# SOIL PEST MANAGEMENT PROGRAMS FOR BAREROOT NURSERIES

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ABSTRACT: The most numerous and economically important pest problems facing bareroot nurserymen in the Pacific Northwest are soilborne. Several soilborne fungus, insect, and nematode species attack conifer seedlings causing economic loss. Control of these organisms is expensive and the use of extreme measures, such as biocidal fumigants, has an adverse effect on beneficial soil organisms. This in turn affects seedling growth and quality. A program for determining the presence and disease causing potential of these pests and their management is discussed.

## INTRODUCTION

Thirteen diseases or disease groups are listed by Sutherland in the recently published Forest Nursery Manual (Sutherland 1984). Eight of those are soilborne, and represent the most economically important diseases. Four of the seven insects listed are also soilborne, and at least three nematode species are known to cause economic loss in bareroot nurseries. Many of the weed problems experienced by bareroot nurserymen are also resident in the soil.

In U.S. Northwest nurseries, soil fumigation with methyl bromide-chloropicrin (M-C: is the most widely used control measure for these organisms. This material while very effective against all of the organisms mentioned is extremely expensive, costing approximately $1200 per acre. Treatment of the soil with M-C also has several adverse side effects. If applied improperly or under unfavorable environmental circumstances it can result in damage to the seedlings. Under some soil conditions stunting of the seedlings is also frequently observed following fumigation. This is believed to be the result of a loss of mycorrhizae and other beneficial soilborne organisms. Another result of the use of this material is the creation of a "biological vacuum". This is a situation in which all microorganisms are eliminated from the soil. As a result the first organism to return to that soil, usually a pathogen, has no antagonists to compete with and usually builds quite rapidly to very high levels.

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## SOIL MONITORING

In British Columbia, Canada, the Pacific Forest Research Center in Victoria monitors the soil fungus populations in all of the government owned bareroot nurseries in B.C. Pythium and Fusarium assays of the soil are made annually for each block to be sown. An effective formulation of M-C is not presently registered for use in Canada so this is not an option where high fungal populations are found. Instead, a summer bare-fallow program which reduces pathogen levels is recommended in these circumstances.

The Washington State Department of Natural Resources Nursery (Webster Nursery) in Olympia, Washington, operates a similar program. However, since M-C fumigation is registered for use in Washington it is recommended for control of high levels of soil fungi.

Peninsu-Lab has adapted and modified these programs to make them available to bareroot nurserymen in the Northwest. We currently assay soils for Fusarium, Pythium, Phytophthora, and Nematodes. Based on the kinds and numbers of organisms found, a recommendation regarding the need for fumigation is made. If no pathogenic fungi and nematodes are found, or if they are found at low levels, alternatives to M-C fumigation are suggested. Because of climatic and management variation between nurseries, the non-fumigation option is usually recommended for only a portion of the nursery during the first couple years of testing to establish disease threshold levels for that nursery. This program has been successfully tried in several nurseries with a considerable savings in fumigation costs and an increase in seedling quality.

The relative importance of these soil organisms depends upon the crop to be grown. Therefore, separate monitoring programs are set up for sowing and transplant blocks within the nursery.

### Sowing Blocks

Fusarium, Pythium, and sometimes Phytophthora are important fungi attacking first-year

conifer seedlings and are analyzed for routinely. If other soil fungi are known to be a problem in the nursery, such as Macrophomina, a special analysis may be requested. Nematodes found to be causing damage to conifer seedlings in the Northwest and assayed for are Pratylenchus, Xiphinema, and Trichodorus.

The results of the laboratory analysis indicate the population level of organisms found. This in combination with cropping history, disease incidence, and other background data from the nursery is used to make a recommendation regarding the need for fumigation. If fumigation is necessary, then a follow-up sample is run to ensure its effectiveness. Follow-up soil and seedling disease assays are used to confirm the predictive assays and to establish threshold damage levels for each nursery. Soil fungus population assays from diseased and healthy areas during the first year of seedling establishment help to identify damaging threshold levels.

Adequate procedures for predictive sampling of soilborne insects have not been established as yet. Cropping history is the best indicator presently. However, during the first two years trapping in the sowing block for the cranberry girdler and root weevil can be used to predict population levels so that preventative control measures may be taken.

Transplant Blocks

Transplant blocks can be managed differently since the seedlings are older and less susceptible to a wide range of fungi. Here the fungi of concern are those causing rootrot, such as Pythium and Phytophthora. A soil fungus assay for Pythium and Phytophthora, along with cropping and disease history, dictate a management decision to deal with these. Sometimes block renovation or repeated between-bed subsoiling can be used to promote good drainage and lessen the chance of fungus infection. In severe cases chemical treatment may be necessary to control the root-rot organisms.

Because transplant blocks are less intensively managed nematode problems tend to occur here. Seedlings with limited root systems, such as 1-1's and plug l's, are especially susceptible to nematode damage. Routine assays can determine potential problem areas and pre- or post-plant nematicides can be applied to correct the problem. Some nematode species such as Xiphinema bakeri can be controlled through summer bare fallow. Other nematode species which feed inside root systems require chemical treatment for control.

Insect damage to transplants is usually less frequent than damage to one and two year old seedlings. However, in areas with high insect populations, they can cause considerable damage. Again, trapping for the cranberry girdler and root weevil is an effective means of predicting potential damage areas. Cropping and damage history is also important.

ASSESSMENT

Sampling Procedures

The most reliable and useful sampling technique is the one presently used by the Webster Nursery (Russell 1976). In this procedure three separate samples are collected for each pipeline in the sowing block. A separate analysis is run on each sample and the results are plotted on the block map. Isolines can then be drawn around the different levels of soil fungi, and problem areas can be located.

We have tested several different types of sampling procedures to determine the most dependable and least costly. While the Webster Nursery technique is the most reliable and most effective means of predicting damage areas within a block, it is also the most costly. At current laboratory prices this would run over $500 an acre. The next most effective sampling technique is to take a composite of soil cores from a two-acre unit and run a single analysis on those. While this does not give as much information regarding distribution of soil organisms, it still enables prediction of problem areas at a cost of less than 1/10 of the previous technique.

It is important that each two-acre unit represent the same soil type and cropping history, as this will affect soil organism populations. Different soil types and cropping history should be sampled separately.

Sampling Time

If bare summer fallow is a management option, samples may be taken in March or April. During the summer the soil should be worked several times to reduce weed populations and bring deeper soil to the surface for drying. In September a sample taken from the area of highest organism count should be analyzed to indicate effectiveness of the fallow or need for fumigation.

If bare summer fallow is not an option, samples should be taken in September after the cover crop has been plowed down and the soil worked. If results indicate fumigation is necessary, a post-fumigation sample should be taken no sooner than one month after fumigation and as late as March the following year. This will determine the effectiveness of fumigation or the need of further treatment.

For blocks to be fall transplanted, samples should be taken in the spring to allow time for proper management procedures. For spring transplants, a fall sampling is necessary.

## MANAGEMENT OPTIONS

Presently the number of management options available to the nurserymen is limited. Whether or not a disease potential is present, most nurseries routinely fumigate with M-C. Crop rotation or bare fallow, such as is used in Canada, has not been widely used in the United States. However, it has been quite effective in D.C. nurseries and deserves further testing in Northwest nurseries.

Other soil fumigants have been used in the past, but have not given consistent results. Recently a new method of application of an old pesticide metham-sodium (Vapam, SoilPrep) has given good results. This material applied through the irrigation system effectively kills soil fungi, nematodes, insects, and weed seeds. It is somewhat less expensive then M-C, but requires careful application to obtain uniform coverage. The effect of this material on beneficial soil organisms has not been determined, but is under study.

Recent studies with contact nematicides have shown their effectiveness in nematode control. This provides nurserymen with another management option and enables them to be more flexible in the control program.

Newly developed fungicides are more specific in their activity and thus allow application against target organisms. The recent registration of Subdue allows for specific control of the water/mold fungi Pythium and Phytophthora. A specific control measure for soilborne Fusarium is still lacking and presently is the weak link in a soil pest management program. Once this hurdle is overcome, it will allow greater flexibility in management and greatly reduce the cost of controlling these organisms.

## FUTURE

Beneficial organisms in the soil are becoming more widely understood and utilized in practical ways. These organisms could be introduced into the soil or encouraged to develop to levels that would inhibit pathogenic organisms. There is still a ways to go before this is fully developed, but it has great potential for use in bare root nurseries.

The value of these various types of soil management programs depends upon the degree of incorporation of these programs in the nursery. They will be of greatest value to nurseries utilizing the full program. This involves continually monitoring the crops and soil to establish threshold levels within the confines of the environment and management practices of the nursery. The eventual result should be reduced use of chemicals, or the use of chemicals directed against specific target organisms. This could be a very important factor since more and more soil applied chemicals are being found in the ground water and being removed from registration. As a result, in the near future we may be forced to look toward other management options.

## REFERENCES

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