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Effect of the Antidesiccant Moisturin® on Conifer Seedling Field Performance

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Two concentrations of the antidesiccant Moisturin® were applied to Douglas-fir (Pseudotsuga menziesii *(Mirb.) Franco) and ponderosa pine* (Pinus pondersosa *Dougl. ex Laws.) seedlings after lifting by either dipping or spraying. Seedlings were outplanted to 5 typically dry sites in Oregon and to a garden plot at Oregon State University. Seedling performance was assessed at the end of the first growing season. Despite trends in plant moisture stress measurements that suggest reduced transpirational loss, there were no significant treatment effects on height growth, survival, or stem diameter growth at any of the study sites nor in the garden plot. These results are consistent with most found in the literature in which conifer seedling field performance was not significantly or consistently improved by application of an antidesiccant* product.Tree Planters' Notes 46(3):97-101; 1995.

Considerable research as well as practical knowledge indicate that a seedling's ability to use water efficiently is crucial to outplanting survival (Rietveld 1989, Burdett 1990). After being transplanted to the field, a seedling must recover from any damage, reestablish root-to-soil contact, and resume water and nutrient uptake in a new environment. During this adjustment period, the seedling continues to transpire, resulting in a stressed condition of physiological drought. It would be useful if a seedling could be protected from water loss during its establishment phase in the field.

Englert and others (1993) found that deciduous seedlings treated with the latex emulsion Moisturin® had significantly less water loss than non-treated controls. The success of Moisturin in trials with hardwood seedlings warranted further research with this compound to assess its utility in forest nurseries and forest outplantings. Moisturin, developed by Burke's Protective Coatings (Washougal, WA), is non-toxic to plant stems, roots, or foliage when applied at the recommended concentration. The white emulsion is visible when applied but dries to a transparent, flexible coating. Theoretically, the coating allows for the transmission of vital gases such as oxygen and carbon dioxide while reducing water loss and retains its effectiveness for several months on dormant plants, or until plants "outgrow" the covering (Badertscher 1991).

This study examined seedling field response to Moisturin applied at differing rates and times. The following null hypotheses were tested: (1) application of Moisturin does not increase seedling field survival and growth, (2) there are no differences in seedling survival and growth between 1:3 and 1:7 concentrated applications of Moisturin, (3) there are no differences in seedling survival and growth when Moisturin is applied before or after lifting, and (4) there are no differences in seedling survival and growth when Moisturin is applied to seedling shoots only or to the entire seedling.

Materials and Methods

Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco.) and ponderosa pine *(Pinus ponderosa* Dougl.) seedlings of varying stocktypes were operationally grown at four different nurseries (table 1). The following 7 treatments were applied at each of the nurseries:

1. Control
2. Spray shoots at 1:7 (Moisturin to water, vol:vol) concentration before lifting, in nursery bed
3. Spray shoots at 1:3 concentration before lifting, in nursery bed
4. Dip shoots in 1:7 concentration after lifting and grading, before storage
5. Dip shoots in 1:3 concentration after lifting and grading, before storage
6. Dip shoots and roots in 1:7 concentration after lifting and grading, before storage
7. Dip shoots and roots in 1:3 concentration after lifting and grading, before storage

All seedlings were lifted and treated in January 1992, with the exception of the ponderosa pine seedlings from Bend Pine Nursery, which were lifted in early March. Moisturin was applied to seedlings in the nursery bed

Table 1-Nurseries, species, stocktypes, and outplanting sites of seedlings in the study

Nursery	Species and stocktype	Outplanting site
Oregon State Department of Forestry, D.L. Phipps Nursery, Elkton, OR	2+0 Douglas-fir	USDI Bureau of Land Management, Roseburg District
International Paper Company, Kellogg Nursery, Oakland, OR	plug+1 Douglas-fir	USDI Bureau of Land Management, Medford District
USDA Forest Service, Deschutes National Forest Bend Pine Nursery, Bend, OR	1+0 ponderosa pine	USDA Forest Service, Mt. Hood National Forest
USDA Forest Service, Rogue River National Forest, J. H. Stone Nursery, Central Point, OR	2+0 ponderosa pine	USDA Forest Service, Fremont National Forest
J. H. Stone Nursery	2+0 Douglas-fir	USDA Forest Service, Umpqua National Forest

(treatments 2 and 3) with a hand-held compression sprayer. The compound was applied 1 day before lifting to allow adequate drying time. Efforts were made to apply the compound while temperatures were greater than 4.5 ºC in order to ensure optimum coverage. For the other treatments (47), Moisturin was applied by dipping seedlings into one of the various concentrations of the compound. Dipping was done outdoors if the temperature was warm enough or in a large, well-ventilated room. After being dipped, seedlings were laid out to allow the coating to dry. To avoid excessive root exposure, seedlings were placed in cold storage within 1 hour, whether or not the compound had thoroughly dried. All seedlings were labeled and kept in cold storage until outplanting.

Seedlings were outplanted to 5 different sites in Oregon (table 1). Each site was selected because of its typically dry environment. Douglas-fir seedlings were planted February 1992, and ponderosa pine seedlings were planted early April 1992. The study design at each field site consisted of a randomized complete block design with 4 blocks, 7 treatments /block, and 10 seedlings/treatment/block.

Initial height, stem diameter, and survival were measured 2 weeks after planting. Total height, stem diameter, survival, and a damage/vigor assessment were recorded at the end of the first growing season.

In addition to the field sites, a garden plot consisting of seedlings from each nursery (with the exception of the Douglas-fir seedlings from the J.H. Stone Nursery) was established at Oregon State University (OSU). The study design for the garden plot consisted of a randomized factorial block design with 4 blocks, both species in each block, 7 treatments/species, and 6 seedlings/species (3 from each nursery)/treatment/block. In addition to taking the same measurements as those taken at the field sites, days to budbreak were monitored.

A small sample of 15 Douglas-fir seedlings (2+0 stock from the D.L. Phipps Nursery) were potted and placed in an OSU greenhouse. Five seedlings were dipped in a 1:3 concentation of Moisturin, 5 were dipped in a 1:7 concentration, and 5 were dipped in water (control). Needles from these potted seedlings were photographed after treatment using scanning electron microscopy (SEM). After approximately 2 months without water, these seedlings were measured with a pressure chamber to determine plant moisture stress (PMS).

Data were analyzed with analysis of variance (ANOVA) procedures to determine if there were differences among treatments. SAS software was used for all analyses (SAS 1989).

Results and Discussion

Application of Moisturin was a fairly simple process requiring very little concentrated product to treat seedlings for the entire project. Air temperatures were above 4.5ºC when Moisturin was applied to the seedlings, as recommended by the manufacturer. However, in a few instances, after applying the spray treatments, overnight temperatures dropped below freezing. When lifting these seedlings the following morning, it was observed that the treated seedlings tended to have more frost on them than the surrounding trees. Also, frozen blue-tinted droplets of Moisturin were visible on the seedlings.

The highly magnified SEM images clearly show the Moisturin coating on the needles (figure 1).

Although the results were not statistically significant (P = .28), the seedlings that were potted and then not watered for 2 months showed encouraging results. The untreated, control seedlings had the lowest mean readings (- 1.95 MPa), that is, the greatest plant moisture stress. Seedlings treated with Moisturin applied by spraying had the next lowest mean readings, with the 1:7 concentration having slightly lower readings (- 1.60 MPa) than the 1:3 concentration (- 1.53 MPa). Seedlings treated with Moisturin applied by dipping had the highest readings (that is, least plant moisture stress), with the 1:7 concentration again exhibiting slightly lower readings (1.56 MPa) than the 1:3 concentration (- 1.43 MPa). These trends suggest that seedlings dipped in a high concentration of Moisturin may have reduced transpirational loss.

Despite trends of reduced transpiration in the potted seedlings, there were no significant treatment effects on height, survival, or stem diameter at any of the study sites (table 2) nor in the garden plot (data not shown). In addition, there were no effects of treatment on budbreak in the garden plot trees. These results lead to an inability to reject the null hypotheses.

Most of the literature addressing research of this nature have found results consistent with the current study. Research with various antidesiccant products show that treatments did not significantly or consistently improve survival or growth of conifer seedlings (Jack 1955, Fowells and Schubert 1955, Roy 1966, Magnussen 1986, Odlum and Columbo 1987, PoljakoffMayber and others 1967, Vera-Castillo 1995, Williams and others 1990).

Interestingly, research has shown that some antidesiccant applications seem to be most effective in reducing water loss under moist soil conditions. However, when soils are dry (that is, when plants actually need protection against water loss) the treatments are no longer effective. In a series of growth chamber, greenhouse, and field experiments with *Pinus halepensis* Mill. seedlings, Poljakoff-Mayber and others (1967) found that antitranspirant treatements were "of little value ...if the soil around the roots of the plants was allowed to dry." In fact, they concluded that plastic mulching was the only treatment that effectively protected seedlings from moisture loss and increased field survival. Magnussen (1986) found that root-coated white spruce *(Picea glauca* (Moench) Voss) seedlings had improved

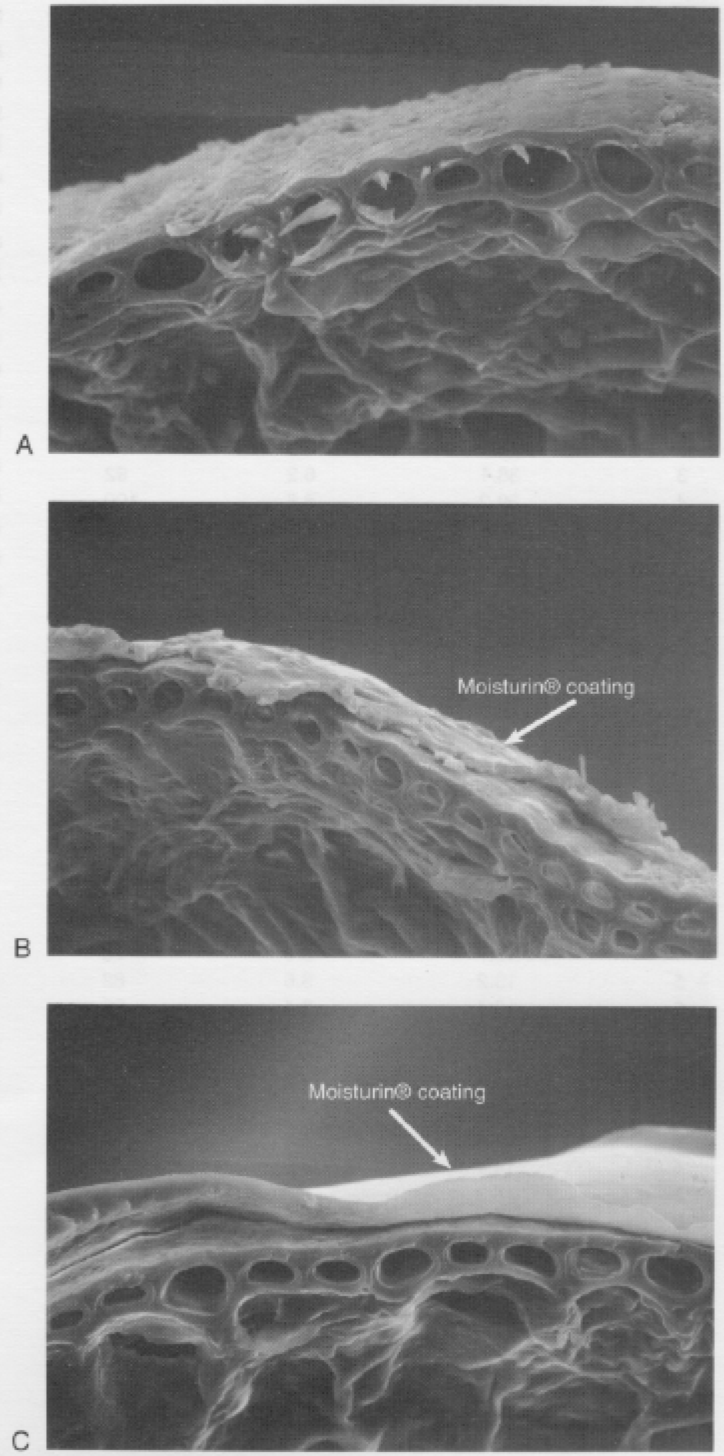

Figure 1—*Cross-section of Douglas-fir needles (600x magnification) showing untreated (a), dipped in 1:7 concentration of Moisturin (b), and dipped in 1:3 concentration of Moisturin (c).*

Table 2- *Mean height, stem diameter, and survival after one growing season.*

Site & treatment	Height (cm)	Stem diameter (mm)	Survival (%)
Douglas-fir			
BLM-Medford			
1	47.7	8.0	100
2	48.7	8.1	100
3	52.2	8.2	97
4	48.0	7.8	100
5	49.0	8.1	100
6	48.4	8.0	100
7	52.4	8.1	97
BLM-Roseburg			
1	36.1	7.5	100
2	35.7	6.5	89
3	38.1	6.2	92
4	39.2	6.6	100
5	41.1	7.0	90
6	37.4	6.7	92
7	39.5	7.1	100
Umpqua National Forest			
1	42.3	6.9	95
2	45.2	7.2	100
3	44.6	6.7	100
4	44.4	7.0	100
5	43.6	6.5	100
6	38.6	6.0	95
7	44.2	7.1	97
Ponderosa pine			
Mt. Hood National Forest			
1	13.6	3.7	74
2	13.3	3.8	90
3	12.2	3.3	77
4	13.7	3.6	75
5	13.2	3.6	82
6	13.4	3.4	85
7	12.2	3.5	74
Fremont National Forest			
1	12.9	4.6	23
2	16.1	5.1	20
3	16.5	5.1	18
4	14.4	4.5	18
5	16.3	5.2	8
6	14.1	4.3	43
7	n/a	n/a	0

survival when exposed to no more than 2 weeks of post-planting drought. However, the root coating had no effect when soils were shielded from natural precipitation for more than 2 weeks.

In fact, many studies have shown that application of an antidesiccant can have negative effects. In an early study on the use of foliar sprays to increase drought resistance of conifer seedlings, favorable reductions in transpiration were offset by unfavorable effects such as increased mortality (Shirley and Meuli 1938). Simpson (1984) noted that antitranspirant treatments that effectively reduce moisture stress also tended to have the most negative effects on root growth and field performance of conifer seedlings. Odlum and Colombo (1987) found that antitranspirants greatly decreased survival of black spruce *(Picea mariana* (Mill) B.S.P) seedlings despite reduced plant moisture stress. Vera-Castillo (1995) found that application of Moisturin after lifting delayed budbreak in ponderosa pine seedlings by 15% in comparison with the untreated control. In addition, antitranspirants can elevate leaf temperatures due to decreases in transpiration (Gale and Hagan 1966) and can decrease the rate of photosynthesis (Olofinboba and others 1974). Furthermore, antidesiccant applications to conifer seedlings can even result in higher stomatal conductances than untreated control seedlings (Vera-Castillo 1995). In a study of six antitranspirants on black spruce container seedlings, Colombo and Odlum (1987) found mixed results. Although some treatments showed promise for reductions in water loss, the effects were also either phytotoxic or short-term.

Conclusions

Moisturin did not show promise for improved conifer seedling field performance. Furthermore, the literature demonstrates that there does not appear to be any product to date that effectively improves growth and survival of outplanted forest tree seedlings on a consistent basis.

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