The Effect of Three Film-Forming Antitranspirants on Moisture Stress of Outplanted Black Spruce Seedlings

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The antitranspirants Cloud Cover, Wilt-pruf NCF, and X2-1337 were applied to black spruce (Picea mariana (Mill.) B.S. P.) container seedlings at the time of planting. Wilt-pruf and X2-1337 reduced plant moisture stress (PMS) for up to 14 days but greatly decreased seedling survival. Cloud Cover had no effect on either PMS or seedling mortality. None are recommended for use on outplanted black spruce seedlings. Tree Planters' Notes 38(4):23-26; 1987.

Drought can be a major cause of tree seedling mortality during plantation establishment. One possible method to reduce mortality would be to reduce transpirational water loss by applying film-forming antitranspirants to seedlings at planting. Various degrees of success have been obtained by using antitranspirants on conifers (3, 5, 7), and screening tests of several antitranspirants have identified some that warrant further study with conifer stock (4, 8, 9).

We describe the effects of three film-forming antitranspirants-Cloud Cover® (Adkar, Inc., McAllen, TX), Wilt-pruf NCF® (Nursery Specialty Products, Greenwich, CT), and X2-1337 (Dow-Corning Canada, Mississauga, ON)-on midday plant moisture stress (PMS) and survival after planting of black spruce (*Picea mariana* (Mill.) B.S.P.) container seedlings. In this paper, plant moisture stress is numerically equal but of opposite algebraic sign to seedling water potential.

Materials and Methods

Black spruce seed from Cochrane Forest District (lat. 50°00' N. long. 83°00' W.) were sown in a peat moss and vermiculite mixture (2:1, vol/vol) in FH408 Japanese paperpots and grown in a greenhouse at Maple, ON (lat. 45° 28 ' N., long. 73° 44' W.) from February to July 1985, under conditions similar to those described by Carlson (1).

Seedlings were planted at the Midhurst Station of the Ontario Tree Improvement and Forest Biomass Institute (OTIFBI) on July 15, 1985, in cultivated, sandy loam soil in a randomized block design of 4 treatments in 4 blocks. Within each block, each treatment consisted of one row of 60 planted seedlings, 35 of which were destructively sampled periodically for plant moisture stress (PMS) measurements and 25 were left to be assessed for survival at the end of the first growing season.

Immediately after planting, all antitranspirants were sprayed onto the seedlings until the spray dripped from the foliage. Wilt-pruf and Cloud Cover were applied at concentrations of 10 and 5% in water, respectively, as recommended by their manufacturers, and X2-1337 was applied at 7.5%, a rate found to be effective in laboratory testing (4). Control seedlings were sprayed with water.

The PMS of 10 control seedlings was determined immediately after planting with a PMS Instrument Co. (Corvallis, OR) Model 1000 pressure chamber. Thereafter, PMS was determined for 4 seedlings randomly selected from each treatment within a block (16 seedlings per treatment) 1, 3, 7, 10, 14, 21, and 28 days after treatment. Dead seedlings were not sampled for PMS measurements. PMS values were determined between 1 p.m. and 3:30 p.m., when moisture stress is expected to be at its highest daily level (10) and variations attributed to sample locations are expected to be lowest (6).

Differences between treatment PMS values at each sample date were identified by one-way analysis of variance (12) and Fisher's LSD test (2), both at the 5% significance level. Survival was analyzed on pooled block survival counts with the Chi-square test (12) at the 5% significance level. During the experiment, daily

minimum and maximum temperatures and precipitation were recorded at a weather station 1 km from the plantation.

Results and Discussion

The most effective antitranspirant was X2-1337, followed by Wilt-pruf, and Cloud Cover. The efficacy of the antitranspirants tested, however, was inversely related to seedling survival.

PMS was reduced significantly by X2-1337 for up to 14 days after planting (fig. 1). Wilt-pruf generally caused a reduction in PMS for the same period, but to a lesser degree than X2-1337. Cloud Cover did not reduce PMS. There were no significant differences in PMS values between treatments by day 21.

Although daily maximum temperatures averaged 26.2 °C and rainfall was minimal (29.3 mm) for the duration of the monitoring period (fig. 2), the most dramatic reduction in PMS occurred on the first day after treatment, before the first rainfall. In this period, the PMS of seedlings treated with X2-1337 and with Wilt-pruf declined from 0.92 MPa (1 megapascal = 10 bars) to 0.32 MPa and 0.67 MPa, respectively, while the PMS of both the control seedlings and those treated with Cloud Cover increased to 1.23 MPa.

This difference probably resulted from a reduced diurnal in

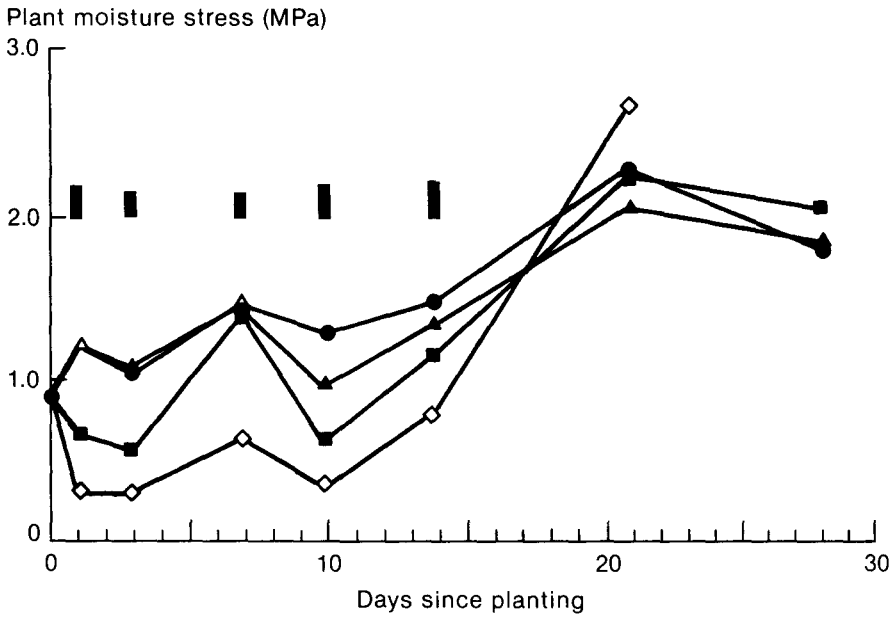

Figure 1—*Plant moisture stress in outplanted black spruce seedlings treated with antitranspirants at time of planting. High mortality in X2-1337-treated seedlings prevented PMS measurements for that treatment on day 28. Vertical bars indicate LSD at the 5% level when analysis of variance indicated a difference between treatment (P < 0.05).*

crease of PMS from low predawn levels in seedlings treated with Wilt-pruf or X2-1337 relative to the increase exhibited by the control and Cloud Cover-treated seedlings.

Some of the seedlings treated with X2-1337 died by day 21 and 81 % were dead by day 28. When the experiment was ended at day 76, 87% of the control seedlings had survived whereas 82%, 50%, and 3% of seedlings treated with Cloud Cover, Wilt-pruf, and X2-1337, respectively, had survived. The survival rates for Wilt-pruf and X2-1337 were significantly less than those for the control or Cloud Cover ($P < .05$). These results are consistent with those of Davies and Kozlowski (5), who found red pine (*Pines resinosa* Ait.) seedlings treated with silicone antitranspirants suffered long-term and potentially lethal reductions in transpiration and photosynthesis.

Similarly, Simpson (9) found that the more effective antitranspirants caused the greatest reductions in survival and shoot growth of four conifer species in the field, apparently because of the long-term antitranspirant

effects. In addition, the elevated leaf temperatures of plants treated with effective antitranspirants (11) could result in heat stress-and thus ultimately seedling mortality-especially of the immature tissue of the actively growing seedlings used in this trial.

In conclusion, the effectiveness of the antitranspirants was inversely related to seedling survival. Although treatment with Wilt-pruf and X2-1337 resulted in significant reductions in PMS in the critical period following planting, seedling mortality was dramatically increased. Cloud Cover did not affect seedling PMS and caused no significant reduction in seedling survival. Because black spruce seedlings were either unaffected or affected negatively by the antitranspirants Cloud Cover, Wilt-pruf, and X2-1337, we cannot recommend them for outplanting black spruce seedlings.

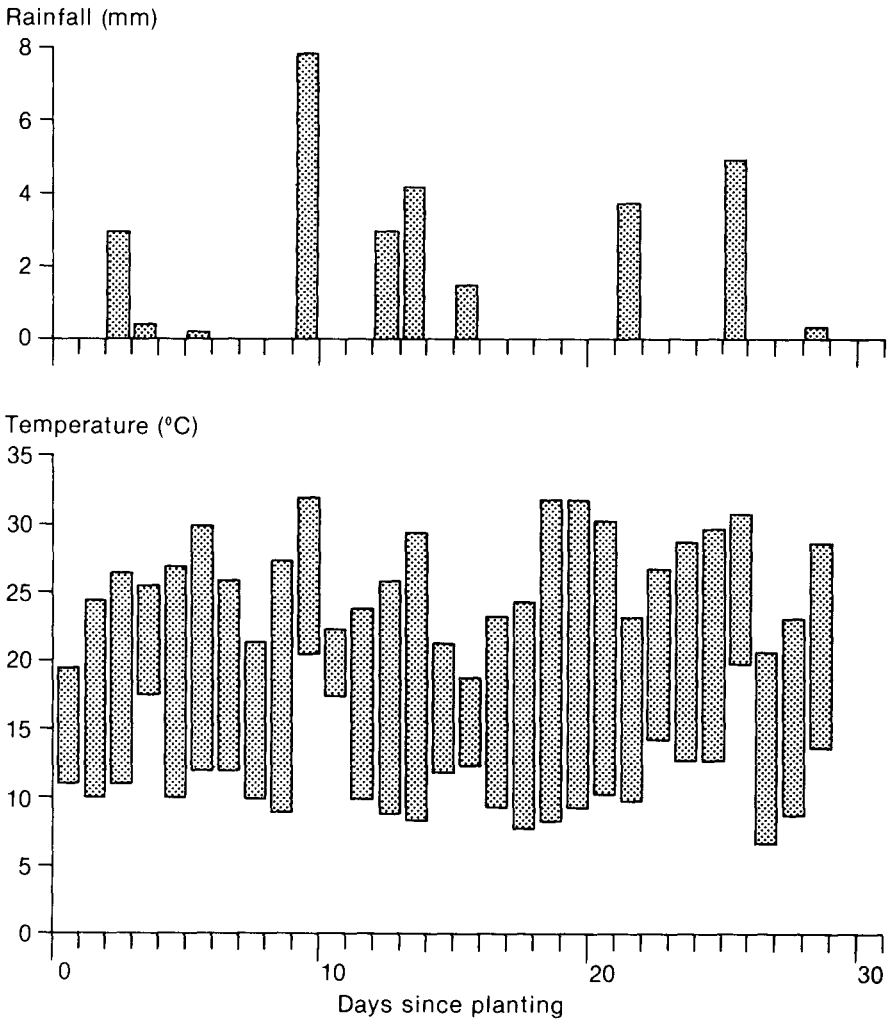

Figure 2—*Daily rainfall and temperature range during PMS monitoring period.*

Literature Cited

1. Carlson, L.W. Guidelines for rearing containerized conifer seedlings in the Prairie Provinces. Inf. Rep. NOR-X-214E. Edmonton, AB: Environment Canada, Canadian Forestry Service, Northern Forestry Research Centre; 1983. 64 p.
2. Chew, V. Comparisons among treatment means in an analysis of variance. ARS/H6. Beltsville, MD: U.S. Department of Agriculture, Agricultural Research Service; 1978. 64p.
3. Colombo, S.J.; Odlum, K.D. Efficacy of six antitranspirants on black spruce container seedlings. New Forests 3: (in press); 1987.
4. Davies, W.J.; Kozlowski, T. Shortand long-term effects of antitranspirants on water relations and photosynthesis of woody plants. Journal of the American Society of Horticultural Science 99:297-304; 1974.
5. Davies, W.J.; Kozlowski, T. Effect of applied abscisic acid and silicone on water relations and photosynthesis of woody plants. Canadian Journal of Forest Research 5:90-96; 1975.
6. Lindquist, J.L. Plant moisture stress patterns in planted Douglas-fir: a preliminary study of the effects of

crown and aspect. Res. Note PSW-325. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1977.5 p.

7. Marshall, H.; Maki, T.E. Transpiration of pine seedlings as influenced by foliage coatings. Plant Physiology 21:95-101; 1946.
8. Odlum, K.D.; Colombo, S.J. Antitranspirants that reduce water loss from black spruce container seedlings. Nurs. Note 116. Toronto: Ontario Ministry of Natural Resources; 1986. 3 p.
9. Simpson, D.G. Film-forming antitranspirants: their effects on root growth capacity, storability, moisture stress avoidance, and field performance of containerized conifer seedlings. Forestry Chronicle 60:355-339; 1984.
10. Waring, R.H.; Cleary, B.D. Plant moisture stress: evaluation by pressure bomb. Science 155:1248-1254; 1967.
11. Williamson, R.E. The effect of a transpiration-suppressant on tobacco leaf temperature. Soil Science Society of America, Proceedings 27:106; 1963.
12. Zar, J.R. Biostatistical analysis. Englewood Cliffs, NJ: Prentice-Hall, Inc.; 1974. 620 p.