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MYCORRHIZAL DEVELOPMENT ON RED PINE IN NURSERY BEDS TREATED WITH AN HERBICIDE[1/]

by

J. G. Palmer, Sr., J. E. Kuntz, J. G. Palmer, Jr., and R. F. Camp[2/]

A single application of the pre-emergent herbicide DCPA (Dacthal W-75) effectively controlled common nursery weeds with no reduction in growth or in formation of ectomycorrhizae of three red pine seedling classes and one transplant class.

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[2/]Research Project Leader, Center for Forest Mycology Research, Forest Products Laboratory; Professor and former Graduate Research Assistant, Department of Plant Pathology; and Manager, F. G. Wilson State Forest Nursery, Boscobel, Wisconsin, respectively.

SCHOOL OF NATURAL RESOURCES • COLLEGE OF AGRICULTURAL AND LIFE SCIENCES
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Seedlings of red pine (Pinus resinosa Ait.) are produced at the F. G. Wilson State Forest Nursery at Boscobel in southwestern Wisconsin for afforestation and reforestation. A major problem in their production is weed competition, especially in seeded beds and transplant beds, throughout the growing season. Hand or mechanical weeding is slow, often unsatisfactory, and increasingly expensive. Consequently the use of herbicides is cost-effective (South and Gjerstad, 1980). During the past decade the pre-emergent herbicide, DCPA (dimethyl 2,3,5,6-tetrachloroterephthalate in the commercial Dacthal formulation) was found to provide satisfactory control of annual grasses and common broadleaf weeds (Kuntz, 1963). Moreover, there was no injury to red pine when DCPA was applied in the spring before germination in seeded beds and before candling of seedlings and transplants. Although populations of certain soil microorganisms were reduced after application of DCPA to outwash sand soil, normality was restored within one year (Bone and Kuntz, 1968). Biological degradation of this herbicide has been found to be rapid in similar soils from other areas (Iyer, Chesters, and Wilde, 1969). Consequently, harmful accumulations in repeatedly treated soils are improbable. Though data are unavailable for red pine, little DCPA was reported to be absorbed by other pine species (Iyer, Chesters, and Wilde, 1969). Consequently DCPA appears satisfactory from most aspects for weed control in nursery beds.

Ectomycorrhizae on root systems of pines and other plants improve survival and growth of outplanted seedlings, especially on sites deficient in minerals and moisture. White pine and Monterey pine seedlings have been reported to possess active mycorrhizae after DCPA treatment in pot cultures, but mycorrhization was not quantified (Iyer, Chesters, and Wilde, 1969). However no data are available regarding the number of ectomycorrhizae that occur on red pine seedling classes in untreated soil or in soil following treatment with DCPA in the Wilson nursery. For comparison with other nurseries in the Great Lakes region, counts are available for seedlings from untreated soils in northern Minnesota and Michigan (Anderson, Krupa, Laidly, and Stewart, 1976) and in southern Michigan (Anderson and Mosher, 1976). Therefore, we determined the number of short roots that were either ectomycorrhizal or were not ectomycorrhizal on three classes of red pine seedlings and one class of transplants in untreated plots and plots treated with DCPA.

Materials and Methods

Beds were fumigated in late summer before fall seeding. Three-year-old seedlings were transplanted into four rows of 74 trees each at spacings of 25 cm (9.8 inches) in the row and 100 cm (39.4 inches) between rows in May, 1977. A 16 cm (6.3 inches) unplanted buffer strip separated each of 18 plots. Plots were sprayed with five dosages of DCPA (Dacthal W-75) suspended in water or with water only (control) to provide three replicates in each of the six treatments (see Table 1). In April, 1979, different beds containing either ungerminated seeds, 1-0 seedlings, or 2–0 seedlings, which had not yet candled (then to be classed as 2-0 and 3-0 respectively) were treated similarly to provide seven treatments plus controls (see Table 2) of three replications each.

In all cases replicates within treatments were dispersed randomly in a complete block design.

In late October, random samples of at least 15 plants were removed from each replicate, placed in plastic bags, returned to the laboratory, and stored at 36°F and 82% relative humidity until examined. For examination of each replicate, the ten seedlings with largest shoot growth were selected, and lateral roots were selected by random numbers to provide a minimum of 6 cm (2.4 inches) per seedling. Viable ectomycorrhizal points (some ectomycorrhizae and short roots were branched) were counted by means of a dissecting microscope, and both total mycorrhizal and non-mycorrhizal root points were recorded. The average number of short root points that were counted for each treatment decreased with increasing age class in seedlings (1-0 = 3,500 root points; 2-0 = 3,000; 3-0 = 2,300). An increasing number of roots lacked viable short roots as seedling age increased. The intertwining of such root systems made separation more difficult. The number of countable points from transplants was similar to that for the 2-0 seedlings. A stained root section from each seedling was examined by light microscopy for characteristic morphology (presence or absence of a Hartig Net). Top growth was measured by determining dry weights of shoots severed at the ground line from the root systems that were examined.

Results and Discussion

Germination of red pine seeds was neither increased nor reduced by DCPA at any dosage. Shoot growth of trees from treated plots did not differ from that of untreated trees, and there was no malformation or discoloration.

Control of broadleaf weeds was excellent throughout the growing season in all four classes of seedlings at dosages of 10 lbs/acre or higher of DCPA. Weed control was especially important in the seeded beds and in the 3-1 transplant beds where spacing between plants allowed numerous weeds with vigorous growth. Since untreated experimental plots were hand-weeded, seedling growth measurements were similar, and possible growth reduction from weed competition was precluded.

In untreated plots of newly seeded beds, only 1% of short root points became ectomycorrhizal (see 1-0 class in Table 2). This should not be considered unusual in this region. Seeds do not germinate until June, and germlings have few feeder roots until late July or August. In addition, the fungus inoculum, most of which must come from mushrooms associated with ectomycorrhizae in the immediate area, is not abundant in July and August. Consequently most of the ectomycorrhizae probably formed in late September and during October. Similar data were recorded from nurseries in northern Michigan and Minnesota (Anderson, Krupa, Laidly, and Stewart, 1976). Their data are comparable presuming their seeded beds had been fumigated. The 25% ectomycorrhizae reported from southern Michigan probably reflect variations in site and climate and moderations in soil temperature. However, in unfumigated or possible even poorly fumigated beds, residual fungus inoculum in the soil might effect these percents.

Seedlings in the 2-0 class had 32% of the root points ectomycorrhizal in October while those in the 3-0 class had only 19% (see Table 2). Actively growing short roots in these age classes had much more time

to come into contact with inoculum from mushrooms and ectomycorrhizae on other plants. The degree of reduction in the 3-0 seedlings was unexpected. However, following the spring growth flush, the large number of vigorous seedlings in each bed undoubtedly caused shading. With increasing shading and competition for nutrients, the sugar produced by photosyntheses would be reduced. Since an excess of sugar over the plant requirements is considered a prerequisite for formation of ectomycorrhizae, mycorrhization would be limited. Though the data are not directly comparable because they were not recorded in the same year, the presence of 62% of ectomycorrhizal points on 3-1 transplants (see Table 1) supports this idea. These plants, already ectomycorrhizal, had been removed from 3-0 beds before candling in the spring and planted with considerable space between them to allow maximum photosynthesis during the summer.

In no treatment were ectomycorrhizal points markedly reduced following treatment with DCPA except at higher dosages in the 3-0 class (see Tables 1 and 2). In both the 2-0 and 3-1 classes, percents of ectomycorrhizae were higher in all treatments.

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Table 1. Ectomycorrhizal short-root points on red pine transplants from nursery beds treated with DCPA (Dacthal W-75) in 1977.

Transplant Class	DCPA Dosage 0	10	15	20	25	30
	(pct.)[1]					
3-1	62	72	79	73	79	74

[1]Percent short-root points ectomycorrhizal of total short-root points.

Table 2. Ectomycorrhizal short-root points on three red pine seedling classes from nursery beds treated with DCPA (Dacthal W-75) in 1979.

Seedling Class	DCPA Dosage 0	5	10	15	20	25	30	35
	(pct.)[1]							
1-0	1	<1	1	3	2	2	2	2
2-0	32	48	47	48	37	41	34	42
3-0	19	10	16	16	10	11	10	10

[1]Percent short-root points ectomycorrhizal of total short-root points.