FOURTH YEAR REPORT **Update**, 03/26/2007

Project title: Soil Fumigation for the Treatment of Specific Orchard Replant Disease.

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Objective
Assess various registered soil fumigants as treatments for Orchard Replant Disease, a critical factor in the growth and productivity of tree fruits planted on sites that recently supported tree fruit production.

Significant findings summary:

The treatment orchard produced it's first significant crop in 2006, the fourth growing season, though yields can be expected to increase by 300 - 400% over the next four years. Yield and fruit size data was taken for the second season in September, and differences were quite evident. The top four treatments (Telone C35 at 30 and 39 gallons per acre, Telone C-17 at 30 gpa, and Methyl Bromide 200 lb. + Chloropicrin 100 lb./A) yielded about 50% more fruit than the untreated check trees. Statistically and numerically, these top four treatments were very similar. The metam treated trees produced 39% more fruit than the untreated check, a significant boost in production, but not nearly at the level of the other treatments.

Fruit size was significantly larger in all fumigated plots than in the untreated checks. This increased size significantly increased the relative economic value of fruit from fumigated trees (see table 6). It is likely that the expense of fumigation would have been more than covered by this increase in economic returns in the fourth season.

As fruiting affects the rate of vegetative growth, trunk size begins to lose validity as an evaluation of fumigation effect as trees come into production. The trees producing the most fruit generally reduce their rate of trunk development to a greater degree than the lightly cropped trees. The statistical analysis of trunk size differentiated the unfumigated check from all of the treatments, but did not differentiate between any fumigant or rate. There were interesting numerical differences amongst the treatments, but variability within the trial obscured the results. The better fumigant treatments had about 25 percent larger trunk cross section areas in comparison to the untreated checks.

Methods and materials:

Test site: The trial is placed in an orchard at Brays Landing, a region north of Orondo, Washington, owned and operated by Dovex, Inc., Wenatchee, Washington. The site had

supported apples during the approximate 25 years prior to 2001, and had been free of orchard for only one season, but root "suckers" were present on the site prior to fumigation. The orchard is in an area where specific orchard replant disease is common. The site is slightly rolling and generally slopes to the West, but with a low lying, potentially cold area on the Eastern edge. The soil is classified as a "Supplee" very fine sandy loam. Supplee soils are described as very deep, well-drained soils on terraces above the Columbia River.

The trees in the trial are Golden Delicious on MM106 rootstock. They were planted March, 2003. The trees are spaced at nine feet along rows that are spaced fourteen feet apart (346 trees per acre). This orchard will not be trellised, and should take at least seven to nine years to reach full production potential. Full production potential can be expected to reach about 60 bins, or about 54,000 pounds per acre. The MM106 rootstock is highly prone to Phytophthora "collar rot," and some of the trees continue to develop symptoms or have died due to this disease, though the death rate has dropped considerably in 2006. There is no correlation between collar rot incidence and the treatment, or to the check. Trees suffering from collar rot are not included in the data.

Severe cold during the first winter after planting (5F on Nov. 5, 2003, and 19 below zero F on January 5, 2004) damaged the MM 106 rootstocks above the soil line. These two abnormal cold weather events damaged about 30% of the young trees in the lowest elevation areas of the fumigation trial. Most of the trees that remain in the test block have recovered and have grown well during the 2004 - 2006 growing seasons. There is no correlation between the degree of cold damage incidence and treatment, or to the check. All treatments have over 200 trees remaining, the equivalent of about 0.6 to 0.65 acre, split into four replicates.

The trees have been managed by organically approved methods since Spring 2004, which has caused complications in soil fertility, weed control and irrigation water distribution. The difficulties with weeds and irrigation were much reduced in 2006, and will likely be even better addressed as the trees increase in size. There are now numerous gaps in the treated rows caused by winter-injury tree death. These gaps have been re-planted, but the new trees are not growing well under the organic, non-fumigated conditions, and will not be included in the future trial data.

Plot design: The plot was set up as a randomized complete block, with four blocks consisting of 11 rows each, one untreated row and two rows each of five treatment.

Materials: The fumigants used in this trial include Telone C-17 at 30 gallons product per treated acre, Telone C-35 at 30 and 39 gallons per treated acre, Methyl Bromide at 200 pounds mixed with chloropicrin at 100 pounds per acre, and metam sodium (sodium methyldithiocarbamate (anhydrous) 42% active ingredient at 75 gallons of product per treated acre.

Application: In September 2002, the site was disc harrowed to incorporate the minor amount of dry vegetation, and then pre-irrigated using hand-line sprinklers to bring the soil to field capacity in the top three or more feet. The soil-injected products (Telone C-17, Telone C-35, and Methyl Bromide + Chloropicrin) were applied in eight foot wide bands, centered on each future tree row. Rates applied were per treated-area. The metam was injected into the irrigation water and applied in about .75 inches of water. The metam application irrigation line was constructed down the middle of each metam treatment area, especially for this

application, and then removed. It is possible that the distal (outer) ½ of each metam treated row was not fully treated, as the irrigation water may not have applied the product evenly from the center out. Poor application is a common reason for variable results with this fumigant, as there are many application variables.

Assessing Fruit Quality and Yield: The fruit on young trees is affected by many factors independent of soil disease. Production on this orchard block was somewhat reduced by bird damage in 2006, but to a lesser extent than in 2005. To more accurately assess the fruit size and yield under these conditions, and to take out the effect of random tree loss due to winter damage, the following method was used:

The fruit was counted on each non-winter damaged tree after hand thinning was completed. A 40 fruit sub-sample of undamaged fruit was picked at random on each row, and each fruit was individually weighed to estimate average fruit size per row. A total of 320 fruit were weighed for each treatment and the untreated check. The average weight of fruit per tree in each row = ((average fruit size for that row) x (the number of total fruit in that row)) / (number of plot trees remaining in that row). (Fruit weight average per tree) x (346 trees per acre) = yield per acre

The 320 individual fruit sizes were used to estimate the percentage of fruit that would fall into each "box size" category. As the economic value of fruit is very much dependent on its size, the estimated yield by box size was used in determining the economic return to the grower per acre by treatment. Average box size may indicate that there is a horticultural impact of a treatment, but that average number cannot be used to evaluate the economic impact. There were obvious differences in box size percentages between the fumigated and un-fumigated check trees.

Economic return per acre: For each treatment, total estimated yield per acre was multiplied by the percent of production within each box size. This estimate of the weight of fruit per acre within each box size was multiplied by 0.66 to adjust for the average cullage percentage in Golden Delicious apples. These adjusted values were divided by 42 pounds, the average weight of the standard box of apples. The resulting estimated number of boxes per acre of each box size was multiplied by the values as indicated in table 5.

Results:

Fruit Weight Per Tree:

Replicate	MBr + Pic	C-17 / 30	C-35 / 30	C-35 / 39	Metam	Untreated
1	48.4	48.0	46.7	45.4	40.6	21.1
2	43.3	42.7	40.7	45.6	42.5	28.7
3	34.3	33.3	36.0	36.9	32.3	26.3
4	39.0	39.0	37.0	40.3	36.9	33.7
Average:	**41.2ab**	**40.7ab**	**40.0ab**	**42.0a**	**38.0b**	**27.5c**

Table 1. Average fruit weight per tree in pounds. Over-all averages of columns may not correlate due to rounding. Values followed by the same letter are not statistically different.

Yield per Acre:

Replicate	MBr + Pic	C-17 / 30	C-35 / 30	C-35 / 39	Metam	Untreated
1	16732	16600	16557	15692	14022	7302
2	14971	14761	14065	15776	14687	9935
3	11877	11532	12277	12759	11165	9093
4	13480	13494	12770	13948	12748	11652
Average:	**14265ab**	**14097ab**	**13917ab**	**14544a**	**13155b**	**9496c**

Table 2. Average yield per acre in pounds. Values followed by the same letter are not statistically different. (346 trees per acre x yield per tree)

Average Fruit Size:

Replicate	MBr + Pic	C-17 / 30	C-35 / 30	C-35 / 39	Metam	Untreated
1	193	202	213	202	208	187
2	209	206	200	211	212	181
3	202	213	224	214	199	170
4	207	210	206	215	205	178
Average:	**202a**	**208a**	**211a**	**210a**	**206a**	**179b**
Box size*	**94a**	**92a**	**91a**	**91a**	**93a**	**107b**

Table 3. Average fruit size in grams. Averages may not correlate due to rounding. * Box size is the number of fruit that will fit into a 40 pound box. Smaller box size numbers indicate larger fruit. Values followed by the same letter are not statistically different.

Percent of Fruit in Each Box Size Category:

Box Size*	MBr + Pic	C-17 / 30	C-35 / 30	C-35 / 39	Metam	Untreated
138	0.3	0	0.3	0	0.9	5.9
125	4.1	2.2	1.3	0.3	2.8	13.4
113	8.4	5.6	3.4	6.3	7.5	22.8
100	27.2	23.1	23.4	21.3	24.7	26.3
88	31.9	35.0	35.0	35.0	28.4	19.7
80	17.2	20.0	19.4	20.0	21.3	8.4
72	10.9	14.1	17.2	17.2	14.4	2.8

Table 4. Percent of fruit within each box size range. * Box size is the number of fruit that will fit into a 42 pound box. Smaller box size numbers indicate larger fruit.

Recent Average Value of Golden Delicious Fruit by Box Size (March 20, 2007):

Size:	138	125	113	100	88	80	72
Returned to Grower:	$10.30	$10.30	$13.21	$14.96	$19.16	$19.16	$20.54

Table 5. Golden Delicious apple, average dollars per box size, after $7.00/ box packing charges have been deducted.

Economic Return per Acre, 4th Year:

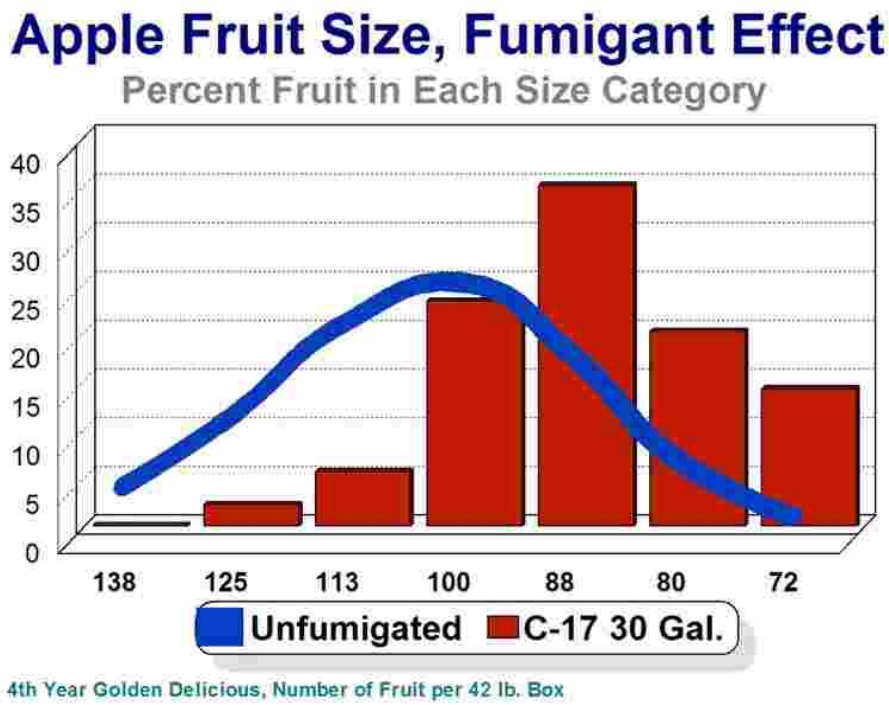
Treatment	MBr + Pic	C-17 / 30	C-35 / 30	C-35 / 39	Metam	Untreated
Return/A:	$3,915	$3,997	$3,994	$4,182	$3,664	$2,262

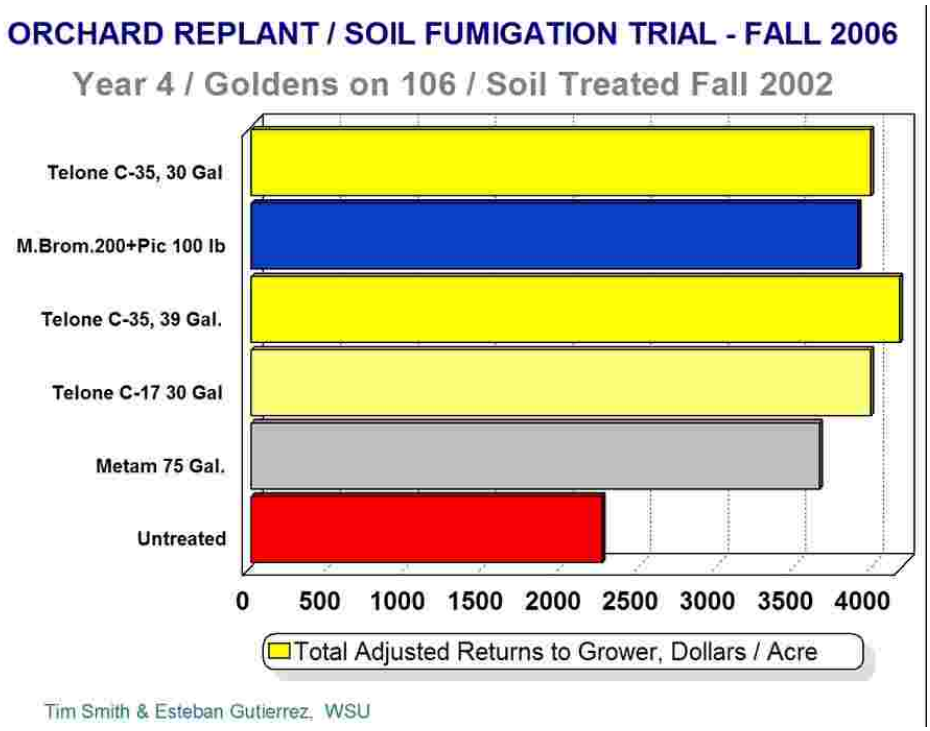
Table 6. Average estimated economic return per acre. Values are adjusted to packed boxes per acre, box size differences, variation of value by box size, minus packing charges, 66 percent packed, 37% culls assumed. No value was assigned to culls.

Average Trunk Size in Square Inches Cross-sectional Area:

Replicate	MBr + Pic	C-17 / 30	C-35 / 30	C-35 / 39	Metam	Untreated
1	5.68	5.49	5.38	5.65	4.43	3.03
2	5.42	5.29	5.49	5.57	5.42	4.46
3	5.48	5.29	5.38	5.38	5.12	5.07
4	5.12	5.02	5.24	4.43	4.86	4.93
Average*:	**5.44a**	**5.29a**	**5.38a**	**5.45a**	**4.92a**	**4.33b**
Square CM*	**35.1a**	**34.1a**	**34.7a**	**35.2a**	**31.7a**	**27.9b**
% of Check	**126**	**122**	**124**	**126**	**114**	**100**

Table 7. Average trunk size, cross-sectional area, average is of all trees within the treatment. *Averages may not correlate, as there were different numbers of trees within each replicate. Replicate values used for statistical analysis. Values followed by the same letter are not statistically different.


Apple Fruit Size, Fumigant Effect
Percent Fruit in Each Size Category
40
35
30
25
20
15
10
5
0
138
125
113
100
88
80
72
Unfumigated
C-17 30 Gal.
4th Year Golden Delicious, Number of Fruit per 42 lb. Box


ORCHARD REPLANT / SOIL FUMIGATION TRIAL - FALL 2006
Year 4 / Goldens on 106 / Soil Treated Fall 2002
Telone C-35, 30 Gal
M.Brom.200+Pic 100 lb
Telone C-35, 39 Gal.
Telone C-17 30 Gal
Metam 75 Gal.
Untreated
0
500
1000
1500
2000
2500
3000
3500
4000
Total Adjusted Returns to Grower, Dollars / Acre
Tim Smith & Esteban Gutierrez, WSU