TEN-YEAR EVALUATION OF A SEED SOURCE STUDY OF EASTERN REDCEDAR IN SOUTH CAROLINA

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Eastern redcedar (*Juniperus virginiana* L.) is a very adaptive conifer, as demonstrated by its widespread occurrence in the eastern half of the United States and the southern portion of Canada *(1)*. It grows on a variety of sites ranging from very dry to extremely moist and occurs on soils having a pH of 4.7 to 7.8 (5). Characteristics of this species have been observed to vary throughout its natural range.

A seed source study in southern Illinois *(2)* demonstrated significant variation among eight sources of eastern redcedar in the following characteristics: winter foliage color, crown form, growth rate, survival, leaf form, and resistance to cedar-apple rust. Although a local source was found to be the most resistant to rust, a central Tennessee source appeared to be superior in overall performance among the characteristics evaluated.

In another study, nine sources of eastern redcedar were tested in southwest Missouri *(4)*. After *5* years, a West Virginia source proved to be superior in survival, height growth, and form. Height growth in the local Missouri, Kentucky, and Arkansas sources was restricted during the first year as a result of an improper tap-root ratio; however, seedlings from these sources grew as well as those from other sources after the first year. Differences in crown form and foliage color were negligible in that most trees were cone-shaped and green.

In 1965*,* Schoenike *(3)* initiated a seed source study of eastern redcedar in South Carolina primarily for the purpose of locating adaptable strains for Christmas tree production. Results obtained after three growing seasons indicated that the seedlings most adaptive to the planting site in the South Carolina piedmont were the North Carolina, Virginia, and local South Carolina sources.

A description of the seed source plot and the various seed sources *(20)* is given in the earlier study *(3)*. The location of the seed sources and planting sites of that study are shown in figure 1. A revaluation of the study plots at age 10 is reported here.

Materials and Methods

Ten growing seasons after planting, measurements were taken of the study plots. Data were collected on survival, total height, maximum width of crown ratio, winter foliage color, foliage density, proportion of juvenile foliage, and disease symptoms. Standard analyses of variance were used to differentiate among seed sources for the continuous variables. Crown ratio was determined by dividing total height by crown width. Winter foliage color was classed as green, red-green, red-purple, and red-brown. Four juvenile foliage classes were established as follows: 0 to 25 percent, 26 to 50 percent, 51 to 75 percent, and 76 to 100 percent juvenile foliage, respectively.

Foliage density was classed as light, medium, and dense, with one experienced estimator making this classification. Symptoms of two diseases, cedar-apple rust caused by *Gymnosporangium juniperi-virginiana* Schw., and stem rust caused by *Gymnosporangium* spp., were tallied for all trees, on the basis of presence or absence.

Results and Discussion

Survival.—Survival was above *70* percent for all but three sources and above *85* percent for 12 sources (table 1). There were no significant differences among the latter; consequently, it appears that geographic variation in this trait is not important. Practically, it means that redcedar from most places in its natural range will survive satisfactorily, for 10 years, in the South Carolina piedmont.

Total height.—Four sources, three derived from the piedmont of adjacent southeastern States, averaged 12 feet or more in height and were significantly taller than other sources. Except for the Kentucky source, those sources showing least growth were from western or northern parts of the species range. In general, trees up to age 10 from the southeast-

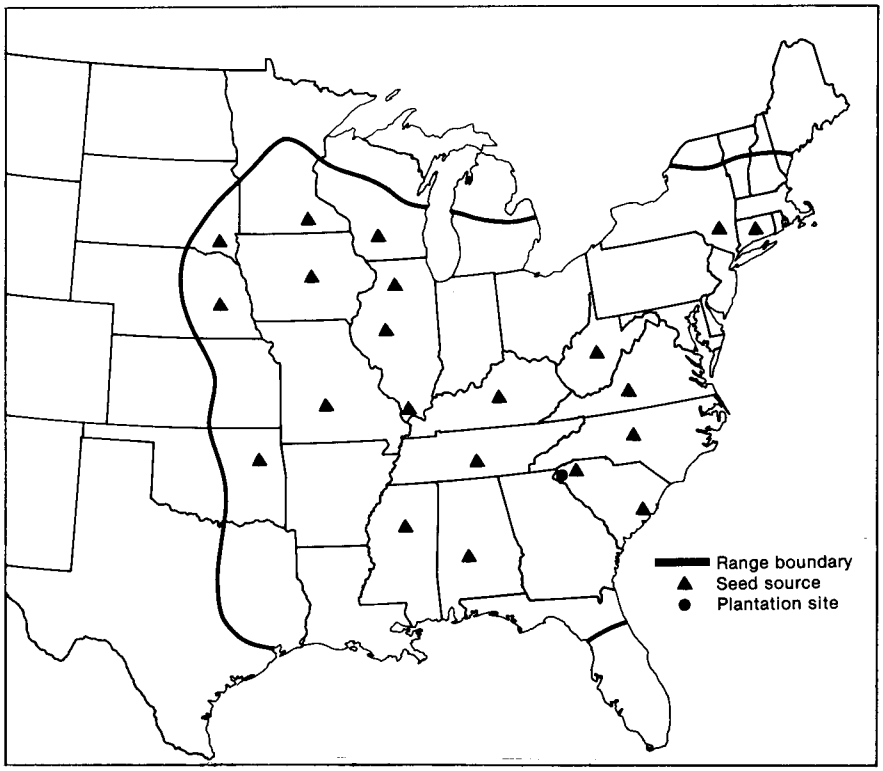

Figure 1.—*Location and planting sites of seed source.*

ern and central sources grew better than trees from other sources.

Crown width.—Differences in this trait were considerable. The widest crowns, from an Alabama source, were nearly 65 percent greater than the narrowest crowns, from a Nebraska source. There were, however, no distinctive geographic variation patterns evident in this trait.

Crown form.—Very high crown ratios, characteristic of columnar trees, were most pronounced in the Mississippi source, whereas low crown ratios, characteristic of broad crowned trees, were found in sources from New York, Alabama, and Illinois. No geographic trend was evident in this trait.

Winter foliage color.—Green and red-green were the most frequently observed winter colors throughout the seed sources. Although variation in foliage color was observed within the sources, a regional pattern also appeared to exist. Trees from the western and southern portions of the range were generally green in color, whereas trees from northern, northeastern, and central sources had a reddish tint in their foliage.

Foliage density.—Light foliage density appeared most often on the less vigorous trees and was characteristic of certain sources, notably two western, one northern, and one southern source. Sources from States in the Southeast generally had trees with dense foliage. A clear geographic trend in this trait was not shown. Juvenile foliage.-At age 10, relatively few trees have retained the juvenile, awl-shaped leaves. Except for the eastern South Carolina source, there were no significant differences among sources for this trait, and no geographic trend was evident.

Disease.—Symptoms of cedar-apple and stem rust were observed on trees from all sources; however, the extent of injury varied among the sources. Trees from the Illinois, Connecticut, and Tennessee sources were most heavily infected with the leaf galls of cedar-apple rust. Stem rust was frequent in an Illinois and a Nebraska source. Resistance to infection by rust fungi was much greater in the Kentucky source than in any other. No geographic pattern in rust susceptibility or resistance was evident from the data.

Adaptability and practical findings.—Adaptability ratings for the different sources were derived

Table 1.—*Mean values for six traits in forestry seed sources of eastern redcedar, in a 10-year-old South Carolina piedmont plantation.* [1]

Seed sourcest arranged from North to South	Trait					
	Survival	Mean height	Disease-free trees	Crown ratio	Light foliage density	Winter green foliage
	percent	*feet*	*percent*		*percent*	
Minnesota	74	10.3	5	3.19	50	0
New York	90	8.4	37	2.22	19	1
Connecticut	44	9.9	24	2.52	24	10
Wisconsin	89	11.1	5	3.29	22	0
South Dakota	89	10.1	35	2.99	20	64
Iowa	50	10.2	28	2.79	18	0
Central Illinois	86	11.7	20	2.79	23	64
Nebraska	72	8.6	7	3.06	46	0
West Virginia	91	10.4	45	2.63	14	50
Virginia	89	12.1	18	2.68	28	88
Kentucky	85	8.8	70	2.82	24	56
Missouri	75	10.9	14	3.05	25	0
Southern Illinois	87	11.6	42	2.97	23	42
North Carolina	85	13.5	47	3.44	7	86
Oklahoma	72	10.4	14	3.23	31	62
Tennessee	92	11.0	24	2.90	18	54
Western South Carolina	89	12.7	34	2.91	12	85
Eastern South Carolina	67	9.9	10	2.48	24	92
Mississippi	84	12.6	7	4.21	30	3
Alabama	87	11.2	31	2.46	23	96

[1]Significant differences (95 percent level) were found for seed sources for all traits.

from a rating *scheme of* three traits: survival, total height, and freedom from disease. Sources were placed in each of four categories ranging from most desirable (category 1) to least desirable (category 4) (table 2). Those sources most adaptable to South Carolina piedmont were those obtained from North Carolina, western South Carolina, and Illinois. Acceptable sources also included species from Alabama, Virginia, and West Virginia. Thus, with one exception, sources closest to the planting site showed the best adaptability after 10 years.

When rating Christmas tree production three additional traits—crown ratio, foliage density, and winter foliage color—are to be considered. Rating schemes were applied to these traits in a similar manner and are also shown in table 2. On the basis of all six characteristics, the best sources for Christmas trees would be North Carolina, western South Carolina, Alabama, Virginia, and West Virginia.

Conclusions

A geographic seed source study in eastern redcedar has revealed important differences in survival, rate of growth, disease resistance, and in various crown and foliage traits after 10 years, among 20 sources representing most of the species' range. For planting in

Table 2.—*Adaptability ratings for six traits in eastern redcedar*

General adaptability rating[1]

Survival	Total Height	Frequency of Disease Free Trees
percent	*feet*	*percent*
(1) >84	(1) >11.9 ft.	(1) 34
(2) 75-84	(2) 11.0-11.9 ft.	(2) 25-34
(3) 65-74	(3) 10.0-10.9 ft.	(3) 15-24
(4) [65	(4) [10.0 ft.	(4) <15

Additional ratings for Christmas trees

Crown Ratio	Foliage Density *percent light*	Winter Foliage Color *percent green*
(1) <2.50	(1) <16	(1) >80
(2) 2.51-3.00	(2) 16-25	(2) 60-79
(3) 3.01-3.50	(3) 26-35	(3) 40-59
(4) >3.50	(4) >35	(4) <40

List of satisfactory and unsatisfactory seed sources based on general adaptability and additional ratings for Christmas trees.

Satisfactory Rating	Unsatisfactory Rating	
North Carolina (1)	Central Illinois	Iowa
Western South Carolina (2)	South Dakota	Mississippi
Alabama (3)	Tennessee	Missouri
Virginia (4)	New York	Oklahoma
West Virginia (5)	Kentucky	Connecticut
Southern Illinois (6)[2]	Eastern South Carolina	Nebraska
	Wisconsin	Minnesota

[1]Number 1 rating is best in all cases.

[2]Rated third for general adaptability and sixth for Christmas trees.

piedmont South Carolina, local sources and those from adjacent States are recommended both for general forest plantings and for Christmas tree production.

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