TECHNOLOGY TRANSFER AMONG TREE AND VINE CROPS

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I recall the first time I saw a tractor injecting methyl bromide (MB) and then laying a polyethylene film onto the field surface. It was in the mid 1960s. Plant debris and soil clods were poking and rubbing holes right through the tarp. The treatment costs seemed enormous. It was easy for me to surmise that this was a technology going nowhere. With advances in glue technology and additional years of field testing, treatments shifted from individual rows to solid fields of plastic film. It was the 1980s before this technology was effectively transferred from California to Florida, Texas, and eventually Mexico. Many areas in the world still don't have this technology. Technology transfer to agriculture is a slow and dynamic process and usually involves people from varied sectors. MB use has reached the level it is today because it provides consistent and observable plant growth benefit. More recently the 1984 banning of ethylene dibromide and the 1990 suspension of 1,3-dichloropropene (1,3-D) further fueled its rise in popularity.

There exists in California two million acres of tree and vine crops. Compared to annual crops the long-term benefit of a pre-plant fumigation to perennial crops and the existence of the replant problem add a unique dimension. A further complication for the tree and vine grouping is the fact that the needs and treatment methods of citrus growers, for example, will be different from those of walnut or grape growers. The broad spectrum value of soil fumigation has bridged across these unique differences making specific crop distinctions almost invisible until one tries to replace fumigants.

There are at least forty UC cooperative extension personnel located across California who have a specific focus on the transfer of new technologies to one or more specific perennial crops. Whether the soil-borne malady is nutrient depletion, phytophthora, ring nematode, or phylloxera the solution to pest and disease problems has been pre-plant fumigation with either 1,3-dichloropropene (1,3-D) or methyl bromide (MB). These advisors generally view the benefits of MB as important but the crop is their main responsibility with or without MB. The pending loss of MB and the current use restrictions on 1,3-D will expose a huge gap in our agricultural technology relative to soil and rhizosphere ecosystems. This information gap will affect growers economically but will also fall square in the lap of these UC farm advisors. These people will be among the first to diagnose and characterize the evolving problems and they are already besieged by the wild claims of numerous alternative treatments. It is time for these advisors to be sitting at the discussion tables and becoming involved with problem identification and solutions for their specific crop and locale. The reality is, however, that these people don't have the funds to even attend a meeting such as this nor the funds to put on a field trial. Unless the alternative to MB is available in a well-labeled bottle, has wheels attached and carries a guarantee of 95% effectiveness; the need for tree and vine farm advisor involvement is now. Since 1993 this author has made a special effort to keep growers and their associated cadre of farm advisors fully advised of research progress relative to a replacement for pre-plant fumigation. Their most frequent question has been: What alternatives are there besides 1,3-D and by the way, can we be sure that 1,3-D will work properly under the current use restrictions?

The prevailing restriction of 35 gallons/acre 1,3-D is adequate only if the soil is adequately dry. The requirement of high surface moisture at time of treatment will negate 1,3-D as an alternative except for the sandier soils. Township caps, and moisture requirements must be recognized as impediments to effectiveness of 1,3-D in California. This is an example where technology needs to be transferred to regulators, manufacturers and applicators. In 1996 this author proposed that the best alternative for tree and vine growers involved a deep shanking of 1,3-D to dry soil followed in 1 to 2 days with a drenching or sprinkling of 250 ppm MITC as a means of reducing 1,3-D volatilization. Such a procedure was recently registered in Washington State. If sprinkling equipment of correct orifice size were more prevalent among California tree and vine growers and if the manufacturers and regulators could develop solutions relative to re-entry times, etc., this technology could quickly be transferred using commercial-sized demonstration plots.

In 1985 we built a prototype "portable soil drenching device" capable of delivering lethal doses of Vapam with uniformity and consistency. We were soon able to demonstrate consistent nematode control and plant growth as long as no old roots were present deep in the soil profile. UC was notified of this development in 1991 and the work was published in 1994. This procedure has its limitations and advantages. A few growers have now learned how to follow our procedures by manually moving drip lines or existing sprinklers. Large scale development of this process is protected by two patents largely because so many detractors said it would never work. This technology is slowly being transferred but only because smaller growers are becoming familiar with use of dripper lines.

A door of opportunity swung open when we demonstrated in 1995 that killing of the old root system plus fallowing a full year could give relief from a major component of the replant problem. This finding plus our finding of several implicit limitations of the method must now receive commercial evaluation. We also need research into additional specific methodologies that will kill roots across a variety of rootstocks and field situations. With grapes we have found only a single method for root kill and that involves delivery of MITC and/or 1,3-D via an existing or temporary dripper line. Since the MITC treatment does not control endoparasitic nematodes within roots below 75 cm depth this treatment must be coupled with the use of rootstocks having broad nematode resistance. Even these rootstocks are a new finding (1993) and will need 20 years of field evaluation. Two commercial field trials are currently underway exploring this possibility and both are supervised by farm advisors. A third farm advisor is currently involved with Roundup herbicide applications to cut tree stumps in two different commercial settings. With peach we have no rootstocks with resistance to ring nematode or root lesion nematode so there are limitations to our technology but not to transfer of technology we do have. For walnuts we have a treatment ready for field evaluation but no trials and thus no technology transfer. Except for the use of MITC, we have not even studied methods of killing roots of kiwifruit, figs, olives, apple, pecan, citrus, pistachio, persimmon, cherry, plum, prune, bush berries or avocado so we have little information to transfer to these very important crops.

As reported elsewhere at this meeting , it is possible to start trees out in NRPS or "virgin soil" and 80% of the time come very close to the performance of MB as long as there is resistance to the pests present or pests are absent. Although there are obvious limitations some of this information is ready for transfer to smaller growers. Funding for the first commercial evaluation has been sought and a farm advisor is involved in that project. This test site will involve the presence of ring nematode and a serious Bacterial Canker problem and will require five years of evaluation.

The approach we have taken with alternatives for trees and vines has involved extensive small and large plot testing of more than 125 potential replacements to MB. Our list has included hot water, steam, compost, manures, cover cropping, fallowing, ozone, hydrogen peroxide, carbon bisulfide, acrolein, enzone, Clorox, urea, methyl iodide, walnut hulls, backhoeing, rootstocks, fertilizers, flooding, grafting, solarization, several biocontrol agents, use of post-plant nematicides and many additional treatments that have been touted as having potential. Our list of treatments worthy of transfer is much smaller now. Take a minute to contrast work I have presented here with the work presented in the USEPA's 30 case studies of MB alternatives. Our direction of study is clearly biased towards eventual technology delivery, but based on results of replicated field evaluations with a check and a MB comparison. The USEPA chose to hire unbiased but unknowing individuals to collect information towards their specific agenda. Solarization is one of the better USEPA suggestions but has never been tried adjacent to MB in any setting that involved perennial crops. However, it has been evaluated in a two year study involving peaches and in that case root knot nematodes preferred the plastic mulching ten to one. Grafting with resistant rootstocks, another worthy MB alternative cited by USEPA, already occurs on at least 1.5 million acres of California orchard and vineyard land and these are the same growers who need MB or its alternative. The final resting place for this divisive, USEPA information was the internet. Meanwhile, there exists among the vineyards and orchards of California a mechanism for problem identification and technology transfer if funding is available and potential technologies have received primary evaluations.