

# Effect of beneficial microbes, biofumigation and anaerobic soil disinfestation on strawberry soilborne disease and yield in a perennial production system

Mahfuz Rahman, PhD

Associate Professor and Plant Pathology Ext. Specialist

West Virginia University, Morgantown, WV 26506





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-2019**

# 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



## SPECIMEN LABEL

### CONTAINS NON-PLANT FOOD INGREDIENTS:

#### GUARANTEED ANALYSIS:

#### SOIL AMENDING INGREDIENTS:

Microbial Inoculant.....	0.30%
<i>Bacillus licheniformis</i> .....	1.20 x 10 <sup>9</sup> cfu/g
<i>Bacillus subtilis</i> .....	6.00 x 10 <sup>8</sup> cfu/g
<i>Bacillus pumilus</i> .....	6.00 x 10 <sup>8</sup> cfu/g
<i>Bacillus amyloliquefaciens</i> .....	3.00 x 10 <sup>8</sup> cfu/g
<i>Bacillus megaterium</i> .....	3.00 x 10 <sup>8</sup> cfu/g
Humic acids (derived from leonardite).....	38.00%
Organic Matter (microbial food) (derived from Soy Protein Hydrolysate, Kelp Extract ( <i>Ascophyllum nodosum</i> 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 (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 (PM+TG+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**



# 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 oxygen 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



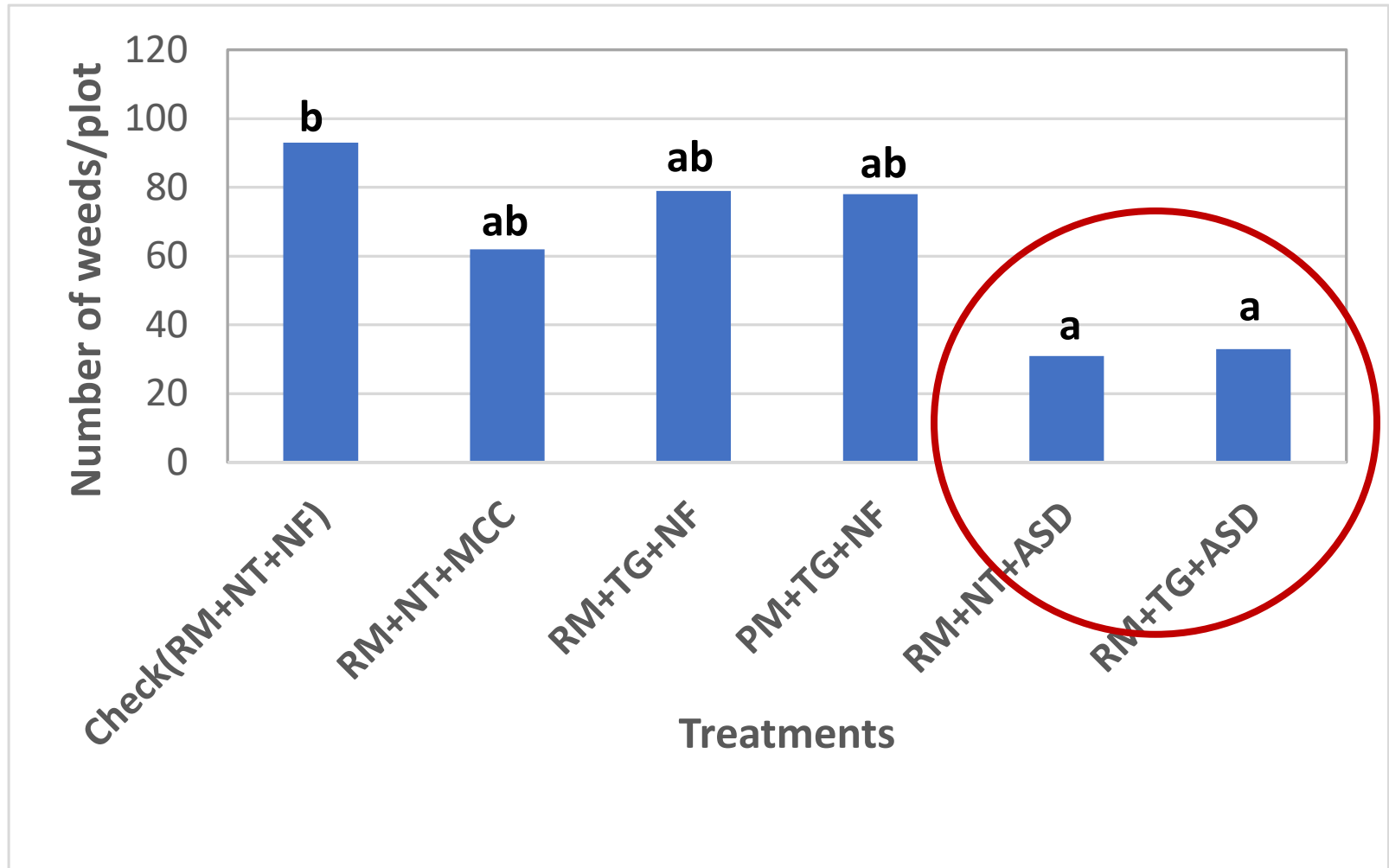
**ASD 3 weeks**

9 ton/ac rice bran used in ASD

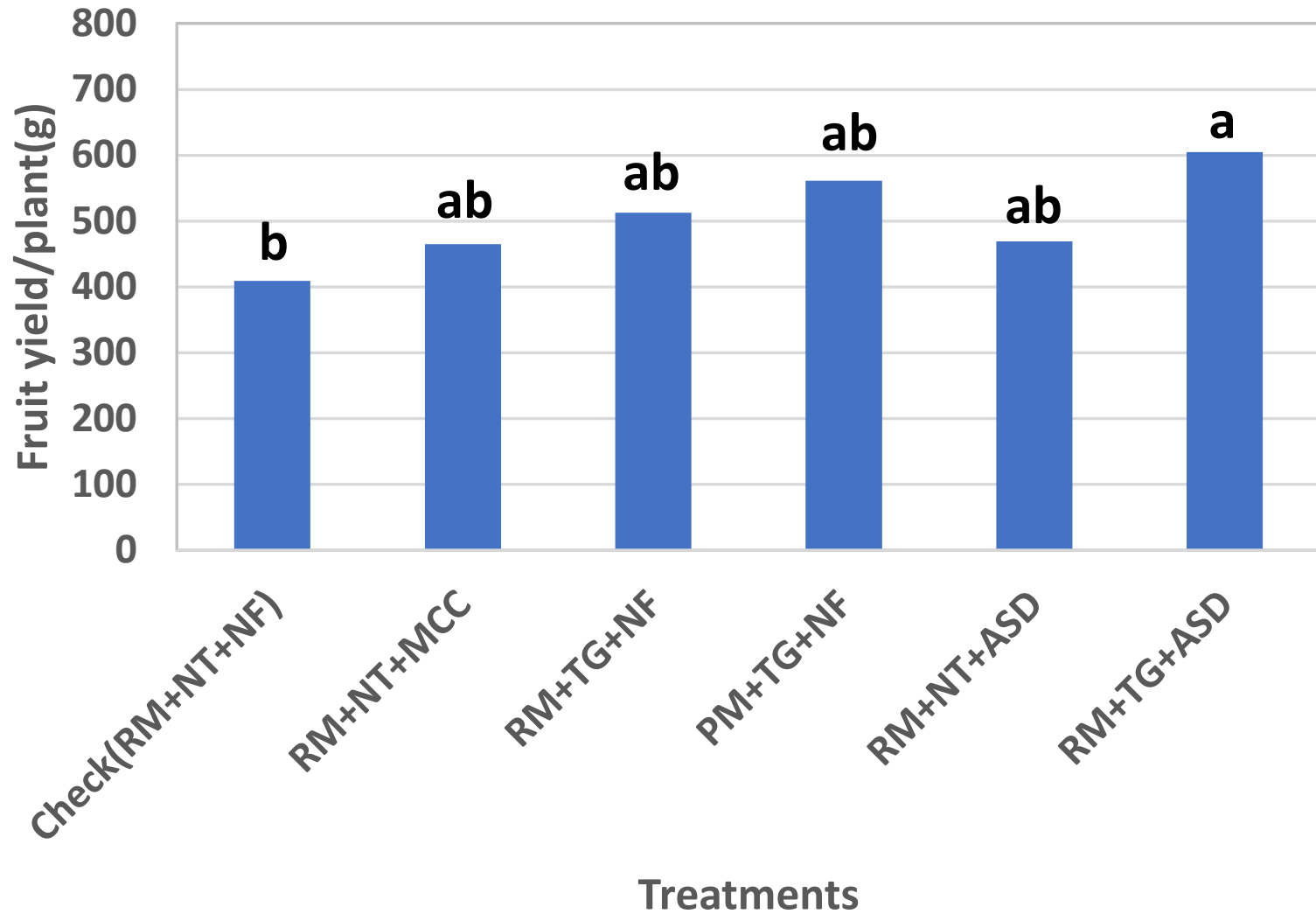


**Untreated**

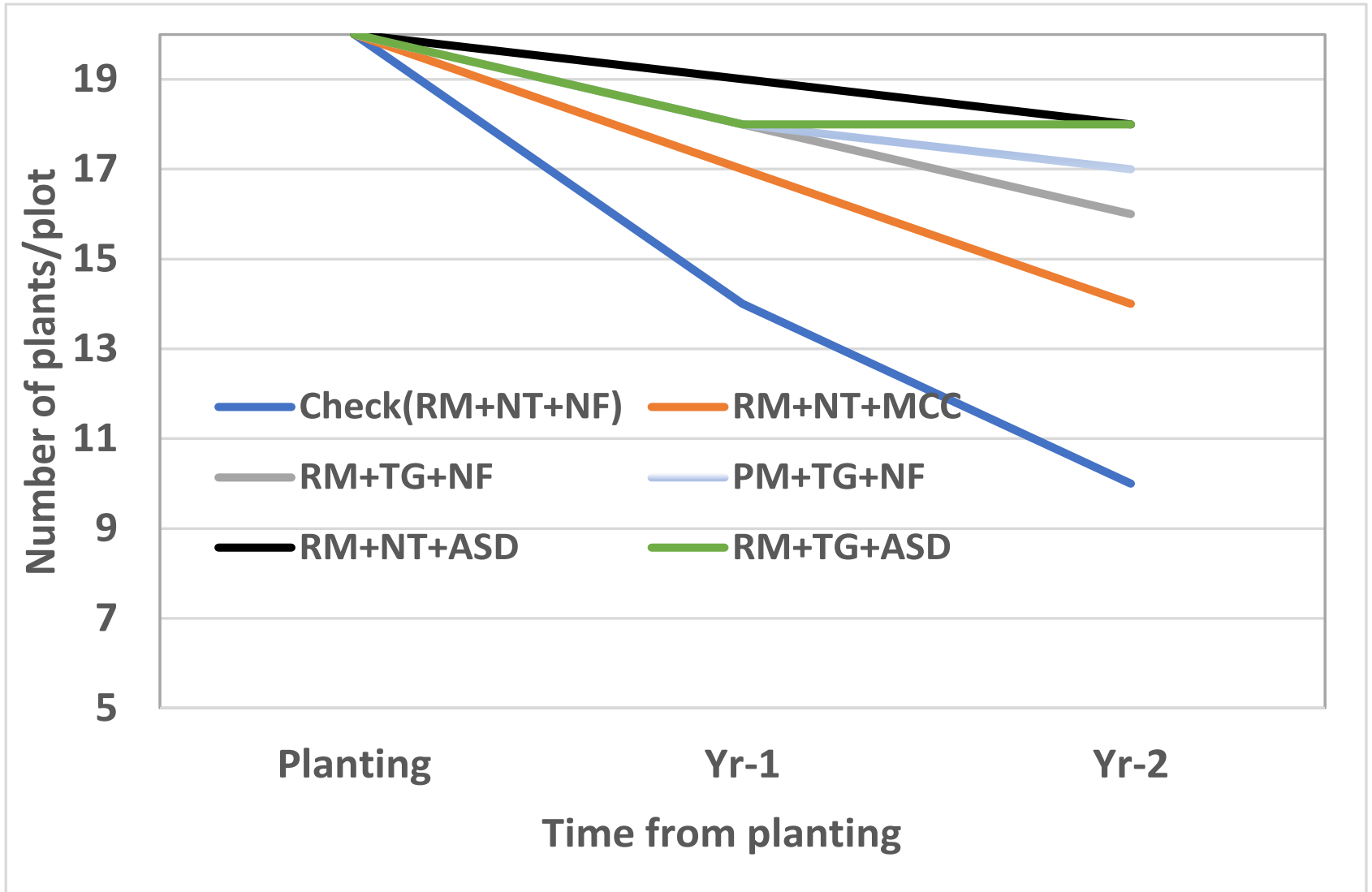
# Results from our study (weeds grew through planting holes)



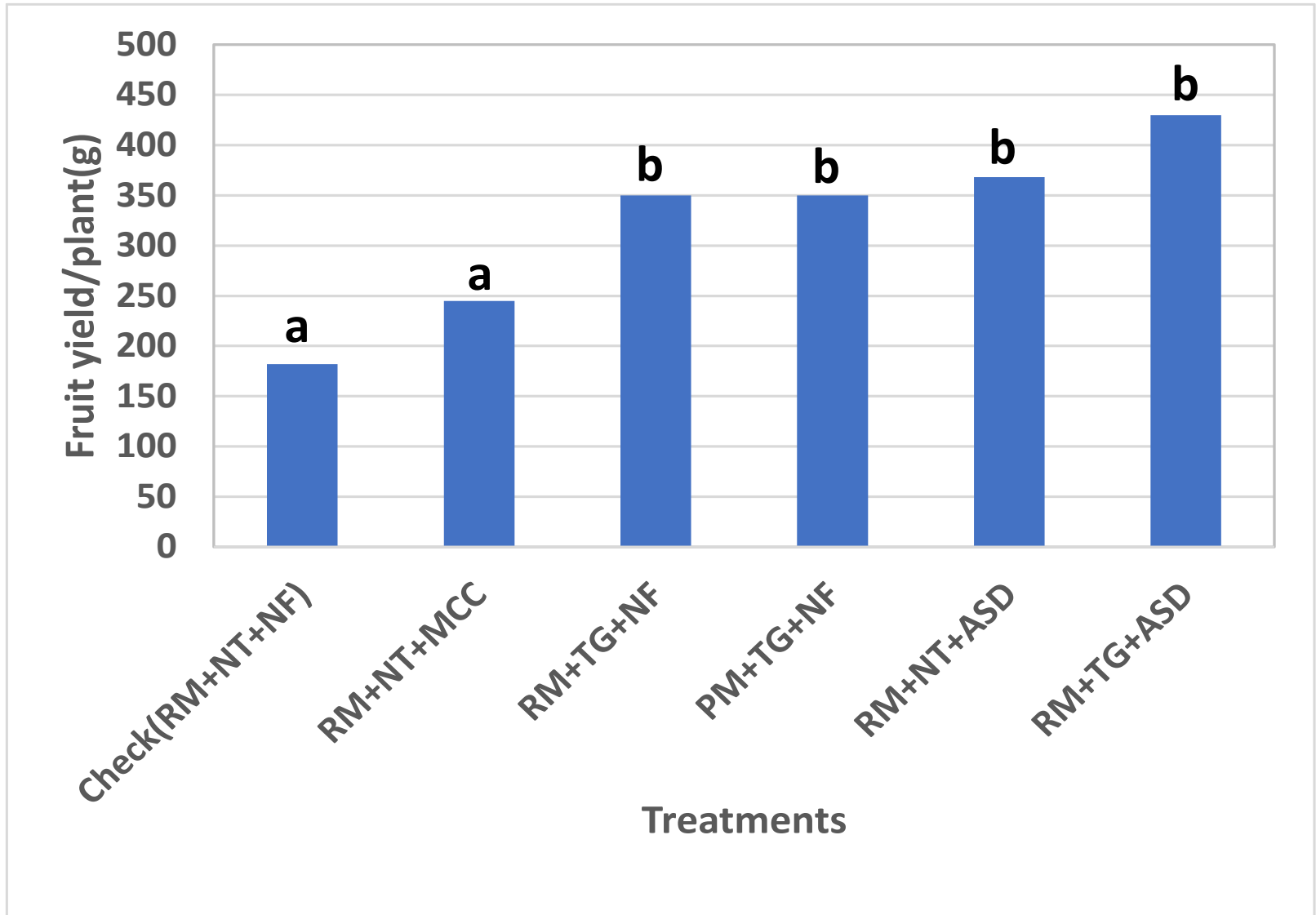
# First year fruit yield



# 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?***

***THANK YOU!***