# Almond Fumigant Studies: Continual Research on Methyl Bromide Alternatives

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**Problem and Significance:** Methyl bromide, the fumigant that has been used historically for control of replant problems, has been banned in developed countries. Research over the past ten years has determined suitable fumigant alternatives to methyl bromide that provide similar, if not better, control of some of the biological replant problems. Since these trials have been established relatively recently, there is little long term data with methyl bromide alternatives on control of nematodes and soil borne diseases. Further research is needed in order to determine the rate of re-infestation of the soil by these pests and pathogens.

**Objectives:**

1. To continue the work of established fumigant plots for control of Prunus Replant Disease and plant pathogenic nematodes.
2. To continue the development of non-fumigant based control measures for almond replant disease and plant pathogenic nematodes within fumigant buffer zones.

**Methods:** This work will continue the efforts set forth by the USDA-ARS Pacific Area-wide Methyl Bromide Alternatives project which concludes in June of 2012. Three fumigant projects within Merced County were established over the past three years. All three projects included main plot designs testing fumigant alternatives to methyl bromide. A fourth project is being established to determine fumigant alternatives for buffer zones. Trials and treatments are described in table 1.

Treatments within the trials will be monitored for tree growth, yield, and nematode control. Harvest data will be collected upon first harvest and continued through the tenth year, possibly longer. Diameter and circumference measurements will be made in the dormant period following the year of growth. Nematodes will be sampled in mid-October by collecting soil from the depth of 18 inches within the dripline of the tree.

Table 1: Basic description of the various fumigant trials established in Merced County. Rates listed under the fumigant treatments are on a treated acre basis.

| Location | Year | Soil | Rootstock | Control | Methyl Bromide rowstrip | Telone II rowstrip | Telone II broadcast | Telone II-C35 row strip | Steam - tree spot | Telone II - C35 tree spot | Chloropicrin tree spot | Fumigant Alternatives |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Livingston | 2010 | Loamy Sand | Viking | 0 lbs/acre | 350 lbs/acre | 340 lbs/acre | - | 525 lbs/acre | - | 525 lbs/acre | - | - |
| Ballico | 2011 | Sand | Nemaguard | 0 lbs/acre | 400 lbs/acre | 340 lbs/acre | 340 lbs/acre | 525 lbs/acre | Yes | - | - | - |
| Winton | 2012 | Sand | Nemaguard | 0 lbs/acre | - | 340 lbs/acre | 340 lbs/acre | 525 lbs/acre | Yes | H – 525, L- 350 lbs/acre | 200 lbs/acre | - |
| N. Livingston | 2012 | Sand | Nemaguard | 0 lbs/acre | - | 340 lbs/acre | - | - | - | - | - | Various |

## Results and Discussion:

### Livingston Trial (2010):

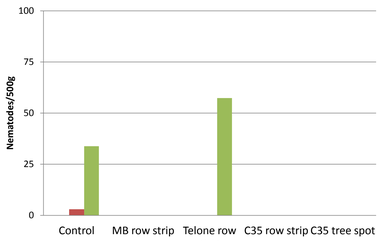


Figure 1: Nematode counts from various treatments taken after one year of growth at the Livingston trial. Sampling performed in 2010.

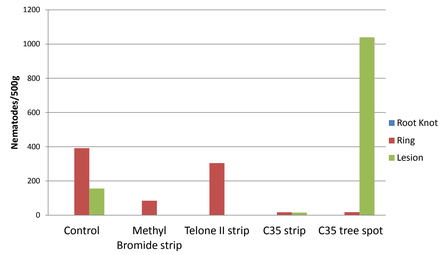


Figure 2: Nematode counts from various treatments taken after three years of growth at the Livingston trial. Sampling performed in 2012.

Table 2: The effect of pre-plant treatments on the yield of replanted almonds at the Livingston trial in 2012, 2013, and cumulative. Treatments followed by * are significantly different from the control (p<0.05).

| Treatment | 2012 Yield (kernel lbs/acre) | 2013 Yield (kernel lbs/acre) | Total Yield (kernel lbs/acre) |
|---|---|---|---|
| Methyl Bromide | 84 * | 235 | 319.3 * |
| C35 Strip | 73 | 210 | 283 |
| C35 Spot | 65.9 | 210 | 275 |
| Telone II Strip | 65 | 184 | 249 |
| Control | 40.8 | 105 | 146.5 |

### Ballico Trial (2011):

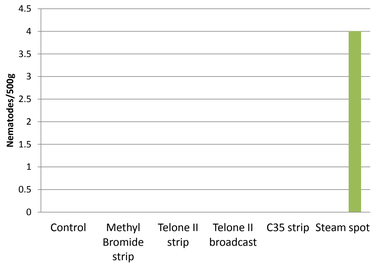


Figure 3: Nematode counts from various treatments taken after one year of growth at the Ballico trial. Sampling performed in 2011.

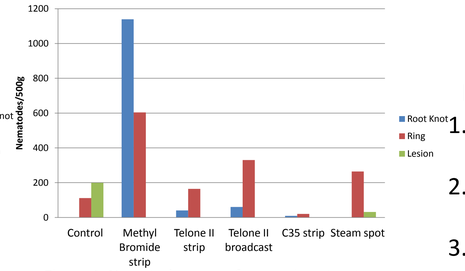


Figure 4: Nematode counts from various treatments taken after two years of growth at the Ballico trial. Sampling performed in 2012.

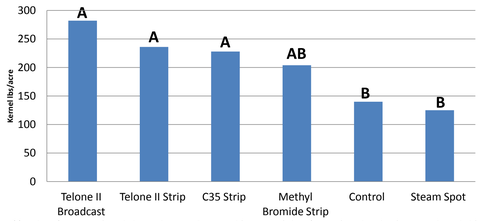


Figure 5: : The effect of pre-plant treatments on the yield of replanted almonds at the Ballico trial in 2013. Treatments followed by different letters are statistically different (p<0.05).

### Winton Trial (2012):

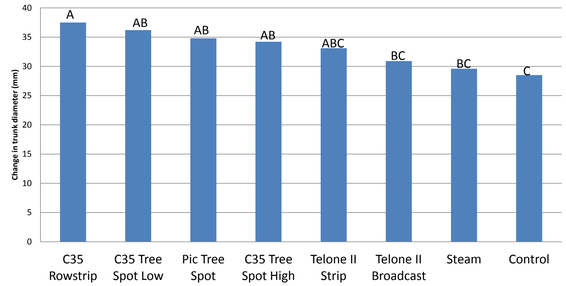


Figure 6: The effect of various non-fumigant pre-plant treatments on the second year of trunk growth of replanted almonds at the Winton trial. Treatments followed by different letters are statistically different (p<0.05).

### N. Livingston Trial (2012):

Table 3: The effect of various non-fumigant pre-plant treatments on the first year, second year, and cumulative trunk growth of replanted almonds at the N. Livingston trial. Treatments followed by different letters are statistically different (p<0.05).

| | Change in Diameter (mm) | | |
|---|---|---|---|
| Treatment | 2012 | 2013 | Total |
| Fumigate+Backhoe | 32.26 A | 46.90 A | 79.17 A |
| Backhoe | 23.93 B | 41.96 AB | 65.88 B |
| Yeast | 23.42 B | 40.62 ABC | 64.04 B |
| 36" Auger | 21.81 B | 37.83 BC | 59.63 B |
| 24" Auger | 23.25 B | 35.66 BC | 59.17 B |
| 36" Auger + Steam | 25.22 B | 33.37 BC | 58.91 B |
| 1% Hydrogen Peroxide | 23.98 B | 33.07 BC | 58.60 B |
| LCS Compost Tea | 23.12 B | 32.82 BC | 57.08 B |
| 24" Auger + Steam | 26.43 AB | 32.74 BC | 55.94 B |
| Control | 23.24 B | 32.2 C | 55.44 B |

Discussion:

1. Nematodes re-infested fumigated soils within 2-3 years after fumigation at both the Livingston and Ballico trials (Figures 1,2,3,4);
2. Only the methyl bromide row-strip treatment increased yields over the non-fumigated control at the Livingston trial (Table 2);
3. Trees planted in soil pre-plant fumigated with Telone II broadcast, Telone II or C35 rowstrip outperformed steam tree spot applications, and the untreated control at the Ballico test site (Fig 5);
4. With the exception of the Telone-II broadcast and rowstrip treatments, all fumigant treatments outperformed the control at the Winton Trial (Fig 6);
5. We were not able to find any alternative fumigant alternatives that outgrew the untreated control at the N. Livingston trial (Figure 7).

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