

Graded Nursery Stock In Shelterbelt Type Planting Evaluated Over 29-Year Span

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The grading of windbreak tree nursery stock by diameter (taken 1 inch above the root collar) classes instead of by the commonly used height classes was started in 1922 by the Northern Great Plains Research Center, Mandan, N. Dak. At that time, the Mandan center was growing and distributing nursery stock of hardy tree and shrub species for planting protective windbreaks on farms in the Plains areas of North and South Dakota, Montana and Wyoming. Observations made of farm windbreaks planted during the 7 years prior to 1922 had shown that first-year survivals were usually higher in those seedlings having the larger diameters. Deciduous stock was shipped as 1- or 2-year seedlings and coniferous stock as 2-1 or 2-2 transplants.

Nursery stock of any species is usually grown from seed collected from more than one tree. Differences in seedling growth in the nursery can be attributed to one or more of the following factors: (1) Inherent differences in seed collected from one tree; (2) inherent differences in seed collected from more than one tree; and (3) differences in seedling density in the nursery row. Regardless of the cause, seedlings having the larger stem diameter at 1 year continued to have that characteristic when grown for a second season in the nursery.

The greater success in establishing seedlings having stem diameters of 1/4 inch or more near the root collar was attributed to their ability to better withstand the frequently prolonged droughts and severe drying conditions common to the northern Great Plains. Starting in the spring of 1923, records were maintained of the caliper-grade size of stock shipped to each farmer. The great variation in climate, soil type, and handling and planting of trees on farms scattered over an area more than 400,000 square miles prevented direct comparisons of survival and growth of different grades of a given species. However, survival counts were made by the planters at the end of the first growing season. These were sufficiently indicative to warrant the grading of nursery stock by diameter rather than height classes. These observations were later supported by Stoeckeler (3) who reported in 1937 that premium grade (larger size) nursery stock of several deciduous species, based on diameter 2 inches above ground, gave better survival rates and grew taller the first season in the field than did the smaller diameter sizes. Clausen (1)

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also reported that, after 9 years in the field, birch trees originally classified as large, medium, and small still maintained their relative position with respect to both tree height and stem diameter.

Methods

A series of caliper-graded plantings of several species was made at Mandan in 1941 to study their growth and survival over a period of years. Species and grades selected for study were four grades of green ash (*Fraxinus pennsylvanica* var. *lanceolata*), three grades of American elm (*Ulmus americana*), and three other species that had to be discontinued at the beginning of the second season because the trees were needed for replacing losses sustained in other studies initiated in 1941.

Twelve seedlings of each grade of green ash and American elm were planted in separate rows. The soil was a fine sandy loam having a low water-holding capacity. The plant spacing was 4 by 10 feet. Annual rainfall during the period of study averaged 16.78 inches. Green ash grades 1, 2, 3, and 4 averaged 2.9, 1.8, 1.5, and 0.8 feet in height and .52, .33, .22, and .15 inches in diameter, respectively, and American elm grades 1, 2, and 3 averaged 2.6, 1.4, and 1.1 feet in height and .42, .24, and .19 inches in diameter, respectively, at planting time. Stem diameters were measured at 1 inch above the root collar in 1941 and 1942 and at d.b.h. from 1943 to 1969. Tree heights were recorded from 1941 to 1969. Tree crown location in relation to surrounding crowns, winter injury, and other pertinent information using the method described by George (2) were also recorded. All the measurements were taken at the end of each growing season.

Results and Discussion

Survival of all grades of green ash was 100 percent throughout the 29-year period. American elm, grade 1, lost one tree after 25 years and grades 2 and 3 each lost two trees after 20 years.

Figure 1 (A) shows average heights in 1941 and at 5, 10, 15, 20, 25, and 29 years of age for each of the four green ash grades. Figure 1 (B) shows diameter measurements for the same period except that the first diameters were measured in 1943 after the trees reached a height of 4.5 or more feet. Green ash, grade 1, had the greatest height and diameter in 1941 and 1943, respectively, and at each succeeding 5-year period throughout the 29 years. Grades 2, 3, and 4 followed in descending order except that the diameter of grade 4 exceeded that of grade 3 at 29 years. Height growth of grades 1 and 2 showed a similar relationship throughout the 29-year period. Grades 3 and 4 also had similar relationships through the first 15 years. Grade 3 showed an appreciable increase in growth at 20 years which levelled off at 25 years, and a decrease at 29 years of age as a result of killing back. Grade 4 trees showed a levelling off between 15 and 25 years and a downward trend at 29 years resulting from killing back. There was very little difference between grades 3 and 4 at the end of the period.

Diameter growth of grade 1 (fig. 113) was more rapid and showed greater differences in relation to the other grades at 29 years than in any of the previous years. Trees in grade 2 showed a faster diameter growth than those of grades 3 and 4 during the first 20 years, after which growth began to level off to approximately the same difference between 25 and 29 years of age. Diameters of grades 3 and 4 main-

tained a similar growth rate throughout the 29-year period.

Figure 2 shows height (A) and diameter growth (B) for grades 1, 2, and 3 of American elm. Height growth rates of all grades were nearly uniform the first 20 years after which one or more grade 1 trees killed back resulting in a decrease in height at 25 years. Growth of grade 2 trees levelled off after 25 years, but was substantially greater than the other two grades at 29 years. Grade 3 trees followed a growth pattern similar to that of grade 1 throughout the 29-year period. However, it was inferior to the other grades at all times.

Diameter growth of American

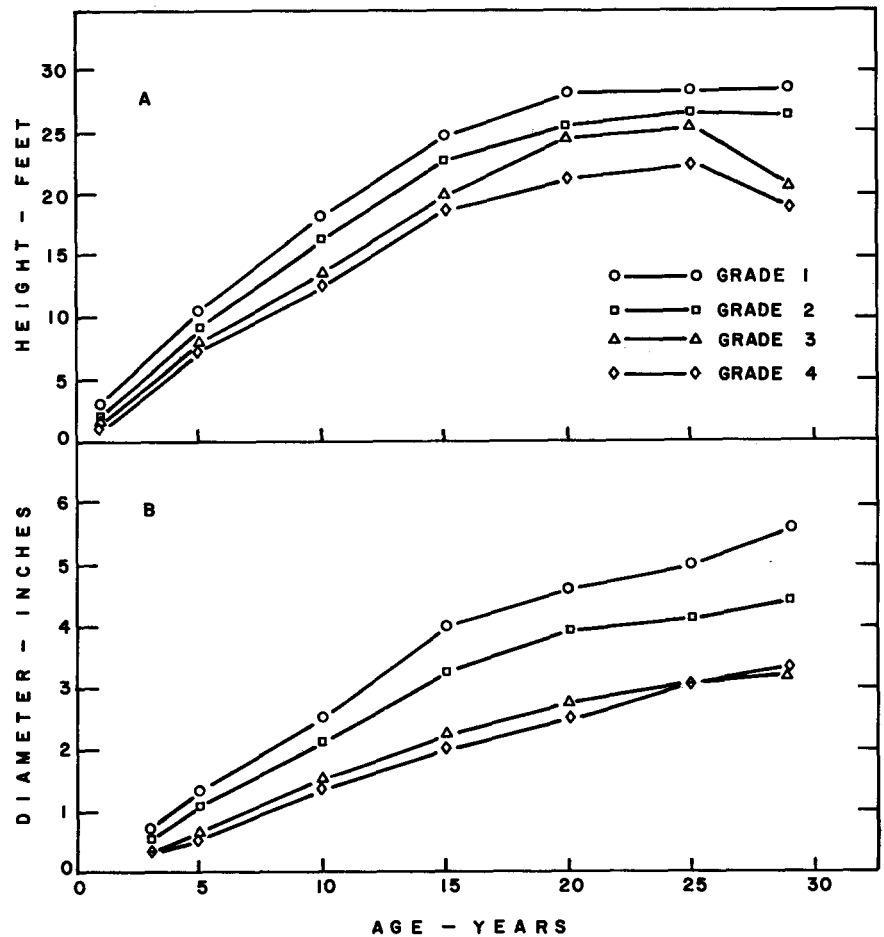


Figure 1.—Average height and diameter measurements of four different diameter sizes of green ash nursery seedlings at selected time intervals after planting.

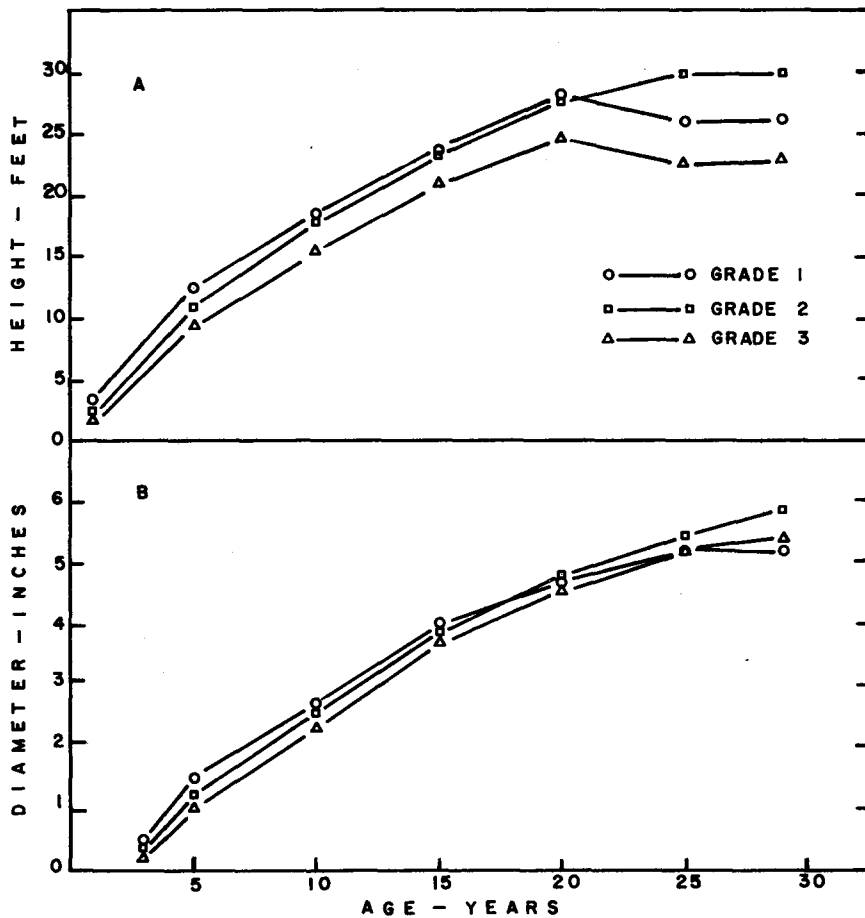


Figure 2.—Average height and diameter measurements of three different diameter sizes of American elm nursery seedlings at selected time intervals after planting.

in more than 1 year. Green ash trees suffered no suppression until after 15 years of growth and American elm showed the first suppression at 5 years of age. Suppression, when present, became more pronounced as age increased.

The close spacing of 4 feet between trees in the row probably contributed to the rate of suppression. Some trees became overtopped early in life, stagnating their growth or, in the more vigorous growers, resulting in an outward growth toward openings in the crown canopy. Some of the latter became codominant, others remained suppressed and showed a reduced growth rate as age increased.

Conclusions

Green ash, grades I and 2, showed superior height and diameter

growth over grades 3 and 4 after 29 years in the field. American elm, grades I and 2, also showed superior height growth over grade 3, but grade 1 was inferior to grades

2 and 3 in diameter growth. The row spacing used in this study was similar to that of multiple-row shelter-belts, thus a similar growth response could

TABLE 1.—Percentage of trees of each crown class based on dominance, suppression, and kill-back.

Year	Dominant or co-dominant crown Grade				Suppressed crowns Grade				Killed-back trees Grade			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
	Percent				Percent				Percent			
<i>Green ash</i>												
1945	100	100	100	100	0	0	0	0	0	0	0	0
1950	100	100	100	100	0	0	0	0	0	0	0	0
1955	92	100	100	85	8	0	0	15	0	0	0	0
1960	83	100	100	85	17	0	0	15	0	0	0	8
1965	75	92	85	85	25	8	15	15	0	0	0	0
1969	67	85	58	42	30	15	42	58	8	8	42	17
<i>American elm</i>												
1945	100	100	92		0	0	8		0	0	0	
1950	100	92	83		0	8	17		0	0	0	
1955	100	92	83		0	8	17		0	0	8	
1960	92	92	83		8	8	17		0	0	0	
1965	73	100	70		27	0	30		17	0	42	
1969	73	92	58		27	8	42		8	8	21	

Figure 2.—Average height and diameter measurements of three different diameter sizes

be expected if plantings consisted of ungraded nursery stock. Trees planted for protective purposes must necessarily be reasonably close together to reduce velocity of strong winds and to hold drifting snow.

Literature Cited

- Clausen, Knud E. 1963. Nursery selection affects survival and growth of birch. Research Note LS-31. Lake States Forest Experiment Station. USDA Forest Service.
- George, Ernest J. 1948. Spacing distances for windbreak trees on the Northern Great Plains. U.S. Department of Agriculture Circular No. 770.
- Stoeckeler, J. H. 1937. Relation of size of deciduous nursery stock to field survival in the Great Plains. J. Forestry 35: