Orchard Replant Management without Methyl Bromide

Tuesday, October 28, 2008

Kearney Agricultural Center

9240 S. Riverbend Ave., Parlier, CA 93648, 559-646-6500

8:00 AM-2:30 PM

8:00 a.m. **Introduction, PCA and continuing education credits sign-up**
Brent Holtz, PhD, Farm Advisor, UCCE Madera County

8:30 a.m. **Cropping Systems for sustainable nematode management of tree crops**
Michael McKenry, *PhD, Nematology Specialist, UC Riverside/KAC*

9:00 a.m. **Replant disease management for almond and peach**
Greg Browne, PhD, USDA plant pathologist, UC Davis

9:30 a.m. **Irrigation management in response to fumigation**
Bruce Lampinen, PhD, Almond and Walnut Specialist, UC Davis

10:00 a.m. **Break and Field Tour**

Fumigant movement and fate as affected by various soil conditions
Michael McKenry, PhD, Nematology Specialist, UC Riverside/KAC

Pacific area-wide trials with integrated methyl bromide alternatives for almond and peach (drip and shank and alternative strip fumigation treatments, crop rotations, and fumigant emissions management)
Greg Browne, USDA-ARS, and Shrini Upadhyaya, UC Davis
David Doll, Farm Advisor "in training", UC Merced
Brand Hanson, Dong Wang, Suduan Gao, USDA-ARS, Parlier

12:00 p.m. **Free lunch-provided by sponsors**
The USDA-ARS Pacific wide program for integrated Methyl Bromide Alternatives, the Almond Board of California, Dow Agro Sciences, the University of California, the California Tree Fruit Agreement, and Tri-Cal Inc

1:00 p.m. **Walnut replant issues**
Bob Beede, Farm Adivsor, UCCE Kings County

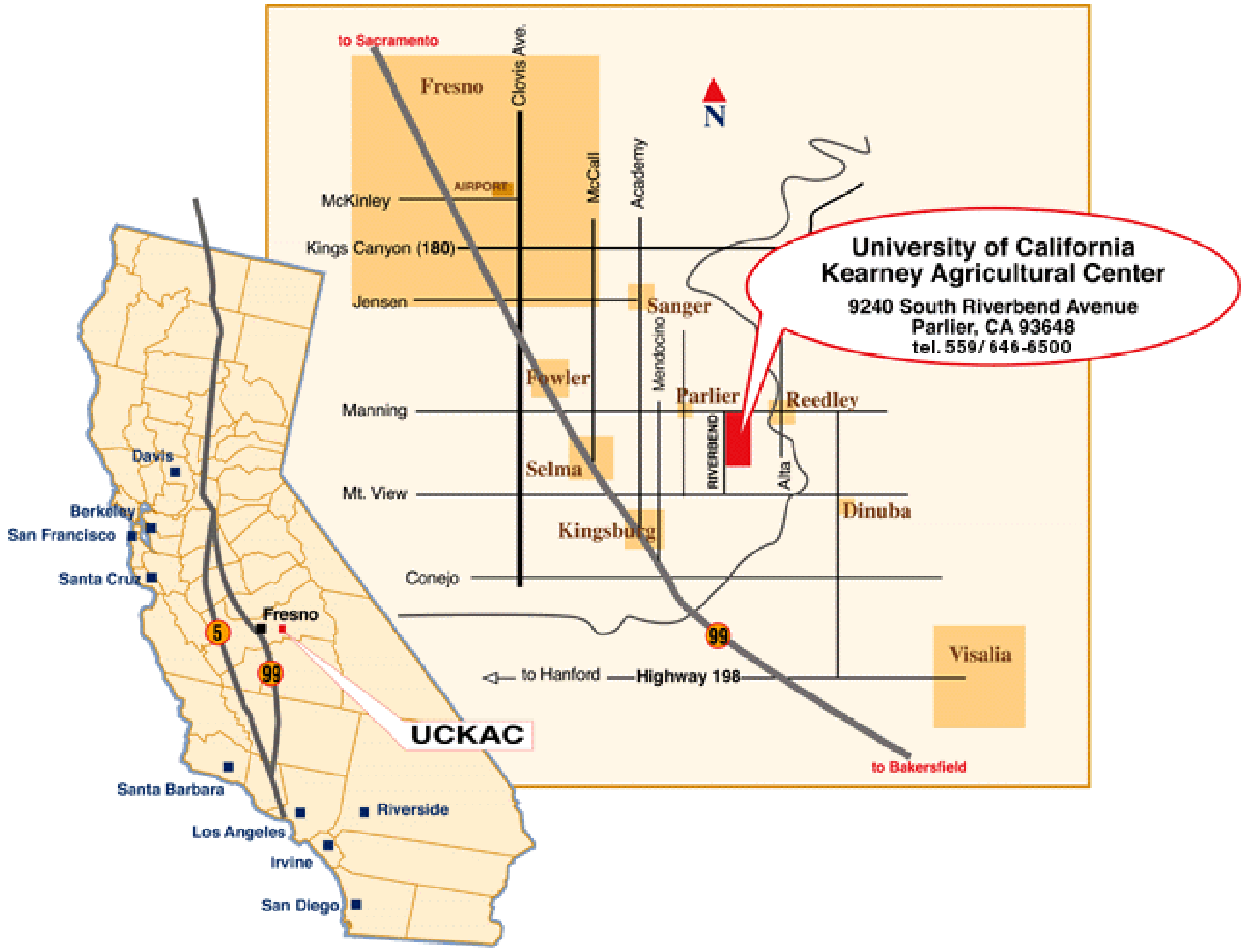
1:30 p.m. **Regulatory issues affecting soil fumigation practices**
Randy Segawa, Scientist, California Department of Pesticide Regulation

2:30 p.m. **Adjourn**

5.0 hours of PCA, CCA and Private Applicators Credit have been requested (including 1.0 hour of laws and regulations).

Reservations: Please RSVP to Madera County UCCE by October 24, 2008 at 559-675-7879 ext 201

Directions to University of California Kearney Agricultural Center:



CHALLENGES AND OPPORTUNITIES FOR ORCHARD REPLANT MANAGEMENT

Greg Browne *USDA-ARS, Davis, CA*
Brent Holtz *UC Cooperative Extension, Madera County*
David Doll *UC Cooperative Extension, Merced County*

Growers, pest control advisors, researchers, and government regulators alike are contending increasingly with environmental mandates that restrict soil fumigation options. Use of methyl bromide (MB) for soil fumigation is now restricted to temporary critical use exemptions because of the fumigant's potential to deplete ozone in the stratosphere. Also, due to risks of chronic human exposure, use of 1,3-dichloropropene-containing fumigants (e.g., Telone II, Telone C35) is capped at set limits within townships. More recently, the California Department of Pesticide Regulation has been required to reduce agricultural emissions of smog-forming volatile organic compounds (VOCs) from soil fumigants and other pesticides. Resulting regulations reduce allowable rates of some fumigants and prescribe practices for fumigant emissions reduction, especially during the period from May 1 to Oct. 31, when air quality is most negatively impacted by VOCs. Finally, based on new fumigant risk assessments, required buffer zone distances are now based largely on the total amount of soil fumigant used in a field, and this can seriously complicate treatment of some fields.

Given the high cost of soil fumigation and the dynamic nature of regulations governing it, it is important for growers to get maximum benefit from every pound of fumigant used. In this newsletter, we feature results from some applicable research that has been supported by the Almond Board of California and the California Walnut Board. In addition, we highlight some findings from a 5-year program designed to foster effective use of MB alternatives for orchard and vineyard crops, strawberries, and several nursery and ornamental commodities. This program, called the Pacific Area-Wide Pest Management Program for Integrated Methyl Bromide Alternatives, includes research and demonstration trials with alternative fumigants, alternative fumigant application methods, and cultural approaches for managing replant problems. The trials are conducted at commercial fields and nurseries and field stations, and early results from some of the almond and stone fruit tests are reported below.

BIOLOGY AND MANAGEMENT OF ALMOND AND STONE FRUIT REPLANT DISEASE

Greg Browne *USDA-ARS, Davis, CA*
Brent Holtz *UC Cooperative Extension, Madera County*
Bruce Lampinen *University of California, Davis, Davis, CA*
Shrini Upadhyaya *University of California, Davis, Davis, CA*
David Doll *UC Cooperative Extension, Merced County*

When orchards are replaced, growth and productivity of the succeeding generations of trees are often suppressed by "replant problems" unless precautions are taken. Replant problems can result from interacting physical, chemical, and biological factors, but the biological aspects usually dominate. Growers can minimize physical and chemical contributions to replant problems by pre-plant ripping and other site remediation practices and amendments to insure good soil water drainage, good soil structure, and optimal soil chemical properties (e.g. pH, soil extract electrical conductivity, etc.). Of course, appropriate soil tests are needed to evaluate the latter properties. Dealing with biological contributions to replant problems should also start with some homework—sampling for nematodes. Although plant parasitic nematodes (ring, lesion, and, on some rootstocks, root knot nematodes) probably contribute to replant problems in less than one third of California's replanted almond and stone fruit orchards (rough estimate), it is important to sample your soil to check for them before replanting. Root damage caused by the ring nematode in sandy soils predisposes almond and other stone fruit trees to bacterial canker disease. In addition, although not common at most sites, *Phytophthora* species, *Armillaria mellea,* and *Verticillium dahliae* infest some orchard soils and can cause tree stunting, decline, and death in young replanted orchards as well as in established ones. It is difficult to detect and assess populations of these pathogens by soil sampling, and therefore a history of disease caused by them in the previous orchard tends to be the best predictor of future replant problems they may incite. Although it varies in severity, the most common replant problem is Prunus replant disease (PRD). In our experience, it occurs nearly universally in replanted almond and stone fruit orchards in California unless precautions are taken.

PRD causes slight to severe growth suppression in almond and stone fruit orchards planted after one another. Instances of severe PRD can kill or prevent growth in more than half of the trees in a replanted orchard (such cases have occurred repeatedly on some soils in Butte County). More commonly, PRD stunts trees, especially during the first year after planting. In any case, cumulative crop production of trees affected by PRD may never fully catch that of trees planted where PRD prevention practices were used. Although the cause of PRD is still being unraveled, it has been associated with a complex of soilborne fungi, oomycetes, and bacteria left from the preceding crop.

There are not currently soil tests available to predict severity of PRD, but such tests may be useful once validated. In the meanwhile, local experience obtained by growers and from field trials such as those described below can be very useful in predicting risk and severity of PRD on a given soil series with a given crop history.

For the past several years, a team involving the authors, the Pacific Area-Wide Pest Management Program for Integrated MB Alternatives, commercial growers, TriCal, Inc., and others has been testing and optimizing fumigant- and crop-rotation based approaches for preventing PRD. Some key aspects we have examined include:

- Testing efficacy of chloropicrin (CP), 1,3-dichloropropene (1,3-D, trade formulation Telone II), and iodomethane (IM, trade formulation Midas), and several mixtures these fumigants, as alternatives to methyl bromide (MB)
- Determining minimum rates of alternative fumigants needed to prevent PRD
- Developing efficient spot fumigation methods with potential to reduce fumigant costs and emissions
- Examining contributions of a single year of fallow or short-term crop rotations with sudan grass or mustard for management of PRD
- Testing effects of irrigation intensity (e.g., from 70 to 120% of ET) on severity of PRD in fumigated and non-fumigated soil.

Below, in summary form, we highlight some of the recent results from this work.

Key findings to date:

- In general, chloropicrin (CP) and mixtures of it with IM, 1,3-D, or MB are more effective for preventing PRD than 1,3-D or MB alone. (IM products are not registered in California at this time) (**See Tables 1-3**).
- Rates of 300 to 400 lb/per treated acre of CP or mixtures of it with 1,3-D or IM appear optimal for prevention of PRD. (**See Tables 1,2**). (Product labels and Ag Commissioner must be consulted for appropriate rates).
- GPS-controlled shank-applied spot treatments (applied to tree sites before planting), with CP or Telone C35 (CP:1,3-D) or drip-applied spot treatments (also applied to tree sites before planting) (**Fig. 1**) with Inline (drip formulation of CP:1,3-D) appear nearly as effective as strip or broadcast treatments with the same fumigants (**See Tables 1-3**).
- Short-term rotations with sudan grass, wheat followed by sudan grass, or mustard, or a single season of fallowing can improve growth or replanted trees, thereby reducing effects of PRD (**See Tables 3,4**).
- It appears important not to over or under water almond trees replanted without pre-plant soil fumigation after removal of almond on peach rootstock; doing so can make PRD worse.

Further demonstration and discussion of pre-plant treatments described above will be featured at a field day at the Kearney Ag Center on October 28 (see announcement with this newsletter). We look forward to seeing you there.

Table 1. First-year growth responses in 2006 almond replant trial near Firebaugh, CA (trees planted Jan 2007)

Trt.	Fumigant, rate per treated area	Treated area (and % of total)	Fumigant per orch. acre (lbs)	Disease severity rating	Increase in trunk diameter by February 2008 (mm)
1	Control	None	0	1.8	20
2	Methyl bromide, 400 lb/a	8-ft strip (38%)	152	0.8	24
3	Telone II, 350 lb/a	8-ft strip (38%)	133	1.0	27
4	Chloropicrin (CP), 400 lb/a	8-ft strip (38%)	152	0.1	38
5	CP, 300 lb/a	8-ft strip (38%)	114	0.4	37
6	CP, 200 lb/a	8-ft strip (38%)	76	0.1	39
7	CP, 400 lb/a	8x8-ft tr.sites (17%)	68	0.5	34
8	Midas (IM:CP. 50:50), 300 lb/a	8-ft row strip (38%)	152	0.3	36
9	Telone C35, 550 lb/ac	8-ft row strip (38%)	209	0.1	36
10	Pic-clor 60, 550 lb/ac	8-ft row strip (38%)	209	0.0	39
11	Pic-clor 60, 400 lb/ac	8-ft row strip (38%)	152	0.3	35
12	Telone C35, 550 lb/ac	8x8-ft tr.sites (17%)	93	0.3	33
13	Telone C35, 550 lb/ac	Broadcast (100%)	550	0.1	37
Minimum significant difference based on 95% confidence intervals:				*0.5*	*9*

Effect of pre-plant fumigation treatments significant at P<0.0001.

Table 2. Treatments applied in October 2007 in almond replant trial near Madera, CA, (trees planted Jan 2008)

Trt.	Fumigant, rate per treated acre	Treated area (and % of total)	Fumigant per orchard acre (lb)	Trunk diameter 29 Aug 2008
m1	Control	None	0	29.1
m2	Methyl bromide, 400 lb/ac	Row strip (38%)	152	30.5
m3	Telone II, 340 lb/ac	Row strip (38%)	129	31.4
m4	IM:Chloropicrin (50:50), 400 lb/ac	Row strip (38%)	152	36.0
m5	Chloropicrin, 400 lb/ac	Row strip (38%)	152	37.1
m6	Chloropicrin, 300 lb/ac	Row strip (38%)	114	35.6
m7	Chloropicrin, 200 lb/A	Row strip (38%)	76	32.3
m8	Telone C35, 544 lb/ac	Row strip (38%)	207	34.9
m9	Pic-Clor 60, 400 lb/ac	Row strip (38%)	152	34.5
m10	Chloropicrin, 400 lb/ac	Tree site (11%)	44	35.3
m11	Telone C35, 544 lb/ac	Tree site (11%)	60	33.0
m12	Telone C35, 544 lb/ac	Broadcast (100%)	544	34.5

Effect of treatments significant at P=0.001.

Table 3. Treatments applied in 2007 peach replant trial near Parlier, CA (trees planted Feb 2008)

Fumigation treatment (Oct 2007)	Fumigant /treated acre (lbs)	Fumigant /orchard acre (lbs)	Sudan grass rotation (Jul-Sep 2007)	Disease severity rating (0 to 5 scale) 7 Jul 2008	Trunk diameter 30 Aug 2008 (mm)
Control	0	--	no	1.5	18.2
			yes	0.9	24.2
Telone C35, by GPS-controlled shanks to 5x 6' tree spots	540	81	no	0.7	31.8
			yes	0.5	33.7
Telone C35, by conventional shanks to 8'-wide row strips	540	227	no	0.3	39.6
			yes	0.3	42.4
Chloropicrin, by GPS-controlled shanks to 5x6' tree spots	400	60	no	0.6	34.5
			yes	0.2	36.6
Inline, by single drip emitters to 4'-dia. tree spots	540	43	no	0.8	31.1
			yes	0.6	32.0
MB, by conventional shanks to 8'-wide row strips	400	168	no	0.9	33.0
			yes	0.5	31.4
None, yeast extract root spray and drench at planting	0	--	no	1.2	21.8
			yes	1.0	24.7

For trunk diameters, effects of pre-plant fumigation and rotation treatments sig. at P<0.0001 and P=0.008, respectively

Table 4. Treatments applied in 2007 almond replant trial near Parlier, CA (trees planted Feb 2008)

Pre-plant fumigation treatment	Pre-plant rotation treatment	Disease severity rating 7 Jul* 2008	Trunk diameter 30 Aug 2008 (mm)
Control	No fallow	0.9	25.3
	1 year fallow	0.7	28.8
	Mustard	0.7	29.0
	Wheat-Sudan	0.5	29.5
Chloropicrin 400 lb/A	No fallow	0.4	34.9
	1 year fallow	0.3	39.1
	Mustard	0.2	40.4
	Wheat-Sudan	0.2	40.7

For trunk diameters, effects of pre-plant fumigation and rotation treatments sig. at P<0.0001 and P=0.0008, respectively

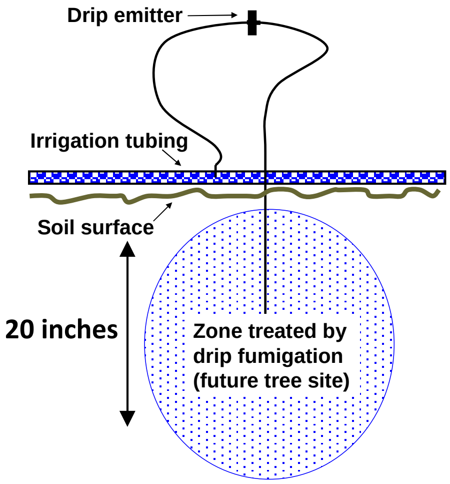


Fig. 1. Side-view diagram (left) and field photo (right) of spot drip fumigation set up used for treating tree sites (*experimental only*).

Cropping Systems for Sustainable Nematode Management of Tree and Vine Crops

Michael McKenry, Tom Buzo, and Stephanie Kaku
UC Riverside/Kearney Agricultural Center

Over the last 15 years a major objective of our research has been to find alternatives to soil fumigation when replanting tree and vine crops. Our first task was to better characterize the various components of the replant problem. This was accomplished by monitoring plant growth in replant and non-replant settings following application of 150 potential remedies. Using this empirical approach while replanting grape, walnut, almond and stone fruits we characterized in 1999 the replant problem as having: a) rejection component, b) soil pest and disease component, c) soil physical and chemical component and d) a nutritional component. Among our test crops there are some non-fumigant alternatives effective against each of these components. We now have five examples from field settings where we have measured no significant or visible differences between our alternative and that achieved by fumigation whether the replants involved grape, almond or stone fruit. Our alternative is the trunk application of a systemic herbicide such as glyphosate after the last harvest followed by waiting one full year prior to replanting on a rootstock of very different parentage. Following grape, *Vitis vinifera*, we have been successful with *V. simpsonii* x Edna or *Vitis rotundifolia* parentage. Following peach, *Prunus persica* cv Nemaguard, our success has been with Hansen 536, a hybrid of Okinawa peach and almond. We now need commercial level field evaluations and greater availability of nematode resistance within rootstocks of different parentage. We refer to our fumigant alternative as: ‘Starve the soil ecosystem, switch rootstock parentage’.

Fumigant movement and fate as affected by various conditions in several soils

Michael McKenry
UC Riverside/Kearney Agricultural Center

The approximate movement and fate of 1, 3-dichloropropene (Telone II) in two soils was predicted using extrapolations from laboratory experiments and soil-vapor phase concentrations obtained from simulated field experiments. The most far-reaching diffusion patterns in mineral soils are those obtained in soils whose moisture content is nearest the wilting point of plants (15 bars moisture tension). As the moisture content of the soil is increased, the diffusion pattern gradually becomes more limited. This effect is most striking when fine-textured soils have moisture contents in excess of ½ bar moisture tension at the one-foot depth.

Fumigation of warm soils (25C = 77F) results in faster rate and greater distance of nematicide diffusion. In colder soils (5C = 41F) the rate of diffusion is slower, and the persistence of the chemical is longer but the total distance of diffusion of an effective dosage is decreased. Increased soil temperatures result in increased rates of hydrolysis of cis- and trans-1, 3-D.

Soil texture and soil type determine to a large extent the amount of soil moisture present and the size of the connecting air spaces. Soil air space and size of pores are important because these chemicals move primarily in the vapor phase and the smaller pores are most easily blocked when water is present. It is important that fumigant applicators are successful in sealing soil surface and chisel shank chimney after an application. Failure to do this results in significant losses to the atmosphere especially if the subsoil is in a moist to wet condition.

Lethal dosage values based on soil vapor phase concentrations were established in order to provide greater predictability of nematode control subsequent to fumigation. The trans-1, 3-D isomer was approximately 60% as effective to root-knot nematodes. Eggs within the brown cysts of cyst nematodes were less affected by the toxicants. Lowered temperatures were found to diminish the lethality of the toxicants.

Additional information:

Goring, C.A.I. 1962. Theory and Principles of Soil Fumigation. Adv. Pest Cont. Res. 5:47-84

McKenry, M. V. and I. J. Thomason. May 1974. 1, 3-Dichloropropene and 1, 2-Dibromoethane Compounds. Hilgardia Vol 42 (11) 391-438

McKenry, M. V. and I. J. Thomason. 1976. Dosage Values Obtained Following Pre-plant Fumigation for Perennials. Pestic. Sci. 1976, 7, 521-544.

ORCHARD WEED NOTES

By Tulio B. Macedo, Ph.D.
UC Cooperative Extension, Madera & Merced County

FALL WEED MONITORING

The end of harvest is approaching and it might be a good time to begin planning next season's weed management program, starting with the fall weed monitoring, which is one of the best times of the year to monitor weeds in an orchard. By monitoring weeds in the fall you may be able to evaluate the current year's weed control program by identifying summer species that escaped control and adjust it to control these species in the next year. Fall monitoring also allow identification of emerging winter species.

It is important to keep in mind that weed growth is directly influenced by rainfall or postharvest irrigation. In case of early rains it may require that you take some actions earlier, such as cultivation and flaming. Early rains also mean the possibility of a tank mix with post-emergent and pre-emergent herbicides applied in winter. An effective fall monitoring program helps to make sure the correct materials are applied at the most efficient rates and timing.

How to survey your fields:

1. After the first rains of the fall look for winter annual weeds in tree rows to check the effectiveness of any pre-emergence herbicide applications.
2. Check the ground cover in row middles for perennial seedlings.
3. Record weed infestation and use a map to show areas of problematic weeds.

Keep watchful eyes for:

Bermudagrass
Cynodon dactylon

Vigorous spring- and winter-growing perennial. Frequently becomes a problem in mowed orchards. Very competitive for moisture and nutrients. Spot treat with postemergents.

Dallisgrass
Paspalum dilatatum

Perennial commonly found in orchards. Seedlings in spring and summer. Tends to become dominant in mowed areas and standing water.

Field Bindweed
Convolvulus arvensis

Vigorous perennial. Seeds can survive for up to 30 years in the soil. Crucial to destroy plants before seeding. Plants may spread from stem or root sections cut during cultivation.

Hairy Fleabane
Conyza bonariensis

Annual plant. Emerges in February and in December if winter temperatures are moderate. It can withstand several mowings and still produce seeds.

Common Purslane
Portulaca oleracea

It is a prostrate summer annual. Germinates in April to early May. It can cause problems with both nut drying and pick-up during harvest operations.

Nutsedge
Cyperus esculentus

It is a perennial weed. It reproduces from tubers that can survive for 2 to 5 years in the ground. Each tuber contains several buds that are capable of producing plants.