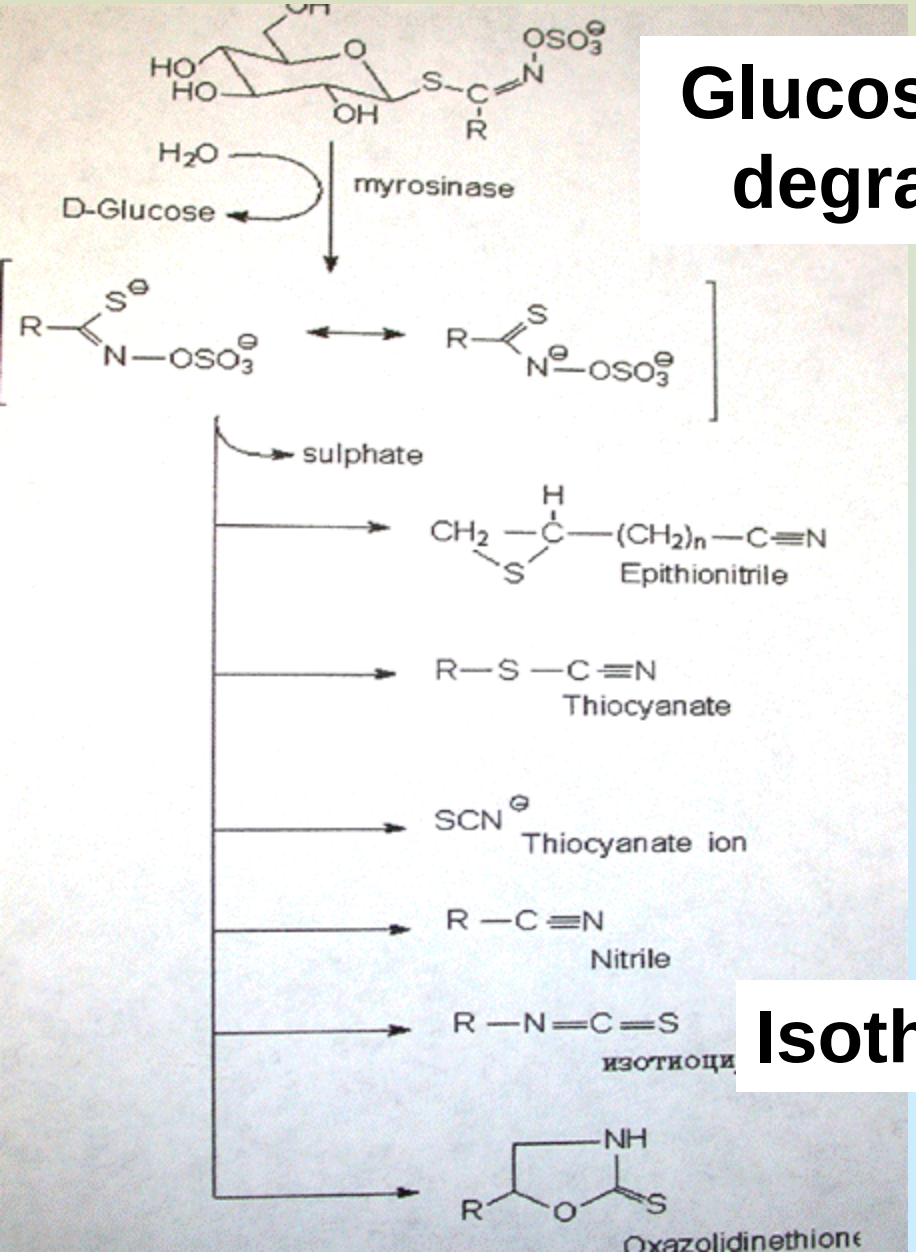
‘Biofumigation’ potential of mustards

Oleg Daugovish,
Jim Downer
Michi Yamamoto,
Maren Mochizuki,
(UCCE-Ventura)

Mustards: *Brassicaceae* family

- **Excellent weed competitors**
- **Taproot breaks compaction**
- **Abundant fast-degrading biomass**
- **Drought tolerance, plasticity**
- **Support bees and natural enemies**
- **Contain allelochemicals**

Pick your active ingredient



Glucosinolates (GSL-s degradation

Isothiocyanates (ITC-s)

ITC-s

- Methyl ITC (active ingredient of Metham Sodium/Vapam)
- Allyl-ITC
- Phenyl-ITC

And other S – containing

- Dimethyl sulfide
- Methanethiol
- Unidentified

Methyl ITC (a. i. of Metham Sodium, Vapam)

- Vapam at 75 gal/ac → 252 lb/ac ITC
- It will take 250 000 lb/ac of dry biomass of mustard (at ITC conc =1000 mg/kg) to match this
- Mustard in Ventura Co. produces 20-25,000 lb/ac (10%)
- Australia: 25%

Biofumigation

Green biomass	Seed products
High amounts of C and water	High C, 5% N
Low concentration of GSLs	High concentration of GSLs
Cheap – can be grown locally, need time to grow	Available from seed processors, often in Canada and PNW, $

Biomass:
How to make mustard ITC-s work for you?

1. High initial GSL concentration in plant
2. Break cells = release
3. Minimize losses = wet soil (aid hydrolysis)

Studies near Santa Paula, CA

5 treatments

- Faba/Bell bean
- Cereal mix
- Oriental mustard
- Yellow mustard
- Bare ground (control)

Breaking cells

Permeable bags with:

- **Citrus Nematodes**
- **Sclerotinia minor**
- **Weed seed:**

- Burclover,

- Annual ryegrass,

- Red root pigweed

Buried at: 12”

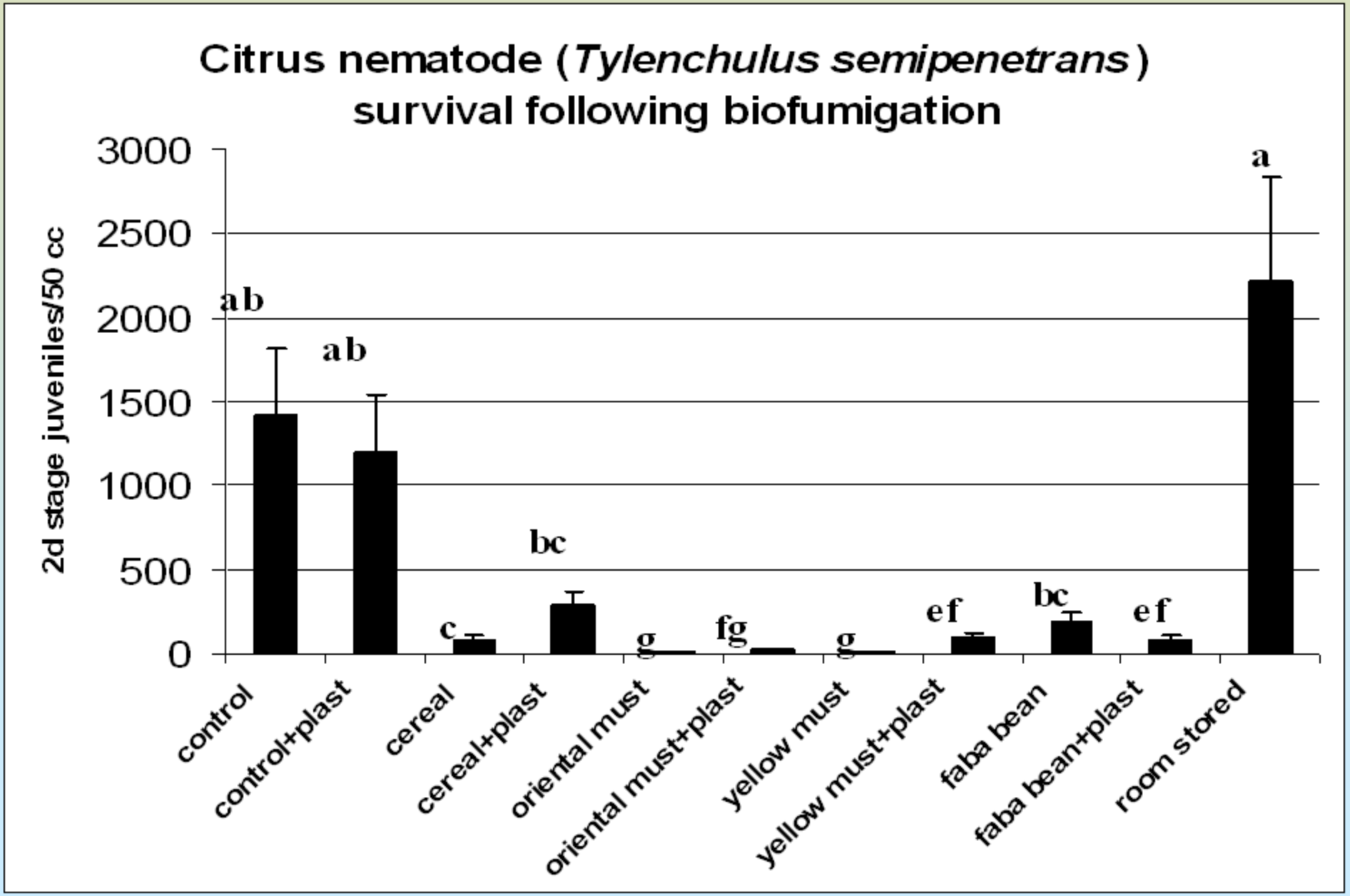
1.4” water:

to trap and hydrolyze

Split-plot: + and – black plastic

Bags recovered after 7 days and pests analyzed

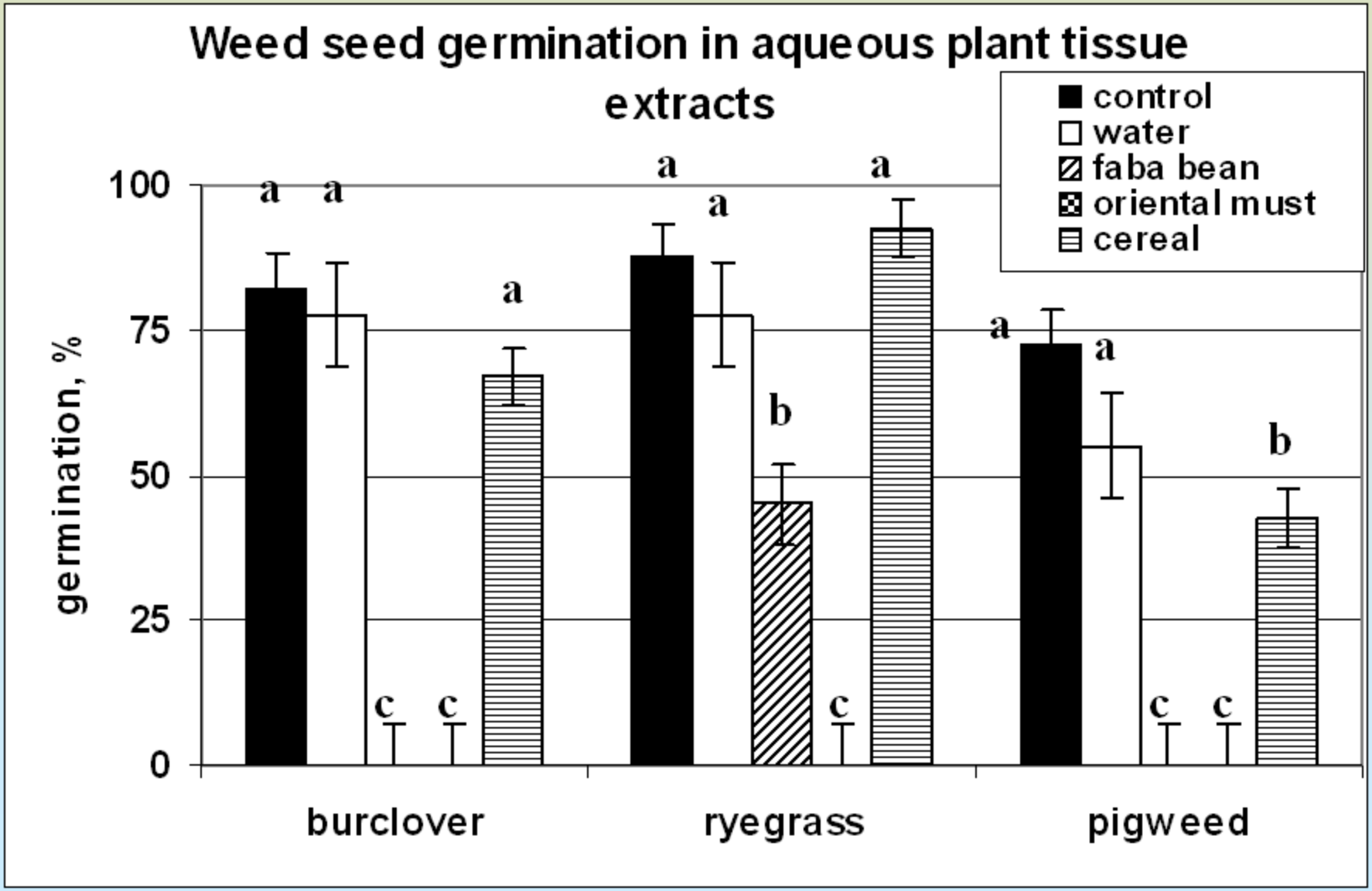
Citrus nematode



Weed seed from field bags:

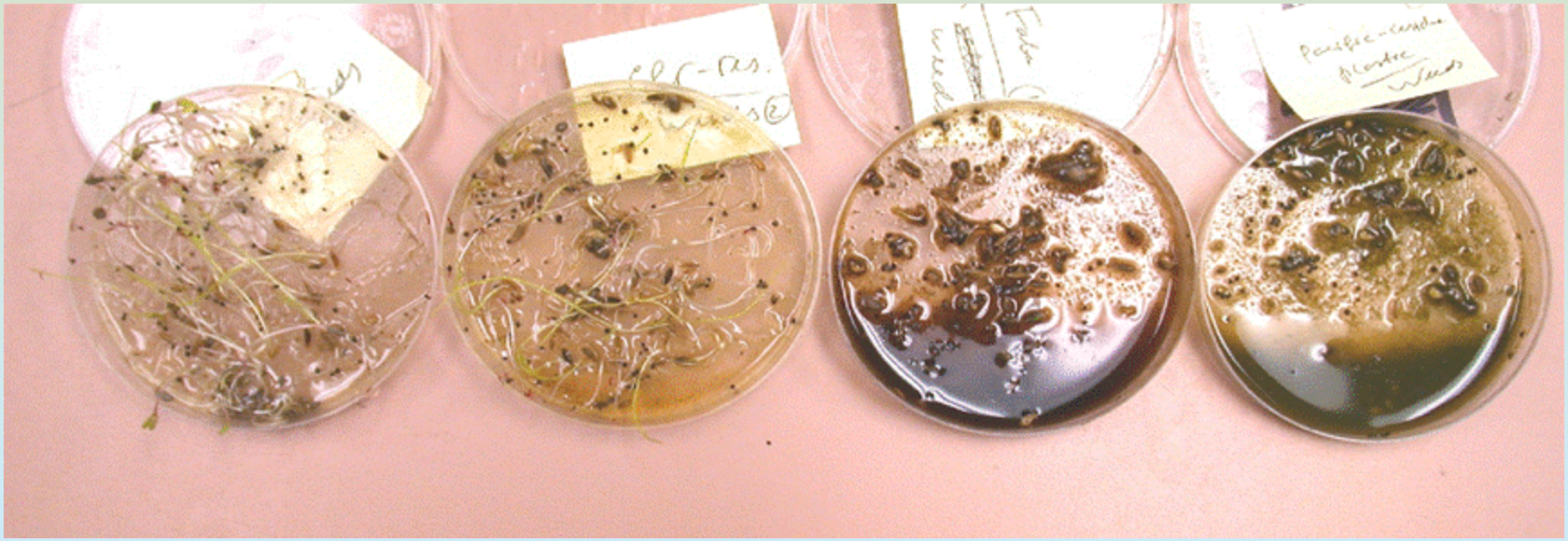
No significant effects of biofumigation on weed survival

Weeds in lab tissue extracts

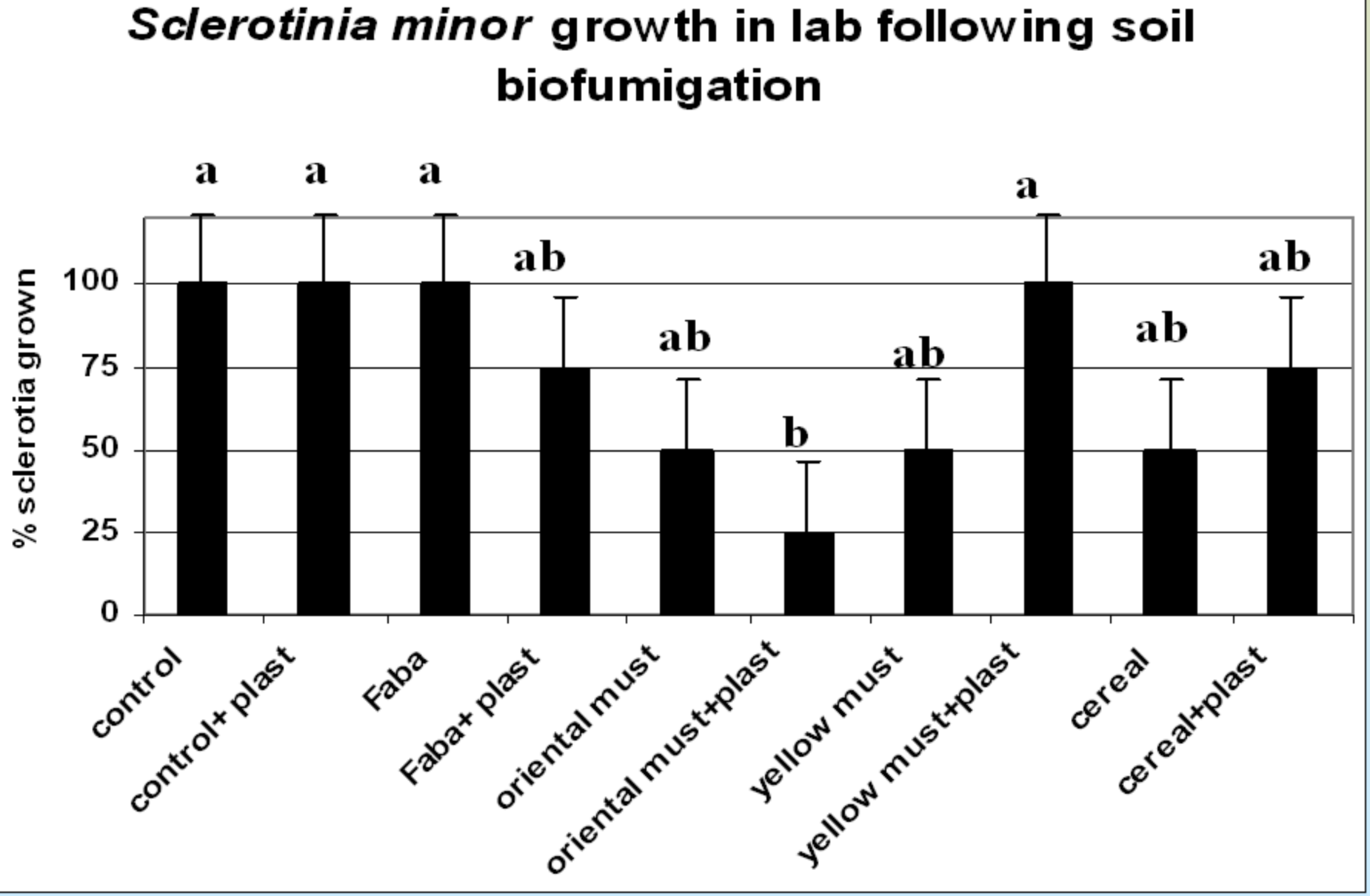


Weeds in tissue extracts

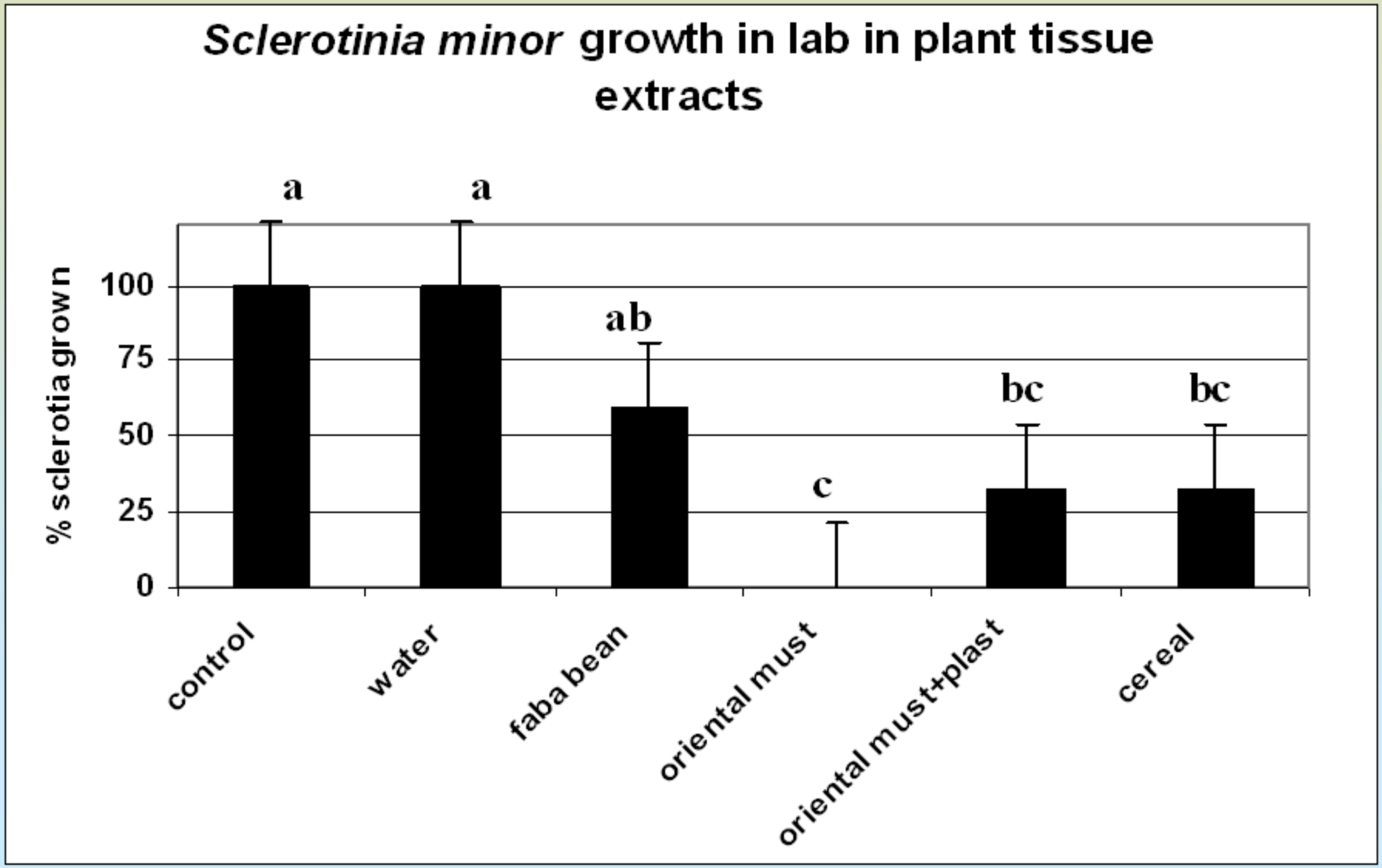
water bare control faba bean oriental must.



Sclerotia


Sclerotinia minor growth in lab following soil biofumigation
% sclerotia grown
100
75
50
25
0
a
a
a
ab
ab
b
ab
a
ab
ab
control
control+ plast
Faba
Faba+ plast
oriental must
oriental must+plast
yellow must
yellow must+plast
cereal
cereal+plast

Sclerotia in tissue extracts



Romaine lettuce and celery were planted following biofumigation

Romaine lettuce

After bare control

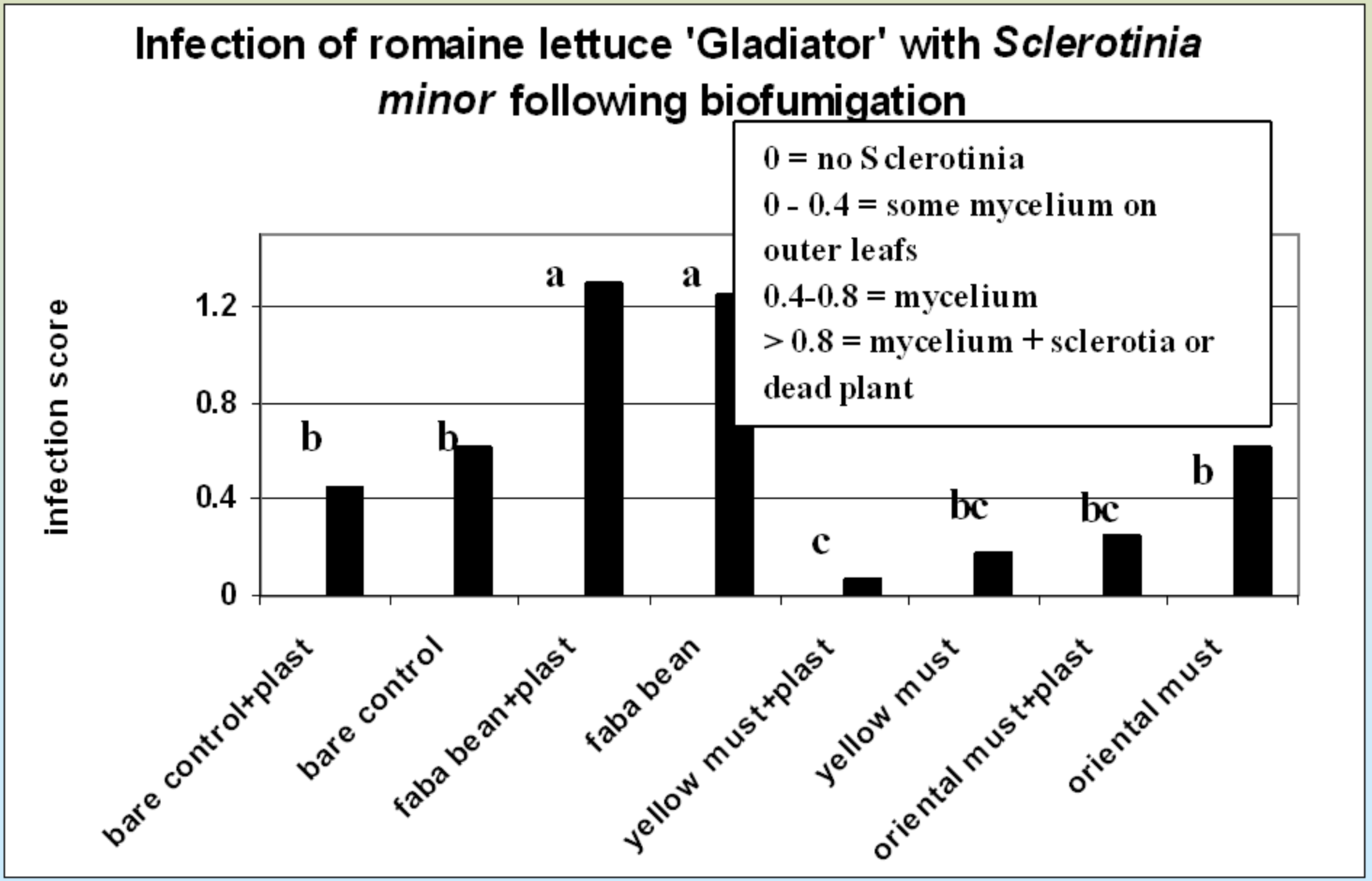
After faba beans

Romaine lettuce

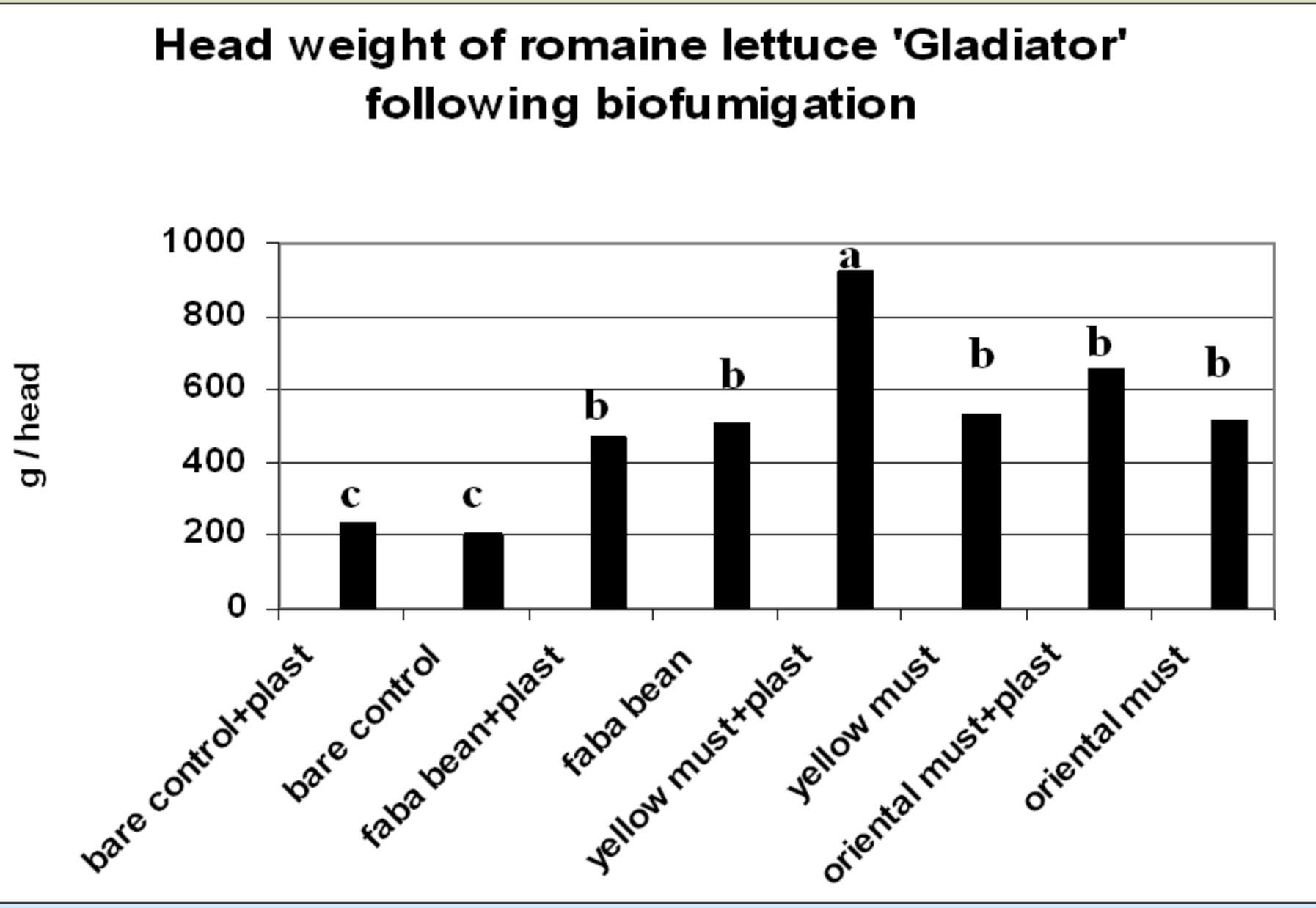
After yellow mustard

After oriental mustard

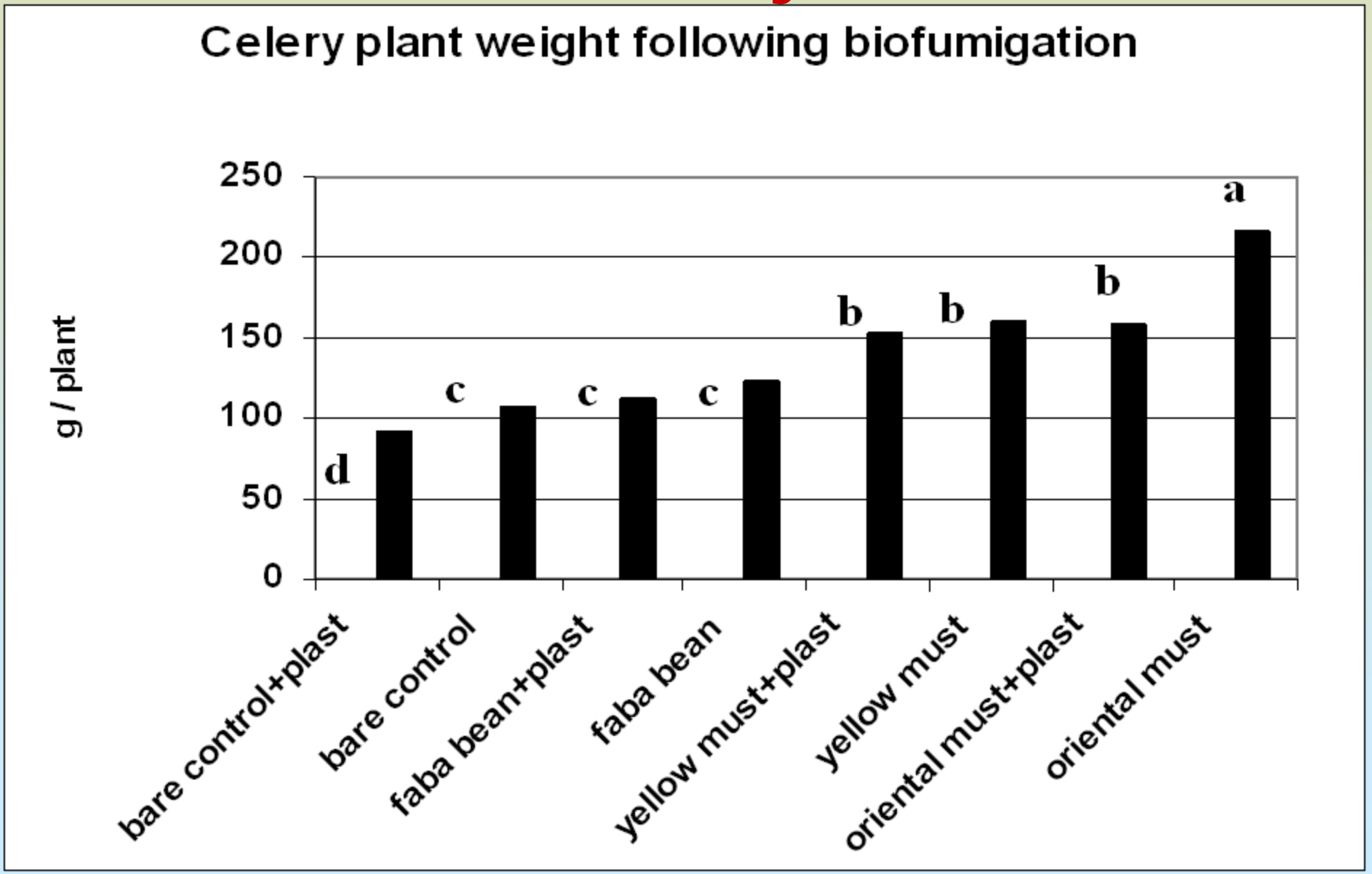
Romaine lettuce



Romaine lettuce



Celery


Celery plant weight following biofumigation
g / plant
250
200
150
100
50
0
d
c
c
c
b
b
b
a
bare control+plast
bare control
faba bean+plast
faba bean
yellow must+plast
yellow must
oriental must+plast
oriental must

Summary:

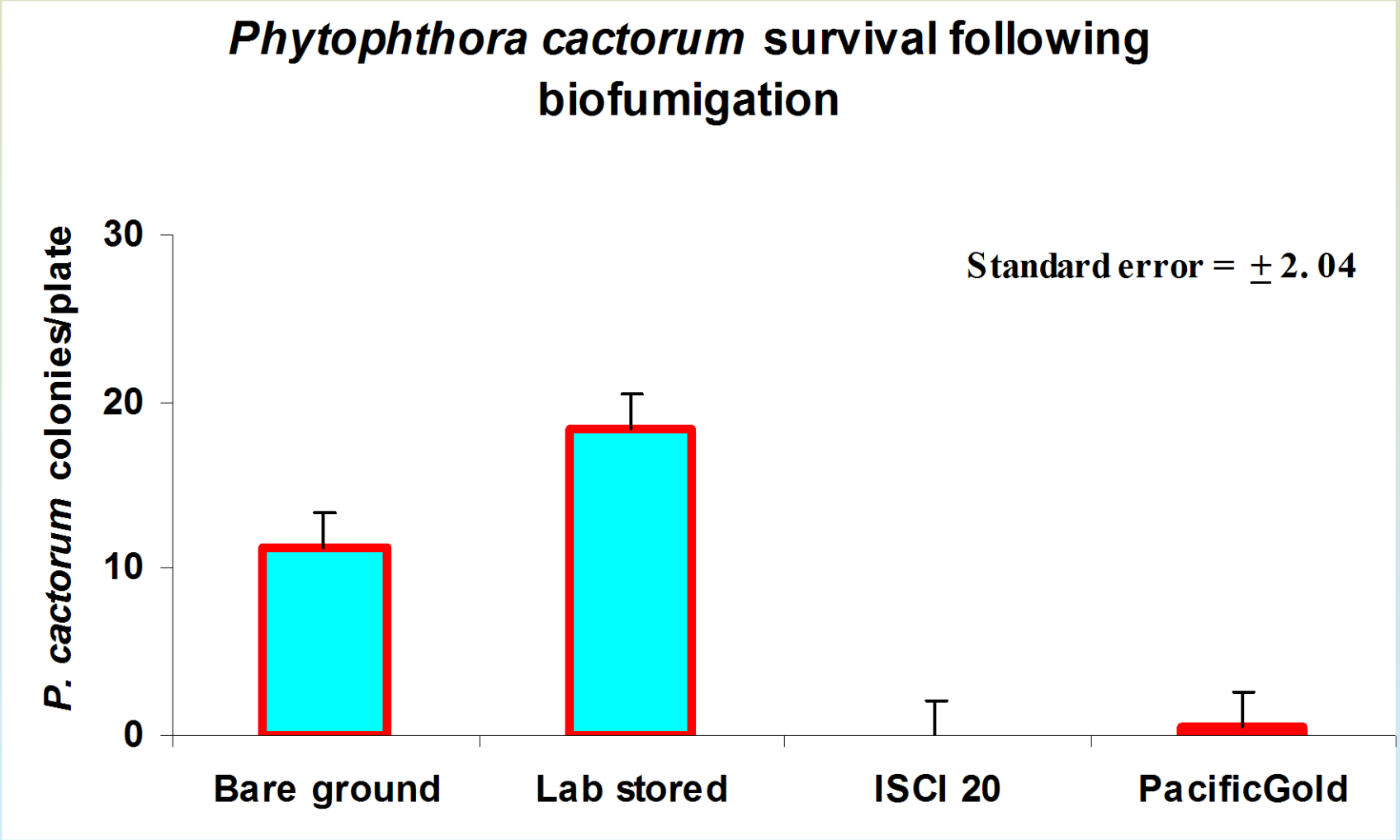
- **Oriental vs. yellow mustard – not consistent**
- **Plastic – not consistent**
- **Improved health and vigor of following crops, observation: abundant *Trichoderma* sp. after mustard**

2004: Pests and pathogens

At 15 and 30 cm (6 and 12”)

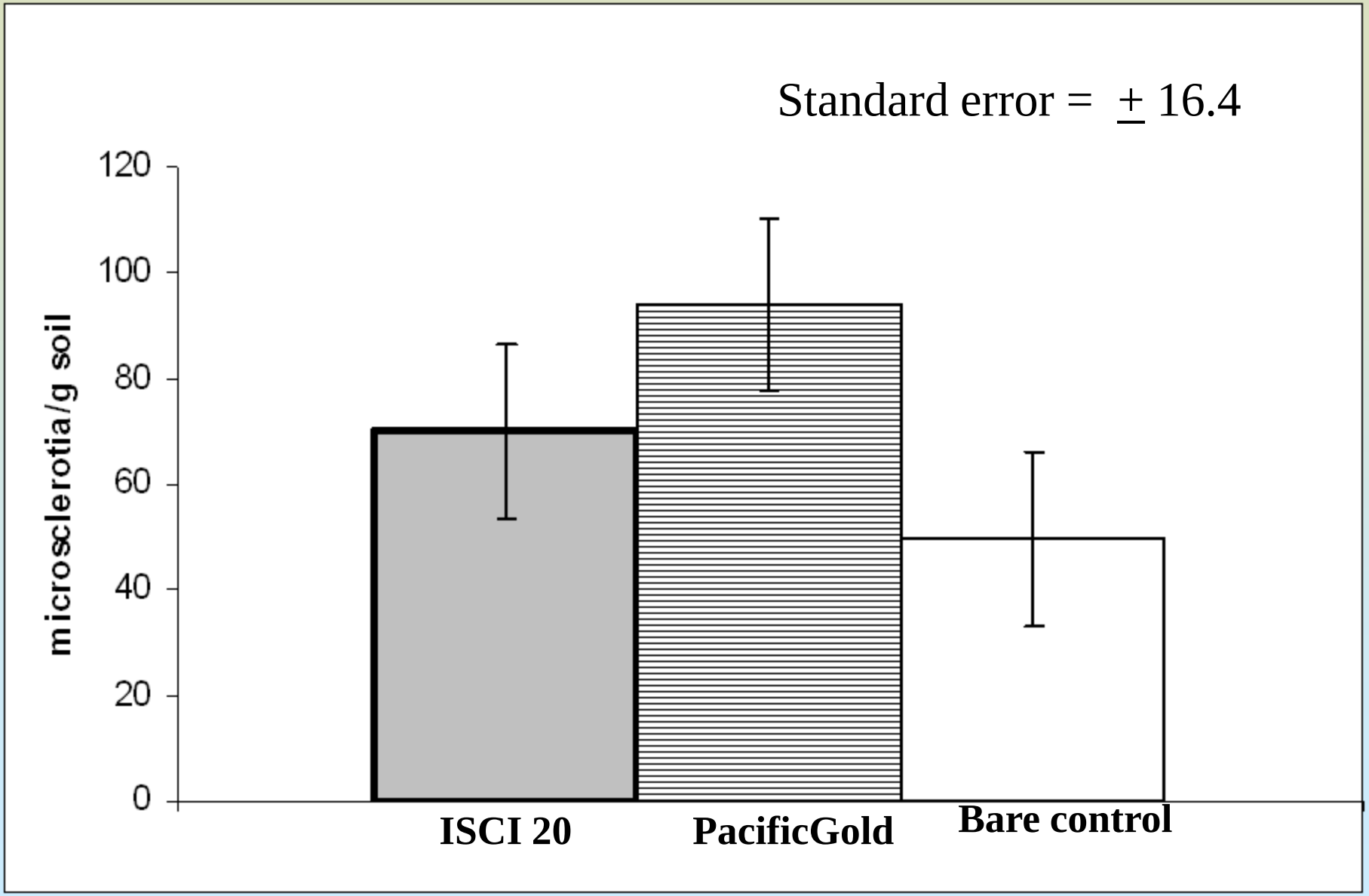
- **Phytophtora *(P. cactorum)***
- **California burclover, little mallow, goosefoot**
- ***Verticilium dahliae* soil samples**

Phytophtora: depth of burial – no effect

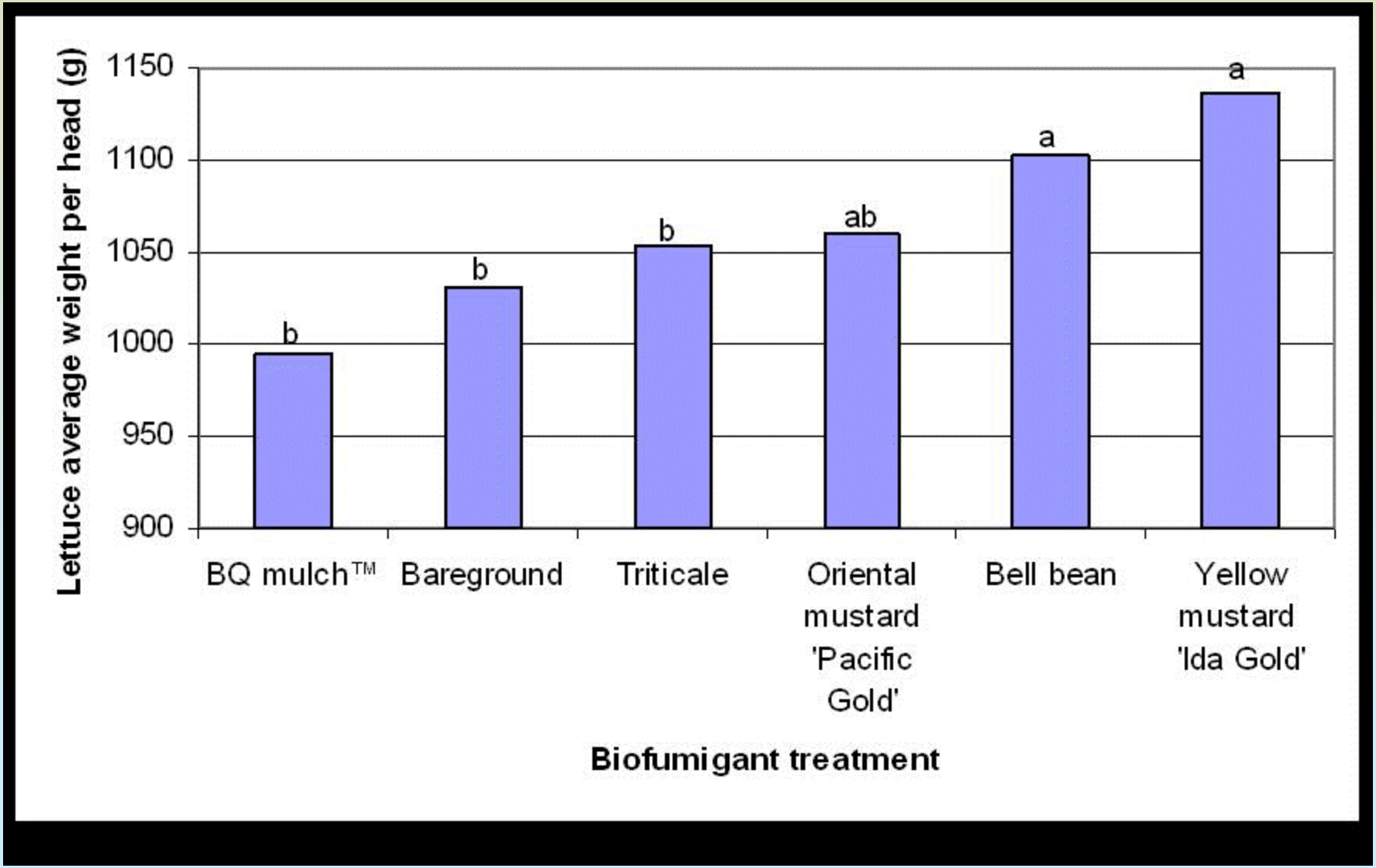


Severe overgrowth with ***Pythium*** spp. after mustards

Verticillium dahliae in soil following biofumigation



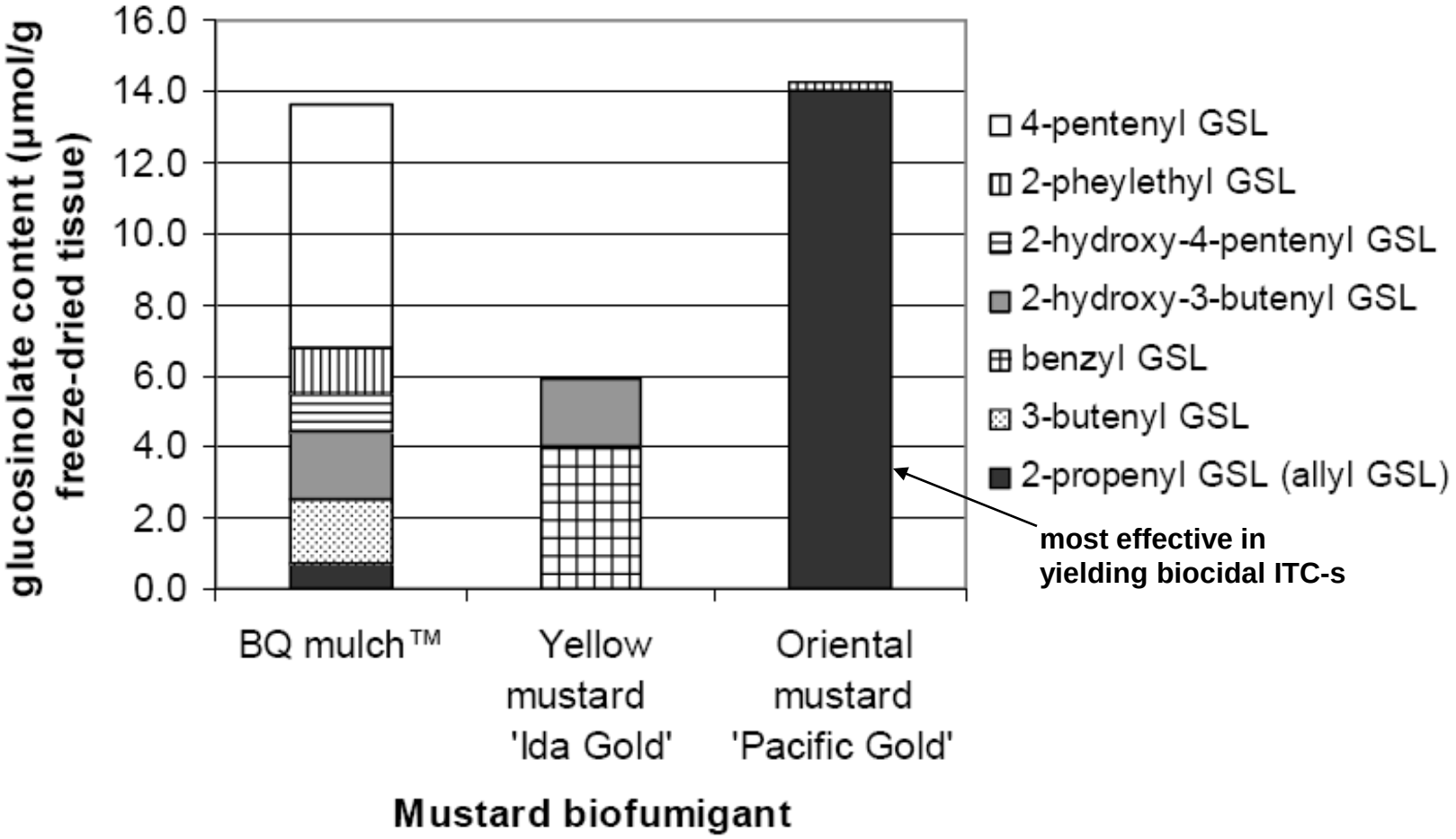
2005: Lettuce head weight after ‘biofumigation’



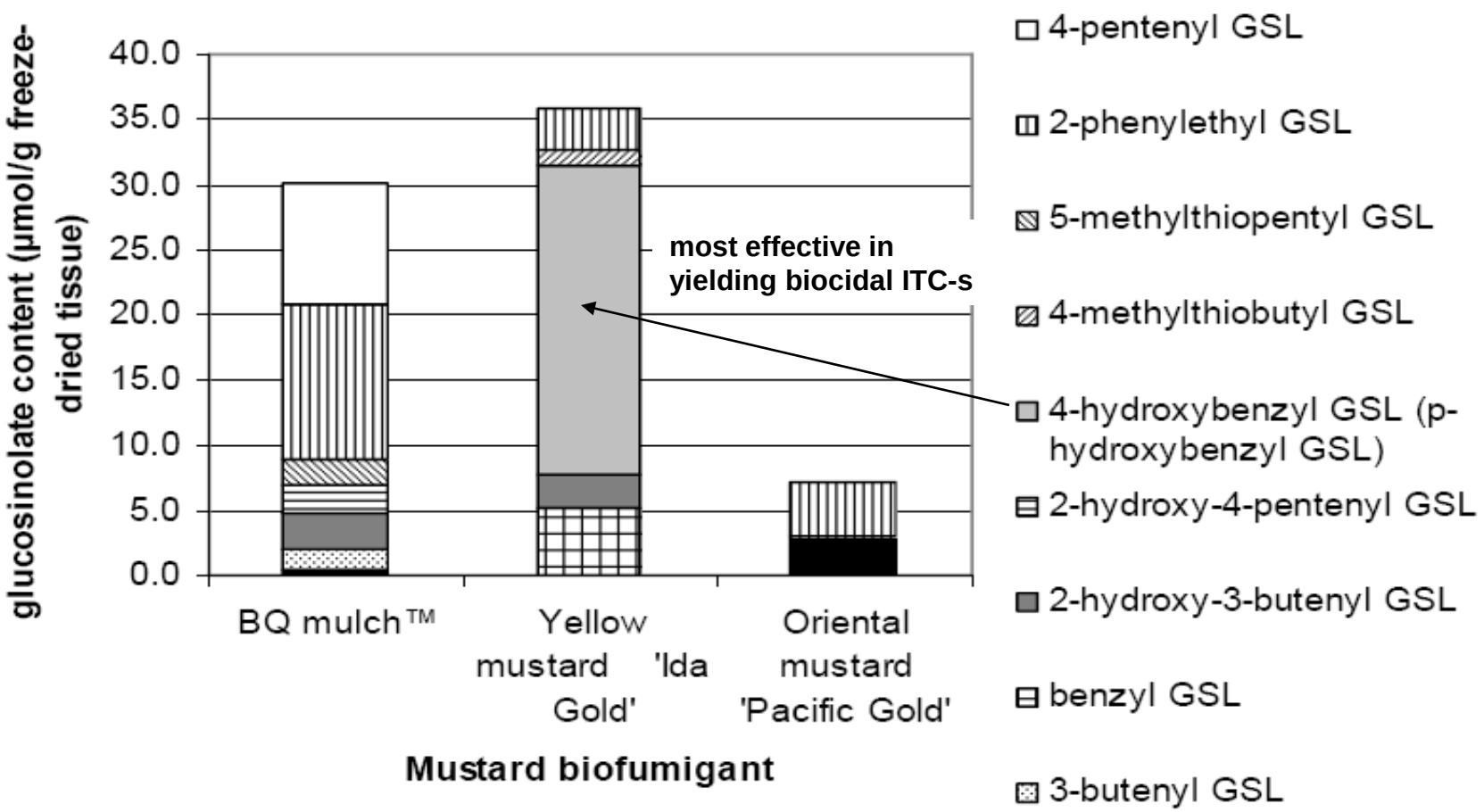
Changes in microbiological activity

Factor	Soil microbial activity (µg fluorescein hydrolyzed per g soil per h)
Cover crop (P<0.0001)	
Bareground	0.084 bc
Bell bean	0.163 bc
Triticale	0.662 ab
'BQ Mulch'™	0.754 a ←
'Ida Gold'	0.933 a ←
'Pacific Gold'	1.023 a ←
Residue (P=0.07)	
1x	0.513 b
2x	0.694 a ←

Composition of glucosinolates: above-ground



Composition of glucosinolates: roots



Summary: biofumigation

+ Yield increases after mustard 'biofumigation'

+ Soil microbial enzymatic activity was higher for 'PacificGold' and 'IdaGold,' compared to bell bean or bare control

-- No reduction in sclerotia of *Sclerotinia minor*, microsclerotia of *Verticillium dahliae* and weed seed viability

+ reduction in citrus nematode and *Phytophthora cactorum* after oriental mustard biofumigation

± *S. minor* severity ratings were reduced 25% when surface cover crop biomass was doubled (or with yellow mustard in 2002), regardless of species or crop type.

Mustard seed meal

Treatment	Rate/ description	Weed densities	Albion	Ventana
		No. (1,000/Acre)	---------- g/plant ----------	
1. Untreated	0	1,322 a	542.6	699.3
2. MBPic 67:33	350 lb/A	49 d	784.2	877.4
3. Steam	70°C 30 min.	29 d	775.0	1017.3
4. Muscodor	2000 lb/A	261 cd	518.7	629.4
5. Brassica meal	2000 lb/A	822 b	743.3	996.8
6. Furfural	600 lbs/A	702 bc	872.7	640.0
7.Fludio. + Ridomil	1 pint + 0.5 lb/A	432 bcd	572.3	863.5
8. Stabilized Urea[1]	300 lbs/A	374 bcd	619.8	651.0
9.Steam+ AgroThrive	70°C 30 min. + 150 lb/A	12 d	648.1	889.9
10. AG3 (NP)	75 GPA	776 b	418.8	598.9
LSD (P=.05)		500	298.0	351.0
Treatment Prob.		0.0001	0.094	0.128

Fennimore et al.


BioFence
L'INNOVAZIONE NATURALE
the natural innov


CLAMPCO
Fertilizer Applicators