# 2004 PROGRESS REPORT
# STATE HORTICULTURAL ASSOCIATION OF PENNSYLVANIA, INC.

## Evaluate orchard floor treatments at an apple replant site to determine the effect on tree health, productivity, soil microbial activity, and the reduction of root diseases, wooly apple aphid infestation, and nematodes


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**Duration:** Year 3 progress report of 5 year project.

**Current Status of Project:**
The plot was established in May of 2002. Trees were planted in 3 treatments (monoammonium phosphate, compost and standard fertilizer) in the first year with 2 of the treatment (corn, rapeseed) planted and accomplished in 2004. Soil and tree treatment effects are being measured and evaluated.

**Introduction/Justification: Review of the Project Background:**
Prevention of replant problems is much easier and more successful than control because there is very little that can be done to correct replant problems once the trees have been planted. One condition which influences productivity is replant problem which has been recognized as a serious and common cause of poor growth and delayed cropping of new apple trees planted in old orchard sites. The loss of income from replant problem in a new apple planting can be high.

One of the major problems in a replant site is caused by a complex of fungi, bacteria, nematodes and soil factors such as pH, moisture stress and insufficient available nutrient for vigorous growth of young trees. Many of these microorganisms have the ability to live on dead plant debris in the soil or to cause disease on weak or stressed living plants. There is very little detrimental effect on the root systems of older apple trees since their root systems are mature and the trees can defend themselves from attack by the disease-causing organism in the soil. However, when young trees with immature root systems are planted within the root zone of the old trees that were removed, some problems may develop. Planting can be a stressful process to the young tree. When it is placed in the ground it has little ability to take in nutrients and water until new fibrous roots develop. Even when it has begun to grow new roots, the root to above ground plant ratio may still be insufficient to completely satisfy all the needs of the tree, especially in times of environmental stress such as heat or drought. The disease causing microorganisms in the soil easily infects young newly planted trees that are stressed due to inadequate root system development or stressed by environmental conditions. The result may not be death of the young tree but poor growth. Very often when roots of young poorly growing apple trees are examined the roots are found to have a small root system with a large percentage of the fibrous roots decaying and dead. Growers have observed this phenomenon for themselves when they observe that young trees growing in the old tree row are smaller and growing more poorly than the young trees that were planted between the rows. There are also other reasons why replanted trees grow poorly. Many herbicides have long residual activity and may have an effect on young developing apple roots years after the application was made. In addition, the wooly apple aphid, although easily tolerated on the root systems of mature apple trees can stunt the growth of young trees. Also, after years of herbicide use and bare ground under apple trees, the organic matter in the soil can be very low in old apple orchard sites that provide less than optimum growing conditions for young trees.

Are there any options for growers other than following the 2-year crop rotation recommendation? Soil fumigation with synthetic chemicals has been the standard alternative to waiting 2 years to replant. Fumigants have been proven highly effective in controlling nematodes, moderately effective in controlling soil disease organisms and some what effective in controlling weeds based on the material and rate. However, they are becoming more restricted in their labeled use and in the case of methyl bromide will be completely banned in the near future.

This research project has been evaluating several alternative approaches to managing soil borne disease organisms and insects and determining their effect on tree growth and productivity. The treatments evaluated in this project included, corn/corn rotation, rapeseed/rapeseed rotation, composted animal manure, monoammonium phosphate and an immediate replant with chemical fertilizer. A discussion of the theory behind the use of each of these treatments follows. Each of the treatments was planted in year 1 or 3 (2004) with Gala on M7 and M9 rootstocks. Treatment plots are located in the old tree row and in the drive rows between old tree rows.

Corn/Corn Rotation. The 2-year rotation has been the standard recommendation for apple replant in Pennsylvania for many years. It allows time for the soil nutrients and pH of the site to be adjusted to recommended levels. In addition, problem weeds can be targeted for elimination prior to planting apples back in the site. There is also evidence that corn and other monocots such as wheat or rye also have beneficial effects on soil microbial population levels and diversity. Although this area needs further study for apple orchards in Pennsylvania there is research evidence from Washington State that these rotational crops begin the process of shifting the soil microbial populations away from the potentially harmful microorganisms that often exist in mature orchards.

Rapeseed/Rapeseed Green Manure. Rapeseed green manure has been proven in Pennsylvania to effectively inhibit nematodes in the soil before replanting. Recently there has been evidence that M26 apple rootstock is susceptible to the Tomato Ringspot Virus and may be causing apple orchard decline where high levels of nematodes and virus exist. Besides inhibiting nematode population levels, rapeseed green manure may increase the levels of beneficial soil microorganisms resulting in less tree disease and improved growth. Dagger nematodes have a broad host range and survive on many different plants including rapeseed and corn. However, rapeseed has nematode suppressive properties if used as green manure. When rapeseed is incorporated into the soil while still green and allowed to decompose the tissues release isothiocyanates which are highly toxic to nematodes. As with other pest control practices best results are achieved under optimum conditions. Rapeseed needs to be incorporated while green and healthy and the soil needs to be relatively warm (above 40 F) and moist.

Composted Animal Manure. Old apple orchards are often low in organic matter, which may favor the build-up of soil pathogens in the replant site. Composted animal manure provides primarily two benefits to an orchard replant site. First, the compost provides organic matter to the site that acts as a food source to enhance beneficial microorganism development at the orchard site. Highly mineralized soils that are low in organic matter may actually favor disease organisms in the soil. Disease organisms can survive in the soil on root exudates and therefore can buildup around apple root systems in soils in the absence of organic matter. Beneficial microorganisms that utilize organic matter as a food source decline in the soil when organic material is low or increase when organic matter is applied to the soil in the form of compost. When soils are high in organic matter, beneficial microorganisms are favored and disease organisms decline in the soil. Secondly, compost serves as a carrier to add beneficial microorganisms to the soil. Compost is a complete package. It delivers the microorganisms, provides the nutrients and food reserves needed by the microorganisms to survive and multiply and improves soil water holding capacity, which favors the beneficial microorganisms over disease causing organisms in the soil. Compost allows beneficial soil microorganisms to out compete disease-causing organisms in the soil.

Monoammonium Phosphate. Research in other parts of the country has shown that application of monoammonium phosphate can significantly improve the growth of apple trees on a replant site. This fertilizer is believed to improve root growth in young apple trees.

Standard/Immediate Replant Treatment. This treatment duplicates planting young apple trees in the spring after tree removal in the fall. Plots are being fertilized according to soil and petiole analysis results.

**Research Objectives:**

Objective 1: Evaluate the effectiveness of orchard floor treatments to suppress root pathogens, wooly apple aphids, Tomato Ringspot virus and nematodes in orchard replant studies.

Objective 2: Evaluate the effect of orchard floor treatments on fruit tree growth, flowering, productivity, and nutrition.

**Procedures:**

This project proposed to develop a biological management system to improve fruit tree health and reduce tree fruit root disease and nematode replant problems. The use of compost and other orchard floor treatments is expected to be profitable for tree fruit growers in PA, since it has the potential to replace soil fumigation, minimize fertilizer use and have a positive influence on tree health and productivity.

*Orchard Floor Treatments*

1) Standard Fertilizer (Immediate replant, yr. 1)
2) Two year rotation with corn (Plant yr. 3)
3) Compost -animal manure (Immediate replant, yr. 1)
4) Two year rotation with rapeseed green manure (Plant yr. 3)
5) Monoammonium phosphate (Immediate replant, yr. 1)

*Plot Location*: The replant orchard utilized in the project is located at the Penn State University, Fruit Research and Extension Center, Biglerville, PA. The site was previously planted to 30 year old ‘Golden Delicious’, ‘Red Delicious’ and ‘Rome Beauty’ apple trees.

*Plot Design:* The experiment was established as a completely randomized design with 5 replications of 3 trees per treatment. Gala apple trees grafted to M7 and M9 were utilized in the experiment and planted on the row (where the pushed trees were planted) and on the drive row.

*Treatment Rates and Timing:* Compost rate was determined based on the orchard soil characteristics, and the compost analysis. Compost was applied at 20 tons per acre in a strip application under the trees. Rates and the timing of all treatment applications were adjusted and optimized for fruit tree health and productivity.

**Results:**

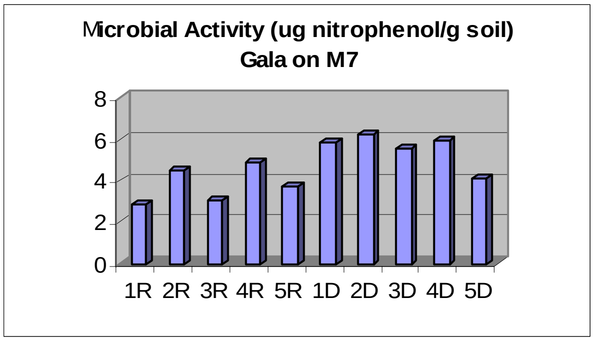
The plot was established in May of 2002. Trees were planted in 3 treatments (monoammonium phosphate, compost and standard fertilizer) with 2 of the treatment (corn, rapeseed) planted and accomplished in 2004.

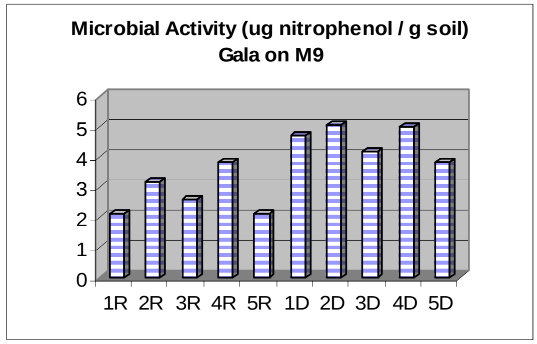
**Soil Microbial Activity**

Soil samples to determine soil microbial activity were collected in the fall of 2003. Laboratory procedures were followed which provide an indirect measure of the soil microbial activity for each treatment plot. The rapeseed and corn treatments had higher microbial activity levels than the other treatments in both the Gala/M7 and the Gala/M9 experimental blocks (Figure 1). Compost treatments showed a higher microbial activity over the standard fertilizer in the Gala/ M7 and the Gala/M9 in the blocks where the old trees were located. The mono ammonium phosphate treatment only increased the microbial activity in the Gala/M7 on the row block. Microbial activity fluctuated between the treatments over the duration of this project as trees replace rapeseed and corn plots, fertilizer plots are maintained as bare soil and compost plots continue degradation and renewal. Soil samples were collected this fall of 2004 and microbial activity analysis is currently underway.

Microbial activity in the soil is a measure of the suppressiveness of the soil to disease organisms. The higher the microbial activity the higher the likelihood that diseases will be inhibited in the orchard. Microbial activity levels do not change quickly in the soil and may take a year and more time to make the transition to higher activity levels.

**Figure 1**. Apple Replant Block Gala on M7 and M9, 2003. Soil Microbial Activity levels of Standard fertilizer/Immediate replant (1), 2-yr. Corn rotation (2), Compost (3), 2-yr. Rapeseed rotation (4) and Monoammonium phosphate (5) in the tree row (R) or drive row (D) of previous orchard.




**<u>Soil and Leaf Tissue Nutrient Analysis</u>**

Leaf analysis in 2003 did not show any dramatic differences for any of the nutrients, although leaf nitrogen was lowest in the standard fertilizer immediate replant (data not shown). The 2004 leaf analysis showed that M7 and M9 treated with the 2 year corn and rapeseed rotations showed highest level of leaf nitrogen (N), phosphorous (P) and potassium (K) (Table 1a-d).

Soil analysis in 2003 showed some effects of treatments where phosphorus levels were highest in the monoammonium phosphate treated plots. Soil potassium levels were highest in the compost treatment as was soil pH (Table 2a). Soil analysis in 2004 showed that phosphorous, potassium, magnesium, calcium, organic matter levels and pH were highest in both M9 and M7 trees planted in compost treated plots (Tables 2b-f). There is no marked difference on the levels of soil nutrients between trees planted on tree row or drive row.

**Table 1a**. Leaf tissue analysis of replant plantings, **Gala/M9 tree row**, 2004*

| | Percent | | | | |
|---|---|---|---|---|---|
| Treatments | N | P | K | Ca | Mg |
| 1. Standard fertilizer/Im.Rep. | 1.95 | 0.12 | 1.68 | 1.13 | 0.17 |
| 2. Corn | 2.65 | 0.17 | 1.75 | 0.82 | 0.24 |
| 3. Compost | 2.10 | 0.12 | 1.61 | 1.22 | 0.18 |
| 4. Rapeseed | 2.60 | 0.18 | 2.06 | 0.87 | 0.23 |
| 5. Monoammonium phosphate | 2.04 | 0.12 | 1.31 | 1.33 | 0.23 |

**Table 1b**. Leaf tissue analysis of replant plantings, **Gala/M9 drive row**, 2004*.

| | Percent | | | | |
|---|---|---|---|---|---|
| Treatments | N | P | K | Ca | Mg |
| 1. Standard fertilizer/Im.Rep. | 2.07 | 0.13 | 1.49 | 1.46 | 0.22 |
| 2. Corn | 2.75 | 0.17 | 1.82 | 0.85 | 0.22 |
| 3. Compost | 2.06 | 0.13 | 1.47 | 1.21 | 0.18 |
| 4. Rapeseed | 2.84 | 0.18 | 2.01 | 0.90 | 0.21 |
| 5. Monoammonium phosphate | 2.18 | 0.13 | 1.09 | 1.28 | 0.26 |

**Table 1c**. Leaf tissue analysis of replant plantings, **Gala/M7 tree row**, 2004*.

| Treatments | Percent | | | | |
|---|---|---|---|---|---|
| | N | P | K | Ca | Mg |
| 1. Standard fertilizer/Im.Rep. | 2.27 | 0.13 | 1.70 | 1.07 | 0.21 |
| 2. Corn | 2.53 | 0.17 | 1.43 | 0.94 | 0.29 |
| 3. Compost | 2.07 | 0.12 | 1.50 | 0.93 | 0.18 |
| 4. Rapeseed | 2.58 | 0.18 | 1.51 | 0.96 | 0.24 |
| 5. Monoammonium phosphate | 2.48 | 0.15 | 1.41 | 1.08 | 0.25 |

**Table 1d**. Leaf tissue analysis of replant plantings, **Gala/M7 drive row**, 2004*.

| Treatments | Percent | | | | |
|---|---|---|---|---|---|
| | N | P | K | Ca | Mg |
| 1. Standard fertilizer/Im.Rep. | 2.24 | 0.13 | 1.57 | 1.00 | 0.20 |
| 2. Corn | 2.94 | 0.19 | 1.31 | 1.02 | 0.28 |
| 3. Compost | 2.08 | 0.14 | 1.51 | 0.98 | 0.19 |
| 4. Rapeseed | 3.08 | 0.23 | 1.71 | 0.94 | 0.24 |
| 5. Monoammonium phosphate | 2.23 | 0.15 | 1.38 | 1.09 | 0.24 |

* Leaf samples were collected in July 2004. Each number is a composite sample of 25 leaves per tree from 5 replicates. Leaves were dried at 104F for 48 hrs, ground at 2mm mesh and analyzed by PSU Analytical Lab.

**Table 2a**. Soil nutritional analysis of replant plantings at FREC in 2003

| Treatment | lb/ Acre | | | | | |
|---|---|---|---|---|---|---|
| | $P_2O_5$ | P | $K_2O$ | MgO | CaO | pH |
| 1. Standard fertilizer/Im.Rep. | 235 | 103 | 311 | 469 | 3007 | 6.0 |
| 2. Corn | 241 | 105 | 382 | 482 | 3145 | 6.0 |
| 3. Compost | 485 | 212 | 905 | 566 | 3764 | 6.6 |
| 4. Rapeseed | 193 | 84 | 431 | 508 | 3158 | 6.5 |
| 5. Monoammonium phosphate | 645 | 282 | 319 | 421 | 2711 | 5.7 |

**Table 2b**. Soil nutritional analysis of replant plantings, **Gala/M9 on tree**, 2004.

| Treatment | lb/ Acre | | | | | |
|---|---|---|---|---|---|---|
| | $P_2O_5$ | P | $K_2O$ | MgO | CaO | pH |
| 1. Standard fertilizer/Im.Rep. | 376 | 164 | 583 | 528 | 3125 | 6.2 |
| 2. Corn | 183 | 80 | 283 | 452 | 2961 | 5.5 |
| 3. Compost | 1937 | 846 | 1022 | 1248 | 9455 | 7.1 |
| 4. Rapeseed | 362 | 158 | 713 | 508 | 3357 | 6.2 |
| 5. Monoammonium phosphate | 1383 | 604 | 406 | 425 | 2550 | 5.3 |

**Table 2c**. Soil nutritional analysis of replant plantings, **Gala/M9 drive row**, 2004*.

| Treatment | lb/ Acre | | | | | |
|---|---|---|---|---|---|---|
| | $P_2O_5$ | P | $K_2O$ | MgO | CaO | pH |
| 1. Standard fertilizer/Im.Rep. | 330 | 144 | 449 | 631 | 3160 | 5.9 |
| 2. Corn | 247 | 108 | 379 | 535 | 3093 | 5.8 |
| 3. Compost | 1649 | 720 | 912 | 1119 | 8190 | 7.1 |
| 4. Rapeseed | 321 | 140 | 583 | 488 | 3029 | 6.1 |
| 5. Monoammonium phosphate | 1347 | 588 | 295 | 375 | 2466 | 5.1 |

**Table 2d**. Soil nutritional analysis of replant plantings, **Gala/M7 on tree row**, 2004*.

| Treatment | lb/ Acre | | | | | |
|---|---|---|---|---|---|---|
| | $P_2O_5$ | P | $K_2O$ | MgO | CaO | pH |
| 1. Standard fertilizer/Im.Rep. | 353 | 154 | 658 | 558 | 3239 | 6.3 |
| 2. Corn | 243 | 106 | 422 | 528 | 2916 | 6.3 |
| 3. Compost | 1383 | 604 | 1133 | 1099 | 7574 | 7.1 |
| 4. Rapeseed | 179 | 78 | 593 | 528 | 3493 | 6.4 |
| 5. Monoammonium phosphate | 426 | 186 | 658 | 554 | 3051 | 6.1 |

**Table 2e**. Soil nutritional analysis of replant plantings, **Gala/M9 drive row**, 2004*.

| Treatment | lb/ Acre | | | | | |
|---|---|---|---|---|---|---|
| | $P_2O_5$ | P | $K_2O$ | MgO | CaO | pH |
| 1. Standard fertilizer/Im.Rep. | 247 | 108 | 650 | 574 | 3156 | 5.9 |
| 2. Corn | 243 | 106 | 394 | 481 | 3056 | 6.0 |
| 3. Compost | 1305 | 570 | 847 | 1029 | 7504 | 7.0 |
| 4. Rapeseed | 147 | 64 | 518 | 498 | 3233 | 6.1 |
| 5. Monoammonium phosphate | 371 | 162 | 691 | 584 | 3069 | 5.9 |

**Table 2f**. Percent Organic Matter Content, 2004*.

| Treatments | Apple cv / Rootstock | | | |
|---|---|---|---|---|
| | Gala/M7 | | Gala/M9 | |
| | Drive Row | Tree Row | Drive Row | Tree Row |
| 1. Standard fertilizer/Im.Rep. | 4.4 | 2.6 | 3.5 | 1.8 |
| 2. Corn | 3.2 | 2.0 | 2.6 | 2.5 |
| 3. Compost | 5.8 | 4.5 | 5.0 | 6.1 |
| 4. Rapeseed | 2.6 | 2.5 | 2.6 | 2.2 |
| 5. Monoammonium phosphate | 4.0 | 2.6 | 3.3 | 2.0 |

* Soil samples were collected in July 2004. Each number is a mean of 10-16 composite samples/treatment collected from 5 replicates.

**Nematodes / Tomato Ringspot Virus**

As in cropping seasons 2002 and 2003, nematode assays recovered several plant-parasitic nematodes in the replant site including dagger nematodes *(Xiphinema sp.*), lesion nematodes (*Pratylenchus sp.*), lance nematodes (*Hoplolaimus sp.*) and spiral nematodes (*Helicotylenchus sp.*). Except for dagger nematodes, the population levels of other pathogenic nematodes were below damage threshold limits. The dagger nematode however, is the vector of Tomato Ringspot Virus and even relatively low numbers can spread disease within the orchard. This is why dagger nematodes are of concern in replant sites whenever a virus susceptible rootstock is planted. Typical population increases of dagger nematodes were observed on corn and rapeseed while lower populations were recovered where herbicides eliminated alternate hosts for the nematode. The cool and wet soil conditions were not optimum for the production of isothiocyanates and reduced the efficacy of the green manure treatment (Table 3a-c).

Suckers and roots from the three rootstocks, i.e., M7, M26 and B9 planted in compost, monoammonium phosphate (MAP) and standard fertilizer/immediate replant plots were bioassayed using ELISA for the presence of tomato ring spot virus. Nine rootstocks (3 B9, 2 M26 and 4 M7) were detected positive with tomato ring spot virus that was planted in the standard fertilizer/ immediate replant treated block only. None were found from compost and monoammonium phosphate treated plots.

**Table 3a**. Nematode (*Xiphinema americanum*) counts in 2003*

| Treatments | Apple cv / Rootstock Gala/M7 | Gala/M9 |
|---|---|---|
| 1. Standard fertilizer/Im.Rep | 11 | 4 |
| 2. Corn | 15 | 72 |
| 3. Compost | 4 | 24 |
| 4. Rapeseed | 20 | 10 |
| 5. Monoammonium phosphate | 2 | 0 |

* Soil samples were collected in November 17, 2003. Each number is a count of 10-16 composite samples from 5 replicates.

**Table 3b**. Nematode (*Xiphinema americanum*) counts in 2004*

| | Apple cv / Rootstock | | | |
|---|---|---|---|---|
| | Gala/M7 | | Gala/M9 | |
| Treatments | Drive Row | Tree Row | Drive Row | Tree Row |
| 1. Standard fertilizer/Im.Rep. | 5 | 2 | 3 | 20 |
| 2. Corn | 13 | 8 | 5 | 5 |
| 3. Compost | 5 | 6 | 6 | 4 |
| 4. Rapeseed | 6 | 23 | 20 | 19 |
| 5. Monoammonium phosphate | 6 | 2 | 0 | 11 |

* Soil samples were collected in July 2004. Each number is a mean of 10-16 composite samples from 5 replicates.

**Table 3c**. Nematode (*Xiphinema americanum*) counts in 2004*

| Treatments | Apple cv / Rootstock: Gala/M7 Drive Row | Gala/M7 Tree Row | Gala/M9 Drive Row | Gala/M9 Tree Row |
|---|---|---|---|---|
| 1. Standard fertilizer/Im.Rep. | 32 | 18 | 25 | 9 |
| 2. Corn | 9 | 10 | 8 | 4 |
| 3. Compost | 19 | 2 | 14 | 7 |
| 4. Rapeseed | 6 | 9 | 17 | 8 |
| 5. Monoammonium phosphate | 32 | 18 | 9 | 18 |

* Soil samples were collected in October 2004. Each number is a mean of 10-16 composite samples from 5 replicates.

**Wooly Apple Aphid & Root Diseases**

M7, B9 and M26 rootstocks were planted in each plot and will allow for destructive sampling and observation of individual root systems throughout the course of the study to observe roots for aphid infestation and isolate for disease and detect virus infection. In order to allow sufficient time for aphids and root diseases to become established, rootstock trees were pulled out this 2004 to observe insect or disease problems (Data observation is currently underway).

**Horticultural Measurements. Tree Size and Yield**

Tree size data in 2002 and 2003 measured by trunk cross sectional area (TCSA) was not influenced by treatments applied to the soil for either rootstock. However, TCSA was influenced by whether the trees were planted in the old rows. For both M.9 and M.7 trees that were planted aligned within the old rows were significantly smaller and had less growth than those planted between the old rows. Trees planted in the old tree row were approximately 27% smaller and had about 35% less growth in 2003. There were no differences in the subjective growth rating of any treatment or planting location (Table 4a). Tree size (TCSA) data in 2004 showed the same trend as in 2003 where trees planted between the old tree rows (drive row) were higher than trees planted in the old tree rows, however, M9 trees (but not M7 trees) were significantly highest in compost treated plots (P=0.05)(Table 4b). Shoot growth of M9 and M7 taken in 2004 showed a similar trend with the TCSA which was not affected by the treatments, however influenced by the location where trees were planted. Trees planted in the drive row of the pushed/old orchard had longer shoots than the trees planted in old tree row (Table 4c).

Fruit counts were higher in M7 and M9 trees, respectively, planted in the drive row compared to the trees planted in the old tree row. M9 trees planted in MAP plot had the highest fruit harvest, while M7 trees had the highest number of fruits in compost treated plot (Table 4d).

**Table 4a**. Tree size (TCSA), growth and growth rating of Gala on M.9 and Gala on M.7 at the FREC in 2003.

| | Gala / Malling 9 | | |
|---|---|---|---|
| Treatment | TCSA, $cm^2$ | Growth | Growth Rating* |
| Monoammonium phosphate | 4.6 a | 2.8 a | 1.3 a |
| Compost | 4.9 a | 3.0 a | 1.2 a |
| Std. Fert./Im. rep. | 4.7 a | 2.9 a | 1.2 a |
| P-Value | 0.378 | 0.5423 | 0.2892 |
| In Old Tree Row | 4.0 a | 2.3 a | 1.3 a |
| In Old Row middle | 5.5 b | 3.5 b | 1.2 a |
| P-Value | 0.0001 | 0.0001 | 0.4240 |

| | Gala / Malling 7 | | |
|---|---|---|---|
| Treatment | TCSA, $cm^2$ | Growth | Growth Rating* |
| Monoammonium phosphate | 8.5 a | 5.4 a | 1.5 a |
| Compost | 9.5 a | 6.0 a | 1.7 a |
| Std. Fert./Im. rep. | 8.8 a | 5.4 a | 1.4 a |
| P-Value | 0.2125 | 0.267 | 0.5254 |
| In Old Tree Row | 7.6 a | 4.6 a | 1.6 a |
| In Old Row middle | 10.3 b | 6.7 b | 1.4 a |
| P-Value | 0.0001 | 0.0001 | 0.2729 |

* Means tree trunk circumference (cm)/tree of 3 trees/treatment- plot replicated 5 times. Means followed by the same letter(s) are not significantly different according to the Tukey-Kramer Test ($P < 0.05$).

**Table 4b.** Tree size (TCSA) of Gala on M.9 and Gala on M.7 at the FREC in 2004.

| Treatment | Tree Row | | Drive Row | |
|---|---|---|---|---|
| | **Gala M.9** | | | |
| Monoammonium phosphate | 9.6 | a* | 11.1 | a |
| Compost | 9.9 | a | 12.2 | b |
| Std. Fert./Im. rep. | 10.1 | a | 11.4 | ab |
| P-Value | 0.0001 | | 0.0001 | |
| | **Gala M.7** | | | |
| Treatment | Tree Row | | Drive Row | |
| Monoammonium phosphate | 13.8 | a* | 17.0 | a |
| Compost | 14.0 | a | 16.8 | a |
| Std. Fert./Im. rep. | 13.8 | a | 16.5 | a |
| P-Value | 0.0001 | | 0.0001 | |

* Means tree trunk circumference (cm)/tree of 3 trees/treatment-plot replicated 5 times. Means followed by the same letter(s) are not significantly different according to the Tukey-Kramer Test (P < 0.05).

**Table 4c**. Shoot growth of Gala on M.9 and Gala on M.7 at the FREC in 2004.

| | Apple cv / Rootstock | |
|---|---|---|
| Treatments | Gala/M7* | Gala/M9* |
| Standard fertilizer/Im.Rep. | 73.8 a* | 75.7 a |
| Compost | 72.3 a | 72.2 a |
| Monoammonium phosphate | 73.8 a | 70.8 a |
| P-Value | 0.6631 | 0.0861 |
| Tree Row | 71.0 a | 70.9 a |
| Drive Row | 75.6 b | 74.9 a |
| P-Value | 0.0094 | 0.0907 |

* Mean shoot length (cm) of 10 shoots/tree x 3 trees / treatment-plot replicated 5 times. Letters refer to the Tukey-Kramer Mean Separation, (P < 0.05).

**Table 4d**. Number of clusters, fruit set, and % fruit set on Gala/M.7and Gala/M.9 at FREC in 2004.

| Treatments | Gala/M7 | | |
|---|---|---|---|
| | # Clusters/Tree | # Fruit Set/Tree | % Fruit Set |
| Standard fertilizer/Im.Rep. | 10.1 a* | 10.99 a | 107.4 a |
| Compost | 13.4 a | 14.2 a | 104.5 a |
| Monoammonium phosphate | 11.0 a | 11.8 a | 106.7 a |
| P-Value | 0.7621 | 0.7777 | 0.5299 |
| Tree Row | 4.5 a | 4.7 a | 103.8 a |
| Drive Row | 18.5 b | 19.9 b | 108.6 a |
| P-Value | 0.0001 | 0.0001 | 0.0818 |

| Treatments | Gala/M9 | | |
|---|---|---|---|
| | # Clusters/Tree | # Fruit Set/Tree | % Fruit Set |
| Standard fertilizer/Im.Rep. | 19.0 a | 19.7 a | 104.0 a |
| Compost | 20.1 a | 20.7 a | 103.0 a |
| Monoammonium phosphate | 26.7 a | 27.7 a | 104.0 a |
| P-Value | 0.1057 | 0.0981 | 0.8810 |
| Tree Row | 14.4 a | 15.1 a | 105.0 b |
| Drive Row | 29.5 b | 30.3 b | 102.0 a |
| P-Value | 0.0001 | 0.0001 | 0.0387 |

* Mean number of fruits x 3 trees/treatment-plot replicated 5 times. Letters refer to Tukey-Kramer Mean Separation, ($P < 0.05$).

**Summary**

This project has begun the evaluation of the effects of several promising orchard floor treatments on apple replant. Preliminary results show some encouraging trends in the positive effect these treatments on increased tree growth, the potential for increased yield and improved tree longevity in the future. As these plots are maintained and monitored over the next several growing seasons a more comprehensive comparison of the treatment effects on tree growth and health is anticipated.

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