Effect of probiotic bacteria, anaerobic soil disinfestation and mustard cover crop biofumgation on soilborne disease suppression and yield of strawberry

Results:

Weed suppression in treated plots

Significant weed suppression was observed in ASD field plots regardless of treatment of plug growing media with TerraGrow or not. Lowest number of weeds were found in non-treated regular media grown plug plants planted in ASD plots followed by TerraGrow inoculated regular media grown plug plants planted in ASD plots indicating that TerraGrow did not play a role weed suppression. Mustard cover crop treated plots also suppressed weed growth to some extent. However, the difference between MCC and non-treated check was not statistically different. As mustard meal was used in ASD treatment as carbo source, quick decomposition and production of toxic gas in ASD may have effectively suppressed weed seed germination. TerraGrow treatment of plug plant growing media without any treatment of fruiting field plots did not show any statistical difference in weed count with that of non-treated check although highest number of weeds were found in non-treated check.

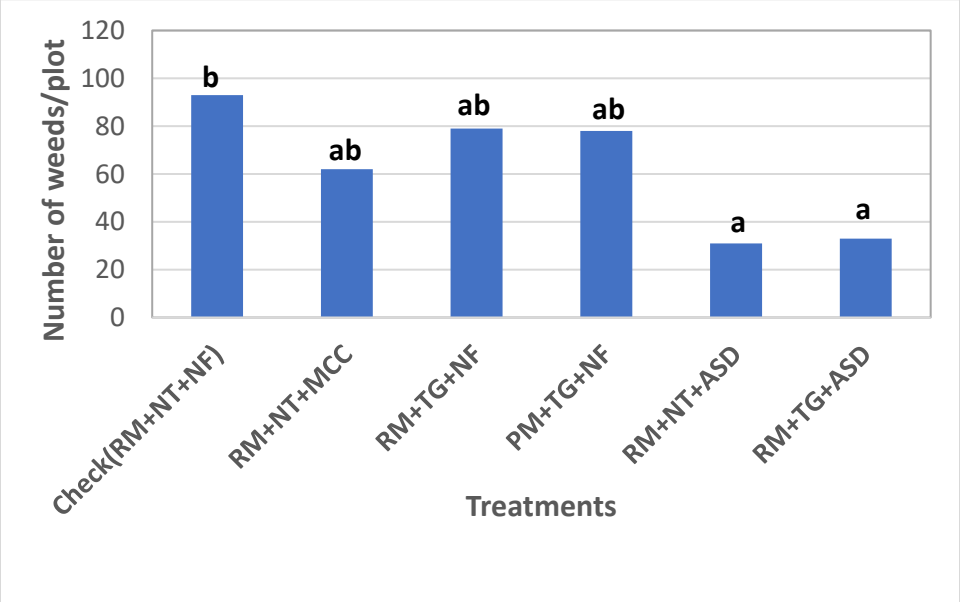

Fig. 1. Number of weeds/treatment. Weeds from all 20 holes were counted and averaged for each replicate of each treatment. Vertical bars having same letter on the top are not significantly different from each other according to Fisher's protected LSD (α=0.05)

Fruit yield in the first and second year

All treatments showed numerical yield enhancement in the first year compared with non-treated check. Fruit yield in different treatments were within the range for organic strawberry production in the Mid-Atlantic region. There have been differences in fruit yield in the treatments with only pasteurized media inoculated with TerraGrow showing significantly higher fruit yield compared to non-treated control (Fig. 2A).

As some plants died at the end of the first-year fruit harvest and some plants in control and other treatments showed diminishing vigor, overall yield in the second year was low. Yield was also affected by spring frost injury to blossoms. However, comparison of fruit yield among different treatments showed that significantly higher yield was obtained from all the treatments except mustard cover crop compared with non-treated check. The highest yield was in combination treatment of ASD plus planting media inoculation with TerraGrow indicating a synergistic effect (Fig. 2B).

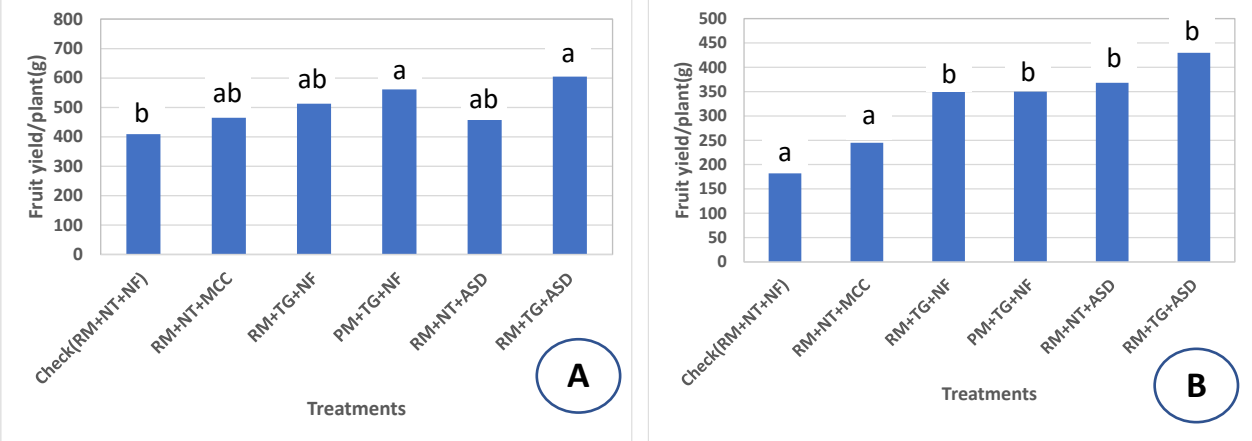

Fig. 2. Strawberry ruit yield; A) First year fruit yield in different treatments; B) Second year yield in different treatments compared to untreated control. Vertical bars having same letter on the top are not significantly different from each other according to Fisher's protected LSD (α=0.05)

Plant vigor and mortality: Immediately after fruit harvest was completed during the summer of Yr-1, diminishing plant vigor, decline and mortality was noticeable in the untreated control plots as well as a few other treatments. Plant mortality in each plot was counted at the end of the summer of Yr-1 and again at the end of the summer Yr-2 at the time of termination of the experiment. The trial was started with 20 plants in each replicate plot of each treatment. At the end of the first year, 6 out of 20 plants died and another 4 died at the end of the second year leaving only 50% of the plants alive. Plant mortality was also recorded from other treatments but to a lower extent. Mustard cover crop plots lost 3 plants/year on an average. Other treatments like combination of probiotic treatment with ASD or ASD alone and probiotic treatments of planting mix with or without pasteurization also had plant mortality in the range of 2-4 plants/plot on an average. The lowest plant mortality was recorded in ASD alone or ASD combined with probiotic bacterial inoculation of planting mix (Fig. 3). Overall plant vigor was also lower in treatments that lost more plants compared to the treatments lost low number of plants. Photos taken at the end of the trial showed remarkable difference in plant health and vigor among treatments (Fig. 4).

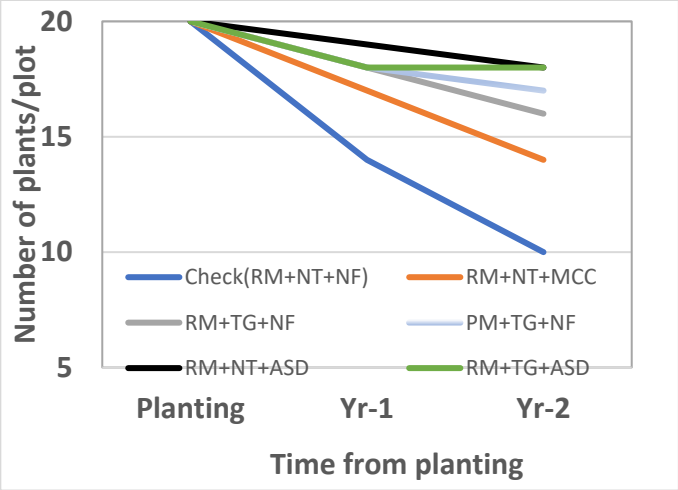

Fig. 3. Plant mortality in different treatments.

Fig. 4. Plant health status showing mortality and vigor in different treatments prior to termination of the trial

Rhizosphere soil analysis

Rhizosphere soil from each treatment was analyzed for major nutrient, pH and organic matter contents at the end of the trial. A composite sample from the whole plot prior to treatment application was also collected and analyzed to obtain baseline nutrient status. Phosphorus (P), Potassium (K) and organic matter contents showed significant differences among treatments but no difference in Magnesium (Mg) or pH. P contents were numerically higher in all treatments with significant difference in MCC and ASD compared to untreated control. Potassium content in all treatments except ASD alone were significantly higher compared with untreated check. As we added lots of biomass in MCC and ASD plots, higher nutrient contents and organic matter contents in these treatments were expected. However, it is very interesting that probiotic bacteria treated planting mix grown plug plants when planted in the field plots likely helped in solubilization of P & K from parent materials and increasing concentration in rhizosphere soil. Organic matter content was increased numerically in all treatments compared to untreated control. However, the difference between untreated control and combination treatment of probiotic bacteria and ASD was only statistically significant (Table 1).

Table 1. Nutrient content and other biological attributes of rhizosphere soil of strawberry plants from different treatments at the termination of the experiment.

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