ALTERNATIVES TO FUMIGATION AND FUNGICIDES IN BAREROOT FOREST NURSERIES: SOIL TREATMENTS AND BIOCONTROL SEED TREATMENTS

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An experiment to investigate soil and biopesticide seed treatments as alternatives to methyl bromide (MB) soil fumigation is being done by Applied Forest Science Limited at the Weyerhaeuser Company's Grandview Reforestation Centre in Armstrong, B.C. The design requires conducting bi-monthly fungal assays in soil treatment plots over 2 years, i.e., one fallow year followed by 1 year with soil treatments planted in lodgepole pine. Soil treatments consist of: (i) an untreated control, (ii) MB fumigation, (iii) a seeded cover crop of peas and oats, (iv) pasteurisation using a clear plastic soil cover (solarization) and (v) bi-weekly, disc-cultivated, bare fallow. Prior to sowing in year 2, seeds were treated with one of three biopesticides made from preparations of species of *Trichoderma*, *Pythium* and *Pseudomonas*. Assessments of 2 years of soil treatments on soil pathogen and antagonistic fungal populations, and 1 year of soil and seed treatments on damping-off, seedling germination and seedling morphology are being made. Soil and seed treatments are shown below:

		Soil Treatments				
		A Untreated control	**B** Methyl bromide fumigation	**C** Seeded cover crop	**D** Solar heat pasteurisation	**E** Bare fallow cultivation
SEED TREAT-MENTS	F	Not sown	Not sown	Not sown	Not sown	Not sown
	G	Untreated seed	Untreated seed	Untreated seed	Untreated seed	Untreated seed
	H	Supresivit[1]	Supresivit[1]	Supresivit[1]	Supresivit[1]	Supresivit[1]
	I	Polyversum[2]	Polyversum[2]	Polyversum[2]	Polyversum[2]	Polyversum[2]
	J	RAL3[3]	RAL3[3]	RAL3[3]	RAL3[3]	RAL3[3]

[1] *Trichoderma* spp. biopesticide
[2] *Pythium* spp. biopesticide
[3] *Pseudomonas* spp. biopesticide

Treatment plots are 3 X 25 metres in size and contain two seedling beds each. The experimental site is laid out in 8 X 9 plots for a total area of 0.56 hectares. The experiment site was disc cultivated on May 2 and plots laid out on May 10, 1994. Afterward, the bare fallow plots and those to be MB fumigated were cultivated with a rotovator at 14 day intervals. The solarization treatments were covered with one mil, clear polyethylene tarps on June 7, 1994. From the first week of July onwards, air temperature and soil temperature below the solarization tarps at the soil surface and at 15 and 25 cm were measured using thermistors and recorded with a datalogger. The MB treatments were fumigated during the week of September 26, 1994. A dilution plate technique was used to assay soil for fungal populations of *Fusarium*, *Pythium* and *Trichoderma* spp. from samples taken in May, July, September and November, 1994 as well as May and July, 1995. Soil was taken using a 2 cm diameter soil probe to a depth of 20 cm. At 6, 12 and 18 metres into each plot, five cores (one central and one 50 cm away in each of the four cardinal directions) were taken and bulked in a labelled bag. Between each plot, the soil probe was sterilised with 95% ethanol. The bagged samples were transported in coolers and stored at 5° C prior to being assayed.

Lodgepole pine seed was inoculated with one of the three biopesticides indicated above and sown in the treatment plots during early May, 1995. Six weeks after sowing, seedling counts were made to assess germination and losses to damping-off. At the same time, all the weeds from 1 m^2 subplots

within each treatment plot were collected and dried for 24 hours at 35°C and weighed to assess soil treatment effects on weed control.

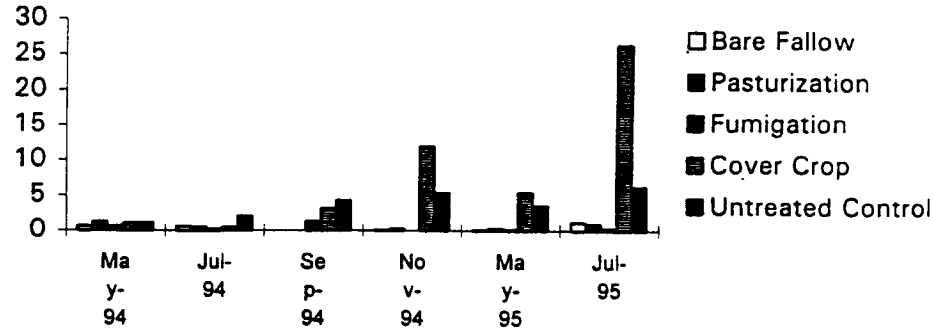
The greatest reduction in propagules per gram (PPG's) of dry soil of all fungal species occurred in the bare fallow and solarization treatments. This includes the MB treatment up to the September sample date, because until fumigated on September 26, it was treated as bare fallow. The general reduction in PPG's over time of all fungal species in the solarization treatments was likely more a function of the physical effects of the treatment on the soil rather than the heat produced under the plastic cover. Maximum hourly temperatures during July approached 50°C at the soil surface, however, at 15 and 25 cm, temperatures were 15-20°C lower. Except at the surface, these temperatures were below those of 45-58°C, required to kill most soil fungi. Declining *Fusarium* and *Pythium* populations in the solarization plots may have resulted from lower water levels here as the cover excluded irrigation and rain. Likewise, the plastic may have simply acted as a physical barrier to air-borne *Trichoderma* spores over the sample period. *Fusarium* populations generally rose over the sample period with the best control being the MB and bare fallow treated soil. *Fusarium* levels became highest in the cover crop and untreated soil plots. The lower levels of *Pythium,* a water mold producing motile oospores, in the bare fallow, MB and solarization treatments from May to September likely results from the soils drying out over the summer. With increased soil moisture in late autumn, *Pythium* PPG's rose between September and November except in the MB plots and continued to rise slightly until July, 1995. *Trichoderma* populations declined over the first 3 months then increased in the MB and cover crop soils. From May until September increased levels of *Fusarium* in the cover crop, MB and control plots coincided with decreased *Trichoderma* levels in these treatments. Perhaps this resulted from the lower *Trichoderma* levels being less antagonistic. *Fusarium* and *Pythium* likely recolonize the soil laterally as well as from below. Thus, the rate at which they reoccur will be relatively slow. This is evidenced by the fact that 7 weeks following the MB fumigation, when the November samples were taken, both *Fusarium* and *Pythium* levels were still undetectable while the *Trichoderma* PPG's had returned to levels higher than observed in May 1994. *Trichoderma* recolonizes soil from airborne inoculum and is traditionally one of the first fungi to be observed in fumigated soil.

The greatest number of surviving germinants overall was observed in MB treated soil, most particularily plots sown with seed treated with a *Pythium* based biopesticide. Overall germination was observed to be next highest in the bare fallow treatments on both seed treated with *Pythium* or *Pseudomonas* based biopesticides.

Weed control as seen by oven dried weights of weeds collected from each treatment plot was greatest in the MB and bare fallow treatments.

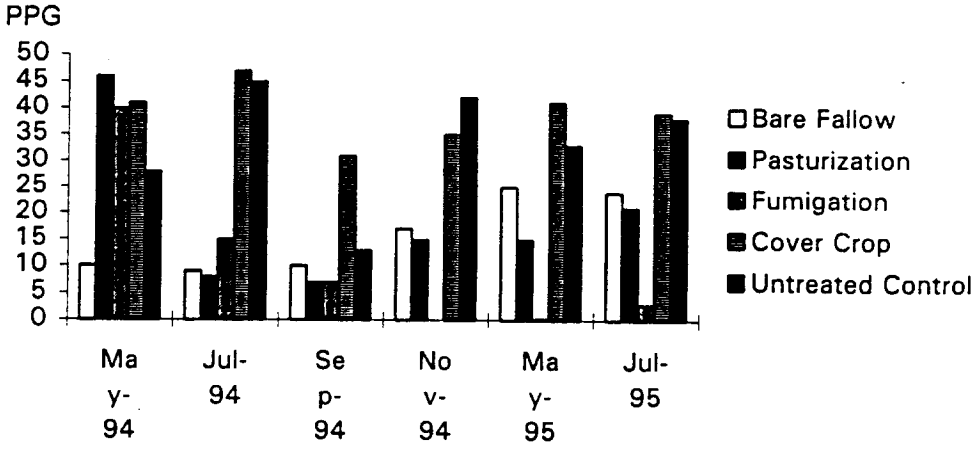
Mean *Fusarium* levels in propagules/g of dry soil

PPG X 100



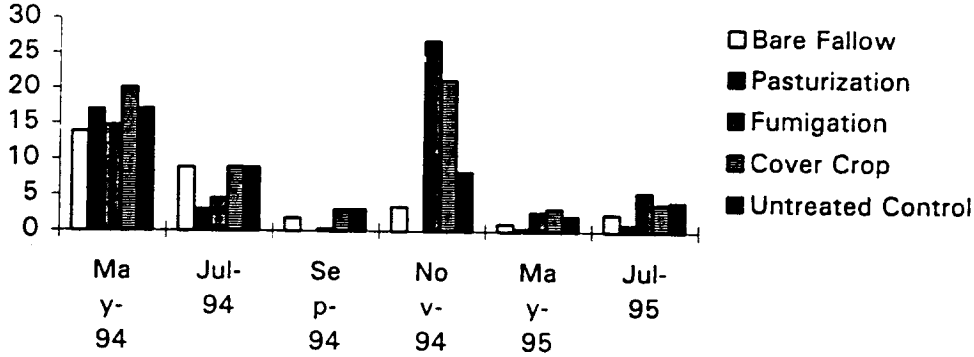
Mean *Pythium* levels in propagules/g of dry soil

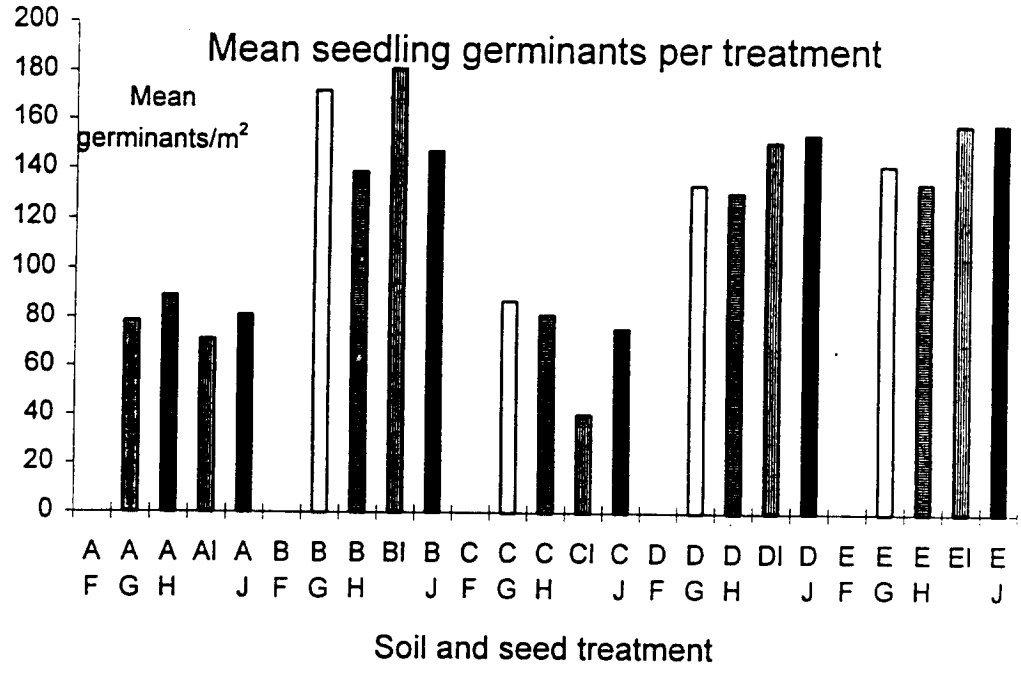
PPG

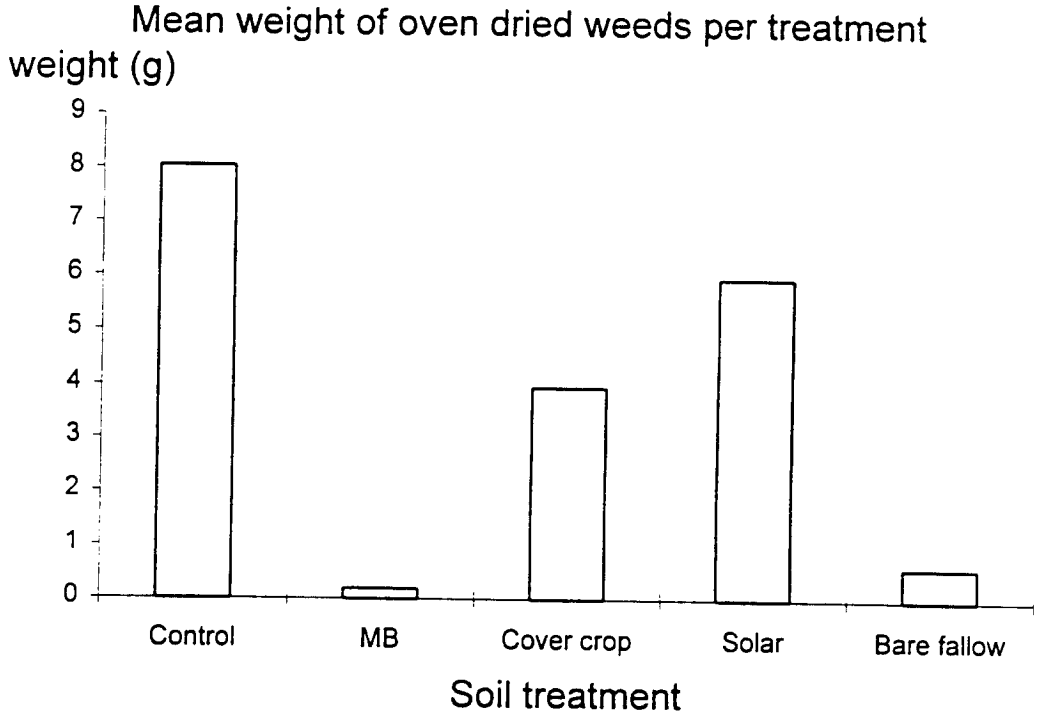


Mean *Trichoderma* levels in propagules/g of dry soil

PPG X 1000




Mean seedling germinants per treatment
Mean germinants/m²
200
180
160
140
120
100
80
60
40
20
0
A F
A G
A H
AI
A J
B F
B G
B H
BI
B J
C F
C G
C H
CI
C J
D F
D G
D H
DI
D J
E F
E G
E H
EI
E J
Soil and seed treatment


Mean weight of oven dried weeds per treatment
weight (g)
9
8
7
6
5
4
3
2
1
0
Control
MB
Cover crop
Solar
Bare fallow
Soil treatment