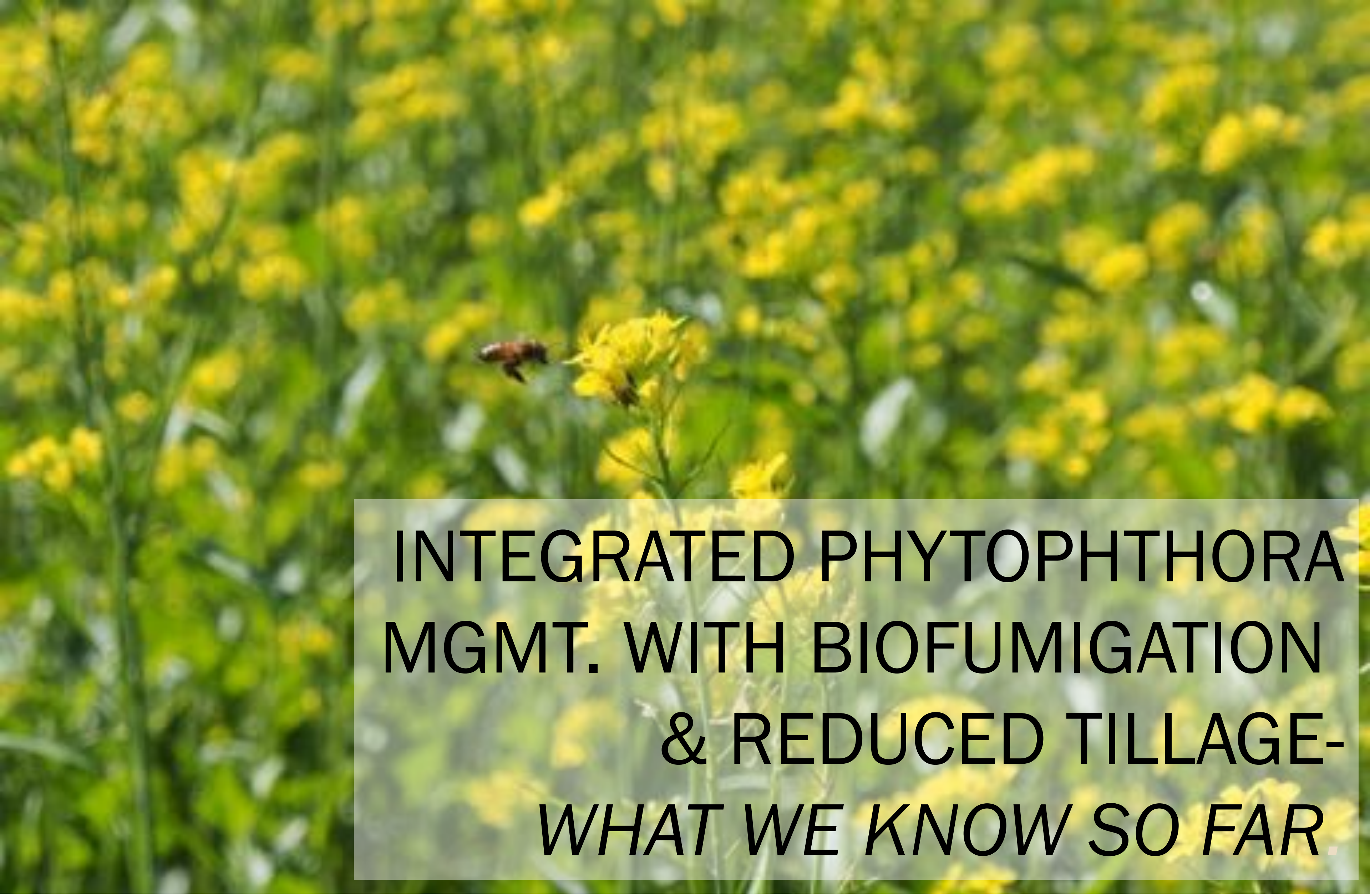

INTEGRATED PHYTOPHTHORA MGMT. WITH BIOFUMIGATION & REDUCED TILLAGE- *WHAT WE KNOW SO FAR.*

WASHINGTON STATE UNIVERSITY EXTENSION

Justin O'Dea, Assistant Professor
Regional Agriculture Specialist, Clark, Cowlitz, & Skamania Counties

Aug, Sept 2011

DAILY NEWS
NEW YORK

NYC Crime | Bronx | Brooklyn | Manhattan | Queens | Education | Weather

Pumkin shortage in NY after Irene damage

BY JOE TEPPER CHRISTINA BOYLE
DAILY NEWS STAFF WRITERS Sunday, September 18, 2011, 4:00 AM

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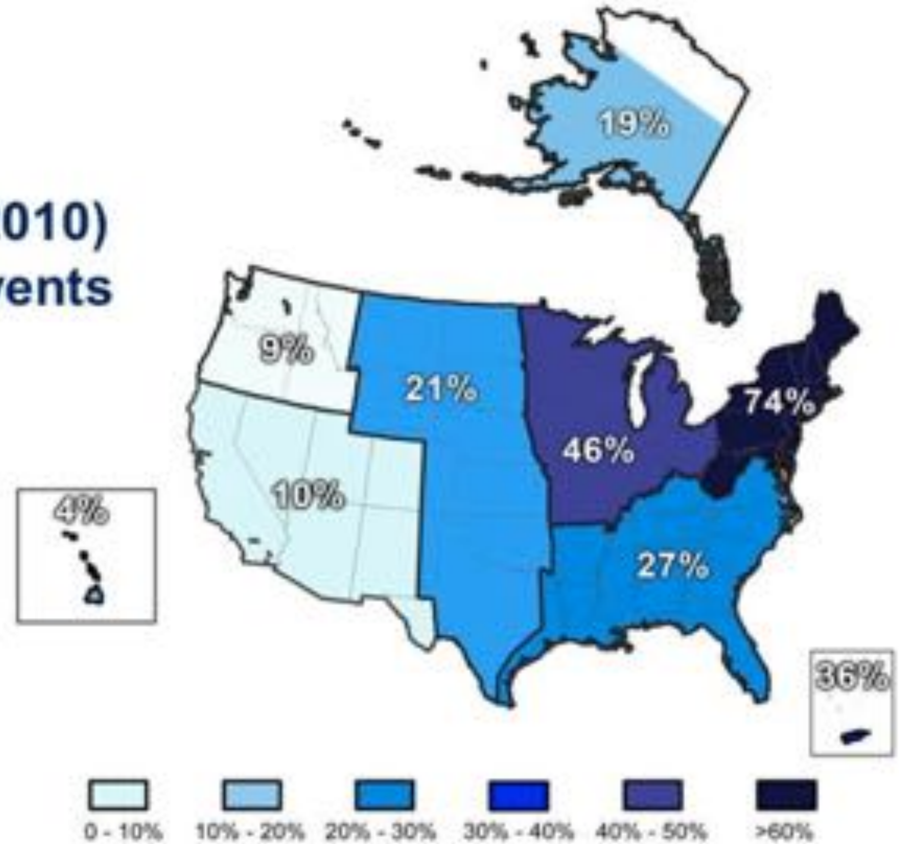
Regardless of Shifts in Total Annual Rain More of It Is Coming in Heavy Downpours

Percent Increase (1958-2010) in Heavy Precipitation Events (>2inch/48 hr)



NOAA, provided by A. DeGaetano, NERCC, Cornell

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Integrated Phytophthora Blight Management in Vegetable Crops with Enhanced Soil Health From Cover Crops, Reduced Tillage, and Brassica Biofumigation

NORTHEAST SARE

Sustainable Agriculture Research & Education

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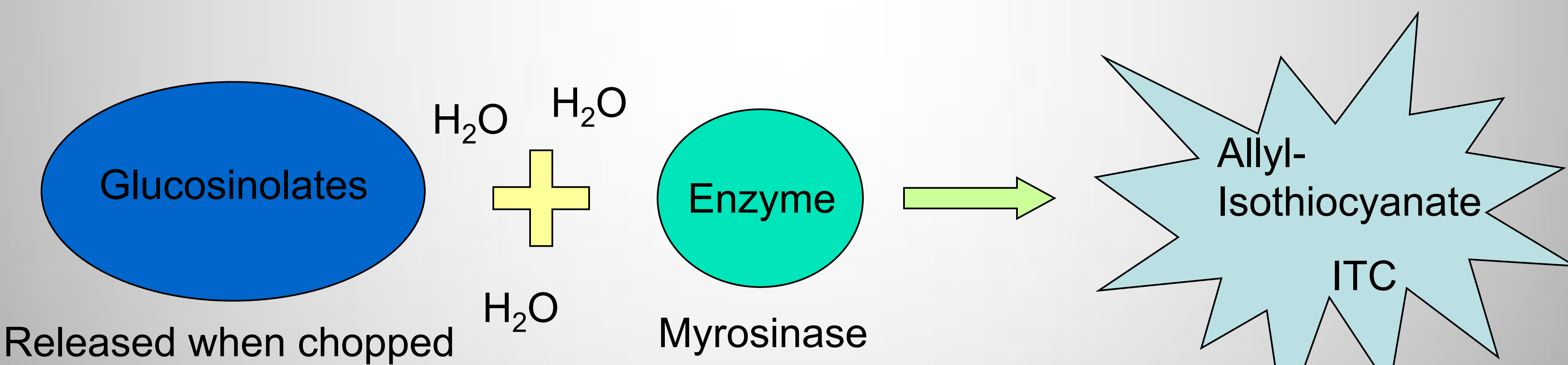
- What is Biofumigation?

  "The suppression of various soil-borne pests and diseases by naturally occurring compounds"

  - Brassicas: mustard, arugula, and others like oilseed radish, rapeseed, canola et al.

How does it work?

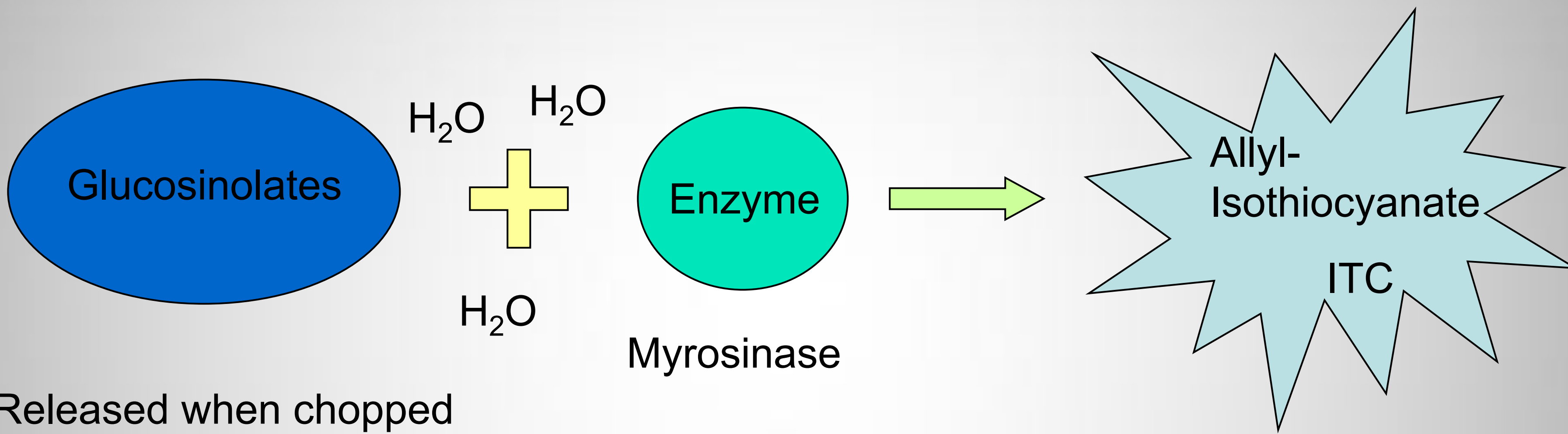
- Brassicas naturally produce *glucosinolates*
  - Sulfur compound that makes certain brassicas “hot/spicy”
  - Essential component in biofumigation



  - Broad-spectrum fumigant
  - Need 10-60x typical biomass to equal Vapam concentration

Similar to active ingredient in *Vapam* (methyl-isothiocyanate)

Facilitate Biofumigation reaction in the field



Similar to compound in *Vapam*
(methyl-isothiocyanate)

- In sequence:
  - Chop > incorporate > seal > (irrigate?)
- ITC is volatile (gas): Activity time is limited!

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D. Gies


wells lamont


D. Gies

Big hopes for Biofumigation

- Soil-borne disease suppression
  - Fusarium, Verticillium, Rhizoctonia, Pythium, Sclerotinia, Botrytis, Phytophthora, +
- Nematode suppression
  - Root knot and root lesion nematode
  - Potato cyst nematode suppression being studied
- Weed seed germination suppression

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CONTROL OF SOIL-BORNE PLANT PESTS USING GLUCOSINOLATE-CONTAINING PLANTS

Paul D. Brown and Matthew J. Morra

Department of Plant, Soil, and Entomological Sciences
University of Idaho
Moscow, Idaho 83844-2339

Plant and Soil **162**: 107–112, 1994.

Biofumigation: Isothiocyanates released from *Brassica* roots inhibit growth of the take-all fungus

J.F. Angus[1], P.A. Gardner[1], J.A. Kirkegaard[1] and J.M. Desmarchelier[2]
[1]*CSIRO Division of Plant Industry, GPO Box 1600, Canberra, 2601, Australia and* [2]*CSIRO Division of Entomology, GPO Box 1700, Canberra, 2601, Australia*

Potential Biofumigation Effects of *Brassica oleracea* var. *caulorapa* on Growth of Fungi

C. M. FAN[1], G. R. XIONG[1], P. QI[1], G. H. JI[1] and Y. Q. HE[1,2]
Authors' addresses: [1]Key Laboratory of Plant Pathology of the Ministry of Education, Yunnan Agricultural University, Kunming 650201, China; [2]Faculty of Agronomics and Biotechnology, Yunnan Agricultural University, Kunming 650201 China (correspondence to Y. Q. He. E-mail: heyu

Plant and Soil **201**: 103–112, 1998.

Biofumigation potential of brassicas

III. In vitro toxicity of isothiocyanates to soil-borne fungal pathogens

M. Sarwar[1], J.A. Kirkegaard[1], P.T.W. Wong[2] and J.M. Desmarchelier[3]
[1]*CSIRO Plant Industry, GPO Box 1600 Canberra ACT 2601, Australia**, [2]*Agricultural Research Institute, NSW Agriculture, Wagga Wagga NSW 2650, Australia and* [3]*CSIRO Division of Entomology, GPO Box 1700, Canberra 2601, Australia*

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Mustard Green Manures Replace Fumigant and Improve Infiltration in Potato Cropping System

Andrew M. McGuire, Lauzier Agricultural Systems Educator, Washington State University Cooperative Extension, Grant-Adams Area, PO Box 37, Ephrata WA

Control of soilborne potato diseases using *Brassica* green manures ☆

Robert P. Larkin*, Timothy S. Griffin

USDA, ARS, New England Plant, Soil, and Water Laboratory, University of Maine, Orono, ME 04469, USA

Soil amendments with *Brassica* cover crops for management of Phytophthora blight on squash

Pingsheng Ji,[a]* Daouda Koné,[a,b] Jingfang Yin,[a] Kimberly L Jackson[a] and Alexander S Csinos[a]

Brassica Green Manure Amendments for Management of *Rhizoctonia solani* in Two Annual Ornamental Crops in the Field

Kimberly A. Cochran and Craig S. Rothrock[1]
Department of Plant Pathology, University of Arkansas, 217 Plant Science Building, 495 North Campus Drive, Fayetteville, AR 72701

Mustard biofumigation disrupts biological control by *Steinernema* spp. nematodes in the soil

Donna R. Henderson[a,b], Ekaterini Riga[a,b], Ricardo A. Ramirez[c], John Wilson[a,b], William E. Snyder[c,*]

Pathogenicity of *Phytophthora capsici* to *Brassica* Vegetable Crops and Biofumigation Cover Crops (*Brassica* spp.)

Charles S. Krasnow and **Mary K. Hausbeck,** Department of Plant, Soil, and Microbial Sciences, Michigan State University, East Lansing,

HortScience 40(7):2016–2019. 2005.

Mustard Cover Crops Are Ineffective in Suppressing Soilborne Disease or Improving Processing Tomato Yield

T.K. Hartz, P.R. Johnstone, E.M. Miyao,[1] and R.M. Davis[2]
Department of Plant Sciences, University of California, Davis, CA 95616

Mustard and Other Cover Crop Effects Vary on Lettuce Drop Caused by *Sclerotinia minor* and on Weeds

Tiffany A. Bensen and **Richard F. Smith,** University of California Cooperative Extension, Monterey County, Salinas 93901; **Krishna V. Subbarao,** University of California, Department of Plant Pathology, Davis 95616; **Steven T. Koike,** University of California Cooperative Extension; and **Steven A. Fennimore** and **Shachar Shem-Tov,** University of California, Department of Plant Sciences, Davis 95616

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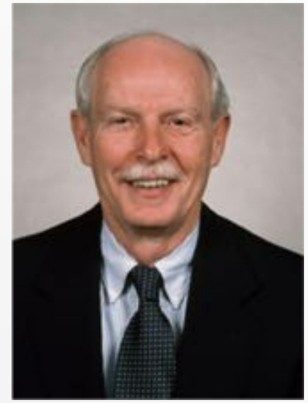
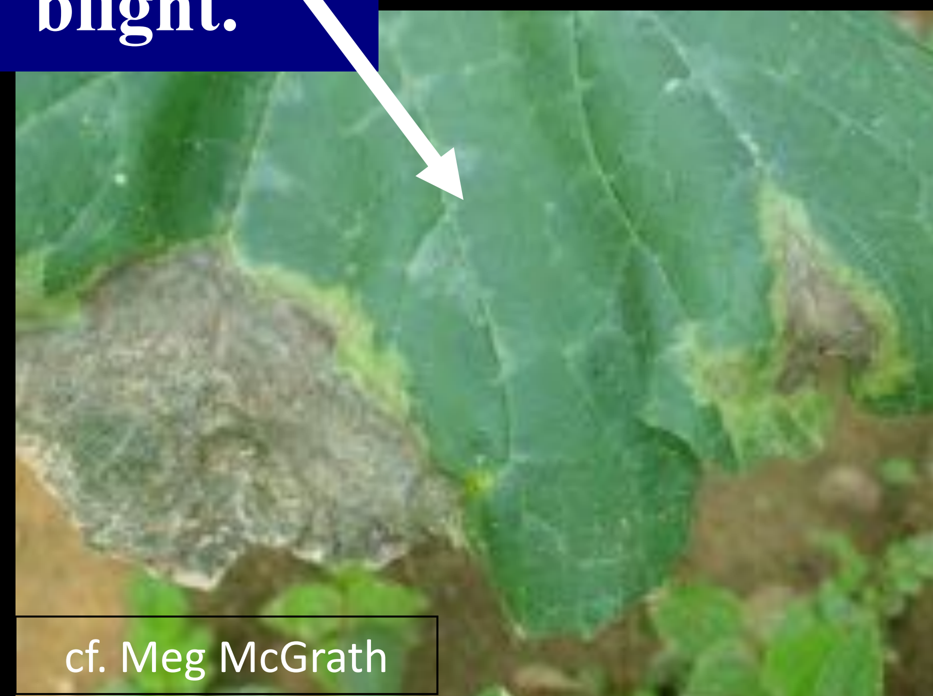
- Tom Zitter
- Meg McGrath
  - Cornell Plant Pathology & Plant Microbe Biology
  - Connected with Dale Gies, E. WA farmer- Biof. info from Italy
- Sandy Menasha- Extension Veg. Specialist, Suffolk Co.
  - Cornell's Long Island Horticulture Research and Extension Center (LIHREC)
    - Preliminary studies with P-cap
    - Some good grower feedback




Healthy zucchini only after mustard.

8-15-08

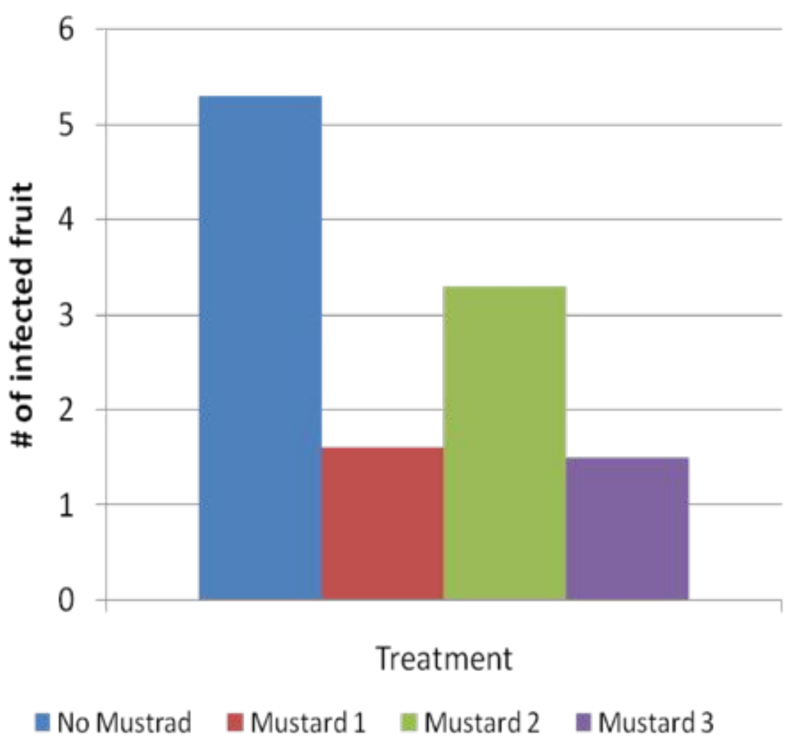
Phytophthora blight.



cf. Meg McGrath

Phytophthora Fruit Rot Incidence

2009

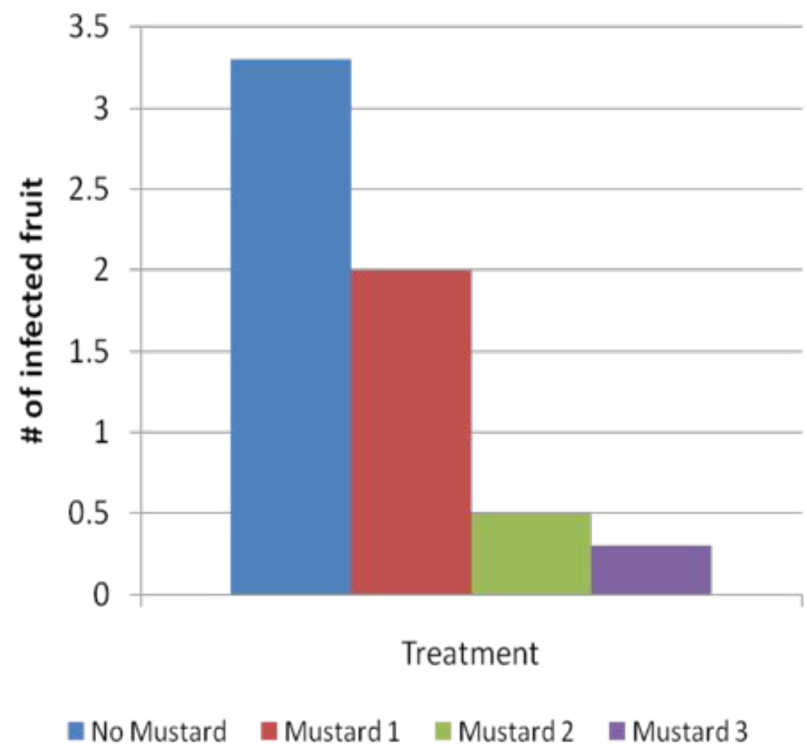


0 lb/A

50 lb/A

100 lb/A

2010



0 lb/A

50 lb/A

100 lb/A

cf. Sandy Menasha

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Integrated Phytophthora Blight Management in Vegetable Crops with Enhanced Soil Health From Cover Crops, Reduced Tillage, and Brassica Biofumigation

NORTHEAST SARE Sustainable Agriculture Research & Education

- Integrated management:
  Current IPM guidelines + biofumigation & reduced tillage
  - Biofumigation reduces inoculum (fumigation, burial)
  - Reduced tillage reduces contact with inoculum
  - Biofumigation + reduced tillage fosters soil health improvement
- 2-year field research component
- 6 on-farm trial sites, plot study at LIHREC
- Biofumigation + RT vs. standard practice, C, N returned to soils, infiltration rates, general soil health

Beyond biofumigation

- Adds organic matter
  - Improve soil fertility
  - Catch cropping & nutrient cycling
  - Improve infiltration and water holding capacity
  - Improve soil aeration
  - Healthy soils > soil borne disease suppression
- Attracts beneficials
- Weed suppression
- Applicable in organic and IPM stystems both

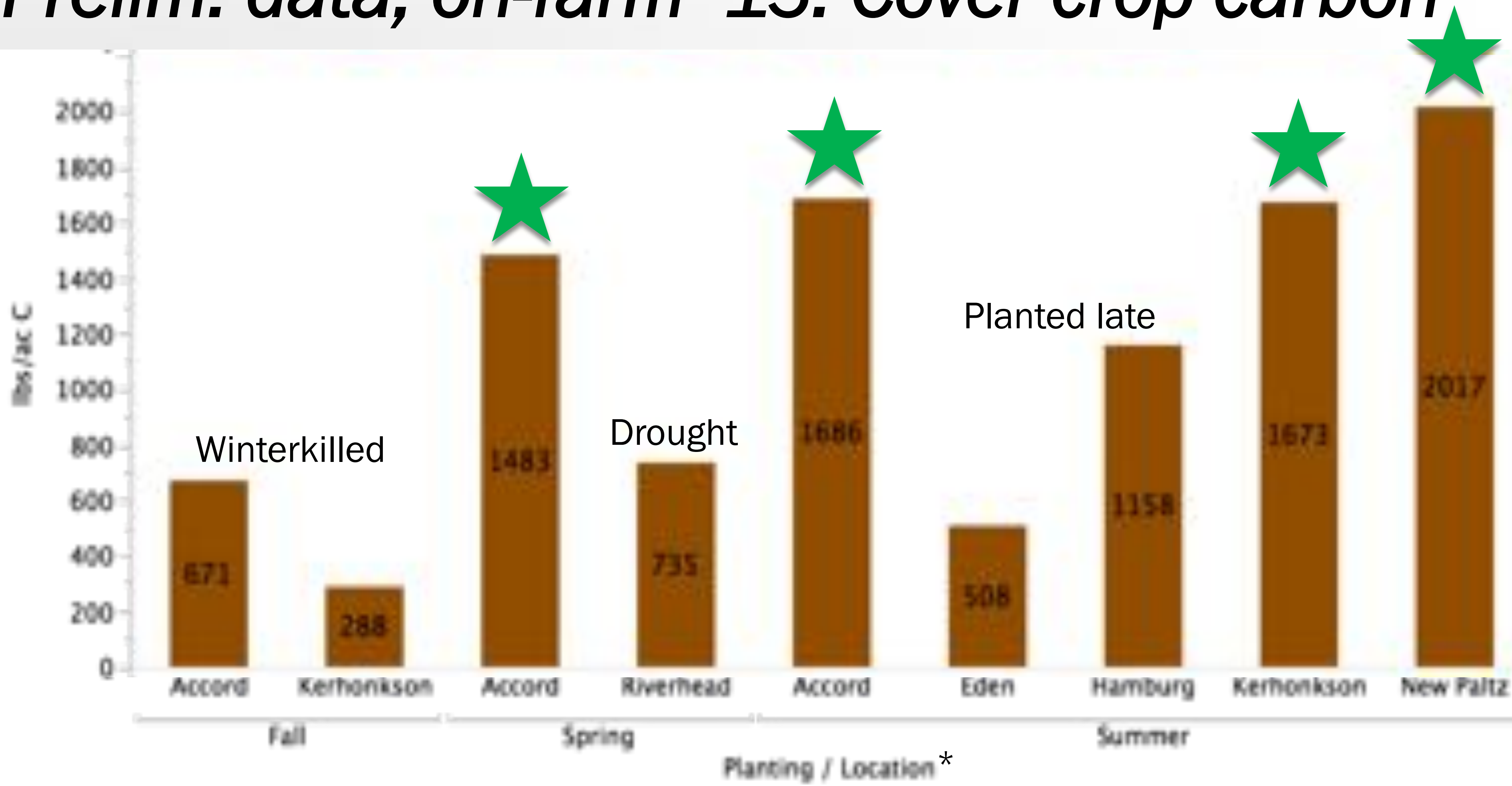
2015: Biofumigation year

- Ex: 2015 ~**Apr 20-** 'Caliente' mustard **> ~June 10-** biofumigation **> ~June 20** cucurbit cash crop

2015 Data collection

- Cover crop biomass
- Cucurbit yield
- P-cap incidence

Prelim. data, on-farm ’15: Cover crop carbon



* Riverhead = Long Island site, Accord, Kerhonkson, Newpaltz = Hudson Valley sites, Eden, Hamburg = western NY sites. Fall planting = ‘Nemat’ arugula, spring and summer plantings = ‘Caliente’ mustard.

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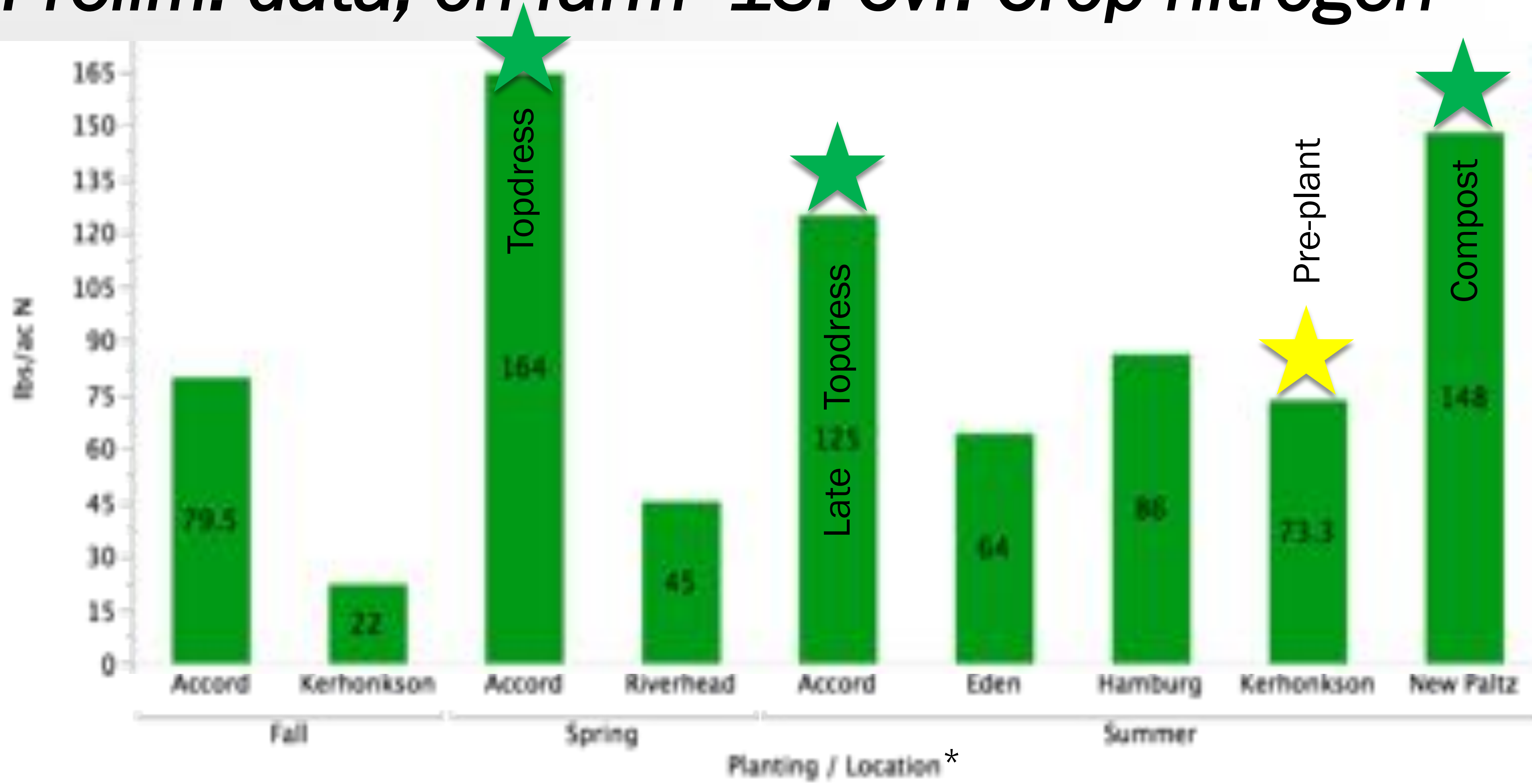
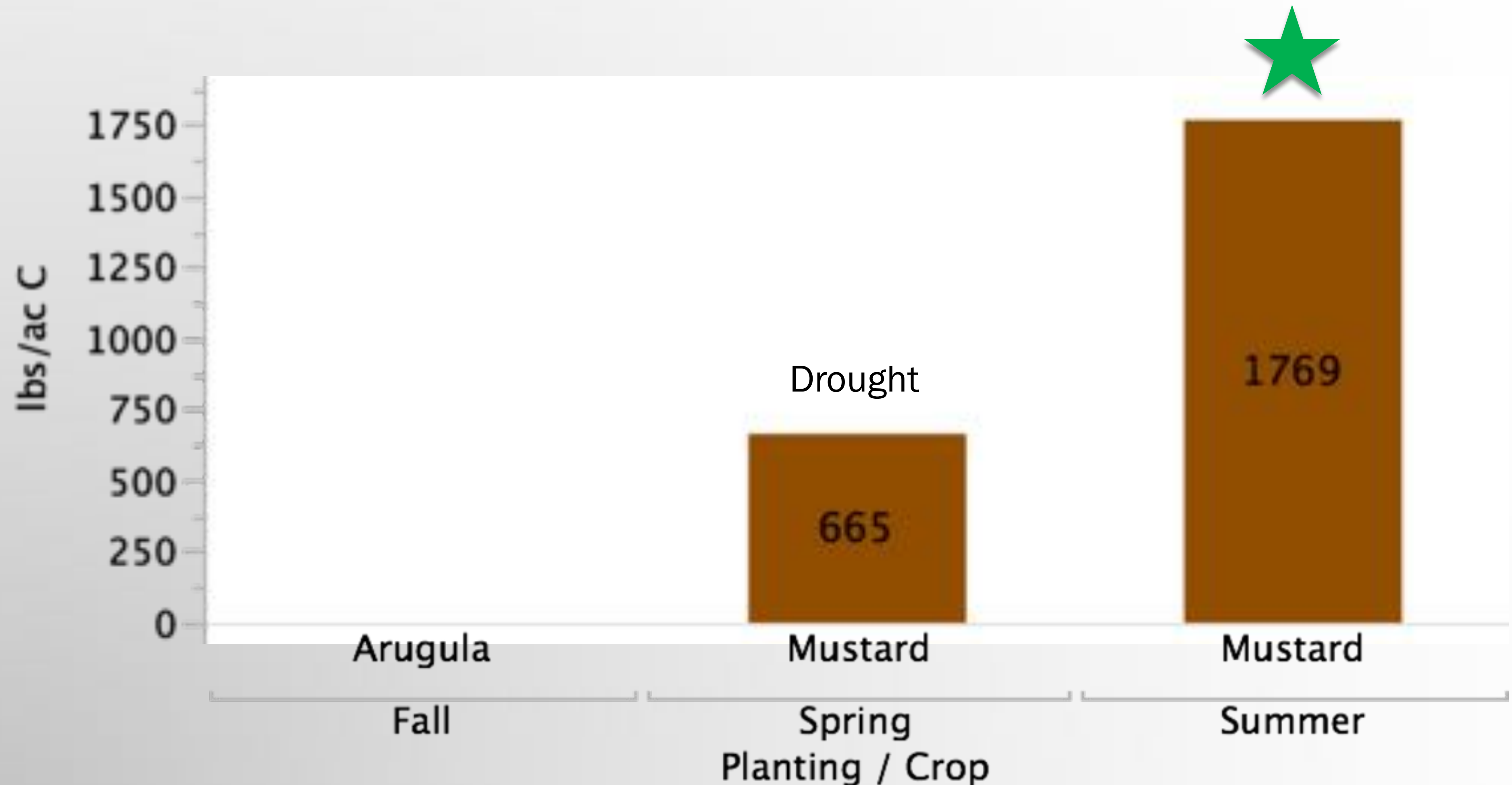
Prelim. data, on-farm '15: Cvr. Crop nitrogen



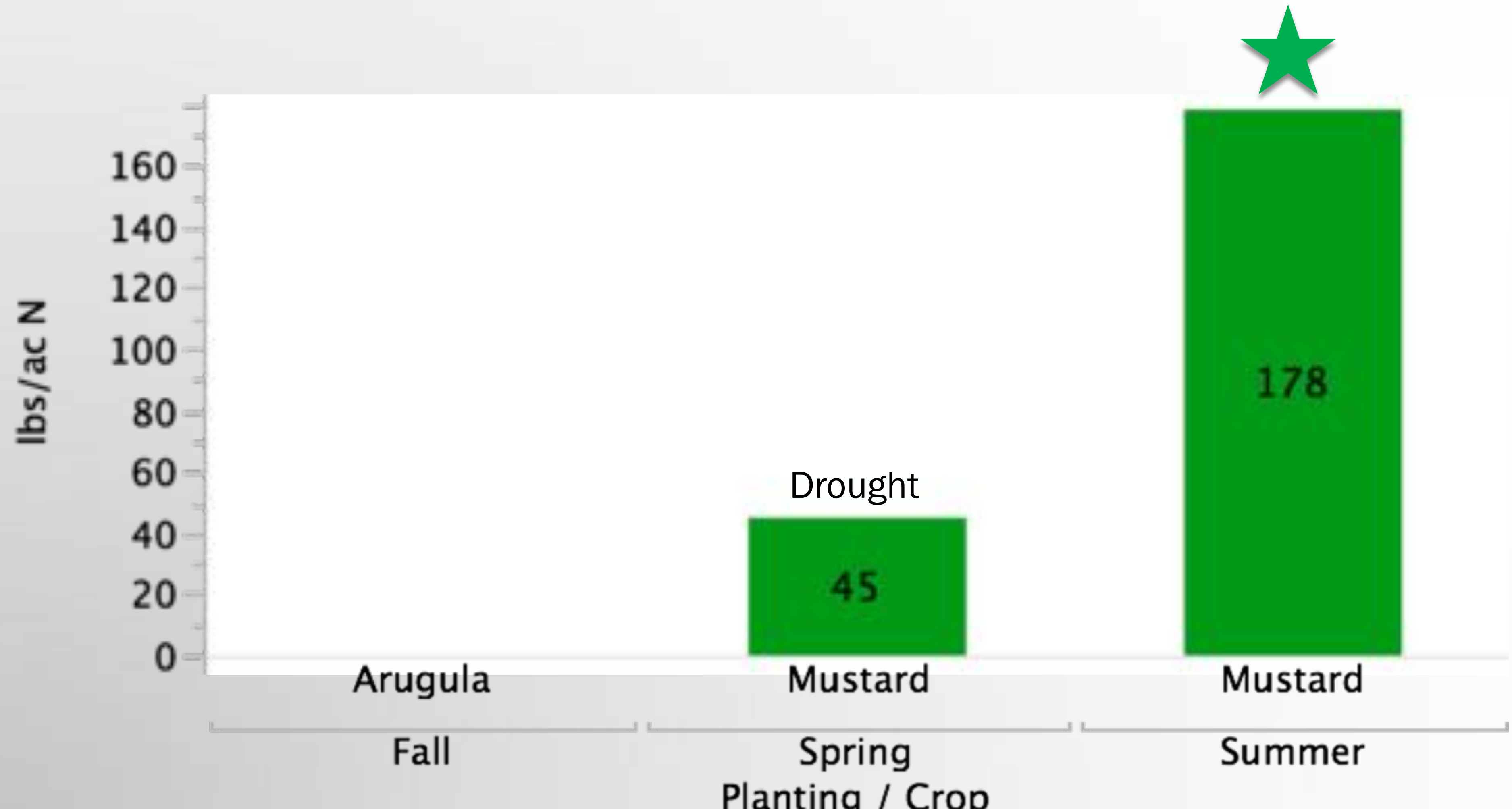
* Riverhead = Long Island site, Accord, Kerhonkson, Newpaltz = Hudson Valley sites, Eden, Hamburg = western NY sites.
Fall planting = 'Nemat' arugula, spring and summer plantings = 'Caliente' mustard.

Prelim. data, LIHREC ’15: Cvr. crop carbon



Prelim. data, LIHREC '15: Cvr. crop biomass

Prelim. data, LIHREC ’15: Cvr. crop nitrogen



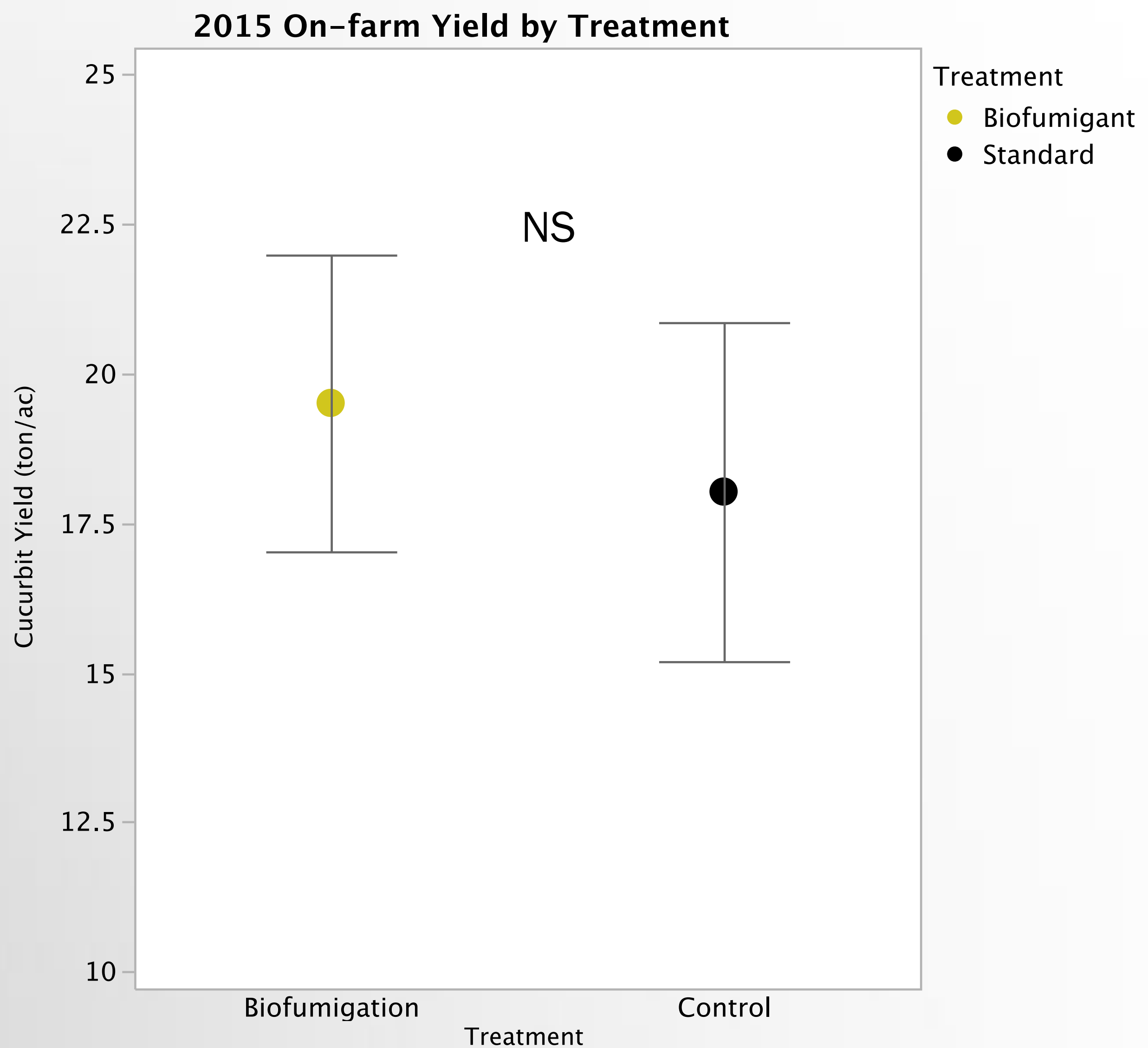
2015 Phytophthora incidence

- A little, but overall, **negligible**!
  - Hypothesis: Generally dry conditions.



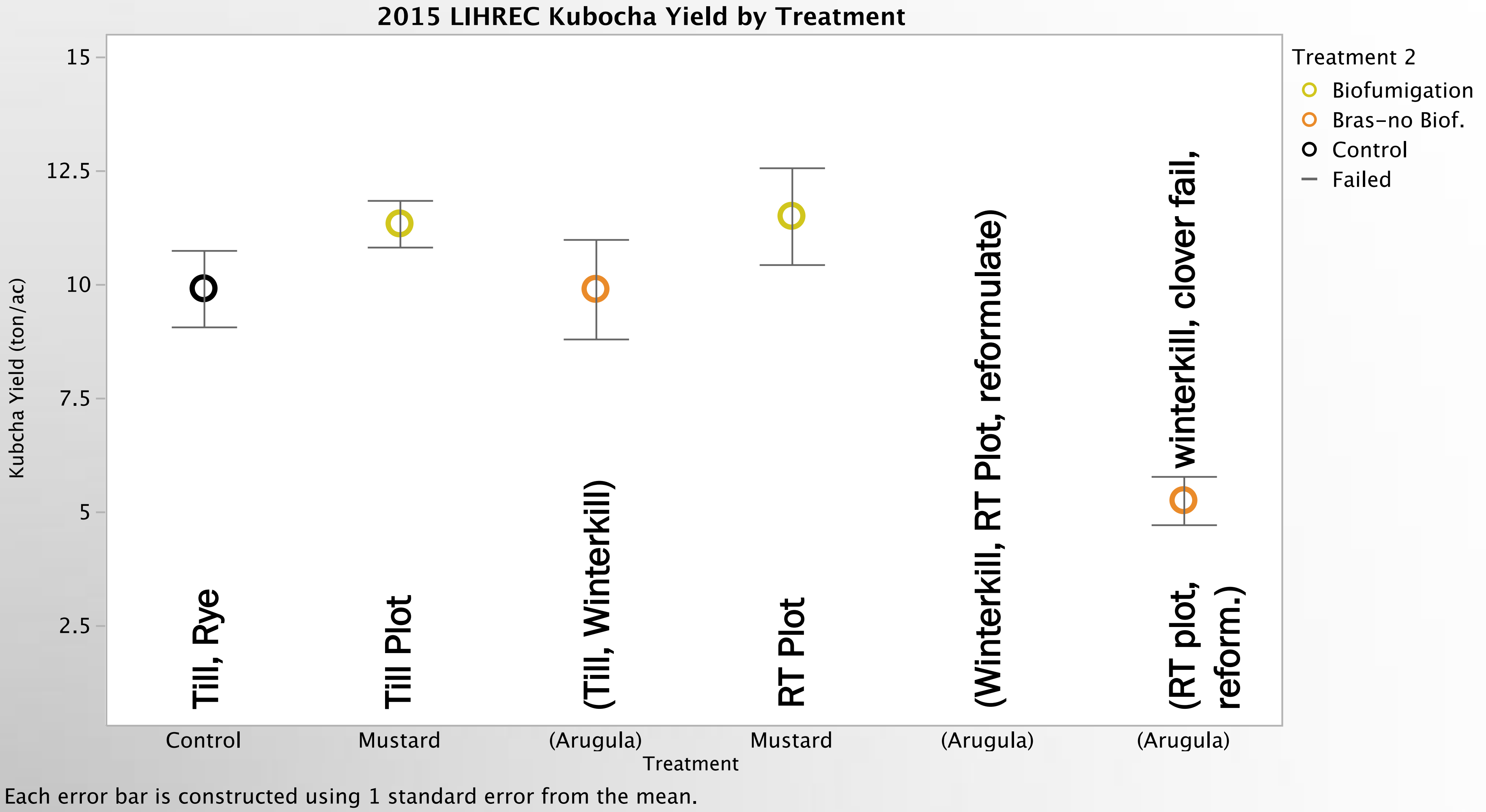
2015 On-farm Yield

- Too much variability…
- Negligible P-cap…

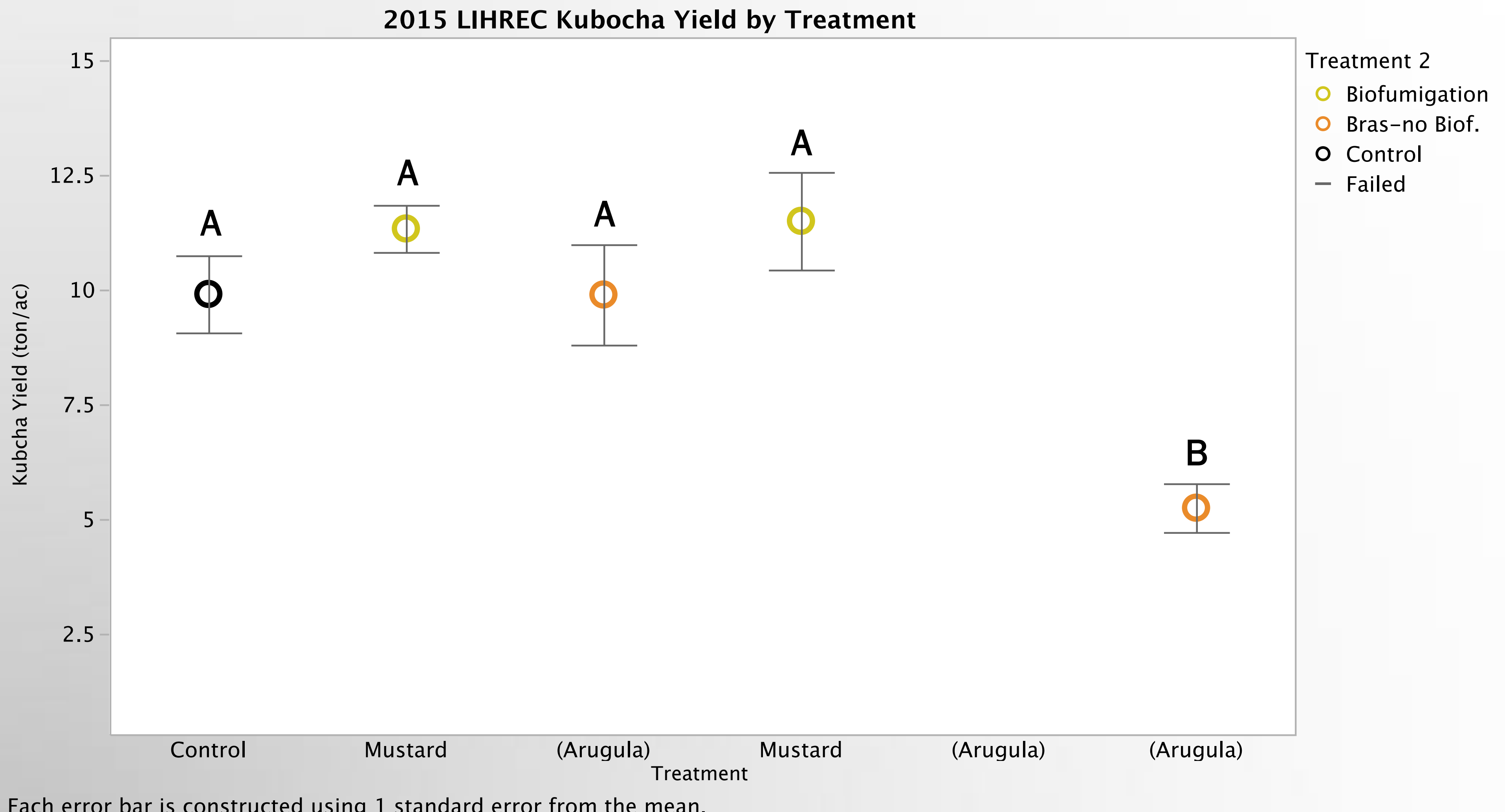


Where(40 rows excluded)
Each error bar is constructed using 1 standard error from the mean.

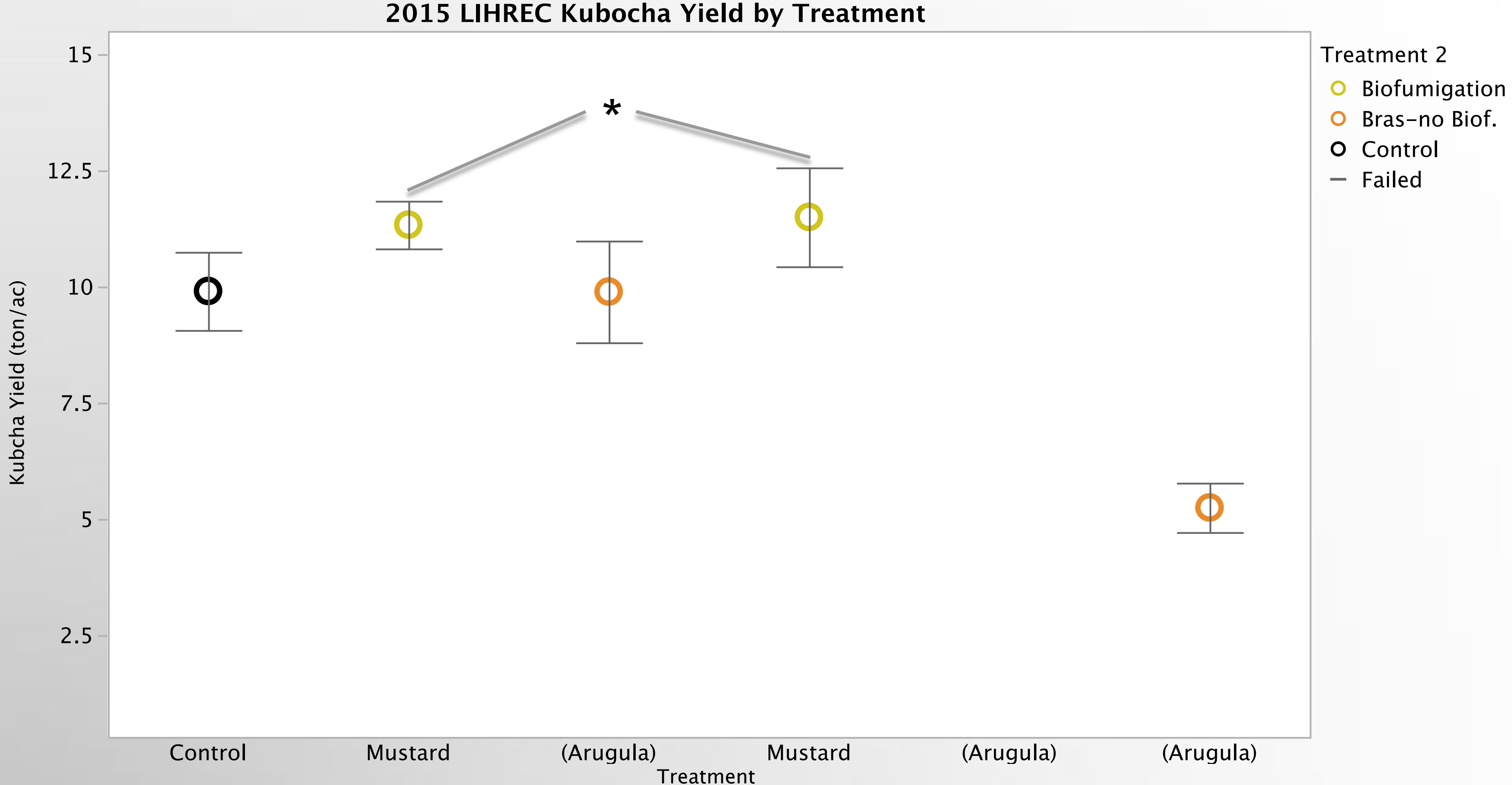
2015 Yield LIHREC



2015 Yield LIHREC



2015 Yield LIHREC



Each error bar is constructed using 1 standard error from the mean.

2016: Reduced tillage (RT) year

- Ex: (**2015 Aug 1**- mustard **>** **Oct 1**- biofumigation)**>** **Oct 10**- rye cover **>** **2016 May**- rolled rye zone till (RT)

2016 Data collection

- Cucurbit yield • p-cap incidence • soil infiltration rates • soil health assay • cover crop biomass

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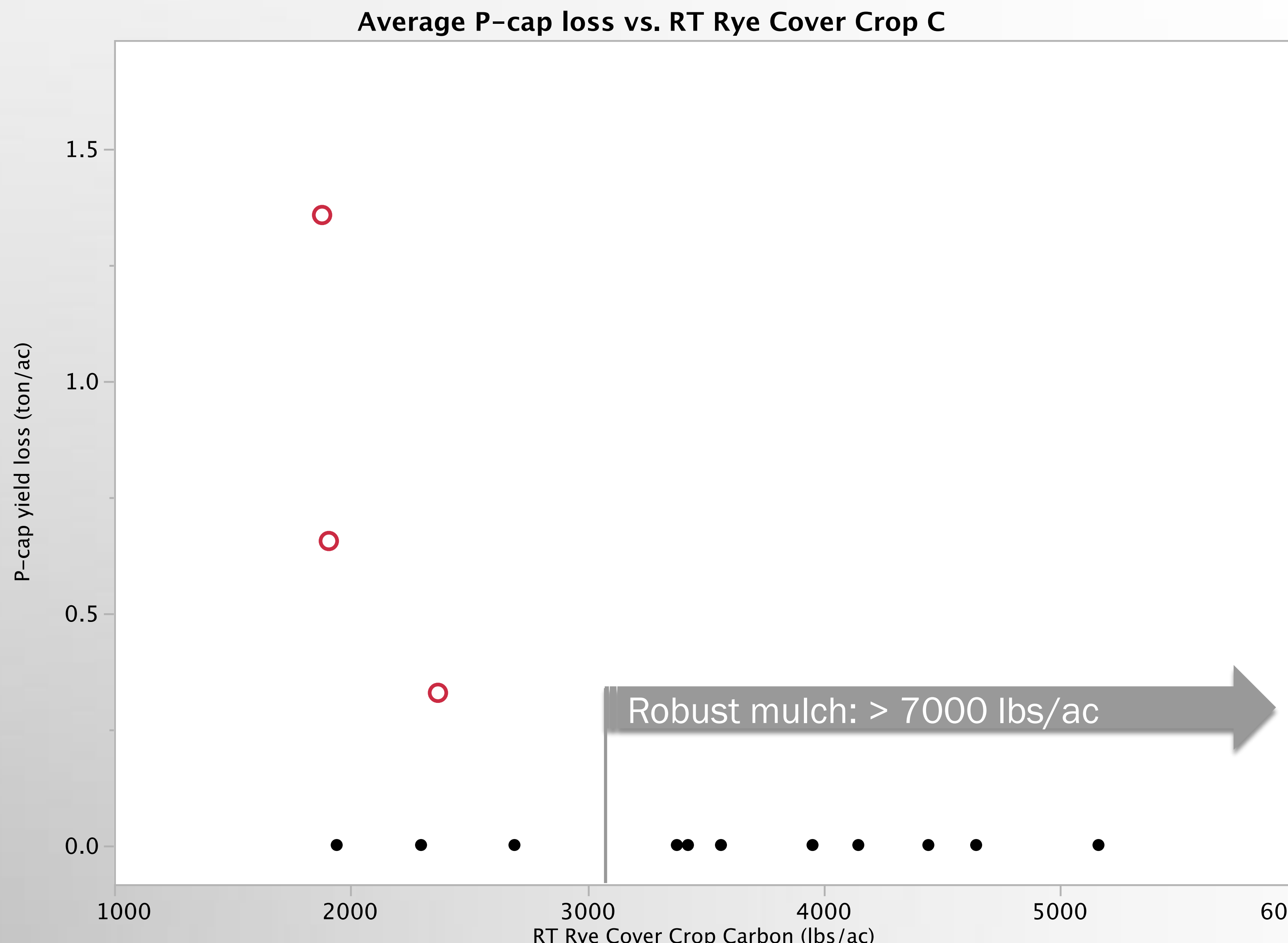
2016 Preliminary observations

- P-cap incidence very low, therefore > low opportunity to collect evidence of treatment effects

2016 Preliminary observations

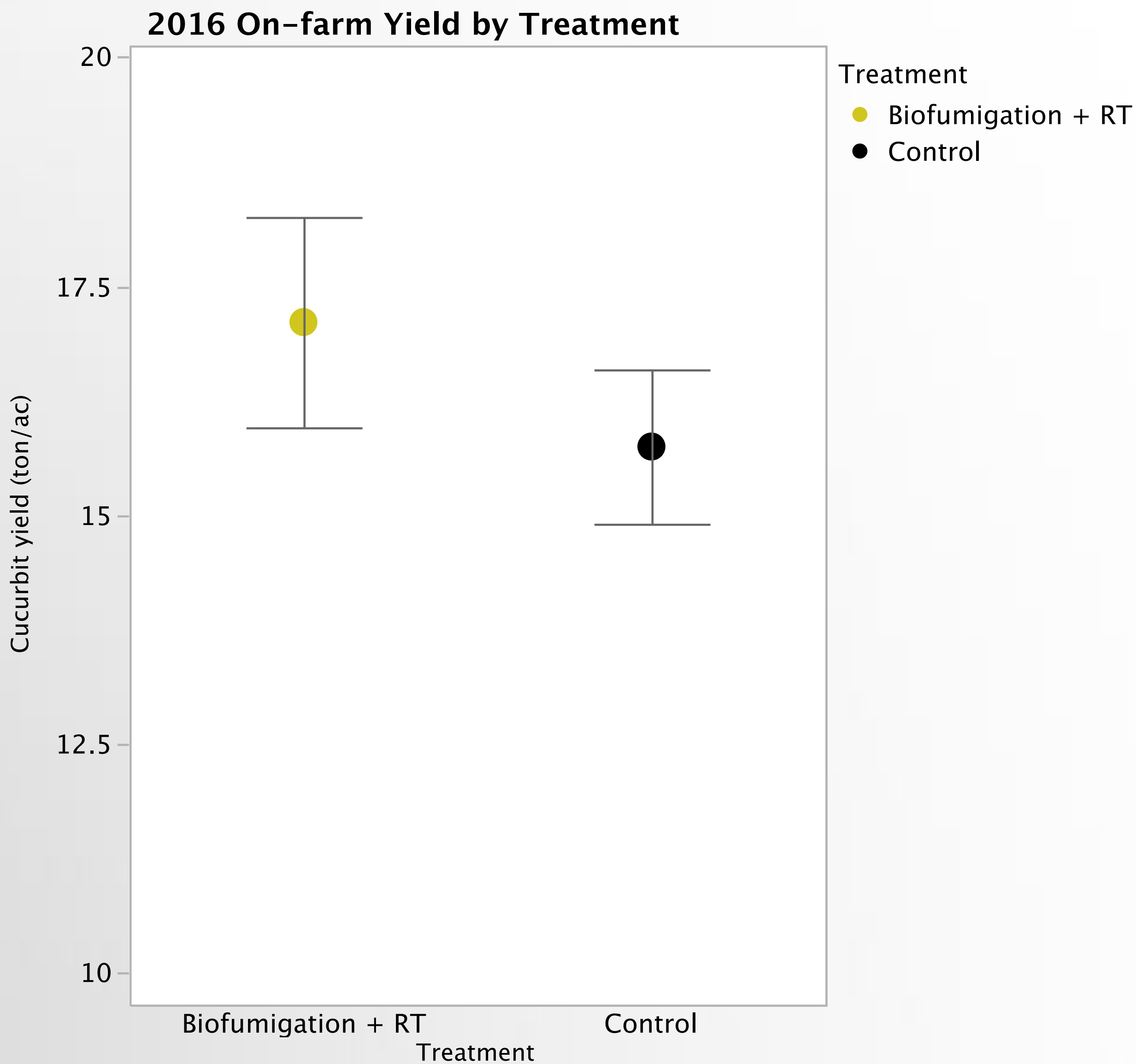
- P-cap incidence overwhelmingly where rye mulch layer was thin or absent & allowed fruit/soil contact

2016 On-Farm response



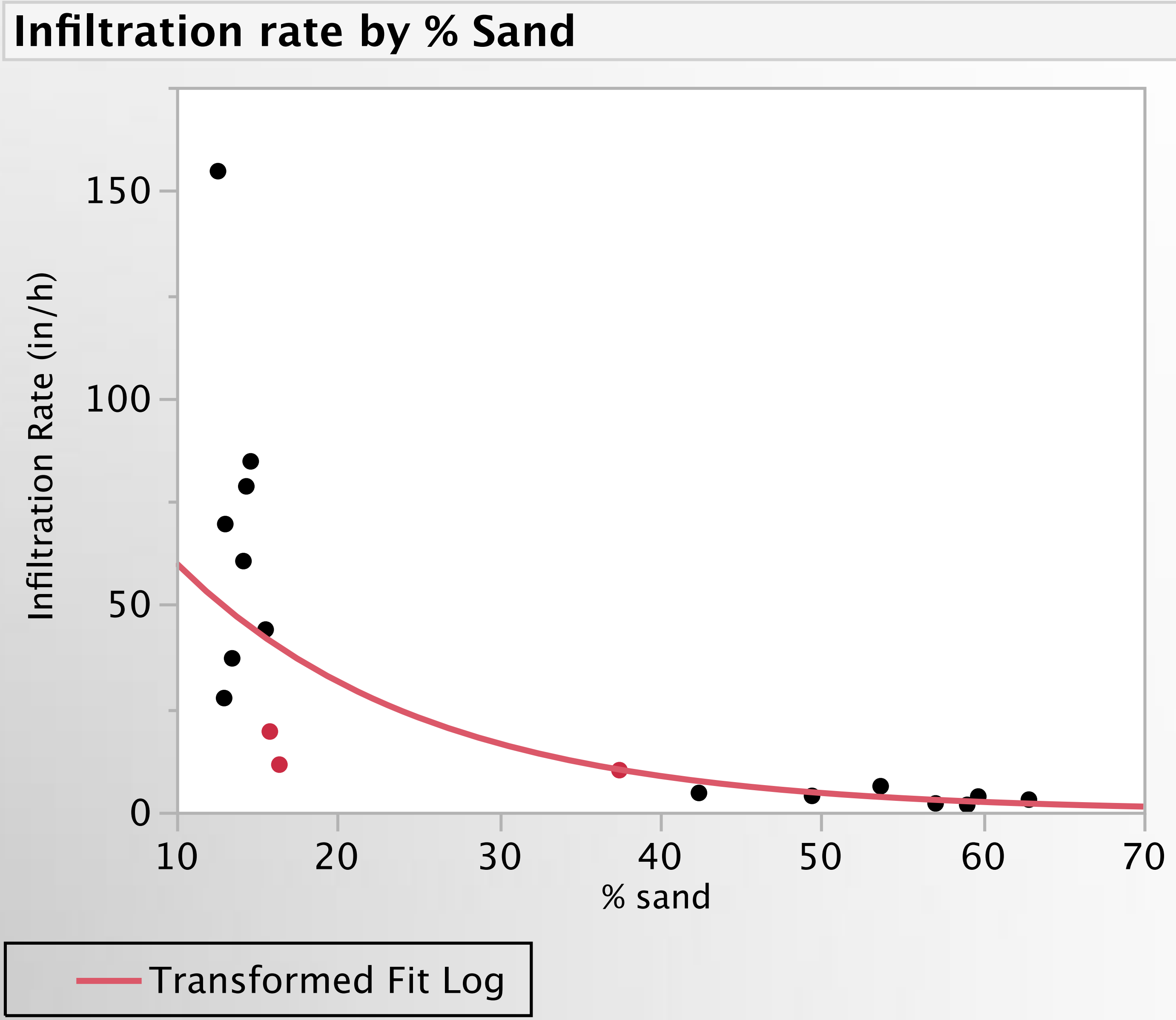
2016 On-Farm response

- Yield: NS!
  - Too much variability…
  - Very low P-cap…
- Infiltration rates: NS!
- Soil health assay: NS!

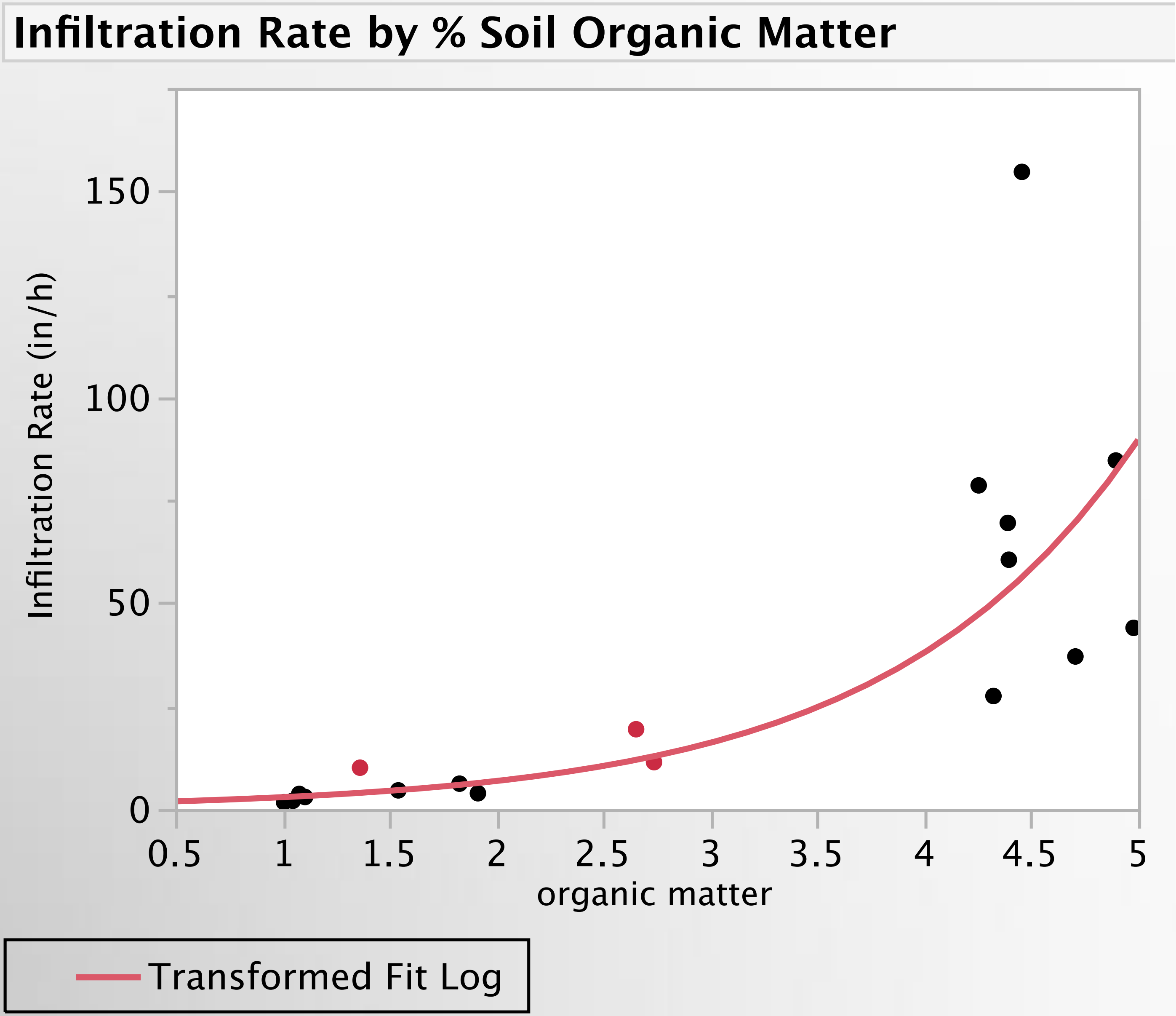


Each error bar is constructed using 1 standard error from the mean.

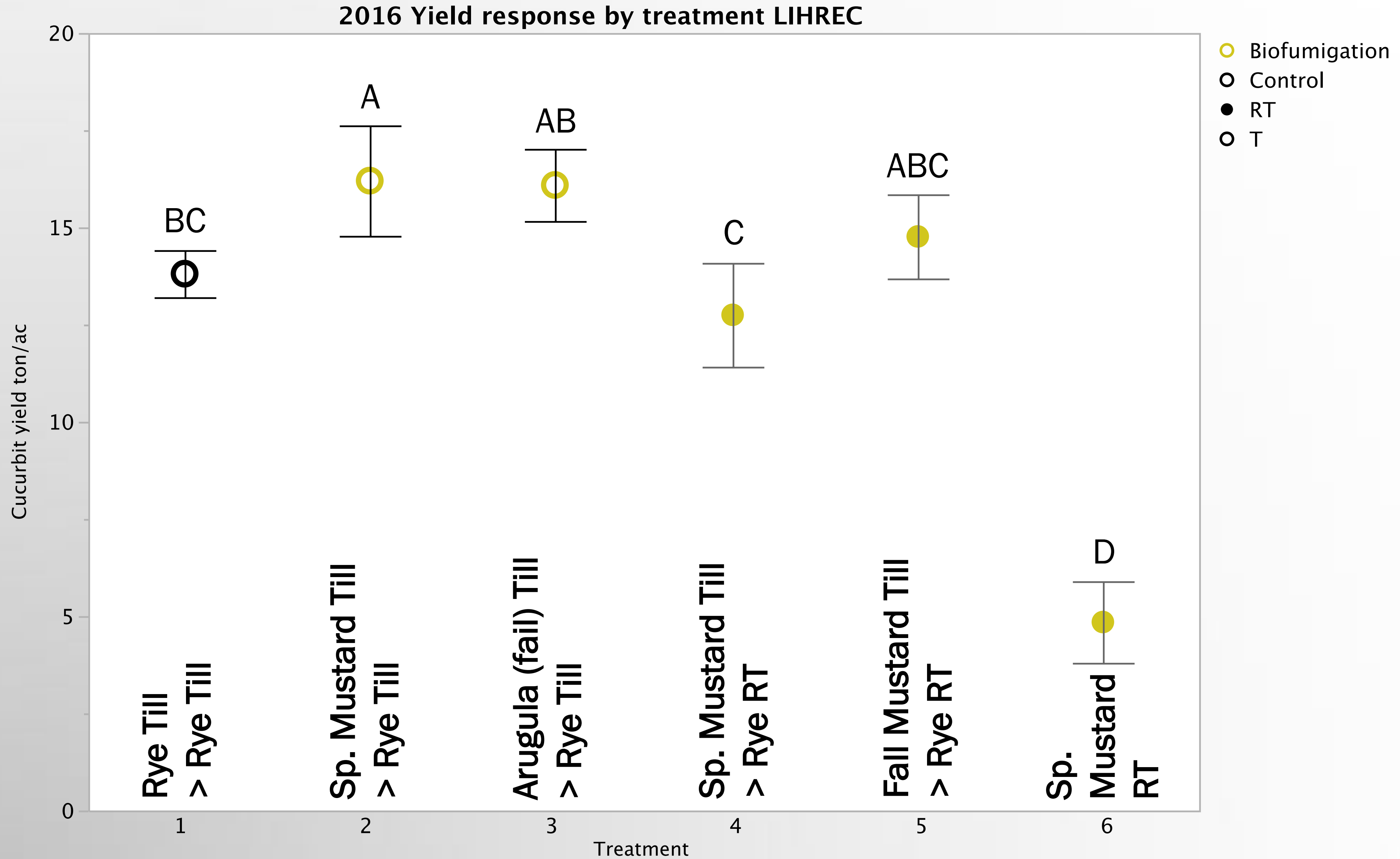
On-farm Infiltration x % Sand



On-farm Infiltration x SOM

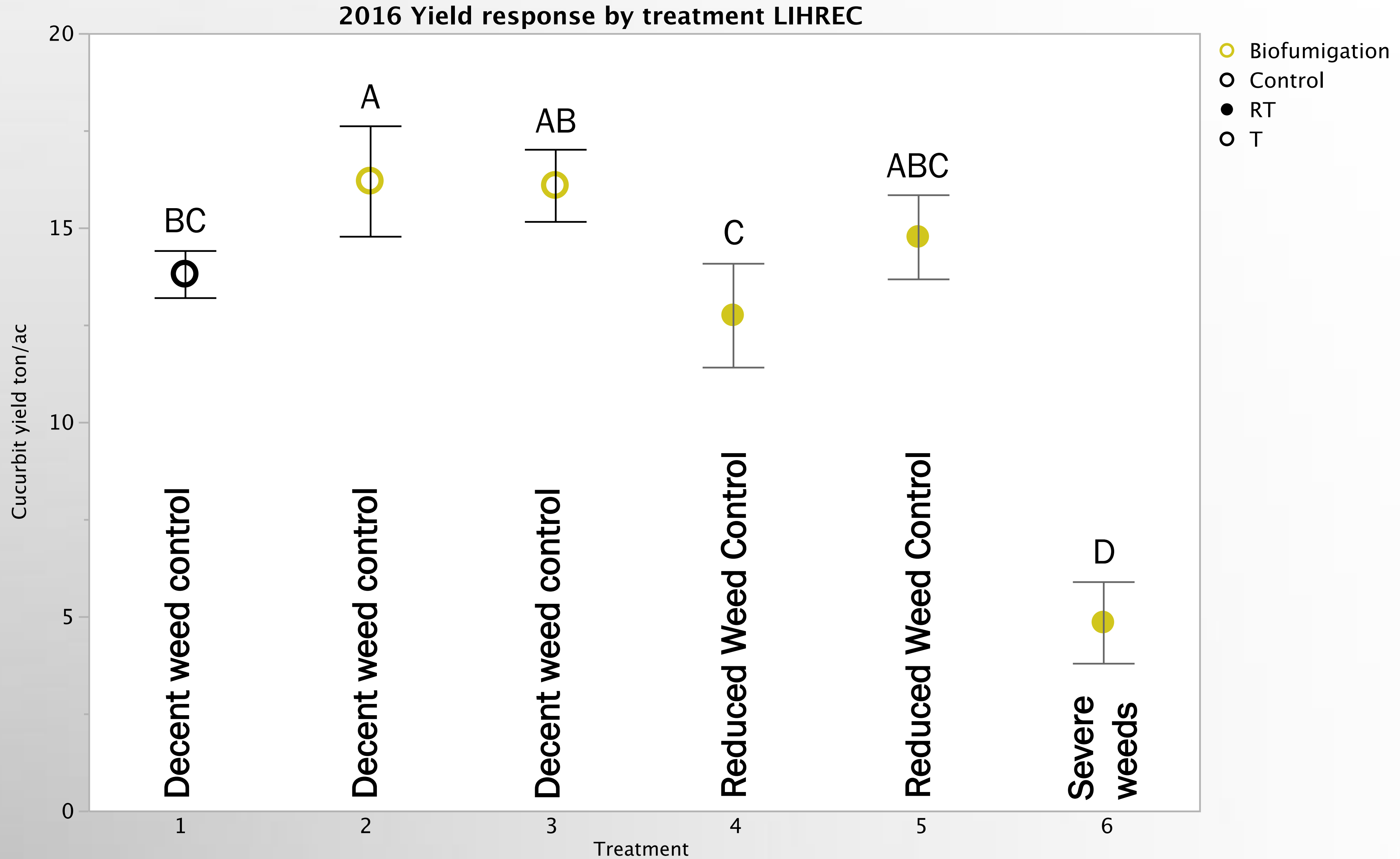


2016 Yield LIHREC



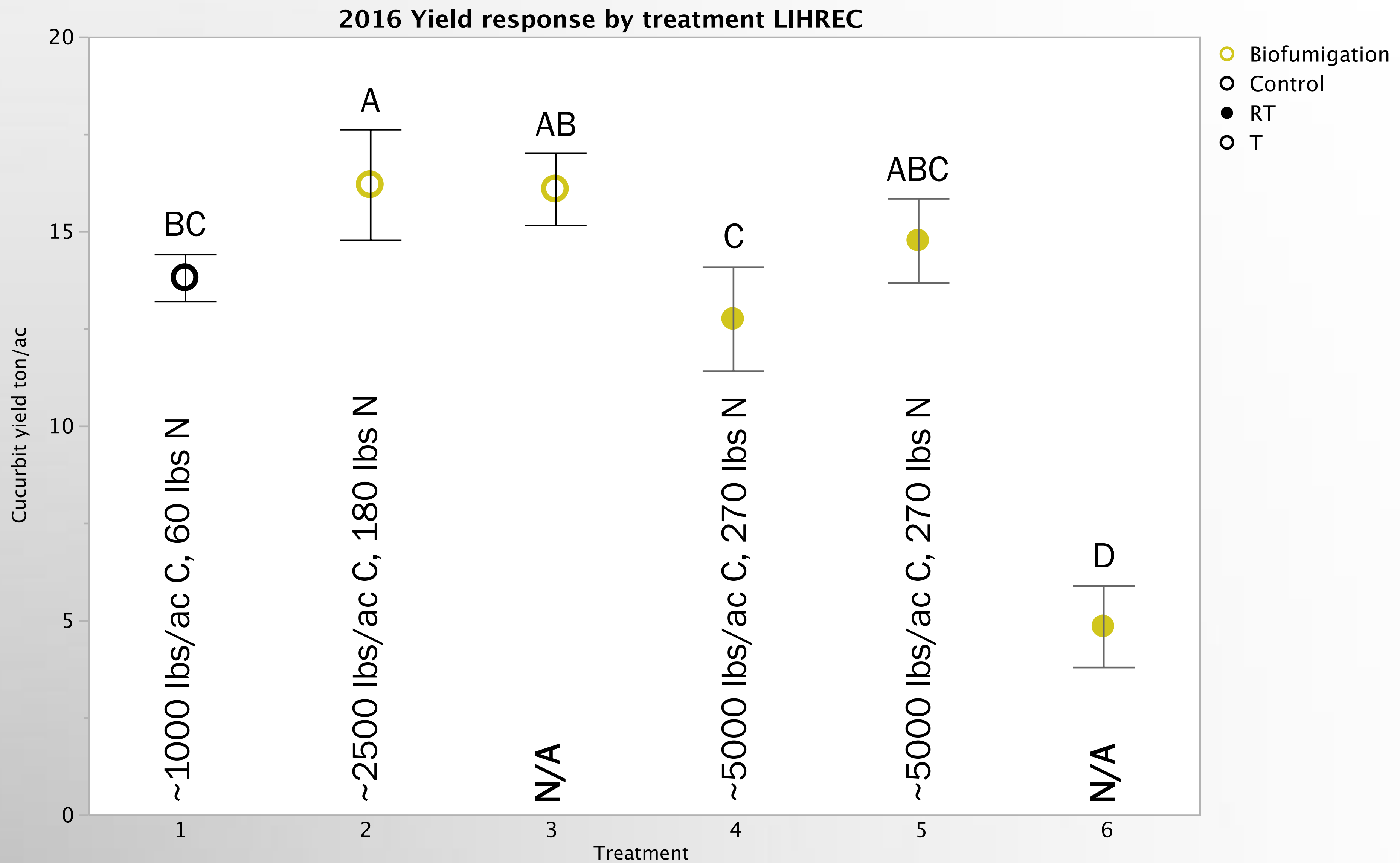
Each error bar is constructed using 1 standard error from the mean.

2016 Yield LIHREC



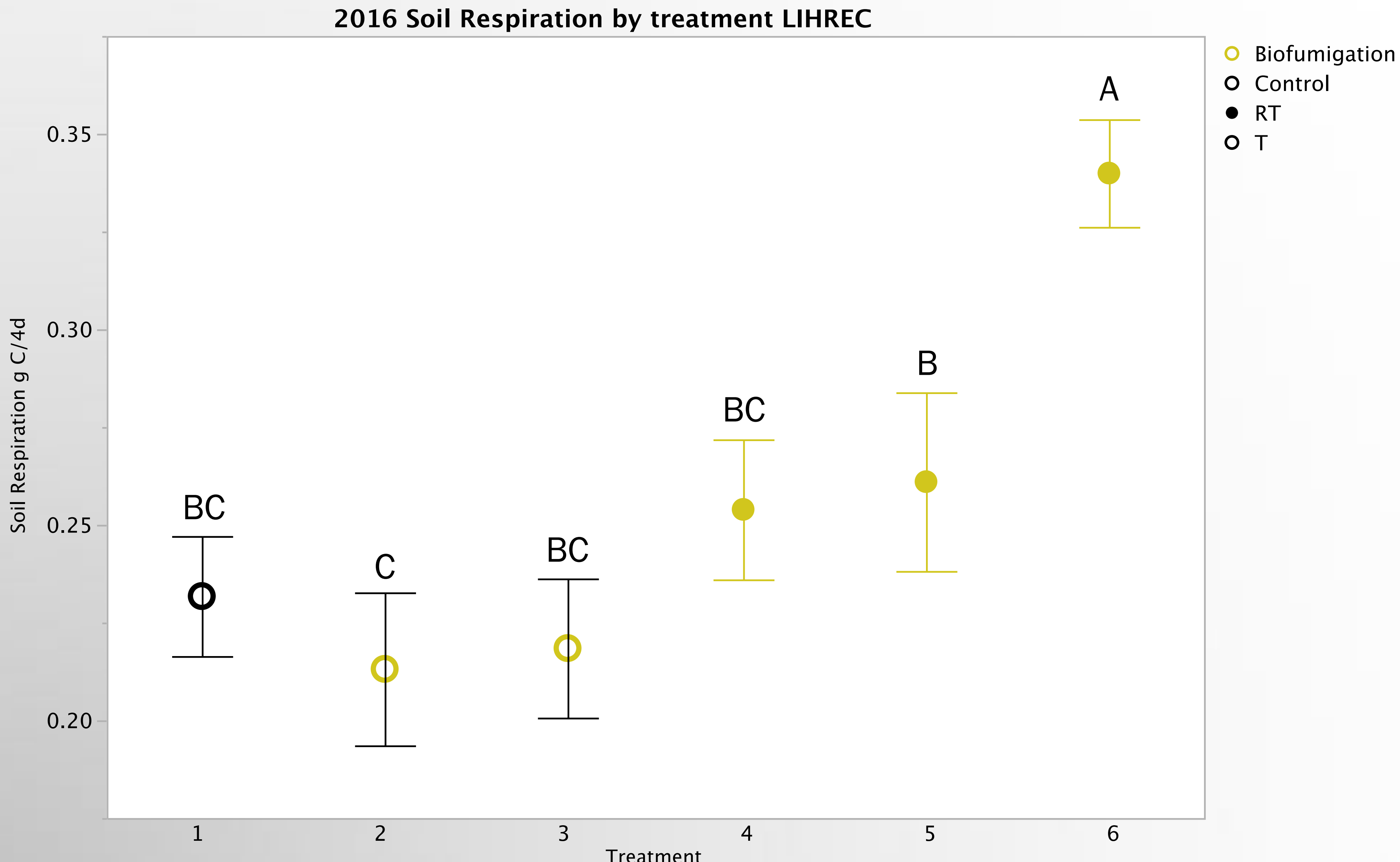
Each error bar is constructed using 1 standard error from the mean.

2yr C & N returned, LIHREC



Each error bar is constructed using 1 standard error from the mean.

2016 LIHREC Infiltration, Health



Each error bar is constructed using 1 standard error from the mean.

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2016 Anecdotal observation-

- Robust rye mulch appeared to boost RT weed control

Yr 1: Biofumigation take Home Points

- Mindset: **Treat it like a crop!**
- Use varieties selected for biofumigation
- Good seedbed prep, weed control
- Ample fertility, moisture
- Seed timely for 50-60 days growth
- Follow biofumigation steps
- *'Nemat' Arugula does not overwinter in NY*
- Consider issues w/brassica diseases, residual herbicides
- View biofumigation as one tool of many
- Consider other benefits of cover crop
  - N catch cropping, & fertility improvement
  - SOM building, infiltration, soil-quality improvement

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Yr 2: To-date RT year take-home points

- Barriers to adoption: Equipment • weed control concerns
- Cover crop kill timing & method can be challenging
- Fertility needs sometimes higher in RT, esp. w/rye mulch
- Robust rolled mulch: lowered fruit/P-cap-infected soil contact?
  - improved RT weed control?
- Likely to help build SOM > improved infiltration over time?
- RT the more potent of the biofumigation + RT combo?
- Fall biofumigation followed by RT may be more promising option- no considerable downsides observed, logistical
- Better understanding of biofumigation is in order
- Longer term studies may be needed for 1) measuring possible cumulative biofumigation & RT effects and 2) assuring p-cap incidence/chances to collect evidence

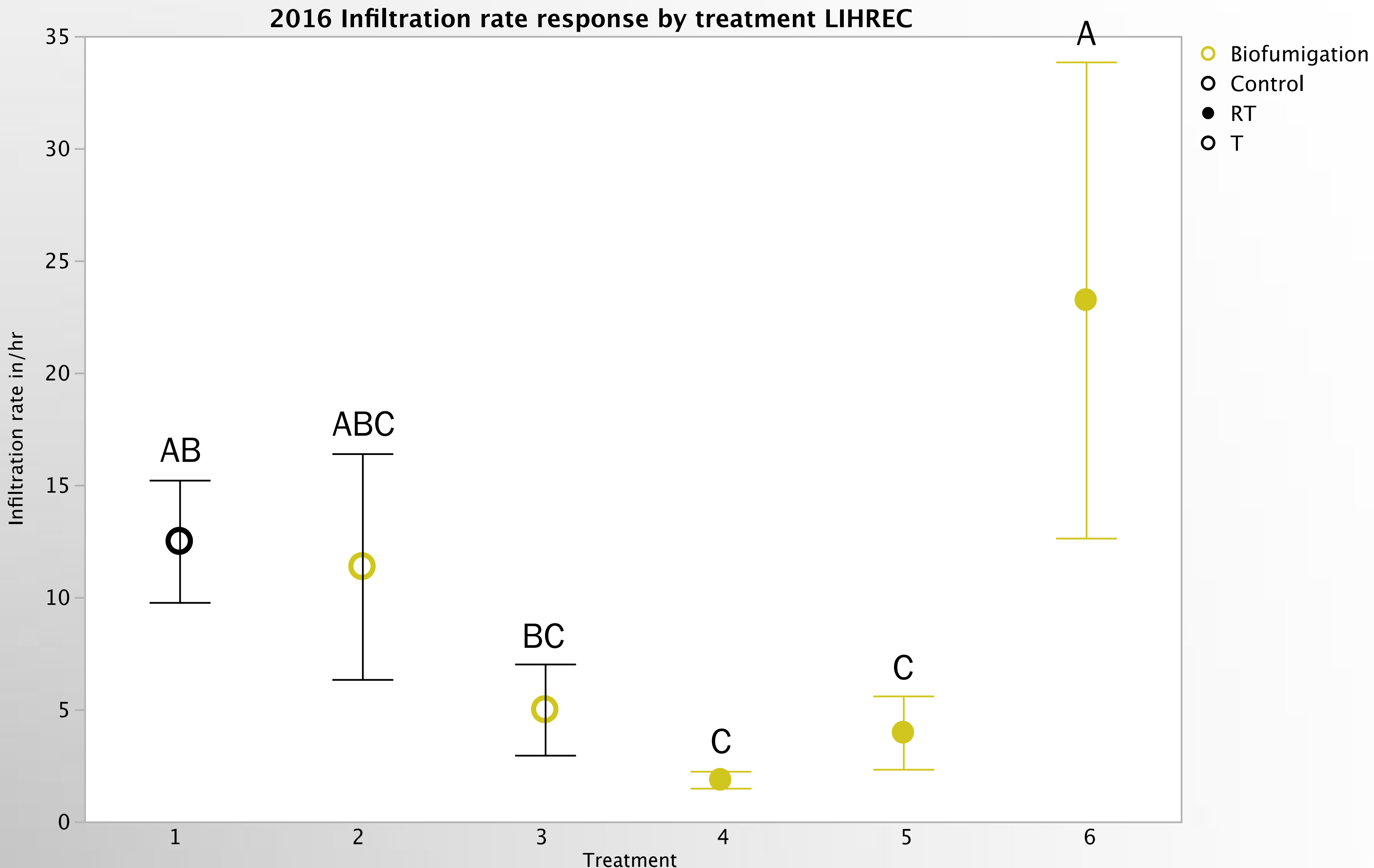
Questions?

Thanks to:

- *NE-SARE*
- *Farmer collaborators*
- *Sandy Menasha*
- *Robert Hadad*
- *Meg McGrath*
- *Summer field staff*

http://ulster.cce.cornell.edu/agriculture/crop-production/integrated-phytophthora-blight-management-in-vegetable-crops-with-enhanced-soil-health-from-cover-crops-reduced-tillage-and-bras

2016 LIHREC Infiltration, Health



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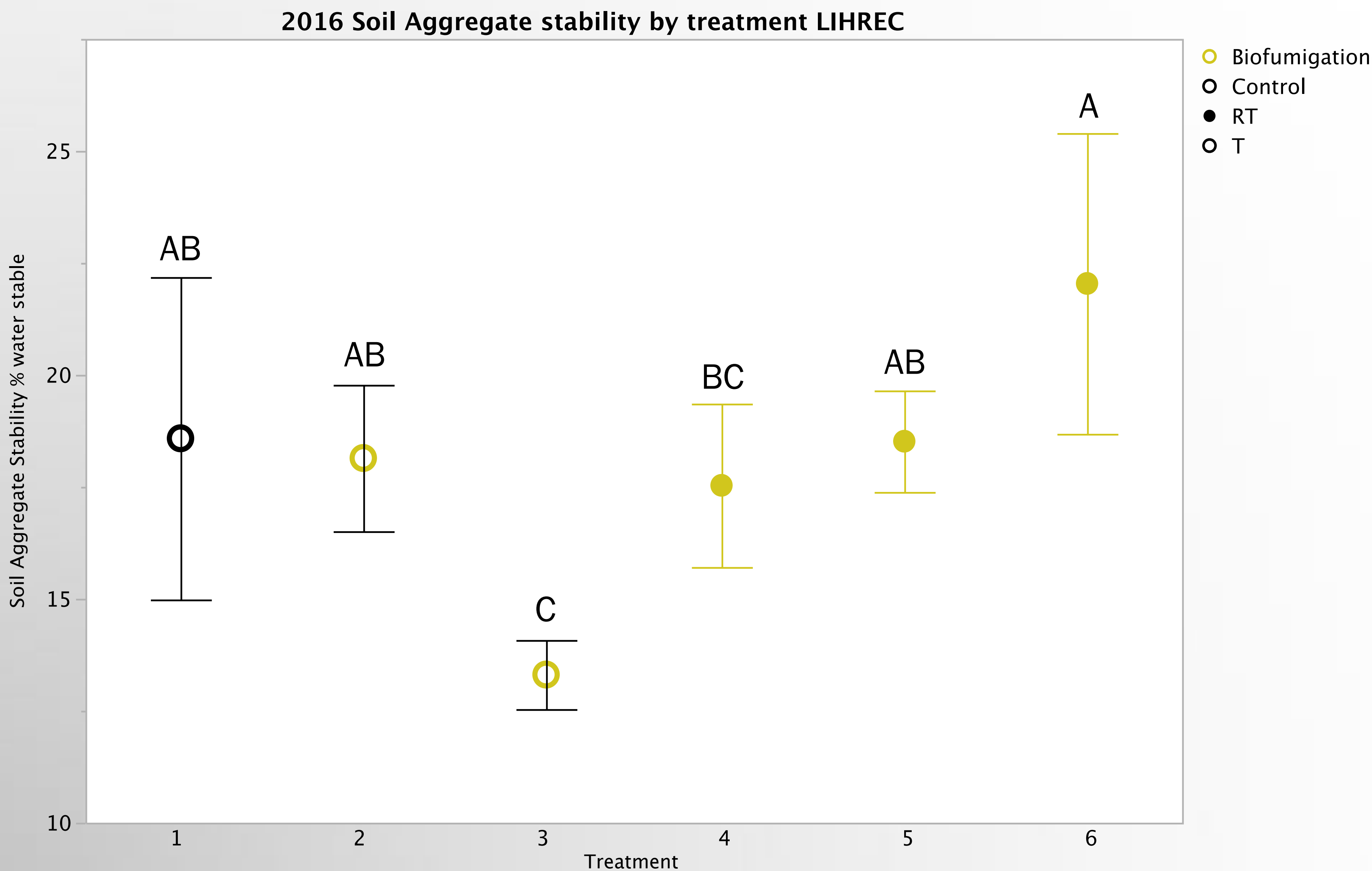
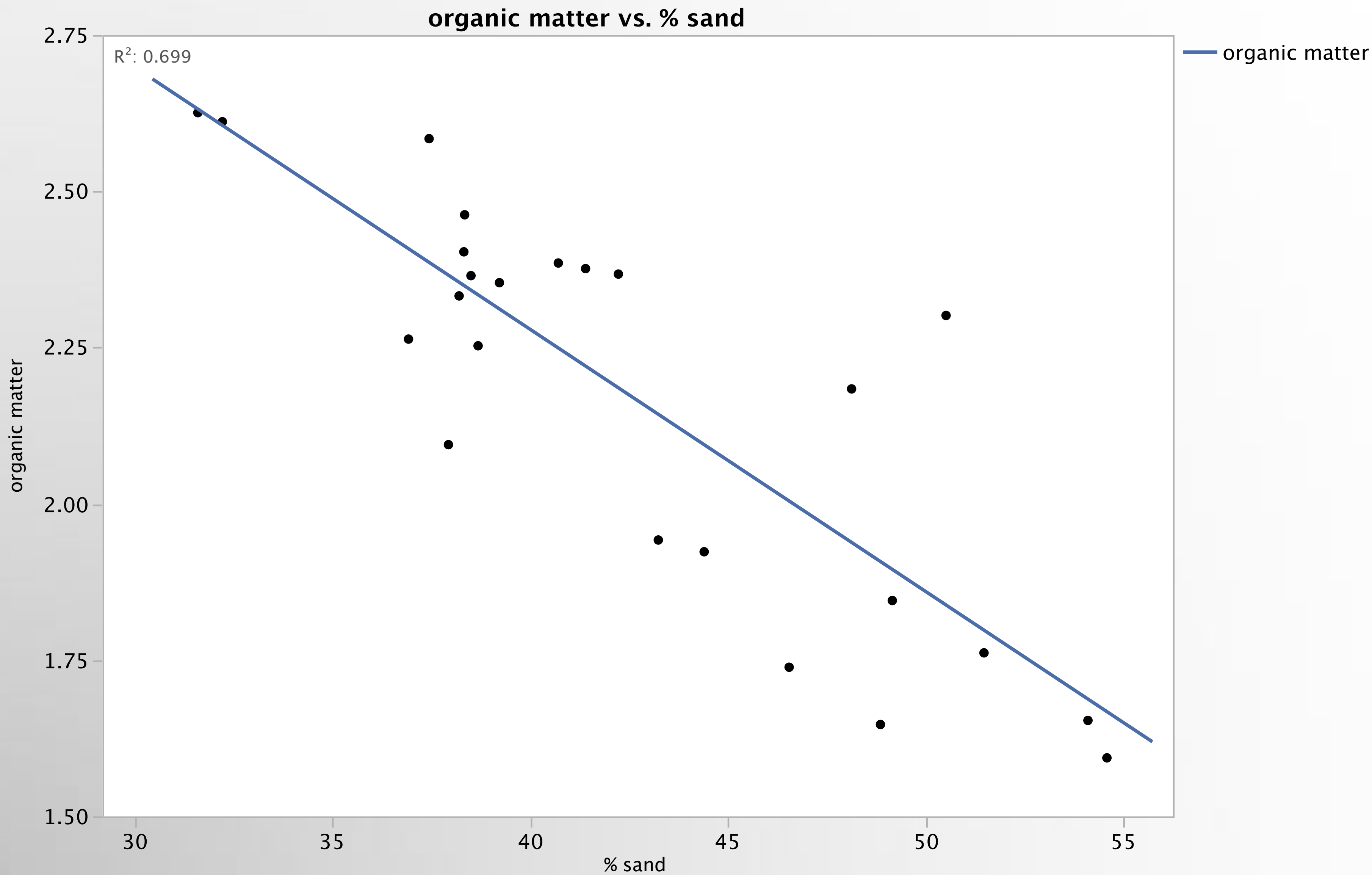
2016 LIHREC Infiltration, Health

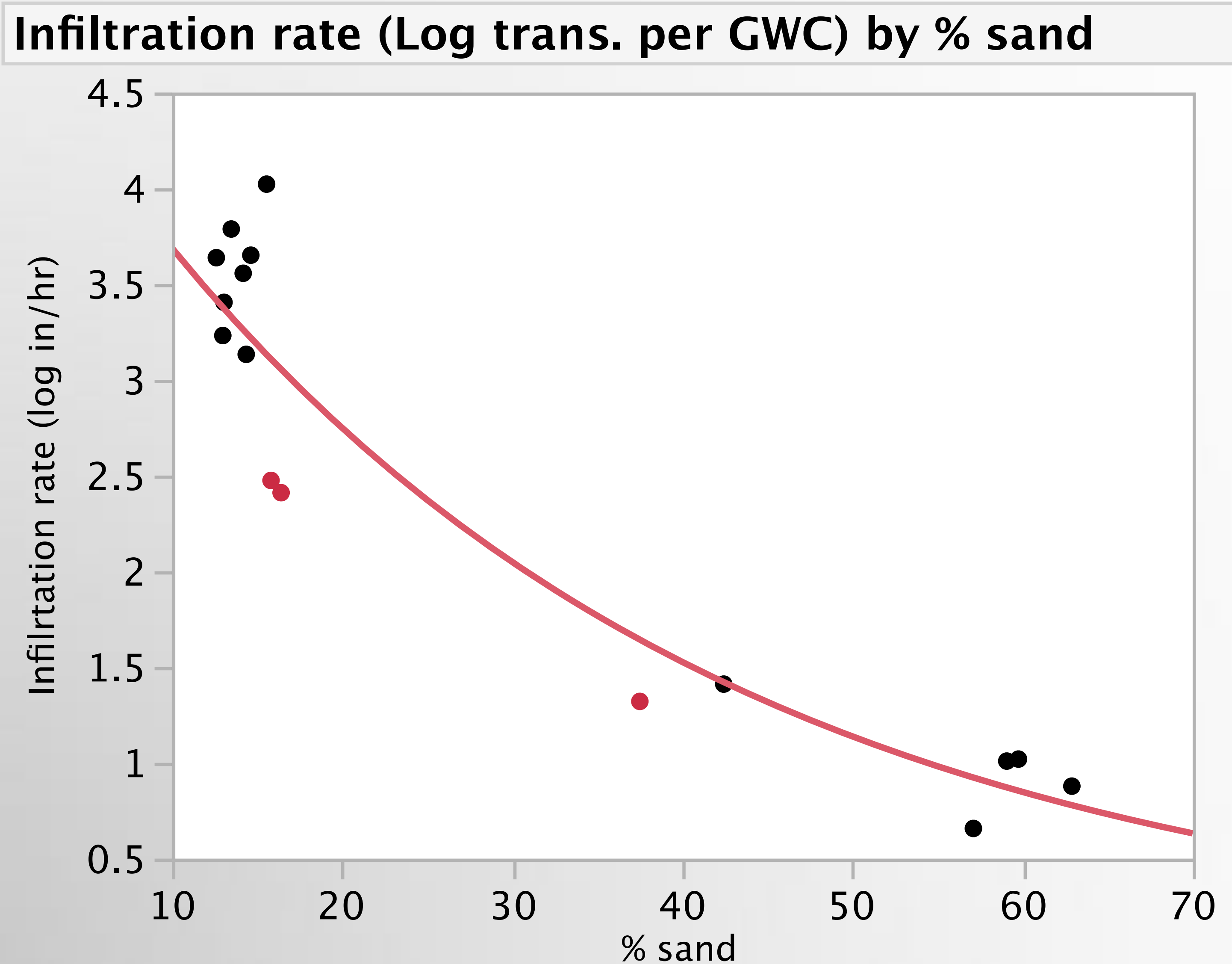


Each error bar is constructed using 1 standard error from the mean.

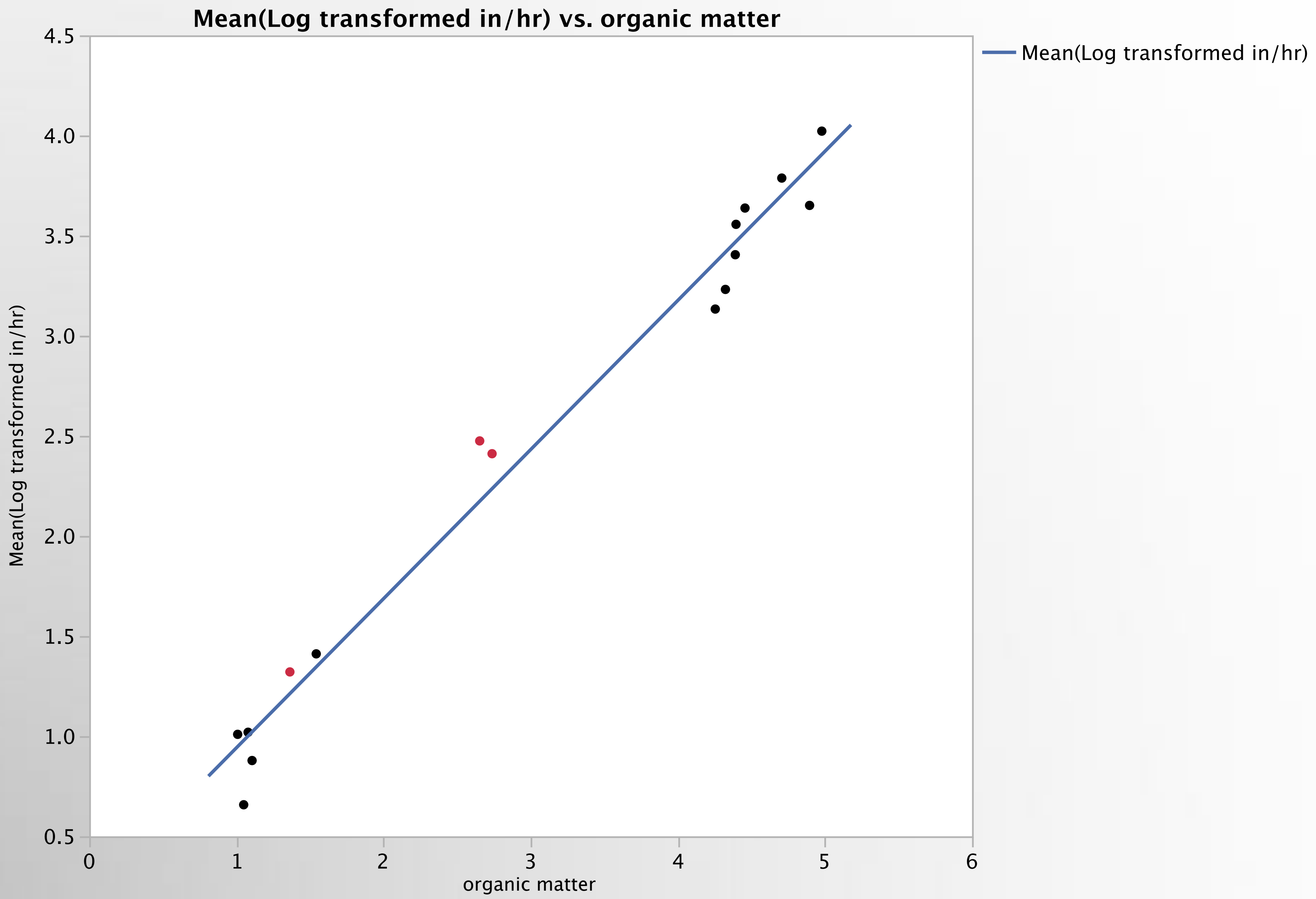
2016 LIHREC %SOM by %Sand



2016 On-Farm response



2016 On-Farm response



Biofumigants and soil health

- Good soil tilth*
- Sufficient depth*
- Sufficient but not excess nutrients*
- Small population of plant pathogens and insect pests**
- Good soil drainage*
- Large population of beneficial organisms*
- Low weed pressure*
- Free of chemicals and toxins that may harm the crop
- Resistant to degradation*
- Resilience when unfavorable conditions occur*


D. Gies

Cornell University
Cooperative Extension, Ulster County

Biofumigation

- Equipment
  - Mower (flail is rec'd)
    - Ruptures brassica cells, releases glucosinolates
  - Tillage implement (rototiller rec'd)
    - Increases biofumigant contact with soil borne pathogens
  - Packing implement (cultipacker rec'd)
    - Seals in ITC biofumigant gas
  - Irrigation lines if droughty
    - Assures conversion of glucosinolates to ITCs
    - Assures start of 7-14 day biofumigation period
    - Helps seal soil surface to retain ITC gas

Growing for biofumigation

- Considerations
  - Species/variety with high *glucosinolate* content
    - ‘Caliente’ varieties (*B. juncea*)
    - ‘Nemat’ arugula (*Eruca sativa*)
    - ‘Pacific Gold’ (*B. juncea*)
    - ‘Ida Gold’ (*B. campestris*)
    - *White mustard (Sinapsis alba)*
    - *Rapeseed, Canola (B. napus)*
    - *Pennycress (Thlaspi arvense)*

Screening *Brassica* species for glucosinolate content

GEORGE F. ANTONIOUS[1], MICHAEL BOMFORD[1] and PAUL VINCELLI[2]
[1] *Department of Plant and Soil Science, Land Grant Program, Atwood Research Center, Kentucky State University, Frankfort, Kentucky, USA*
[2] *Department of Plant Pathology, University of Kentucky, Lexington, Kentucky, USA*

Glucosinolate and isothiocyanate concentration in soil following incorporation of *Brassica* biofumigants

A.L. Gimsing[a,b,*], J.A. Kirkegaard[a]
[a] *CSIRO Plant Industry, GPO Box 1600, Canberra ACT 2601, Australia*
[b] *Department of Natural Sciences, The Royal Veterinary and Agricultural University, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark*

Received 31 October 2005; received in revised form 17 January 2006; accepted 24 January 2006
Available online 27 March 2006

BIOFUMIGANT COMPOUNDS RELEASED BY FIELD PENNYCRESS (*Thlaspi arvense*) SEEDMEAL[1]

STEVEN F. VAUGHN,* TERRY A. ISBELL, DAVID WEISLEDER, and MARK A. BERHOW

New Crops and Processing Technology Research
USDA, ARS, National Center for Agricultural Utilization Research
1815 N. University St., Peoria, Illinois 61604, USA

Growing for biofumigation

- Considerations
  - ***<u>TREAT IT LIKE A CASH CROP!</u>***
  - Crop rotation
    - Sequence before soilborne disease-sensitive cash crops
    - Distance from brassica cash crops in time and space
    - Past herbicide?
  - Season timing (~50-60d growth)
    - Spring (April - June)
    - Winter (Sept - winterkill or May)
    - Late summer (Aug – Oct)*

Growing for biofumigation

- Seedbed preparation
  - Conditioning for small seeded crop
  - Weed-free
  - Pre-plant fertility
    - Soil test recommended P, K, micros for mustards
    - Starter N (~20 lbs mimimum, esp. in spring!!)
    - S (~20 lbs or ~6:1 N:S ratio; gypsum will not lower pH)
    - *Your biofumigation can only be as good as your fertility*

Growing for biofumigation

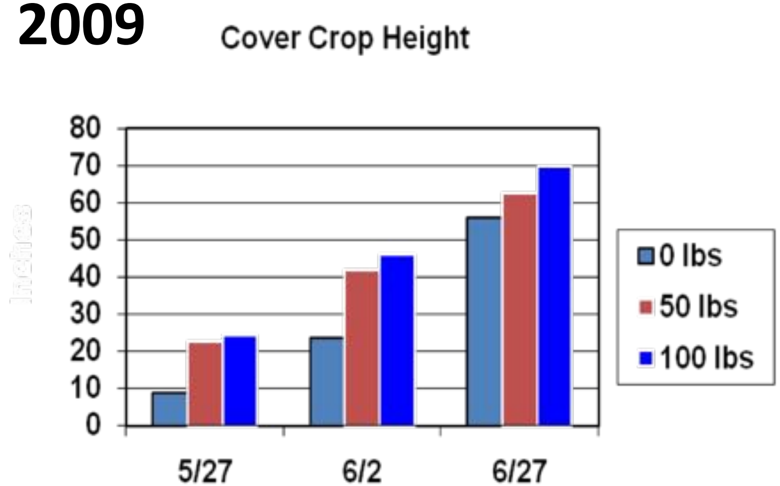
- Seeding
  - Use drill (rec'd) or broadcast
  - Seed depth: ¼ to ½"
  - Mustards: 10-12 lbs/ac
  - Arugula: 6-8 lbs/ac
    - Late seedings, shortened season > can increase rate

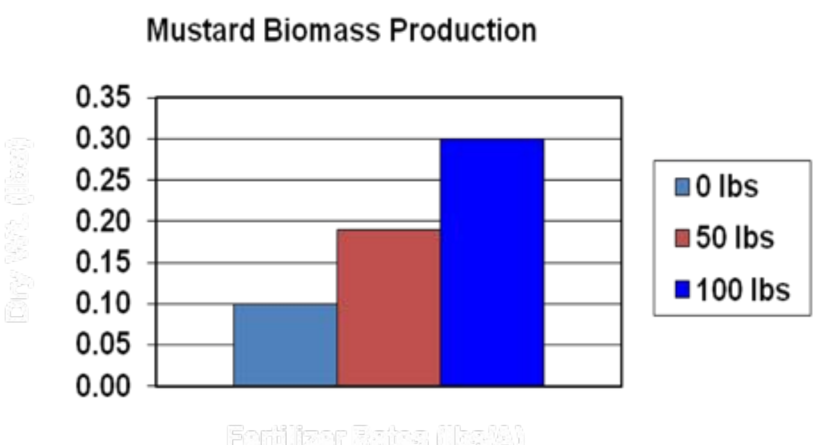
Growing for biofumigation

- Management
  - Topdress N (usually needed)
    - 50-100 lbs/ac total applied N is optimal
    - Depends on crop history, inherent fertility
  - Weed control?
  - Irrigate if droughty

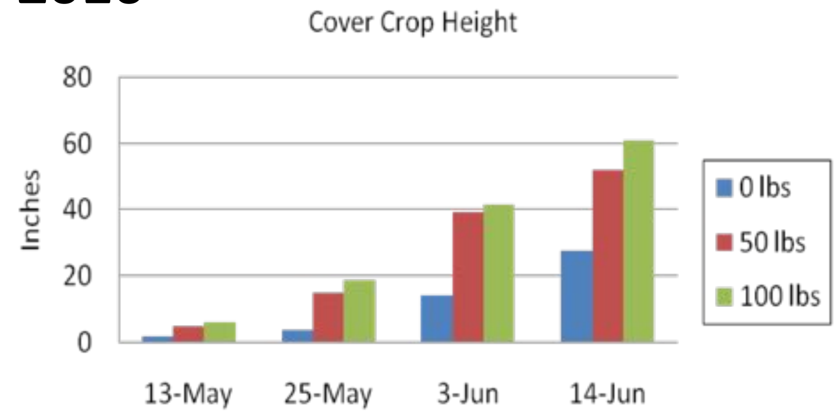
Nitrogen Fertility and Biomass Production

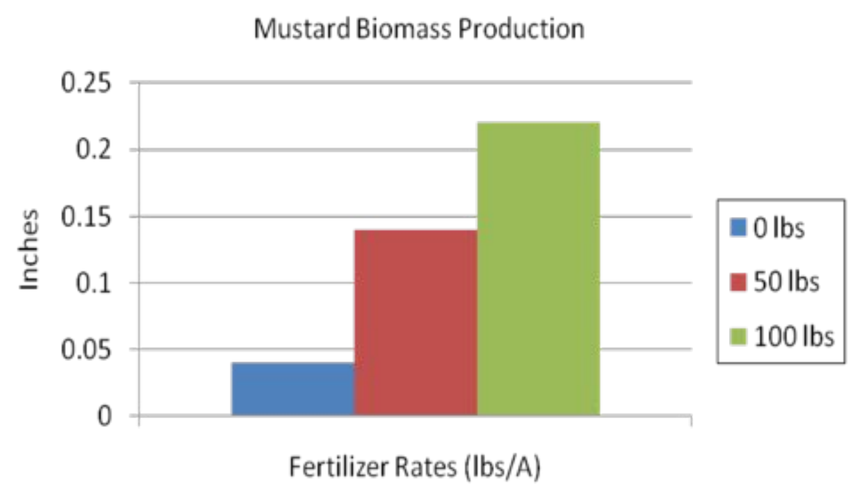
2009





2010





cf. Sandy Menasha

Growing for biofumigation

- What to Expect:
  - Begins flowering after ≥30 d usually ~2½-3'
    - Let it flower away!
  - Viable seed 6 weeks from flower
  - Doubles in height after flowering
  - Grows up to ~5 ft
  - Incorporate 2-4 weeks after flower
  - Biofumigation potential drops after maturity
    - Mustard weed seed after maturity

Biofumigation

- ~10 day biofumigation recommended
- Should inhibit weed seed germination by default
- SO- do not plant crops in biofumigating soils also- poor germ risk!
- Light tillage after biofumigation period will help assure release of any remaining gases
- *Heavier soils may hold in gas more?*
  - *Also may not biofumigate as thouroughly?*

Y

- X

Prelim. data, on-farm '15: Cvr. crop biomass