ALTERNATIVES TO FUMIGATION IN FOREST NURSERIES IN THE WESTERN UNITED STATES

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In 1993-1995, seven bareroot forest tree nurseries in the western United States conducted alternatives to fumigation trials to evaluate cultural control methods for soilborne pathogens, insects and weeds. Seedling density, mortality, and quality factors were evaluated at the end of the first and second growing seasons. In 1995, seedlings from the first trial were lifted and pre-plant treatments were repeated for a second trial to see if the results are reproducible. Conifer seedlings are in their first season of growth in the second trial, that repeated the various treatments customized for each nursery.

Cultural methods tested include: bare fallow with tilling, adding slowly decomposing organic matter in the form of sawdust or compost, sowing seed earlier in the year, and sowing seed on the soil surface and covering it with mulch. Dazomet and/or methyl bromide + chloropicrin fumigants were also applied in several of the trials. Tree species varied according to the location of the nursery, species tested include: Shasta red fir (Abies magnifica var. shastensis) in California, Douglas-fir (Pseudotsuga menziesii), ponderosa pine (Pinus ponderosa), or lodgepole pine (Pinus contorta var. latifolia) in Oregon and Idaho.

In the first trial (1993-1995), seedling quality and production levels with bare fallow with and without periodic tilling were similar to that achieved with chemical fumigation in most nurseries. In the nurseries that do not use cover crops but routinely bare fallow and fumigate between plantings, presow Fusarium levels in non-fumigated treatments were not significantly different from fumigated treatments. Bare fallow and tilling may be a suitable replacement for chemical fumigation.

At the USDA-Forest Service Bend Pine nursery in central Oregon, both bare fallow with and without tilling yielded ponderosa pine seedling densities comparable to the nursery standard practice of pea cover crop followed by methyl bromide + chloropicrin fumigation. High levels of ponderosa pine seedling mortality occurred in the pea cover crop, without fumigation treatment resulting in significantly lower density in that treatment. Seedling height and caliper were significantly greater in the fumigated treatment while seedlings from the bare fallow with and without tilling treatments were of acceptable caliper and height. Surviving seedlings in the pea cover crop, without fumigation treatment had larger calipers and root volume because of reduced competition.

At the USDA-Forest Service J. Herbert Stone Nursery near Medford, OR, Douglas-fir seedling density after bare fallow with tilling and sawdust amendment was significantly greater than seedling density in dazomet treated plots. Bare fallow with tilling provided acceptable Douglas-fir seedling density and quality, with calipers and heights comparable to that with dazomet.

At the USDA Forest Service Lucky Peak Nursery near Boise, Idaho, bare fallow with tilling (with and without sawdust amendment) yielded ponderosa pine seedling densities comparable to that from plots treated with methyl bromide + chloropicrin. Seedling shoot height and caliper from the bare fallow with tilling treatment and methyl bromide + chloropicrin treatment were also comparable.

At the USDA-Forest Service Humboldt Nursery near Eureka, CA there were no significant differences in seedling density or seedling quality from bare fallow and tilled plots and plots treated with dazomet or methyl bromide + chloropicrin.

At the USDA-Forest Service Placerville Nursery in the foothills of the Sierras east of Sacramento, fall bed formation with a winter mulch cover and early sow increased seedling production levels and seedling quality in red fir. The operational nursery practice had been to fumigate with methyl bromide in August, plant a vetch cover crop over the winter, form beds and sow in April. The nursery discontinued fumigating in 1994. In 1994 and again in 1995, over 7 million high-quality 1-0 & 2-0 seedlings were grown without pesticides. However, in the 1996 crop unacceptably high mortality occurred due to charcoal root rot caused by the soilborne fungus Macrophomina phaseolina. The disease is affecting Douglas-fir, sugar pine, giant sequoia, pinyon pine, white fir and red fir. Damage was also heavy in red fir seedlings in the second Alternatives to Fumigation trial which was sown into ground that had not been fumigated for 5 years.

Bare fallow with or without tilling and other modified cultural practices can provide effective and inexpensive pest control that is safe for humans and the environment. However, this method of control may not be sustainable for many repeated cropping cycles or for certain pathogens. Early sowing with mulch seed cover can help provide temporal and physical barriers to pathogen infection. However planting may be delayed by weather, making seedlings more susceptible to pathogens. Bare fallow instead of using cover crops lowers pathogen levels but also increases soil erosion and storm damage. Alternative sources of soil organic matter need to be added. Seedlings may be smaller or have less well developed root systems than those grown under a regime with fumigation. Cultural practices may need refining for optimizing seedling growth under a non fumigated management program.

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96 J. H. Stone Nursery Douglas-fir Density and Mortality

Treatment	total Seedlings/sq ft Douglas-fir Jun-96	live seedlings/sq ft Douglas-fir Jun-96	total seedlings/sq ft Douglas-fir Sep-96	live seedlings/sq ft Douglas-fir Sep-96	%Mortality Douglas-fir Sep-96	Presow Fusarium	Presow Pythium
sd + N basamid	15.94ns	14.97ns	13.86ns	11.6a	20.19a	866.58	4.42
sd + N till	15.37ns	14.40ns	13.70ns	10.0a	34.19a	7988.12	60.24
sd + N no till	14.50ns	13.87ns	13.27ns	10.7a	23.65a	4796.56	45.56
no sd, till	14.67ns	13.74ns	12.30ns	7.0b	44.02b	4303.37	46.25
sawdust no N till	14.47ns	14.24ns	13.97ns	10.5a	25.93a	2653.36	46.63

96 J. H. Stone Nursery Ponderosa Pine Density and Mortality

Treatment	total Seedlings/sq ft Ponderosa Jul-96	live seedlings/sq ft Ponderosa Jul-96	total seedlings/sq ft Ponderosa Sep-96	live seedlings/sq ft Ponderosa Sep-96	%Mortality Ponderosa Sep-96	Presow Fusarium	Presow Pythium
sd + N basamid	17.40ns	17.40ns	17.36ns	15.40a	9.80a	866.58	4.42
sd + N till	17.10ns	17.10ns	17.00ns	15.20a	12.02a	7988.12	60.24
sd + N no till	17.36ns	17.36ns	17.40ns	15.63a	9.20a	4796.56	45.56
no sd, till	16.40ns	16.40ns	15.25ns	13.46b	14.00b	4303.37	46.25
sawdust no N till	17.07ns	17.07ns	16.93ns	15.73a	7.37a	2653.36	46.63

96 Bend Pine Nursery Ponderosa Pine Seedling Density and Mortality

Treatment	Seedlings/ sq ft Jun-96	live seedlings/ sq ft jun-96	Seedlings/ sq ft Aug-96	live seedlings Aug-96	%Mortality Jun-96	%Mortality Aug-96	Presow Fusarium	d-Fusarium Jun-96	Presow Pythium	d Pythium Jun-96
Peas + fum	20.03a	19.17a	19.34a	18.94a	4.04a	6.58a	1197.29	0.47	49.008	0.891714
Fallow + till	19.44a	18.47a	20.44a	19.80a	5.00a	8.38a	507.01	-0.35	69.164	1.527924
Fallow no till	18.50a	17.94a	18.74a	18.20a	4.24a	10.55a	2227.89	1.57	231.788	5.358486
Peas no fum	10.96b	8.94b	8.80b	7.34b	18.22b	44.04b	5090.2	5.42	389.72	14.04323

% mortality (June) is percent diseased seedlings/total emerged seedlings. % mortality (Aug) is cumulative diseased seedlings/ total emerged seedlings
d-Fusarium and d-Pythium is initial (pretreatment, spring 1995) ppg count minus presow ppg count (spring 1996) divided by pretreatment count