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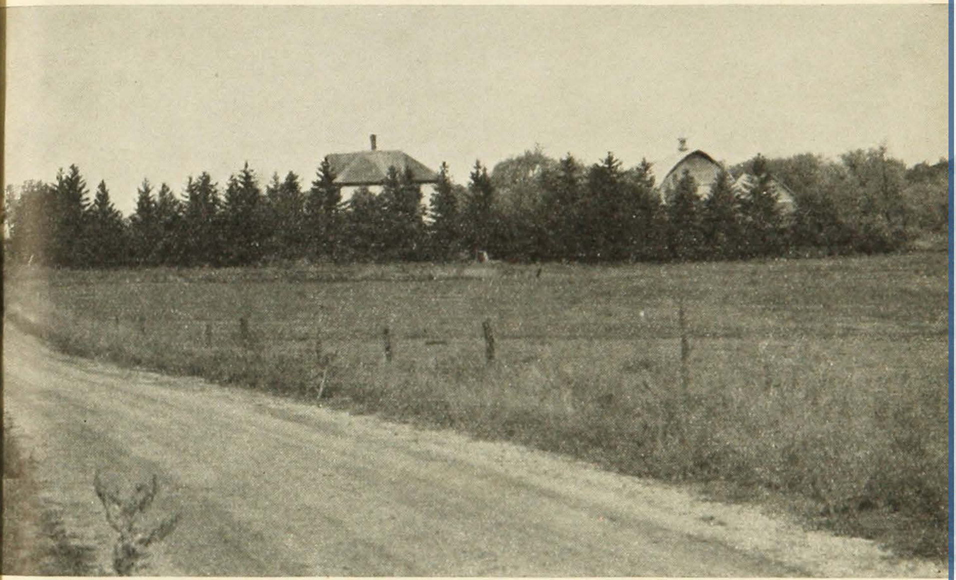

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

A Resurvey of the Demonstration Prairie Shelterbelts in Minnesota

HENRY L. HANSEN AND HENRY SCHMITZ[1]

INTRODUCTION

To demonstrate the benefits to be derived from well-planned shelterbelts and to demonstrate the methods by which successful tree plantings can be made, the Division of Forestry of the University of Minnesota carried on an extensive demonstration shelterbelt project from 1920 to 1927. During this period, about 330 shelterbelts were planted throughout the state. The number of such demonstration shelterbelts was limited to two per township. Unfortunately, about 80 of these shelterbelts had to be discontinued because the owners failed to give the trees proper care.

This project was essentially similar to the project undertaken by the Northern Great Plains Field Station of the United States Department of Agriculture at Mandan, North Dakota.[2] Trees, furnished to cooperators at low cost, were planted by the cooperators on their own land according to instructions furnished by the Division of Forestry. First, each proposed location was carefully inspected. If it was approved, a detailed planting plan was prepared and at least one inspection was made following planting. Most of the demonstration shelterbelts in Minnesota were planted according to the Minnesota standard plan.[3] This plan calls for a rather large number of trees designed to furnish fuel, posts, and farm timbers in addition to protection for the farmstead. Additional trees were furnished to replace trees that died the first year or two.

A survey of these demonstration shelterbelts in 1926[4] furnished information on the effects of cultivation, results of mulching, rate of growth, and comparative values of the trees planted. Since that time, however, no systematic attempt has been made to inspect these demonstration shelterbelts. The present survey was made in the summer of 1936 and was undertaken primarily to determine the growth and survival of the different kinds of trees planted.

[1] The authors wish to express their appreciation for the suggestions and assistance given by Prof. R. M. Brown and Prof. E. G. Cheyney, Division of Forestry, and by Parker O. Anderson, Extension Forester, University of Minnesota, St. Paul, Minnesota.

[2] George, E. J. (1936) Growth and survival of deciduous trees in shelterbelt experiments at Mandan, North Dakota, 1915-1934. U. S. Dept. Agr. Tech. Bull. 496, 48 pp., illus.

[3] Anderson, P. O. (1935) Planting the standard windbreak. Minn. Agr. Ext. Div., Spec. Bull. 168, 8 pp.

[4] Cheyney, E. G. (1931) Establishment, growth, and influence of shelterbelts in the prairie region of Minnesota. Minn. Agr. Expt. Sta. Bull. 285, 36 pp., illus.

These shelterbelts, which now average about 14 years of age, have been exposed to climatic conditions unusually severe even for Minnesota. As a result of the drouth of 1931 and subsequent years, a large number of the older trees in the plantings in the prairie region have died. Unfortunately, many farmers who have seen their old groves and shelterbelts gradually thin out as a result of drouth, mismanagement, or old age have hesitated to replace them. The interest of many others, however, has continued in spite of these setbacks. Although few prairie farmers question the desirability and benefits of a good shelterbelt, during the recent drouth years some farmers have questioned the practicability and even the possibility of growing trees successfully on prairie land.

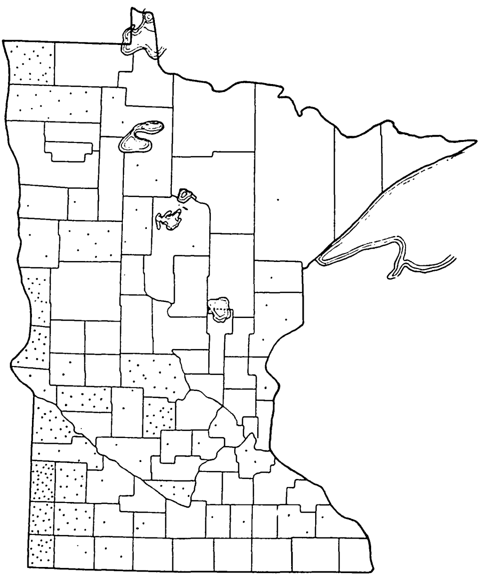

FIG. 1. LOCATION OF ALL DEMONSTRATION SHELTERBELTS PLANTED IN MINNESOTA, 1920 TO 1927

Each dot represents one shelterbelt.

A survey in 1934 of the shelterbelts in the prairie regions of Minnesota showed that the number of trees less than ten years old was 15 per cent below the number required to maintain the existing shelterbelts.[5]

WHERE AND HOW THE SURVEY WAS MADE

Conditions over the entire prairie area were sampled by an examination of 64 demonstration shelterbelts. These shelterbelts were distributed throughout the following five counties: Kittson, Wilkin, Lincoln, Lyon, and Stearns. These counties were selected with the object of securing conditions representative of the extreme western, the southwestern, and the central parts of the state, where most of the demonstration shelterbelts were planted.

Figure 1 shows the location of all of the demonstration shelterbelts planted in Minnesota during 1920-1927, inclusive. Figure 2 shows the location of the shelterbelts examined in this survey, and also the approximate boundary between the woodland and prairie areas of the state.

[5] Deters, M. E., and Schmitz, H. (1936) Drouth damage to prairie shelterbelts in Minnesota. Minn. Agr. Expt. Sta. Bull. 329, 28 pp., illus.

To determine the survival of the trees, it was necessary to count only the number of each kind of tree still alive, because the planting records show not only the number of trees originally planted but also all replacements. The percentage of survival was determined by dividing the number of trees of each kind remaining by the total number planted during the period. Thus the losses recorded include not only those taking place immediately after planting, the planting loss, but also the losses occurring after the trees were established.

In most of the plantings, the diameter breast high and total height measurements were taken on every fourth tree. In small plantings, however, every tree was measured, and in very large plantings only every tenth tree. Because of the uniform size of the trees, it is felt that the number of measurements taken was considerably in excess of the minimum needed for a representative sample. Trees with dead tops were measured to the tip of the longest green shoot. This accounts for the apparent slow growth of box elder, willow, and silver maple, many of which had died back from the tops.

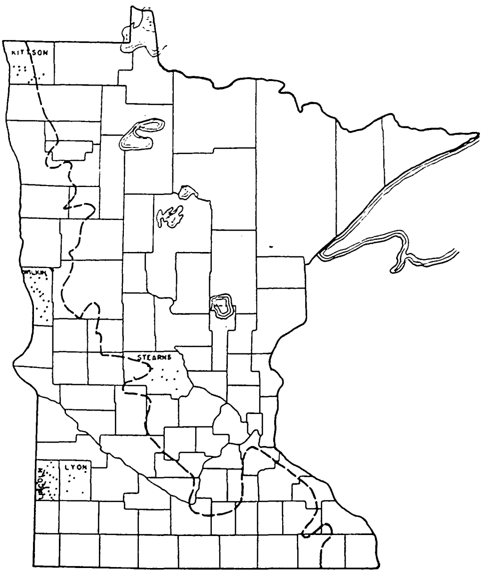

FIG. 2. LOCATION OF ALL DEMONSTRATION SHELTERBELTS EXAMINED IN 1936

Each dot represents one shelterbelt. The approximate boundary between the woodland and prairie areas of Minnesota is indicated by the broken line.

In addition, notes were taken on crown density, character and density of ground cover and litter, soil texture, and, insofar as could be determined, the causes for the death of the trees. Wherever possible, the cooperator was interviewed to determine the effectiveness of the shelterbelt as a means of checking drifting snow.

CLIMATE AND SOIL OF THE REGION

Trees planted in western Minnesota must be able to withstand extreme climatic conditions. The most important single factor affecting tree growth in this region is the occurrence of periods of subnormal precipitation. Table 1 gives the annual precipitation for four of the five counties covered in the resurvey. Figures for Lincoln County are not available.

Table 1. Annual Precipitation Record for Area Covered
(From U. S. Weather Bureau records. No data available for Lincoln County.)

Year	Kittson County (Hallock)	Stearns County (Collegeville)	Lyon County (Tracy)	Wilkin County (Campbell)	Average for state
		Total precipitation—inches			
1921	22.33	20.09	20.29	29.11	22.62
1922	20.58	18.85	15.31	21.80	22.97
1923	20.15	16.44	19.85	20.81	19.77
1924	22.09	26.26	25.20	23.92	24.78
1925	26.55	18.68	18.73	24.27	23.76
1926	20.38	26.47	21.34	25.87	24.68
1927	18.20	22.75	20.72	30.15	24.44
1928	16.41	24.45	22.41	24.57	25.56
1929	15.67	18.22	24.16	21.42	20.56
1930	20.50	16.87	19.92	16.84	22.59
1931	19.61	19.56	18.93	23.58	22.53
1932	19.14	16.85	17.94	17.24	21.68
1933	13.96	16.29	15.91	16.02	20.97
1934	15.01	18.14	19.29	12.12	20.33
1935	16.34	25.18	19.09	19.97	25.87
1936	15.23	22.96	16.77	14.38	18.23
Average 1921-1936, inclusive	18.88	20.50	19.74	21.38	22.58

These figures show that the trees planted in 1921 have had to endure an annual precipitation as low as 14, 15, or 16 inches during some years of their existence. In addition, weather records show that the monthly precipitation was often less than one inch during the growing season. Such long periods of midsummer drouth profoundly influence tree growth and mortality.

Temperature records for the region show a minimum of —50° F. and a maximum of 110° F., a range of 160°. The climate of this region is characterized by great fluctuations in temperature during the early spring, which often injure the trees and other plant life.

The shelterbelts examined were located on eight distinct surface formations. These formations, as described by Leverett and Sardeson[6], are as follows:

1. LAKE-BED CLAY.—This formation, which is limited to a number of plantings in western Kittson County, consists of a uniform, black clay loam with no boulders.
2. CLAY TILL.—This differs from the lake-bed clay in not being uniform. It may be streaked with sand or gravel deposits and is often covered with boulders.

[6] Leverett, F., and Purssell, U. G. (1915) Surface formations and agricultural conditions of northwestern Minnesota. Minn. Geol. Survey Bull. 12, 78 pp., maps and illus.

Leverett, F., Sardeson, F. W., and Purssell, U. G. (1919) Surface formations and agricultural conditions of the south half of Minnesota. Minn. Geol. Survey Bull. 14, 147 pp., maps and illus.

3. Lake-bed sand.—The sand is often underlaid by clay at a shallow depth. The depth to the water table and the nature of the subsoil, which vary considerably, are important in their effects on vegetation.
4. Clay moraine.—The clay moraine is somewhat similar to the lake-bed clay except that it occurs in ridges and may have a mixture of coarser materials in it.
5. Lake-washed sandy till.—This includes the sandier till soils which have been worked by water action and usually are covered with boulders.
6. Mixed sand and clay moraine.—A moraine of this type is composed of a mixture of coarse and fine particles. The surface is generally undulating.
7. Sand moraine.—This includes the moraines of the foregoing group made up chiefly of sand.
8. Outwash gravel.—Soils of this formation are coarse-textured gravels and sands, but occasionally contain a little clay. The only shelterbelts on this soil were found in parts of Stearns County.

KINDS OF TREES PLANTED

Twenty-five different kinds of trees were originally planted in the demonstration shelterbelts. Of these, 17 were found to occur in at least 5 different shelterbelts. The remaining 8 species were not considered in determining growth and survival. The following 17 tree species occurred in sufficient numbers to warrant their consideration:

Common Name	Scientific Name
American elm	*Ulmus americana*
Blue spruce	*Picea pungens*
Box elder	*Acer negundo*
Caragana (Siberian pea tree)	*Caragana arborescens*
Green ash	*Fraxinus pennsylvanica* var. *lanceolata*
Jack pine	*Pinus banksiana*
Laurel-leaved willow	*Salix pentandra*
Northern white cedar	*Thuja occidentalis*
Northern white pine	*Pinus strobus*
Northwest poplar	*Populus* sp.
Norway pine	*Pinus resinosa*
Russian olive	*Elaeagnus angustifolia*
Russian poplar	*Populus* sp.
Scotch pine	*Pinus sylvestris*
Silver maple	*Acer saccharinum*
White spruce	*Picea glauca*
White willow	*Salix alba*

SURVIVAL OF DIFFERENT KINDS OF TREES

The percentage survival for each of the 17 kinds of trees is given in Figure 3. These percentages were determined by dividing the total number of trees remaining in the shelterbelts by the number originally shipped to the cooperator, plus any replacements. These figures show that after 13 to 15 years, the survival of 4 of the species was over 45 per cent, and the survival of green ash and box elder was 70 per cent. If only survival is considered, green ash, box elder, American elm, and Caragana may be considered best of the trees examined, for planting in the region. The adaptability of green ash to the prairie regions of Minnesota and North Dakota has been frequently noted in the past. Although box elder showed a very high survival, it was not very thrifty. Most of the trees had dead tops, still others were only clusters of sprouts from the stumps of the original trees. Each clump of sprouts was counted as only one tree. The tops of many silver maple and willow trees were also killed back. American elm also showed this type of injury to some extent. In the few shelterbelts in which they were planted, the survival of chokecherry and buffalo berry was high (76 and 89 per cent, respectively). Obviously those species that are native to the region and that grow on dry upland soils would be expected to survive far better than the introduced trees. They have also done better than the native poplars and willows which require more moisture. The Caragana seems to be an exception; although not a native species, it has survived well. For the region as a whole, these figures also show that the survival of the evergreens, in general, has not been so satisfactory as the survival of the broadleaf trees. Two promising evergreens, ponderosa pine *(Pinus ponderosa)* and eastern red cedar *(Juniperus virginiana)*, were not planted in large enough numbers to warrant definite conclusions.

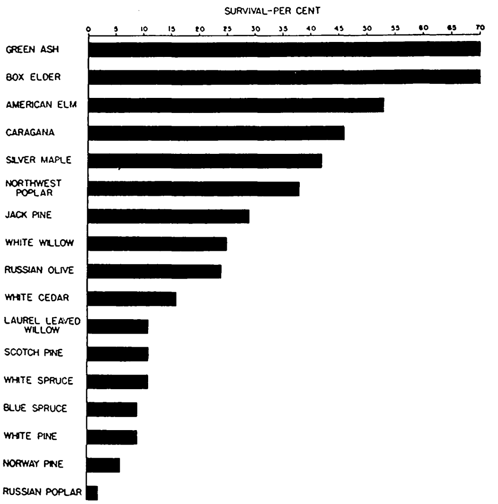

FIG. 3. RELATIVE SURVIVAL OF DIFFERENT KINDS OF TREES

Survival figures are for an average age of 13 years after all losses have been deducted.

Characteristics other than ability to survive successfully are important in determining the most desirable trees. These include: rate of growth, freedom from insects and fungi, and suitability of the wood for farm use.

THE INFLUENCE OF SOIL ON TREE SURVIVAL

Figures 4 and 5 show the relative survival of hardwoods and evergreens on light and heavy soils. In this survey, all coarse-textured soils, such as sands and sandy loams, were classified as light soils. Silt and clay loams were considered heavy soils. These heavy soils bake and become hard during drouth, and they vary from neutral to strongly alkaline in their chemical reaction. Alkaline soils are common in the bottom formations of the glacial Lake Agassiz in the Red River Valley.

Figure 4 shows the relative survivals on light and heavy soils of various broadleaved trees. Although there is an indication that these trees survived better on the heavier soils, the difference is too small to be significant. None of the broadleaved trees, however, survived better on the light soils than on the heavy soils.

As shown in Figure 5, the evergreen trees planted in the prairie region had a significantly lower survival on the heavy soil types than on the lighter soil types. This difference in survival is very significant for Scotch pine and significant for white pine. Throughout the region, the evergreens grew best on the light-textured soils. However, soil texture alone is not an infallible indication as to whether evergreens can or cannot be grown successfully. In parts of Kittson and Wilkin counties, some very successful evergreen plantings are growing on clay-loam soils. In general, however, the growing conditions associated with the heavier clay soils are usually more favorable for such hardwoods as green ash and American elm than for the evergreen trees.

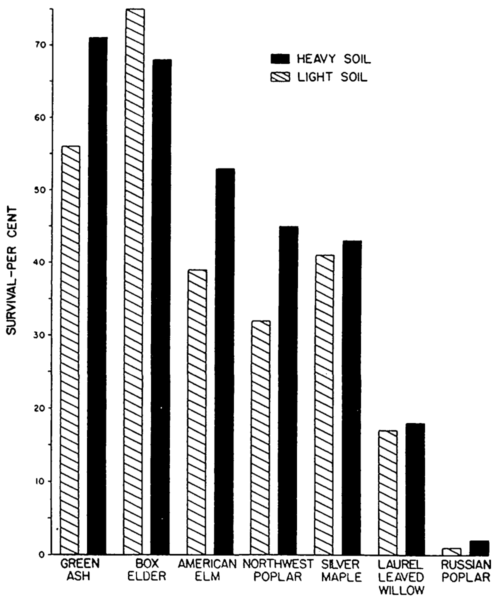

Fig. 4. Relative Survival of Broadleaved Trees on Light and Heavy Soils

The sensitivity of many evergreens to alkaline soils has been observed in the past. The alkaline nature of the clay soils in this region may be one reason for the lower survival of evergreens on such soils. The compact, baked condition of the heavier clay soils, with the consequent lack of aeration during the years of drouth, may also seriously affect the survival of evergreens on such soils. The fact that the survival of the broadleaved trees is about the same on heavier

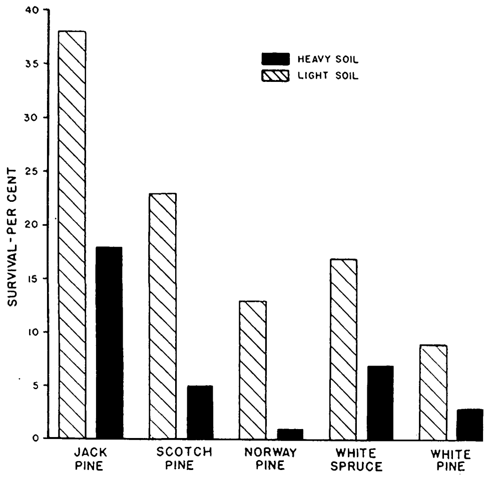

FIG. 5. RELATIVE SURVIVAL OF EVERGREENS ON LIGHT AND HEAVY SOIL TYPES

and lighter soils may indicate that the cause is associated with the characteristics of the evergreen trees themselves.

RATE OF GROWTH

The height and diameter of the shelterbelt trees, at the average age of 13 years, are shown in Figures 6 and 7. The average annual height growth of seven kinds of trees has been a foot or more a year. The apparently slow height growth of some trees is a result of the tops dying back in dry years. This is true of laurel-leaved willow, silver maple, box elder, and, to some extent, American elm. Green ash, usually considered a slow-growing tree, overtopped many of the other trees, which under normal conditions grow faster. This is because it did not die back during drouth periods. Jack pine made the fastest growth of the evergreens. White and blue spruce grew slower than the pines.

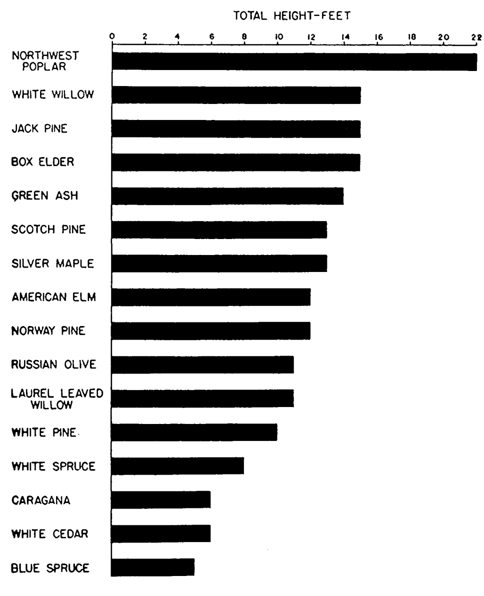

FIG. 6. AVERAGE HEIGHT OF TREES AT AN AGE OF 13 YEARS IN DEMONSTRATION SHELTERBELTS

THE INFLUENCE OF SPACING AND THINNING

The trees in the demonstration shelterbelts examined were planted with the following spacings: 2x6 feet, 4x6 feet, 4x8 feet, 6x8 feet, and 6x12 feet. Plantings which averaged less than 40 square feet per tree were considered closely spaced, and plantings which averaged more than 40 square feet per tree were considered widely spaced. The average survival of the trees closely spaced was not significantly different from the survival of the trees widely spaced. This means that the factor of spacing is not so important in determining survival as other factors such as cultivation, kind of trees, grazing, and the amount of soil moisture.

From this, however, it must not be inferred that spacing is unimportant. Observations indicate that relatively close spacing may be more desirable for shelterbelt plantings, chiefly because ground vegetation is shaded out earlier. It is important to eliminate any competition from grass and weeds for soil moisture if good survival is to be secured. For this reason, the trees must be carefully cultivated, especially when young. This can be done most efficiently by horse cultivation. As the trees get larger and their roots extend in all directions, cultivation should be done by hand. If the trees are planted with a 4x6- or 4x8-foot spacing, the branches will begin to interlace when they are 10 or 12 years old; if they are spaced wider than 6x8 feet, the branches will interlace when they are from 15 to 17 years old under average conditions. The period during which the shelterbelt must be carefully cultivated is therefore reduced by close planting. In addition, a closely spaced shelterbelt effectively protects the farm at an earlier age. Shelterbelts in which the trees are planted 4x6 feet and in which the survival is good become highly effective barriers to drifting snow as early as five years after planting.

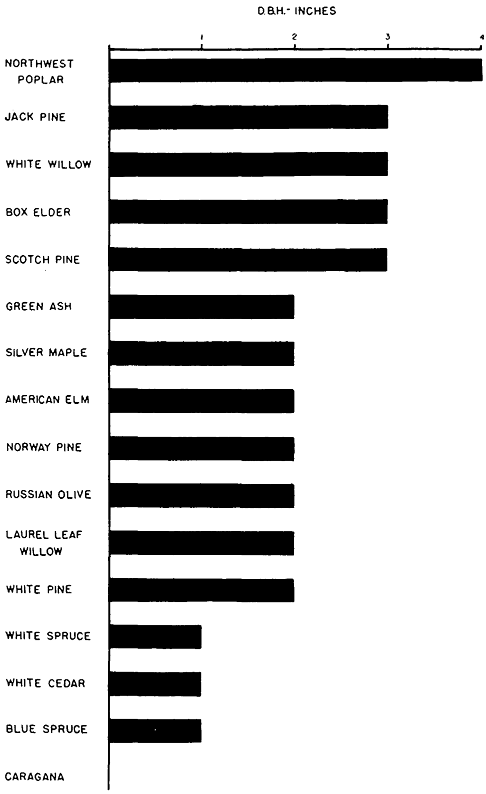

FIG. 7. AVERAGE DIAMETER AT BREAST HEIGHT OF TREES IN DEMONSTRATION SHELTERBELTS
The average age of these trees is 13 years.

Close spacing is also recommended for ash and elm to secure a well pruned clear bole earlier. The wood of these trees, especially ash, is well suited for farm use. The Minnesota shelterbelt plan calls for planting a large number of trees and anticipates reducing the number by thinnings. A 4x6- or 4x8-foot spacing is recommended for green ash and American elm to secure maximum quality of timber and to afford early protection from winds and snow.

All trees do not respond the same to identical spacing. Previous investigations[7] at the Mandan Field Experiment Station demonstrated that a relatively close spacing (2x8 feet, 4x4 feet, or 4x8 feet) is desirable only where suppression by faster-growing species in adjacent rows is not likely to occur. The results obtained at the Mandan Field Experiment Station are similar to results observed on the Minnesota prairie shelterbelts.

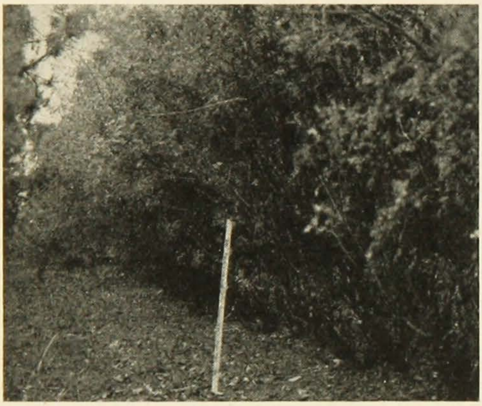

FIG. 8. A CARAGANA HEDGE

This row of Caragana planted two feet apart makes a tight hedge and stops the wind from blowing underneath the taller trees.

Hedge trees such as Caragana, chokecherry, wild plum, and buffalo berry should be planted with a 2x4- or 2x6-foot spacing. In this way a dense, effective barrier is made against snow and wind. An effective hedge planting is necessary in every shelterbelt to prevent the wind from blowing underneath the taller trees, blowing out the leaves which should accumulate in the summer and the snow which should be held in winter. Figure 8 shows a very effective Caragana hedge in which the trees are planted two feet apart.

SHELTERBELT MANAGEMENT

Thrifty shelterbelts can be grown only by giving them considerable care and protection. Much greater care is necessary during unfavorable weather conditions. In the prairie regions of Minnesota, the amount of available moisture is usually the limiting factor for successful tree growth. For this reason, every effort should be made to increase the amount of moisture in the soil and to prevent its loss throughout dry summer months. The design of the shelterbelt can materially affect the total amount of precipitation which reaches the ground and is retained. If it is at least six rows wide and has a tight outside hedge and a wide enough "snow trap" between the hedgerows and the main body of the shelterbelt, a large amount of snow will be caught and held. This additional snow will help build up the supply of soil moisture in the spring.

[7] George, E. J. *op. cit.*

In addition, the trees should be cultivated as often as possible to reduce the amount of water lost by the soil through evaporation. An earlier investigation[8] showed that young trees respond well to cultivation and that well-cultivated trees show decidedly greater average heights than trees not cultivated. Cultivation also keeps down the rank growth of weeds and grasses which utilize and transpire a large amount of moisture. This moisture can be and must be saved for the trees by cultivation.

The capacity of the soil to retain moisture may be increased by building up the supply of leaf litter and organic material present. One of the most efficient methods of doing this is by establishing and maintaining a tight hedgerow. If a row or two of low-growing shrubs or trees such as Caragana or buffalo berry are planted close together, they will effectively reduce the velocity of the wind near the ground. As a result, the tree leaves will accumulate and decompose on the ground. Figure 9 shows the interior of a shelterbelt in which a heavy layer of leaf litter and organic material has been built up by a tight hedgerow of Caragana.

FIG. 9. A SUCCESSFUL MINNESOTA PRAIRIE SHELTERBELT

The trees in this 14-year-old shelterbelt have had rapid growth. Green ash is on the left and American elm on the right. The heavy accumulation of leaf litter and the absence of ground vegetation give this planting a forest-like appearance.

Before the trees are planted, the site should be thoroughly cultivated in order to insure a good supply of soil moisture for the young trees during the critical period when they are getting established. This may be done by plowing and working the soil for at least a year, preferably two years, before planting. This serves two purposes: first, it keeps the weeds and grasses under control and thereby reduces the competition for soil moisture during the period of establishment of the tree seedling; second, by cultivating the soil and letting it lie fallow for a year or two, the amount

[8] Cheyney, E. G., *op. cit.*

of moisture retained by the soil is increased considerably. The area might be used during this period for cultivated crops such as corn or potatoes. Planting in the spring while the seedlings are still in a dormant condition is recommended.

A light thinning was recommended on 8 of the 64 shelterbelts examined, although none of these plantings was seriously overcrowded. The slower-growing, diseased, or injured trees should be removed in thinning, and the healthy, well-formed trees should be left. Too many trees should not be removed, or grass will begin to grow under the openings made. For plantings similar to the demonstration shelterbelts, the initial thinning need not be made before 15 years unless unusually rapid growth has occurred.

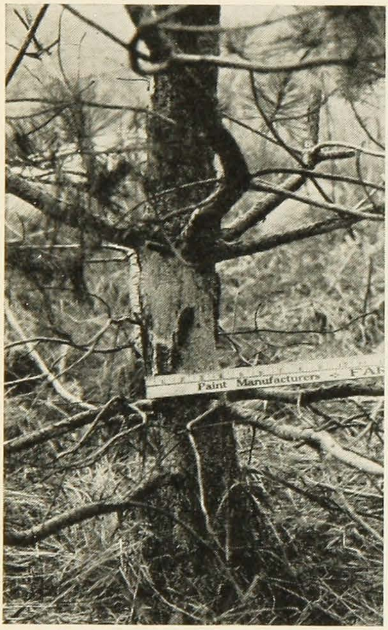

FIG. 10. A SCOTCH PINE GIRDLED BY RABBITS

Livestock should be kept out of the shelterbelt at all times. This is one of the most important measures in the proper management of a shelterbelt. That grazing is especially harmful during dry periods has been pointed out by many investigators. Livestock pack the surface layer of soil so hard that neither air nor moisture, which are essential to plant life, can penetrate and circulate in the soil. Furthermore, animals often severely injure the trees by eating the leaves, breaking twigs and branches, and stripping off the bark. These scars are ideal places for rot fungi to get a start.

A considerable amount of damage to evergreens and to some hardwood trees has been done by rabbits and mice. A stock-proof and rabbit-proof fence is recommended as an effective method to eliminate injury by livestock and rabbits. Practically all damage by rabbits is done during the winter months when other food is scarce. For that reason, the fence must be high enough to project several feet above the snow line, if possible. Types of rabbit injury are shown in Figures 10 and 11. In Figure 10 the Scotch pine was girdled just at the snow line. The trees shown in Figure 11 were girdled and the tips of the lower branches eaten. Undoubtedly, rabbits were partly responsible for the nearly blank rows where evergreens had been planted in this shelterbelt. The rabbits seem to prefer Scotch pine, Chinese elm, and white pine. Therefore, where rabbits are numerous, these species should not be planted.

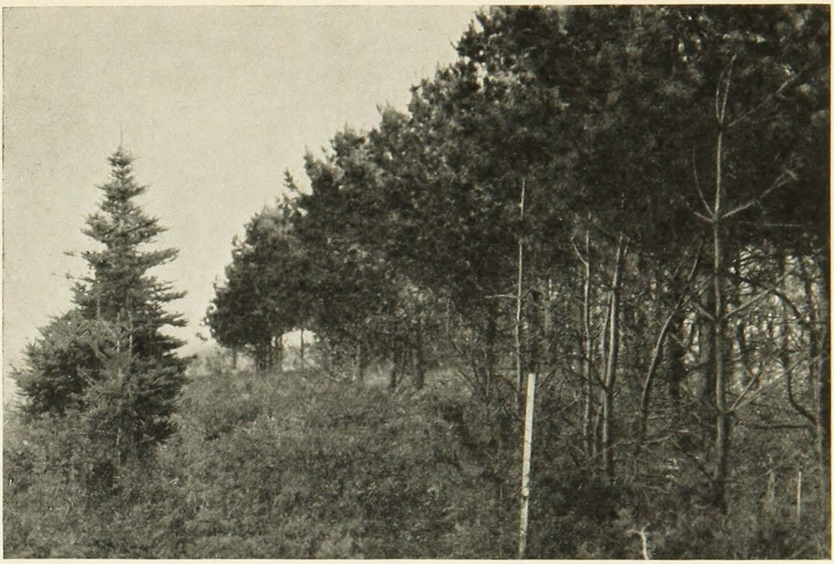

FIG. 11. RABBIT DAMAGE TO PINE AND SPRUCE

The spruce trees on the left have had their growth seriously retarded, and the Scotch pines on the right have lost their lower branches as the result of injury by rabbits.

Mice and other rodents often build nests in any material used for a mulch. During the winter when food is scarce, they are apt to feed on the trees. For this reason, mulching is not recommended.

SUMMARY OF FINDINGS

About 330 demonstration farm shelterbelts were planted in the agricultural regions of Minnesota from 1920 to 1927. About 80 were discontinued because cooperators failed to care properly for the trees.

These shelterbelts were examined in 1926 to determine the effects of cultivation, results of mulching, rate of growth, and comparative value of the trees planted. Sixty-four of the shelterbelts in the western and central parts of the state were re-examined during the summer of 1936.

The region studied is characterized by extreme climatic conditions and by a great diversity of soil types. The amount of available soil moisture is usually the limiting factor for successful tree growth.

Of the 25 kinds of trees planted, only 17 occurred in sufficient numbers to furnish reliable data. The survival of four of these, green ash, box elder, American elm, and Caragana, was 45 per cent or more 13 to 15 years after the original shelterbelt was started. The survival of both green ash and box elder was 70 per cent.

Green ash was found to be the best tree to plant in the region studied.

The tops of box elder, silver maple, willow, and, to some extent, American elm, had died back during the recent drouth years.

The evergreen trees examined showed a significantly lower survival on the heavier clay soils than on the lighter soils of a sandier nature.

The height growth of seven of the different kinds of trees examined averaged a foot or more per year. Some of the normally fast-growing trees showed a slow height growth because they died back from the tops in dry years.

Eight of the 64 shelterbelts were in need of a light thinning, although none were seriously overcrowded.

Two of the most important causes for the poor condition of many of the shelterbelts examined are grazing by livestock and lack of cultivation and care. In many cases this poor management is by tenants who have little or no interest in the shelterbelt.

In some localities, during the winter months, rabbits do considerable damage to Scotch pine and Chinese elm by girdling the trunks and killing the lower branches.

RECOMMENDATIONS

If given proper care and attention, farm shelterbelts can be successfully grown on Minnesota prairies. Every prairie farm should have its shelterbelt.

Trees native to the region, such as green ash and American elm, are able to endure periods of drouth and are therefore best suited to planting in prairie shelterbelts. The native cottonwood and the northwest poplar are also suitable as fast-growing trees where moisture conditions are somewhat more favorable. Although the native cottonwood was not planted extensively in the original demonstration shelterbelts, its success in other similar plantings makes it a desirable species for this region.

A mixture of several kinds of trees should be planted rather than a solid block of one kind.

A hedgerow or two of low-growing trees or shrubs is necessary to check the wind from blowing under the taller trees. Caragana, wild plum, lilac, chokecherry, and buffalo berry make excellent snow hedges. The trees or shrubs in the hedge should be planted close together. Spacing the trees two feet apart is most effective in developing a tight barrier to wind and snow. If more than one row is used, a spacing of 4 or 6 feet between rows is best.

In order to shade out ground vegetation and furnish early protection from winds and drifting snow, the trees should be planted with a 4x6- or a 4x8-foot spacing.

Scotch pine, Chinese elm, and white pine should not be planted where rabbits are numerous. Where possible, fencing should be used to keep rabbits out.

Never allow livestock to graze in the shelterbelt.

If few trees die and the trees grow rapidly, the shelterbelt may be lightly thinned when it is about 15 years old. Remove diseased and poorly formed trees unless they are necessary to maintain the shelterbelt's efficiency.