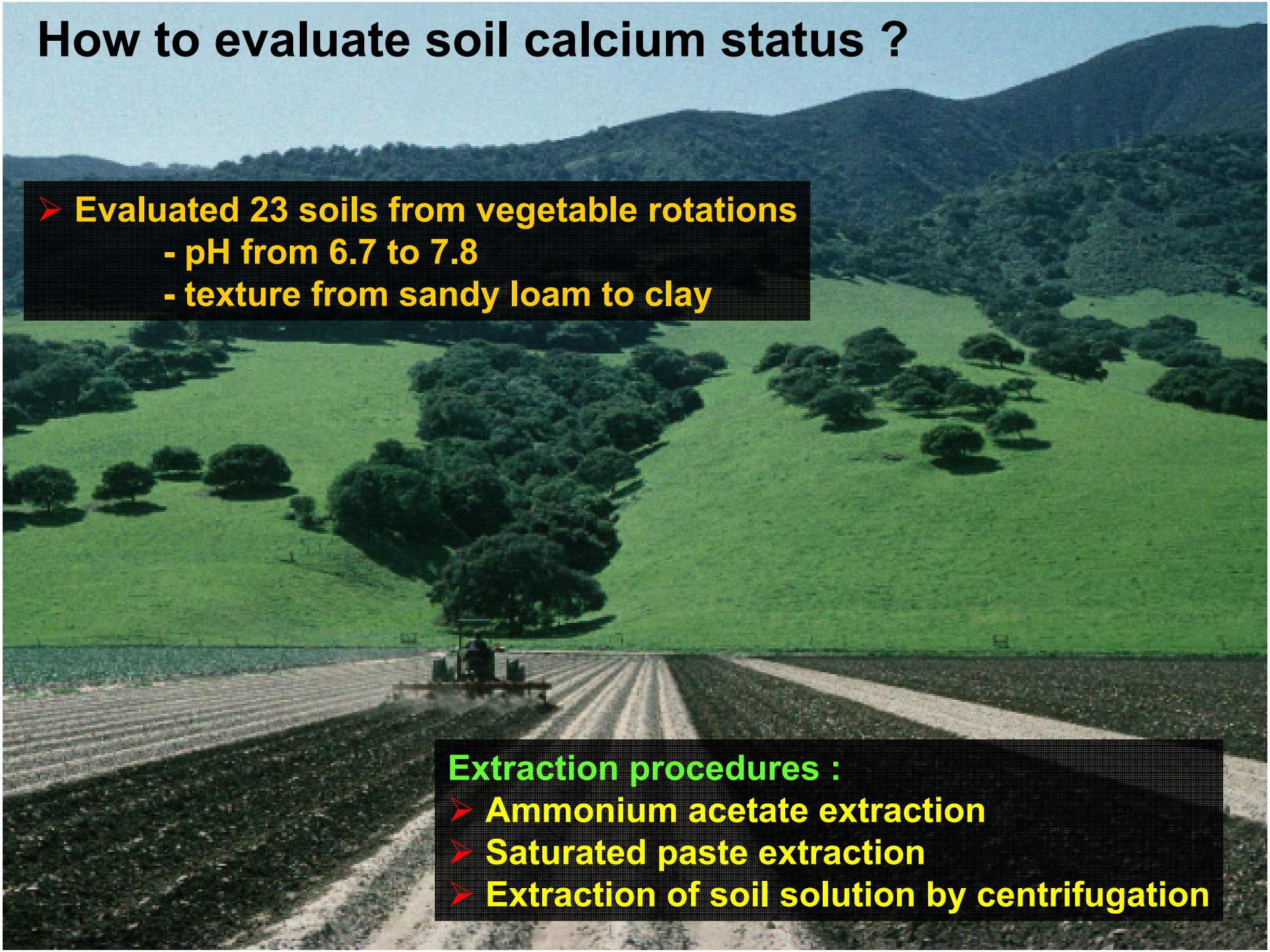
Soil calcium availability and lettuce tipburn
Are they related ?
Can tipburn be controlled ?

Thanks to :
Mike Cahn and Richard Smith

How to evaluate soil calcium status ?



- Evaluated 23 soils from vegetable rotations
  - pH from 6.7 to 7.8
  - texture from sandy loam to clay

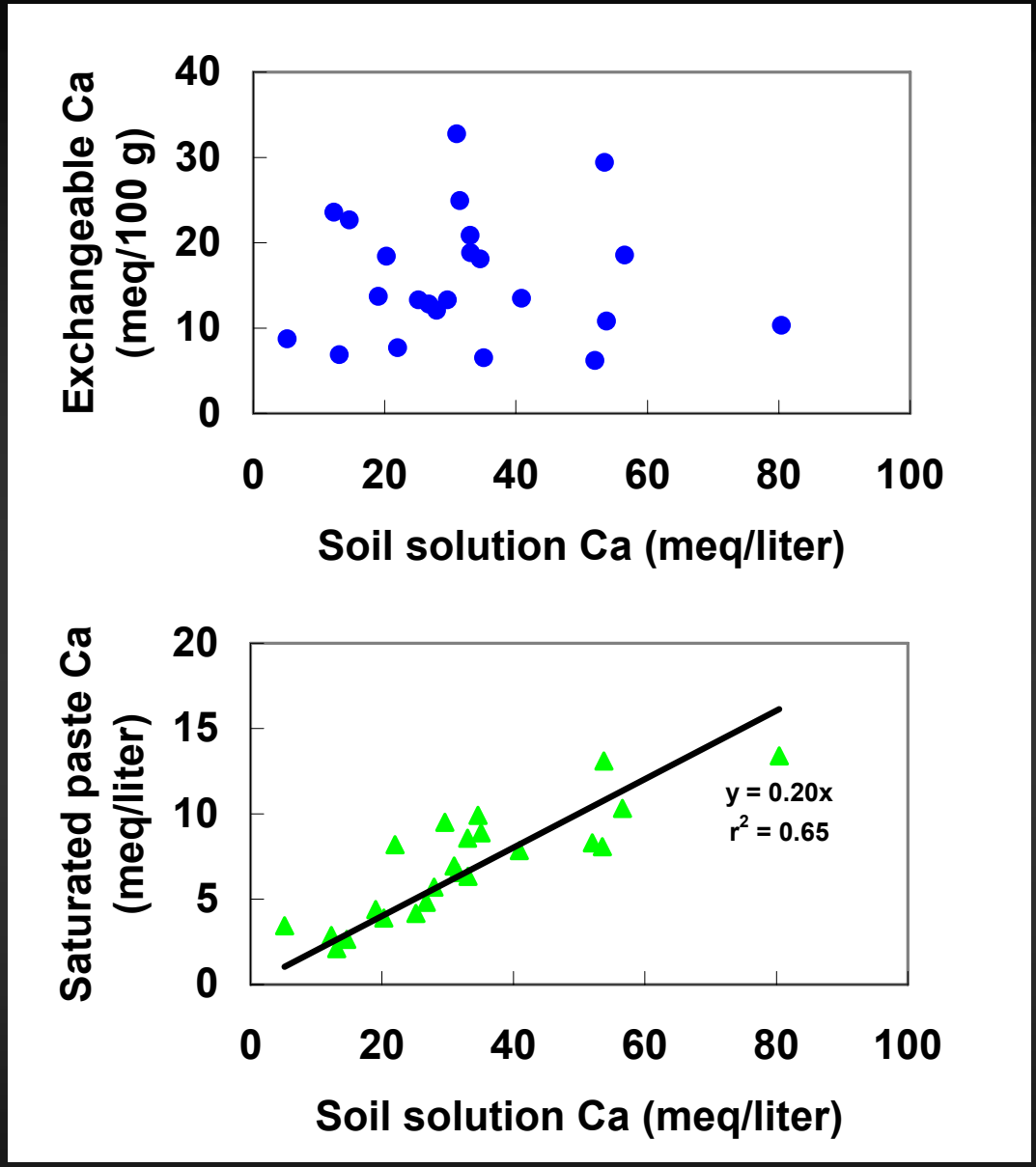
Extraction procedures :

- Ammonium acetate extraction
- Saturated paste extraction
- Extraction of soil solution by centrifugation


40
35
30
25
20
15
10
7.5
5

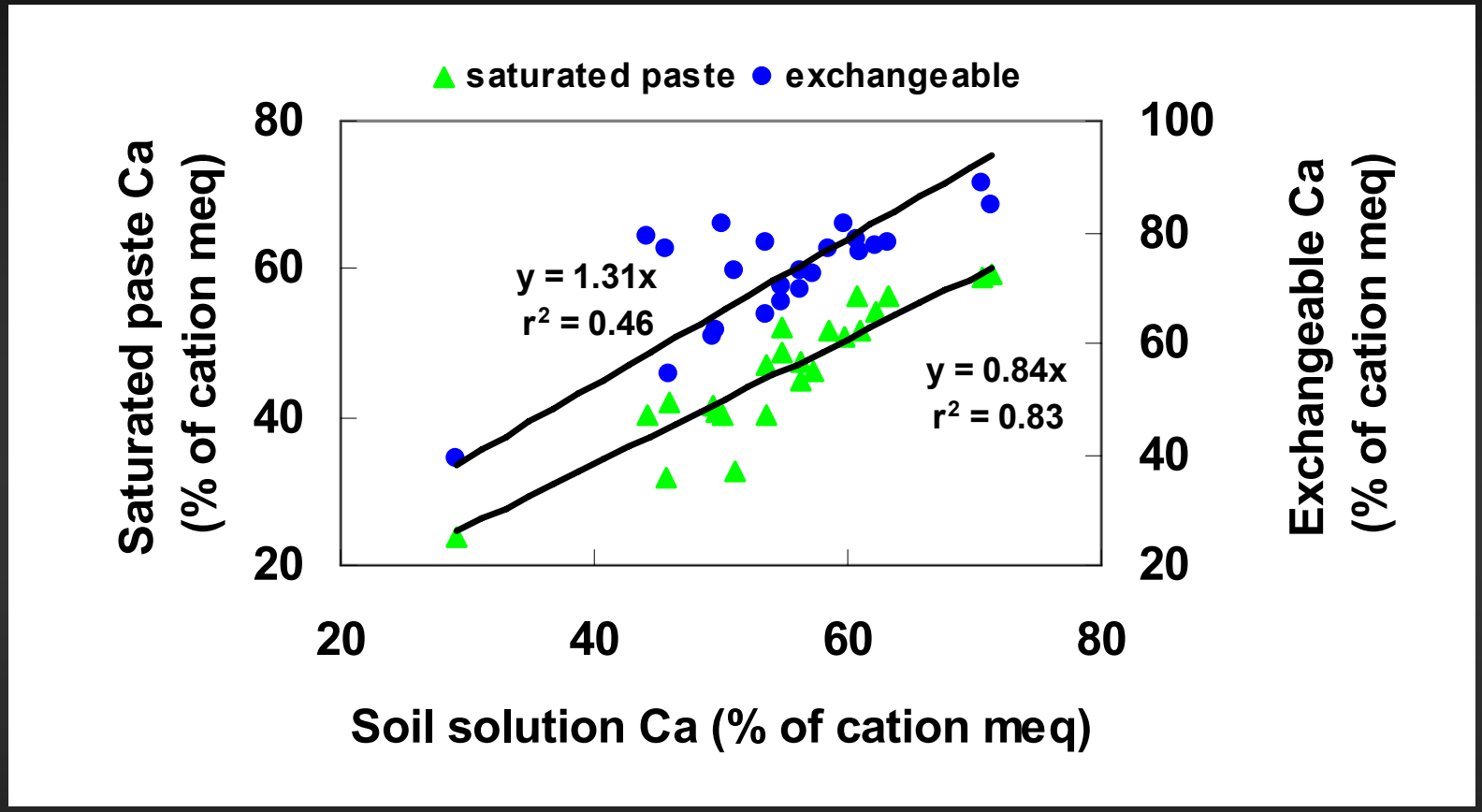

OPEN
0.00
SORVALL LEGEND RT


SARSTEDT
SARSTED

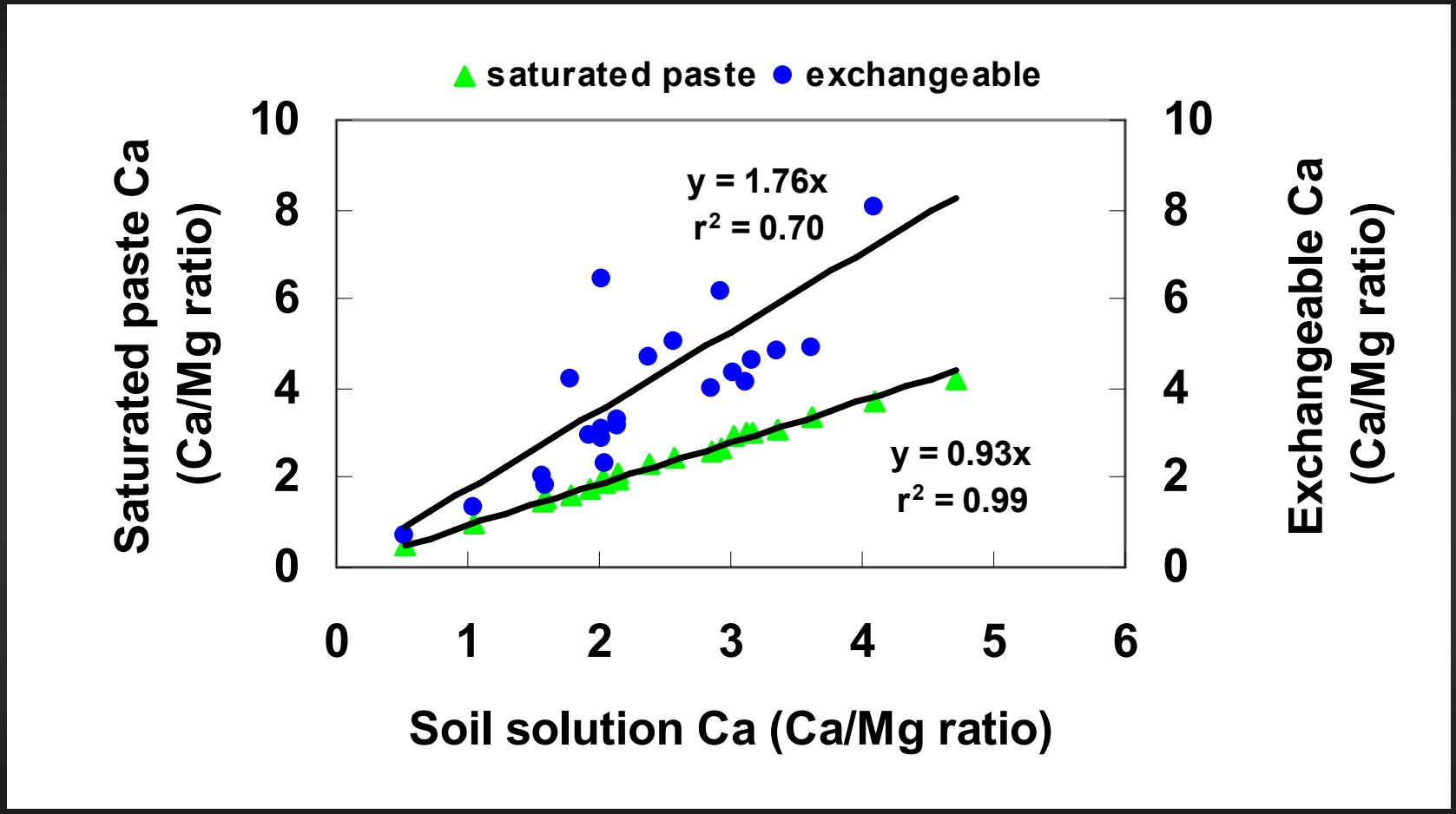


1 meq Ca / liter = 20 PPM

greenhouse nutrient solutions typically 5 – 10 meq/liter Ca



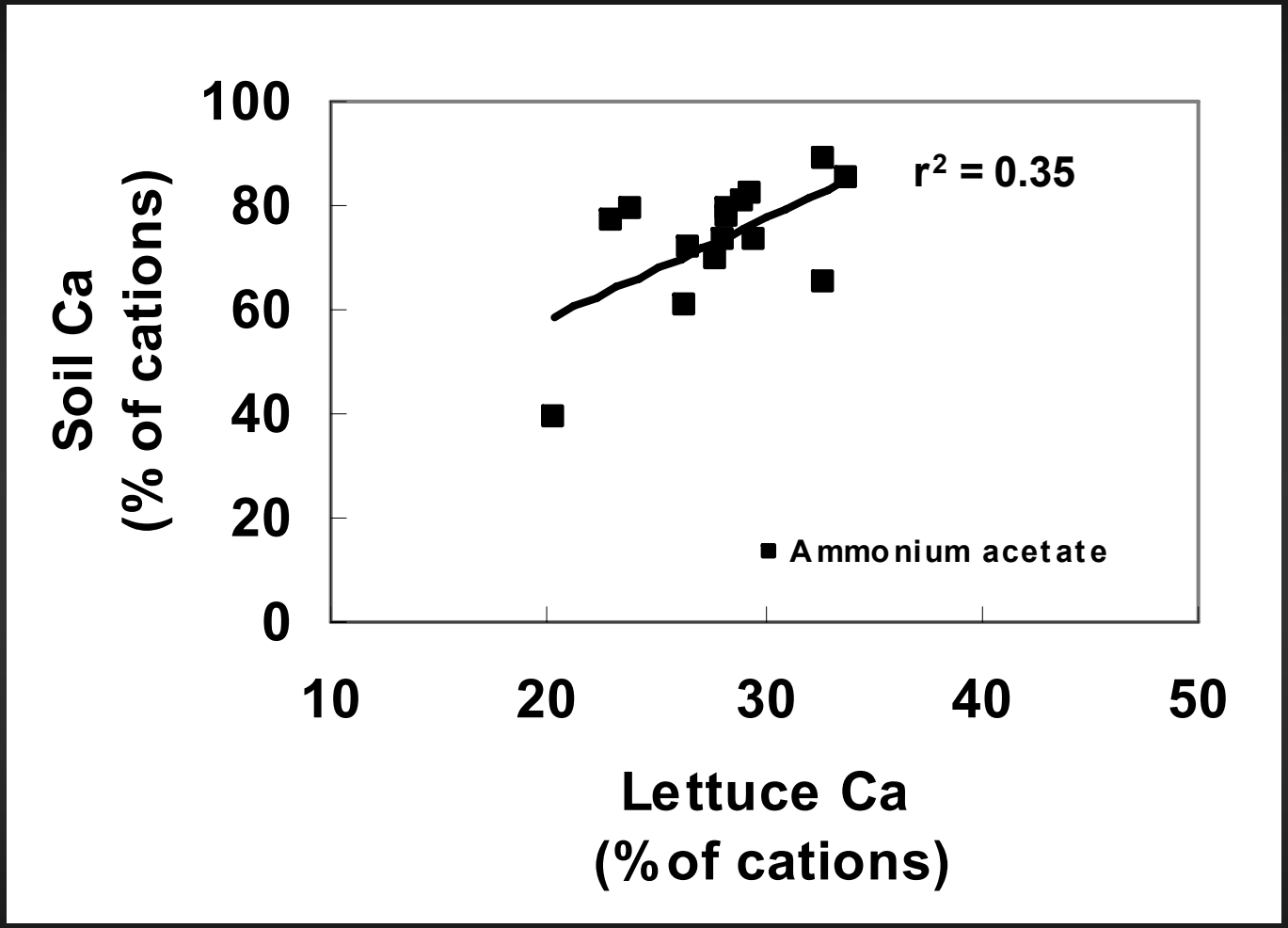
Greenhouse nutrient solutions typically 30-50% Ca on meq basis

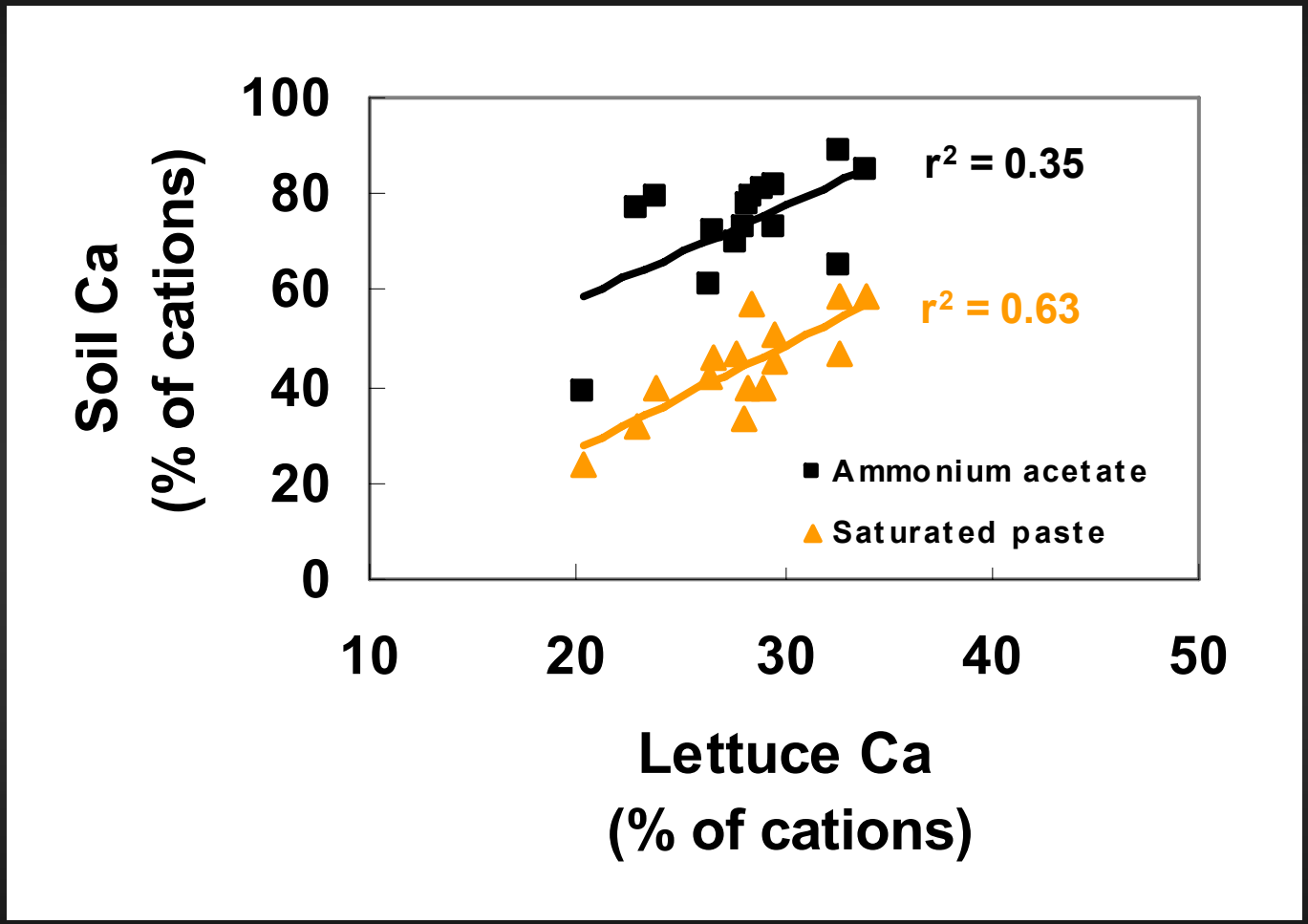

saturated paste
exchangeable
Saturated paste Ca (Ca/Mg ratio)
Exchangeable Ca (Ca/Mg ratio)
y = 1.76x
r2 = 0.70
y = 0.93x
r2 = 0.99
0
2
4
6
8
10
0
1
2
3
4
5
6
Soil solution Ca (Ca/Mg ratio)

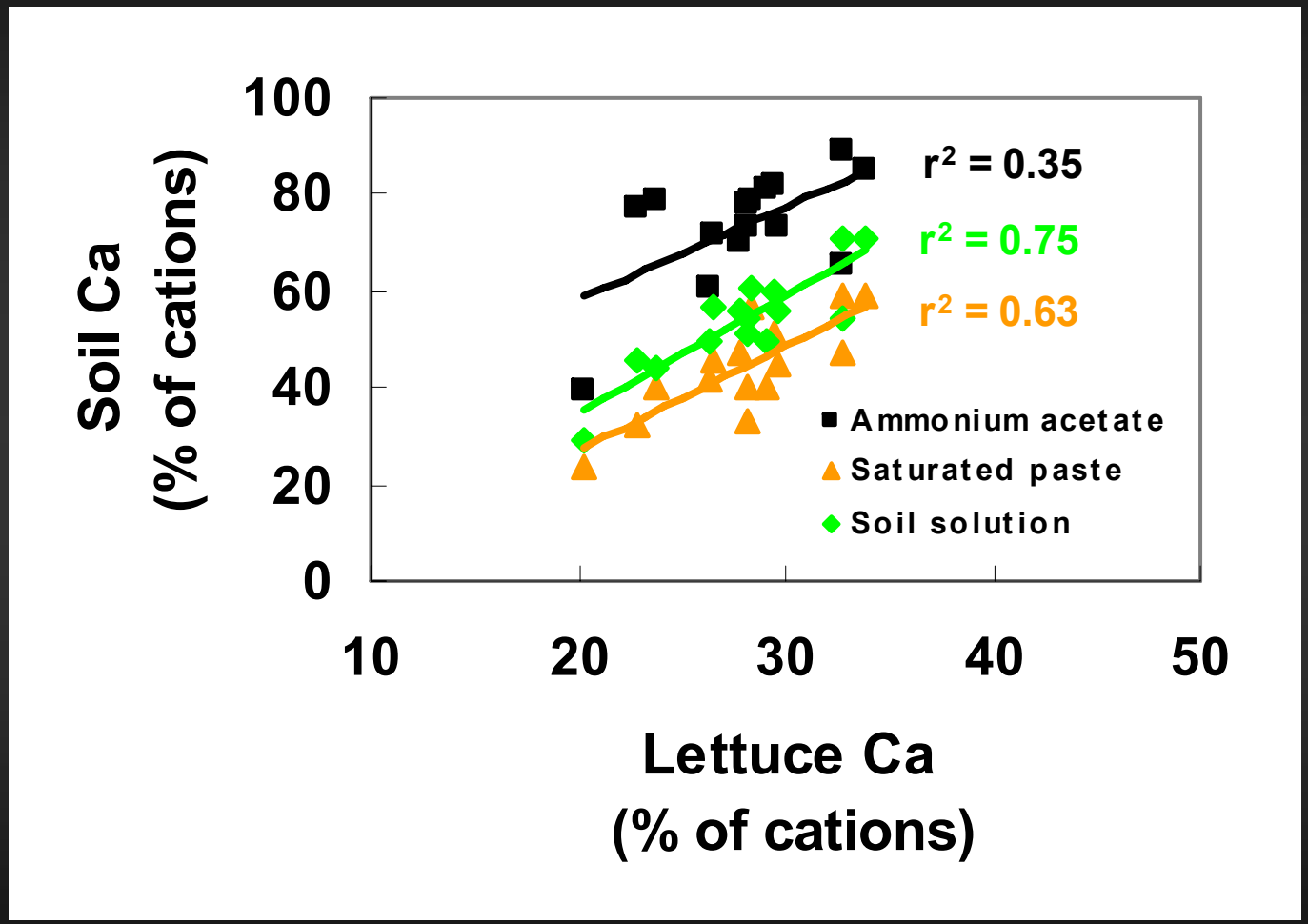
What soil test best predicts plant Ca uptake ?

Greenhouse assay :

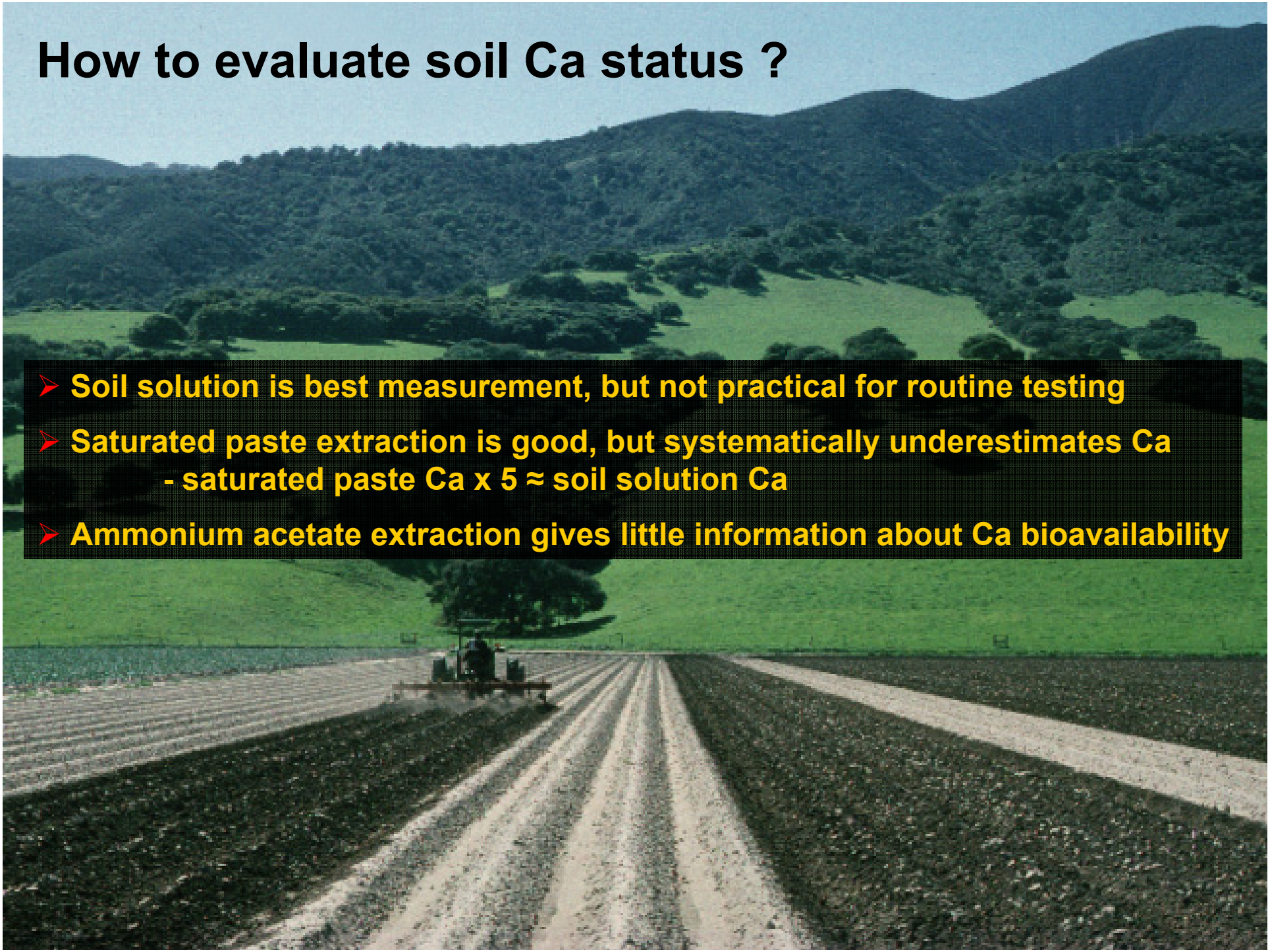
- **15 field soils**
- **romaine lettuce grown for 6 weeks**
- **whole plant cation uptake determined**


Soil Ca
(% of cations)
100
80
60
40
20
0
10
20
30
40
50
Lettuce Ca
(% of cations)
r2 = 0.35
Ammonium acetate


Soil Ca
(% of cations)
100
80
60
40
20
0
10
20
30
40
50
Lettuce Ca
(% of cations)
r2 = 0.35
r2 = 0.63
Ammonium acetate
Saturated paste


Soil Ca
(% of cations)
100
80
60
40
20
0
10
20
30
40
50
Lettuce Ca
(% of cations)
r2 = 0.35
r2 = 0.75
r2 = 0.63
Ammonium acetate
Saturated paste
Soil solution

How to evaluate soil Ca status ?

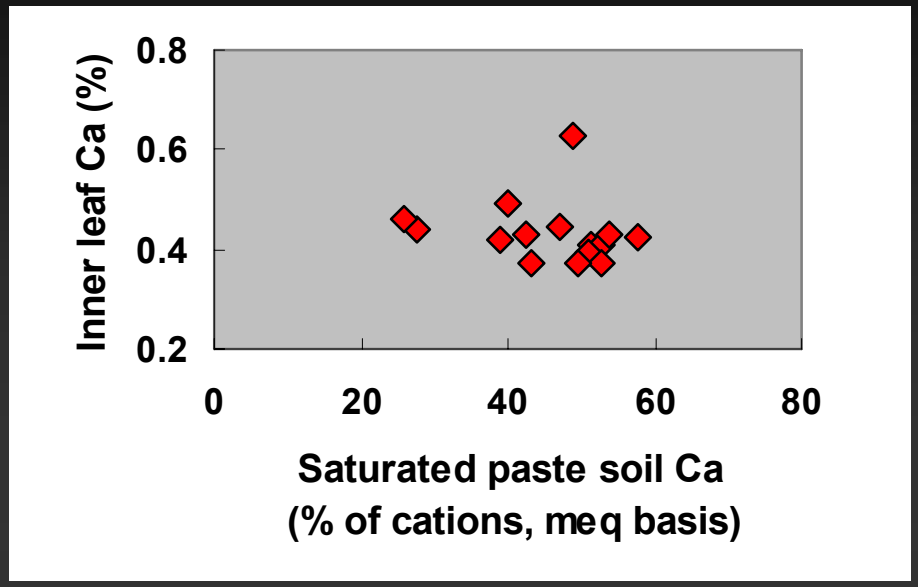


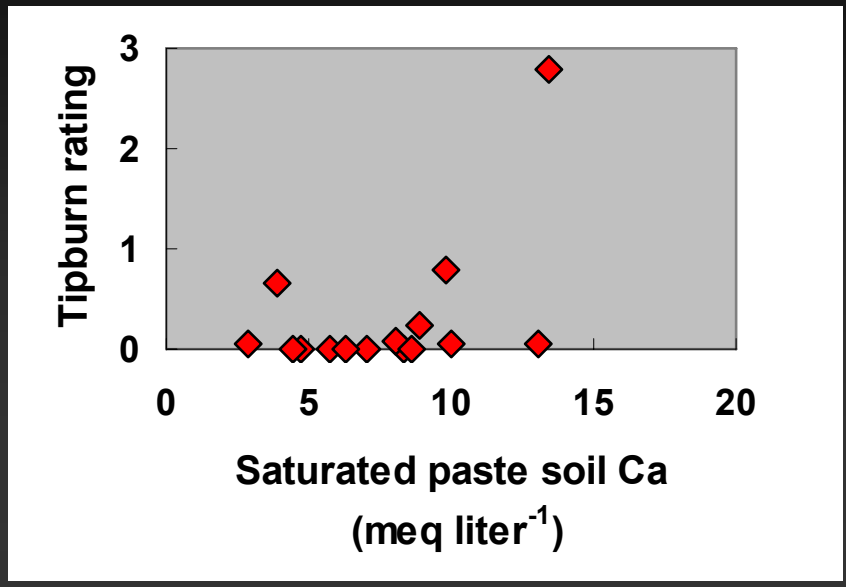
- Soil solution is best measurement, but not practical for routine testing
- Saturated paste extraction is good, but systematically underestimates Ca
  - saturated paste Ca x 5 ≈ soil solution Ca
- Ammonium acetate extraction gives little information about Ca bioavailability

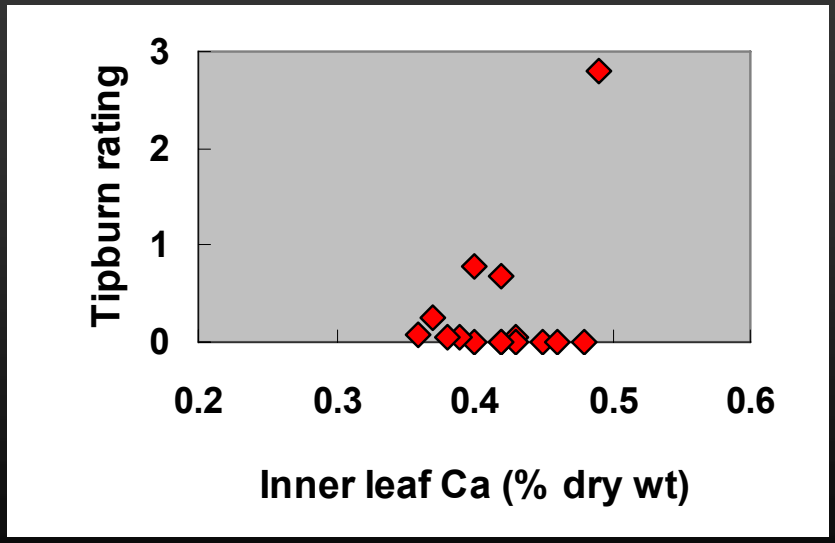
Calcium effects on tipburn of romaine lettuce :

Survey of 15 commercial fields for tipburn severity, and soil and plant Ca

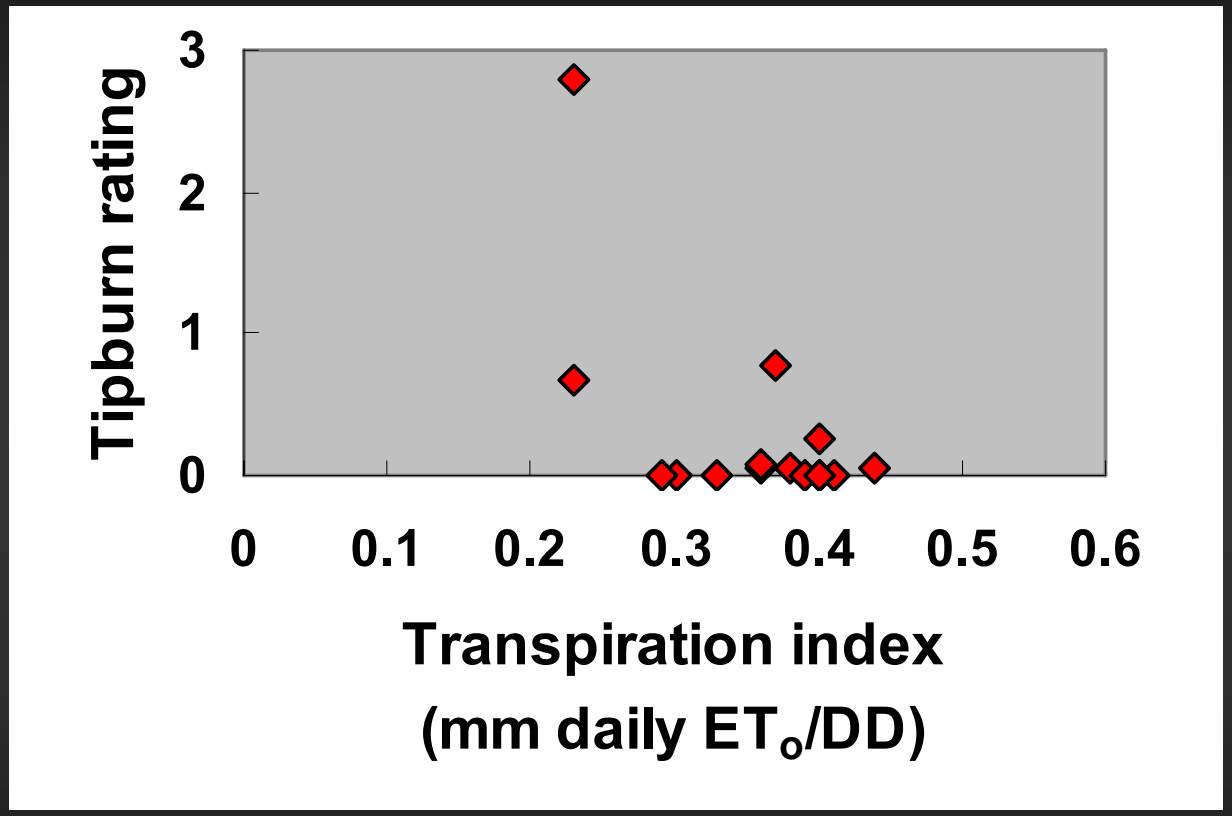
- saturated paste soil Ca
- Ca concentration of inner leaves
- tipburn severity (mean number of affected leaves / plant)


Inner leaf Ca (%)
0.8
0.6
0.4
0.2
0
20
40
60
80
Saturated paste soil Ca
(% of cations, meq basis)


Tipburn rating
3
2
1
0
0
5
10
15
20
Saturated paste soil Ca
(meq liter-1)

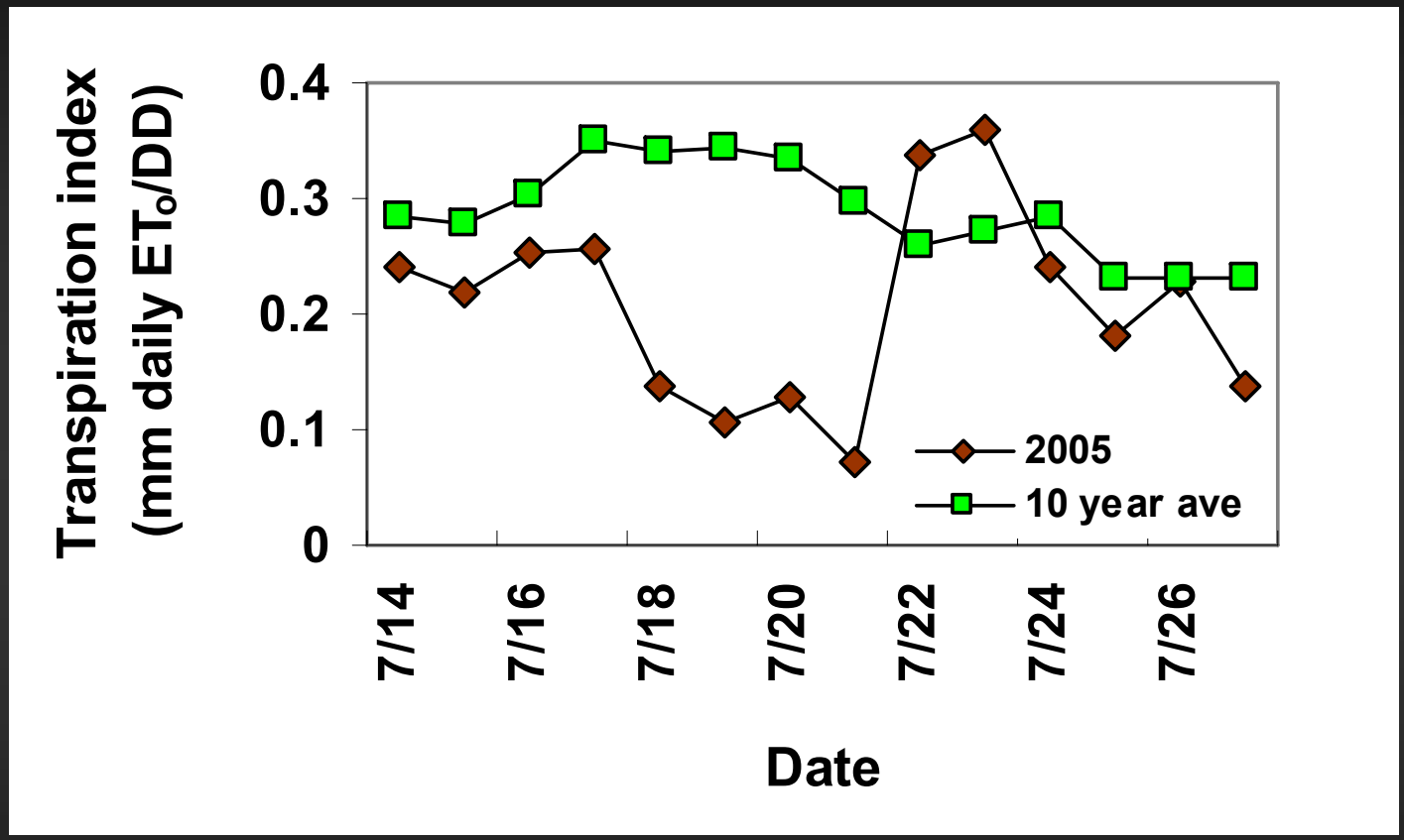

Tipburn rating
3
2
1
0
0.2
0.3
0.4
0.5
0.6
Inner leaf Ca (% dry wt)

If not soil Ca status, what drives tipburn ?



- ✓ Daily ET_o / GDD = transpiration per unit of growth potential
- ✓ The lower the transpiration rate, the greater the chance of tipburn

For the worst tipburn fields :



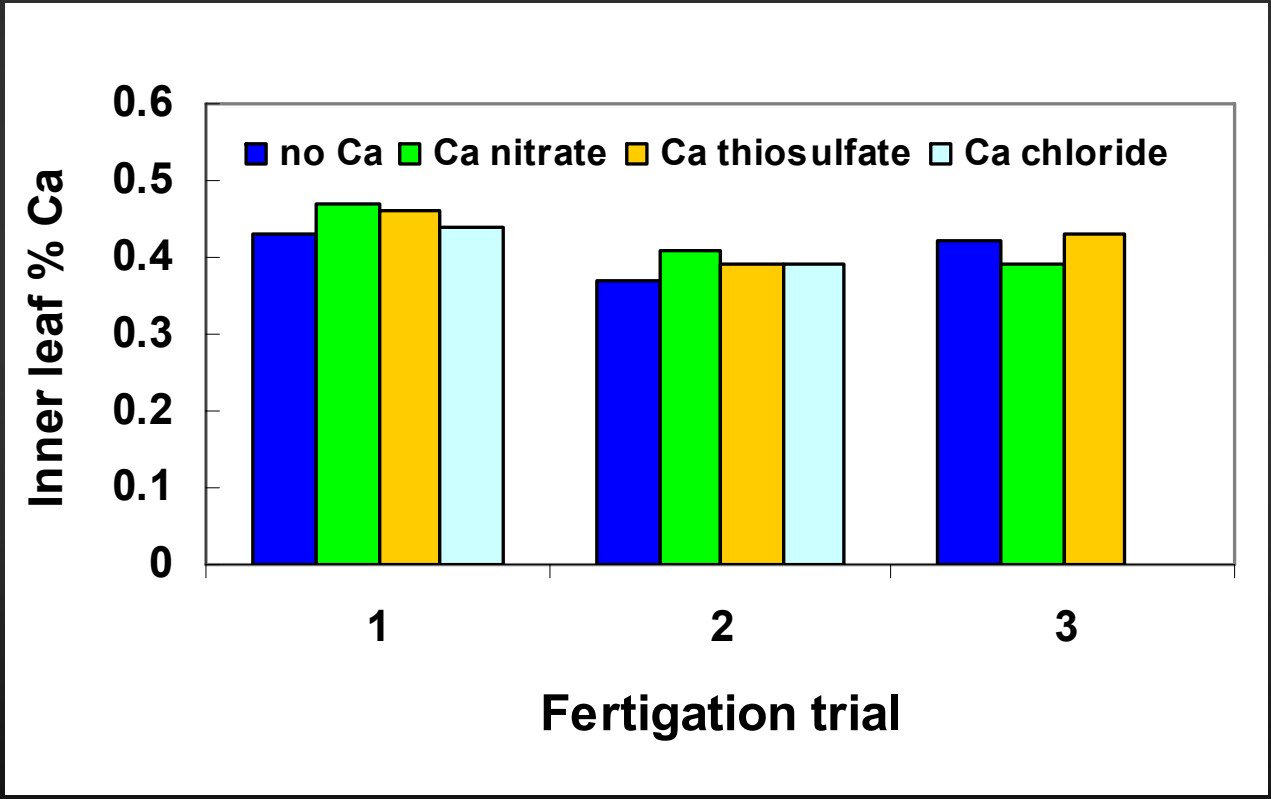
What else limits transpiration rate ?
Water stress !

Calcium fertigation trials on romaine :

- 2 trials in 2005, 1 trial in 2006
- Ca fertilizer treatments compared to no Ca control
  - calcium nitrate (CN-9)
  - calcium thiosulfate (CATS)
  - calcium chloride ($CaCl_2$)
- 15 lb Ca/acre fertigated 14 and 7 days preharvest in 2005
- 25 lb Ca/acre fertigated 7 days preharvest in 2006

Results :

- No Ca effects on yield
- Tipburn incidence low, no Ca treatment effects
- No Ca treatment effects on inner leaf % Ca



Why such marginal effects from calcium fertigation ?

1) Amount applied is small in comparison to soil solution Ca

Example :

Loam soil with 6 meq Ca/liter in saturated paste extract = 120 PPM Ca

120 PPM Ca x 5 = *600 PPM Ca in soil solution*

1.5 inches available water = *200 lb Ca / acre in soil solution*

15 meq/100 g soil = *12,000 lb exchangeable Ca*

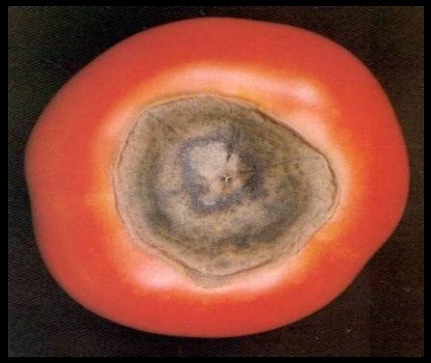
Fertigation of 15 gal / acre CAN-17 in an application of 0.25 inches of water

15 gal / acre x 1.1 lb Ca / gal = 17 lb Ca / acre

17 lb Ca / acre in 0.2 inches of water = 300 PPM Ca

Why such marginal effects from calcium fertigation ?

2) Ca disorders usually linked to restricted transpiration, therefore difficult to manage with Ca application

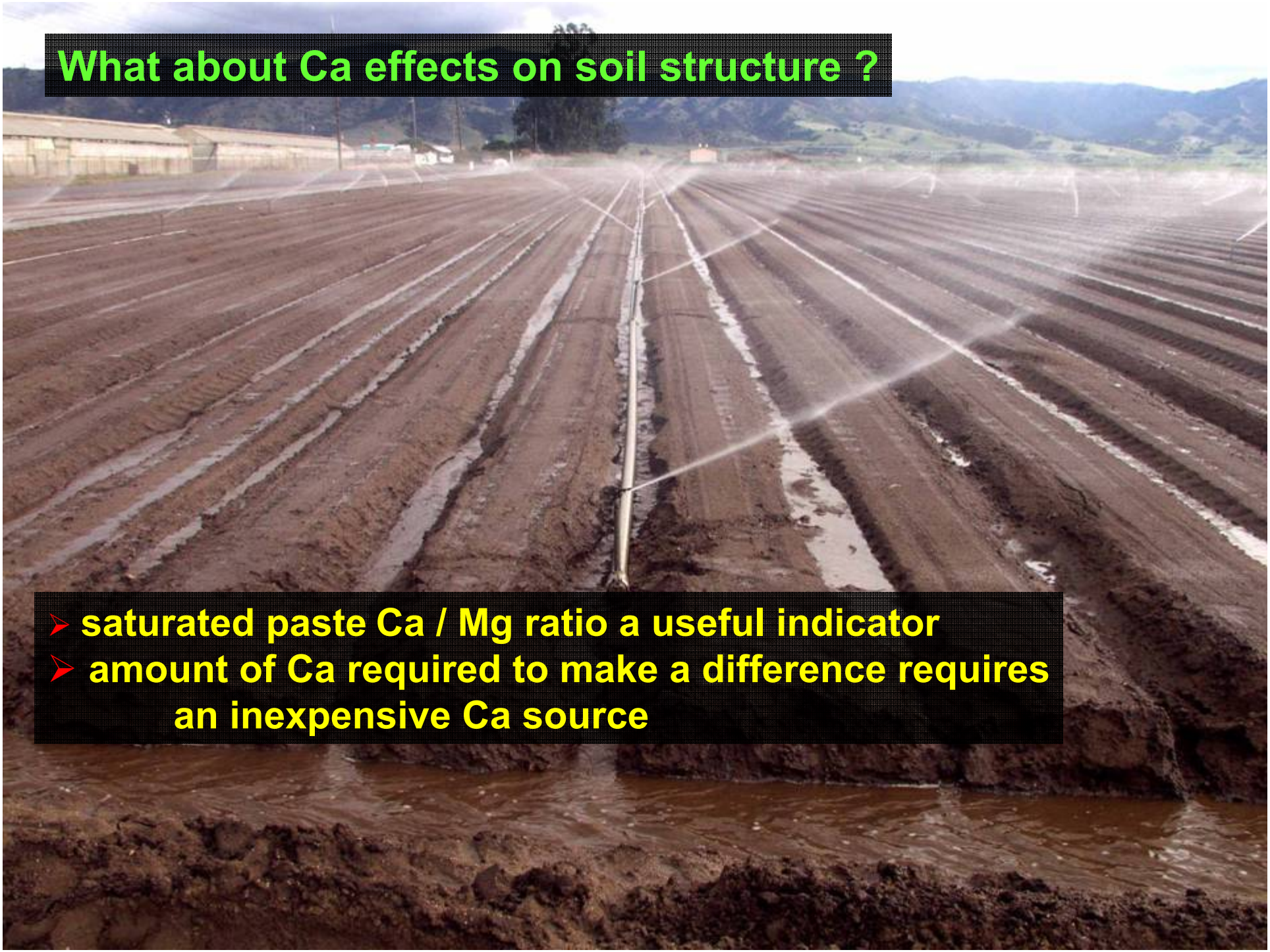


Link between transpiration and tissue Ca :

Crop	Plant part	Ca (% dry wt)
Lettuce	oldest leaf	1.5 – 2.5
	wrapper leaf	1.0 – 1.5
	inner leaf	0.4 – 0.6
Pepper	oldest leaf	2.0 – 4.0
	fruit	0.1 – 0.2

When will is Ca application most likely to be useful ?

- In coarse textured soils (low soil solution Ca)
- In soils with low Ca in saturated paste extracts
  - < 3 meq/liter
  - < 40% of cations (meq basis)
- In low pH soils



What about Ca effects on soil structure ?

- saturated paste Ca / Mg ratio a useful indicator
- amount of Ca required to make a difference requires an inexpensive Ca source

In summary :

- Saturated paste extract gives useful information on soil Ca status, but ammonium acetate extraction is of marginal value
- Tipburn is more often related to low transpirational flow than to soil Ca limitation in typical California soils
- Calcium application may improve soil physical condition, but large amounts may be required for efficacy, particularly in high CEC soils