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Biological Science

WINTER DAMAGE AND SEED SOURCE OF PLANTED PINES IN NORTHERN MINNESOTA

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The winter of 1947–48 will be long remembered in Minnesota for the damage it brought to trees and shrubs, especially conifers. Such severe conditions have not occurred often, but they are almost sure to come again. How, then, can future winter damage be avoided?

It would be foolish to persist in planting species which are subject to heavy winter damage. However, often overlooked is the fact that many tree species include several races which may vary in resistance to winter damage as they do in other characteristics. For this reason there should be considerable interest in observations made in northern Minnesota on experimental pine plantations containing trees of several seed sources.

WINTER WEATHER CONDITIONS, 1947–48

A combination of conditions made the period from October 1947 to March 1948 unusually hard on plants in northern Minnesota. In the vicinity of the experimental plantations on the Chippewa and Superior National Forests, October 1947 was the warmest on record. Temperatures reached 80 degrees F. or higher. In November the weather turned cold abruptly, and subzero temperatures occurred. Up to mid-February the winter was not particularly unusual, although temperatures were below normal. Maximum temperatures crawled slightly above freezing on one or two days in December and January, but in mid-February they exceeded 40 degrees F. In some localities, at least, this warm period was accompanied by bright sunshine and drying winds. Whether or not this happened in the plantations described here is unknown; records do show that over half the days in February were clear. During the first half of March, temperatures again dipped sharply and reached —30 degrees F. or colder.

The causes of damage to conifers may have been: freezing of poorly hardened tissue during the sudden cold following the unseasonably warm October, excess transpiration or sunscald damage during the February warm spell, freezing damage during the March subzero period, or some combination of these conditions. Observa-

[1] Maintained by the U. S. Department of Agriculture, Forest Service, in cooperation with the University of Minnesota, St. Paul.

tions in a northeastern Wisconsin locality established the fact that the browning of foliage appeared there immediately after the mid-February warm period (3). Be that as it may, the trees in the experimental pine plantations developed brown foliage to various degrees as a result of winter conditions.

EXTENT OF INJURY

On the Chippewa National Forest there are experimental plantations of Scotch pine (*Pinus sylvestris*) of 40 seed sources representing 15 European countries. Three plantations with ages of 12, 17, and 19 years from seed were studied.[2] Because of similarities of response the results were grouped together.

The percentage of trees with browned foliage ranged from 0 to 98 for the different sources. Generally those from the more northerly sources showed less browning than those from farther south. But latitude alone did not explain the differences. However, when those sources from a climate similar to that of the Chippewa National Forest (according to Köppen's classification) were compared with those from milder localities, the differences were striking. In the former group (sources from Romania, Finland, Poland, Sweden, Norway, Latvia, East Prussia, and Russia) from 0 to 27 percent of the trees had injured foliage and no source had over 3 percent of the trees with heavy injury. In the latter group (sources from Romania, Poland, Hungary, France, Central Germany, Denmark, Holland, Scotland, and Austria) from 61 to 98 percent of the trees had injured foliage and from 10 to 72 percent of the trees were heavily injured (2).

On the Superior National Forest in northeastern Minnesota there was examined a plantation containing 37 sources of red pine (*Pinus resinosa*) and 20 sources of Scotch pine 19 years old from seed and an additional 7 sources of Scotch pine two years younger.[3] The red pine sources represented 35 localities in the Lake States and 2 in New England. The Scotch pine lots, which were obtained partly from foreign sources and partly from local plantations, included one from Manchuria, 7 of known or supposed northern European origin, and 19 of known or supposed central European origin.

Based on percentage of foliage injured there were differences of high statistical significance within the species as well as between the two species (table 1). On the average, Scotch pine sustained about four times the damage that red pine did. However, Scotch pines of Manchurian and northern European origin actually averaged less foliage injury than the local northeastern Minnesota red pine sources. On the other hand, Scotch pines of central European origin were damaged much more than the poorest red pine lots. On

[2] Field examination was made by Paul J. Zehngraff.
[3] Field examination was made by E. I. Roe

TABLE 1

WINTER INJURY AND RECOVERY AMONG PLANTED PINES OF DIFFERENT SEED ORIGINS IN NORTHEASTERN MINNESOTA

RED PINE

Region of Seed Origin	Sources	Amount Foliage Injured		Trees with Unsatisfactory Recovery	
		Average	Range	Amount	Range
	Number	Percent	Percent	Percent	Percent
Northeastern Minnesota	7	4.0	2.2— 6.2	0	....
Northwestern Wisconsin	5	4.6	3.0— 6.1	0	....
North-central Minnesota	3	6.5	3.3—12.3	0	....
Northeastern Wisconsin	7	7.1	5.2— 8.0	0	....
Upper Peninsula, Michigan	4	11.7	6.1—20.4	0	....
Central Wisconsin	4	12.9	10.6—15.4	0.6	0 — 1.6
Lower Michigan	5	31.4	18.9—44.3	6.4	0 — 19.0
New England	2	38.8	22.1—55.3	9.6	0 — 30.8
All Sources	37	10.7	2.2—55.3	1.2	0 — 30.8
SCOTCH PINE					
Manchuria	1	0.0	....	0	....
Northern Europe	7	2.4	0.0—21.9	1.2	0 — 17.1
Central Europe	19	78.8	58.6—92.0	79.2	50.0—100.0
All Sources	27	44.4	0.0—92.0	44.3	0 —100.0

the basis of the number of trees with less than 10 percent of their foliage injured, there were included 94 percent of the northern European Scotch pine (including one Asiatic source), 71 percent of the red pine, and only 4 percent of the Central European Scotch pines (table 2).

Among the various red pine sources from 2 to 55 percent of the foliage had been injured. On the average the local, northeastern Minnesota sources, had suffered least (4 percent). There was a trend toward increasingly greater injury with distance of origin from the planting site, as follows: northwestern Wisconsin (5 percent), north-central Minnesota (6 percent), northeastern Wisconsin (7 per cent), Upper Michigan (12 percent), central Wisconsin (13 percent), lower Michigan (31 percent), and New England (39 percent). If the poorest northeastern Minnesota source (6.2 percent foliage injury) be taken as a base, significantly more injury was suffered by trees of the following sources: one from north-central Minnesota, 2 from Upper Michigan, 2 from central Wisconsin, and all those from Lower Michigan and New England (table 1). Viewed from another aspect the best 25 percent of the lots (those with least injury) included 4 from northeastern Minnesota, 3 from northwestern Wisconsin, and 2 from north-central Minnesota. The poorest

TABLE 2

DEGREE OF RECOVERY ACCORDING TO SEVERITY OF FOLIAGE INJURY DURING 1947-48 WINTER — PINE PLANTATIONS ON SUPERIOR NATIONAL FOREST

RED PINE

Amount of Foliage Injured	Degree of Recovery [4]					No Injury	Total	Basis Trees	Proportion of Total
	None	Poor	Fair	Good	Excellent				
Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent
0	....	....	....	....	....	100.0	100.0	485	27.9
1— 10	....	....	....	0.1	99.9	....	100.0	745	42.9
11— 25	....	....	....	2.1	97.9	....	100.0	333	19.2
26— 50	....	....	2.7	18.0	79.3	....	100.0	111	6.4
51— 75	....	....	9.3	46.5	44.2	....	100.0	43	2.5
76— 90	....	13.3	53.4	20.0	13.3	....	100.0	15	0.9
91—100	....	25.0	75.0	....	....	....	100.0	4	0.2
Total	.....	0.2	1.1	2.9	67.9	27.9	100.0	1,736	100.0
SCOTCH PINE, NORTHERN EUROPEAN ORIGIN [5]									
0	....	....	....	....	....	100.0	100.0	462	91.5
1— 10	....	....	....	....	100.0	....	100.0	14	2.8
11— 25	....	....	....	11.8	88.2	....	100.0	17	3.3
26— 50	....	....	42.9	14.3	42.8	....	100.0	7	1.4
51— 75	....	....	33.3	33.3	33.4	....	100.0	3	.6
76— 90	....	100.0	....	....	....	....	100.0	1	.2
91—100	....	100.0	....	....	....	....	100.0	1	.2
Total	.....	0.4	0.8	0.8	6.5	91.5	100.0	505	100.0
SCOTCH PINE, CENTRAL EUROPEAN ORIGIN									
0	....	....	....	....	....	100.0	100.0	15	2.4
1— 10	....	....	....	....	100.0	....	100.0	7	1.1
11— 25	....	....	....	37.5	62.5	....	100.0	8	1.3
26— 50	....	....	11.6	44.2	44.2	....	100.0	43	6.9
51— 75	....	3.8	40.0	42.5	13.7	....	100.0	80	12.8
76— 90	0.4	74.0	19.8	5.4	0.4	....	100.0	258	41.3
91—100	0.9	87.8	10.4	0.9	....	....	100.0	213	34.2
Total	0.5	61.1	17.6	11.5	6.9	2.4	100.0	624	100.0

[4] Based on proportion of crown with new growth, as follows: None, 0; poor, less than ¼; fair, ¼–½; good, ½–¾; and excellent, more than ¾.

[5] Includes one Asiatic source.

25 percent, on the other hand, included 5 from Lower Michigan, 2 from New England, and one from Upper Michigan.

The Scotch pines of known or supposed northern European origin were much less injured than those of central European origin (table 1). The best of the latter (59 percent) had more than double the amount of foliage injury sustained by the poorest of the former (22 percent). Except for one lot there were no significant differences

between the northern European sources. Among those of known or supposed central European origin, 15 sources were significantly poorer than the best lot, but only 6 were significantly better than the poorest lot.

RECOVERY FROM WINTER INJURY

The amount of winter injury to trees is of considerable interest, but it is more important to know the degree of recovery. Detailed observations of recovery were made on the Superior National Forest plantations during the late summer of 1948, after the trees had a chance to put on one season's growth subsequent to their injury.

Since recovery appeared to be related chiefly to severity of injury, results were grouped for red pine, northern European Scotch pine (including the one Asiatic source), and central European Scotch pine (table 2). Considering new growth on at least half of the crown of injured trees as satisfactory recovery, 98 percent of the red pine, 87 percent of the northern European Scotch pine, and 19 per cent of the central European Scotch pine fall into this class. If we combine trees with good and excellent recovery with those not injured, the percentages become 99 for red pine, 99 for northern European Scotch pine, and 21 for central European Scotch pine (table 2).

Trees which did not have more than one-fourth their foliage injured recovered satisfactorily (good or excellent). Poor recovery was confined to those trees which had more than three-fourths of their foliage injured. There was satisfactory recovery by about 25 percent of the red pine, but by only about 3 percent of the Scotch pine which had more than three-fourths of their foliage injured (table 2).

Still the need for thorough knowledge of individual seed sources cannot be overlooked even from the standpoint of recovery. All red pine trees from the northern parts of Minnesota, Wisconsin, and Michigan recovered satisfactorily, while small, but increasingly greater, percentages from central Wisconsin, Lower Michigan, and New England did not (table 1). Yet, even among some sources from these latter localities, all trees recovered satisfactorily. All Scotch pines of several northern European sources also recovered satisfactorily, but only 0 to 50 percent of those from known or supposed central European origin showed suitable recovery.

No detailed examinations of recovery were made in the Scotch pine plantation on the Chippewa National Forest, but general observations indicated that most of the trees which had less than half their foliage injured recovered reasonably well. Most of those which had more than half of their foliage injured recovered poorly; some died outright. These observations agree closely with the findings on the Superior National Forest plantations.

PRACTICAL SIGNIFICANCE OF THE RESULTS

The resistance to winter damage and the ability to recover from it shown by planted red and Scotch pines of several seed sources emphasizes the desirability of planting pines of local or climatically similar origins in northeastern Minnesota. This agrees with previous findings for red pine based on survival, growth, vigor, form, and soundness (1). However, it modifies previous findings for Scotch pine. Prior to the present winter-damage the more rapid growth of central European Scotch pines had given them an apparent advantage over those of northern European origin. This advantage has now been wiped out.

The results of this study add another shred of evidence to the general case in favor of selecting the right seed sources as well as proper species in forest planting. By such means severe winter damage and other ill effects of poorly adapted tree races may be avoided.

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OBSERVATIONS ON THE ACTION OF THE CARDIAC, PULMONIC, AND AORTIC VALVES IN THE BEATING HEART

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ABSTRACT

The perfusion of the isolated heart of the rabbit or dog is a well-known laboratory procedure. In its simplest form it consists of cannulating the aorta and connecting it to a reservoir of oxygenated Ringer-Locke Solution which is placed at a sufficient height above the heart to provide a pressure of about 100 mm. Hg.

In order to observe the mitral and tricuspid valves the atrial walls are incised and retracted sufficiently to permit direct observation of the opening and closing of the cardiac valves. The ventricles are usually kept supplied by the flow of fluid from the Thebesian vessels and other vessels from which fluid finds its way into the opened chamber. If the fluid thus supplied is insufficient, a tube can be run from the reservoir of Ringer-Locke solution to one or both ventricles and additional fluid can thus be provided for keep-