USDA United States Department of Agriculture

April 2018

FINAL STUDY REPORT
Bismarck Plant Materials Center
Bismarck, North Dakota

Potential of Lodgepole Pine as a Windbreak Species in the Northern Great Plains

Craig Stange*

ABSTRACT

USDA-Natural Resources Conservation Service field office staff have requested additional tall tree species for windbreaks and other conservation plantings in the Northern Great Plains. Six lodgepole pine (*Pinus contorta* var. *latifolia*) seed sources were chosen from a provenance test of lodgepole pine seed sources near Mandan, ND with potential for conservation plantings. Objective of this study was to determine the adaptability of these seed sources for use in conservation plantings across the Northern Great Plains. The 6 seed sources were compared to Scots pine (*Pinus sylvestris* var. *mongolica*) and Ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson var. ponderosa C. Lawson) in replicated and non-replicated plantings in Southwest and Central ND and Southwest SD. Growth rate of lodgepole pine was similar to Ponderosa but less than Scots pine. Preliminary findings indicate as precipitation increases, coarser soil textures favor satisfactory growth of lodgepole pine. Weed control for at least the first three years of establishment is essential for a successful stand. Deer browse protection is necessary until trees have grown above browse heights. Based on results from these initial plantings, lodgepole pine has the potential to be a suitable windbreak tree for the Northern Great Plains. Additional plantings are needed to determine full area of adaptation of the 6 lodgepole pine accessions.

INTRODUCTION

Windbreaks are an integral part of conservation across the Great Plains (Shultz et al., 1995). Due to climatic conditions, the number of tree species suitable for windbreak usage is limited. Introduced tree pests such as gypsy moth (*Lymantria dispar*) and emerald ash borer (*Agrilus planipennis*) continue to pose a threat to the few adapted species. Lodgepole pine is a native conifer species known for its long, slender trunk and high, thin crown. It grows on a wide variety of soils but does best on medium-textured soils derived from coarse parent materials. Lodgepole seedlings are susceptible to drought at planting, but drought losses decline considerably after the first growing season (Burn and Honkala, 1990). Lodgepole pine has a native range that covers much of western Canada and the US, from Baja, California to the Yukon Territory, from the Pacific Ocean to the Black Hills of South Dakota. It occurs in a wide range of elevation and precipitation zones. Lodgepole pine may have potential as an additional tall tree species for conservation use in the western parts of North Dakota and South Dakota.

The success, after 25 years, of lodgepole pine in a provenance test planted in 1980 at the USDA-Agriculture Research Service (ARS), Great Plains Northern Research Laboratory, Mandan, ND, prompted a study to evaluate seed sources for windbreaks (Dow et al., 1998). Objective of this study was to determine the suitability of selected seed sources of lodgepole pine for use in conservation plantings across the Northern Great Plains.

*Craig Stange is the State Forester (retired) at the USDA, Natural Resources Conservation Service, Bismarck, ND.

MATERIALS AND METHODS

Lodgepole pine seedlings were planted in field trials at four locations in western and southwestern North Dakota and southwestern South Dakota (Hettinger, ND; Hebron, ND; Grant County, ND; Hot Springs, SD). Ponderosa pine and Scots pine were used as standards of comparison (Table 1). The source of lodgepole pine seed for this study was from a provenance study planted in 1980 at the ARS, Mandan, ND. The soils at the site of the provenance study are loamy fine sands and fine sandy loams, Conservation Tree and Shrub groups 7 and 5, respectively. There were 25 accessions replicated 20 times in the provenance planting. Plant Materials Center staff collected cones in April 2006 from the best performing trees based on height, vigor, and cone crop. The collections represented 11 of the 25 accessions. Seed was extracted from the cones by PMC staff. Only six of the accessions provided enough seed for propagation (Table 1). The Towner State Nursery (ND Forest Service), Towner, ND, grew seedlings of the 6 accessions in 7 inch styroblocks for initial plantings and first-year replants. Although some accessions may be genetically pure, the seedlings are considered half siblings because of cross pollination potential in the provenance planting. The Mongolian pine were grown by the PMC from seed initially collected in the province of Heilongjiang, north of Harbin, China. Ponderosa pine seedlings were grown by the Towner State Nursery and Big Sioux Nursery (Watertown, SD) from seed collected in orchards managed by the nurseries.

Table 1. Seed sources of lodge pole, Scots and ponderosa pine for conservation plantings in North and South Dakota, USDA-NRCS Bismarck, ND.

Accession	Origin	Source
14107(LP 107)	Lodgepole pine - British Columbia (Jacobie Creek)	ARS
14108(LP 108)	Lodgepole pine - British Columbia (Lac le Jeune)	ARS
14109(LP 109)	Lodgepole pine - British Columbia (Clearwater)	ARS
14070 (LP 070)	Lodgepole pine - Colorado (Routt National Forest - Salida)	ARS
13351-10 (LP 1-10)	Lodgepole pine - Montana (Beaverhead National Forest – Dillon)	ARS
14105 (105)	Saskatchewan (Cypress Hills Provincial Park)	ARS
MP-718	Mongolian Scotch Pine (Nenjiang Co. Heilongjiang Province, China)	PMC
MP-158	Mongolian Scotch Pine (Bayan Co. Heilongjiang Province, China)	PMC
MP - 157	Mongolian Scotch Pine (Nenjiang Co. Heilongjiang Province, China)	PMC
MP -154	Mongolian Scotch Pine (Kedong Co. Heilongjiang Province, China	PMC
MP - 156	Mongolian Scotch Pine (Bayan Co. Heilongjiang Province, China)	PMC
PP	Ponderosa Pine Towner State Nursery common stock)	Towner State Nursery

Planting locations: Hettinger Research and Extension Center, Sec. 14, T129N, R96W, Hettinger, ND (Hettinger; Fig. 7), Angostura State Park, Sec. 28, T8S, R6E, Hot Springs, SD (Angostura); Flying O Ranch, NW1/4, sec. 3, T140N, R91W, Hebron, ND (Hebron; Fig. 8); Ronald Boll property, sec. 24, R133N, R89W, Grant County, ND (Grant),

Major Land Resource Area (MLRA): All sites are in MLRA 54 the Rolling Soft Shale Plain except Angostura State Park. Angostura State Park is in MLRA 61, the Black Hills Foot Slopes.

Soils: The Angostura site is Pierre clay. The Grant County site is Vebar and Velva fine sandy loams. The Hebron site is Parshall fine sandy loam. The Hettinger site is Arnegard loam and Shambo silt loam

Climate: The average annual precipitation for MLRA 54 is 12 to 17 inches with an average freeze-free period of 110 to 135 days. The average annual precipitation for MLRA 61 is 15 to 18 inches with an average freeze-free period of 110 to 140 days.

Planting Plan:

a) Hettinger - This site is part of a supplemental windbreak planting on cropland, protecting a livestock facility (Fig. 7). The lodgepole pine accessions planted were: 14070, 14105, 14107, 14108, 14109, and 13351-10. The Mongolian pine accession was MP-718. The Ponderosa pine was conservation stock. Each accession was planted in 3-tree plots and replicated 5 times for a total of 120 trees
b) Angostura State Park - This planting, on sodded parkland, was to be a visual screen as part of a recreational area. The lodgepole pine accessions planted were: 14070, 14105, 14107, 14108, 14109, and 13351-10. The Mongolian pine accession was MP-718. The Ponderosa pine was conservation stock. Each accession was planted in 3-tree plots and replicated 5 times for a total of 120 trees.
c) Hebron - This site in western North Dakota near Hebron, is part of a supplemental windbreak planting in a crop field (Fig. 8). The lodgepole pine accessions planted were: 14105, 14070, 14107, 14109, and 13351-10. The Mongolian pine accession was MP-158. The Ponderosa pine was conservation stock. Five plants of each accession were planted in five plant blocks. Extra plants of accession 109 were used to make up stock shortages of accession 108 which was not included due to stock shortages. Forty trees total were planted.
d) Grant - The site in Grant County, ND, on cropland, was intended as a wildlife planting. The lodgepole pine accessions planted were: 14070, 14105, 14107, 14109, and 13351-10. The Mongolian pine accession was MP-158. The Ponderosa pine was conservation stock. Each accession was planted 10 times. Plots were not replicated. Twice the number of accession 109 were planted to compensate for accession 108 shortages. Eighty trees total were planted. Half the plants of each accession were planted on an upland site of Velva fine sandy loam and half were planted on a riparian site of Velva fine sandy loam.

When trees died at one of the sites they were replaced with the same accession in 2009. When lodgepole pine stock was not available in 2010, Mongolian or Ponderosa pine were planted to fill the gap.

Plot Preparation: All sites were cultivated prior to planting.

Planting and Initial Maintenance:

a) Hettinger - Six-foot wide weed barrier fabric was installed prior to tree planting. Trees were hand planted through weed barrier. At planting time, five-foot tall x 16’ long stockade panels were bent into wire cages and placed around each tree to protect it from deer. The area between the fabric strips was seeded to blue grama with the district drill the day the trees were planted.

b) Angostura - Trees were planted into six-foot-wide bands of well-tilled soil on May 14, 2008. 3' x3' fabric squares were placed around trees after planting. No tree protectors were installed till the following year.

c) Hebron - The trees were hand-planted into a 6'-wide weed barrier fabric. No tree protectors were installed.

d) Grant - Trees were hand planted in into a tilled, somewhat weedy seedbed. No weed barrier or tree protectors were installed.

Planting Dates: Hettinger-May 12, 2008; Angostura-May 14, 2008; Hebron-May 16, 2008; Grant county-May 9, 2008.

Irrigation: The trees were not irrigated.

Replanting and Maintenance: Trees were replanted at every site in 2009 and in 2010 except for the Grant County site, which was replanted only in the spring of 2009.

Evaluations and Measurements: Vigor was rated on a scale of 1-9 where one (1) equals best and nine (9) equals poor. Tree height was determined on all trees in each planting by measuring from ground level to the absolute height of the tree. Percent survival was determined by counting the number of live trees at the end of the year. Performance as related to growing conditions was also noted.

RESULTS AND DISCUSSION

Deer browse was extensive the year of planting at all sites, except at Hettinger where wire cages protected the trees (Fig. 1). At Angostura, wire cages were installed on most trees in year 2, which greatly reduced deer browse. Of the uncaged trees at Angostura, 32 of 48 did not survive due to deer browse. After the second year, deer pressure along with weed pressure and dry conditions killed most of the trees at the Grant County site, so the site was abandoned in the fall of 2009. Deer pressure continues at all sites where trees are not protected with cages.

Weed pressure and tree mortality was greatest at the sites with no weed barrier fabric. The 3'x 3' fabric squares at Angostura did not appear to supply adequate weed control. Smooth brome (*Bromus inermis*) was an issue along the edge of the fabric, which likely reduced the amount of available moisture to the trees. A 6'x 6' fabric piece would have been more effective in controlling weeds. At the Hebron site, weeds protected the trees from deer browse (Fig. 2). In 2010, dry, Russian thistles (*Salsola kali*) tumbling from adjacent fields formed a prickly barrier around trees. At Hettinger, many of the holes made in the fabric to plant the trees, and the edge of the fabric have had a major flush of annual weed growth (kochia). The heaviest infestations were removed by hand, and Preen® (triflurilan) was granularly applied and incorporated by hand into the fabric openings in 2010. Observations in 2011 indicated that the one-time application of Preen® was effective in controlling weeds. Some bindweed (Convolvulus spp.) were noted in the holes in 2017.

Fig. 1. 7-Yr. old lodgepole pine at Hettinger.

Some of tree mortality appears to be attributed to poor planting stock. No root development was found when removing some of the dead trees in the first few years.

Soils appear to affect tree performance of all planted species. At Hettinger, it is evident replication 4 and parts of replications 3 and 5 are on less productive soils. Trees are shorter and exhibit less vigor. At Angostura, the trees were planted on a soil with a tight clay component, making them more likely to pond water. The trees did not grow very well where water ponded. At the Hebron site, the sandy soils have less water holding capacity likely making the impact of the weed competition and drought more pronounced. Dense sod competition has proven damaging in tree plantings across the state. It is assumed that the impact of this competition is more pronounced on sandy soils (less water holding capacity) such as those at the Hebron site.

Fig. 2. Surviving 7- year old lodgepole pine in middle row at Hebron study site.

Tip damage was noted in 2012 on lateral branches for a small number of trees of each of the three species at Hettinger. Rarely more than 5 branches per tree had dead tips. The damage was from Pine pitch nodule maker (*Petrova luculentana*). Unless the insect damages an apical tip, it should have minimal impact on the planting.

A hailstorm at the Hettinger site on May 29, 2013 heavily damaged the trees (Fig. 3). In 2015, the entire planting showed hail injury to the trees, exposed xylem on the limbs and trunks, double leaders, crooked stems and decreased vigor. Two years after the hailstorm, ponderosa pine showed no double leaders and minimal damage on the stem. The Mongolian Scots pine showed up to 40% double leaders while the lodgepole pine showed 21-75% double leader depending upon the accession. There was still exposed xylem on the lodgepole pine two years after the hailstorm. Species such as lodgepole pine, when moved an extended distance geographically and climatically from their original location are often more susceptible to catastrophic events that cause more damage than would be evident on an endemic source (Mary Mahalovich, personal communication). Lodgepole pine is considered a thin barked tree (Burns and Honkala, 1990). The thin bark of the lodgepole pine and origins of the accessions (not North Dakota) likely made them more susceptible than ponderosa pine or Mongolian pine to hail damage. Little or no difference in tree height occurred between trees with double leaders by 2015. This supports the concept that tree height growth is more a factor of site condition and tree genetics than tree form or stocking rate (Personal Communication, Zeleznick, 2018).

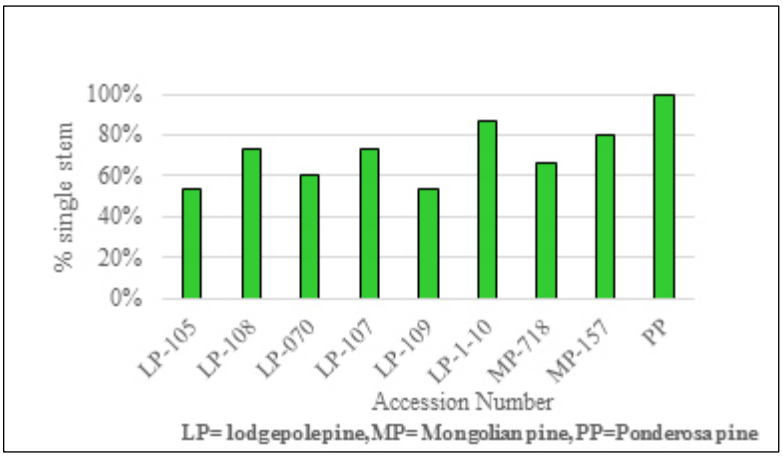

Fig. 3. Hettinger percent single apical stem after 2013 hailstorm.

The lodgepole generally exhibited the darkest green color. The Ponderosa pine exhibited a grey/green color while the Scots pine exhibited a noticeably yellow tint to the foliage.

Due to Park construction in 2013, all trees at the Angostura site were destroyed.

Percent Survival and average height of the lodgepole pine, Mongolian pine, and Ponderosa pine are found in figures 4, 5 and 6. Most accessions of lodgepole pine had comparable survival percentages. Survival of Mongolian pine was better than lodgepole pine at all locations, but differences were minimal. At the Hettinger site, where deer and weeds were controlled, there was very little difference in survival between lodgepole pine, Mongolian and ponderosa pine.

CONCLUSION

Based on results from these initial plantings, lodgepole pine has the potential to be a suitable windbreak tree for the Northern Great Plains. Additional plantings are needed to determine full area of adaptation of the 6 lodgepole pine accessions and the feasibility of adding it to the NRCS approved planting list of conservation trees in the Northern Great Plains. General observations and discussions with other foresters about lodgepole pine are summarized below:

- Lodgepole pine is not as forgiving of improper handling and care as some of the commonly used species for conservation planting (name 3 or 4 species). It requires proper care from the time stock is lifted at the nursery until it has become established.

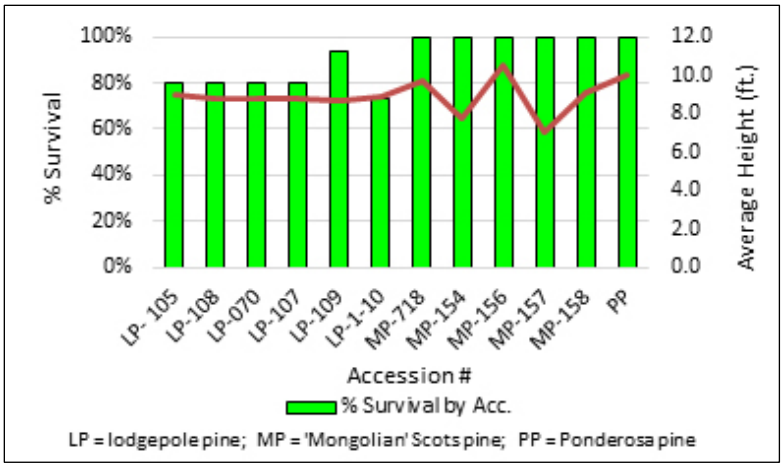

Fig. 4. Survival and average height of trees 10 years (2017) after planting, Hettinger, ND.

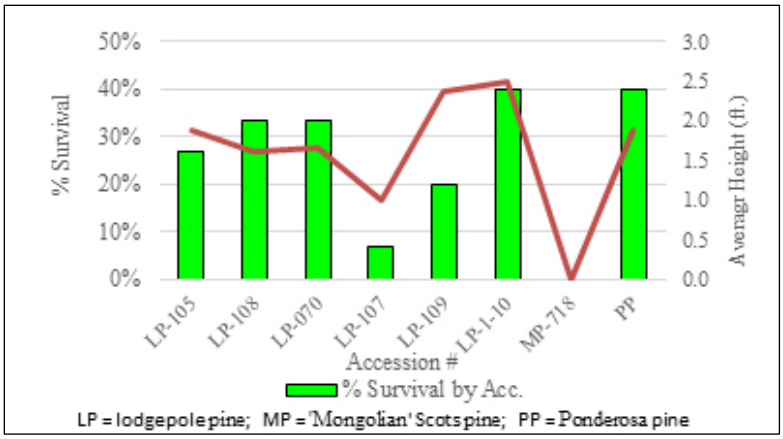

Fig. 5. Survival and average height of trees 5 years after planting, Angostura State Park, Hot Springs, SD.

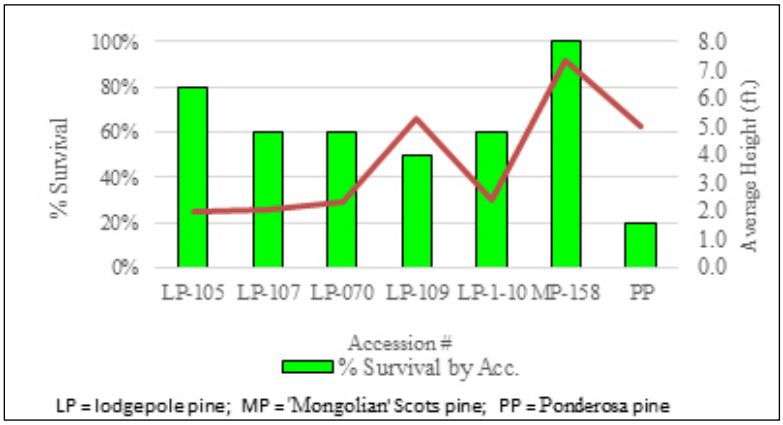

Fig. 6. Survival and average height of trees 8 years after planting, Hebron, ND.

- Once lodgepole has been growing onsite for over 3 years, it will continue to grow well except for severe weather, or human caused damage, or extreme competition from dense sods, or animal predation. Therefore, the use of seedling protectors and weed fabric should be included in the planting process.
- Especially on coarser soils, lodgepole pine responds favorably to good weed control. Once trees are 10 years old and supporting large dense canopies, the shade from the tree will suppress many sod forming grasses. If dense sod becomes established, tree growth will be greatly reduced and survival in times of stress may be compromised.
- Our findings support the literature, which states that lodgepole do best on soils formed of coarse parent material. We do not recommend planting lodgepole pine on soils of finer texture than silt loam.
- Though lodgepole is likely to be damaged by extended drought, it is thought that as precipitation increases, the planting site soils should become coarser for satisfactory growth. For example: If trying to grow lodgepole in eastern ND, plant on soils that are fine sandy loam or coarser. If planting in western ND they may perform satisfactorily on soils as tight as a silt loam. Findings from the Angostura site and collective forestry experience would indicate the species does poorly on clay soils.
- Most pine trees, and especially lodgepole pine must be protected from deer browse to be successful. They may need to be protected from other wildlife such as rabbits, voles, and porcupines.
- Recommended planting of lodgepole pine would be in Conservation Tree Subgroup 1, 1S, 3, and 5. If planted in MLRA 56 in ND, plant only on beach ridges.
- Additional plantings are needed to determine feasibility of adding lodgepole pine to the NRCS approved planting list for conservation in the Northern Great Plains.

The author wishes to acknowledge the following cooperators for their assistance with planting and evaluations: The USDA Natural Resources Conservation Services, Plant Materials Center (PMC), Bismarck, North Dakota, in cooperation with: NRCS field staff located at Dickinson, Hettinger, and Carson, ND, and Hot Springs, SD; Lake Angostura State Park, SD; NDSU Hettinger Research Extension Center (HREC), ND; Northern Great Plains Research Lab, Mandan, ND; Towner State Nursery, North Dakota Forest Service, Towner, ND; and the Flying O Ranch near Hebron, ND and Ronald Boll of Grant County, ND.

LITERATURE CITED

Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Silvics of North America: Volume 1. Conifers. U.S. Department of Agriculture (USDA), Forest Service, Agriculture Handbook 654.

Davies, R. J. 1988. Sheet Mulching as an Aid to Broadleaved Tree Establishment II. Comparison of Various Sizes of Black Polythene Mulch and Herbicide Treated Spot, Forestry, Vol. 61, No. 2,1988, Fort Augustus, Invcrnesshire PH32 4BT, Scotland.

Dow, Beverly, R.A. Cunningham, J.M. Kuprinski. 1998. USDA Agriculture Research Service, Northern Great Plains Station, Fifteen-year Provenance tests of lodgepole pine (*Pinus contorata*) in North Dakota. Western Journal of Applied Forestry, Volume 13, Issue 1 January 1998, pp 5-11.

McDonald, P. M., O. T. Helgerson, 1990, Mulches Aid in Regenerating California and Oregon Forests: Past, Present, and Future, United States Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-123

Nicholls, Thomas H.; and Robbins, Kathryn. 1984. Sirococcus Shoot Blight. Forest Insect & Disease Leaflet 166 (revised). USDA Forest Service, Washington, D.C.

Shultz, R.C. J.P. Colletti and R.R Faltonson. 1995. Agroforestry opportunities for the United States of America. Agroforestry System: 31:117-132.

Yang, B., and Wang, Q. 1989. Distribution of pine wilt nematode in China and susceptibility of some Chinese and exotic pines to the nematode. Canadian Journal of Forest Resources vol. 19, pp 1527-1530.

Fig. 7 Hettinger, ND lodgepole pine test site.

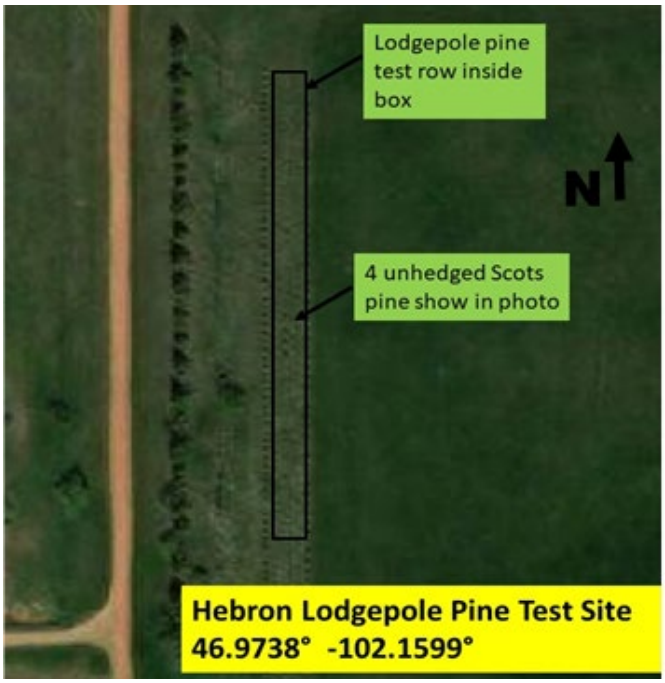

Fig. 8 Hebron, ND lodgepole pine test site.