AUBURN UNIVERSITY
SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE

RESEARCH NOTE 95-3

ANTI-STRESS 2000™ Fails to Protect Pine Seedlings Against Frost

by

Janusz Zwolinski

INTRODUCTION:

There has been several significant incidents of frost damage to pine seedlings in the South recently, both in nurseries and shortly after planting in the field. Symptoms of frost injuries were associated with rapidly fluctuating temperatures at times when trees were actively growing. Anti-Stress 2000™ has been used to reduce frost stress in horticultural and agronomic crops in California. This chemical is a blend of high performance carbon chain polymers specially formulated for foliar application. Theoretically, the semi-permeable coating over the plant, ''mechanically'' protects against damaging effects of frost, drought, drying winds or transplant shock for up to 60 days after application. In this study, an attempt was made to determine if Anti-Stress 2000™ can protect pine seedlings against frost damage.

METHODOLOGY:

In early October 1994, 390 containerized loblolly pine seedlings were removed from the nursery. The seedlings were watered thoroughly a night before application of Anti-Stress 2000™. Thirty of these seedlings were left as an untreated control. The remaining 360 seedlings were randomly grouped by 40 into 3 treatments and 3 replications. Each group was treated either with Anti-Stress 2000™ dissolved in water at the volumetric rate (i) 1:40 or (ii) 1:20, or (iii) they were sprayed with clean water. The spray rate was 1500 l\ha. The plants were watered after the first application and treated again the same way one week later. Two days after the second application, the seedlings were placed in a freezer. The roots were protected with 3 cm thick layer of dry vermiculite. Temperature probes were placed in the root zone as well as in the shoot space. The gradual decrease in the temperature was interrupted by opening the freezer for removal of seedlings or by switching the freezer off to prevent frost temperatures to occur in the root zone. The temperature change is shown in Figure 1. After 280, 420, 940 or 1670 minutes of exposure, 10 seedlings per treatment and replication were removed from the freezer and potted in a greenhouse. The seedlings were left for 1 month for the damage symptoms to develop.

The above experiment was repeated with seedlings lifted from a nursery in February 1995. This time, however, 8 seedlings were studied for each exposure time, treatment and replication. The application rates were higher. During the first spray, the water (control) and 1:40 Anti-Stress 2000™ treatments were applied at 2400 l/ha rate, while 1:20 Anti-Stress 2000™

treatment was used at 3350 l/ha. During the second application, water and the 1:20 solution of the polymer were used at 3550 l/ha, and the 1:40 solution at the 4440 l/ha. The exposure time was either 0, 105, 188, 313 or 405 minutes, and the temperature changed as shown in figure 1. One month after removal from the freezer, the fresh mass of shoots and new shoot growth were determined for each seedling. The leader was defined as alive if the growing point was green and the shoot was classified as alive if any green tissue could be spotted.

The design of this factorial experiment was an RCB. The data were analyzed with the analysis of variance and means were separated with Tukey's HSD test. The percentage survival of leaders and shoots was analyzed after arcsin data transformation. The count data were also analyzed with chi-square test after combining observations for the seedlings exposed to frost.

RESULTS:

In October 1994, all seedlings exposed to frost treatment died irrespective of the treatment. The loss of turgor (wilting of shoots) was observed the next day after frost exposure, and the total discoloration of foliage and stems occurred within a few days later. Contrary to the frost-exposed seedlings, the seedlings not exposed to frost showed normal growth, no loss of turgor, and no pathological discoloration.

In February 1995, the seedlings showed much more resistance to frost (Table 1). The biomass of the seedlings treated with Anti-Stress 2000™ was lower than that of the untreated control. This resulted from more frost damage and less hydrated (green) tissue on the Anti-Stress 2000™ treated seedlings which were exposed to frost. The mass differences, however, were not significant for any of the frost exposure time.

There was no pathological discoloration or mortality of leaders and shoots among the seedlings not exposed to frost, irrespective of the Anti-Stress 2000™ treatment. However, the analysis of count data of the seedlings exposed to frost showed association between the treatment and mortality of leaders and shoots. Overall, the leaders of the untreated seedlings (control) survived better than those treated with Anti-Stress 2000™. Their survival was by 83% ($p<0.001$) and 22% ($p<0.05$) better than after spray with 1:20 and 1:40 water solution of Anti-Stress 2000™, respectively. The survival of the untreated shoot, however, was only better ($p<0.001$) compared to the survival of the seedlings treated with 1:20 Anti-Stress 2000™ solution.

MANAGEMENT IMPLICATIONS:

Anti-Stress 2000™ does not appear to be a reliable method of frost protection and we cannot at this point recommend its use.

Table 1. Green weight and survival of loblolly pine seedlings exposed to frost temperatures after treatment with water or water solution of Anti-Stress 2000™ (20:1 or 40:1) in February 1995 (no significant differences between the means within a column block were found with the analysis of variance).

Exposure time to frost (min)	Treatment	Mass (g)		Survival (%)	
		shoot	shoot growth	leaders	shoots
0	water	1.42	0.47	100	100
	20:1	1.48	0.43	100	100
	40:1	1.49	0.57	100	100
105	water	1.31	0.38	96	96
	20:1	1.05	0.28	67	79
	40:1	1.03	0.26	79	83
188	water	1.04	0.29	75	88
	20:1	0.83	0.17	42	58
	40:1	0.91	0.17	58	75
313	water	0.96	0.28	50	63
	20:1	0.72	0.20	13	17
	40:1	0.90	0.19	42	46
405	water	0.97	0.26	83	83
	20:1	0.83	0.25	46	58
	40:1	1.01	0.29	71	79

Figure 1. Air and root zone (soil) temperature to which seedlings were exposed in October 1994 (above) and February 1995 (below).

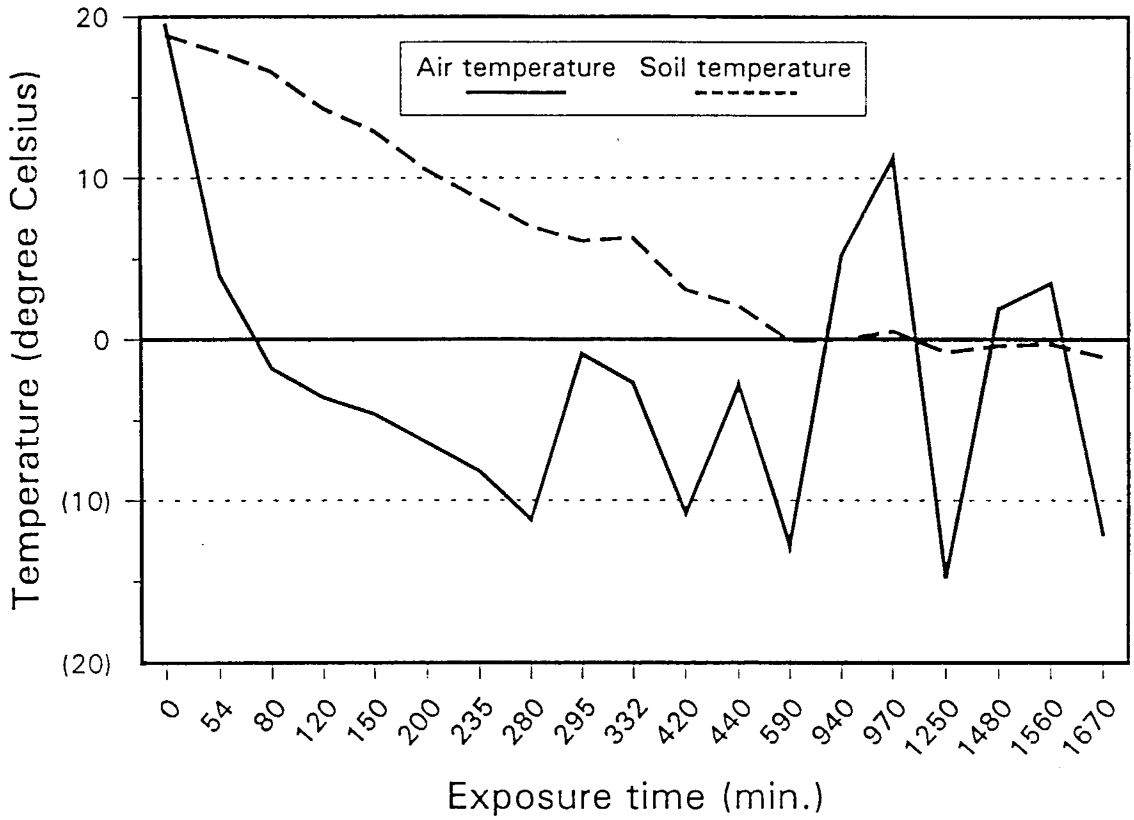

Fig1 (left)

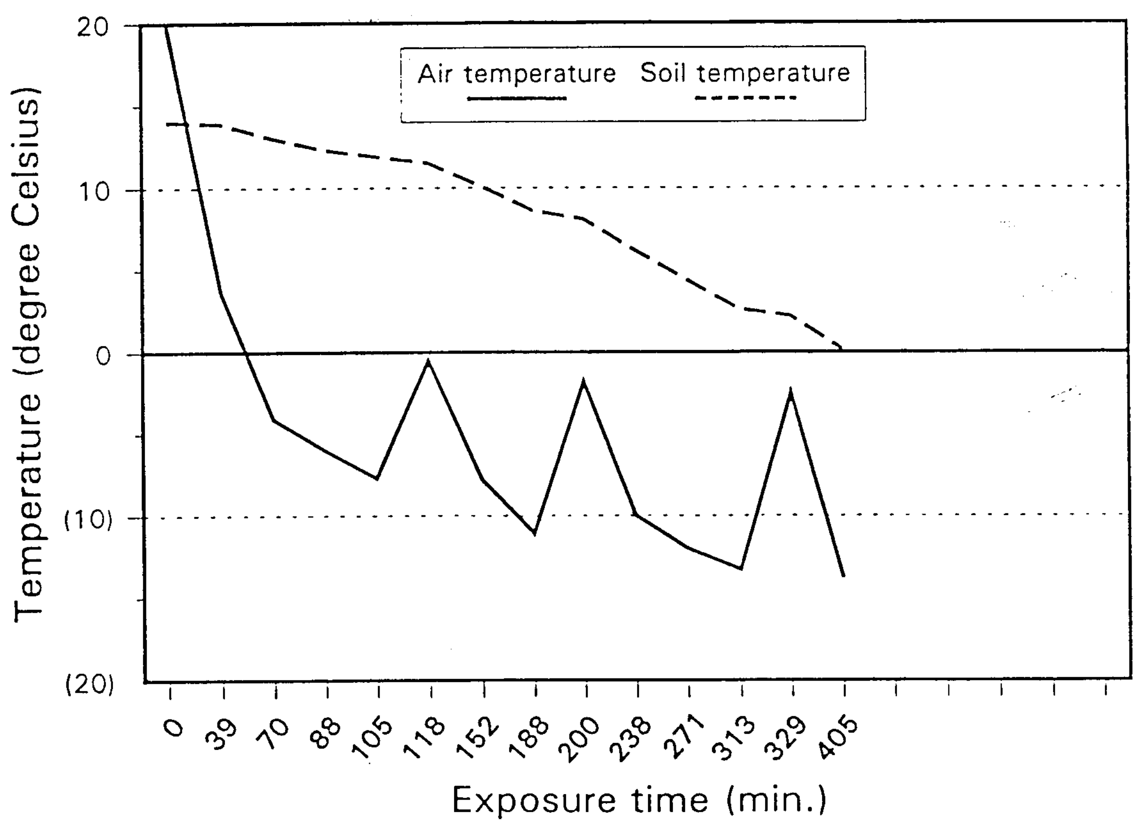

Fig1. (right)