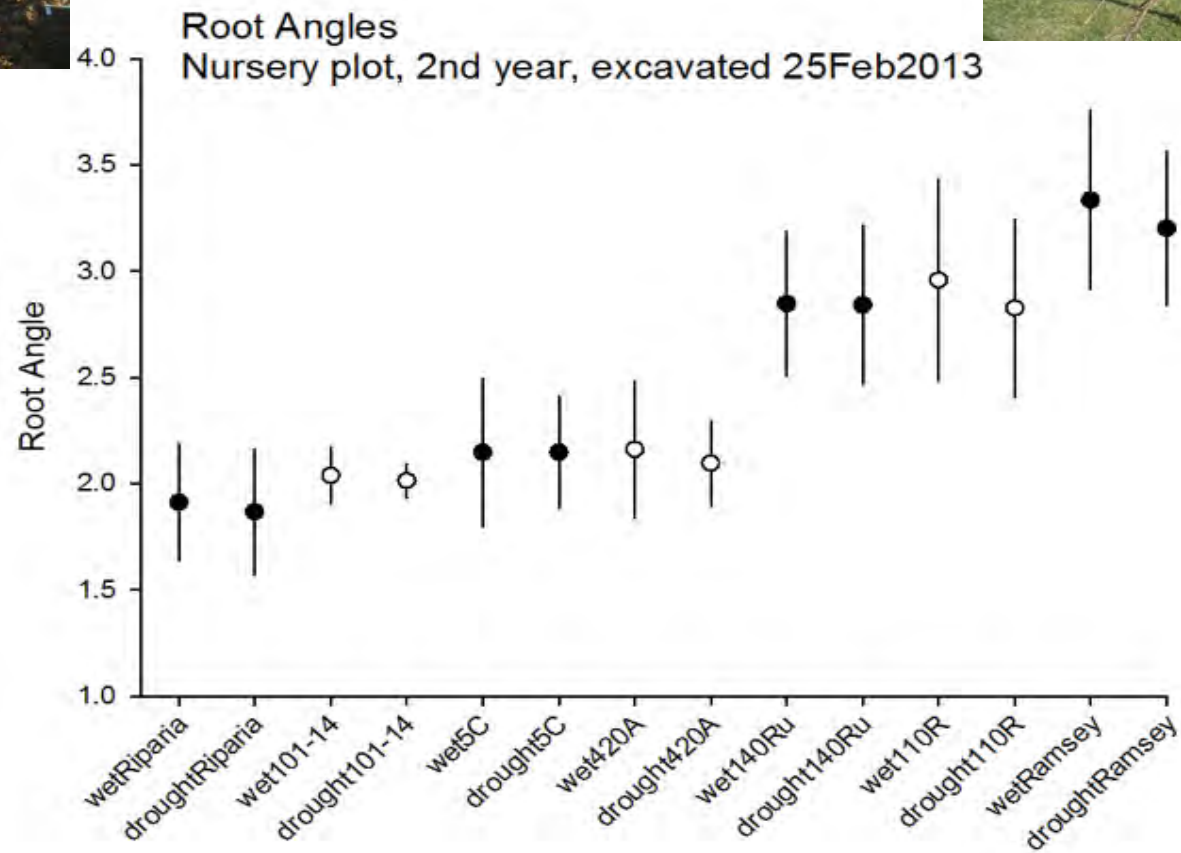
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Riparia Gloire de  
Montpellier

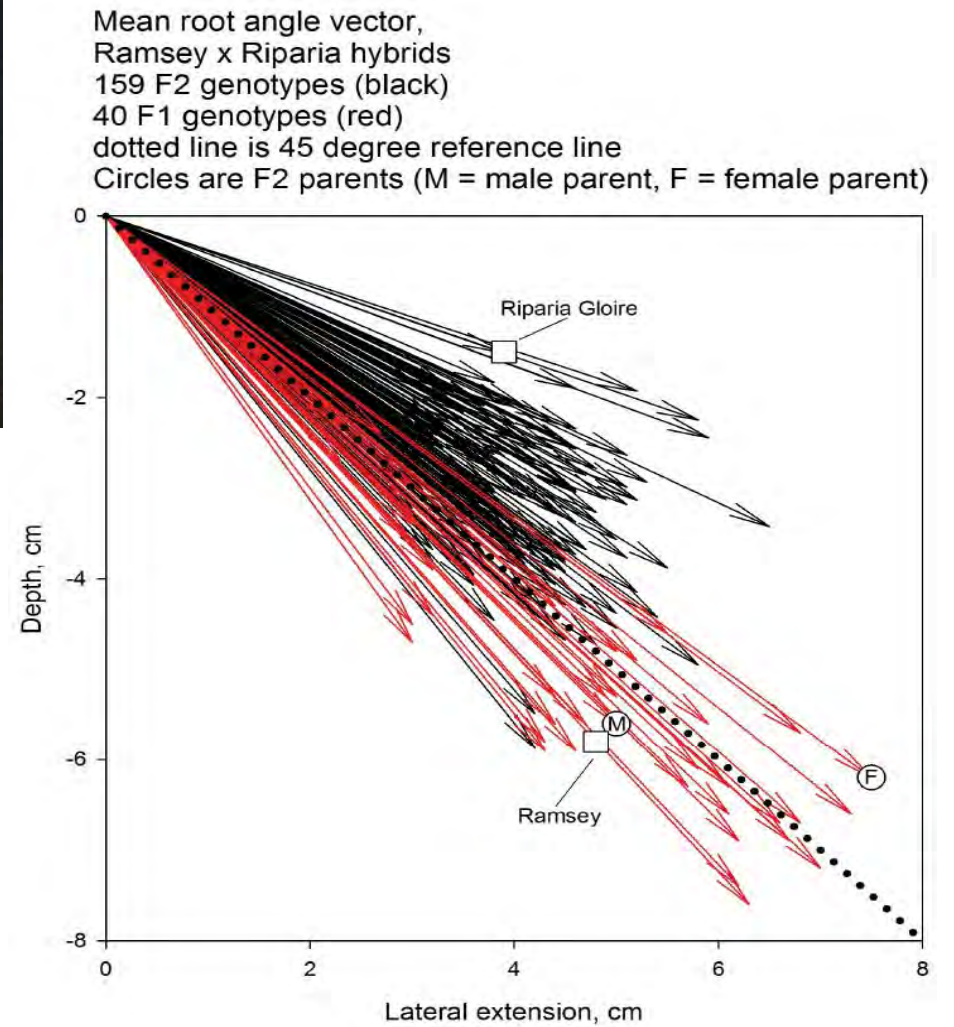
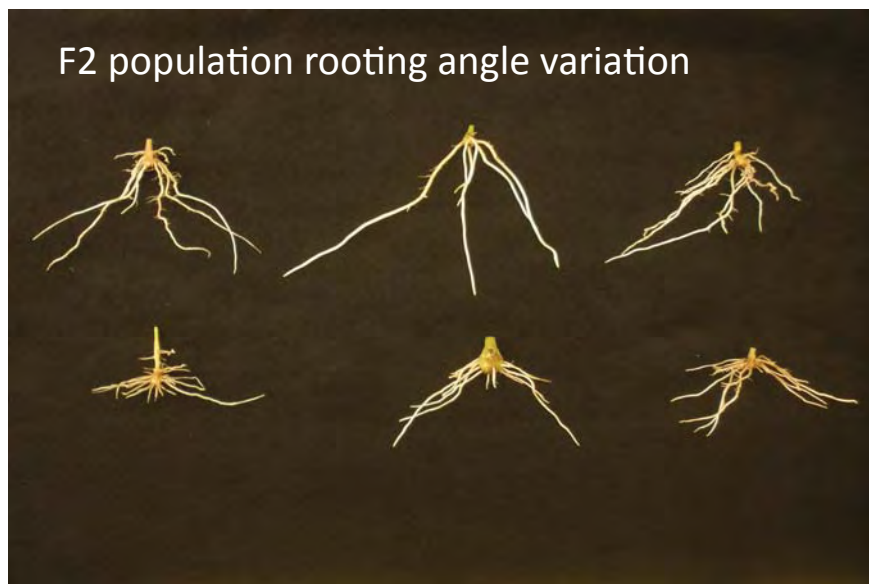
Ramsey (*V. champinii*)



# Root architecture from field-grown vines: Cecilia Osorio / Kevin Fort

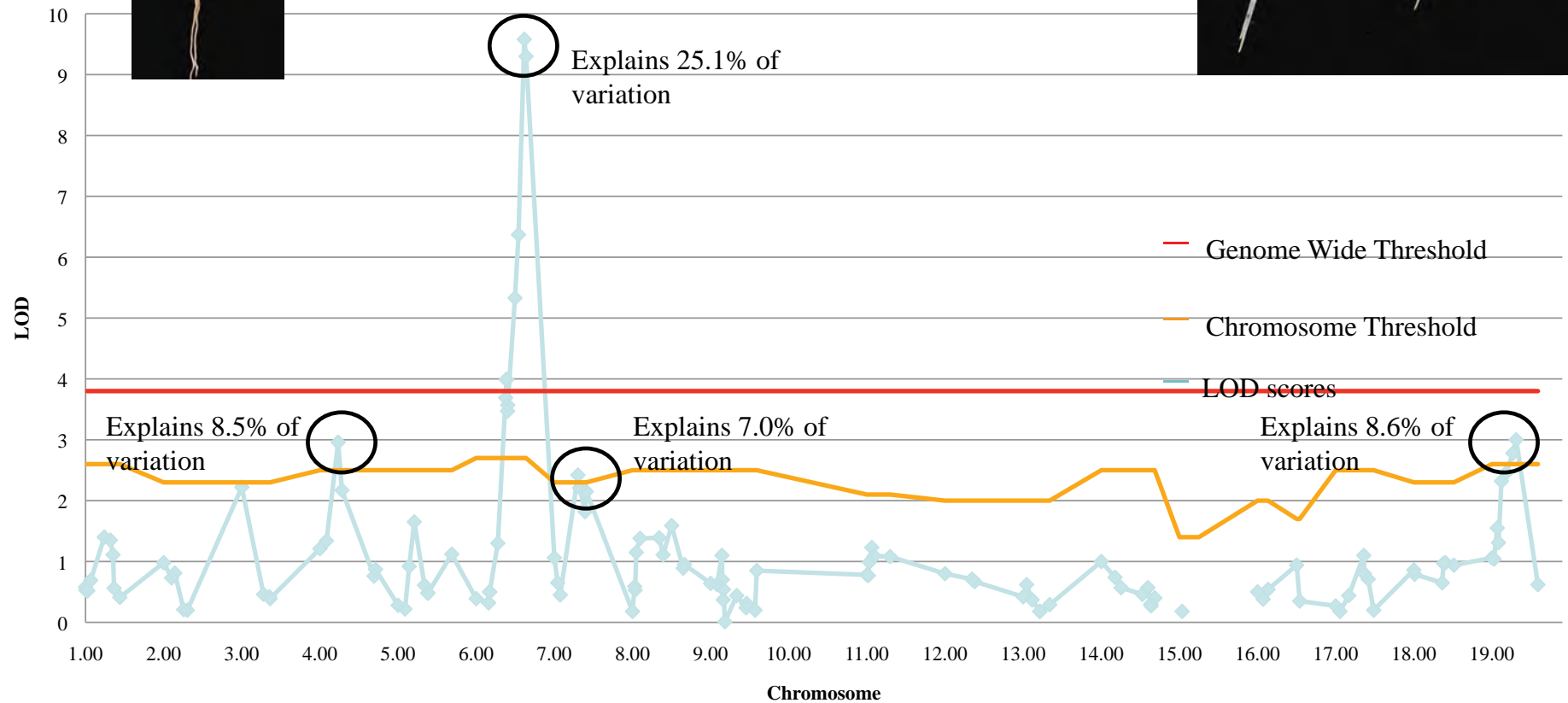








# QTL Analysis: All Roots



# Salt Resistance – Kevin Fort

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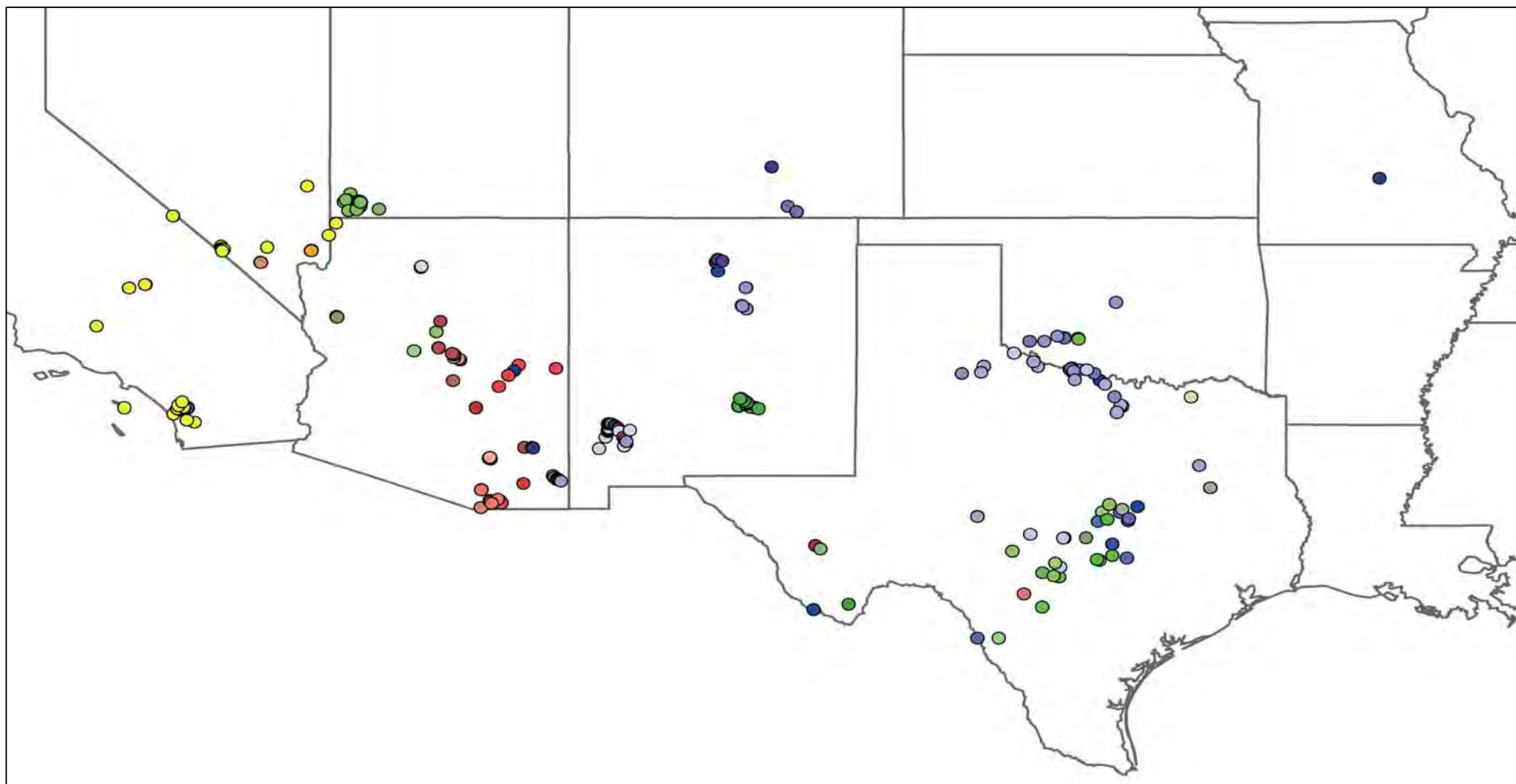
- Salt and drought resistant rootstocks exist, but need better forms of resistance
- Salt resistance assay now matches Australian field data
  - Ramsey is good; St. George and 140Ru are better; and selections of *acerifolia*, *arizonica*, *berlandieri*, *doaniana* and *girdiana* are better yet
- Working closely with Andrew McElrone to understand mechanisms... screen more accurately

## Salt Resistance in SW *Vitis* — Claire Heinitz

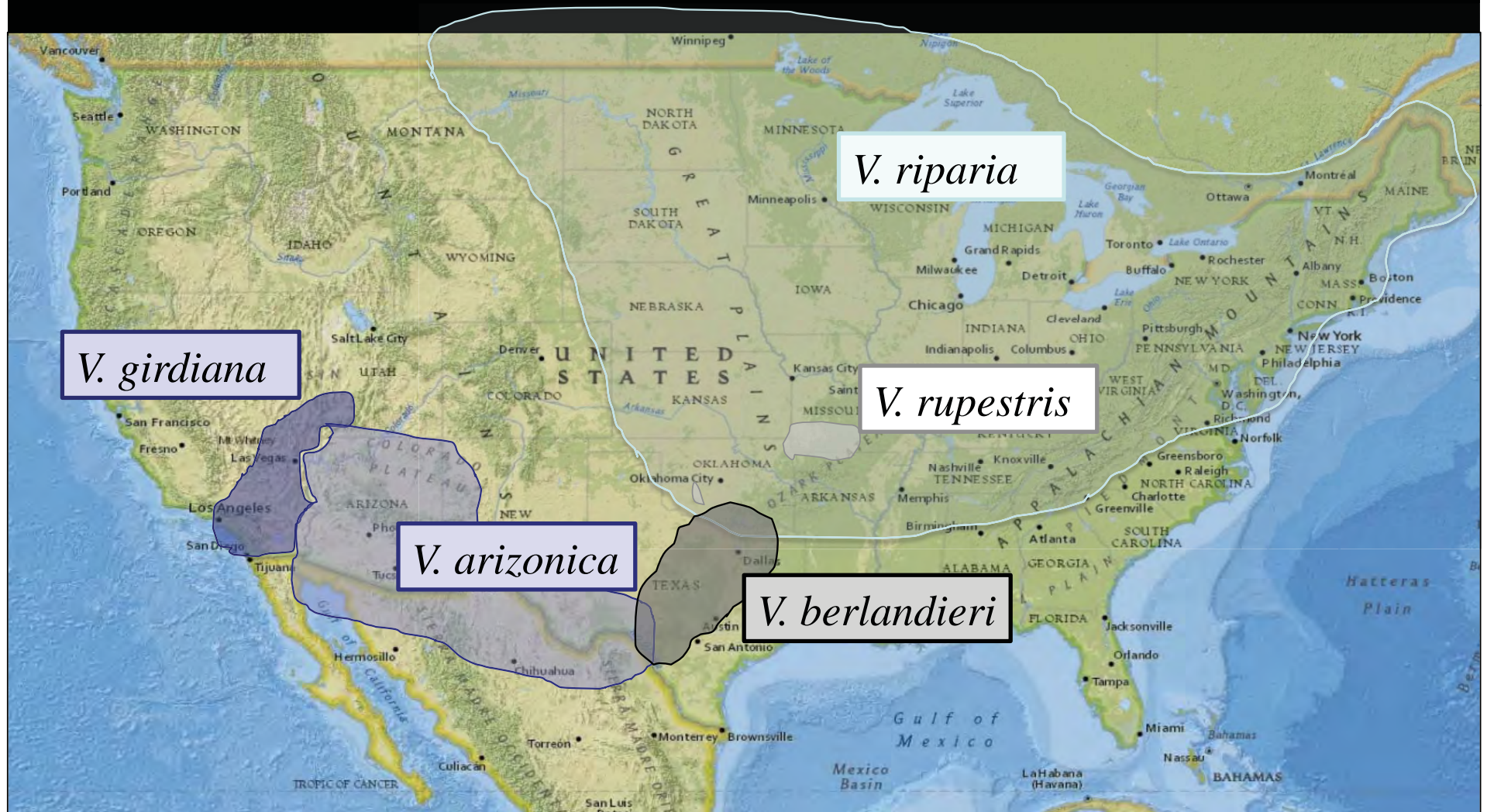
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- Plant material from the southwest U.S. has been the source of resistance to:  
PD, *X. index*, salt (chloride exclusion), drought
- Taxonomic relationships are unclear:
  - *V. arizonica* a complex group of hybrids with other species
  - *V. doaniana* and intermediates





# North American *Vitis*





# North American *Vitis*

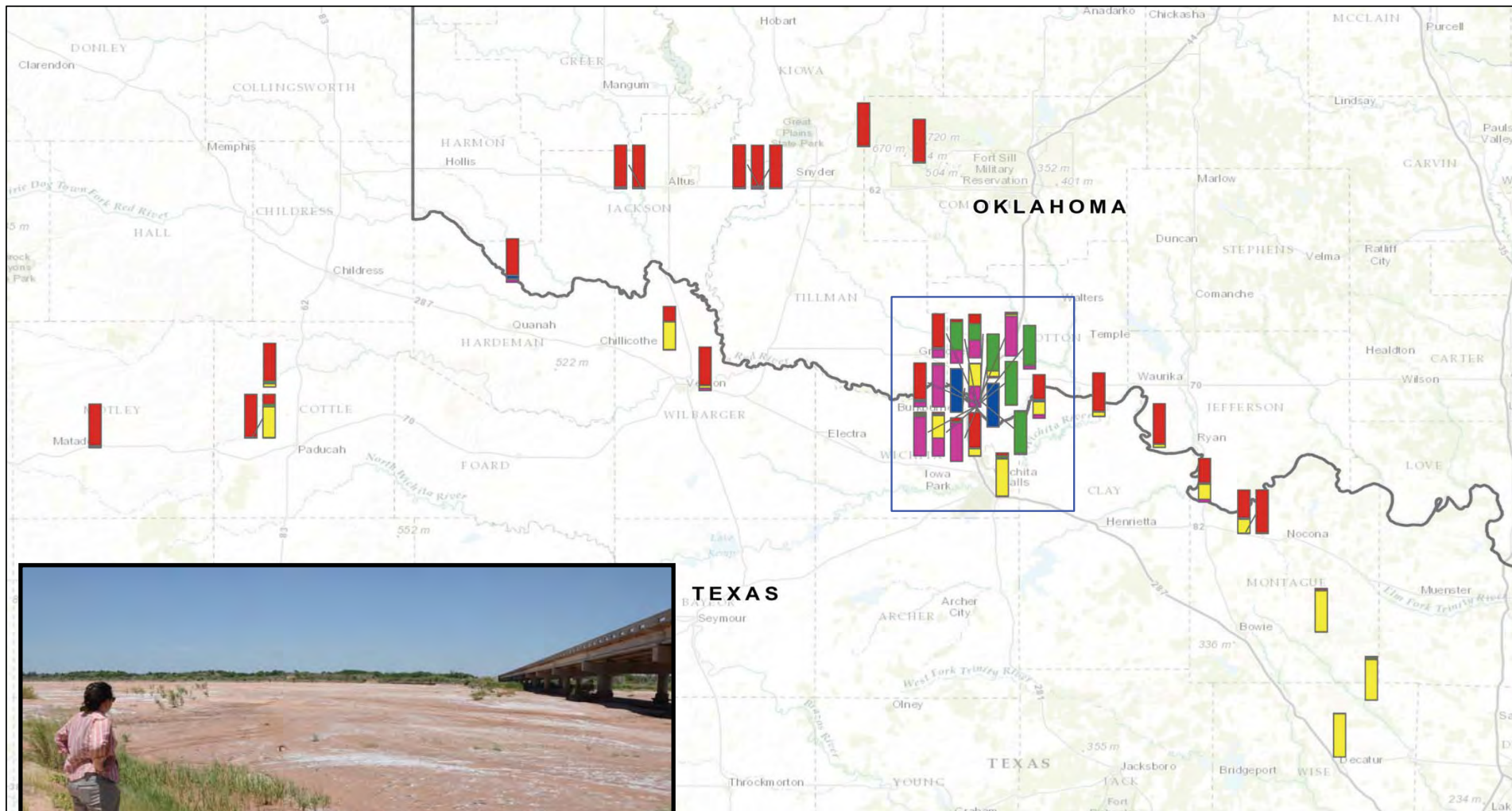




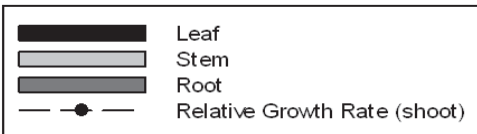
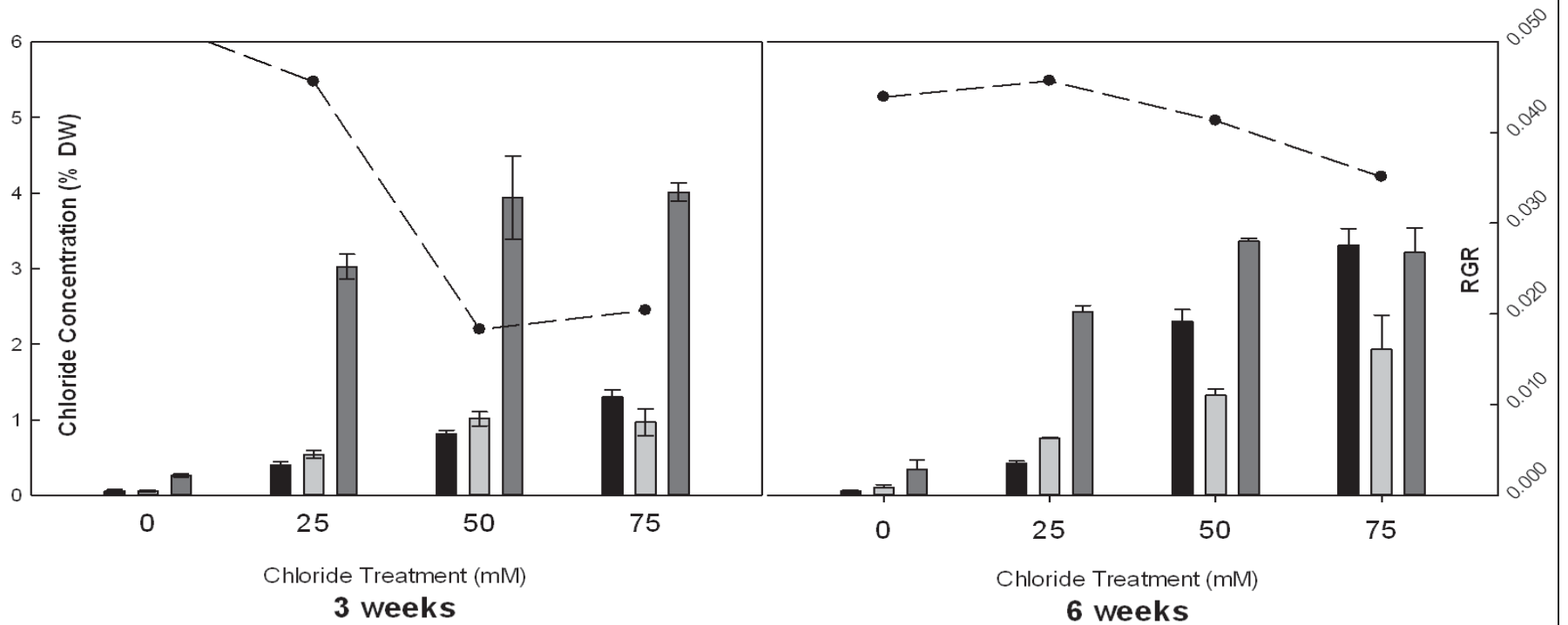
# Conclusions

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- Main sources of chloride exclusion in Ash Meadows and Red River populations are from distinct genetic backgrounds
  - likely represent different mechanisms of resistance
  - need to include both in mapping and breeding efforts
- *V. girdiana* has a potentially narrow genetic base
  - important for breeding and conservation
- Chloroplast SSRs are a powerful tool for understanding patterns of gene flow

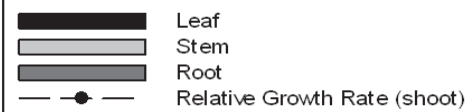
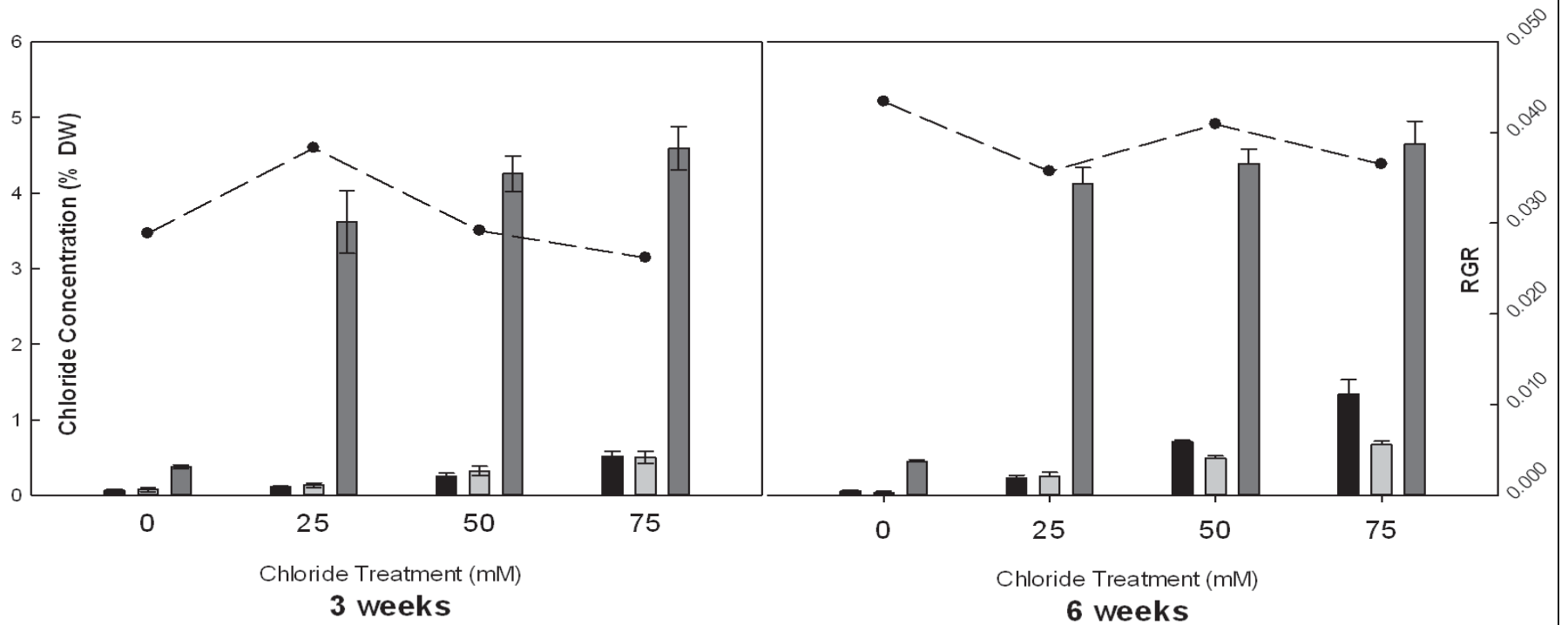


## Ramsey

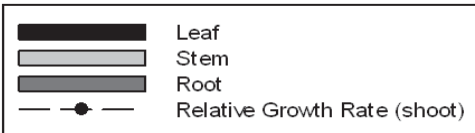
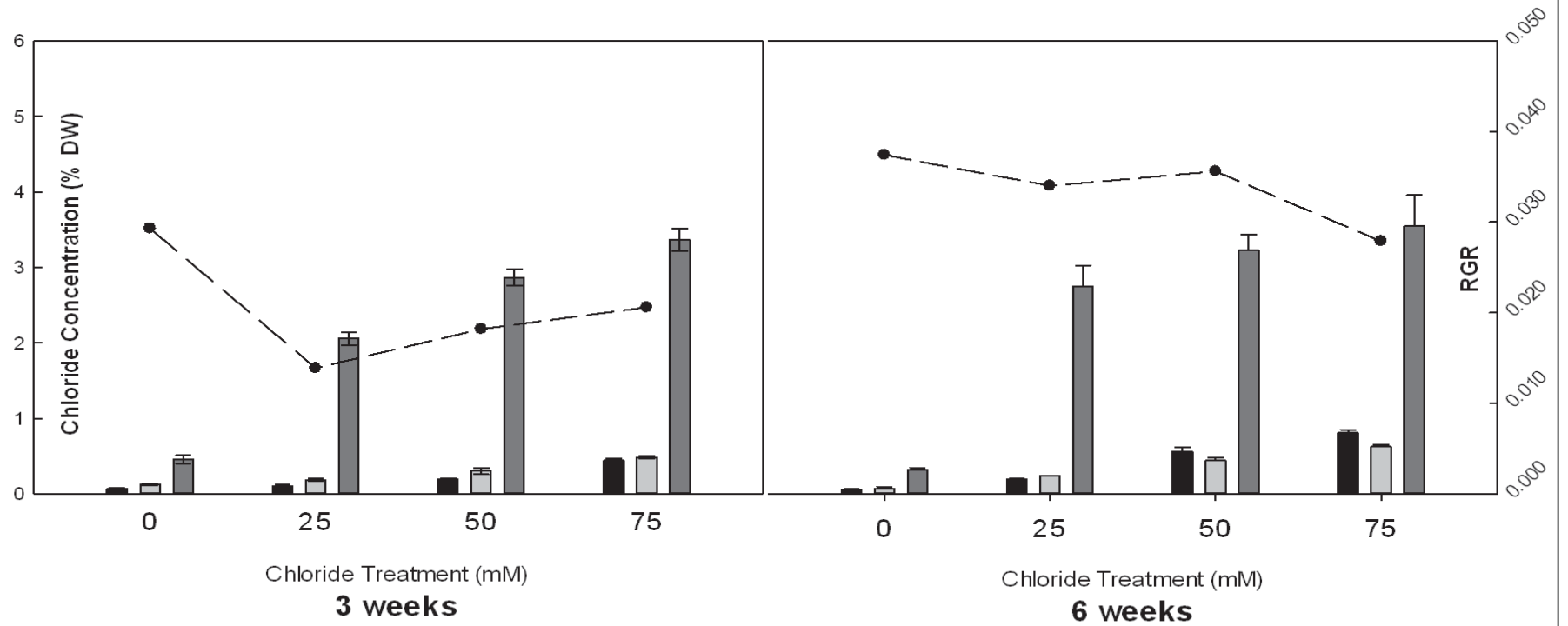




## berlandieri 9031



# SC1



GIRDIANA SCOTT'S CASTLE X ARIZONIA A56





## Salt resistance – 150mM, 2 weeks

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Selection	Parentage	#Salt resistant
12-102-03	101-14 x NM03-17 ( <i>treleasei</i> )	13
12-108-28	101-14 x 9028 ( <i>doaniana</i> )	3
12-125-03	OKC-1 SO1 ( <i>acerifolia</i> ) x GRN-2 9363-16	4
12-126-02	OKC-1 SO1 ( <i>acerifolia</i> ) x GRN-4 9365-85	1
12-126-08	OKC-1 SO1 ( <i>acerifolia</i> ) x GRN-4 9365-85	2
12-129-22	OKC-1 SO1 ( <i>acerifolia</i> ) x St. George	4
12-142-04	<i>girdiana</i> -11 x <i>arizonica</i> A56	7
12-143-09	<i>girdiana</i> -22 x <i>arizonica</i> A56	2
12-144-01	<i>girdiana</i> Scotty's Castle x <i>arizonica</i> A56	9

Thanks!

