MEETING RESOURCE MANAGEMENT GOALS THROUGH SUSTAINABLE FOREST SEEDLING PRODUCTION USING ALTERNATIVE TREATMENT STRATEGIES

Will Littke, Nursery Pathologist, Weyerhaeuser Forestry Research. Centralia, WA.

Almost fifty years ago, the Weyerhaeuser Company created a vision of managing private forests on a sustainable basis. This vision was largely fulfilled by creating a series of primarily bare-root nurseries across the United States and British Columbia, Canada from which today we generate 300-400 million seedlings annually. This success is in part attributed to methyl bromide and chloropictin used since the mid-1970's as our operational soil fumigant. For the last hventy or so years, MB has achieved broad spectrum efficacy against a wide range of soil-born pests (insects, disease, nematodes, and weeds). Furthermore, MB is also considered to be generally superior to other alternatives with respect to worker and off-site safety, and reduced ground water contamination potential. By the mid-1980's, concern over MB long term future had already arisen, and the research into alternatives treatments had begun.

The first step in the process of replacing MB required an understanding of the criteria needed to evaluate alternatives, we identified five specific areas; including: (1) worker and offsite safety, (2) environmental effects, (3) control efficacy, (4) cost, and (5) registration compliance. However, to be truly successful at replacing MB we needed to shift our entire cultural approach from a "reactive" to a "proactive" mode where management systems were firmly based *in* integrated pest management. Our research efforts have been divided amongst five strategic alternative treatment areas: (a) chemical control or alternative chemical fumigants, (b) biological control, (c) physical treatments, (d) cultural methods, and (e) stock type selections.

We have tested various leading candidate chemical fumigants such as Vorlex, Basamid, Soil Prep and Telone comparing their efficacy with that of MB. These trials suggest several conclusions; (1) similar levels of seedling emergence can be expected using most alternative chemicals, (2) MB seedlings have significantly greater caliper and height at pack, (3) when applied as specified in the label all give equivalent "knockdown" potential against *Fusarium oxysporium*, (4) pathogen control efficacy of MB was more consistent from sandy soils to heavier loamy sands and from low organic matter content (1%) to high OM content (11%). (5) MB was the most efficacious weed control agent, although some weeds like nut sedge are not controlled entirely by MB, and (6) unlike MB, other chemical agents do not appear to be suitable for spring fumigation. Chemical alternatives may serve the short-term goal of replacing MB but must be viewed as tool to estend the time to develop non-chemical approaches.

Biological control of soil-born nursery pathogens have been investigated by our nurseries through the use of soil amendments (composts) and as seed treatments (biological control agents "BCA"). Preliminary tests of composted yard waste, mill wood wastes, crab processing residues, chicken-litter, and cricket litter (bait farm residue) has resulted in mixed results. While composts are excellent sources of organic matter (applied as 1/2" depth or 70 cuyrds/acre), it is difficult to detect direct suppression of *F. oxysporium* populations under field conditions. Yard waste and mill waste composts with C/N ratios of > 30: 1 showed reduced root infection levels by Fusarium but resulted in chlorotic seedlings, while composts with CM ratios less than 2-t: 1 did not have observable effects on root pathogen levels. Loblolly seedlings grown on composted (chicken litter) amended soils had larger caliper and height, but whether treatment effects were related to increased fertility supplied by the compost treatments, microbial effects, or both is uncertain. Research into BCA seed treatments have only recently been installed in our Douglas-fir nurseries in Oregon. We expect biological based treatments to have disease control potential but considerable research must be done to reach the operational consistency of chemical agents.

Physical treatments such as solarization and steam pasteurization of soil show potential to reduce *Fusarium* levels while also controlling other pests. However, techniques and equipment need to be developed to broaden the application sites. Solarization trials conducted in Arkansas, with J-mil tarp over well water nursery soil, demonstrated that soil temperatures can reach 50-60C at 3-inches depth during July and August. This was sufficient to depress *Fusarium* levels through two successive loblolly pine crops. However, similar trials in Olympia, Washington conducted in 1993-1994 failed to achieve 40-50C in the 3-inch depth zone. In vitro trials suggests sustained temperature exposures of 50C for 30 minutes and 60C for 30 minutes are needed to control (LT90, 90% reduction) *Fusarium roseum* complex and *F. oxysporium* respectively. Combination treatments are envisioned whereby solarized soils can be heated to sufficient levels to make soil pasteurization more economically feasible.

Cultural strategies embody all aspects of pest control including chemical, biological, crop management, and stock type solutions. This strategy seeks to tighten the quality chain from the seed orchard through soil preparation, seedling culture, lifting grading and storage. Life history nursery plots with family structure are used to focus our efforts on critical leverage points to control seed losses, seedling mortality, and quality issues. Some critical issues identified include; (a) optimize seed maturation to achieve high vigor seed, (b) control seed-born pathogens as sources of disease and reinfestation of soils, (c) achieve maximum irrigation uniformity by timing and duration coupled with maintenance, (d) reduced nitrogen fertilization during summer months when maximum post-emergence mortality occurs, (e) root culture through undercutting, pruning, and bed wrenching to achieve morphology and to optimize soil aeration, and (f) strict adherence to quality and grading standards. This research has changed our approach to soil management through selection of cover crops and/or bare-fallow treatments which reduce the need to fumigate prior to sowing. A proactive approach to cultural operations reduces the buildup of cumulative stressors and has reduced the magnitude of disease outbreaks.

Pest avoidance through stock type selection is an equally attractive alternative. This has been implemented in sowing high value genetic stock ingreenhouse to be latter sown in bare-root nurseries (e.g. Mini Plugs or other plug+ l transplants). Simply put, this technique avoids soil-born disease and sow-bed environments which combine to cause pre- and post-emergent mortality.

Society as a whole, has greatly benefited from the past fifty years of MB use, where since 1948 seedling regeneration in the U.S. has risen from less than half a million to over 1.9 billion trees. MB has allowed nursery capacity industry-wide to effectively keep pace with regeneration needs driven by ever-increasing demands for forests products. Time is short to develop replacement methods (less than three crop rotations cycles in Pacific Northwest nurseries). Our current dilemma has been brought on by a reliance on a single “magic bullet”. The challenge before us is to diversify, think “outside of the box” and modify current cultural practices to overcome the immediate shortcomings inherent in available chemicals, while we investigate the potential of a full spectrum of non-chemical approaches of the future.