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**FIELD TRIALS FOR DAMPING-OFF  
CONTROL IN 1973**

**PART I: FUNGICIDE SEED-TREATMENT  
STUDIES**

**PART II: FUNGICIDE SOIL-DRENCH  
STUDIES**

by  
**W. LOCK, L. J. SLUGGETT  
AND JACK R. SUTHERLAND**

**PACIFIC FOREST RESEARCH CENTRE  
CANADIAN FORESTRY SERVICE  
VICTORIA, BRITISH COLUMBIA**

**INTERNAL REPORT BC-48**

**DEPARTMENT OF THE ENVIRONMENT  
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\* Referred to as Interior spruce in the text.



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✓ Correction to 1972 report (Lock, W. and J.R. Sutherland. Fungicide seed-treatment field trials in 1972. Internal Report BC-44, Pacific Forest Research Centre, Victoria, B.C.) The top three lines on page 3 should read: ... to methyl cellulose (1% solution, wt: volume) sticker - treated seed at a rate of 1.5 oz (42.5g) Benlate to 28 lb (12.7kg) of seed. To obtain the necessary coverage each lb of Benlate was mixed with 1 lb....



## INTRODUCTION

Although Captan<sup>R</sup> and Arasan<sup>R</sup> fungicide seed treatments have been used for damping-off control in British Columbia Forest Service (BCFS) nurseries for several years, it is not known how effective they are or if other, or newer, materials would give better disease control. Canadian Forestry Service and BCFS personnel are cooperating in a series of field trials to answer these questions. Because disease incidence and severity vary each year, it was agreed that to obtain valid answers the experiments should be repeated over several years. The first experiments were made in 1972 and a report was written (1). The present report summarizes the 1973 trials. The first part of the report deals with seed fungicide-treatment experiments; the second describes and gives the results of fungicide soil-drench studies. Both experiments were carried out at the Koksilah, Surrey and Red Rock forest nurseries.

## PART I

### SEED FUNGICIDE - TREATMENT STUDIES

#### MATERIALS AND METHODS

Field plot design and layout: A randomized complete block design, used at all three nurseries is illustrated in the 1972 report (1). 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 at Koksilah while Douglas-fir, Sitka spruce, and White (interior) spruce [Picea glauca (Moench) Voss], seedlot 1848, were sown at Surrey. Lodgepole pine (Pinus contorta Dougl.), seedlot 1975, and White spruce were used at Red Rock. Previous laboratory tests showed germination rates of 87, 81.5, 78 and 69.5% for Douglas-fir, Sitka spruce, White spruce and Lodgepole pine, 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 (3.5 oz) 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) Captan 50W, applied to methyl cellulose (1% solution, wt:volume) sticker-treated seeds at a rate of 0.054 oz (1.53g) fungicide to 0.35 oz (10g) of seed. The cost of treating 1 lb of seed was 12.5¢.
- (3) Benlate 50W, E.I. DuPont de Nemours and Co., [Methyl 1-(butyl carbamoyl)-2-benzimidazole carbamate], a systemic fungicide applied to methyl cellulose sticker-treated seed at a rate of 1.5 oz (42.5g) Benlate to 28 lb (12.7 Kg) of seed. To obtain

the necessary coverage, each pound of Benlate was mixed with 1 lb of talc. Excluding the cost of the talc, Benlate (purchased at \$8 per lb) seed pelleting cost 2.6¢ per lb of seed.

(4) Polyram 80W, Niagara Chemical Co., (Zinc-activated polyethylene thiuram disulphide) applied to methyl cellulose sticker-treated seeds at a rate of 0.054 oz (1.53g) fungicide to 0.35 (10g) of seed. The purchase price of Polyram was 70¢ per lb and the cost of treating 1 lb of seed was 1.4¢.

(5) Vitavax 75W, 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 (50g) 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 7 and 8 at Koksilah; May 14 and 15 at Surrey, and May 28 to 30 at Red Rock. After sowing, the seeds were covered with  $\frac{1}{4}$  inch of washed, coarse, gray sand. Throughout the growing season, fertilization, irrigation and 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 in field 2 and ran easterly for about 600 ft in row 34 (measuring from the nursery road). During 1972, the area had grown a crop of 1-0 Douglas-fir and in 1971 it had been fallowed and fumigated in August with 60 gallons (Imperial) per acre of Vorlex. At Surrey, the plots were in the east 400 ft of rows 40 and 41, panel 4. A crop of 1-0 Douglas-fir had been produced in 1972, and when the area was fallowed in 1971 the soil had been treated with 44 gallons



(Imperial) of Vapam per acre. The Red Rock plots were in panel 16, and ran about 600 ft from the west end of the row immediately south of pipeline 54. The area was fallowed in 1972 and had produced a crop of lodgepole pine during 1970-71.

Data Collection and analysis: Once a week during the early part of the 1973 growing season and less frequently later, counts were made of healthy seedlings and seedlings killed by early or late damping-off, and those damaged by insects or birds. When counted, killed or damaged seedlings were removed from the plots. The data were firstly subjected to an analysis of variance using the cumulated data for each parameter 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 (transformed to arcsin of the square root for analysis of variance) of the total number 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. Treatment means were compared using the Newman-Keuls test (2) and these results are given in Tables 1 to 7. Next, to determine the effects of fungicides and time, or their combined effects, on germination, early and late damping-off, the percentage data collected throughout the season were transformed (as previously) and subjected to analysis of variance. When significant time-fungicides were indicated by the analysis of variance, the means were compared using the Newman-Keuls test (2). These results appear in Figures 1 to 7. Our formula for calculating the various percentages (used for both analyses of variance) were:

$$(1) \quad \% \text{ germination} = \frac{(FC + TDO + B + I)}{\text{No. of seeds sown}} \times 100$$

$$(2) \quad \% \text{ early damping-off} = \frac{\text{No. EDO}}{[FC - (\text{No. LDO} + \text{No. bird} + \text{No. insect})]} \times 100$$

- (3) % late damping-off = 
$$\frac{\text{No. LDO}}{[\text{FC} - (\text{No. EDO} + \text{No. bird} + \text{No. insect})]} \times 100$$
- (4) % total damping-off = 
$$\frac{\text{No. TDO}}{[\text{FC} - (\text{No. bird} + \text{No. insect})]} \times 100$$
- (5) % insect losses = 
$$\frac{\text{No. insect losses}}{[\text{FC} - (\text{TDO} + \text{No. bird})]} \times 100$$
- (6) % bird losses = 
$$\frac{\text{No. bird losses}}{[\text{FC} - (\text{TDO} + \text{No. insect})]} \times 100$$
- (7) % survival as percent of seeds sown = 
$$\frac{\text{FC}}{\text{No. seeds sown}} \times 100$$
- (8) % survival as percent of germinants = 
$$\frac{\text{FC}}{(\text{FC} + \text{TDO} + \text{No. bird} + \text{No. insect})} \times 100$$

where:

FC = final count of healthy seedlings

EDO = total seedlings killed by early damping-off

LDO = total seedlings killed by late damping-off

TDO = total damped-off (early and late) seedlings

insect = total seedlings killed by insects

bird = total seedlings killed by birds

seeds sown = no. of seeds sown

In late September, 1973, shoot height (soil line to tip of terminal bud) of six 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 (2).

## RESULTS AND CONCLUSIONS

The results are shown in the tables and figures, and written interpretations are given in outline form for each nursery, tree species and experimental parameter such as percent germinations. The tables contain the

cumulative (over the entire growing season) results for each parameter while the figures show how germination, and early and late damping-off progressed throughout the growing season. In Tables 8 and 9, the 1973 results for germination, total damping-off and survival are compared between nurseries and with those obtained in 1972 (1).

I. Koksilah nursery (Tables 1 and 2; Figures 1 and 2)

A. Douglas-fir (Table 1; Figure 1)

1. Germination was inhibited by Captan seed soak and was no better in the other treatments than in the control (Table 1) and the germination pattern was similar for all treatments (Fig. 1, A to F). Consequently, we conclude that germination was not benefitted by seed treatment. These results agree with observations made this year at Surrey and with the 1972 results at both Surrey and Koksilah (Table 8).
2. Early damping-off was greatest in the Captan seed soaked plots (Table 1, Fig. 1, A to F) and since there were no differences between any of the other treatments and control, the conclusion is that none of the fungicides were beneficial.
3. Late damping-off losses were highest in the Captan soak and none of the other treatments significantly affected disease severity (Table 1; Fig. 1, A to F); thus, we conclude that none of the treatments were worthwhile.
4. Total damping-off losses in general paralleled the early and late losses and again there was no beneficial effect of seed treatment (Table 1). These results agree with the 1973 Surrey data and the observations made at Koksilah and Surrey in 1972 (Table 8).
5. Insect losses were unaffected by any of the treatments (Table 1).



These data agree with the 1973 Surrey observations (Table 3).

6. Bird losses were not recorded.
7. Survival of germinants was poorest in the Captan soak and although there were some statistically significant differences among treatments (Table 1), germinant survival was similar in the control and the best treatment, i.e. Polyram. We conclude that the treatments were of no economic benefit.
8. Survival as a percent of seeds sown is probably the most interesting factor for the nurseryman and the data show that Captan soak was detrimental while survival was best in the control plots (Table 1). Thus seed treatment was of no benefit in increasing seedling stands. This conclusion agrees with the 1972 Koksilah data and the 1973 Surrey results (Table 8).
9. Shoot length (Table 1) was unaffected by any of the treatments.
10. The overall conclusion is that Captan seed soak was detrimental and none of the other treatments were any better than the controls. However, Benlate, which was never worse than the controls in 1972 or 1973 (Table 8), could be used as an insurance measure.

B. Sitka spruce (Table 2; Figure 2)

Polyram and Vitavax reduced germination and there were no clear-cut differences between other treatments and the control. Other parameters such as damping-off were not affected by treatment and the depressing effect of Polyram and Vitavax was evident in the survival based on seed sown values which showed best survival in the control plots. Shoot length was unaffected by treatment. The overall conclusion is that seed treatment was of no benefit. Since

Captan soak and Benlate have not yet shown any detrimental effects on Sitka spruce (Table 8), they could be used as insurance measures on this species.

II. Surrey nursery (Tables 3, 4 and 5; Figures 3, 4 and 5)

A. Douglas-fir (Table 3; Figure 3)

1. Germination (Table 3; Figure 3) was reduced significantly by the Captan soak, and since there were no differences between any of the other treatments and the control, we conclude that treatment did not benefit germination. These results agree with those obtained for fir at Koksilah and Surrey in 1972 and with the 1973 Koksilah results (Table 8).
2. Early damping-off incidence was highest in the Captan pellet treatment (Table 3; Fig. 3). None of the other treatments reduced losses or altered the loss pattern; thus, the conclusion is that seed treatment was of no benefit.
3. Late damping-off was lowest in the control (Table 3; Fig. 3), and since there were no significant differences among treatments, it is concluded that they were of no benefit.
4. Total damping-off followed the same trend as late damping-off.
5. Insect losses were unaffected by treatment.
6. Bird losses were increased by Vitavax treatment but there were no significant differences among the other treatments.
7. Survival of germinants was no better in the best treatment (Polyram) than in the control plots; thus, seed treatment was not considered beneficial.
8. Survival as per cent of seeds sown was poorest in the Captan soaked seeds and was not increased significantly above the control

by any treatment. Consequently, seed treatment was not beneficial.

9. Shoot length was unaffected by treatment.
10. The overall conclusion is that the Captan seed soak treatment was harmful to Douglas-fir germination and that the other treatments failed to produce any significant economic benefits. In general, this conclusion agrees with the 1972 results at Surrey and Koksilah and the 1973 Koksilah observations (Table 8). Again, Benlate, which has not shown any detrimental effects (Table 8), could be used as insurance against disease losses.

B. Sitka spruce (Table 4; Figure 4)

1. Germination was significantly less in the Captan pellet treatment, next lowest in the Polyram treatment and best in the Vitavax, control and Benlate plots (Table 4) and showed the same general time-germination pattern in all plots (Fig. 4). However, since there were no significant differences between the best treatments and the control, it is concluded that germination was not improved by seed treatment.
2. Early damping-off control was best in the Benlate plots, poorest in the Polyram treatment (Table 4; Fig. 4) and similar in the other treatments. These results show a trend (not statistically significant) similar to that observed on Sitka spruce at Koksilah in 1973 and at Surrey in 1972.
3. Late damping-off was unaffected by treatment (Table 4) and was most prevalent in all treatments on September 25 (Fig. 4).
4. Total damping-off losses were significantly less in the Benlate treatment, mainly because this material had reduced early



damping-off losses. Polyram increased total losses while there were no differences among the other treatments.

- 5 and 6. Insect and bird losses were unaffected by seed treatment.
7. Survival of germinants was best in the Benlate plots because the seedlings suffered less early damping-off.
8. Survival as per cent of seeds sown was poorest in the Polyram and Captan pellet plots, intermediate in the Captan soak, control and Captan pellet treatments, and best in the Benlate treatment. This was because Benlate did not inhibit germination and it controlled early damping-off.
9. Shoot length was unaffected by treatment.
10. The overall conclusion is that since Benlate increased final seedling stand by over 10% (Table 4), it may be valuable as a Sitka spruce seed treatment, especially at Surrey. Captan soak may also have some insurance value on Sitka spruce (Table 8). These conclusions are supported by trends shown in the 1973 Sitka spruce data at Koksilah and the 1972 results at both Surrey and Koksilah (Table 8).

C. Interior spruce (Table 5; Figure 5)

1. Germination was reduced by Polyram and Captan pellet (these results agree with this year's Sitka spruce results at Surrey), was higher in the Captan soak and Vitavax treatments and was highest in the Benlate and control plots (Table 5; Fig. 5). The conclusion is that seed treatment was of no benefit.
2. Early damping-off was significantly worse in the Vitavax, Polyram and Captan pellet plots while there were no significant differences among the Benlate, control and Captan soak treatments (Table 5;

Fig. 5). This indicates that the treatments were of no benefit.

3. Late damping-off was not affected by seed treatment (Table 5) and, as was the case with Sitka spruce, this disease was most prevalent in August (Fig. 5).
4. Total damping-off followed the same incidence (Table 5) as early damping-off; thus, the treatments were not beneficial.
- 5 and 6. Insect and bird losses were unaffected by the treatments.
7. Survival of germinants was below the levels for the control in all treatments except Benlate, i.e. seed treatment did not provide subsequent protection of the seedlings.
8. Survival as per cent of seeds sown showed that Captan pellet and Polyram were very detrimental to final seedling stand (similar results were obtained for Sitka spruce) while the Benlate and control plots contained the most seedlings. These results indicate that Benlate could be used as an insurance measure.
9. Shoot length was altered significantly by seed treatment, with the smallest and largest trees occurring in the Captan and Benlate plots, respectively.
10. The overall conclusion is that none of the treatments produced any benefit over the untreated seeds. However, Benlate, which to date has not produced any adverse effects, could be used as insurance against high incidence of disease.

### III. Red Rock nursery (Tables 6 and 7; Figures 6 and 7).

#### A. Lodgepole pine (Table 6; Figure 6)

1. Germination was drastically reduced by Polyram and to a lesser extent by Captan pellet and Vitavax and was best in the Captan

soak, Benlate and control treatments (Table 6). The failure of Captan soak to reduce Lodgepole pine germination agrees with the 1972 results (Table 9).

- 2, 3, 4, 5, 6, (bird losses not recorded) and 7. Early damping-off, late damping-off, total damping-off, insect losses and survival of germinants were not affected by seed treatment (Table 6; Fig. 6).
8. Survival as per cent of seeds sown followed the same pattern as germination.
9. Shoot length was not affected by treatment.
10. The overall conclusion is that none of the treatments produced any benefit over untreated seeds; however, Captan soak or Benlate, which failed to produce detrimental effects in either 1972 or 1973; could be used as insurance (Table 9).

B. Interior spruce (Table 7; Figure 7)

1. Germination was poorest in the Polyram, Vitavax and Captan pellet treatments and best in the Captan soak, control and Benlate plots.
- 2, 3 and 4. Early, late and total damping-off were unaffected by seed treatment.
5. Insect losses were affected by seed treatment, but the results need to be viewed with caution because fungicide phytotoxicity may have been confused with insect damage; e.g. the lowest insect damage was recorded in those plots with the least phytotoxicity (best germination).
6. Bird losses were not recorded.
7. Survival of germinants was unaffected by treatments.
8. Survival as per cent of seeds sown paralleled the per cent germination results.

9. Shoot length was not influenced by treatment.
10. The overall conclusion is that none of the fungicides were beneficial, but Captan soak or Benlate could be used as an insurance measure since they did not reduce seedling stand in 1972 or 1973 (Table 9).

## PART II

### FUNGICIDE SOIL-DRENCH STUDIES

#### MATERIALS AND METHODS

Field plot design and layout: These were the same as for the seed fungicide-treatment studies (see Part I of this report).

Seeds and fungicide treatments: The same seedling species, seedlots, etc., were used in this trial as in the seed fungicide-treatment studies. The soil drenches were applied in a 2-inch-wide band straddling each drill row. Each 4-ft-long replicate (Fig. 1) of each treatment was drenched with the appropriate amount of fungicide in 1 pint of water. The drenches were applied 10, 20 and 40 days after sowing the seeds. The materials (see Part I of this report for their chemical contents and manufacturers) and their application rates were:

- (1) Captan 50W applied at a rate of 0.0233 oz (667 mg) per each 4-ft-long x 2-inch-wide replicate. This is an application rate of 27.98 lb of Captan per seedbed acre (a seedbed acre = 10,888 linear ft of seedbed surface) for each time the drench was applied. These calculations take into account the fact that the drench was applied in 2-inch-wide bands and not to the entire seedbed. The cost of Captan for one drench is \$27.98 and for three drenches it is \$83.94 per seedbed acre.
- (2) Captan 50W applied at one-half the above rate; thus, the costs are also halved.
- (3) Benlate 50W was applied at a rate of 0.0028 oz (0.08g) for each 4-ft-long x 2-inch-wide replicate. This is equivalent to 3.5 lb per seedbed acre. Enough material to drench a seedbed acre would cost \$28 and for three drenches the cost would be \$84.

- (4) Vitavax 75W was applied at a rate of 0.0032 oz (0.09g) per 4-ft-long x 2-inch-wide replicate, which is equivalent to 3.95 lb of fungicide per seedbed acre. The three drenches cost \$74.06, or \$24.69 per drench.
- (5) Control. No fungicide drench.

Dates seeds were sown, plot care and location: These were the same at each nursery as for the seed fungicide-treatment study.

Data collection and analysis: Counts were made 8, 16 and 20 weeks after sowing at Koksilah and Red Rock, and 8, 9, 10, 11, 16 and 20 weeks after sowing at Surrey to determine germination, numbers of seedlings killed by early and late damping-off, and insect and bird losses. Killed and damaged seedlings were removed from the plots when counted. By using the same methods as were used for the seed-treatment experiment (pages 4 and 5), the data for each experimental parameter were cumulated for the entire growing season. These percentage data were then transformed (arcsin of the square root), subjected to an analysis of variance, and the means compared using the Neuman-Keuls test (2). After completing these analyses, it was obvious that the benefits of the treatments were not justified by the high costs of applying the materials, e.g. the highest application rate of Captan cost \$83.94 per acre for the material alone. Consequently, no analyses were made to detect time-fungicide interactions. In late September 1973, seedling heights were measured (soil line to tip of the terminal bud) of six randomly-selected seedlings of each treatment in each of 10 randomly-selected blocks. These data were subjected to analysis of variance and the means compared using the Neuman-Keuls test (2).



## RESULTS AND CONCLUSIONS

The results are shown in Tables 10 to 16, and written interpretations and conclusions are given in outline form for each nursery, tree species and experimental parameter such as per cent germination (cumulated over the entire 1973 growing season). Where applicable, the results are compared among nurseries and species. These comparisons are summarized in Table 17.

### I. Koksilah nursery (Tables 10 and 11)

#### A. Douglas-fir (Table 10)

None of the parameters except shoot length were affected by the soil-fungicide drenches. Seedlings were smallest in the Vitavax plots, intermediate in both Captan treatments, and largest in the Benlate and control plots. Disease incidence was low and we conclude that the drenches were of no benefit (Table 17).

#### B. Sitka spruce (Table 11)

Because there were no treatment effects, the conclusion is that the treatments were of no benefit.

### II. Surrey Nursery (Tables 12, 13 and 14)

#### A. Douglas-fir (Table 12)

1. Germination was reduced by both Captan treatments and did not differ from the control in the other treatments. These results agree with those obtained at Koksilah (Table 17).
2. Early damping-off was unaffected by the treatments.
3. Late damping-off was less prevalent in all treated plots than in the control, but there were no clear-cut differences between treated and untreated plots. Captan drench at  $0.5\text{g/ft}^2$  reduced disease incidence by (3.3%), which is not significantly different from the level in the control plots; thus, it seems unlikely that the treatment

is economically worthwhile.

4, 5, 6, 7 and 8. Total damping-off, insect and bird losses, survival as per cent of germinants, and survival as per cent of seeds sown were all unaffected by treatment.

9. Shoot length varied with treatment but the differences were not distinct.

10. The overall conclusion is that although Captan at  $0.5\text{g/ft}^2$  reduced late damping-off losses by 3.3% compared to the control, the treatment is probably not of economic significance, especially since final stand (survival as a per cent of seeds sown) was the same in treated and control plots.

B. Sitka spruce (Table 13)

1. Germination was poorest in the Vitavax and best in the control plots and although there were statistically significant differences among the various treatments, the two best treatments were control and Benlate drench.

2. Early damping-off incidence followed the same pattern as germination and again the control and Benlate treatments produced the most favorable results.

3. Late damping-off was unaffected by treatment.

4. Total damping-off losses reflected early damping-off losses and were controlled best in the Benlate and control plots.

5 and 6. Insect and bird losses were unaffected by treatment.

7. Survival of germinants was poorest in the Vitavax and best in the Benlate plots, respectively.

8. Survival as a per cent of seeds sown again showed the detrimental effects of Vitavax and the better performance of seedlings in Benlate-drenched and control plots.

9. Shoot length was not altered by any treatment.

10. The over-all conclusion is that, in general, the drench treatments were of no benefit (Table 17). Benlate soil drench might be used as an insurance measure but it would seem to be more practical to use it as a seed treatment (Table 8).

C. Interior spruce (Table 14)

1. Germination was poorest in the Vitavax-drenched plots, better in the Captan treatments, and best in the Benlate and control plots.

2. Early damping-off losses were greatest in the Vitavax and Captan (1.0g/ft<sup>2</sup>) plots and smallest in the Benlate and control plots.

3. Late damping-off losses were unaffected by treatment.

4. Total damping-off losses reflected the incidence of early damping-off.

5, 6 and 7. Insect and bird losses and survival of germinants were unaffected by treatment.

8. Survival as a per cent of seeds sown was best in the control plots.

9. Shoot lengths were unaffected by the treatments.

10. The overall conclusion is that none of the soil drench treatments were of any benefit. These results agree with those obtained on this species at Red Rock (Table 17).

III. Red Rock nursery (Tables 15 and 16)

A. Lodgepole pine (Table 15)

None of the treatments affected any of the measured parameters; thus, we conclude that the soil drenches were of no benefit.

B. Interior spruce (Table 16)

1. Germination was best in the 1.0g/ft<sup>2</sup> Captan and control plots, i.e. there was no benefit from the treatments.

2 and 3. Early and late damping-off were not recorded.

4, 5, 6 and 7. Total damping-off, insect and bird losses (not recorded), and survival as per cent of germinants were unaffected by any of the treatments.

8. Survival as per cent of seeds sown was best in the control plots.

9. Shoot length was unaffected by the treatments.

10. The overall conclusion is that none of the treatments were of any value. These results at Red Rock agree with those for interior spruce at Surrey (Table 17).

#### DISCUSSION

This and the previous (1) report contain the results of seed-fungicide field trials carried out for 2 consecutive years (1972 and 1973) to control damping-off. The objective of these trials has been to determine whether or not certain fungicides are of any value in controlling the pre-emergence and early forms of the disease. Some of the systemic fungicides, such as Benlate, might also provide protection against late damping-off, and Captan seed soak has been tried because it simplifies the procedure for getting the fungicide onto the seed. The important criteria for judging the usefulness of a material is that it must control disease while not inhibiting germination because, for the nurseryman, the most important factor is final seedling stand (per cent survival of seeds sown). The results of both years' trials are summarized and compared with the control in Tables 8 and 9. For species grown in coastal nurseries (Table 8), the data show that Captan soak is consistently harmful to Douglas-fir seeds and actually increases damping-off losses. Benlate and Polyram (tried only in 1973), which were no worse than the controls, might be used as insurance measures on these species. Surprisingly, Captan soak has not harmed Sitka spruce seeds and Benlate has,

in some instances, significantly improved Sitka spruce stands. Either of these treatments might be used on Sitka spruce. All treatments except Benlate were harmful to interior spruce. On lodgepole pine and interior spruce (Table 9) at Red Rock, Captan soak and Benlate have been as good as the controls. Thus, after 2 years' trials, we conclude that only Benlate has consistently produced results on all species as good as those in the control plots and this material could be used as an insurance measure against damping-off. We recommend that future trials be made with Benlate, either as a pellet or seed soak, and quality of seeds should be incorporated as an experimental factor.

The soil fungicide drenches were carried out in 1973 to evaluate their effectiveness for controlling late damping-off. Because no benefits were evident from these treatments, their high costs (material and application) prohibit their use.

#### ACKNOWLEDGMENT

We thank B.C. Forest Service personnel for carrying out the field aspects of these trials.

#### REFERENCES

1. Lock, W. and J.R. Sutherland. 1973. Fungicide seed-treatment field trials in 1972. Internal Rep. BC-44. Canadian Forestry Service, Pacific Forest Research Centre, Victoria, B.C., 12 p.
2. Miller, R.G., Jr. 1966. Simultaneous statistical inference. McGraw-Hill Book Co., Inc., New York.

Table 1. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Douglas-fir seedlings in 1973 fungicide seed-treatment trials at Koksilah nursery<sup>a/</sup>

	Treatments <sup>b/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	48.3a	83.4b	85.7b	82.6b	82.7b	86.5b
Early damping-off, %	7.9a	3.2b	2.9b	2.2b	3.0b	2.5b
Late damping-off, %	2.1a	0.8b	0.7b	0.0b	0.6b	0.2b
Total damping-off, %	9.7a	4.0b	3.6b	2.2c	3.6b	2.7bc
Insect losses, %	2.2a	1.3a	1.3a	0.5a	1.1a	0.6a
Bird losses, %	Not recorded					
Survival as % of germinants	86.7a	94.8b	95.3b	97.4c	95.4b	96.8bc
Survival as % of seeds sown	42.5a	79.1b	81.6bc	80.4bc	78.8b	83.7c
Shoot length, inches	4.14a	3.94a	4.20a	3.92a	3.92a	4.13a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 2. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Sitka spruce seedlings in 1973 fungicide seed-treatment trials at Koksilah nursery<sup>a/</sup>

	Treatments <sup>b/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	65.7ab	64.7ab	73.9ab	59.4a	60.5a	75.3b
Early damping-off, %	9.9a	9.8a	8.6a	12.8a	11.1a	9.2a
Late damping-off, %	0.9a	1.0a	0.9a	2.0a	2.9a	1.7a
Total damping-off, %	10.7a	10.6a	9.4a	14.2a	13.4a	10.7a
Insect losses, %	6.7a	5.4a	5.5a	7.2a	5.6a	4.4a
Bird losses, %	Not recorded					
Survival as % of germinants	84.3a	85.4a	86.0a	81.1a	82.6a	85.9a
Survival as % of seeds sown	55.8abc	55.9abc	63.5ab	49.0c	50.6ac	65.1b
Shoot length, inches	1.15a	1.16a	1.09a	1.10a	1.13a	1.10a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%)

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.



Table 3. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Douglas-fir seedlings in 1973 fungicide seed-treatment trials at Surrey nursery<sup>a/</sup>

	Treatments <sup>b/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	45.1a	79.4b	83.5b	82.9b	73.5c	79.5b
Early damping-off, %	3.1a	5.1b	2.0a	2.2a	2.2a	2.0a
Late damping-off, %	7.8ab	7.1ab	9.3ab	6.8ab	10.7a	6.0b
Total damping-off, %	10.6ab	11.7ab	10.9ab	8.7ab	12.5a	7.7b
Insect losses, %	0.5a	0.2a	0.4a	0.1a	0.5a	0.7a
Bird losses, %	1.4ab	0.6a	1.4ab	0.0a	2.7b	0.5a
Survival as % of germinants	87.8ab	87.7ab	87.7ab	91.2a	85.2b	91.3a
Survival as % of seeds sown	39.7a	69.7b	73.2bc	75.6c	62.7d	72.5bc
Shoot length, inches	1.96a	2.14a	2.33a	2.20a	1.89a	2.10a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 4. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Sitka spruce seedlings in 1973 fungicide seed-treatment trials at Surrey nursery<sup>a/</sup>

	Treatments <sup>b/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	74.5a	59.0b	84.5c	65.1d	80.0ac	80.2ac
Early damping-off, %	14.1ab	15.0ab	5.8c	19.2a	11.7b	10.0b
Late damping-off, %	5.4a	6.8a	3.7a	11.9a	6.1a	6.0a
Total damping-off, %	18.1a	19.7a	9.0c	27.3d	16.5a	14.9a
Insect losses, %	8.7a	2.9a	5.7a	5.5a	2.4a	8.8a
Bird losses, %	1.3a	0.9a	0.4a	1.1a	0.8a	1.8a
Survival as % of germinants	75.4ab	77.9ab	86.8c	69.7a	81.3b	77.6ab
Survival as % of seeds sown	56.7a	46.0b	73.3c	45.3b	65.1a	62.5a
Shoot length, inches	0.69a	0.63a	0.74a	0.69a	0.67a	0.67a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of round-off they do not always total 100%)

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 5. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of interior spruce seedlings in 1973 fungicide seed-treatment trials at Surrey nursery<sup>a/</sup>

	Treatments <sup>b/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	58.8a	42.1b	74.9c	41.1b	60.7a	76.0c
Early damping-off, %	4.0a	13.4b	1.7a	12.4b	8.1b	3.7a
Late damping-off, %	2.1a	5.2a	3.0a	3.0a	4.4a	1.9a
Total damping-off, %	5.9a	16.4b	4.9a	14.4b	11.8b	5.5a
Insect losses, %	3.1a	4.7a	0.6a	1.5a	4.5a	1.1a
Bird losses, %	0.6a	0.4a	0.9a	0.8a	0.9a	0.1a
Survival as % of germinants	90.7ab	80.2c	94.0a	83.8bc	84.2bc	93.6a
Survival as % of seeds sown	53.0a	34.4b	70.4c	34.9b	51.3a	71.1c
Shoot length, inches	0.34ab	0.29a	0.44b	0.34ab	0.40ab	0.39ab

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%)

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 6. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of lodgepole pine seedlings in 1973 fungicide seed-treatment trials at Red Rock nursery<sup>a/</sup>

	Treatments <sup>a/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	78.1a	61.2b	76.5a	31.7c	68.7d	79.1a
Early damping-off, %	2.1a	2.4a	2.9a	3.9a	3.4a	1.3a
Late damping-off, %	6.0a	6.3a	6.6a	6.3a	7.7a	6.4a
Total damping-off, %	7.8a	8.4a	9.1a	9.3a	10.7a	7.5a
Insect losses, %	3.7a	3.0a	2.2a	3.8a	3.9a	2.1a
Bird losses, %	Not recorded					
Survival as % of germinants	89.0a	89.1a	89.1a	87.6a	86.1a	90.7a
Survival as % of seeds sown	69.5a	54.7b	68.1a	27.8c	59.1b	71.9a
Shoot length, inches	0.20a	0.19a	0.16a	0.21a	0.20a	0.21a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%)

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 7. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of interior spruce seedlings in 1973 fungicide seed-treatment trials at Red Rock nursery<sup>a/</sup>

	Treatments <sup>b/</sup>					
	Captan soak	Captan pellet	Benlate	Polyram	Vitavax	Control
Germination, %	67.3a	55.5b	75.2a	46.3b	50.9b	70.7a
Early damping-off, %	8.2a	6.3a	8.2a	10.4a	10.5a	9.6a
Late damping-off, %	4.1a	4.3a	4.8a	4.6a	4.7a	5.1a
Total damping-off, %	11.5a	10.2a	12.1a	14.1a	13.5a	14.0a
Insect losses, %	5.4ab	8.1ab	3.8a	7.3ab	12.4b	4.7ab
Bird losses, %	Not recorded					
Survival as % of germinants	84.4a	83.0a	85.2a	80.6a	77.9a	82.4a
Survival as % of seeds sown	57.2a	46.3b	64.6a	37.5b	40.6b	58.6a
Shoot length, inches	0.19a	0.16a	0.17a	0.18a	0.16a	0.18a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%)

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 8. Comparison of germination, total damping-off and survival (based on number of seeds sown) of treated with untreated (control) seeds in the 1972 and 1973 fungicide seed-treatment field trials at Koksilah (Ko) and Surrey (Su) nurseries<sup>a/</sup>.

Seedling species and treatments	Germination				Total damping-off				Survival			
	1972		1973		1972		1973		1972		1973	
	Ko	Su	Ko	Su	Ko	Su	Ko	Su	Ko	Su	Ko	Su
<u>Douglas-fir</u>												
Captan soak	W*	W*	W*	W*	S	S	W*	S	S	W*	W*	W*
Captan pellet	-	-	S	S	-	-	S	S	-	-	W*	S
Benlate	S	S	S	S	S	S	S	S	S	S	S	S
Polyram	-	-	S	S	-	-	S	S	-	-	S	S
Vitavax	S	S	S	W*	S	S	S	W*	S	S	W*	W*
<u>Sitka spruce</u>												
Captan soak	S	S	S	S	S	S	S	S	S	S	S	S
Captan pellet	-	-	S	W*	-	-	S	S	-	-	S	W*
Benlate	S	S	S	S	S	S	S	B*	S	S	S	B*
Polyram	-	-	W*	W*	-	-	S	W*	-	-	W*	W*
Vitavax	S	S	W*	S	S	W*	S	S	S	S	W*	S
<u>Interior spruce</u>												
Captan soak	-	-	-	W*	-	-	-	S	-	-	-	W*
Captan pellet	-	-	-	W*	-	-	-	W*	-	-	-	W*
Benlate	-	-	-	S	-	-	-	S	-	-	-	S
Polyram	-	-	-	W*	-	-	-	W*	-	-	-	W*
Vitavax	-	-	-	W*	-	-	-	W*	-	-	-	W*

<sup>a/</sup> Legend: - = no trial; S, B and W = statistically (5% level) the same, better or worse than the control; \* = better or worse than the control by at least 3%.

Table 9. Comparison of germination, total damping-off and survival (based on number of seeds sown) of treated with untreated (control) seeds in the 1972 and 1973 fungicide seed-treatment field trials at the Red Rock nursery.<sup>a/</sup>

Seedling species and treatment	Germination		Total damping-off		Survival	
	<u>1972</u>	<u>1973</u>	<u>1972</u>	<u>1973</u>	<u>1972</u>	<u>1973</u>
<u>Lodgepole pine</u>						
Captan soak	S	S	S	S	S	S
Captan pellet	-	W*	-	S	-	W*
Benlate	S	S	S	S	S	S
Polyram	-	W*	-	S	-	W*
Vitavax	S	W	S	S	S	W*
<u>Interior spruce</u>						
Captan soak	S	S	S	S	S	S
Captan pellet	-	W*	-	S	-	W*
Benlate	S	S	S	S	S	S
Polyram	-	W*	-	S	-	W*
Vitavax	S	W*	S	S	S	W*

<sup>a/</sup> Legend: - = no trial; S, B and W = statistically (5% level) the same, better or worse than the control; \* = better or worse than the control by at least 3%.



Table 10. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Douglas-fir seedlings in 1973 fungicide soil-drench trials at Koksilah nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	83.0a	82.7a	85.9a	83.7a	81.1a
Early damping-off, %	0.2a	0.0a	0.1a	0.0a	0.2a
Late damping-off, %	0.2a	0.1a	0.6a	0.2a	0.2a
Total damping-off, %	0.3a	0.1a	0.7a	0.2a	0.4a
Insect losses, %	0.7a	0.0a	0.1a	0.0a	0.2a
Bird losses, %	Not recorded				
Survival as % of germinants	99.0a	99.9a	99.3a	99.8a	99.4a
Survival as % of seeds sown	82.1a	82.6a	85.2a	83.5a	80.6a
Shoot length, inches	4.33ab	4.54ab	4.81a	4.16b	4.82a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 11. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Sitka spruce seedlings in 1973 fungicide soil-drench trials at Koksilah nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	55.9a	60.9a	61.5a	60.9a	62.5a
Early damping-off, %	0.6a	0.2a	0.0a	0.0a	0.1a
Late damping-off, %	2.5a	1.3a	1.8a	1.4a	1.4a
Total damping-off, %	3.1a	1.5a	1.8a	1.4a	1.5a
Insect losses, %	4.3a	3.7a	3.0a	5.3a	3.1a
Bird losses, %	Not recorded				
Survival as % of germinants	92.9a	94.9a	95.4a	93.4a	95.6a
Survival as % of seeds sown	52.1a	57.5a	58.4a	57.4a	59.5a
Shoot length, inches	1.36a	1.29a	1.32a	1.10a	1.26a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 12. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Douglas-fir seedlings in 1973 fungicide soil-drench trials at Surrey nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	75.1a	77.1ab	81.5b	80.1ab	81.1ab
Early damping-off, %	3.2a	1.3b	0.7b	0.8b	1.1b
Late damping-off, %	3.7ab	3.2a	3.6ab	5.1ab	6.5b
Total damping-off, %	6.8a	4.4a	4.3a	5.8a	7.4a
Insect losses, %	0.3a	0.2a	0.2a	0.0a	0.1a
Bird losses, %	0.2a	0.7a	0.1a	0.1a	0.0a
Survival as % of germinants	92.8a	94.8a	95.5a	94.2a	92.5a
Survival as % of seeds sown	69.9a	73.0a	77.9a	75.4a	74.9a
Shoot length, inches	3.62ab	3.88a	3.70ab	3.20b	3.84a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 13. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of Sitka spruce seedlings in 1973 fungicide soil-drench trials at Surrey nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	78.3ab	80.0ab	83.7a	75.5b	81.6a
Early damping-off, %	15.1ab	11.0ac	6.2c	19.2b	7.5ac
Late damping-off, %	4.8a	6.5a	2.8a	4.6a	4.3a
Total damping-off, %	18.8a	16.3ab	8.7c	22.5a	11.3bc
Insect losses, %	1.7a	0.6a	2.2a	6.2a	0.9a
Bird losses, %	0.3a	0.7a	0.1a	1.0a	0.7a
Survival as % of germinants	80.2a	82.8a	89.5b	73.3c	87.4a
Survival as % of seeds sown	63.2a	66.5a	74.9b	55.7c	71.4ab
Shoot length, inches	1.09a	1.19a	1.22a	0.89a	1.15a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 14. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of interior spruce seedlings in 1973 fungicide soil-drench trials at Surrey nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	69.3ab	71.5ab	74.0a	68.3b	74.5a
Early damping-off, %	9.3a	5.0ab	2.0b	6.6ab	1.6b
Late damping-off, %	4.1a	3.0a	2.9a	1.8a	3.2a
Total damping-off, %	12.9a	7.7ab	4.7b	8.2ab	4.7b
Insect losses, %	6.6a	4.0a	4.4a	1.1a	0.2a
Bird losses, %	0.1a	0.7a	0.3a	0.4a	0.1a
Survival as % of germinants	84.9a	88.8a	90.9a	90.5a	95.1a
Survival as % of seeds sown	59.3a	64.3ab	67.3ab	61.8ab	70.7b
Shoot length, inches	0.76a	0.78a	0.76a	0.76a	0.88a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 15. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of lodgepole pine seedlings in 1973 fungicide soil-drench trials at Red Rock nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	48.1a	50.8a	51.5a	45.8a	51.6a
Early damping-off, %	Not recorded				
Late damping-off, %	Not recorded				
Total damping-off, %	4.8a	3.3a	5.6a	3.0a	4.5a
Insect losses, %	0.3a	0.1a	0.7a	0.3a	0.0a
Bird losses, %	Not recorded				
Survival as % of germinants	94.9a	96.6a	93.9a	96.7a	95.5a
Survival as % of seeds sown	45.8a	49.1a	48.5a	44.4a	49.3a
Shoot length, inches	0.45a	0.47a	0.44a	0.40a	0.45a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.

Table 16. Germination, losses (damping-off, insect and bird damage), survival and shoot lengths of interior spruce seedlings in 1973 fungicide soil-drench trials at Red Rock nursery<sup>a/</sup>

	Treatments <sup>b/</sup>				
	Captan 1g/ft <sup>2</sup>	Captan 0.5g/ft <sup>2</sup>	Benlate	Vitavax	Control
Germination, %	60.4ab	58.5ab	53.5a	55.1a	63.9a
Early damping-off, %	Not recorded				
Late damping-off, %	Not recorded				
Total damping-off, %	8.3a	7.4a	7.1a	10.1a	5.7a
Insect losses, %	1.2a	0.6a	0.1a	0.7a	0.5a
Bird losses, %	Not recorded				
Survival as % of germinants	90.9a	92.2a	92.8a	89.3a	93.8a
Survival as % as seeds sown	55.5ab	54.1ab	49.9a	49.5a	60.1b
Shoot length, inches	0.28a	0.28a	0.29a	0.28a	0.30a

<sup>a/</sup> See text of materials and methods for dosage rates, etc., and for formulas for calculating percentages (because of rounding-off they do not always total 100%).

<sup>b/</sup> % values are means of 15 replicates; shoot lengths are means of 10 replicates; reading across means followed by the same letter are not significantly different at the 5% level.



Table 17. Comparison of germination, total damping-off and survival (based on number of seeds sown) in fungicide drenched and undrenched (control) plots in 1973 field trials at the Koksilah (Ko), Surrey (Su) and Red Rock (RR) forest nurseries.<sup>a/</sup>

Seedling species and treatments	Germination			Total damping-off			Survival		
	Ko	Su	RR	Ko	Su	RR	Ko	Su	RR
<u>Douglas-fir</u>									
Captan 1 g/ft <sup>2</sup>	S	S	-	S	S	-	S	S	-
Captan 0.5 g/ft <sup>2</sup>	S	S	-	S	S	-	S	S	-
Benlate	S	S	-	S	S	-	S	S	-
Vitavax	S	S	-	S	S	-	S	S	-
<u>Sitka spruce</u>									
Captan 1 g/ft <sup>2</sup>	S	S	-	S	W*	-	S	S	-
Captan 0.5 g/ft <sup>2</sup>	S	S	-	S	W*	-	S	S	-
Benlate	S	S	-	S	S	-	S	S	-
Vitavax	S	W*	-	S	W*	-	S	W*	-
<u>Interior spruce</u>									
Captan 1 g/ft <sup>2</sup>	-	S	S	-	W*	S	-	W*	S
Captan 0.5 g/ft <sup>2</sup>	-	S	S	-	S	S	-	S	S
Benlate	-	S	S	-	S	S	-	S	W*
Vitavax	-	W*	S	-	S	S	-	S	W*
<u>Lodgepole pine</u>									
Captan 1 g/ft <sup>2</sup>	-	-	S	-	-	S	-	-	S
Captan 0.5 g/ft <sup>2</sup>	-	-	S	-	-	S	-	-	S
Benlate	-	-	S	-	-	S	-	-	S
Vitavax	-	-	S	-	-	S	-	-	S

<sup>a/</sup> Legend: - = no trial; S, B and W = statistically (5% level) the same, better or worse than the control; \* = better or worse than the control by at least 3%.

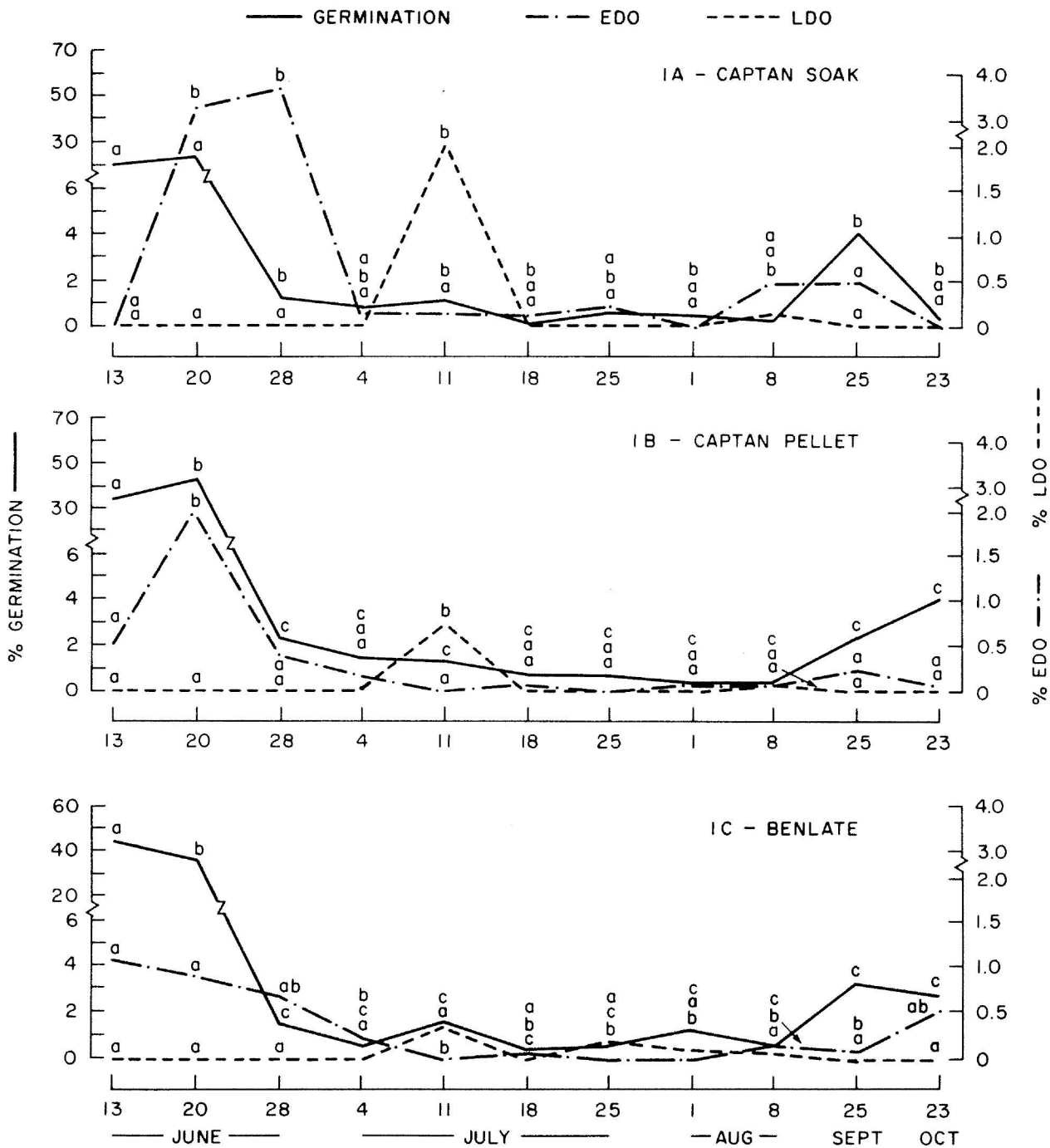


FIGURE 1, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Douglas-fir in the 1973 fungicide seed-treatment trials at Koksilah nursery. Points with the same letter are not significantly different at the 5% level.

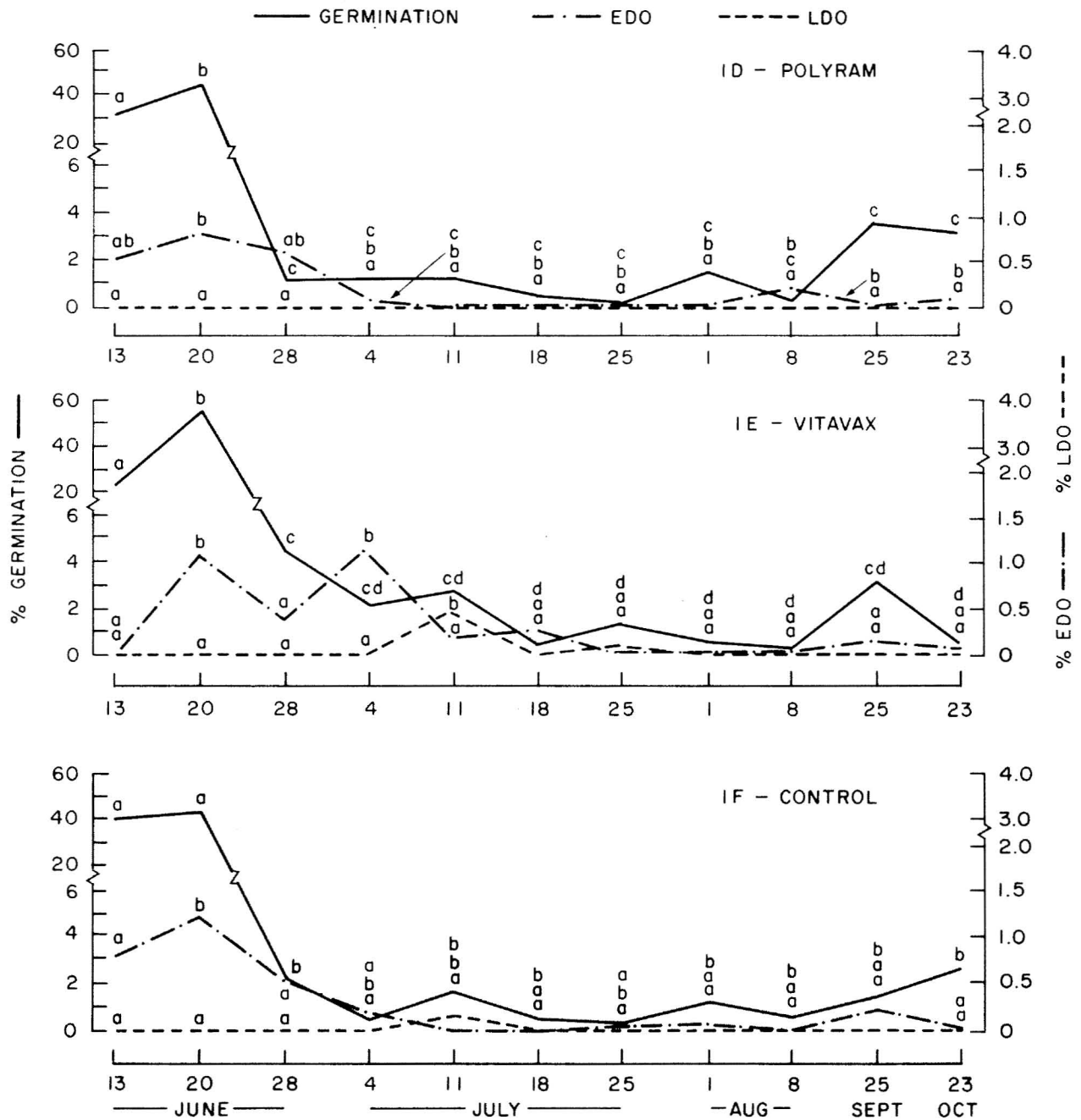


FIGURE 1, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Douglas-fir in the 1973 fungicide seed-treatment trials at Koksilah nursery. Points with the same letter are not significantly different at the 5% level.

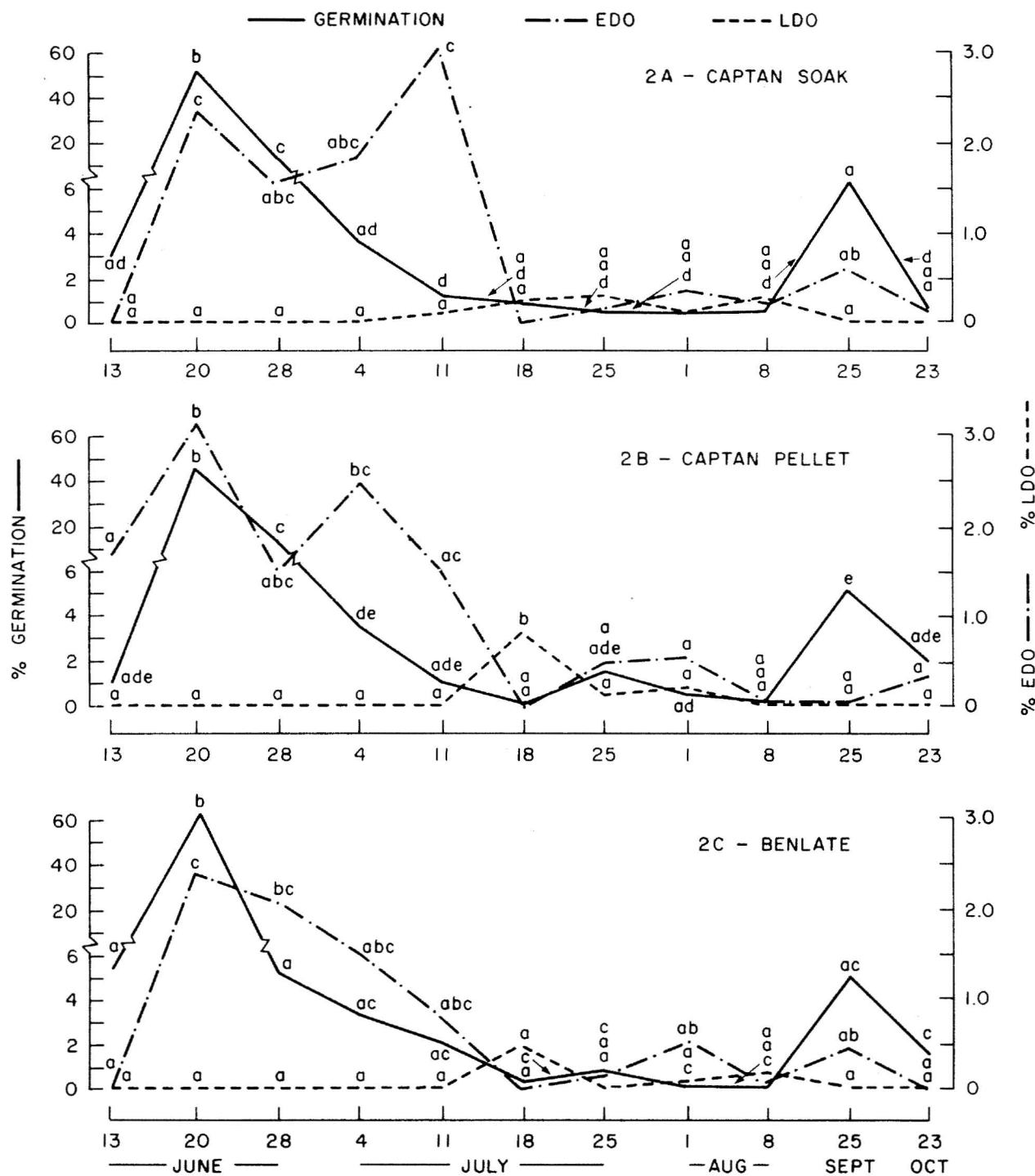


FIGURE 2, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Sitka spruce in the 1973 fungicide seed-treatment trials at Koksilah nursery. Points with the same letter are not significantly different at the 5% level.

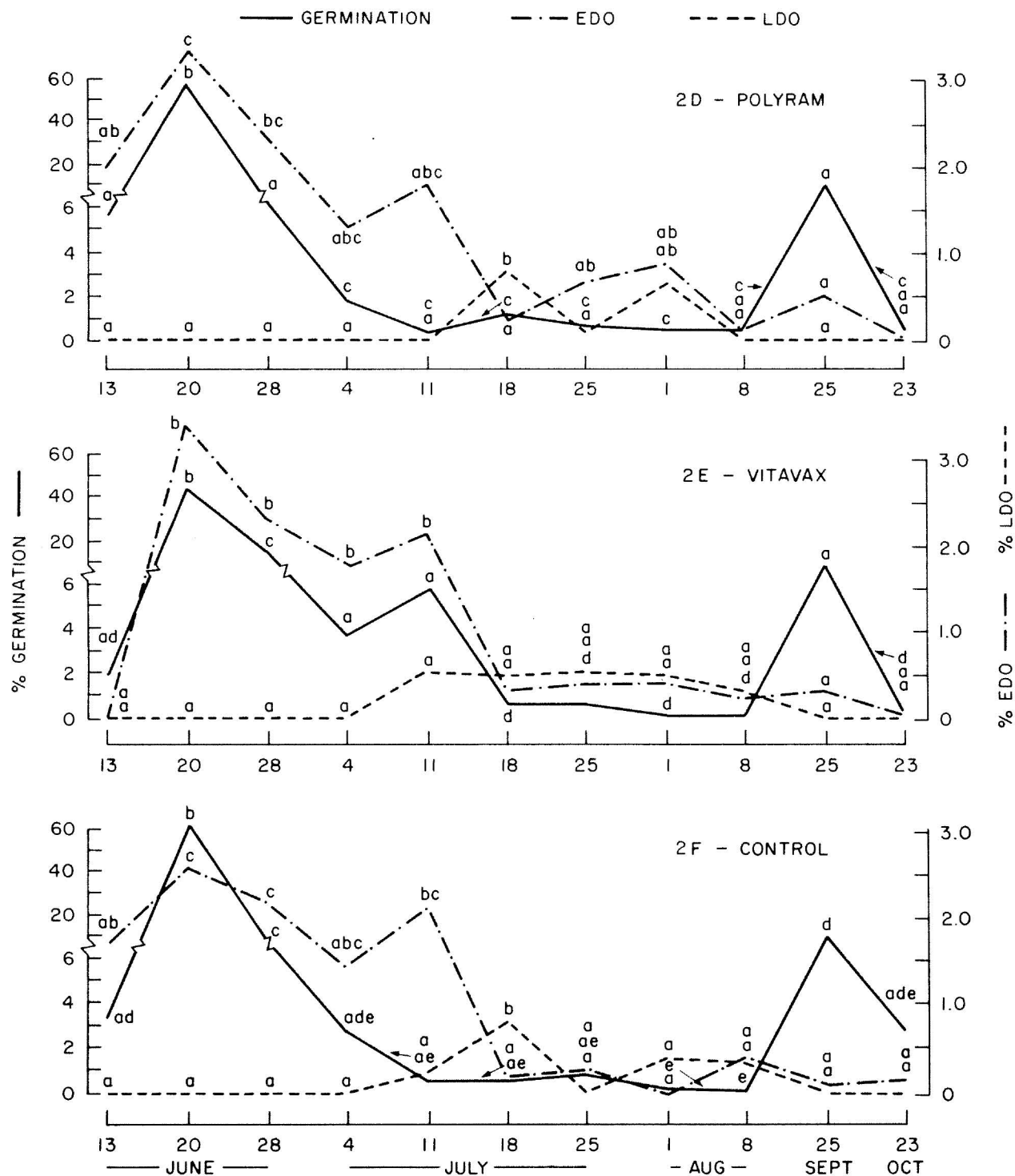


FIGURE 2, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Sitka spruce in the 1973 fungicide seed-treatment trials at Koksilah nursery. Points with the same letter are not significantly different at the 5% level.

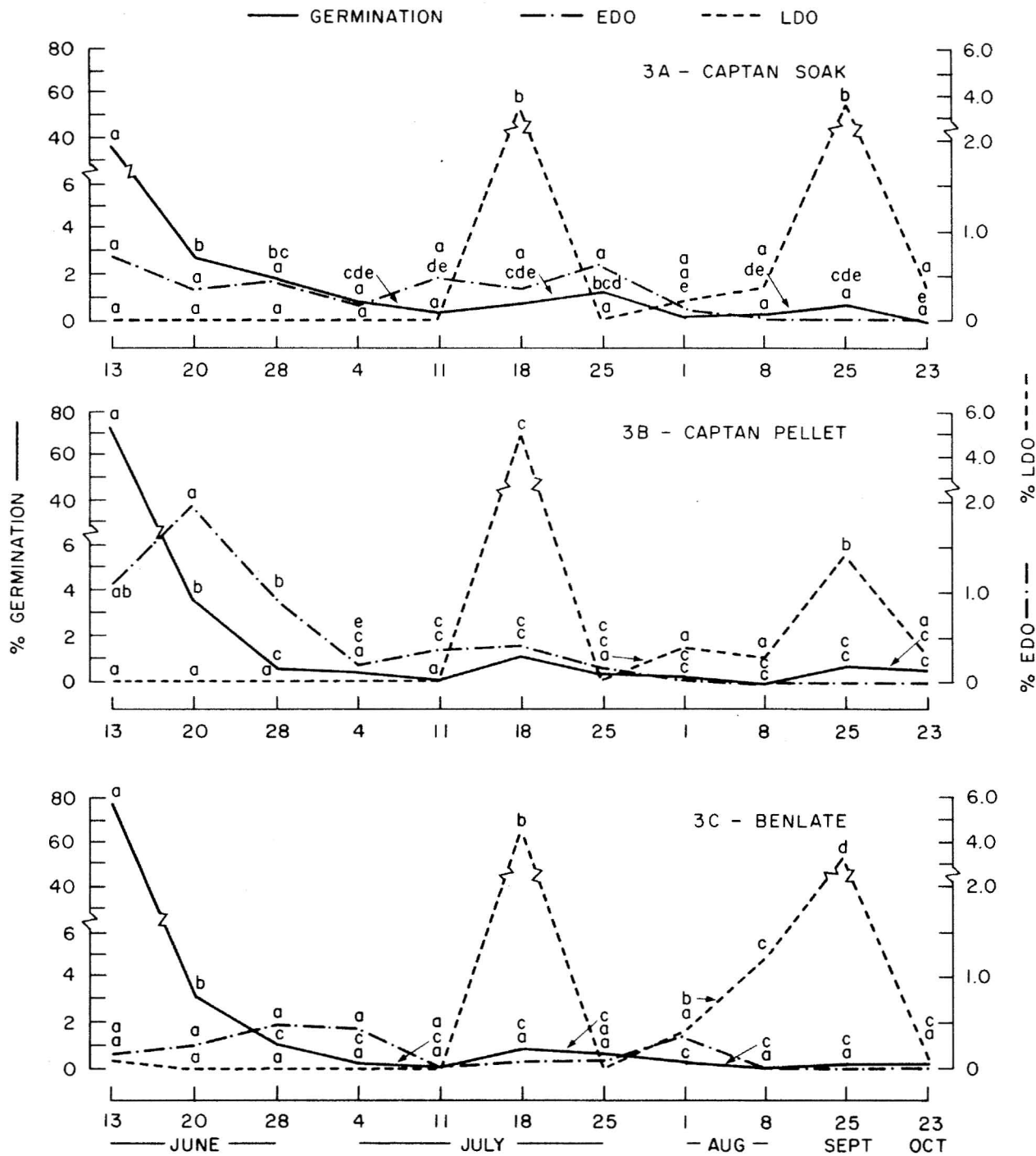


FIGURE 3, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Douglas-fir in the 1973 fungicide seed-treatment trials at Surrey nursery. Points with the same letter are not significantly different at the 5% level.

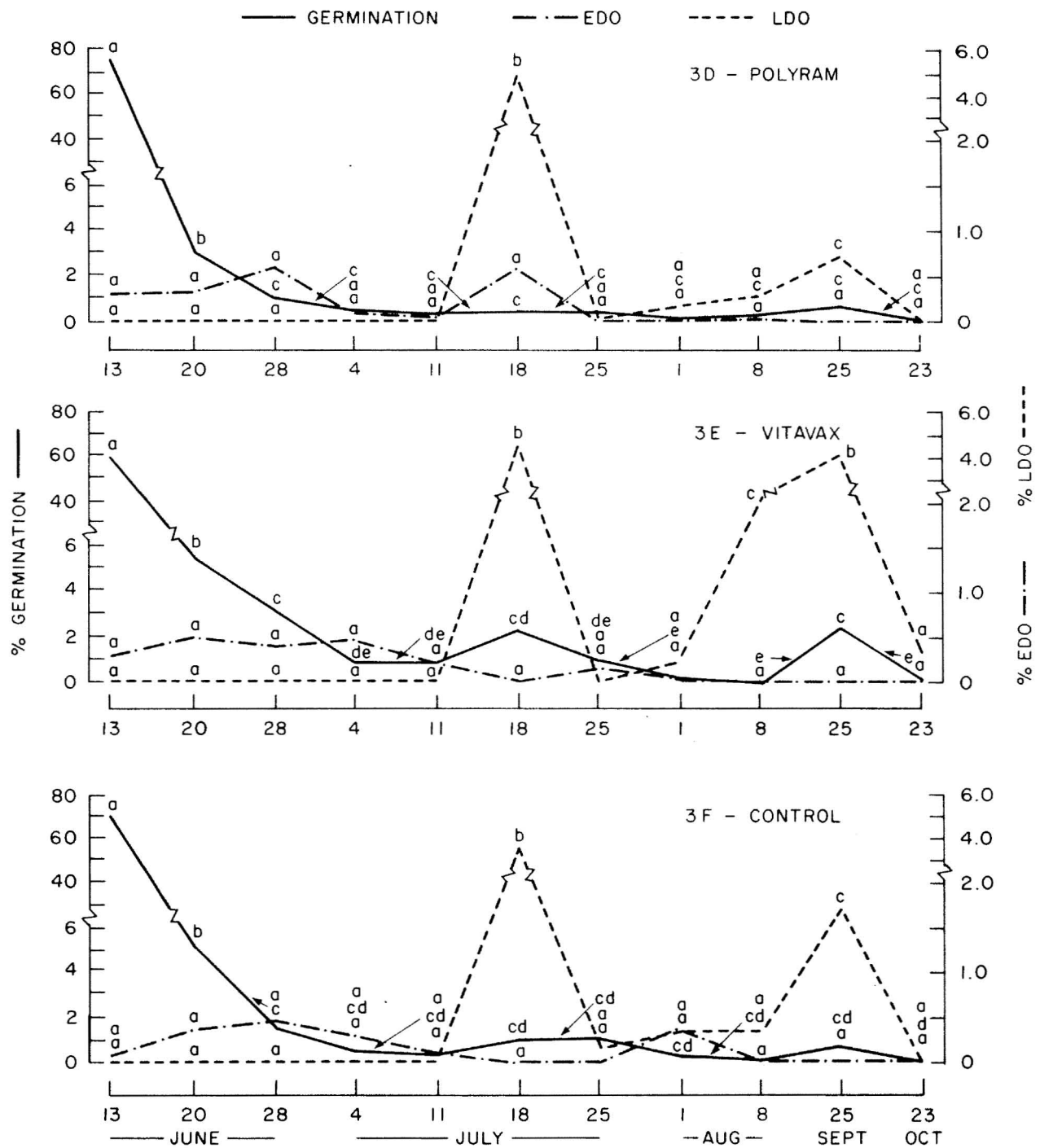


FIGURE 3, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Douglas-fir in the 1973 fungicide seed-treatment trials at Surrey nursery. Points with the same letter are not significantly different at the 5% level.

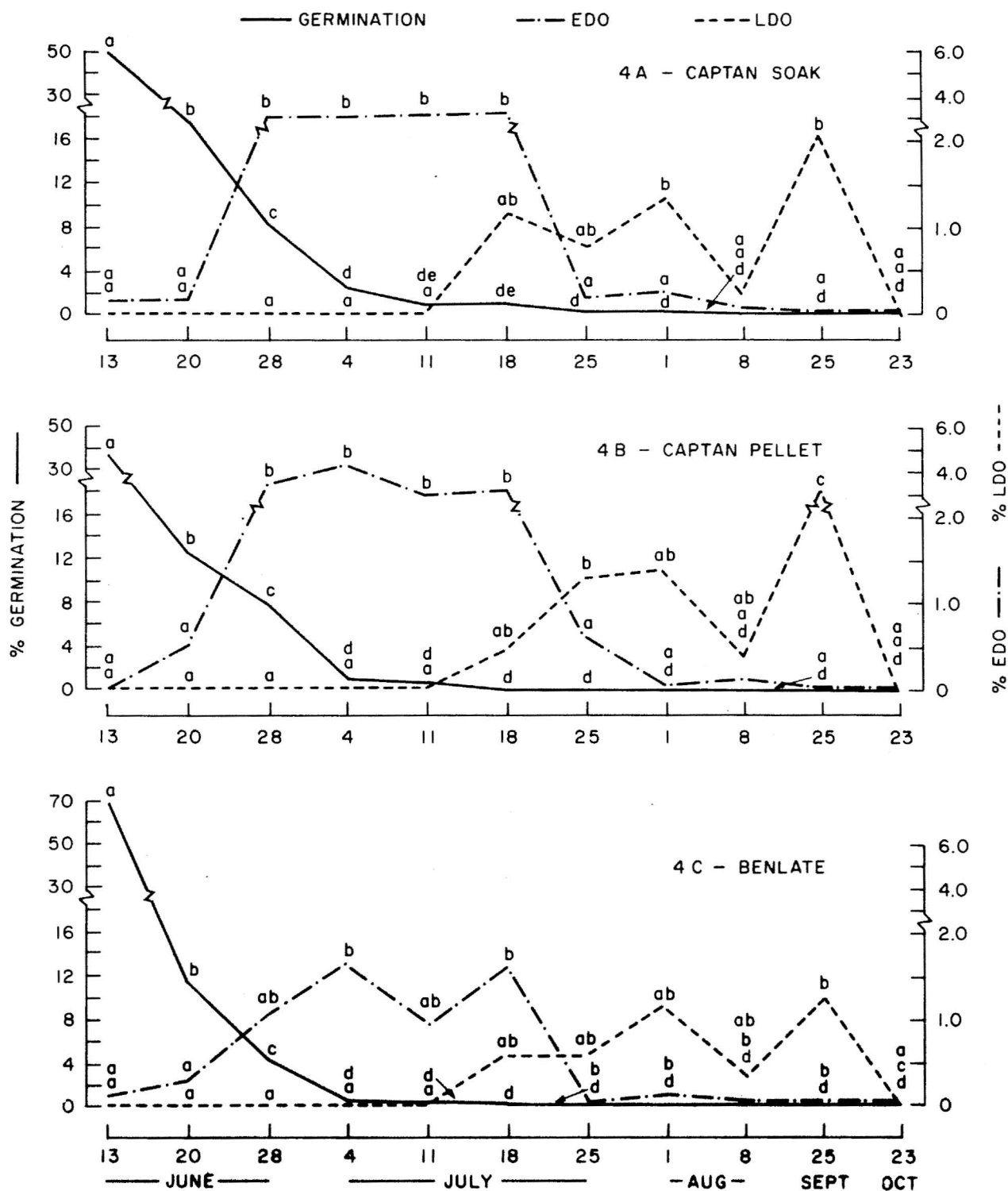


FIGURE 4, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Sitka spruce in the 1973 fungicide seed-treatment trials at Surrey nursery. Points with the same letter are not significantly different at the 5% level.



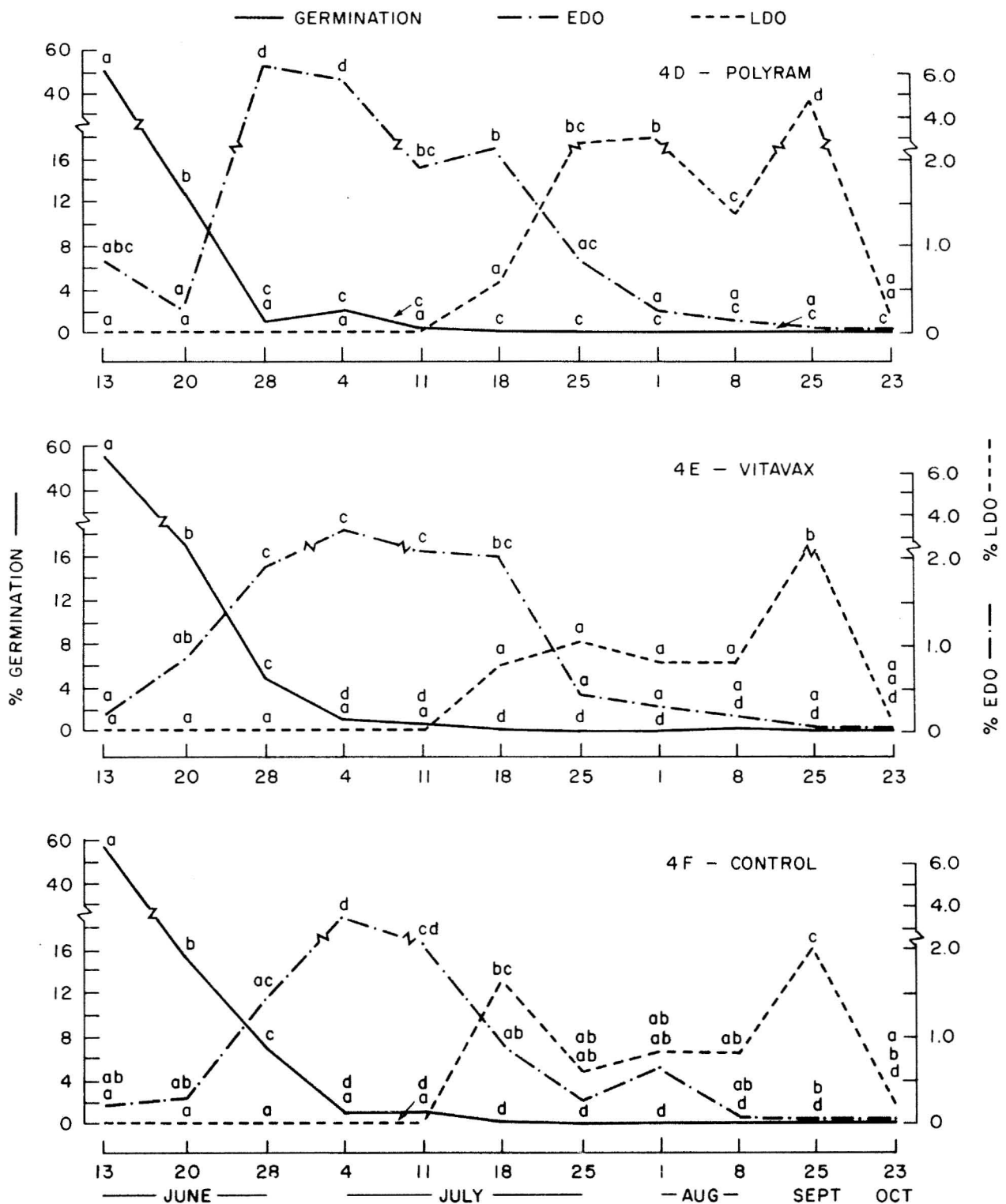


FIGURE 4, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Sitka spruce in the 1973 fungicide seed-treatment trials at Surrey nursery. Points with the same letter are not significantly different at the 5% level.

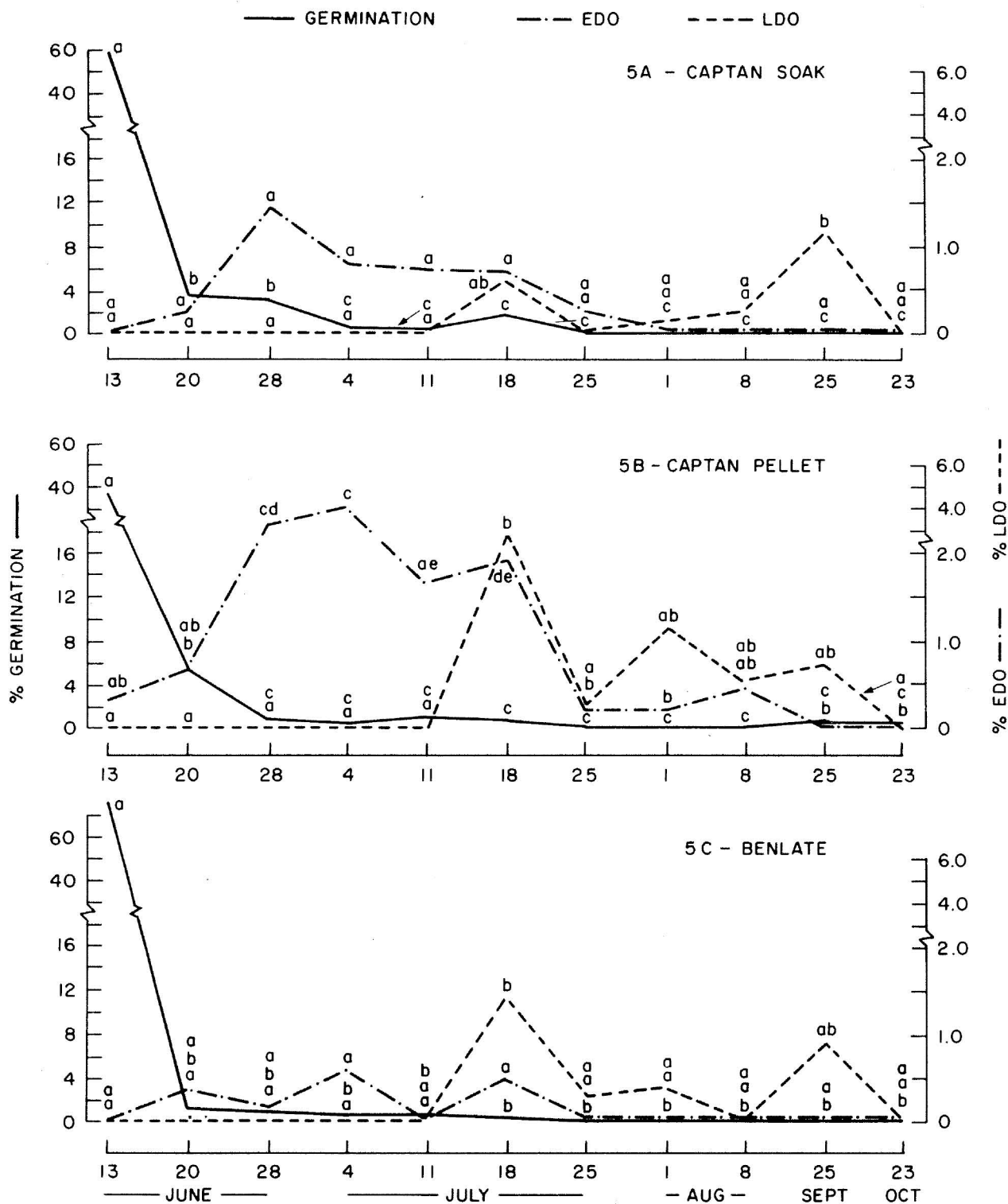


FIGURE 5, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Interior spruce in the 1973 fungicide seed-treatment trials at Surrey nursery. Points with the same letter are not significantly different at the 5% level.

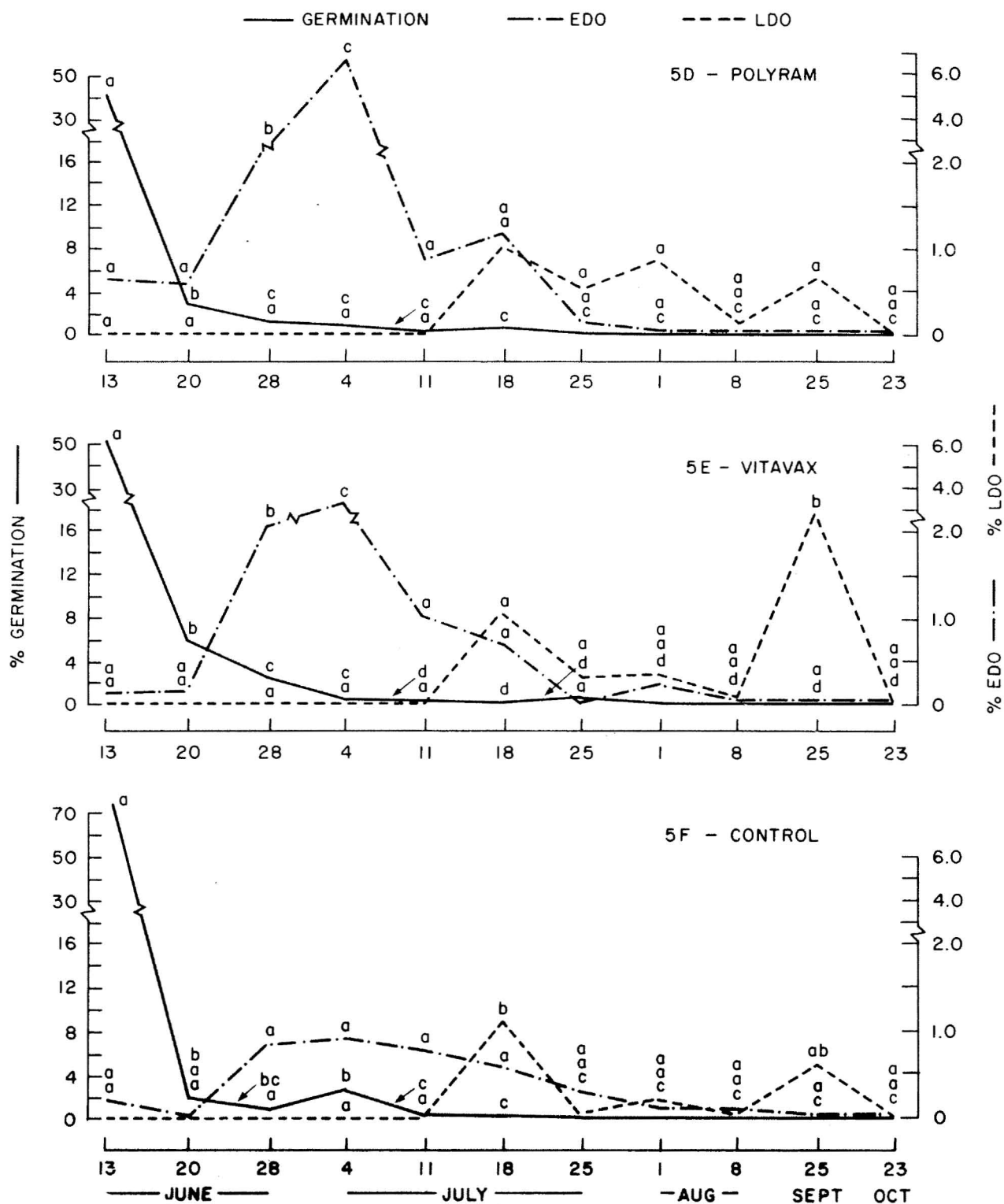


FIGURE 5, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Interior spruce in the 1973 fungicide seed-treatment trials at Surrey nursery. Points with the same letter are not significantly different at the 5% level.

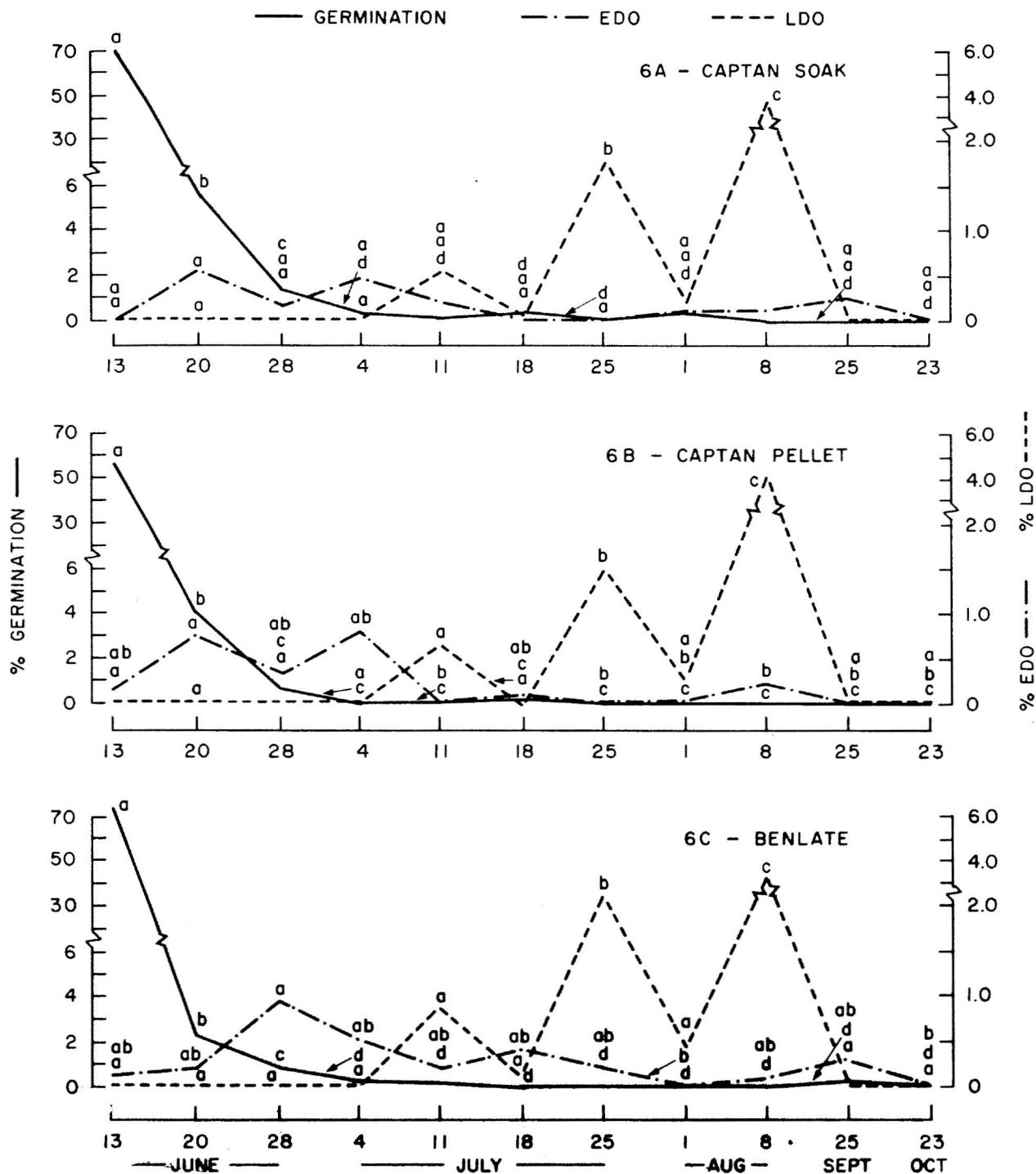


FIGURE 6, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of lodgepole pine in the 1973 fungicide seed-treatment trials at Red Rock nursery. Points with the same letter are not significantly different at the 5% level.

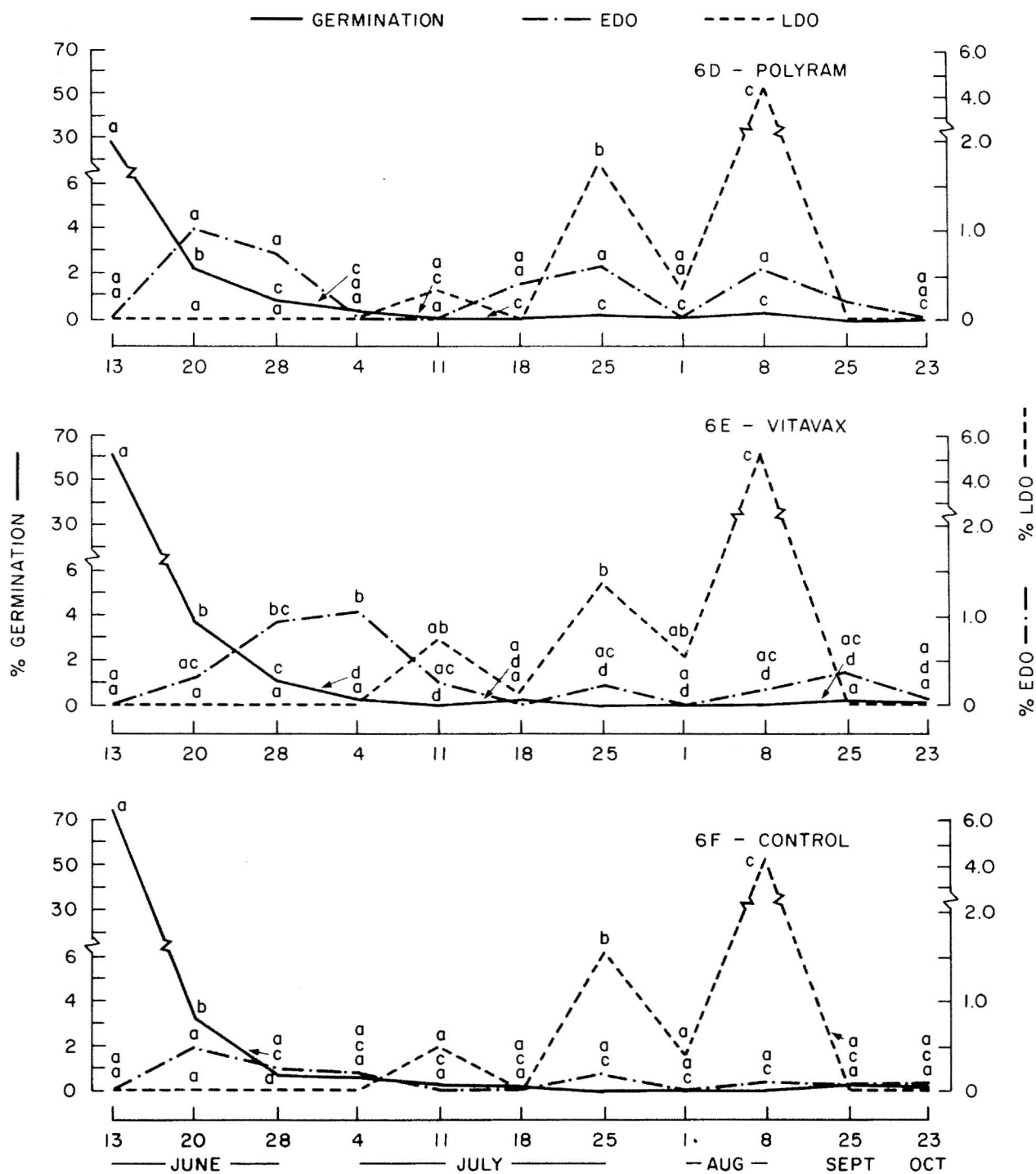


FIGURE 6, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of lodgepole pine in the 1973 fungicide seed-treatment trials at Red Rock nursery. Points with the same letter are not significantly different at the 5% level.

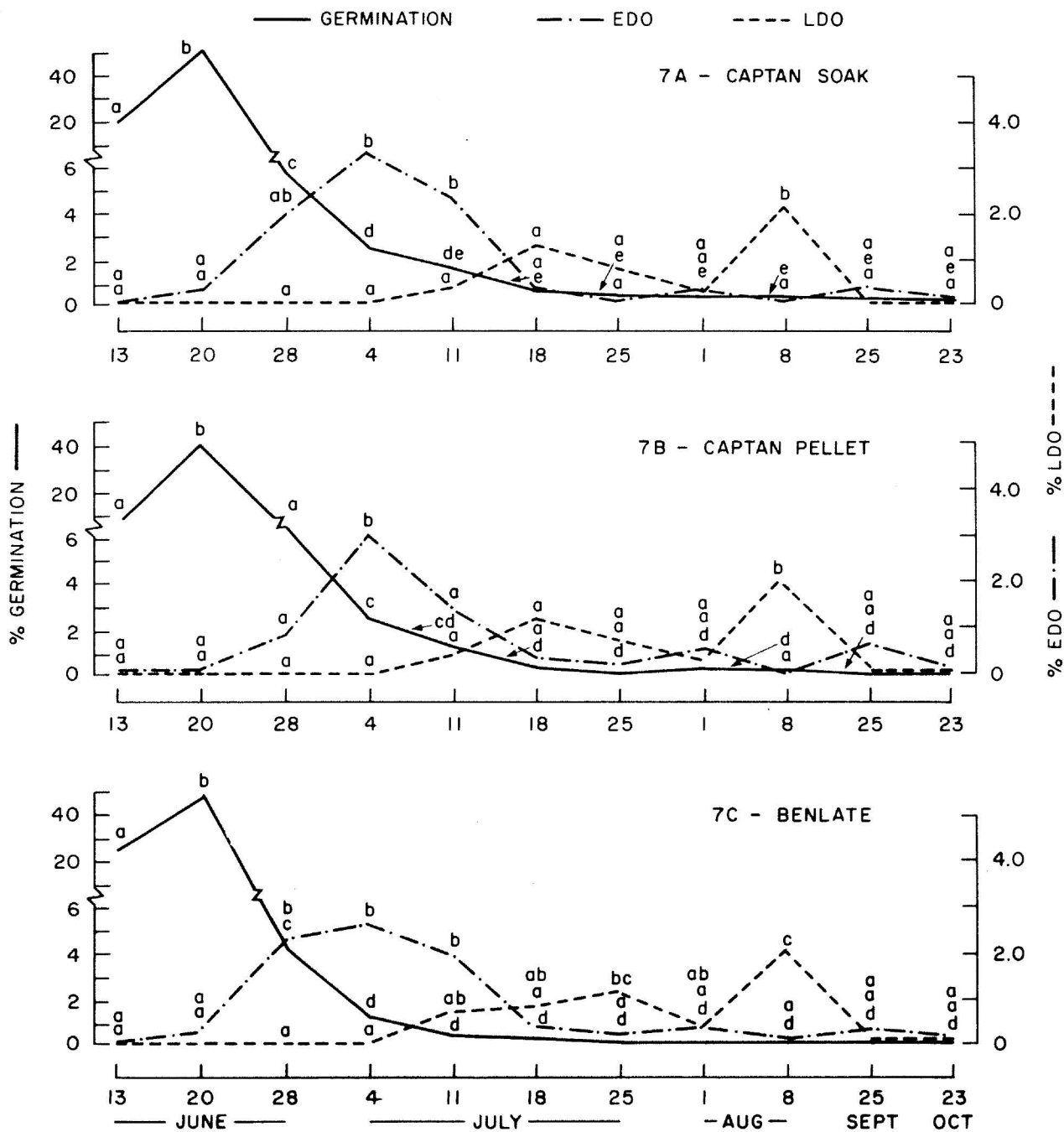


FIGURE 7, A to C. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Interior spruce in the 1973 fungicide seed-treatment trials at the Red Rock nursery. Points with the same letter are not significantly different at the 5% level.

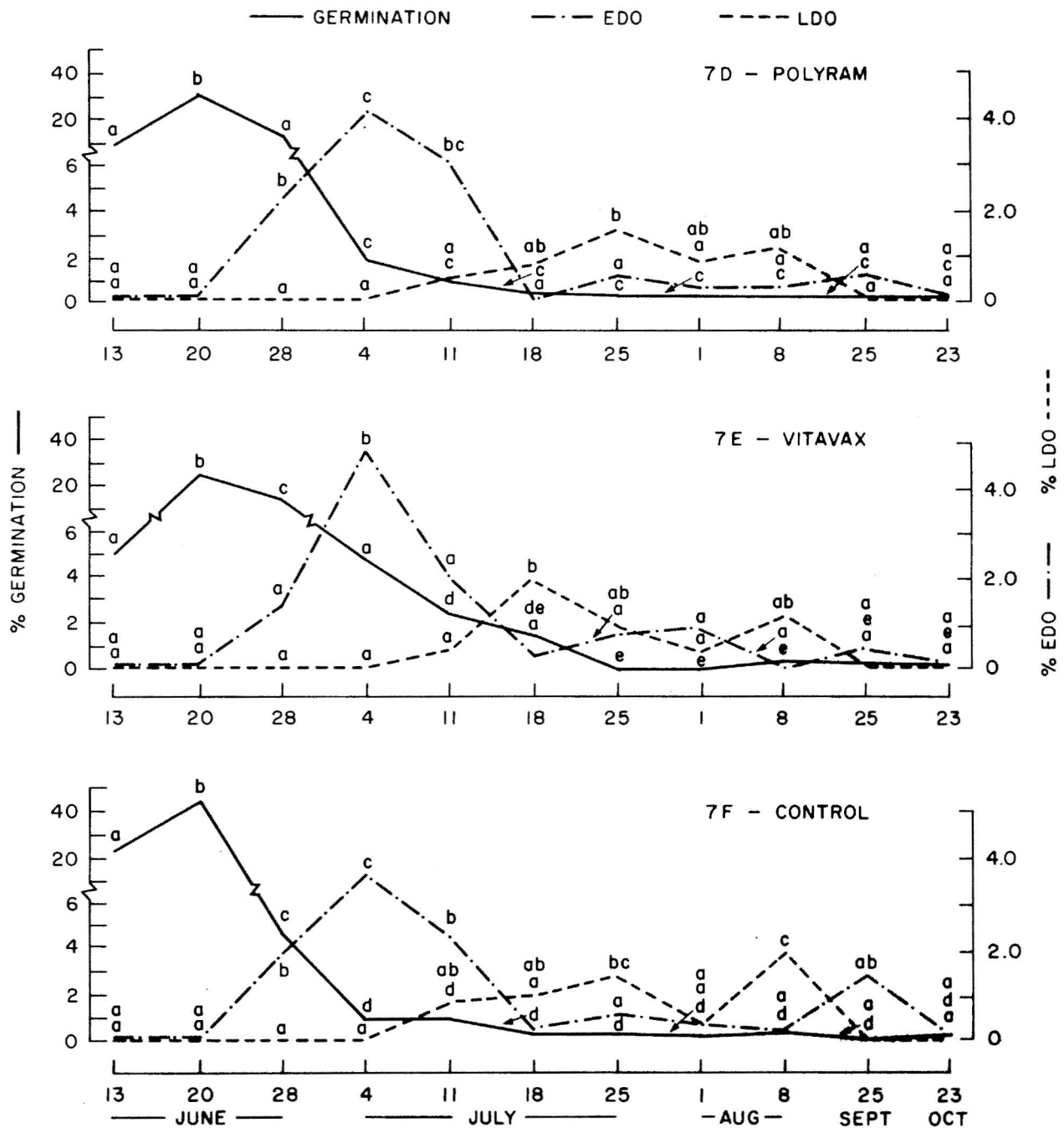


FIGURE 7, D to F. Time-fungicide effects on germination and incidence of early (EDO) and late (LDO) damping-off of Interior spruce in the 1973 fungicide seed-treatment trials at the Red Rock nursery. Points with the same letter are not significantly different at the 5% level.