Potassium nutrition of grapes in the Lodi Winegrape District

58th Annual Grape Day
Lodi, CA
February 2, 2010

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Potassium

- Most abundant inorganic element in grapes
- Main cation (+) in must and wine
- Cell osmoregulation, turgor, growth
- Harvest removal approx 5 lb/ton fruit
- Some evidence of deficiency in ~25% of acreage in Lodi district (2006 LWC/UC grower survey)
- Very wide range of soil available K levels in district soils

K excess – wine/juice impacts

- High juice K increases pH
- Negative effect on wine quality, e.g., decreases free tartaric acid
- Decreases color quality of red wines
- Increases susceptibility to oxidation and spoilage

K excess – soil/irrigation impacts

- Magnesium deficiencies?
- Reduction in infiltration (San Joaquin loam where using very low EC irrigation water)

-- UC research in SJV, Peacock, 2005

K uptake by vines and fruit

- Rapid uptake after veraison
- High concentration in berry skins
- Some K remobilization late in season
- High fruit loads can lead to deficiencies
- Rootstock influences K supply to vines
- A link between fruit load and berry K has not been established

Diagnosing K status

- Visual symptoms
- Petiole K (1.0-1.5% K at bloom, 0.8% midsummer)
- Soil test K – 100 ppm (ammonium acetate extractable) – limited value
- Sap analysis, nutrient ratios – some research, not used
- No test/interpretive criteria for berry K

K fertilizer materials

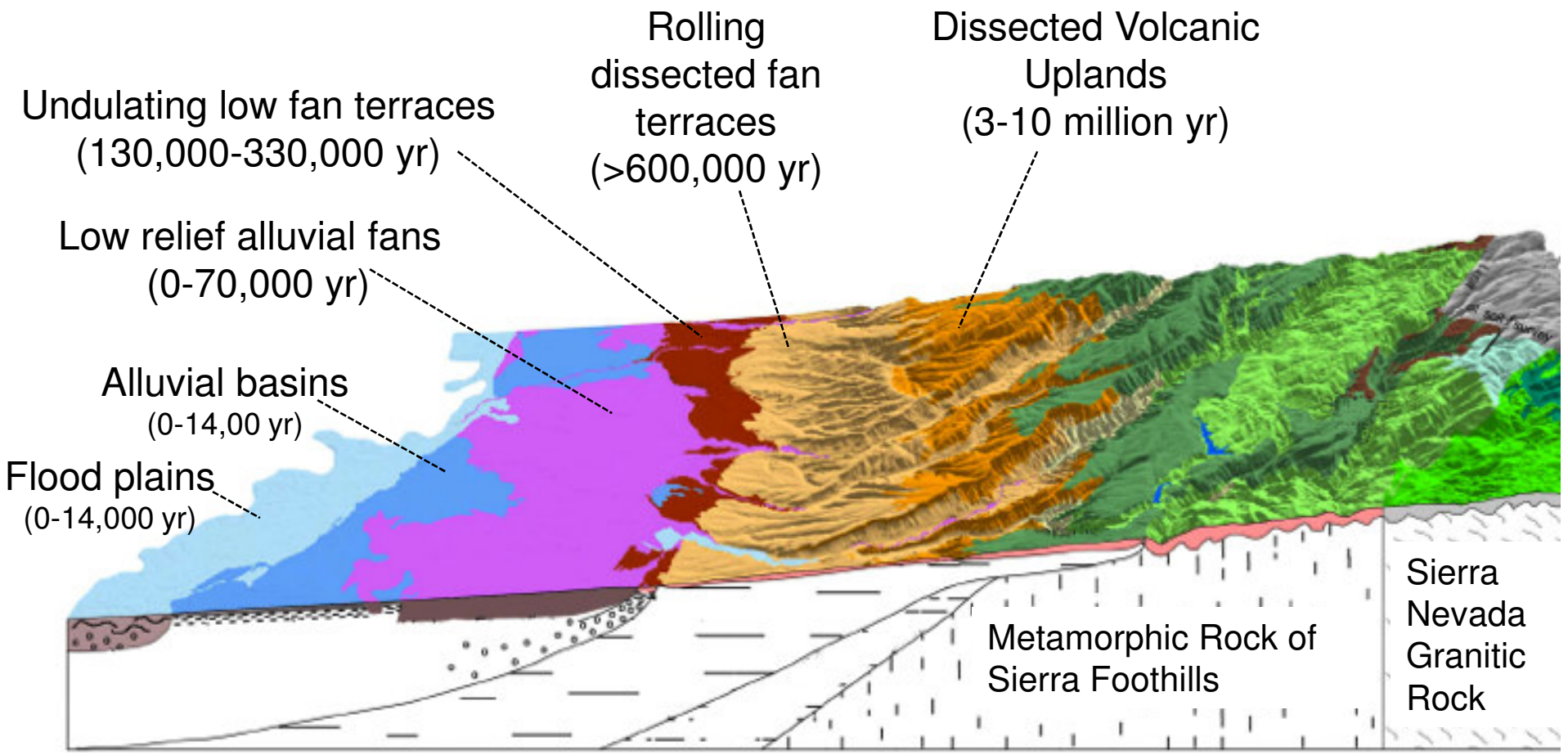
Potassium chloride (KCl)	solid	0-0-60
	solution	0-0-10
Potassium sulfate ($K_2SO_{4)}$	solid	0-0-50-18S
	solution	0-0-6
Potassium thiosulfate – KTS ($K_2S_2O_3$)	solution	0-0-25-17S (acid reaction)

Others: Potassium nitrate, K-Mg sulfate, K/NH_4 phosphate, manure-based composts

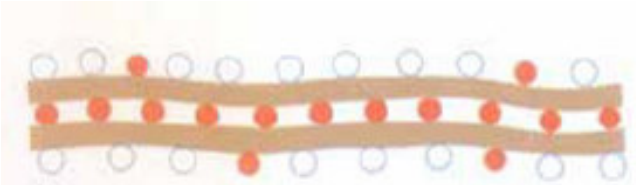
K applications to soil

- Historically very wide range of K rates recommended: 30 to >1500 lb K_2O/acre)
- K moves to roots by diffusion – very short distance
- Late season deficit irrigation under drip can reduce root uptake – when K demand is high
- Drip fertigation appears to be an efficient way to supply K to vines – much lower rates required
- ***Few K fertilizer rate studies published***

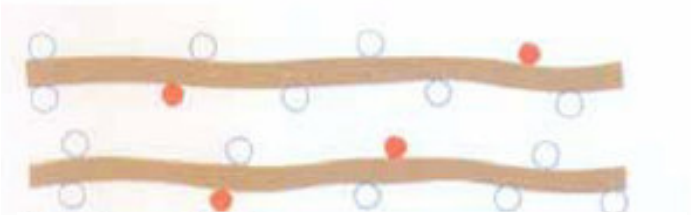
Generalized Geomorphic Model of Alluvium in the San Joaquin Valley, CA



Effects of clay minerals on the fate of K



Vermiculite-intermediately weathered soils

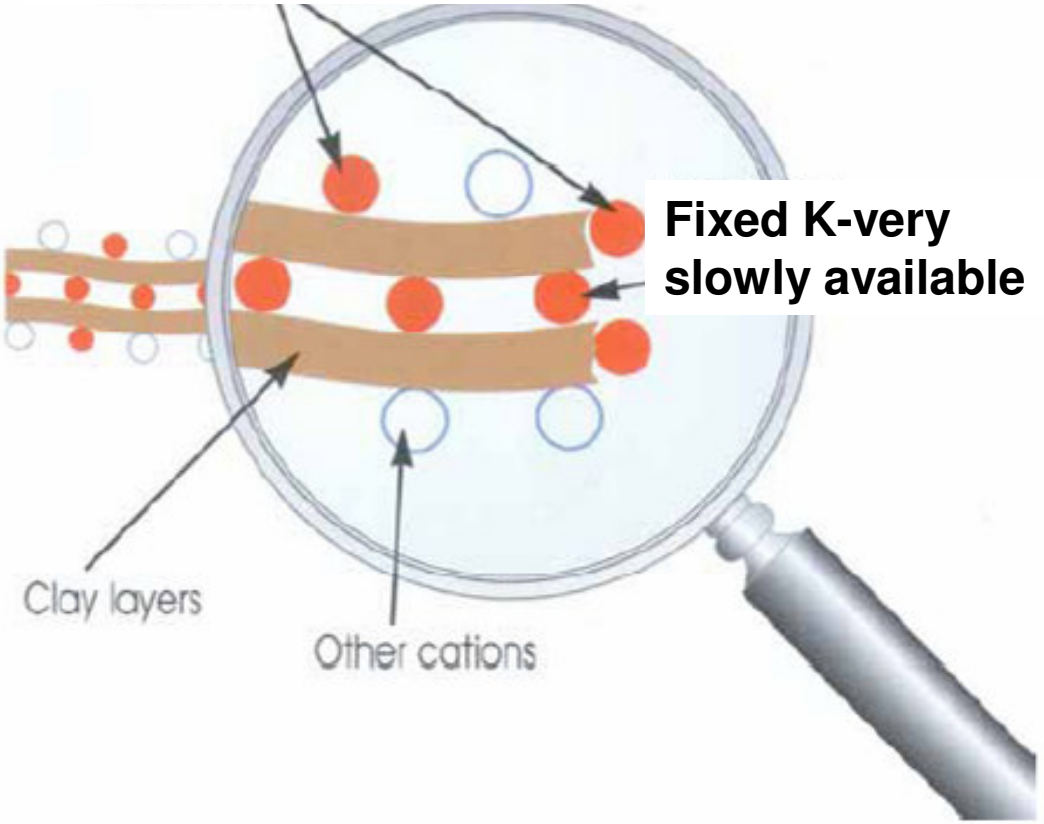


Smectite-shrink swell clays

Kaolinite-old, highly weathered soils

Potassium ions
Other cation
Clay mineral

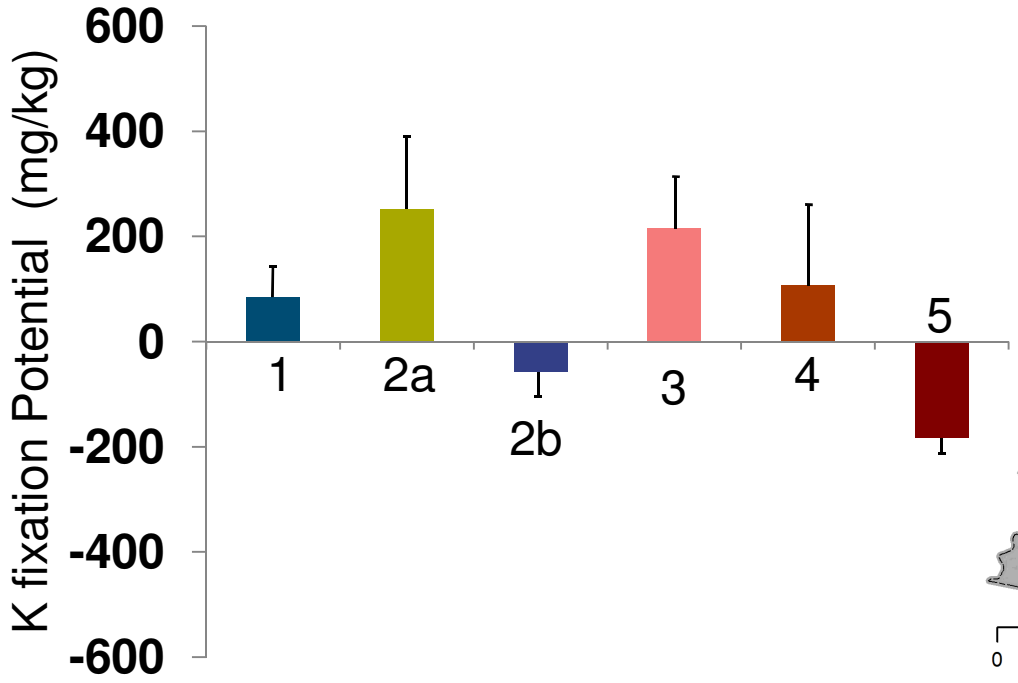
Exchangeable K on clay surface & edges

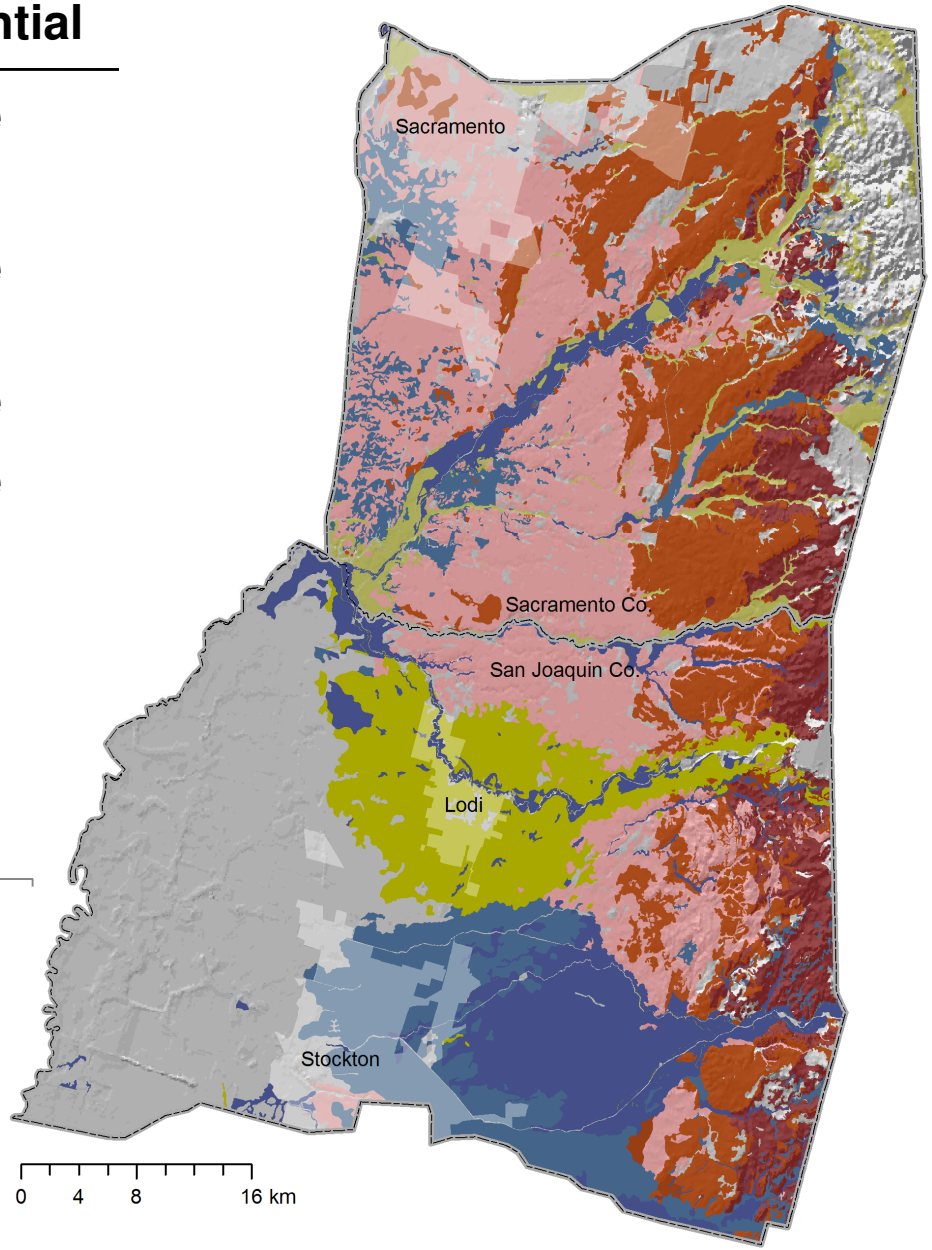


Source: Potash for heavy soils, 1999 (PDA publication)

Summary Map and Validation

Region	Exchangeable K	K Fixation potential
1	High	None
2a	Low	Mod.
2b	Mod.	None
3	Low	High
4	Mod.	None
5	High	None

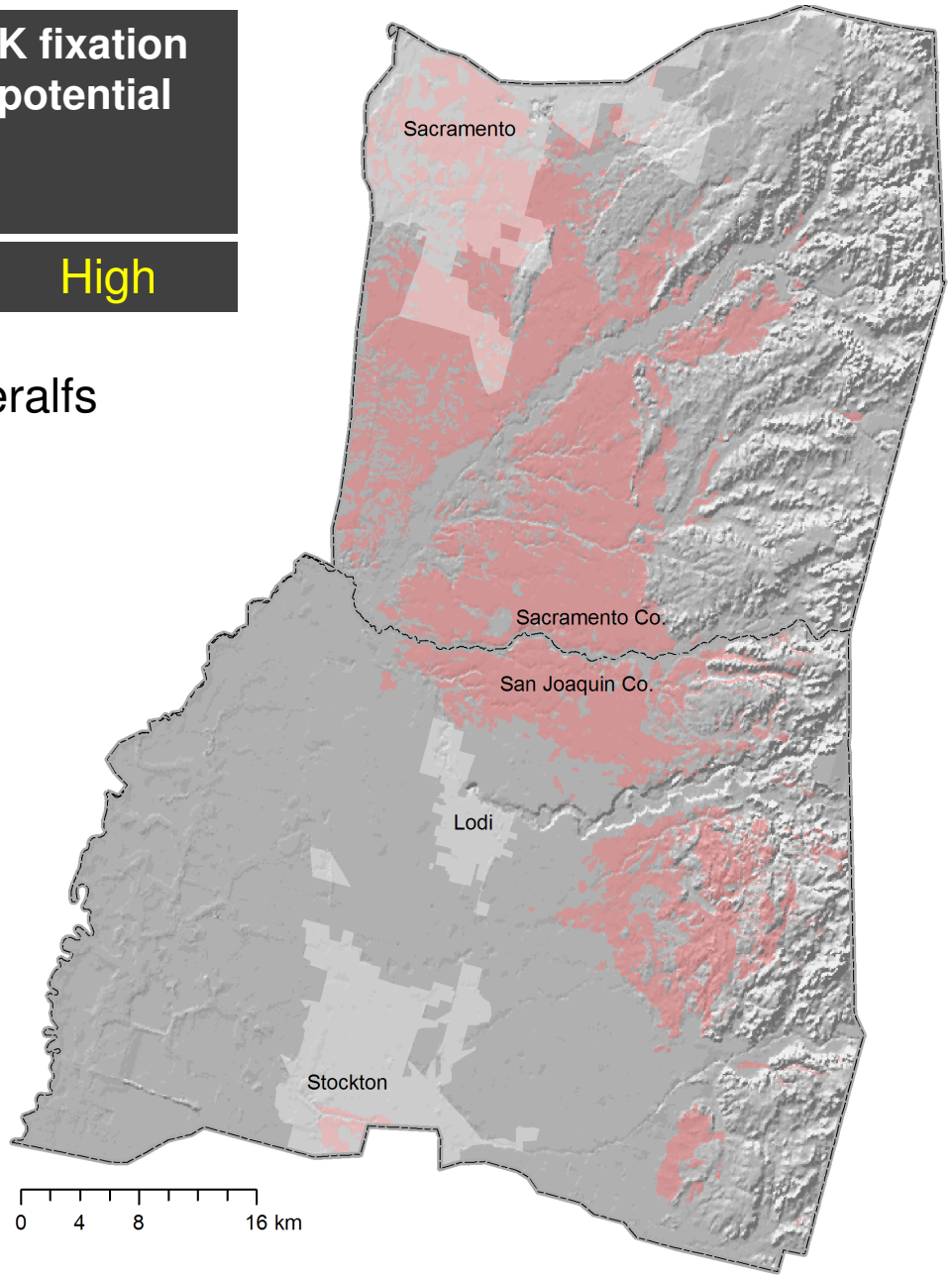




Region 3: Undulating, low fan terraces

K-rich weatherable minerals	Weathering intensity	Exchangeable K	K fixation potential
Moderate	Moderate	Low	High

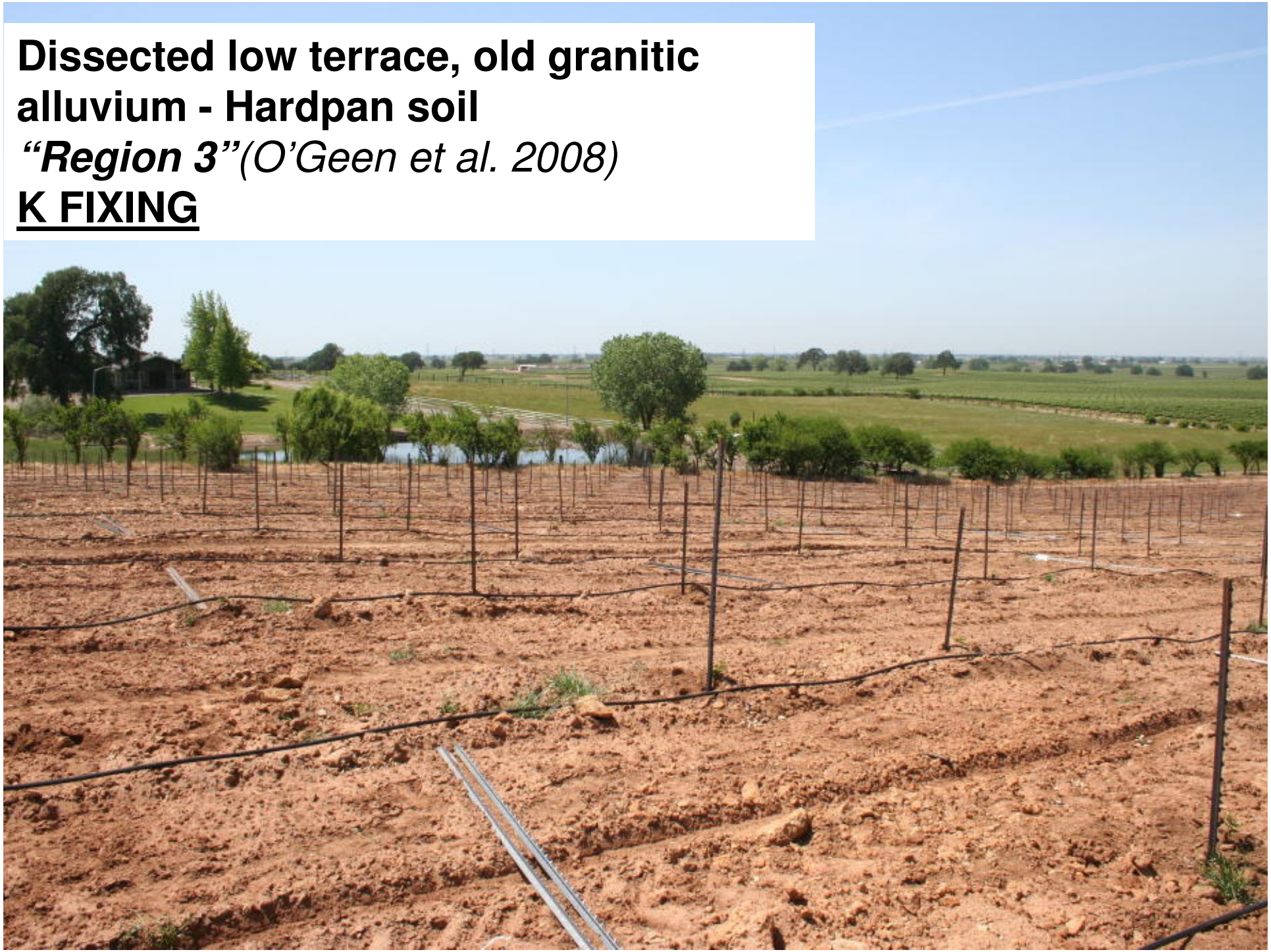
3. Durixerepts, Durixeralfs, and Palexeralfs developed from granitic alluvium



Dissected low terrace, old granitic alluvium - Hardpan soil

"Region 3"*(O'Geen et al. 2008)*

<u>K FIXING</u>



Soil K fixation in Lodi winegrape district:

Summary of profiles from 141 locations in 36 vineyards

(2006-09 -- Pettygrove, Southard, O'Geen, and Minoshima, UC Davis)

Landscape position	*K-fixing*	*Location-dependent*	*Non K-fixing*
Fine textured alluvial basin	Dierssen, Guard, Scribner	Archerdale, Hollenbeck	Galt, Stockton, Clearlake
Flood plain low relief alluvial fans	Sailboat	Tokay, Columbia	Tujunga, Acampo, Kingdon
Rolling, dissected low fan terraces	San Joaquin, Yellowlark, Kaseberg	Montpellier, Cometa, Bruella	Madera, Alamo
Rolling dissected higher fan terraces		Redding	
Dissected volcanic uplands			Pentz, Bellota

Site 1 **San Joaquin loam**

K fixation potential: HIGH

Depth *inches*	K soil test *ppm*	K fixation	
		ppm	*lb K_2O/acre-8 inches*
0-8	133	0	0
8-16	62	126	361
16-24	59	161	455

Site 2 **Tokay sandy loam**

K fixation potential: LOW

Depth *inches*	K soil test *ppm*	K fixation	
		ppm	*lb K_2O/acre-8 inches*
0-8	213	0	0
8-16	117	0	0
16-24	86	5	14

Rootstock capacity to provide K to vines

High K rootstocks[1,2]		**Low K rootstocks**[1,2]	
	Vigor rating[1,2]		*Vigor rating*[1,2]
Freedom	H	420A*	L
St. George	H	110R*	M/H
1616C	L	5BB*	M
039-16	H	5C*	L/M
SO4*	L/M	1103P*	H
		140Ru	H

* *V. berlandieri* parentage

[1] *Winegrape Varieties in California.* 2003. UC ANR Pub 3419
[2] Lambert et al., 2008. California Agriculture, 62(4):202-207.

Soil K fixation mapping could be useful for

- Selection of rootstock or scion variety
- Assessing need for high rates of K
- Design of drip irrigation system (e.g., arrangement of independently controlled blocks)
- Delineation of petiole sampling and monitoring zones within vineyards

2009 UC K fertilizer experiments

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Site 1 – San Joaquin silt loam
Site 2 – Tokay fine sandy loam

PLOT MAP – TOKAY SOIL SITE

1 plot = 3 rows x 20 vines

A 5	C 6	X 15	D 16
B 4	D 7	D 14	C 17
X 3	B 8	A 13	B 18
D 2	A 9	B 12	A 19
C 1	X 10	C 11	X 20

Trtmt	K applied April	K apply in June	K apply post harv	2009 Total K
	----------*lb/K_2O/acre*----------			
A, X	0	0	0	0
B	30	0	0	30
C	30	30	0	60
D	45	45	0	90

- Syrah on 110R (Tokay soil) or Freedom (San Joaquin soil)
- K fertilizer = KTS, 0-0-25 under emitters or through drip system

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Measure

- Yields
- Cluster weights
- Pruning wts
- Petiole K
- Soil K levels
- Fruit properties

K fertilizer plots – 2009 results

San Joaquin and Tokay sites

No effects of K applications at either site on

- *Fruit yield or cluster weights*
- *Pruning weights*
- *Berry K, pH, brix, titratable acidity*

Slight increase in petiole K at veraison

Petiole K at veraison

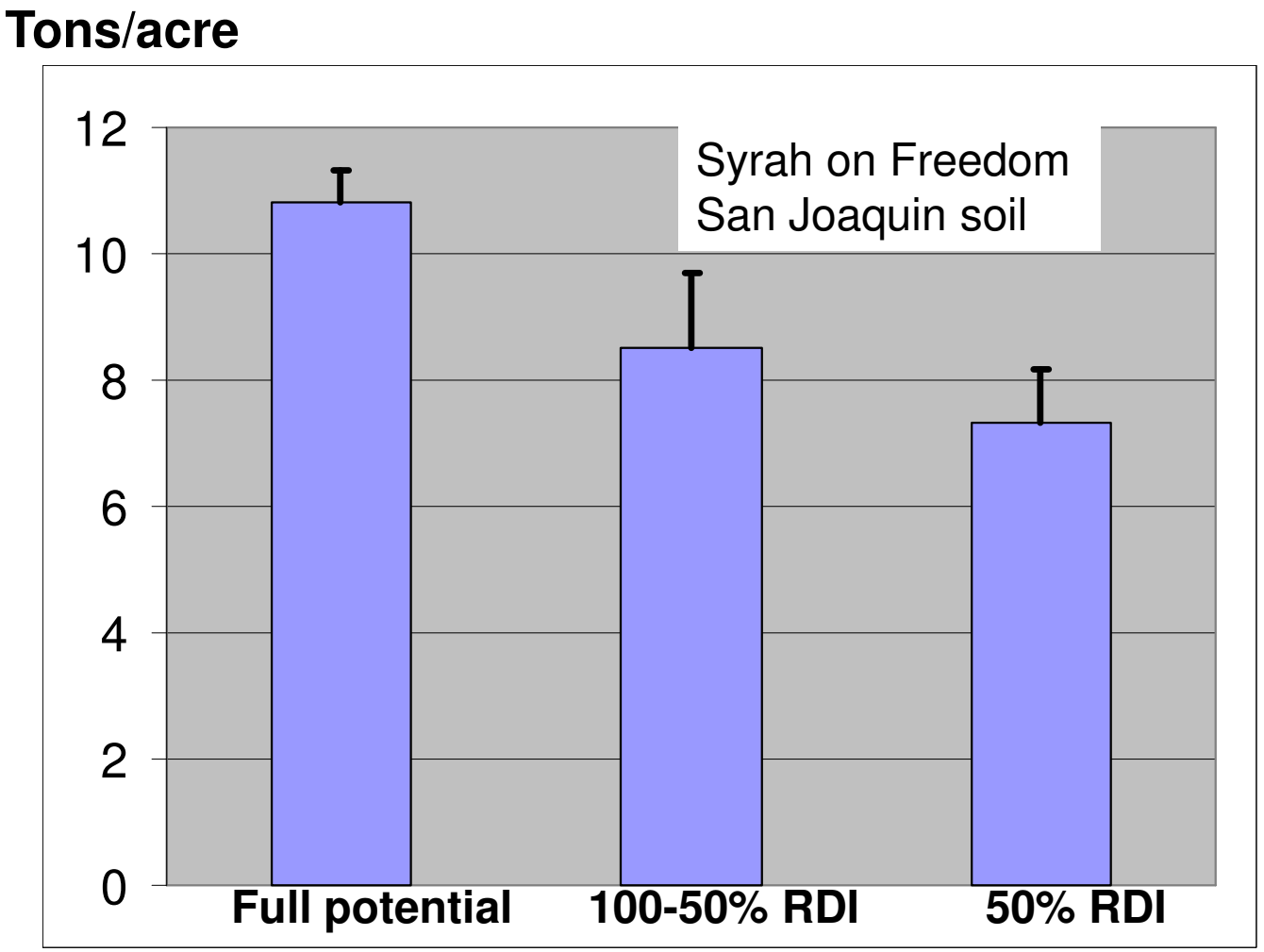
2009 – first year of experiment

K fert applied	K fix soil (San Joaquin)	Non K fix (Tokay)
lb K_2O/A	*%*	*%*
0	2.9	2.9
30	3.1	2.9
60	3.4	3.4
90	3.3	3.2

Critical value at mid-summer = **0.8% K** (*UC Pub 4087)*

At the San Joaquin soil vineyard, there were strong residual effects of deficit irrigation treatments imposed by UC researchers during 2005-08.

Residual impact of 2005-08 deficit irrigation treatments on 2009 fruit yield at San Joaquin site



2005-2008 irrigation treatments (T. Prichard)

Summary

- K fixation is a significant property of some vineyard soils in the district, but its significance for winegrape production is not understood.
- We have established experiments in 2 commercial vineyards (and will add 1 more) to determine whether
  - K-fixing and non K-fixing soils require different K fertilization practices
  - Typical K rates applied by drip are adequate for K-fixing soils
  - Excess K is a problem in the region

UC Research Team

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Support

- Lodi Winegrape Commission
- LWC Research Committee
- Lodi district grape growers and crop consultants
- Pacific Agri Lands
- Gallo
- Wilbur-Ellis Co.