Effect of Preplant Spraying or Soaking on Growth and Water Relations of Jack Pine *(Pinus banksiana* Lamb.) Seedlings[1]

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Spraying seedlings before bagging in the nursery and soaking them immediately before planting were each investigated for their effects on the water potential and root-to-shoot ratio of jack pine seedlings over the course of their first growing season. Neither treatment had any significant effect on the root-to-shoot ratio of the seedlings after one growing season. Reaction in terms of xylem pressure potential also suggested that neither treatment produced lasting effects on seedlings. Therefore, barring undue stress or damage due to improper storage or handling, jack pine seedlings will probably not benefit markedly from either treatment. (Tree Planters' Notes 36(4):24-27, 1985)

The success of a conifer plantation may well rest on the survival and establishment of planted seedlings during the first growing season. One of the most important environmental factors affecting seedling survival is the availability of moisture. Consequently, knowledge of the effects of water stress on the physiology of conifer seedlings is desirable.

Past studies have shown that water stress both directly and indirectly affects a myriad of physiological processes. The level of water stress directly influences plant water potential (2,6) and stomatal closure (4). Water stress indirectly affects three major physiological processes: photosynthesis, transpiration, and respiration. Experiments with a wide variety of coniferous seedlings all show significant declines in photosynthesis as a result of increases in water stress (1,2,6). Similarly, transpiration rates diminish as stress increases. The rate at which transpiration decreases reflects stomatal sensitivity to water stress, which varies greatly with species (4,5). Respiration has also been demonstrated to be under the indirect influence of water stress (6).

Unfortunately, very little can be done about optimizing the amount of water received by seedlings in the field during the growing season. On a commercial scale, irrigation is usually impractical for economic reasons. Growers can, however, easily regulate the period of time preceding planting during which seedlings are handled and subjected to stressful conditions. Stress encountered by bareroot stock due to lifting, packaging, and storage can be avoided or controlled by simply growing containerized stock, but in the Lake States species such as jack pine *(Pinus banksiana* Lamb.), red pine *(Pinus resinosa* Ait.), and white spruce *(Picea glauca* (Moench) Voss) are still predominantly planted as bareroot seedlings. The level of water stress that such seedlings experience before and during the time of planting may have a significant effect on their establishment and survival. Therefore, it is surprising that relatively little research has been done to quantify the effects of water stress on coniferous seedlings. The following experiment was designed to measure the influence of two preplanting treatments on the water potential and root-to-shoot ratio of jack pine seedlings over the course of their initial growing season.

Materials and Methods

Two hundred 2+0 jack pine seedlings were lifted by hand from the Southern Michigan State Forest Nursery on April 16, 1981, quickly sorted to assure uniformity, and placed in two standard plastic-lined paper seedling bags. For the *spray* treatment, 100 seedlings were placed in each bag. Before the bags were sealed, the seedlings were removed from one bag, sprayed, with water, and then replaced.

The bags were then stapled shut, taken to the Michigan State University Tree Research Center, and placed in cold storage. They remained in storage at 40 °F for 39 hours. Six seedlings were then chosen randomly from the sprayed and unsprayed bags. These twelve seedlings were tested with a Scholander pressure bomb to determine xylem pressure potentials (ψ_X). The procedures were standardized so that all seedlings were cut exactly 17 centimeters from the terminal

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bud, and 3 centimeters of bark was stripped from the severed end of each seedling before testing.

The second preplanting treatment (soak) under investigation was soaking the roots of seedlings immediately before planting. Half of the sprayed and unsprayed seedlings were soaked for 30 minutes in tap water. The seedlings were planted in loamy sand soil in a cultivated nursery bed at the Michigan State University Tree Research Center on April 18.

Of the original 200 seedlings, 12 were sacrificed for presoak ψ_x determinations and 144 were planted. From the remaining 44 seedlings, 24 were randomly chosen for an additional set of ψ_x readings (6 for each factor level) to determine the overall effect of the soaking and spraying treatments on unplanted seedlings.

Because of the uniformity of the nursery bed, the seedlings were planted in a completely randomized design. The two treatments were regarded statistically as two factors, each at two levels. A total of 144 seedlings, 18 per factor level, were planted in two replications. During later ψ_x readings, a group of three seedlings was considered a single experimental unit of three subsamples.

The planted seedlings were measured on three different days throughout the growing season to determine ψ_x. Each set of readings consisted of 24 seedlings, two replications of each experimental unit per factor level. Two separate sets of readings were taken on each date, one before dawn and one at noon. The dates chosen for ψ_x determination were at the beginning (April 25), middle (July 20), and end (September 28) of the growing season. The seedlings used for the final two sets of readings on September 28 were lifted to provide root-to-shoot ratio data in addition to ψ_x (table 1).

Results and Discussion

Spraying seedlings before sealing them in seedling bags resulted in a markedly significant increase ($P = 0.005$), in ψ_x (table 2). The subsequent preplant soaking treatment also resulted in a significant increase in ψ_x. When analyzed together, the soaking treatment produced a much greater effect on ψ_x than did the spraying treatment (table 2). Although both treatments increased ψ_x, no interactive effects between soaking and spraying were evident.

The analysis of data gathered from planted seedlings over the course of the season was complicated by the loss of 10 seedlings to rodent damage. However, no other seedlings died. In addition to the spray and soak treatments, differences in ψ_x were analyzed with regard to the time of day and the date on which pressure bomb readings were taken.

Table 1—*Chronology of treatments*

Action/treatment	Date	Number of seedlings			
Lifted and sorted	4/16	200			
Treatment 1	4/16	100 (spray)		100 (no spray)	
ψ_x measured[1]	4/18	6		6	
Treatment 2	4/18	47 (soak)	47 (no soak)	47 (soak)	47 (no soak)
ψ_x measured[2]	4/18	6	6	6	6
no. of plants[3]	4/18	36	36	36	36
ψ_x predawn	4/25	6	6	6	6
ψ_x noon	4/25	6	6	6	6
ψ_x predawn	7/20	6	6	6	6
ψ_x noon	7/20	6	6	6	6
ψ_x predawn[4]	9/28	6	6	6	6
ψ_x noon[4]	9/28	6	6	6	6

[1]Seedlings sacrificed for psi_x measurement, total of 188 remain.
[2]Seedlings sacrificed for psi_x measurement, total of 164 remain.
[3]Of 164 seedlings, only 144 were planted.
[4]Ratio of root/shoot dry weight determined from these seedlings.

Table 2—*Average xylem pressure potential of jack pine seedlings before planting, expressed in negative bars*[1]

Treatment	Before soaking	After soaking
Sprayed seedlings	4.6a	—
Soaked	—	3.5a
Not soaked	—	6.3b
Unsprayed seedlings	8.3b	—
Soaked	—	4.5a
Not soaked	—	7.2b

[1]Means in columns followed by different letters differ significantly (P = 0.005).

Interestingly, the time of day-predawn or noon-produced no significant change in ψ_X on the days when readings were taken. The only important factor influencing ψ_X of the seedlings was the time of the season on which ψ_X was measured (table 3). Although little change was apparent during the first half of the growing season, this factor showed significant differences (P = 0.005) over the whole growing season.

The final analysis concerned the effect of spraying and/or soaking on the root-to-shoot ratio of the seedlings. Analysis of the data collected at the end of the season (table 4) demonstrated that neither spraying, soaking, nor a combination of the two produced any significant difference (P = 0.05) in root-to-shoot ratio of the seedlings, although the ratio of soaked seedlings was higher.

The relatively dramatic effect of both spraying and soaking on ψ_X of jack pine seedlings before planting proved to be merely temporary in duration. A lack of significant difference in ψ_X after planting suggests the absence of permanent physiological change due to spray or soak treatments. This theory is supported by the insignificant root-to-shoot ratio differences at season's end. Either the untreated seedlings were not subject to sufficient stress to cause long-term damage, or the treatments themselves were unable to alleviate this damage for more than a short time. Because of the absence of mortality (other than from rodent damage) and the vigorous appearance of the seedlings over the entire season, the former explanation seems most plausible. Therefore, barring additional stress or damage due to improper storage or handling, it can be interred that jack pine seedlings will not benefit markedly from being sprayed before bagging or soaked before planting.

The curious result of ψ_X varying with date, but not time of day, can be best explained as follows. Immediately before both the first and second sets of readings, precipitation was relatively high. Thus, it was unlikely that soil water poten-

Table 3—*Average xylem pressure potential of jack pine seedlings by time of day and date, expressed in negative bars*[1]

Time of day	April 25	July 20	September 28
Predawn	2.3a	2.3a	3.9a
Noon	2.6a	2.5a	4.2a
Pooled average	2.5	2.4	4.0

[1]Means in columns followed by the same letter do not differ significantly (P = 0.05).

Table 4—*Average root-to-shoot ratios of treated seedlings after their initial growing season*

Treatment	Average weight (g)		Root/shoot[1]
	Root	Shoot	
Spray/soak	10.5	14.8	0.71a
Spray/no soak	11.2	19.0	.59a
No spray/soak	7.6	10.7	.71a
No spray/no soak	4.4	7.1	.62a

[1]Values in column followed by the same letter are not significantly different (P = 0.05).

tial within the test plot was low enough to cause appreciable stress during noon readings. Conversely, the third set of ψ_x readings was preceded by relatively dry weather. The low water-holding capacity of the sandy soil placed a greater burden of water stress on the seedlings, so that ψ_x values were significantly more negative than those obtained earlier in the season under wet conditions. Furthermore, jack pine, a drought-tolerant species, has been shown to quickly curtail transpiratory water loss by rapid stomatal closure (4,5). Stomates that normally closed before dawn may simply have stayed closed through the middle of the day. The end result was that ψ_x varied only minutely from predawn to noon readings.

Further investigations into the quantitative effects of preplant treatments on the physiology of jack pine and other less drought-tolerant coniferous seedlings are needed. These studies should focus on simulating abusive treatment during storage and handling, rather than on developing treatments to alleviate stress, so that potentially injurious handling practices can be identified and eliminated.

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Erratum

In "A Comparison of Nursery Sowers," by J. N. Boyer, D. B. South, C. A. Muller, and H. Vanderveer, in the Summer 1985 (Vol. 36, No. 3) issue of Tree Planters' Notes, two values in table 1 are incorrect. Please change the Singles value for Whitfield sowers to 27.8%b and the Coefficient of variation of seeds per row to 10.0.