Cultural Alternatives for Control of *Fusarium Oxysporum* on Non-fumigated Soil at Magalia Nursery[1]

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Abstract. Two mulches and two sowing depths were compared for their effectiveness to protect conifer seedlings from loss caused by Fusarium oxvsporum in non-fumigated soil. Survival rates were highest in treatments using sawdust and pine needle mulches combined with shallow sowing, and lowest in the controls.

INTRODUCTION

Methyl bromide and chloropicrin have been used at the California Department of Forestry and Fire Protection, Magalia Nursery for 30 years, as a preplanting soil fumigation for the control of weeds, soil insects and especially soil borne pathogenic fungi. Fusarium oxvsporum can cause high losses among susceptible conifer species during their first year. Losses by Fusarium with red fir (Abies magnifica) and white fir (A_. concolor), and sugar pine (Pinus lambertiana) have been as high as 75 percent at Magalia Nursery. Losses were reduced considerably by using fall fumigation, instead of the customary spring fumigation. However, because of the potential for human health risks and the probability of legislation to reduce or eliminate use of these chemicals, alternative disease control methods are being. evaluated. Additionally, fumigation may reduce opportunity for spring mycorrhizal colonization of first year conifer seedlings.

This report of a 1991 sowing culminates five years of a continuing study to monitor the effects of mulches and seed sowing depths for reduction of fusarium impacts on conifer seedlings in non-fumigated soils. Germinants of red and white fir, and sugar pine are very susceptible to killing by Fusarium. The objective of this study is to evaluate the effectiveness of two organic mulches and two sowing depths on non-fumigated soils for reduction of Fusarium impact on these species.

MATERIALS AND METHODS

The data presented in this report (Table 1) are from nursery beds last fumigated with methyl-bromide and chloropricin in August 1987 (one non-fumigation cycle) and in August 1984 (two non-fumigation cycles). The nursery (test) beds of this report were sown in April 1991.

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Plot Set-Up

The four foot wide test bed rows were divided into 4 foot by 6 foot plots with 2 foot buffers between treatments and 4 foot buffers between species. Six treatments were randomized and replicated four times in all three species in the one cycle soil, and randomized and replicated twice in the two cycle soil. The six treatments per replication are as follows:

- sawdust, drilled seeds.
- sawdust, lightly-drilled seeds.
- pine needles, whole, drilled seeds.
- pine needles, shredded, lightly drilled seeds.
- controls (2), drilled seeds.

Sawdust used in this study is from a 100 year old pile on a former mixed conifer mill site. Pine needles (Pinus ponderosa) are collected locally in the fall from asphalt-paved parking lots. Shredded needles were prepared in a small garden-type shredder. Drilled seeds are those that were drilled to the usual planting depth for the species. Lightly drilled seeds were drilled to half-expose the seed. Sawdust and pine needles were layered over the drilled seed to a depth of one-half inch.

Data Collection

Dead seedlings (Fusarium-killed) were counted and removed weekly from June 5, 1991 through October 10, 1991. Later in October 1991, all living seedlings were counted and survival percentages totaled.

RESULTS AND DISCUSSION

Results at the end of the 1991 growing season were compiled and survival percentages compared and evaluated for disease control efficacy, Table 1.

Spring Sowing

In all three species tested, the survival percentages of both the sawdust and the pine needle treatments were higher than either of the controls. Survival for both sawdust and pine needle treatments averaged in the 90 percent range.

Comparisons between one non-fumigation cycle (1) and two non-fumigation cycles (2) show that most of the four treatments have at least 90 seedling survival, while the two controls have generally lower seedling survival rates.

Table 1. Combined results of the three-year (1) and six-year (2) cycle non-fumigated soil study. Percentages given are for survival of first-year germinants.

TREATMENTS	TOTAL PERCENT SURVIVAL BY SPECIES					
	White Fir		Red Fir		Sugar Pine	
	(1)	(2)	(1)	(2)	(1)	(2)
SAWDUST:						
Drilled seed	90	88	93	84	96	95
Lightly drilled seed	97	94	97	93	97	96
PINE NEEDLES:						
Drilled seed, whole needles	94	95	95	86	99	96
Lightly drilled seed, shredded needles	97	96	98	95	99	94
CONTROL:						
Drilled seed 1	59	72	75	57	89	80
Drilled seed 2	55	61	64	56	87	83

All four treatments appear to increase survival measurably in both nonfumigation cycles. For white fir, the survival increase averaged nearly 40 percent for the three year cycle and nearly 30 percent for the six year cycle. Red fir survival increased about 25 percent for the three cycle and about 30 percent for the six year cycle. Sugar pine survival increased about 10 percent for both cycles.

White fir survival over the four year study has averaged in the low 90 percent range for the sawdust and pine needle treatments and in the mid 50 percent range for the controls (Table 1). Red fir survival over the four year study has averaged in the low 90 percent range for sawdust and pine needle treatments and in the high 60 percent range for the controls. Sugar pine survival in both control treatments was considerably higher than the four year average for this species at Magalia Nursery. Survival for sugar pine over four years has averaged in the low 90 percent range for the sawdust and pine needle treatments and the high 50 percent range for the controls.

In general, the treatments involving lightly drilled seed with either sawdust or shredded pine needles resulted in the highest survival (average in the mid 90 percent range) while the control plots resulted in the lowest survival (average in the low 60 percent range).

Fall Sowing

All seed for the study of this report was sown in late April or early May, 1991, which is typical for spring sowing at this nursery. Over the past three years, a limited amount of fall sowing has been attempted. Seed has been sown in late fall (November) with a 24 hour soak and no stratification, and was lightly drilled and covered with a layer of sawdust. In addition, a layer of whole pine needles was then spread over the sawdust to prevent the winter rains from washing off the sawdust and exposing the seed.

The advantage of fall sowing over spring sowing is that the seed germinates 4-6 weeks earlier in the spring (usually around mid-March), and thereby becomes more resistant to attack by Fusarium and other diseases, which become more active with warmer soil temperatures.

Commencing in the fall of 1991, nearly all true fir and sugar pine seeds were fall sown in non-fumigated soil for the 1992 growing season. They were lightly drilled and covered with a light layer of sawdust; a layer of pine needles was added over the sawdust to reduce soil erosion during the winter. The pine needles were removed in the spring after the seedlings had begun to germinate. Preliminaryresults after the first growing season indicate that survival rates were acceptable and that we were able to produce for the first time marketable 1-0 true fir and sugar pine seedlings.

CONCLUSIONS

From the results given in Table 1, survival of white fir, red fir, and sugar pine seedlings grown on non-fumigated soil is higher when using shallow sowing and mulches compared to the controls. Throughout this study, lightly drilled seed in both the sawdust and pine needle treatments resulted in the highest survival, while the control plots had the lowest survival. The survival for both lightly drilled seed treatments averaged in the middle 90 percent range, with survival for the control plots averaging in the low 60 percent range.

We feel that a survival of at least 85 percent for these three species grown in non-fumigated soil is acceptable. For the first time (1991) the entire sowing was done on non-fumigated soil. Every bed was sown with lightly drilled seed covered with a light layer of sawdust. Sawdust was chosen over shredded pine needles due to an easily accessible and unlimited supply and the ease of spreading.

In conclusion, the spring sowing of lightly drilled seed covered with either sawdust or pine needles has enabled growing Fusarium-susceptible species of true fir and sugar pine without soil fumigation. Additionally, we find that fall sowing with light drilling and sawdust and pine needle mulching adds the benefits of disease reduction and field seed stratification and eliminates early spring entry into wet fields.