

WILLOW CLONES DIFFER IN SUSCEPTIBILITY
TO COTTONWOOD LEAF BEETLE

W. K. Randall¹/

Abstract.--Amount of defoliation by the cottonwood leaf beetle on 1-year-old trees from 37 clones of black willow ranged from 21 to 95 percent. Male clones of black willow were damaged significantly more than female clones. Two clones of *Salix babylonica* X *S. alba* and three of sandbar willow were very lightly attacked. The only clone of *Salix* X *argentinensis* was 52 percent defoliated.

Larvae of the cottonwood leaf beetle (*Chrysomela scripta* F.) defoliate willows as well as poplars. When numerous, these insects may remove all leaves and severely damage terminal shoots. The ease with which black willow (*Salix nigra* Marsh.) can be vegetatively propagated and its rapid growth on wet sites makes it a candidate for genetic improvement, and results of the exploratory study reported here indicate that clones of black and other willows vary considerably in their resistance to defoliation by the cottonwood leaf beetle.

MATERIALS AND METHODS

During March 1970, cuttings were taken from 30 randomly selected black willow trees that were 30 to 40 years old and from 13 that were 2 or 3 years old. At the same time, cuttings were taken from three sandbar willows (*Salix interior* Rowlee) 2 or 3 years old. This species is classed as a shrub or small tree; it may reach a height of 30 feet (Vines 1960). Also included in the experiment were two clones of the cross *Salix babylonica* L. X *Salix alba* L. (Ragonese and Alberti 1965) and one of *Salix* X *argentinensis* 'Mestizo Usoz,' which is probably a natural hybrid of *Salix babylonica* and *Salix humboltiana* Willd. These hybrids were sent to the Southern Hardwoods Laboratory in June 1965 by Dr. Arturo Ragonese of the National Center of Agricultural Investigations at Cestellar, Argentina. They have been maintained in a nursery, and for the present test 1-year-old cuttings were taken from rootstocks that were 2 years old. A total of 49 clones were included in the experiment.

Unrooted cuttings 18 inches long were planted in late March 1970 on the Delta Experimental Forest near Greenville, Mississippi. The design was a randomized complete block with six replications of single-tree plots. Spacing was 10 by 10 feet.

¹/ The author is Associate Silviculturist at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station, USDA Forest Service, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

The site was cleared during the fall prior to planting. Soil is Sharkey clay, and the site is low; water covers much of the area during winter and early spring. The recommendations of McKnight (1970) for establishing cottonwood plantations were followed in planting and cultivating.

The original purpose of the study was to observe growth of willows on a heavy clay site, but cottonwood leaf beetles caused heavy defoliation during the summer of 1970.

On September 30, 1970, before any trees had recovered from the attacks, heights were measured to the nearest 1/10 foot and the amount of defoliation was estimated to the nearest 10 percent. A defoliation rating of from 1 to 10 was assigned, with 1 representing less than 10 percent loss of foliage, and 10 representing more than 90 percent.

Six clones that consisted of cuttings from mature black willows did not root satisfactorily; they were excluded from the analysis. Remaining were balanced data on 37 black willow clones, three sandbar willow, and three hybrids. Analyses of variance were calculated to find differences among means that were statistically significant at the 0.05 level. A simple correlation was calculated between clone means for defoliation and height.

RESULTS

Average height of all trees in the plantation was 6.0 feet at the end of the first growing season. The highest clone averages were for sandbar willows, which averaged 9.4 feet tall. Slightly less tall at 8.6 feet were the two clones of the hybrid *S. babylonica* X *S. alba*. The hybrid clone *S. X argentinensis* was 6.1 feet tall. The range for clone means of black willow was 2.0 to 8.0 feet, and the mean was 5.6 feet. The black willow population was divided into three groups: male, female, and sex unknown. The average height for the clones of unknown sex was 7.0 feet, significantly taller than either the male or female groups. Male clones of black willow were slightly but not significantly taller than female clones at the end of the first year. All other group means were significantly different from each other. Averages and ranges for height and defoliation are presented in table 1.

Amount of defoliation by the cottonwood leaf beetle varied significantly by species and clone. The overall average defoliation was 63 percent, and clone means ranged from 5 to 95 percent. Sandbar willow and the two interspecific hybrid clones (*S. babylonica* X *S. alba*) received the least damage (less than 10 percent). There was no significant difference between these two groups. The other interspecific hybrid clone, *S. X argentinensis* was 52 percent defoliated. The average for all black willow clones was 69 percent, and clone means ranged from 21 to 95 percent. Significantly less attack occurred on the 11 female clones than on the 13 male clones (55 percent versus 78 percent). The group of 13 clones for which the sex was unknown was intermediate between and not significantly

different from either the male or the female clones. The simple correlation between defoliation and height ($r = 0.21$) was not statistically significant. Broad-sense heritability for resistance to defoliation, based on clone means, was $h^2 = 0.95$.

Table 1.--Variation among willow clones in first-year height and in defoliation by the cottonwood leaf beetle

Species or hybrid	Number of clones	Height		Defoliation	
		Average	Range of clone means	Average	Range of clone means
		Feet		Percent	
Black willow (<u>Salix nigra</u>)	37	5.6	2.0-8.0	69	21-95
Male	13	5.0e	4.3-5.7	78a ^{1/}	52-95
Female	11	4.6e	2.0-5.9	55b	21-80
Sex unknown	13	7.0c	5.9-8.0	71ab	40-92
<u>S. X argentinensis</u>	1	6.1d	--	52b	--
Sandbar willow (<u>S. interior</u>)	3	9.4a	8.9-9.8	9c	8-10
<u>S. babylonica X S. alba</u>	2	8.6b	8.6-8.7	5c	5- 5
All clones	43	6.0	2.0-9.8	63	5-95

^{1/} Group means with the same letter are not significantly different by Duncan's multiple range test at the 0.05 level.

DISCUSSION

Newly developing larvae of the cottonwood leaf beetle must have a readily available source of food, since they cannot move more than a few inches. Certain clones may be more resistant to the leaf beetle because they are unsuitable for larval development, or because they are unacceptable to the ovipositing female. Resistance may be due to a combination of these factors or to other physiological or morphological characters of the host.

The black willow clones of unknown sex may have grown taller than either the female or male clones because of the physiological condition of the cuttings. Male and female cuttings came from the crowns of trees 30 to 40 years old, whereas cuttings from the group of unknown sex were taken from seedlings that were 2 to 3 years of age. In cottonwood, cuttings from 1- to 3-year-old seedlings have better survival and first-year growth than cuttings from the crowns of older trees.

Willows that were lightly attacked during the fall of 1970 were also lightly attacked in the spring of 1971. The tops of many trees that were heavily attacked died back during the late fall and winter of 1970-71. During the spring of 1971 crown deterioration continued, and many of the heavily attacked clones were either dead or dying. This die-back may be caused by a combination of severe beetle damage and an unknown pathogen, but attempts to isolate a pathogen have been unsuccessful.

Although the results apply only to a single group of clones on a single site, heritability was very high for resistance to the leaf beetle. Certainly, research to confirm these results and to determine the factors responsible seems justified.

LITERATURE CITED

McKnight, J. S. 1970. Planting cottonwood cuttings for timber production in the South. USDA Forest Serv. Res. Pap. SO-60, 17 pp. South. Forest Exp. Stn., New Orleans, La.

Ragonese, A. E., and Alberti, F. R. 1965. Nuevos sauces hibridos forestales obtenidos en la Republica Argentina. IDIA-Supl. For. 65-74.

Vines, R. A. 1960. Trees, shrubs and woody vines of the Southwest. 1104 pp., illus. Univ. Tex. Press, Austin.