Utilization of Biologicals and Biofumigation for Effective Management of Soilborne Diseases in Fruits and Vegetables

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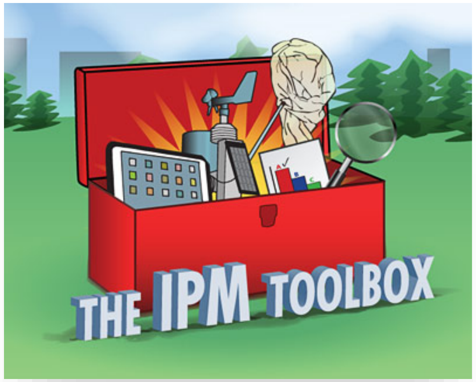
USDA United States Department of Agriculture National Institute of Food and Agriculture



Northeastern IPM Center

October 4, 2022

Webinar Details

Welcome

A recording of this webinar will be available within a week at

http://www.neipmc.org/go/ipmtoolbox

We Welcome Your Questions

Please submit a question **at any time** using the Q&A feature to your right at any time

If you'd like to ask a question anonymously, please indicate that at the beginning of your query.

Webinar Presenter

- Dr. Mahfuz Rahman

Associate Professor and Plant Pathology Ext. Specialist

West Virginia University

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Some Questions for You

Crop Loss from Soilborne Diseases

- Can cause 50%–75% yield loss for many crops
- *Pythium* spp., *Rhizoctonia* spp., *Fusarium* spp., *Sclerotinia* spp., *Verticillium* spp., and *Phytophthora* spp. are major soilborne fungi
- Some bacteria, viruses, and nematodes can also be soilborne
- Can persist for many years in the plant residues, organic matter, and in the form of special survival structures (sclerotia)
- Difficult to control, even with conventional strategies except fumigation

Commodities Tested

- Strawberry-Black root rot and crown rot
- Tomato - Verticillium and Fusarium wilt
- Eggplant – Verticillium wilt
- Okra - Verticillium wilt

Healthy root system (left) with many white roots and a healthy network of fibrous roots. Roots affected by Black root rot (right) have a poor fibrous root structure, are black or have many brown lesions, and take on a "rat-tail" appearance

Phytophthora crown rot

Anthracnose crown rot

Fumigation alternatives

- Black root rot complex and crown rots build up over time to cause major yield and vigor loss in a perennial system
- Crop rotation is not feasible to small/UPick growers
- New regulations and need for special application tools prevent small growers using synthetic fumigants
- SF poses risks to environment and human health

Matted row strawberry, Mineral county, WV

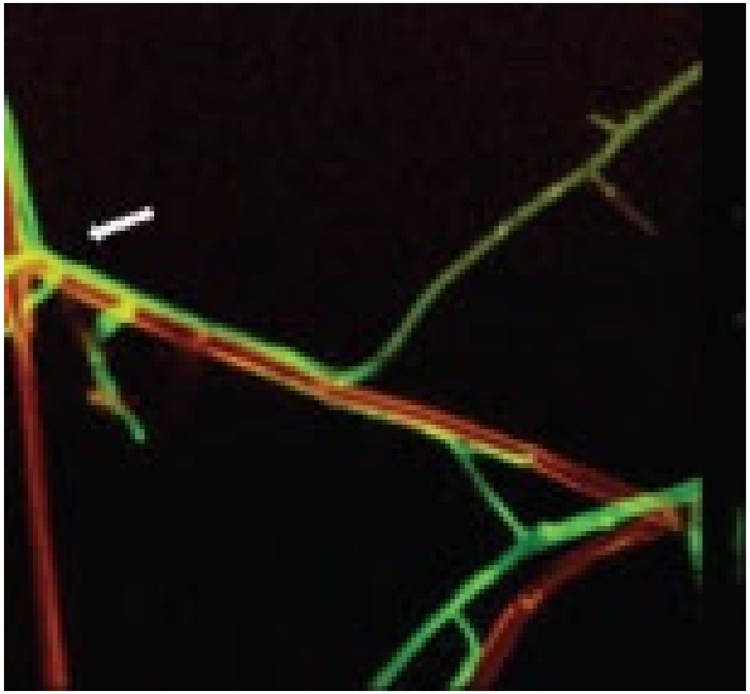
Mechanism of Bio-control

- Indirect antagonism: Competition-

I. Sites-prevent colonization of root tissues

II. Nutrients-consumed by beneficial microbes

a. Nutrient source-Root leakage or exudates



Root-Orange color; *Trichoderma*-Green

Biological Control Mechanism

- Antagonism-Attack and feed on pathogen

-Direct antagonism (Hyper parasitism/predation): *Pasteuria penetrans, Trichoderma virens*

- Antibiosis-Production of antibiotics and lytic enzymes

-Cyclic lipopeptides

-Chitinases; overexpression in plants

-Glucansaes-β-1,3-glucanase

Pseudomonas putida siderophore

Bacillus mycoides strain Bac J

Organic options for soilborne disease management

Pre-colonize plant root system with beneficial microbes (Terragrow) and planted in treated (biofumigated/ASD) field plots

1. Non-treated
2. Mustard cover crop
3. Regular planting mix inoculation with probiotic bacteria
4. Pasteurized planting mix inoculation
5. Anaerobic soil disinfestation (ASD)
6. Synergistic (3+5)

replicated 4 times

V6

TerraGrow®

OMRI LISTED For Organic Use

SPECIMEN LABEL

CONTAINS NON-PLANT FOOD INGREDIENTS:
GUARANTEED ANALYSIS:
SOIL AMENDING INGREDIENTS:

Microbial Inoculant.. 0.30%
Bacillus licheniformis.. 1.20×10^9 cfu/g
Bacillus subtilis.. 6.00×10^8 cfu/g
Bacillus pumilus.. 6.00×10^8 cfu/g
Bacillus amyloliquefaciens.................................. 3.00×10^8 cfu/g
Bacillus megaterium.. 3.00×10^8 cfu/g
Humic acids (derived from leonardite)............................. 38.00%
Organic Matter (microbial food) (derived from Soy Protein Hydrolysate, Kelp Extract (*Ascophyllum nodosum* and Potassium Hydroxide)* and Molasses)... 56.00%
TOTAL OTHER (INERT/INACTIVE) INGREDIENTS
(water or carrier and microbial food)............................ 5.70%

*Extracted with Potassium Hydroxide

CAUTION

KEEP OUT OF REACH OF CHILDREN

DIRECTIONS FOR USE

For best results, use TerraGrow in conjunction with BioSafe Systems plant disease control products. Follow use directions carefully to avoid any negative effects from these products on the performance of TerraGrow.

NOTE: 1 teaspoon = 0.1 oz., 3 tablespoons = 1.0 oz., 1 cup = 5 oz.

FRUITS, VEGETABLES AND OTHER FIELD GROWN CROPS

Soil Treatment:
Direct Inject Applications:

- Apply TerraGrow to soil through drip or overhead irrigation systems at a rate of 1.0-1.5 lbs. per acre prior to or immediately after sowing or transplanting.
- Calculate required amount of TerraGrow based on number of acres to be treated.
- Prepare a stock solution by mixing TerraGrow in enough water to completely dissolve powder. Mix every 1 lb. of TerraGrow with at least 4–5 gallons of water.
- Mix TerraGrow under continuous agitation or circulation. Add powder slowly to the mix tank to avoid clumping. Powder must be thoroughly saturated to dissolve completely.
- Thoroughly mix solution. If necessary, probe bottom of mix tank to

Treatment Description

(2 & 5: field only; 3 & 4 plug production; 6(3+5)-combination)

1. **Non-treated Check (<u>RM+NT</u>+NF);**
2. **Mustard cover crop (<u>RM+NT</u>+MCC);**
3. **Regular TerraGrow (<u>RM+TG</u>+NF);**
4. **Pasteurized TerraGrow (<u>PM+TG</u>+NF);**
5. **ASD (<u>RM+NT</u>+ASD);**
6. **Synergistic (<u>RM+TG</u>+ASD)**

RM-regular media; NT-no treatment; NF-no field treatment; PM-pasteurized media; TG-TerraGrow; MCC-mustard cover crop; ASD-anaerobic soil disinfestation

Biofumigation with mustard cover crop

'Caliente' mustard at flowering stage

incorporation in plots

QUESTIONS?

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ASD on selected plots were done in 3 steps:

1. Incorporated OM (mustard meal) to provide C source to activate soil microbes. Mixed with a walk behind rototiller.
2. Covered the area with air impermeable tarp.
3. In the third step, irrigated the soil to saturation to create anaerobic conditions and stimulate the anaerobic decomposition of incorporated organic material and enhance diffusion of by-products.

Accumulation of toxic/suppressive products (e.g. organic acids, volatile organic compounds) should kill pathogenic microbes

Incorporation of C source (rice bran, mustard meal, grape pomace etc.)

Saturation of beds (under plastic)

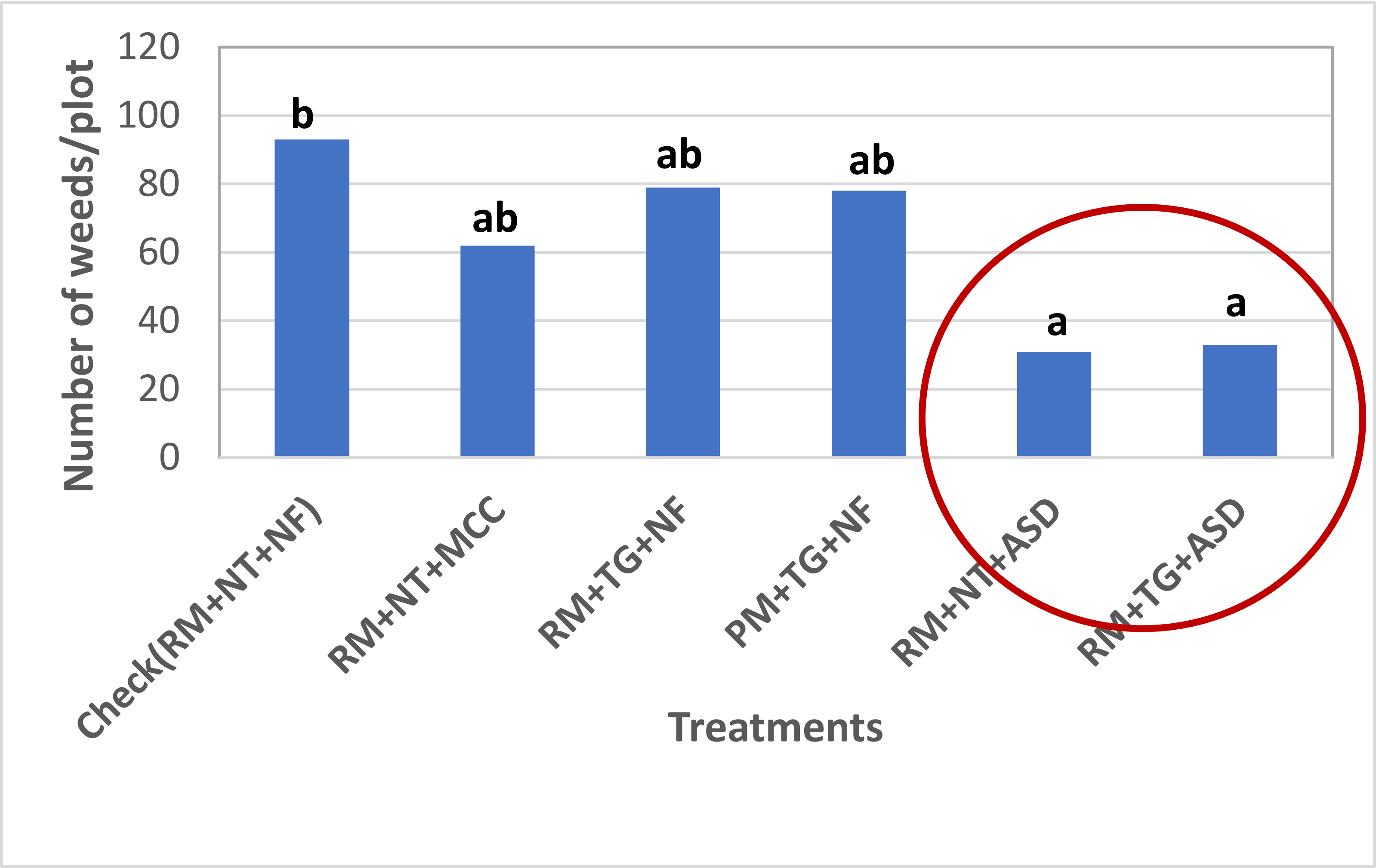
Results: California trial on Verticillium wilt of strawberry

ASD 3 weeks

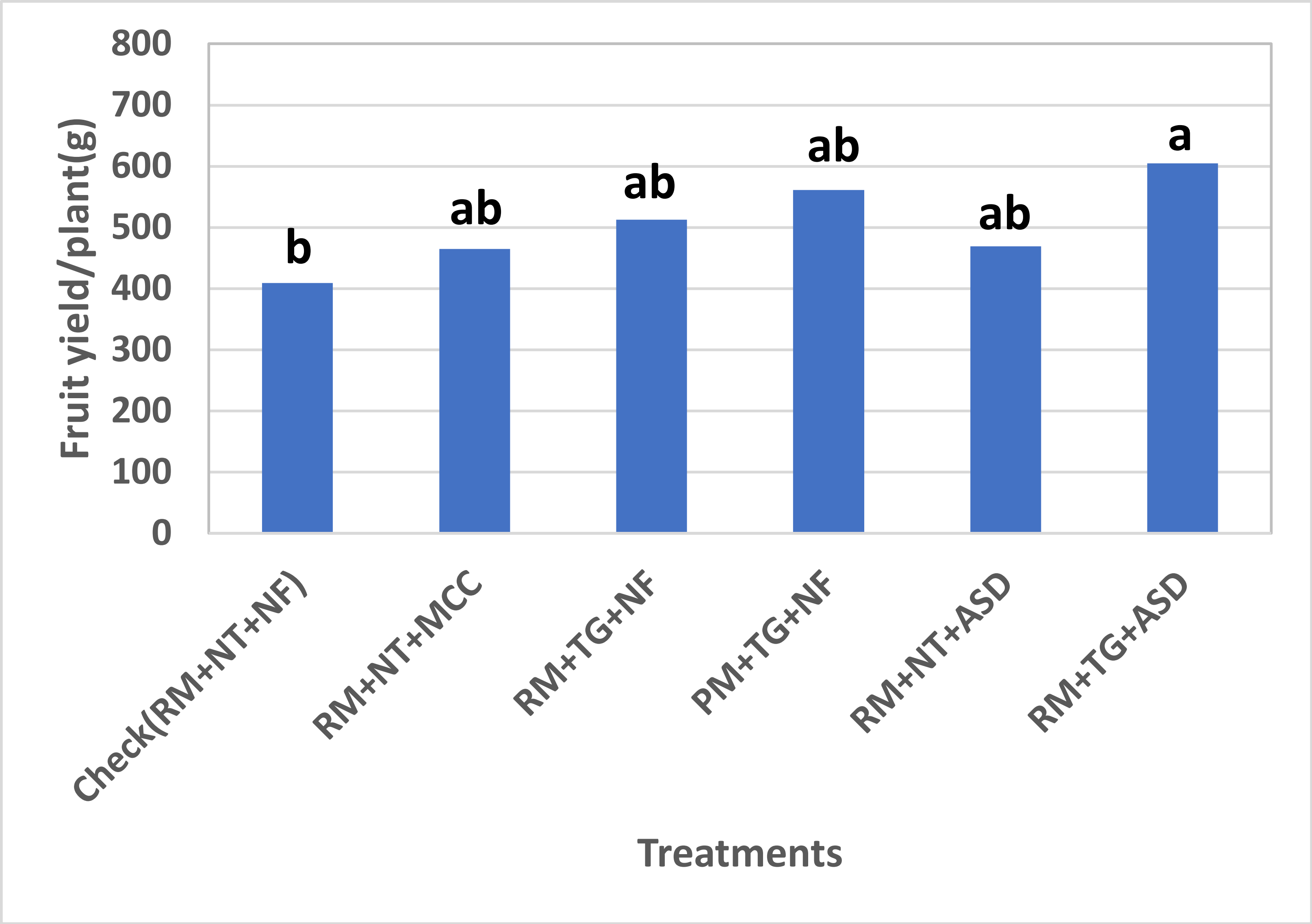
Untreated

9 ton/ac rice bran used in ASD

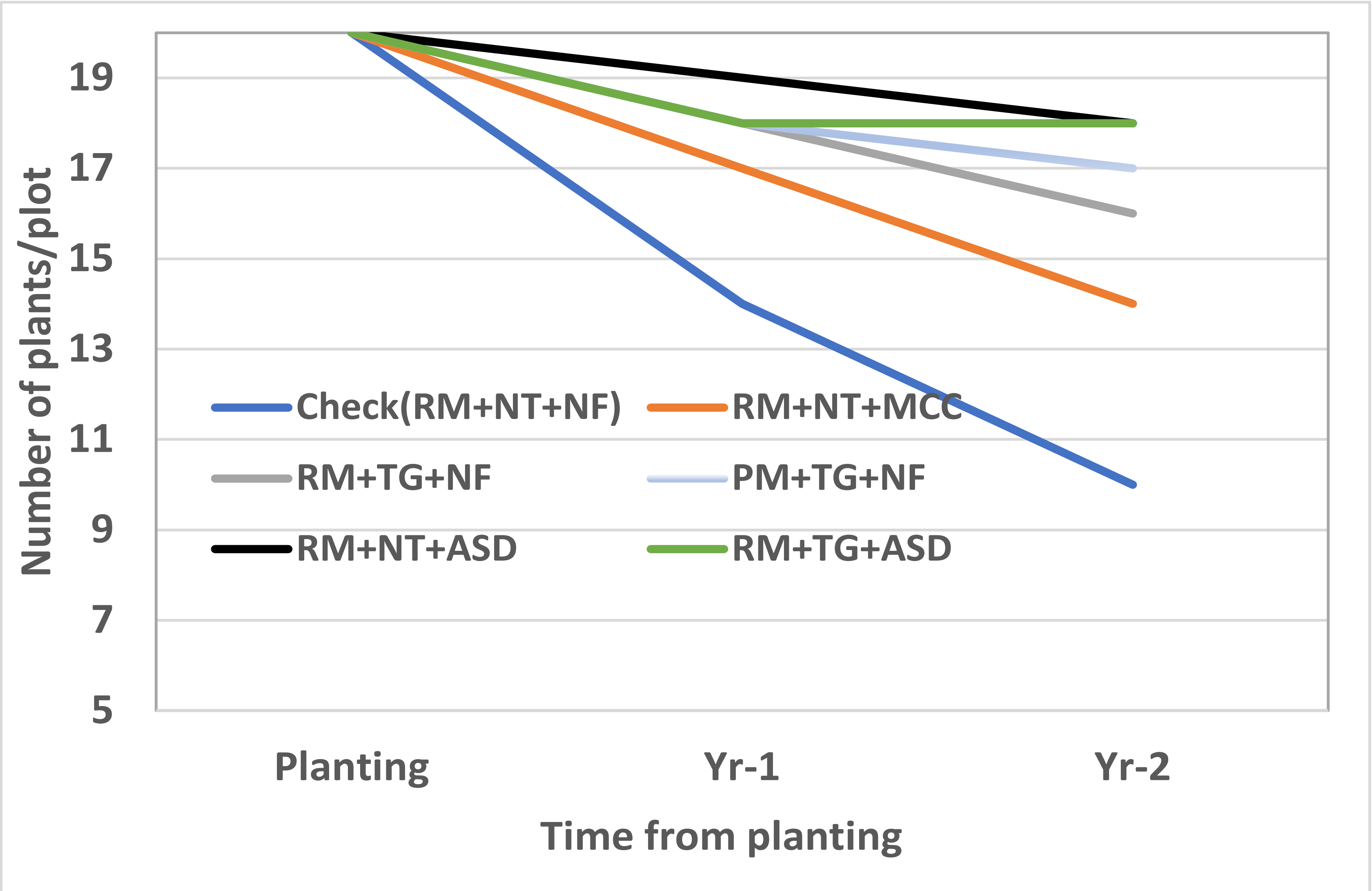
Results from our study (weeds grew through planting holes)



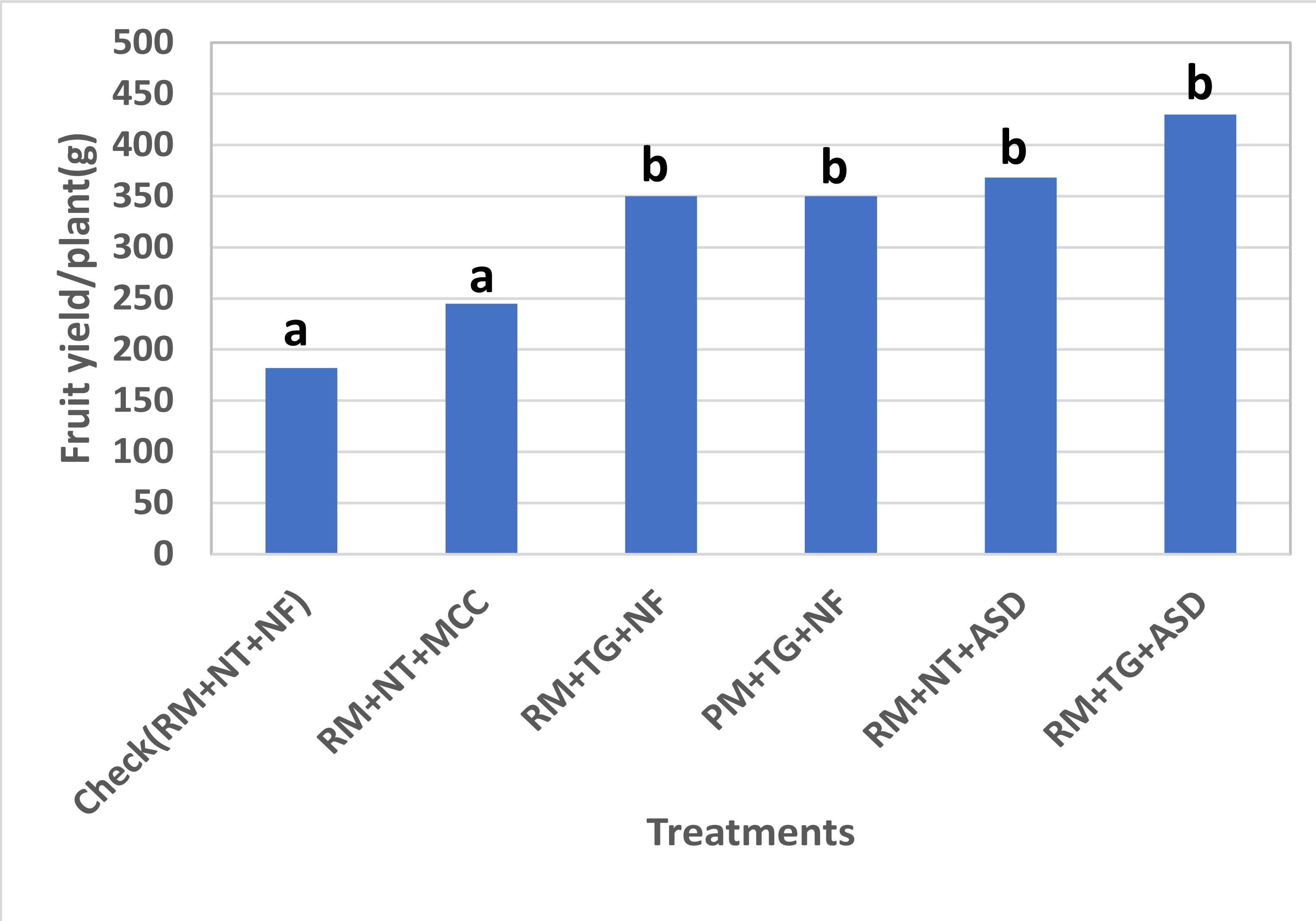
First year fruit yield



Plant Mortality in Different Treatments



Second year fruit yield



Plot Description:

1) **Non-treated Check(RM+NT+NF);**
2) **Mustard cover crop (RM+NT+MCC);**
3) **Regular TerraGrow (RM+TG+NF);**
4) **Pasteurized TerraGrow (PM+TG+NF);**
5) **ASD (RM+NT+ASD);**
6) **Synergistic RM+TG+ASD**

Rhizosphere soil nutrient contents at experiment termination

Treatment	Phosphorus (ppm)	Potassium (ppm)	Magnesium (ppm)	Average soil pH	Organic matter (%)
Check (RM+NT+NF)	130 c	230 c	190 a	6.3 a	7.7 b
RM+NT+MCC	210 a	340 a	195 a	6.6 a	8.6 ab
RM+TG+NF	160 bc	315 ab	188 a	6.3 a	8.5 ab
PM+TG+NF	154 bc	301 ab	187 a	6.5 a	8.3 ab
RM+NT+ASD	170 b	277 bc	213 a	6.3 a	9.5 ab
RM+TG+ASD	185 ab	310 ab	225 a	6.4 a	9.8 a

Cause of plant decline & mortality

- Low vigor due to black root rot
- Phytophthora crown rot was involved with mortality
- Nematode population did not vary significantly in treated plots
- Enumeration of beneficial microbes in the rhizosphere is in progress

Summary and Future Prospects

- Finding suitable alternative of synthetic fumigants may be difficult
- Probiotic bacteria may provide benefit to strawberry plants for multiple years
- Synergistic effect from probiotic bacteria and ASD can be the best alternative of synthetic fumigation
- Unraveling the mechanism of synergistic effect from microbial analyses

QUESTIONS?

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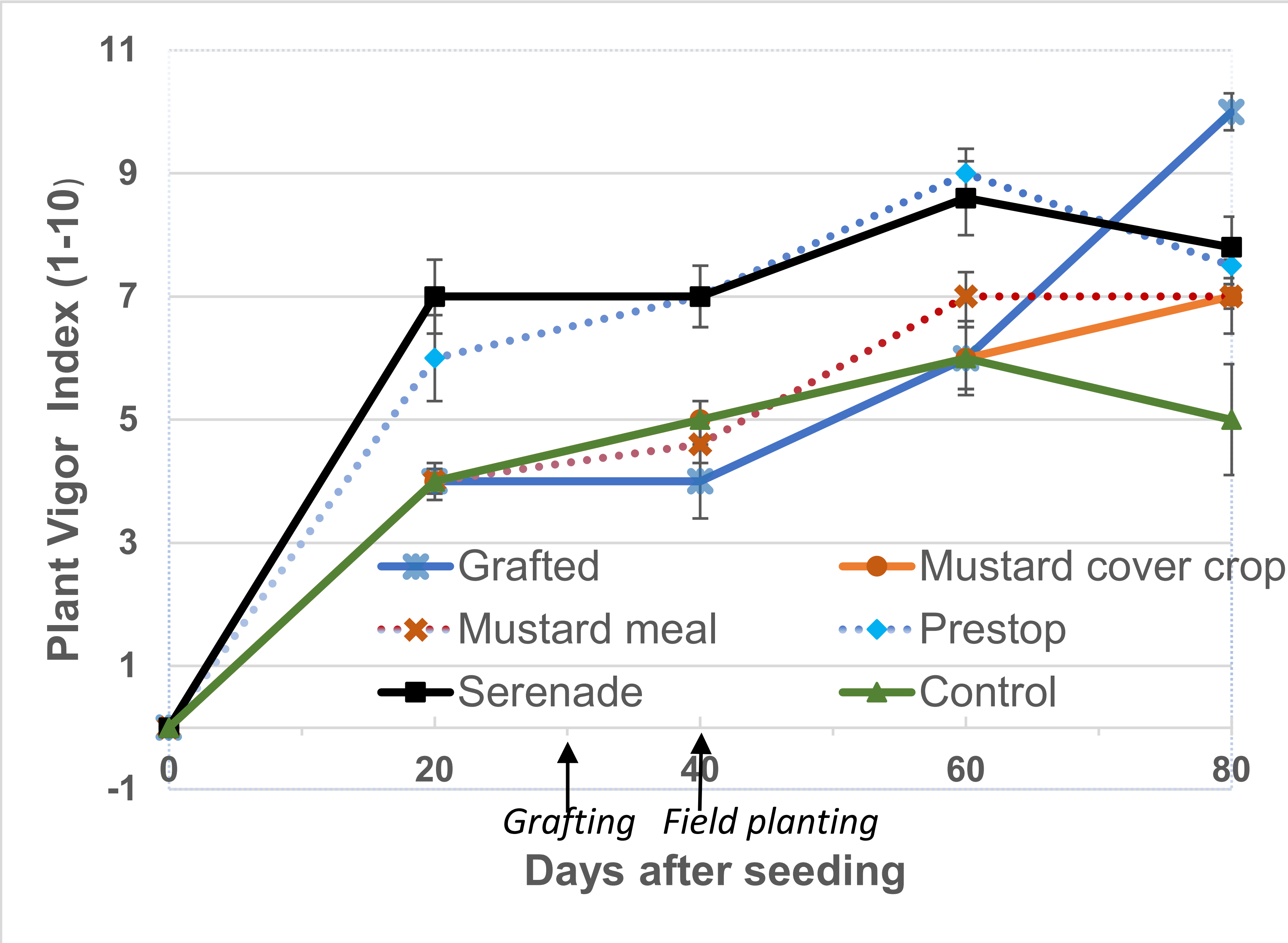
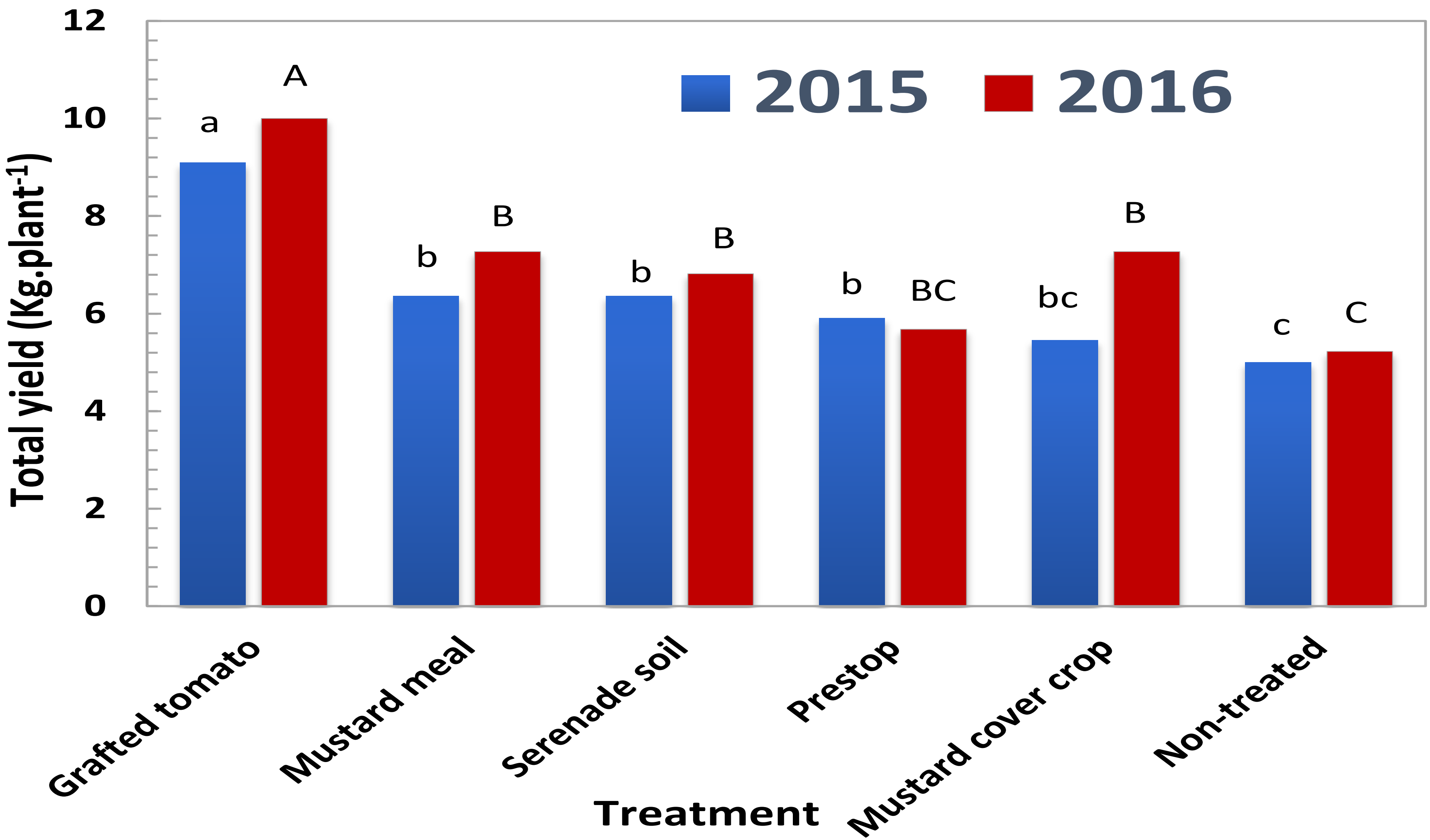
Wilt Diseases of Tomato



Fruit yield from all harvests



Eggplant Verticillium wilt: Plant vigor as affected by treatment

Treatment	Eggplant vigor on a 1-5 scale
1) Non-treated check (RM+NT+NF)	3.5 b
2) Non-treated planting mix grown seedlings planted in mustard cover crop field plots (RM+NT+MCC)	3.7 b
3) Seedlings grown on pasteurized planting mix treated with TerraGrow + Terragrow applied in planting holes (Effect of TerraGrow with higher colonization potential-PM+TG+PH)	4.5 a
4) Seedlings grown on regular RootShield treated planting mix (RM+RS+NF)	4 ab
5) Seedlings grown on regular TerraGrow treated planting mix + TerraGrow applied in planting holes (Effect of TerraGrow with regular colonization potential-RM+TG+PH)	3.8 ab
6) Seedlings grown on non-pasteurized planting mix treated with TerraGrow and planted in ASD plots (Combined effect of ASD and TerraGrow-RM+TG+ASD)	4.8 a

Fig. Differential Verticillium symptom expression on eggplant leaf as affected by soil inoculation with *Verticillium* colonized oat grains followed by different treatments of plants pre and post planting in inoculated plots;

Verticillium wilt of okra

Management of Verticillium wilt on okra; a) Non-treated; b) Seedlings grown on Terragrow inoculated planting mix; c) anaerobic soil disinfestation + b.

Non-treated; canopy thinning

TerraGrow treated

TerraGrow plus ASD

Yield and plant mortality

Treatment	Fruit/plant	Fruit weight/ plant (oz)	Average plant height (ft)	Mortality (%)
Non-treated	52	45	5.6	55
Probiotic at seedling production (PSP)	67	60	5.8	5
PSP+ASD (anaerobic soil disinfestation)	72	62	6.2	0

QUESTIONS?

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THANK YOU!

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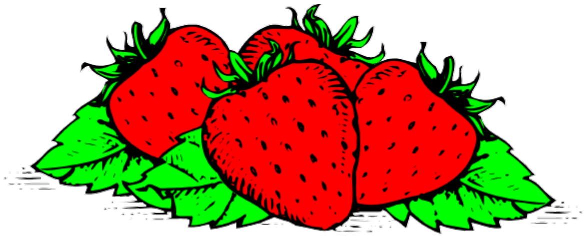

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Upcoming Webinars

Cooperative Extension in Indigenous Communities: Experiences of Educators
November 8, 2022, 2:00 p.m. – 3:00 p.m.
Presenter: Katie Hartmann – Adjunct Assistant Professor, Agriculture Education and Studies Department at Iowa State University

Non-traditional Areas for IPM Careers and the Associated Challenges for 2SLGBTQIA+ Individuals in Pursuing Them
December 7, 2022, 11:00 a.m. – 12:00 p.m.
Presenter: Ryan Gott – Fellow at Longwood Gardens, Kennett Square, Pennsylvania

https://www.northeastipm.org/ipm-in-action/deij-in-ipm/

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Recording of IPM Toolbox Webinar Series

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You can watch as often as you like.

Land Acknowledgment

The Northeastern IPM Center is based at Cornell University in Ithaca, New York.

Cornell University is located on the traditional homelands of the Gayogo̱hó꞉nǫ' (the Cayuga Nation). The Gayogo̱hó꞉nǫ' are members of the Haudenosaunee Confederacy, an alliance of six sovereign Nations with a historic and contemporary presence on this land. The Confederacy precedes the establishment of Cornell University, New York state, and the United States of America. We acknowledge the painful history of Gayogo̱hó꞉nǫ' dispossession, and honor the ongoing connection of Gayogo̱hó꞉nǫ' people, past and present, to these lands and waters.

This land acknowledgment has been reviewed and approved by the traditional Gayogo̱hó꞉nǫ' leadership.

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