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FUNGICIDE SEED-TREATMENT FIELD TRIALS IN 1972

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INTERNAL REPORT BC-44

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INTRODUCTION

Pre- and post-emergence damping-off (early and late forms) occur yearly at endemic levels in British Columbia forest nurseries. Occasionally one or all of these diseases become epidemic and cause considerable seedling mortality. Salisbury (6) and Bloomberg and co- workers (1,2,3 and 4) have reviewed the problem in B.C. forest nurseries. Earlier changes in nursery practices such as covering seeds with sand and spring-sowing stratified seeds, have helped reduce seedling losses, as have pelleting seeds with fungicides, such as Arasan® and Captan®. More research is needed to find fungicides that (1) are less phytotoxic to seed and seedlings, (2) control a wider spectrum of damping-off problems and pathogens, (3) are less expensive and more practical to apply, and (4) do not produce undesirable environmental side effects. This report gives the results of a seed fungicide treatment field trial carried out simultaneously at Koksilah, Surrey and Red Rock forest nurseries by CFS and BCFS personnel during the 1972 growing season and spring of 1973.

MATERIALS AND METHODS

Field plot design and layout: Figure 1 shows a portion of the randomized complete block design used at the aforementioned nurseries. Within each 10-ft-long block, each of the six treatments (5 fungicides and 1 control) was assigned at random to a 4-ft-long section of drill rows 2, 4, and 6 (rows 1, 3, 5 and 7 were not sown). A 1-ft-wide, unsown buffer strip across the middle of each block separated the 4-ft-long plots, and at each end of each block there was a 6-inch-wide, unsown buffer strip. One hundred seeds were sown evenly along the middle 39.5 inches of each 4-ft-long plot. Each experiment was laid out along 150 linear ft (15 blocks

x 10-ft length for each block) of seedbed in a nursery area considered to have representative nursery soil and environmental conditions.

Seeds and fungicide treatments: Douglas-fir [Pseudotsuga menziesii (Mirb.) Franco], seedlot 315, and Sitka spruce [Picea sitchensis (Bong.) Carr], seedlot 951, were used in the Koksilah and Surrey experiments; lodgepole pine (Pinus contorta Dougl.), seedlot 1975, and interior (white) spruce [Picea glauca (Moench) Voss], seedlot 1848, were used at Red Rock. Previous laboratory tests showed germination rates of 87, 81.5, 69.5 and 78% for Douglas-fir, Sitka spruce, lodgepole pine and interior spruce, respectively.

The treatments, applied shortly before sowing to stratified seeds (previously dried during the extraction process to less than 10% moisture content, oven-dry wt basis), were:

(1) Captan 50W, [Chevron Chemical Co. (Ortho Division), n-(trichloromethylthio)-4-cyclohexene-1, 2-dicarboximide] applied by soaking seeds for 24 hr at 30°C (86°F) in a 0.2% aqueous (wt/wt basis) suspension of wettable Captan powder. One hundred grams of seed were soaked in 400 ml of Captan-water suspension. Based upon a purchase price of $1 per lb for Captan this treatment cost 0.8¢ to treat 1 lb of seed.

(2) Arasan 75W, E.I. DuPont de Nemours and Co., [Bis (dimethylthiocarbamoyl) disulfide]. Same procedure as for Captan above. The cost to treat 1 lb of seed with Arasan (purchased a $1.80 per lb) was 1.4¢.

(3) Benlate 50 W, E.I. DuPont de Nemours and Co., [Methyl 1-(butyl carbamoyl)-2-benzimidazole carbamate], a systemic fungicide applied

to methyl cellulose (1% solution, wt: volume) sticker-treated seed at a rate of 1.5 oz (42.5g) 1 Benlate to 28 lb (12.7kg) of seed. To obtain the necessary coverage each lb of Benlate was mixed with 1 lb of talc. Not including the cost of the talc, Benlate (purchased at $8 per lb) seed pelleting cost 2.6¢ per lb of seed.

(4) Zineb 85 W, Rohm and Hass, (Zinc ethylene bisdithio carbamate), frequently used as a protective foliar fungicide, was applied to methyl cellulose (1% solution)-sticker-treated seeds at a rate of 0.054 oz (1.53 g) fungicide to 0.35 oz (10 g) of seed. The cost of treating 1 lb of seed with Zineb (purchased at $1 per lb) was 15.2¢.

(5) Vitavax 75 W, Uniroyal Chemical Co., (5, 6-Dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide), a systemic fungicide, was applied to methyl cellulose (1% solution)-sticker-treated seeds at a rate of 0.035 oz (1 g) fungicide to 1.75 oz (50 g) of seed. It cost 12.5¢ to treat 1 lb of seed with Vitavax (purchased at $6.25 per lb.).

(6) Control. Stratified seeds only (no sticker).

Dates seeds were sown, plot care and location: Seeds were sown on May 10 and 12 at Koksilah; May 18, 19 and 23 at Surrey, and May 30 and 31 at Red Rock. After sowing, the seeds were covered with ¼ inch of washed, coarse, gray sand. Throughout the growing season, fertilization, irrigation and the use of herbicides and hand weeding followed normal nursery practice. None of the seedbeds had side-boards or shade frames. At Koksilah, the plots were located on the south side of field 2 in row 3. In 1971, this area had been bare fallowed and disked in the summer and in August, 1971, the soil

had been fumigated with 60 Imperial gallons per acre of Vorlex (Methyl isothiocyanate-chlorinated C_3 hydrocarbon mixture). At Surrey, the plots ran parallel (east to west) to the roadway between panels 1 and 2 and were in seedbeds A and B. The 1972 seedling crop was the first grown on this area which had been previously cleared of forest trees and then treated with 60 Imperial gallons per acre of Vorlex on March 17, 1971. The plots at Red Rock were located in the middle of panel 20; the soil in this area had never been fumigated.

Data Collection and analysis: Once a week during the early part of the 1972 growing season and less frequently later, counts were made of healthy seedlings and seedlings killed by either early or late damping-off (root-rot). No attempt was made to separate these two types of damping-off. When counted, killed seedlings were removed from the plots. Graphing percent germination, percent damping-off, and percent survival against time showed that all treatments (fungicides and control) produced almost identical trends throughout the growing season, i.e., there were no apparent interactions of fungicides with time or seedlings species. Thus for statistical analyses, the data for each parameter were cumulated for the entire growing season; e.g. in each plot the number of damped-off seedlings at each counting date was added together and expressed as a percent of the total number (healthy plus killed) of seedlings that had germinated in that plot over the entire growing season; this value was used as one of the 15 replicates in the analysis of variance. Summing up, our formula for calculating the various percentages was:

$$(1)\ \%\ \text{germination} = \frac{\text{total germinants (healthy plus diseased)}}{\text{number of seeds sown}} \times 100$$

(2) % survival = $\frac{\text{number of healthy seedlings}}{\text{number of seeds sown}} \times 100$

(3) % damping-off = $\frac{\text{number of seedlings damped off}}{\text{number of total germinants (healthy plus diseased)}} \times 100$

The percentage data were transformed to the arcsin of the square root for analysis of variance, and treatments means were compared using the Newman-Keuls test (5).

In the spring of 1973, shoot height (soil line to tip of terminal bud) of 6 randomly selected seedlings of each treatment in each of 10 randomly-selected blocks was measured. The data were subjected to analysis of variance and the means compared using the Newman-Keuls test (5).

RESULTS AND CONCLUSIONS

The results are shown in tabular form and written interpretations and conclusions are given in outline form for each nursery, tree species and experimental parameter such as percent germination.

I. Koksilah nursery (Table 1)

A. Douglas-fir

1. Germination was inhibited by soaking seeds in Captan or Arasan and germination was no better in the other treatments than in the control. We concluded that seed treatment did not benefit germination.

2. Damping-off was reduced appreciably by Captan or Arasan, but since there were no significant differences among any of the treatments and the control, we concluded that none of the treatments were beneficial.

3. Survival was not increased significantly by any of the treatments.

4. Shoot growth was unaffected by any of the treatments.

B. Sitka spruce

No treatment significantly affected germination, damping-off control, survival or shoot growth; thus the overall conclusion was that none of the treatments were beneficial in 1972.

II Surrey nursery (Table 2)

A. Douglas-fir

1. Germination was significantly inhibited by soaking seeds in Captan or Arasan and germination was no better in the other treatments than in the control (this trend was the same as that observed at Koksilah). We concluded that seed treatment did not benefit germination at this level of disease.
2. Damping-off incidence was low and since there were no significant differences among the treatments, we concluded that seed treatment did not benefit damping-off control.
3. Survival was poorest when seeds were treated with Captan or Arasan and there were no significant differences among the other treatments and the control. Because the Captan and Arasan treatments decreased survival and none of the other treatments increased survival above that in the control, we concluded that seed treatment did not benefit survival.
4. Shoot growth was unaffected by any of the treatments.

B. Sitka spruce

1. Germination was reduced by Zineb and there were no significant differences among the other treatments and control. The conclusion was that seed treatment did not benefit germination.

2. Damping-off was highest in the Zineb and Vitavax treatments and there was no clear-cut trend among the other treatments and the control which had the lowest damping-off incidence. We concluded that seed treatment did not reduce damping-off.

3. Survival was poorest in the Vitavax treatment, better and similar in the Arasan, Captan and control plots, and best in the Benlate plots. We concluded that (i) although Benlate was significantly better than the other treatments, its use was probably not justified because it increased survival by only 3.2% over the controls, and (ii) Zineb should not be used on Sitka spruce at Surrey.

4. Shoot growth was best when seeds were treated with Arasan, the same in the Captan, control, Zineb and Benlate treatments, and poorest in the Vitavax plots. If Vitavax also reduces spruce root growth, its use could increase frost heaving losses.

III. Red Rock Nursery (Table 3)

A. Lodgepole pine

None of the treatments significantly affected germination, damping-off control, survival or shoot growth; therefore, we concluded that none of the seed treatments were beneficial in 1972.

B. Interior spruce

Germination, damping-off control, survival or shoot growth were not significantly affected by any of the seed treatments. Thus we concluded that seed treatment was of no value in 1972.

DISCUSSION

This study has shown that none of the seed treatments used in the 1972 trials significantly increased seedling survival above that in plots with untreated seeds. Captan and Arasan on Douglas-fir at Koksilah (Table 1) provided some (not statistically significant) protection against damping-off but, since these fungicides killed almost as many seedlings as they protected, final seedling survival was not significantly affected. It must be emphasized that these results are applicable only for 1972, when damping-off incidence was comparatively low. Perhaps in a year when the disease was prevalent, the fungicides would have saved more than enough seedlings to justify their use. Because no methods are available to predict damping-off intensity, fungicide use can be viewed as an insurance measure that will probably continue to be justified until such time as enough data have been collected over several years to show whether or not damping-off is a major nursery problem. Changes in cultural practices, such as use of soil fumigants, may influence the future need for seed fungicide treatments, e.g. the low incidence of damping-off at Koksilah and Surrey nurseries may have resulted from these nursery soils having been Vorlex fumigated the year before establishment of 1972 seed-treatment experiments.

ACKNOWLEDGMENT

We thank B.C. Forest Service personnel for helping carry out these experiments and Dr. W. J. Bloomberg for the experimental design.

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Table 1. Germination, damping-off, survival and shoot lengths of Douglas-fir and Sitka spruce seedlings in 1972 fungicide seed-treatment trials at Koksilah nursery[a/]

	Treatments[b/]					
	Captan	Arasan	Benlate	Zineb	Vitavax	Control
Douglas-fir						
Germination, %	60.9a	69.2b	76.6c	76.0c	73.06c	73.6bc
Damping-off, %	15.3a	15.4a	20.4a	21.5a	17.5a	23.4a
Survival, %	51.7a	59.2a	62.1a	60.8a	60.6a	57.1a
Shoot length, inches	3.99a	3.85a	4.26a	3.83a	3.92a	4.08a
Sitka spruce						
Germination, %	71.6a	73.0a	70.4a	66.8a	70.8a	69.2a
Damping-off, %	10.6a	9.8a	12.4a	15.2a	13.6a	10.7a
Survival, %	64.2a	66.3a	61.6a	56.7a	61.6a	62.1a
Shoot length, inches	2.30a	2.23a	2.03a	2.15a	2.07a	2.16a

a/ See text of materials and methods for dosage rates, etc., and for the formulas for calculating percentages (because of the method used to calculate the percentages they do not total to 100%).

b/ % values are means of 15 replicates, heights are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 2. Germination, damping-off, survival and shoot lengths of Douglas-fir and Sitka spruce seedling in 1972 fungicide seed-treatment trials at Surrey nursery [a/]

	Treatments[b/]					
	Captan	Arasan	Benlate	Zineb	Vitavax	Control
Douglas-fir						
Germination, %	70.7a	76.3b	86.8c	83.6c	83.3c	85.5c
Damping-off, %	3.8a	3.0a	4.7a	2.6a	2.5a	1.6a
Survival, %	68.0a	74.0b	82.8c	81.5c	81.2c	84.1c
Shoot length, inches	2.82a	2.66a	3.01a	3.02a	2.68a	2.98a
Sitka spruce						
Germination, %	81.4a	81.3a	83.9a	74.2b	80.1a	80.0a
Damping-off, %	5.5ab	5.4ab	4.4a	10.8c	9.46c	3.7a
Survival, %	77.0ab	76.9ab	80.3b	66.7c	72.8a	77.1ab
Shoot length, inches	1.02ab	1.04a	0.97ab	0.97ab	0.85b	1.02ab

[a/] See text of materials and methods for dosage rates, etc., and for the formulas for calculating percentages (because of the method used to calculate the percentages they do not total to 100%).

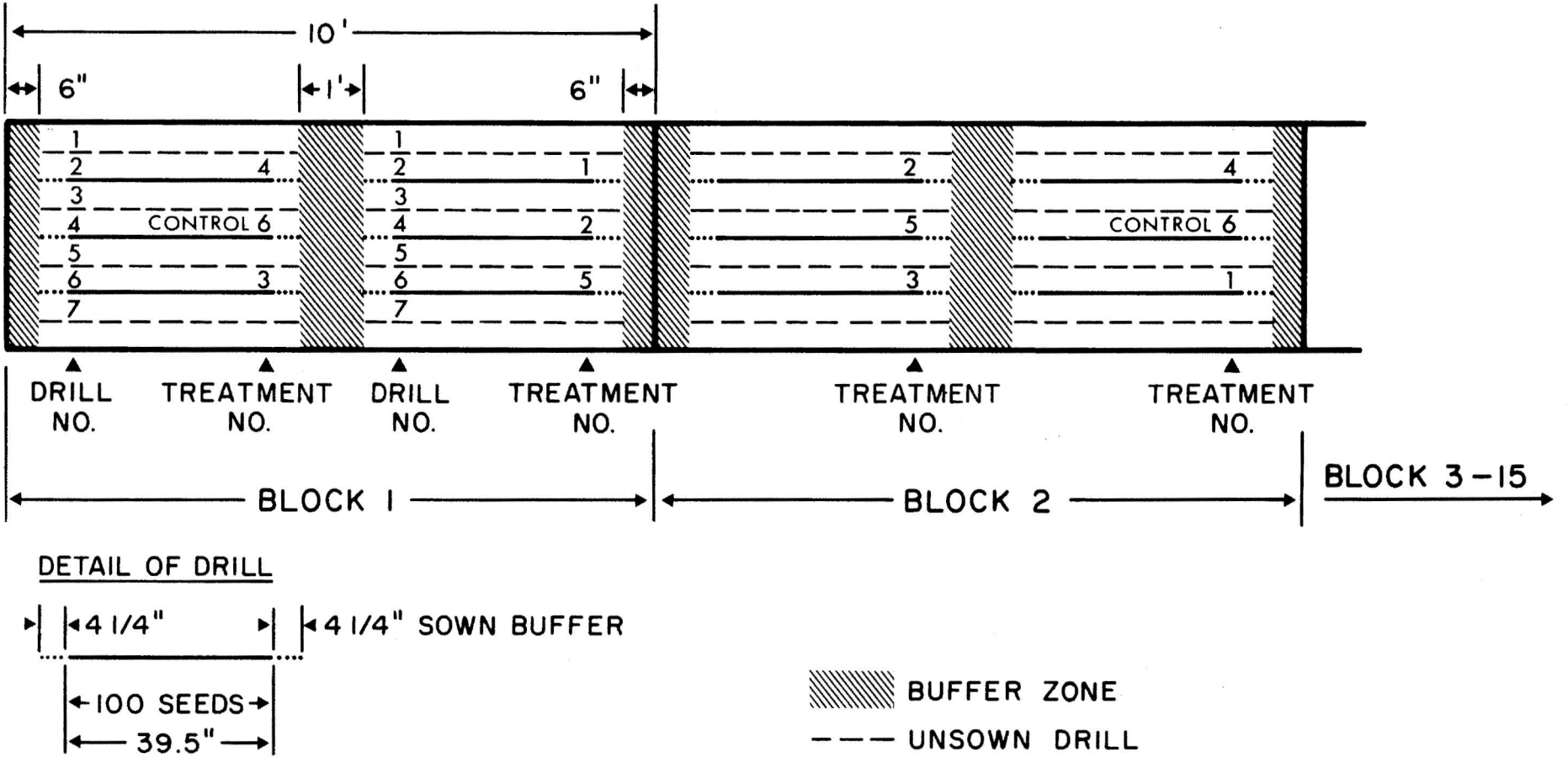
[b/] % values are means of 15 replicates, heights are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 3. Germination, damping-off, survival and shoot lengths of lodgepole pine and interior (white) spruce seedlings in 1972 fungicide seed-treatment trials at Red Rock nursery.[a/]

	Treatments[b/]					
	Captan	Arasan	Benlate	Zineb	Vitavax	Control
Lodgepole pine						
Germination, %	74.0a	61.8a	69.2a	63.0a	71.8a	74.0a
Damping-off, %	10.7a	11.0a	10.0a	15.1a	12.0a	10.9a
Survival, %	66.1a	55.5a	62.5a	53.9a	63.2a	65.9a
Shoot lengths, inches	0.84a	0.78a	0.81a	0.76a	0.74a	0.80a
White spruce						
Germination, %	59.2a	56.4a	58.9a	59.2a	52.2a	63.8a
Damping-off, %	15.4a	12.3a	13.3a	11.5a	14.3a	11.3a
Survival, %	50.7a	49.8a	51.5a	52.7a	45.7a	56.8a
Shoot length, inches	0.87a	0.78	0.72a	0.77a	0.74a	0.75a

[a/] See text of materials and methods for dosage rates, etc., and for the formulas for calculating percentages (because of the method used to calculate the percentages they do not total 100%).

[b/] Values are means of 15 replicates; reading across means followed by the same letter are not significantly different at the 5% level.



Legend to Figure

Figure 1. Two typical blocks showing layout and arrangement of treatments for 1972 fungicide seed-treatment trials.