

Fitting bio-fumigant cover crops into intensive vegetable production systems for integrated crop management



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Some potential benefits of cover crops



What are bio-fumigant cover crops?

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Fumigants

Synthetic chemicals

- Methyl bromide***
- Methyl iodide***
- Telone***
- Vapam***
- Vorlex***

Plant residue

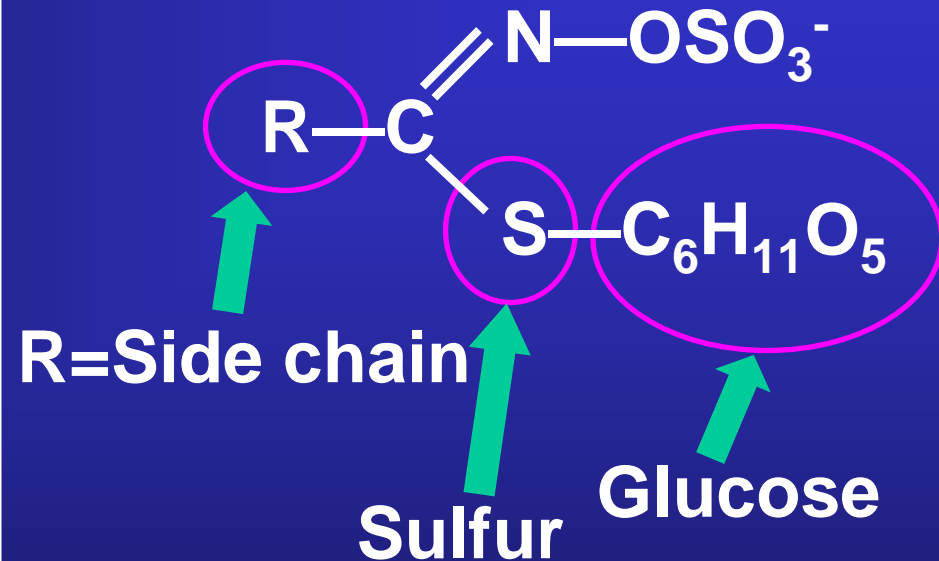
- Mainly plants that produce glucosinolates***

Natural chemicals more accepted than synthetic ones?

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Glucosinolates

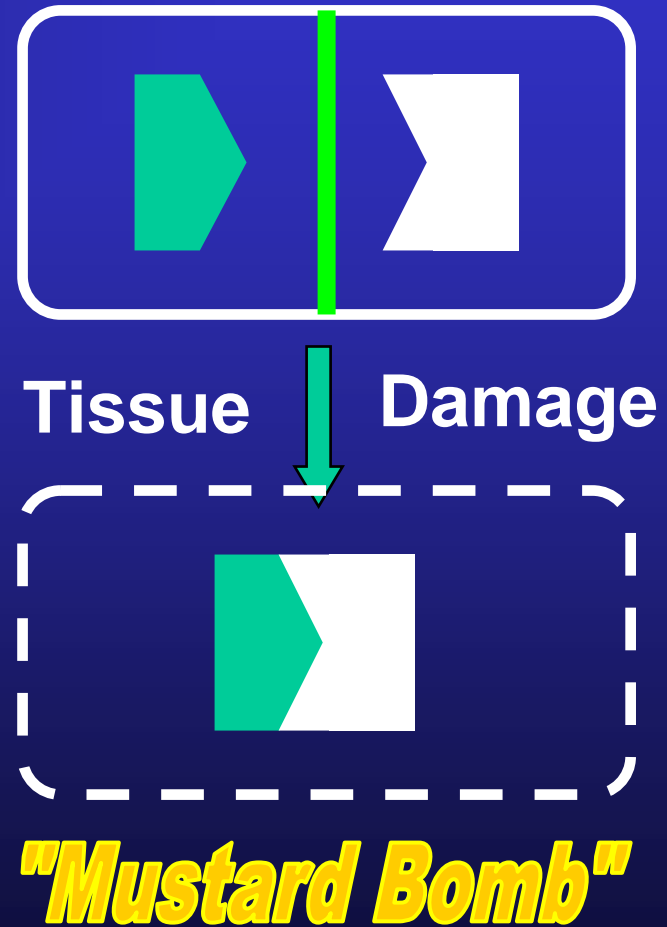
- ❑ Secondary plant metabolites
- ❑ Produced by 15 plant families
- ❑ Mainly the Brassica (or mustard) family.
- ❑ >100 glucosinolates have been identified ($\neq R$)



Glucosinolates are not toxic
But their breakdown products are

Degradation of Glucosinolates

- ❑ *Myrosinase enzymes are responsible for the degradation of glucosinolates*
- ❑ *But Myrosinases and glucosinolates are located in different compartments in the cell*
- ❑ *Tissue Damage triggers the reaction*

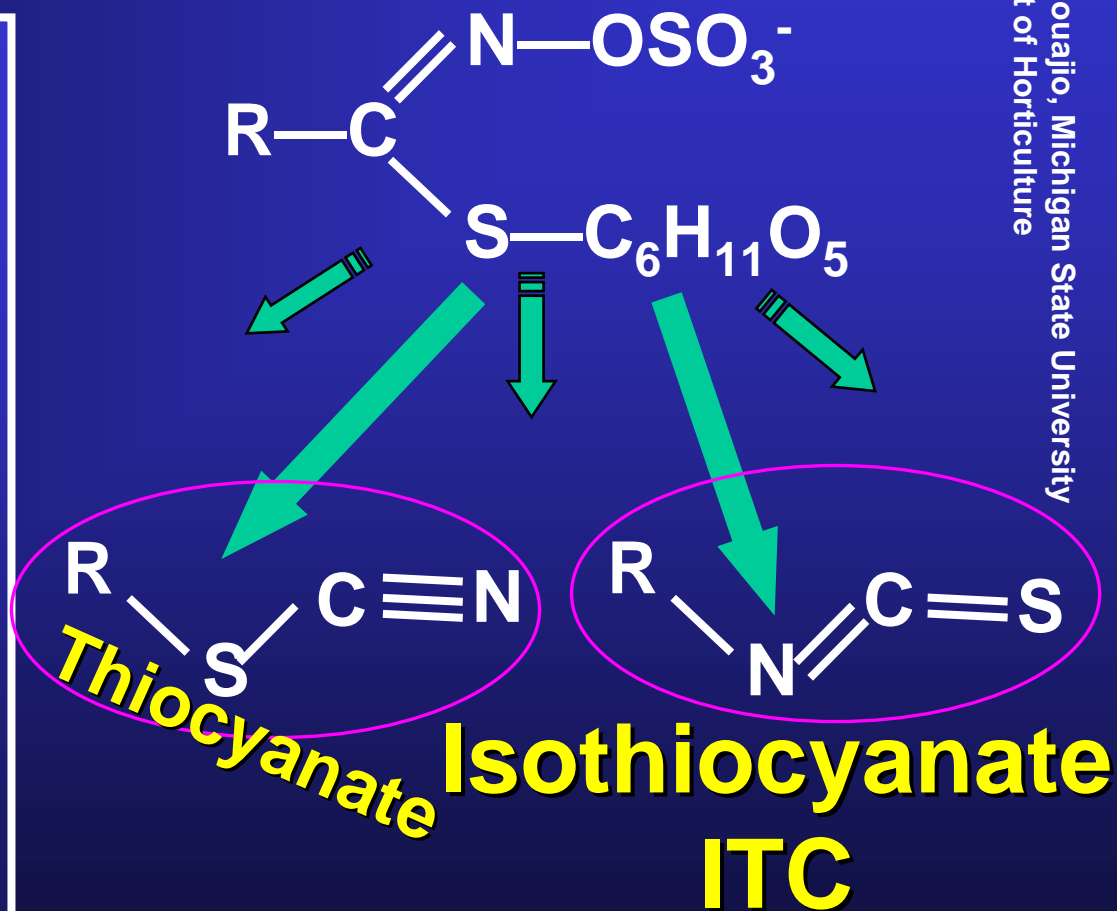


Many different products are formed depending on pH

Glucosinolates Degradation Products

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- Isothiocyanate is the most important breakdown product of glucosinolates
- Used in Commercial fumigants



Isothiocyanate used in Vapam

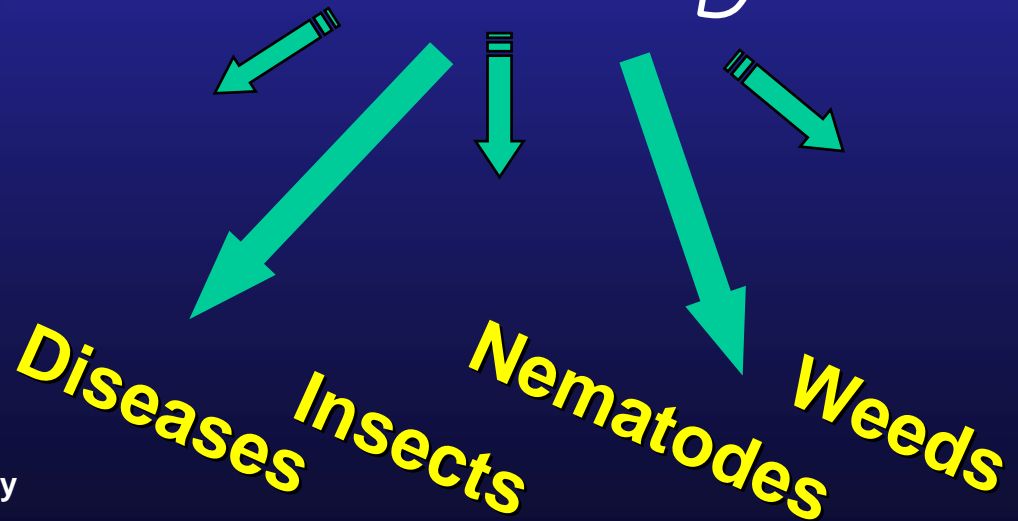
Isothiocyanate Activity

- *Isothiocyanate has shown activity on many plant pests*



Isothiocyanate

Activity



Biofumigants-Biofumigation



Brassica Species are called **Biofumigants** because they release isothiocyanate upon damage of their tissues



The process of incorporating fresh residues of Brassica Species in the soil is called **Biofumigation**

How to improve the biofumigation effect of brassica species?

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How to improve biofumigation?

1

**Maximize biomass production
and glucosinolates content**

Biofumigants-Biofumigation

- Species selection***
- Appropriate seeding rate***
- Seeding time (tolerate freezing temperature down to 28 F)***
- Initial fertilizer if soil is poor***
- Allow the cover crop to grow up to flowering stage (do not allow seed set)***



Brassica Biofumigants species

**Oilseed radish
Oriental mustard
Yellow mustard
Brown mustard
Arugula**

Others

- ***Turnip***
- ***Rape***
- ***Broccoli***
- ***Etc***

Seeding rate

<i>Cover Crop</i>	<i>Range</i>	<i>Rate Used</i>
Oilseed radish	10 to 25	<u>15</u>
Oriental mustard	4 to 6	6
Yellow mustard	10 to 14	8
Brown mustard	10 to 14	8
Sudangrass	40 to 80	60

Rate: Lbs/A

- Broadcast and incorporated
- Large scale: Drilled

How to improve biofumigation?

2

**Crush the tissue and
incorporate in the soil**

Biofumigation in small research plots

Oct. 13, 2003



Mini tiller

Biofumigation in small research plots

Oct. 13, 2003



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Brassica Cover Crops Management

**Cover crops incorporated at flowering stage
June 23, 2006
About 45 Days after planting**



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Biofumigants Incorporation

Use multiple passes of a disc or a rototiller



Use of a flail mower for biofumigation



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Brassica Cover Crops Management

***Simultaneous flail
mowing and
incorporation***



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Efficiency of biofumigation

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Flail mowing + incorporation



Rototiller



Disc



No killing no incorporation

Examples of impacts of biofumigant cover crops in vegetable cropping systems

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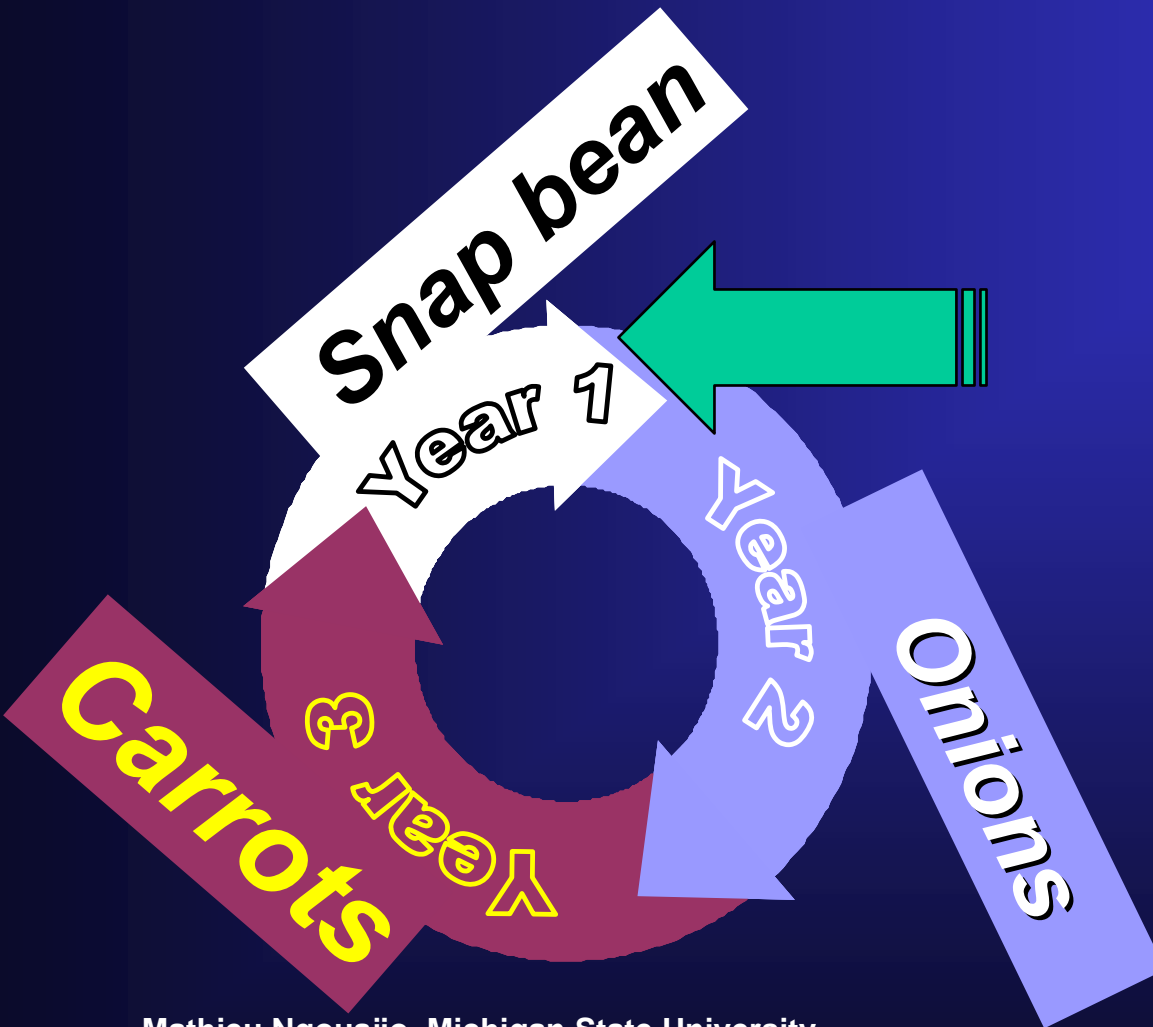
1

Onions production systems

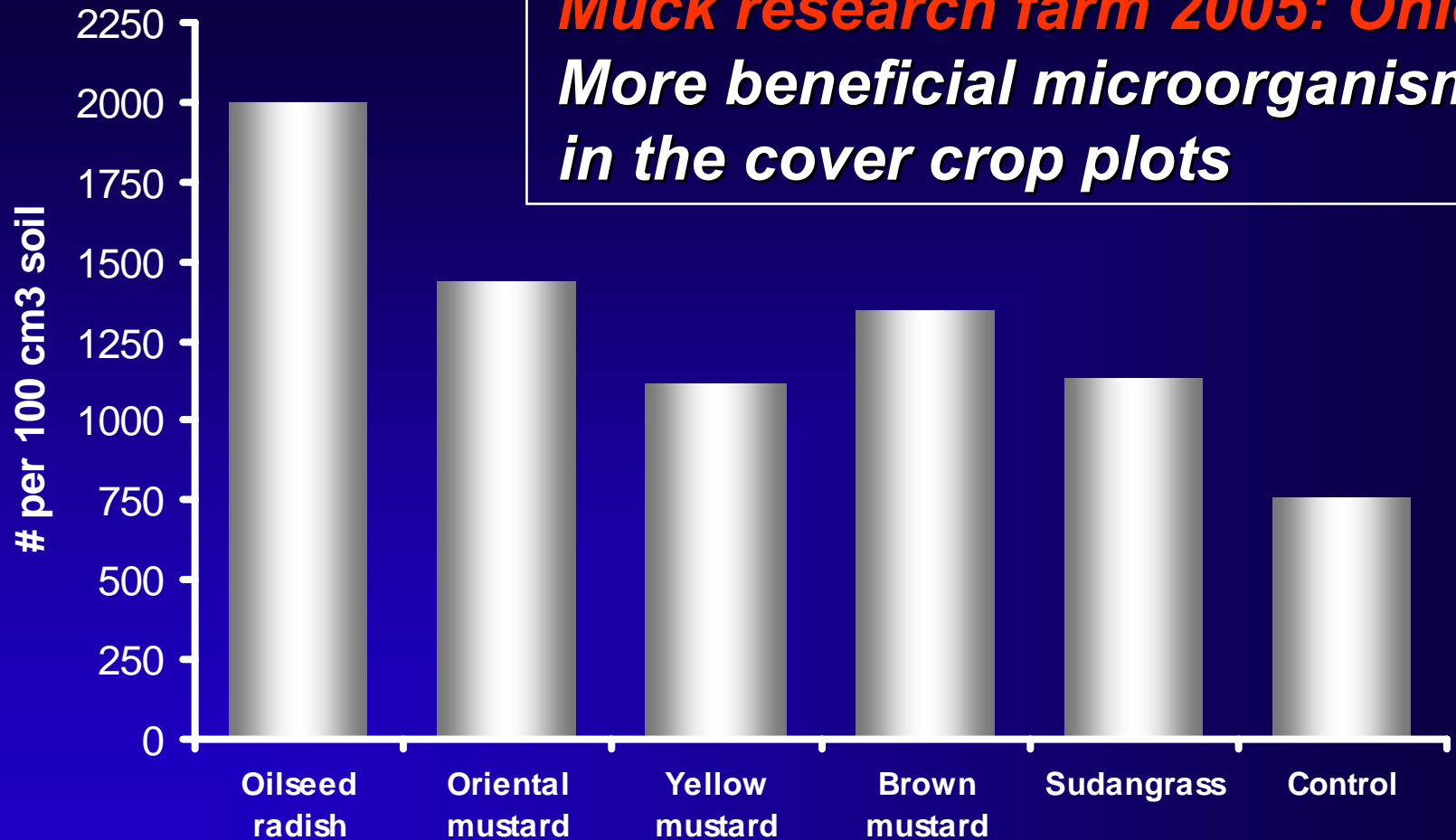


Cover crop timing

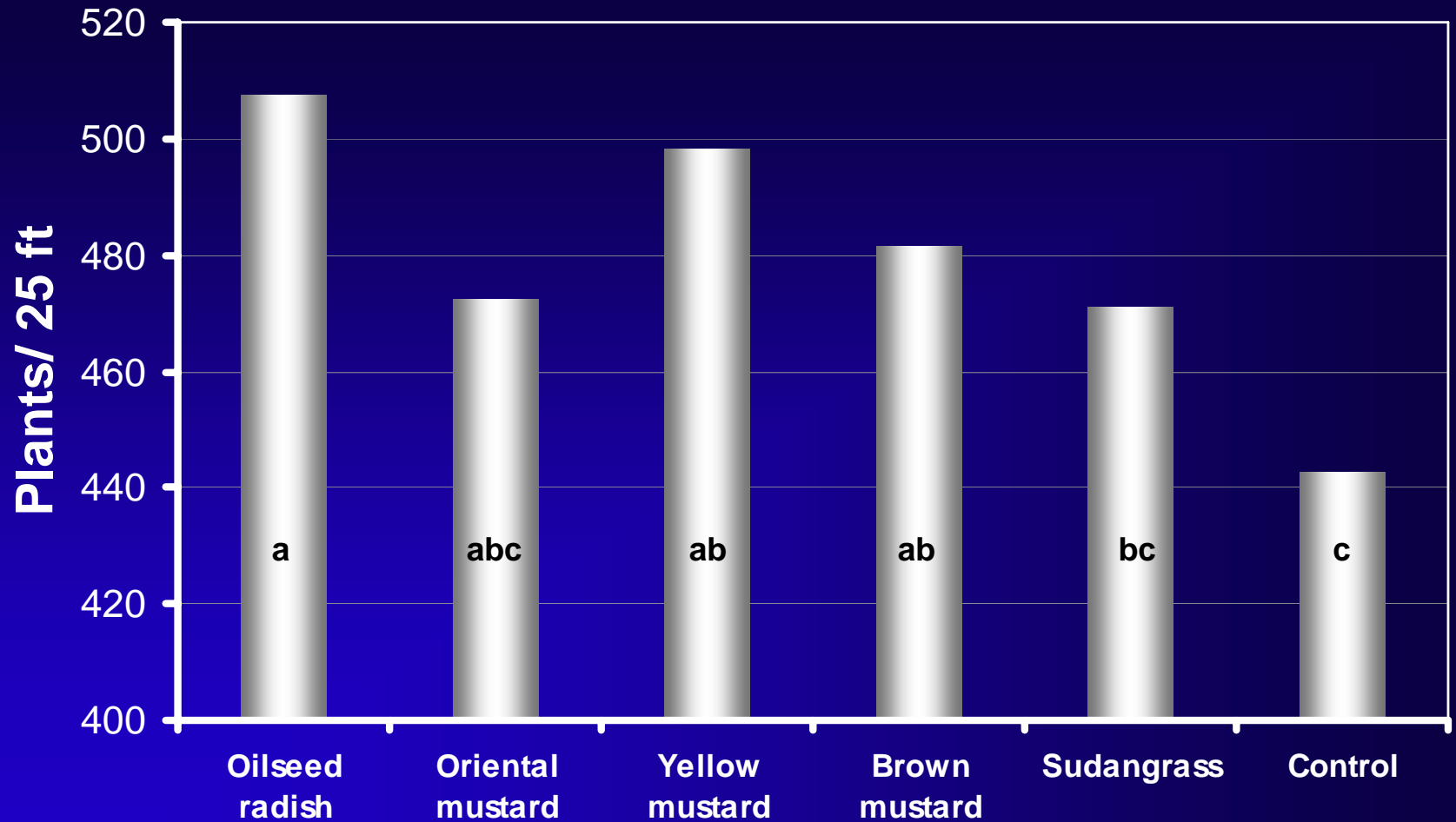
The cover crop should be scheduled in the rotation system and planted in fall of the year before onions



Population of beneficial microorganisms



Onion Stand 2006



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2

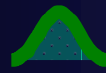
Celery production systems

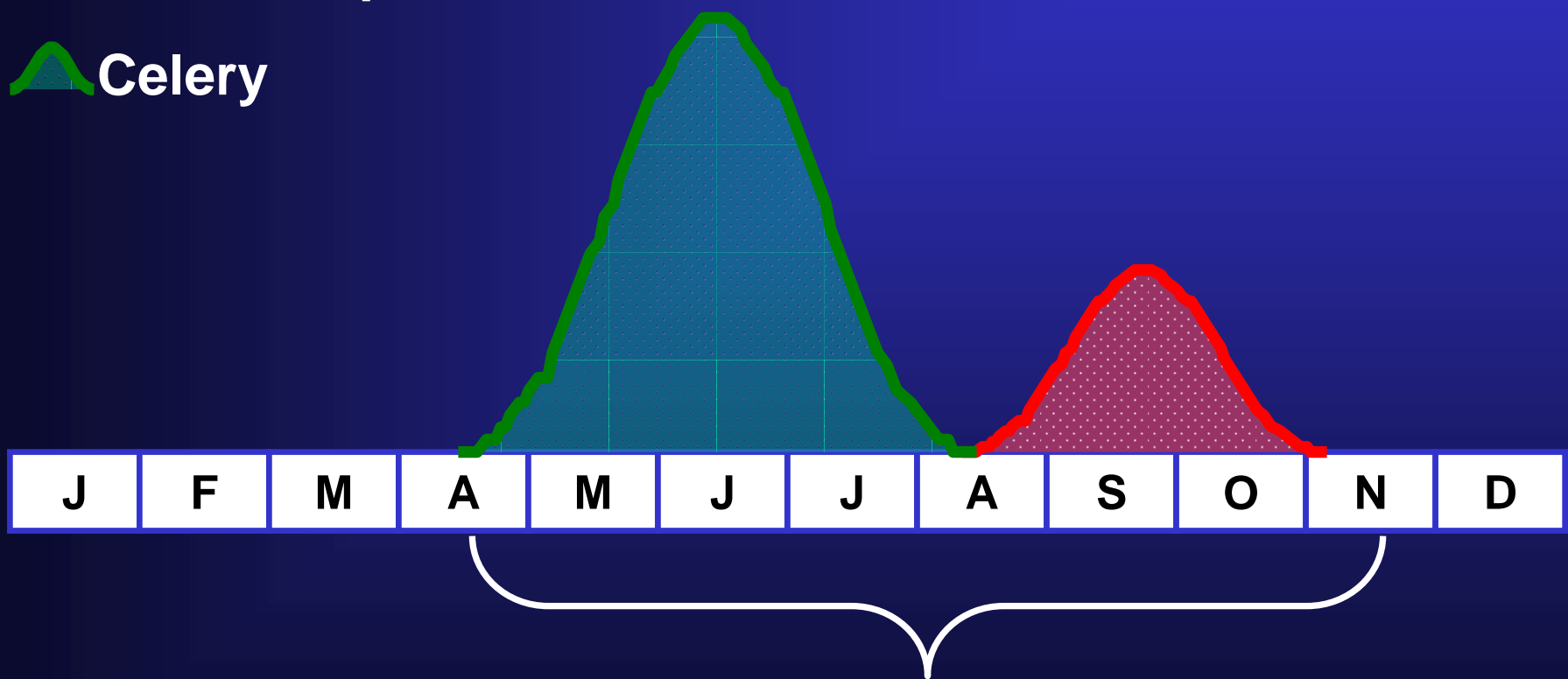


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Celery cropping systems

Cover crop windows: Fall

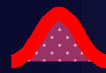
 Cover crop
 Celery

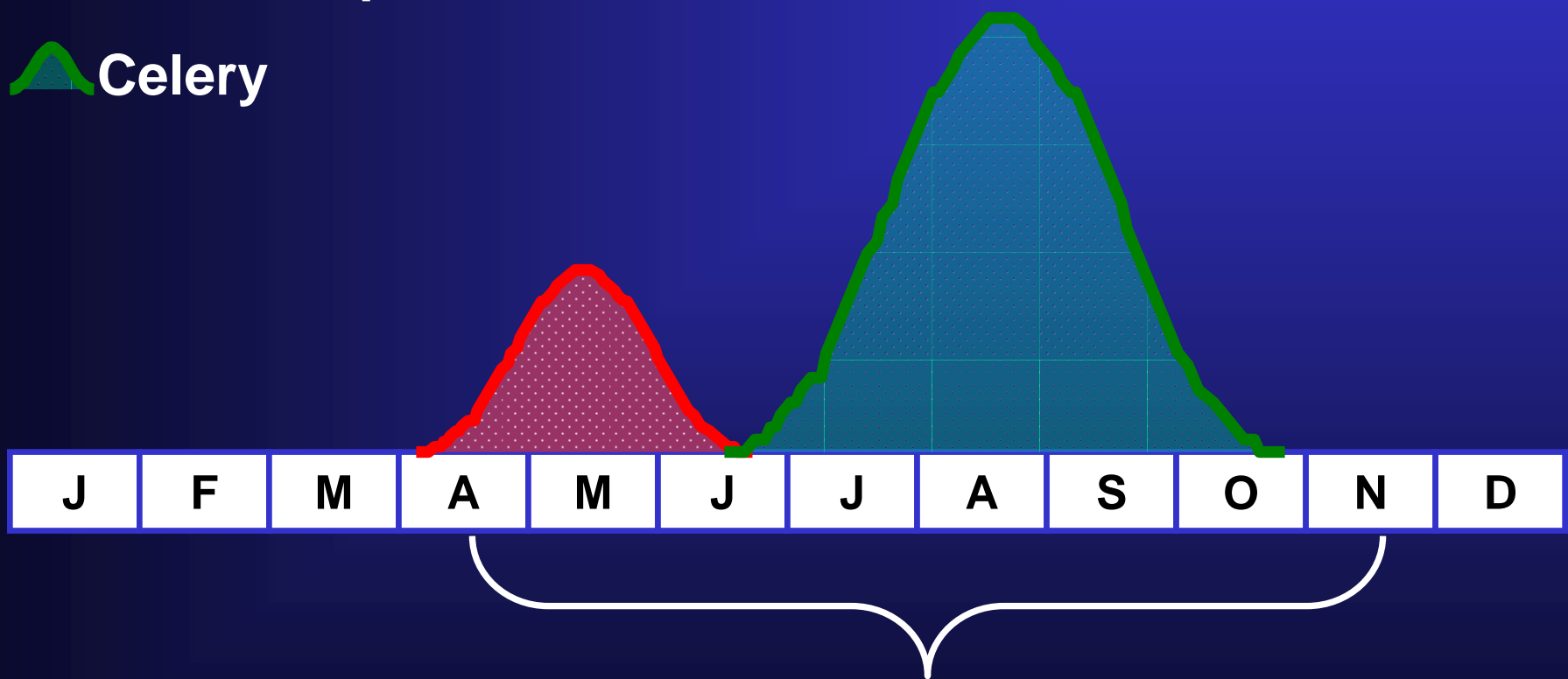


Celery growing season

Celery cropping systems

Cover crop windows: Spring

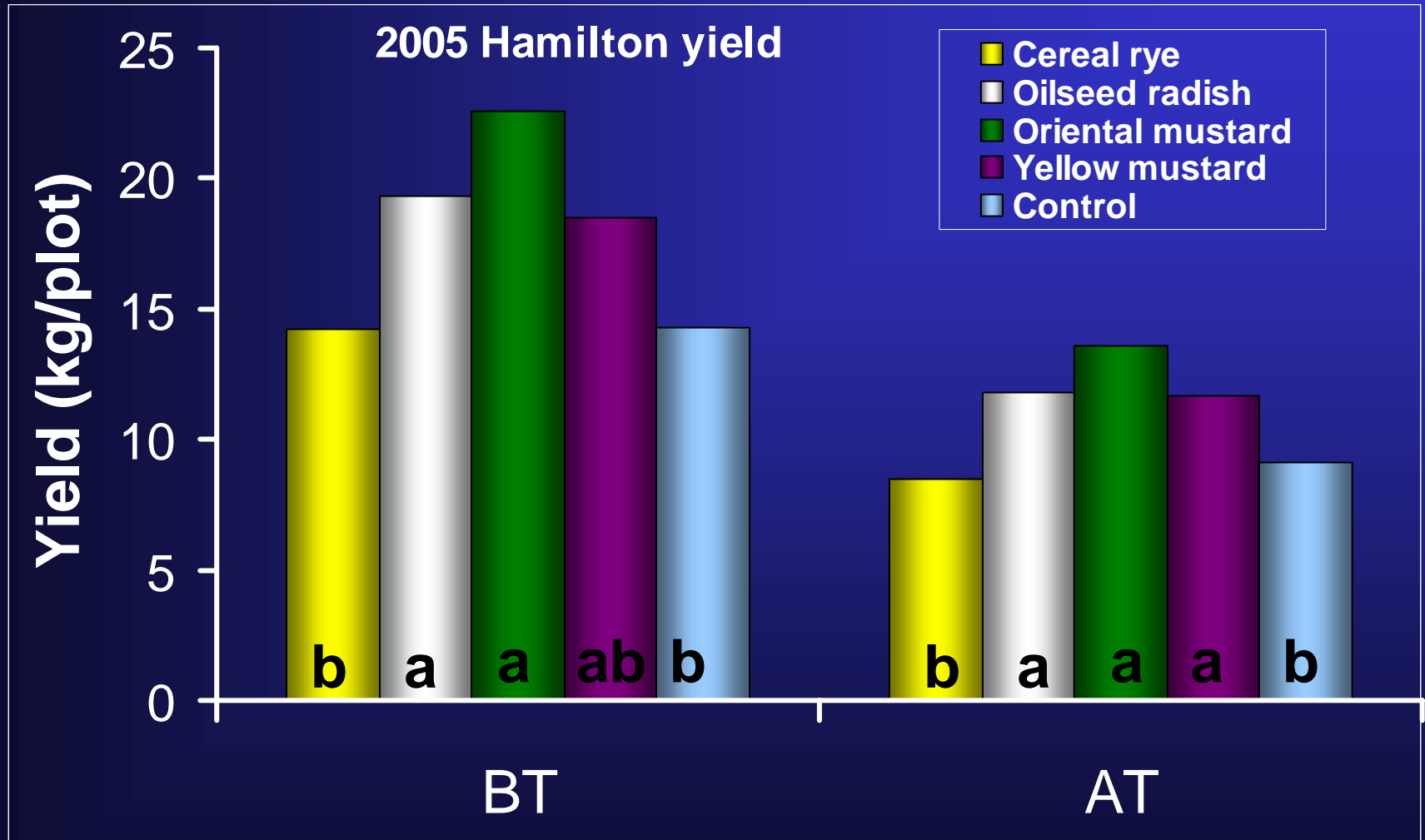
 Cover crop
 Celery



Celery growing season

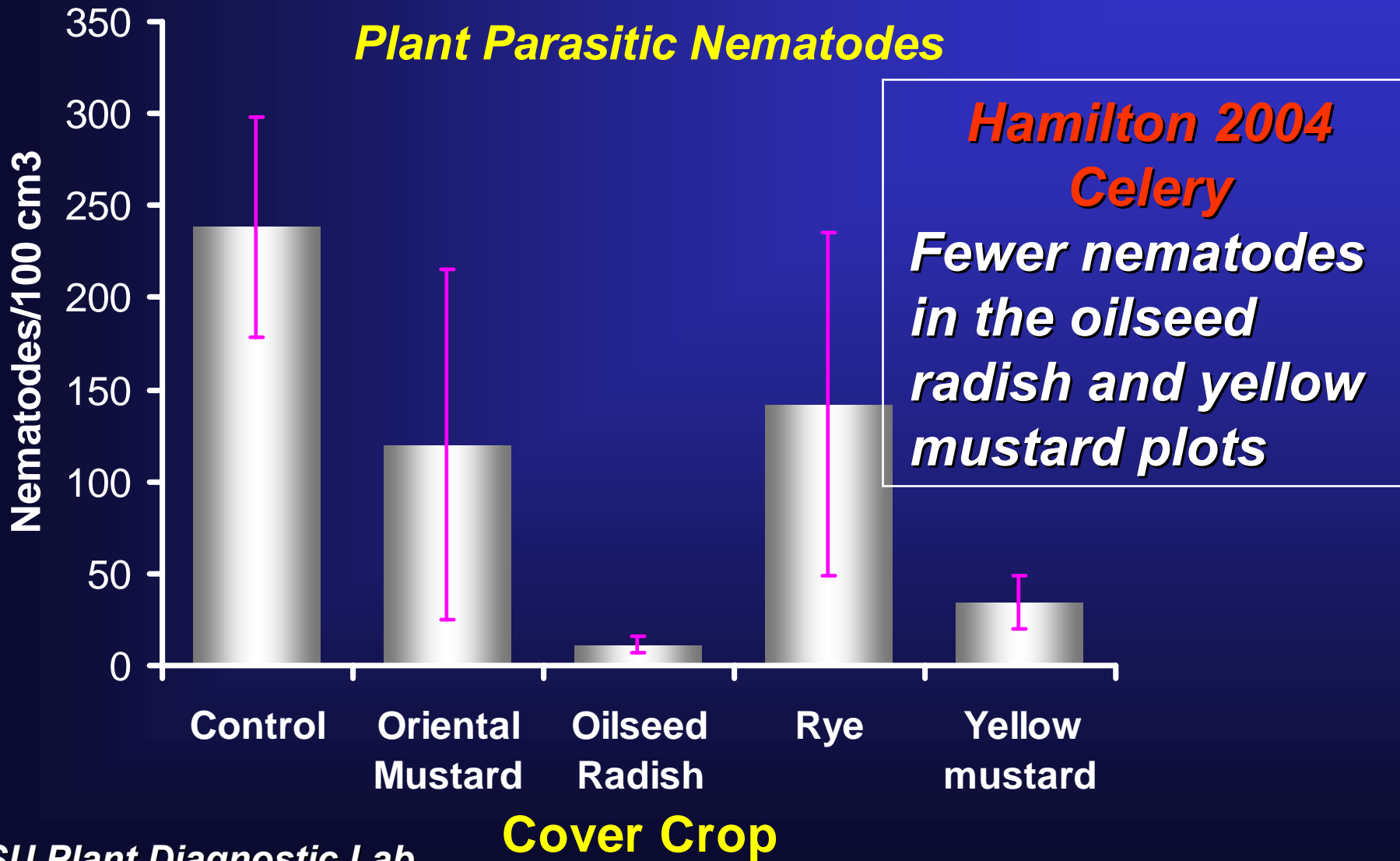
Fall planting of the cover crops

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The Brassica species improved celery yield in 2004 & 2005

Nematode populations



Spring Planting 2006

Two Sites



Decatur

- *7 Cover Crops*
- *Control*
- *seeding April 5*

*Collaboration
with Dr. Bird Lab*

Hamilton

- *5 Cover Crops*
- *Control*
- *Seeding April 14
& 28*

Cover crop growth



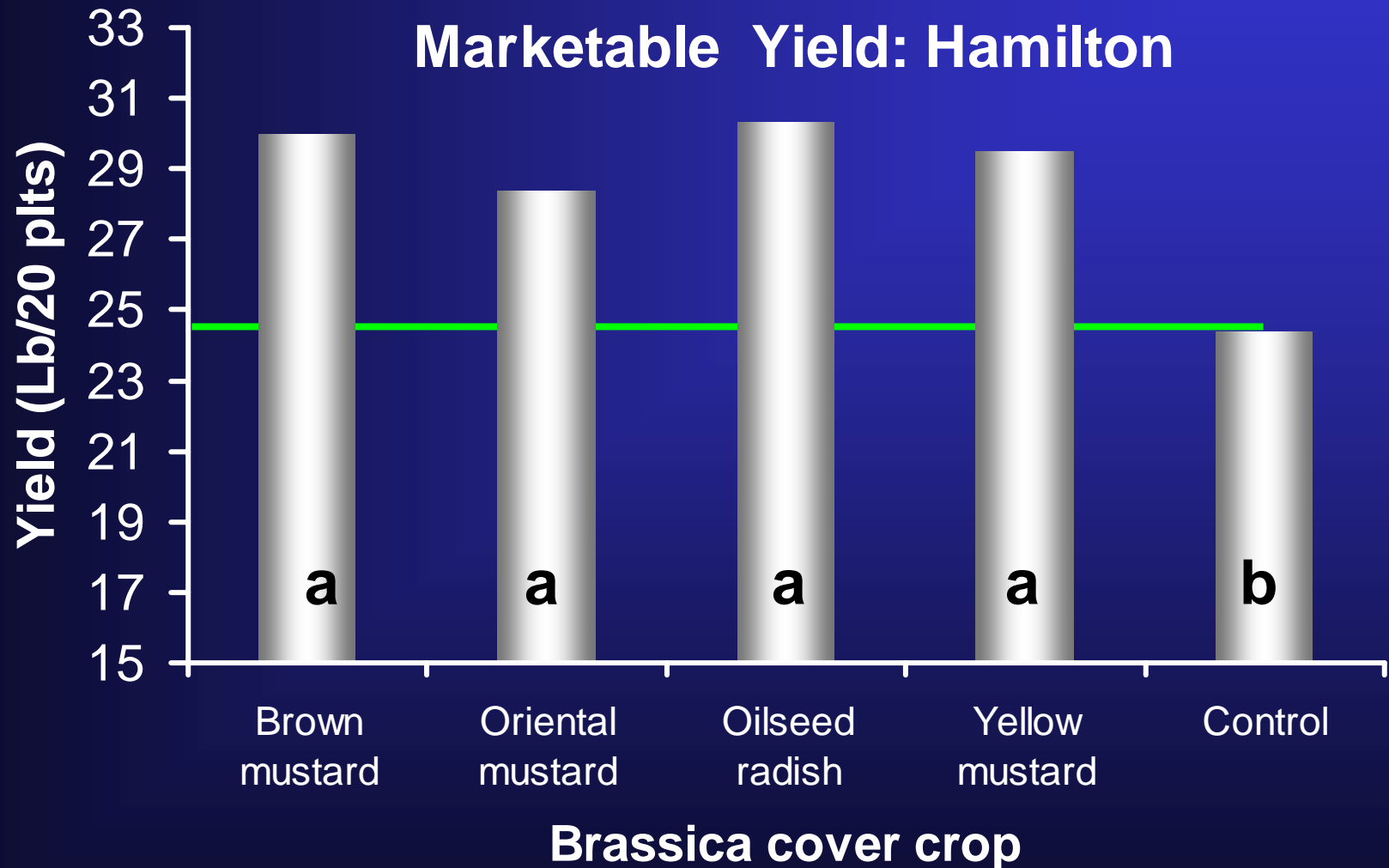
Decatur site
About 7 acres



Hamilton site
About 3 acres

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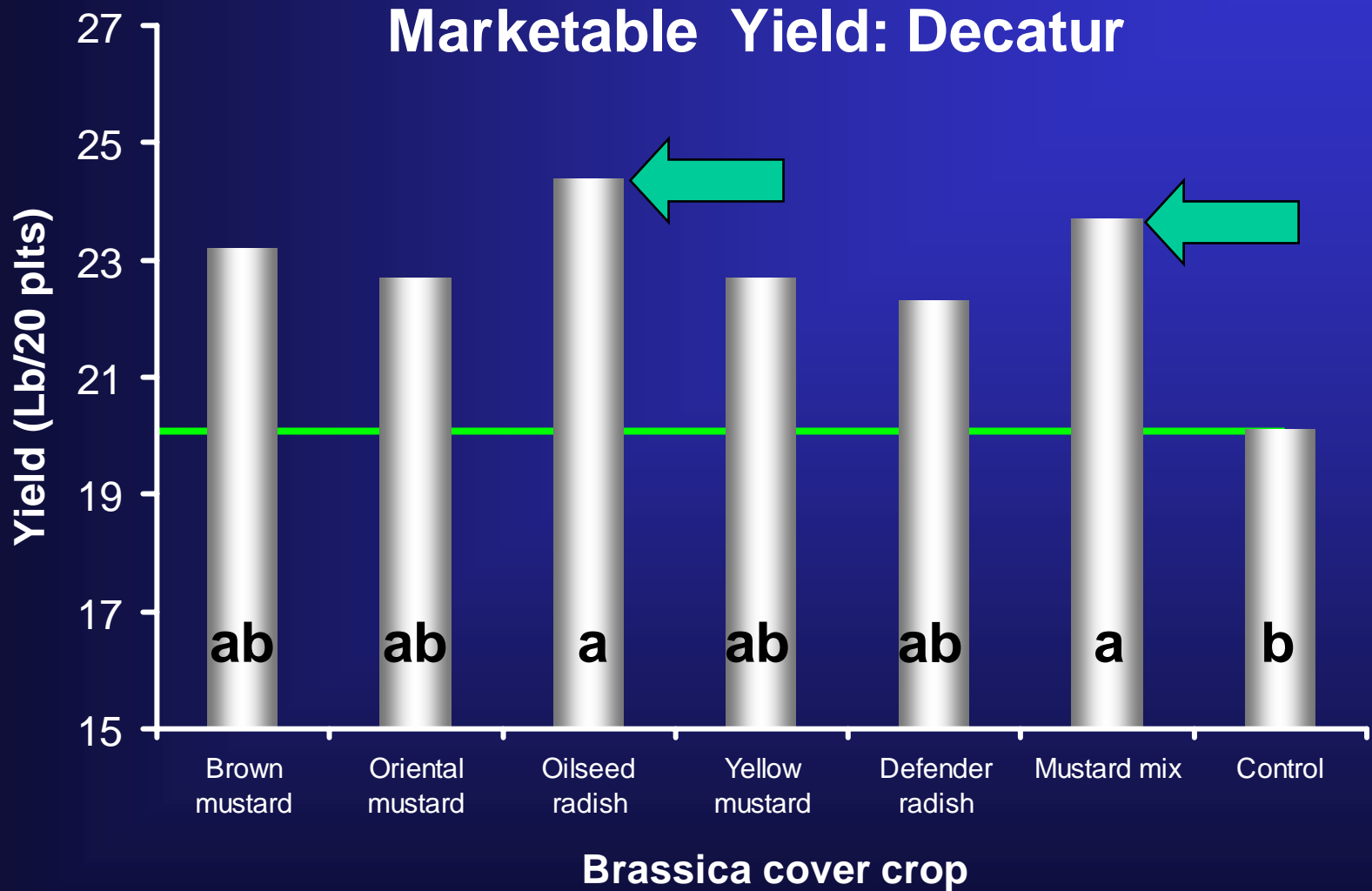
Celery yield in Spring cover crop



Control plots have lowest yield

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Celery yield in Spring cover crop



Control plots have lowest yield

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3

Eggplant production systems



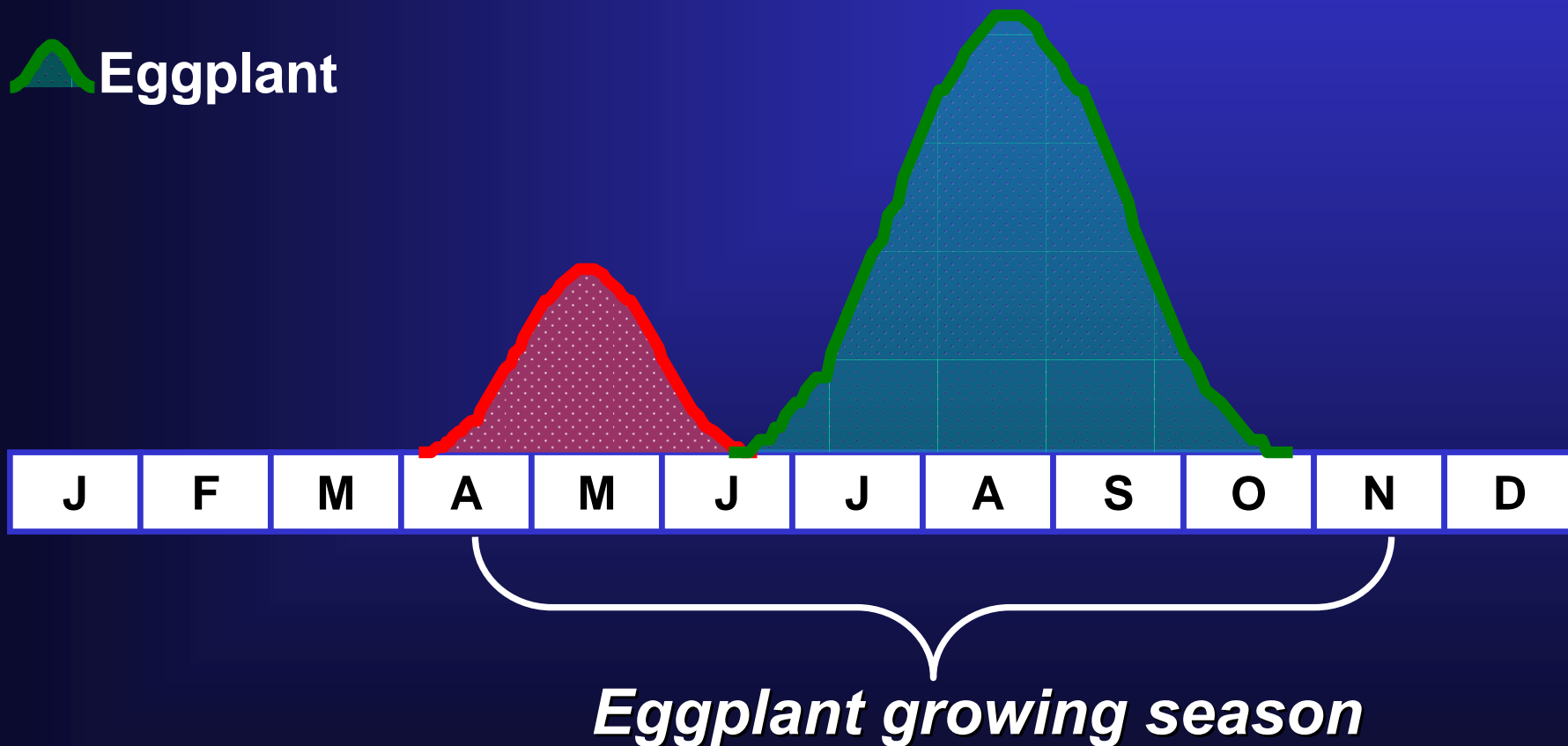
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Eggplant cropping systems

Cover crop windows: Spring

 Cover crop

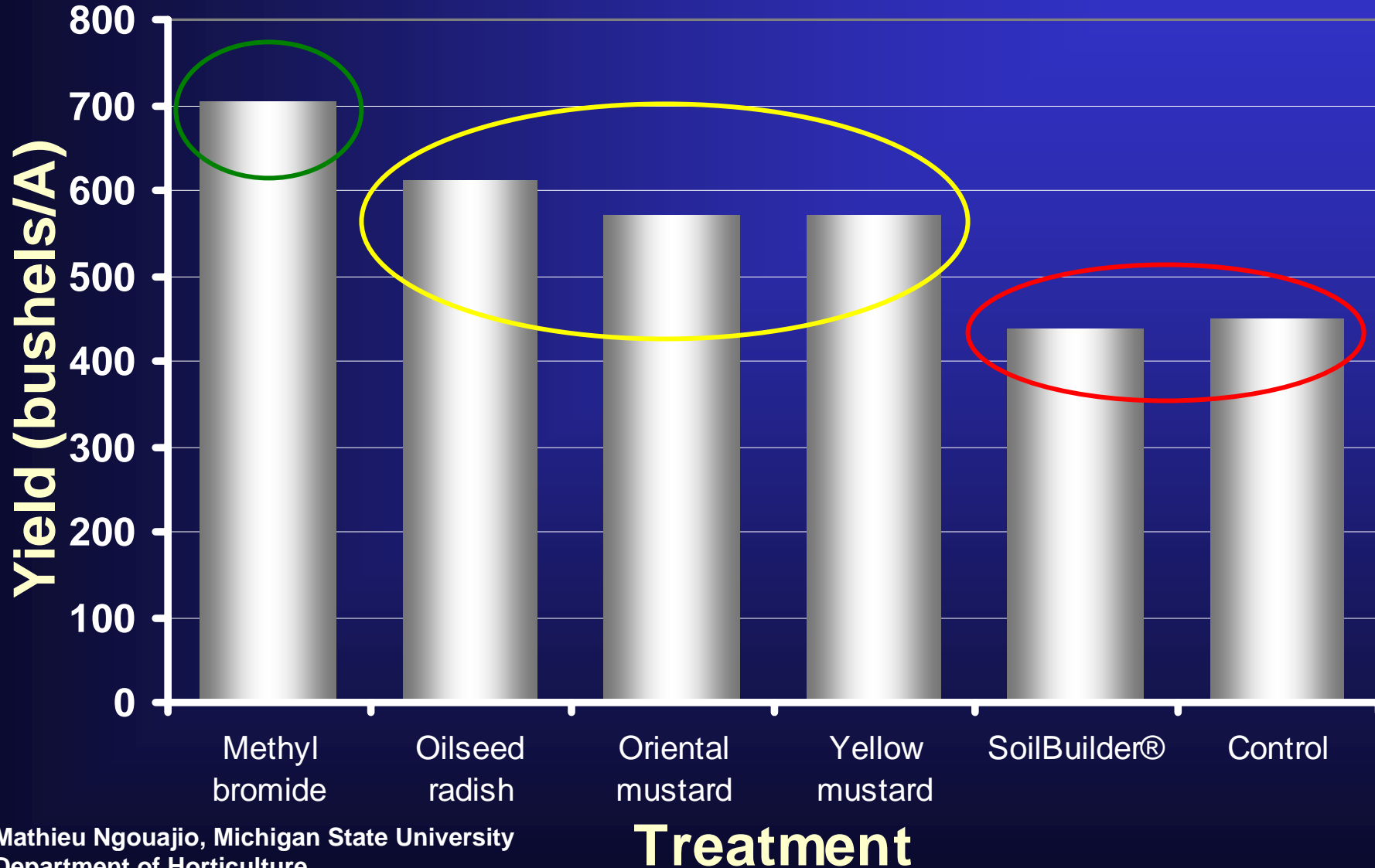
 Eggplant



Eggplant growing season

2007

Total Fruit Yield



Summary



- ***The biofumigants improved various vegetable production systems***

Summary



- They should be used in combination with other management tools.***
- They should be considered as a cover crops first and any biofumigation effect should be a plus.***

Thanks!!

Questions?