Fungicide Trials on Sugar Pine at a Southern Oregon Nursery

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Treatment of sugar pine seedbeds with the fungicides captan, benomyl, and Banrot did not consistently reduce losses from fusarium root rot.

Fusarium root rot, caused by *Fusarium oxysporum* Schlect., is common in many bare-root conifer nurseries. Most conifer species are susceptible to some degree to infection by *F. oxysporum* during early seedling growth. Observations of nurserybeds at the J. Herbert Stone Nursery (U.S. Department of Agriculture, Forest Service) in southern Oregon show that severe fusarium root rot occurs in sugar pine (*Pinus lambertiana* Dougl.) seedlings. Resultant mortality or root decay leads to fewer seedlings and increased culling of surviving ones. Although all beds are fumigated in the fall before spring sowing, additional treatment is sometimes needed where fumigation was inadequate, fungal reinfestation has occurred, or highly susceptible species are sown. It was felt that fungicide treatment of seedbed soil, in addition to fumigation, might provide protection from fusarium root rot. Treatment of first-year sugar pine seedbeds with fungicides in 1980 and 1981 is described.

Methods

In April 1980, the fungicides benomyl (Benlate 50 WP, Dupont), captan (Orthocide 50 Wettable, Ortho), and Banrot (Banrot 40 WP, Mallinckrodt) were applied to one seedlot of sugar pine. These beds had been fumigated in the fall of 1979. Benomyl was tested at 20 pounds per acre (10 lb. a.i./acre) and captan at 13 pounds per acre (6.5 lb. a,i./acre), rates commonly used in Pacific Northwest forest nurseries. Two rates of Banrot, 61 pounds per acre (24.4 lb. a.i./acre) and 25 pounds per acre (10 lb. a.i./acre), were tested. These were the label-recommended rate and approximately one-half of the recommended rate, respectively. Captan was applied immediately before sowing; benomyl and Banrot were applied 14 days after emergence.

In April 1981, Banrot was applied to two sugar pine seedlots to determine an effective rate and time for a single application and an optimal number of applications (up to three) at a single rate. Seedlot 1 was treated with two rates of Banrot, 41 pounds per acre (16.4 lb. a.i./acre) and 61 pounds per acre (24.4 Ib. a.i/acre), at three different times: sowing, 20 days after sowing, and 40 days after sowing. Seedlot 2 was treated with one, two, or three applications of Banrot at 41 pounds per acre at sowing, at sowing and 20 days later, at 20 days and 40 days after sowing, and at sowing and 20 days and 40 days later. In both 1980 and 1981 trials, fungicides were applied as drenches to 4-by 10-foot portions of nurserybeds. Four replications of each treatment (including checks) were laid out in a randomized block design over each seedlot. Four 1/2- by 4-foot sampling subplots were established in each 4- by 10-foot treatment plot.

The percentage of mortality was determined by making counts of living and dead seedlings within subplots at 1- or 2-week intervals. Mortality counts were made from June 2 to September 22, 1980, and from June 18 to August 27, 1981.

The data from each trial were subjected to analyses of variance and tests to compare treatment means.

Results and Discussion

***1980 trials*.** As shown in figure 1, treatment with the high rate of Banrot resulted in the best survival (82.2 percent) at the final measurement date. The poorest survival (69.7 percent) was seen with no treatment (check), followed by the low rate of Banrot (71.1 percent), benomyl (73.6 percent), and captan (75.0 percent). Significant differences ($P < 0.05$) were found between high rates of Banrot and no treatment and between high and low rates of Banrot. Significance was determined by the Newman-Keuls test of multiple means.

1981 trials. Only small differences in percentage of survival were found when Banrot was ap-

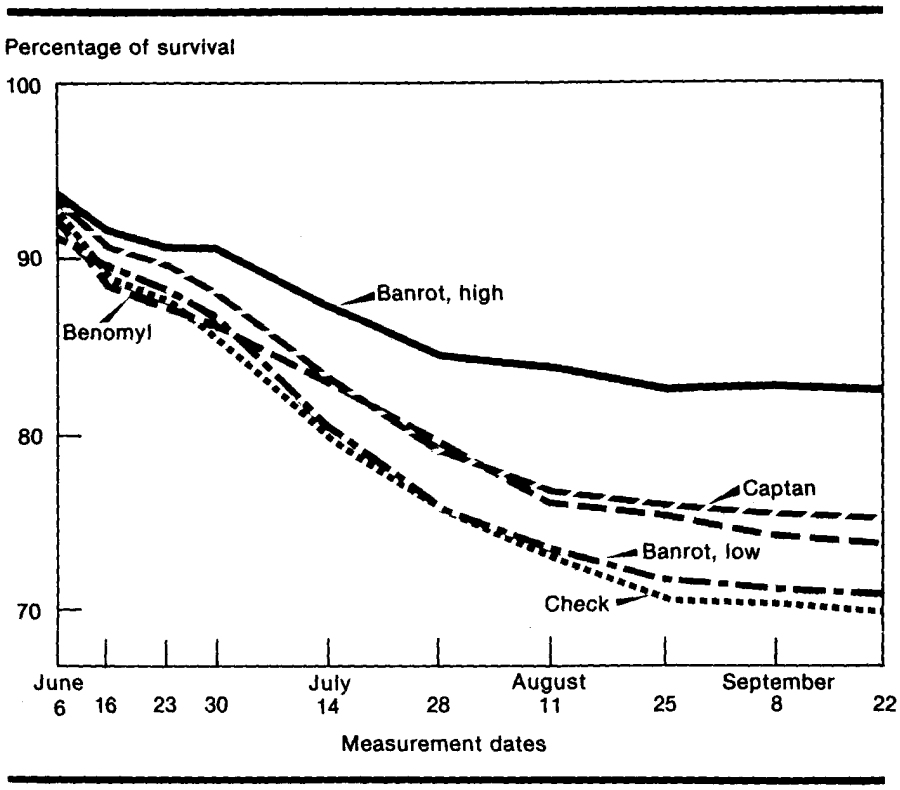

Figure 1.—*Percentage of survival of sugar pine seedlings after treatment with fungicides—1980.*

plied to seedlot 1 at 41 and 61 pounds per acre at sowing, 20 days after sowing, and 40 days after sowing (fig. 2). Although average survival was greatest with applications of 61 pounds per acre 20 days after sowing and 40 days after sowing, enough variation existed between replications in all treatments to make any differences statistically insignificant. Average survival over all treatments using 41 pounds per acre was 61.0 percent, over all treatments using 61 pounds per acre was 70.3 percent, and with no treatment was 63.1 percent.

Similarly, no significant differences in percentage of survival were found between one, two, and three applications applied at 41 pounds per acre to seedlot 2 (fig. 3). Survival was highest, 79.5 percent, in plots treated twice, at sowing and 20 days after sowing. Survival for all other treatments, including the check, was virtually identical, ranging from 68.0 to 70.2 percent.

Benomyl and captan are commonly used in forest nurseries as soil treatments for control of such soil-borne fungi as *Fusariurn* spp., *Pythium* spp., and *Rhizoctonia* spp. Reports of control success are varied (*1, 2, 3, 4, 5, 7*). Banrot has not been used widely in Pacific Northwest conifer nurseries, and reports of its performance have been sparse. Good fungicidal control of fusarium root rot in conifer nurseries has been achieved either with high rates of captan (52 to 65 lb. a.i/acre) applied two times after sowing (*1*) or when a systemic such as benomyl or thiophanate methyl (systemic ingredient in Banrot) is combined with a nonsystemic such as chloroneb or ethazole (e.g., Banrot, Benlate and Tersan, Benlate and Truban) and applied at sowing (*6*).

No adequate explanation can be found for differences in performance of Banrot in 1980 and 1981. Factors such as soil properties, inoculum load, rate of seedling development, or temperature may have adversely influenced the activity, persistence, and fungicidal properties of Banrot in 1981.

These data suggest that the fungicide treatments had little or no effect on growth of surviving seedlings at the end of the first growing season.

Conclusions

Consistent control of fusarium root rot in sugar pine seedlings

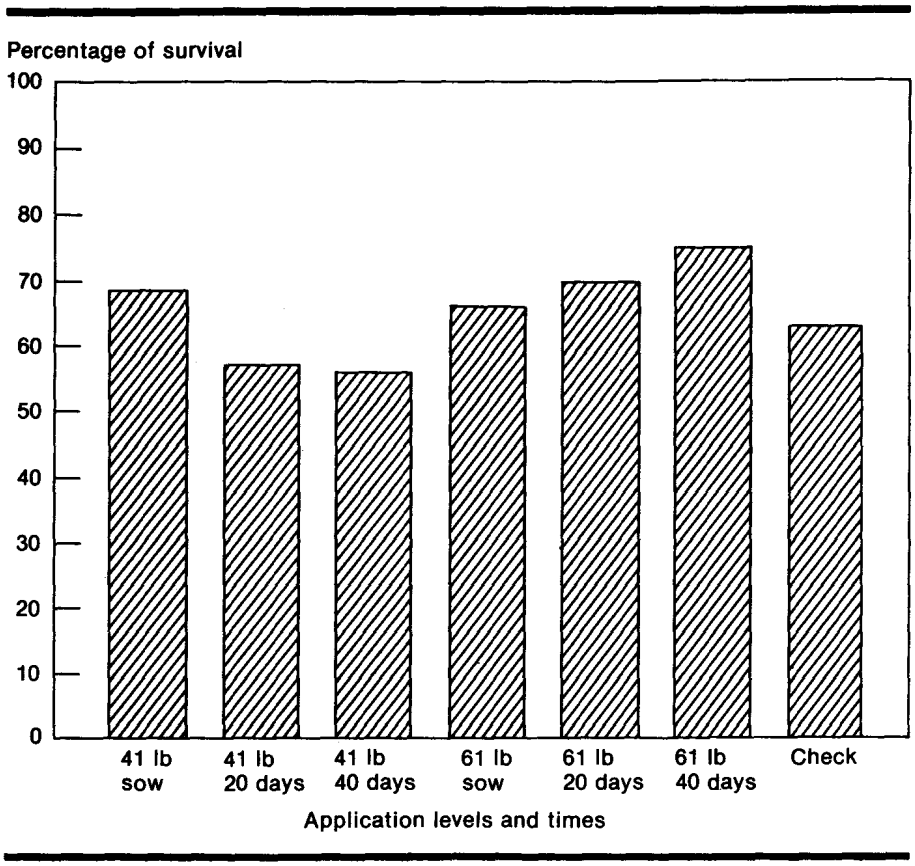

Figure 2.—*Percentage of survival for seedlot 1. Single application of Banrot at different times at 41 pounds per acre or 61 pounds per acre—1981.*

was not achieved with the fungicide Banrot during 1980 and 1981. The highest rate tested, 61 pounds per acre, applied 14 days after seedling emergence in 1980, resulted in superior survival. Improved seedling survival was not realized with earlier or multiple Banrot applications in 1981. The fungicides benomyl and captan gave poor disease control when applied at rates commonly used in Pacific Northwest nurseries. Until biological effectiveness is clearly established and cost-effectiveness is determined, operational use of these fungicides at the tested rates is not recommended for control of fusarium root rot in Pacific Northwest forest nurseries.

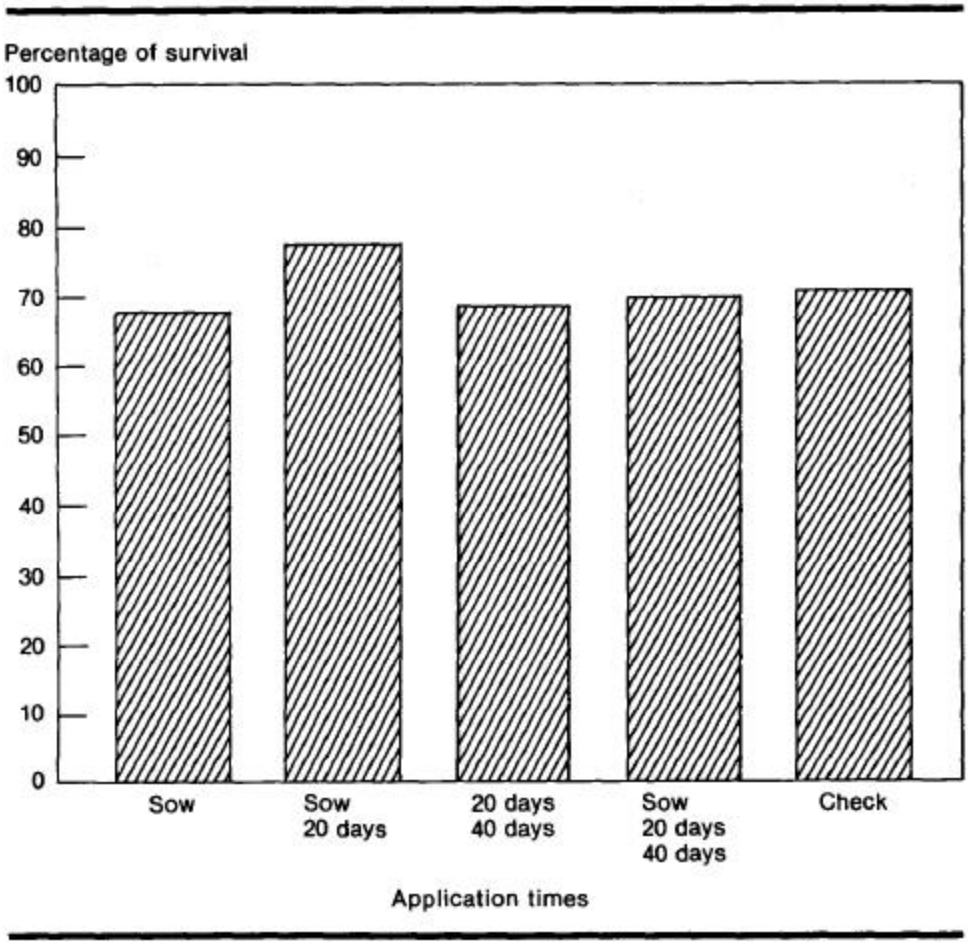

Figure 3.—*Percentage of survival for seedlot 2. Single and multiple applications of Banrot at 41 pounds per acre—1982.*

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